



Draft Environmental
Impact Statement for the

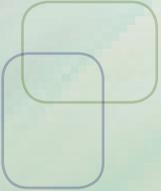


Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375-D)

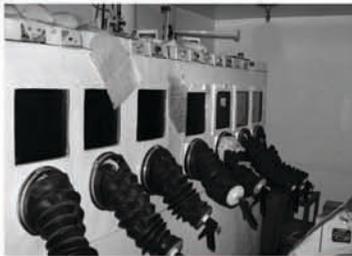
Volume 2: Chapter 9 through Appendix J

On the cover:

The photographs on the front cover are, from left to right: glove boxes contaminated with GTCC Other Waste, abandoned Am-241 and Cs-137 gauges and shipping shields, and disused well logging sources being loaded into a 55-gallon drum.



U.S. DEPARTMENT OF ENERGY

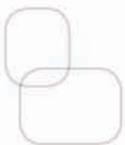


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Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375-D)

Volume 2: Chapter 9 through Appendix J



February 2011



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NOTATION**ACRONYMS AND ABBREVIATIONS**

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4	ACRONYMS AND ABBREVIATIONS	
5		
6	ACHP	Advisory Council on Historic Preservation
7	AEA	Atomic Energy Act of 1954
8	AEC	U.S. Atomic Energy Commission
9	ags	above ground surface
10	AIP	Agreement in Principle
11	AIRFA	American Indian Religious Freedom Act of 1978
12	ALARA	as low as reasonably achievable
13	AMC	activated metal canister
14	ATR	Advanced Test Reactor (INL)
15	ATSDR	Agency for Toxic Substances and Disease Registry
16		
17	BEIR	Biological Effects of Ionizing Radiation
18	bgs	below ground surface
19	BLM	Bureau of Land Management
20	BLS	Bureau of Labor Statistics
21	BWR	boiling water reactor
22		
23	CAA	Clean Air Act
24	CAAA	Clean Air Act Amendments
25	CAP88-PC	Clean Air Act Assessment Package 1988-Personal Computer (code)
26	CCDF	complementary cumulative distribution function
27	CEDE	committed effective dose equivalent
28	CEQ	Council on Environmental Quality
29	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
30	CFA	Central Facilities Area (INL)
31	CFR	<i>Code of Federal Regulations</i>
32	CGTO	Consolidated Group of Tribes and Organizations
33	CH	contact-handled
34	CTUIR	Confederated Tribes of the Umatilla Indian Reservation
35	CWA	Clean Water Act
36		
37	DCF	dose conversion factor
38	DCG	derived concentration guide
39	DOD	U.S. Department of Defense
40	DOE	U.S. Department of Energy
41	DOE-EM	DOE-Office of Environmental Management
42	DOE-ID	DOE-Idaho Operations Office
43	DOE-NV	DOE-Nevada Operations Office
44	DOI	U.S. Department of the Interior
45	DOT	U.S. Department of Transportation
46	DTRA	Defense Threat Reduction Agency
47		

1	EDE	effective dose equivalent
2	EIS	environmental impact statement
3	EPA	U.S. Environmental Protection Agency
4	ESA	Endangered Species Act of 1973
5	ESRP	Eastern Snake River Plain (INL)
6		
7	FFTF	Fast Flux Test Facility (Hanford)
8	FONSI	Finding of No Significant Impact
9	FR	<i>Federal Register</i>
10	FTE	full-time equivalent
11	FY	fiscal year
12		
13	GAO	U.S. Government Accountability (formerly General Accounting) Office
14	GIS	geographic information system
15	GTCC	greater-than-Class C
16	GSA	General Separations Area (SRS)
17	GTRI/OSRP	Global Threat Reduction Initiative/Off-Site Source Recovery Project
18		
19	HEPA	high-efficiency particulate air
20	HEU	highly enriched uranium
21	HF	hydrofluoride
22	HMS	Hanford Meteorology Station
23	h-SAMC	half-shielded activated metal canister
24		
25	ICRP	International Commission on Radiological Protection
26	IDA	intentional destructive act
27	IDAPA	Idaho Administrative Procedures Act
28	IDEQ	Idaho Department of Environmental Quality
29	INEEL	Idaho National Engineering and Environmental Laboratory
30	INL	Idaho National Laboratory
31	INTEC	Idaho Nuclear Technology and Engineering Center (INL)
32	IPCC	Intergovernmental Panel on Climate Change
33	ISFSI	independent spent fuel storage installation
34		
35	LANL	Los Alamos National Laboratory
36	LCF	latent cancer fatality
37	L _{dn}	day-night sound level
38	L _{eq}	equivalent-continuous sound level
39	LLNL	Lawrence Livermore National Laboratory
40	LLRW	low-level radioactive waste
41	LLRWPA	Low-Level Radioactive Waste Policy Amendments Act of 1985
42	LMP	Land Management Plan (WIPP)
43	LWA	Land Withdrawal Act (WIPP)
44	LWB	Land Withdrawal Boundary (WIPP)
45		
46		

1	MCL	maximum contaminant level
2	MDA	material disposal area (LANL)
3	MMI	Modified Mercalli Intensity
4	MOA	Memorandum of Agreement
5	MOU	Memorandum of Understanding
6	MSL	mean sea level
7		
8	NAAQS	National Ambient Air Quality Standard(s)
9	NAGPRA	Native American Graves Protection and Repatriation Act of 1990
10	NASA	National Aeronautics and Space Administration
11	NCDC	National Climatic Data Center
12	NCRP	National Council on Radiation Protection and Measurements
13	NDA	NRC-licensed disposal area (West Valley Site)
14	NEPA	National Environmental Policy Act of 1969
15	NERP	National Environmental Research Park
16	NESHAP	National Emission Standard for Hazardous Air Pollutants
17	NHPA	National Historic Preservation Act
18	NMAC	<i>New Mexico Administrative Code</i>
19	NMED	New Mexico Environment Department
20	NNSA	National Nuclear Security Administration (DOE)
21	NNSA/NSO	NNSA/Nevada Site Office
22	NNSS	Nevada National Security Site (formerly Nevada Test Site or NTS)
23	NOAA	National Oceanic and Atmospheric Administration
24	NOI	Notice of Intent
25	NPDES	National Pollutant Discharge Elimination System
26	NPS	National Park Service
27	NRC	U.S. Nuclear Regulatory Commission
28	NRHP	<i>National Register of Historic Places</i>
29	NTS SA	Nevada Test Site Supplemental Analysis
30		
31	PCB	polychlorinated biphenyl
32	PCS	primary constituent standard
33	P.L.	Public Law
34	PM	particulate matter
35	PM _{2.5}	particulate matter with an aerodynamic diameter of 2.5 µm or less
36	PM ₁₀	particulate matter with an aerodynamic diameter of 10 µm or less
37	PSD	Prevention of Significant Deterioration
38	PWR	pressurized water reactor
39		
40	R&D	research and development
41	RCRA	Resource Conservation and Recovery Act
42	RDD	radiological dispersal device
43	RH	remote-handled
44	ROD	Record of Decision
45	ROI	region of influence
46	ROW	right-of-way

1	RWMC	Radioactive Waste Management Complex (INL)
2	RWMS	Radioactive Waste Management Site (NNSS)
3		
4	SAAQS	State Ambient Air Quality Standards
5	SDA	state-licensed disposal area (West Valley Site)
6	SDWA	Safe Drinking Water Act
7	SHPO	State Historic Preservation Office(r)
8	SNF	spent nuclear fuel
9	SRS	Savannah River Site
10	SWB	standard waste box
11	SWEIS	Site-Wide Environmental Impact Statement
12		
13	TA	Technical Area (LANL)
14	TC&WM EIS	Tank Closure and Waste Management EIS (Hanford)
15	TDEC	Tennessee Department of Environment and Conservation
16	TEDE	total effective dose equivalent
17	TLD	thermoluminescent dosimeter
18	TRAGIS	Transportation Routing Analysis Information System
19	TRU	transuranic
20	TRUPACT-II	Transuranic Package Transporter-II
21	TSCA	Toxic Substances Control Act
22	TSP	total suspended particulates
23	TVA	Tennessee Valley Authority
24		
25	USACE	U.S. Army Corps of Engineers
26	USC	<i>United States Code</i>
27	USFS	U.S. Forest Service
28	USFWS	U.S. Fish and Wildlife Service
29	USGS	U.S. Geological Survey
30		
31	VOC	volatile organic compound
32		
33	WAC	waste acceptance criteria or <i>Washington Administrative Code</i>
34	WHB	Waste Handling Building (WIPP)
35	WIPP	Waste Isolation Pilot Plant
36	WSRC	Westinghouse Savannah River Company
37	WTP	Waste Treatment Plant (Hanford)
38		

1 **UNITS OF MEASURE**

2

ac	acre(s)	m ³	cubic meter(s)
ac-ft	acre-foot (feet)	MCi	megacurie(s)
		mg	milligram(s)
°C	degree(s) Celsius	mi	mile(s)
cfs	cubic foot (feet) per second	mi ²	square mile(s)
Ci	curie(s)	min	minute(s)
cm	centimeter(s)	mL	milliliter(s)
cms	cubic meter(s) per second	mm	millimeter(s)
		mph	mile(s) per hour
d	day(s)	mR	milliroentgen(s)
dB	decibel(s)	mrem	millirem
dBa	A-weighted decibel(s)	mSv	millisievert(s)
		MW	megawatt(s)
°F	degree(s) Fahrenheit	MWh	megawatt-hour(s)
ft	foot (feet)		
ft ²	square foot (feet)	nCi	nanocurie(s)
ft ³	cubic foot (feet)		
		oz	ounce(s)
g	gram(s) or acceleration of gravity (9.8 m/s/s)	pCi	picocurie(s)
gal	gallon(s)	ppb	part(s) per billion
gpd	gallon(s) per day	ppm	part(s) per million
gpm	gallon(s) per minute		
		R	roentgen(s)
h	hour(s)	rad	radiation absorbed dose
ha	hectare(s)	rem	roentgen equivalent man
hp	horsepower		
		s	second(s)
in.	inch(es)	t	metric ton(s)
kg	kilogram(s)	VdB	vibration velocity decibel(s)
km	kilometer(s)		
km ²	square kilometer(s)	yd	yard(s)
kph	kilometer(s) per hour	yd ²	square yard(s)
kV	kilovolt(s)	yd ³	cubic yard(s)
		yr	year(s)
L	liter(s)		
lb	pound(s)	µg	microgram(s)
		µm	micrometer(s)
m	meter(s)		
m ²	square meter(s)		

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CONVERSION TABLE^a

Multiply	By	To Obtain
<i>English/Metric Equivalents</i>		
acres (ac)	0.4047	hectares (ha)
cubic feet (ft ³)	0.02832	cubic meters (m ³)
cubic yards (yd ³)	0.7646	cubic meters (m ³)
degrees Fahrenheit (°F) –32	0.5555	degrees Celsius (°C)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m ³)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft ²)	0.09290	square meters (m ²)
square yards (yd ²)	0.8361	square meters (m ²)
square miles (mi ²)	2.590	square kilometers (km ²)
yards (yd)	0.9144	meters (m)
<i>Metric/English Equivalents</i>		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m ³)	35.31	cubic feet (ft ³)
cubic meters (m ³)	1.308	cubic yards (yd ³)
cubic meters (m ³)	264.2	gallons (gal)
degrees Celsius (°C) +17.78	1.8	degrees Fahrenheit (°F)
hectares (ha)	2.471	acres (ac)
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
kilometers per hour (kph)	0.6214	miles per hour (mph)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km ²)	0.3861	square miles (mi ²)
square meters (m ²)	10.76	square feet (ft ²)
square meters (m ²)	1.196	square yards (yd ²)

^a Values presented in this Draft GTCC EIS have been converted (as necessary) by using the above conversion table and rounded to two significant figures.

9 NEVADA NATIONAL SECURITY SITE: AFFECTED ENVIRONMENT AND CONSEQUENCES OF ALTERNATIVES 3, 4, AND 5

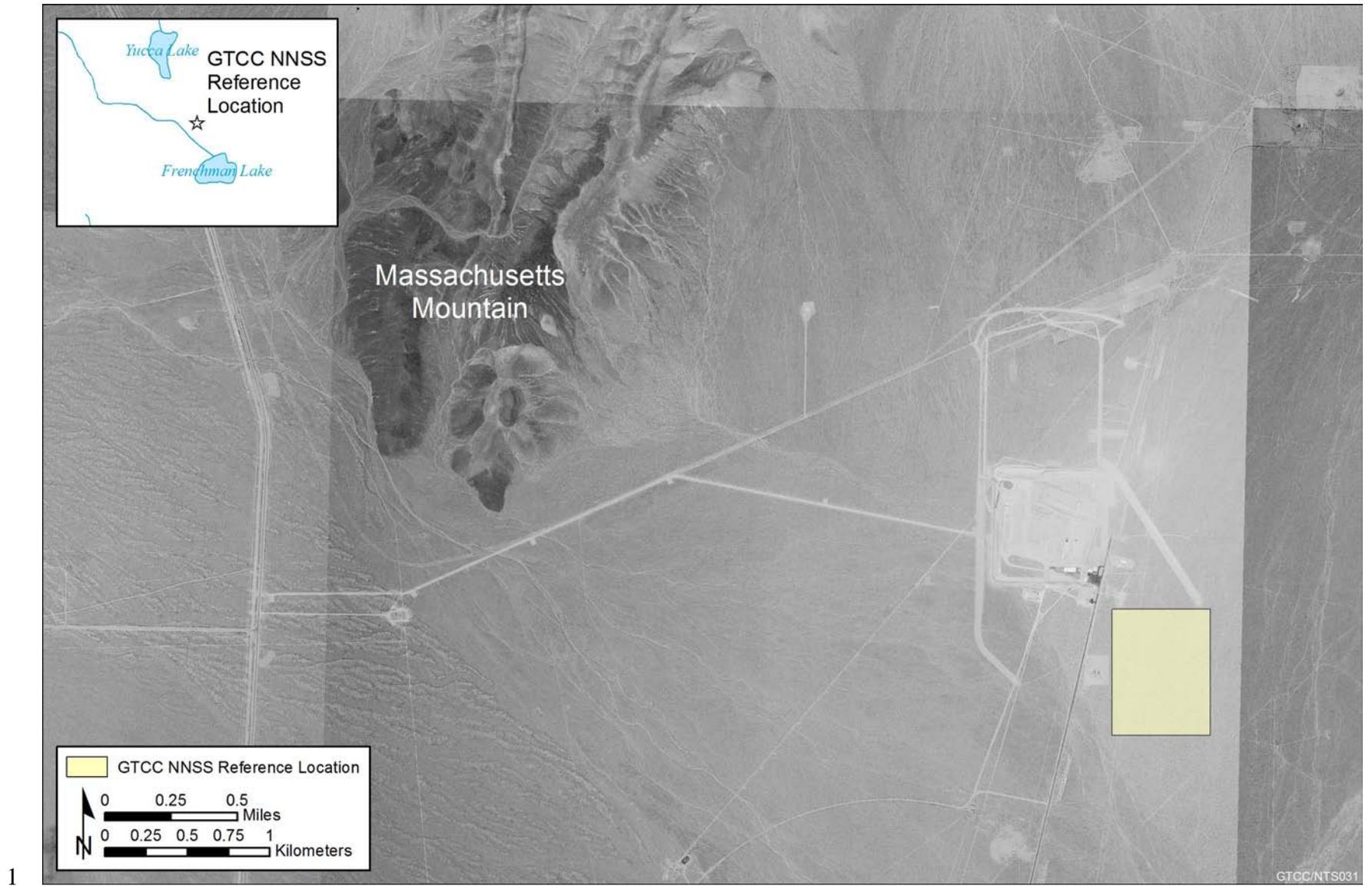
This chapter provides an evaluation of the affected environment, environmental and human health consequences, and cumulative impacts from the disposal of GTCC LLRW and GTCC-like waste under Alternative 3 (in a new borehole disposal facility), Alternative 4 (in a new trench disposal facility), and Alternative 5 (in a new vault disposal facility) at NNSS. (NNSS was formerly the Nevada Test Site or NTS; this site is referred to as NNSS throughout this EIS except when citing site reports that were published as NTS reports.) Alternatives 3, 4, and 5 are described in Section 5.1. Environmental consequences that are common to the sites for which Alternatives 3, 4, and 5 are evaluated (including NNSS) are discussed in Chapter 5 and not repeated in this chapter. Impact assessment methodologies used for this EIS are described in Appendix C. Federal and state statutes and regulations and DOE Orders relevant to NNSS are discussed in Chapter 13 of this EIS.

This chapter also includes tribal narrative text that reflects the views and perspectives of the Consolidated Group of Tribes and Organizations representing 16 Paiute and Shoshone tribes affiliated with NNSS. The tribal text is included in text boxes in Section 9.1. Full narrative texts provided by the tribes are in Appendix G. The perspectives and views presented are solely those of the tribes. When tribal neutral language is used (e.g., Indian People, Native People, Tribes) within the tribal text, it reflects the input from these tribes unless otherwise noted. DOE recognizes that American Indians have concerns about protecting traditions and spiritual integrity of the land in the NNSS region, and that these concerns extend to the propriety of the Proposed Action. Presenting tribal views and perspectives in this EIS does not represent DOE's agreement with or endorsement of such views. Rather, DOE respects the unique and special relationship between American Indian tribal governments and the Government of the United States, as established by treaty, statute, legal precedent, and the U.S. Constitution. For this reason, DOE has presented tribal views and perspectives in this Draft EIS to ensure full and fair consideration of tribal rights and concerns before making decisions or implementing programs that could affect tribes.

9.1 AFFECTED ENVIRONMENT

This section discusses the affected environment for the various environmental resource areas evaluated for the GTCC reference location at NNSS. The GTCC reference location is located within Area 5 (Figure 9.1-1). The reference location was selected primarily for evaluation purposes for this EIS. The actual location would be identified on the basis of follow-on evaluations if and when it is decided to locate a land disposal facility at NNSS.

9-2



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2 **FIGURE 9.1-1 Map Showing Location of Frenchman Flat and GTCC Reference Location at NNSS**

9.1.1 Climate, Air Quality, and Noise

9.1.1.1 Climate

NNSS is located in the extreme southwestern corner of the Great Basin. Consequently, the climate is arid and with limited precipitation, low humidity, large daily temperature ranges, and intense solar radiation during the summer months (NOAA 2008). The four seasons are well defined, with a hot and mostly dry summer, cool temperatures in the spring and late fall, and cool to cold temperatures in the winter (Soule 2006).

Complex topography, such as that at NNSS, can influence wind speeds and directions. Furthermore, there is a seasonal as well as strong daily periodicity to local wind conditions. The winds at NNSS exhibit strong diurnal effects near the surface during all seasons of the year. The

American Indian Text

The CGTO knows that the southern bajada (alluvial fan) of French Peak and associated hills to the east combine to periodically cause massive runoffs which flow rapidly towards Frenchman Playa making it a seasonal shallow lake. Frenchman Playa has a 140 square-mile watershed that could impact the GTCC site as it potentially does the current RWMS. Especially considered in these Indian comments are runoffs from the north of the proposed GTCC storage area. This watershed involves 13.6 square miles and directly impacts the current RWMS. This runoff from this area is normally sheetflow, but every 23 years or so a major flood occurs. This threat has resulted in the RWMS building a large diversion dike and trench to protect the current Radioactive Waste Management Complex. The Raytheon study indicates that the southwest corner of the RWMS is located in the 100-year flood hazard zone, but the entire northern alluvial fan brings runoff directly into the immediate area.

The CGTO requests an analysis of the hydrological and ecological impacts of the existing water diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE recognizes that this is a very flood prone area, with major flooding episodes occurring about every 23 years. Indian people visiting this site observed that even though the current dike has been built recently and thus not experienced a 23-year flood, it has diverted and consolidated sufficient runoff that a small arroyo has been established. The Indian people visiting this site believe that the existing dike has unnaturally stressed down-slope plants and animals who now do not receive normal sheet runoff. The Indian people visiting the site believe that by concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet runoff because the consolidated runoff moves more quickly and only flows in the new and developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC facility to be established east of the current RWMS then the dike would necessarily have to be extended causing an even greater runoff shadow and an even greater developing arroyo. The desert tortoise in the area will have to move out of this larger runoff shadow and may be concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will expose them to higher levels of radioactivity. The Indian people visiting the site believe that these current and potential impacts should be analyzed, monitored by Indian people, and reported back to the CGTO at the next annual meeting.

American Indian Text

The CGTO knows that the climate of the region has changed over the thousands of years that the Indian people have lived in this region. The NNSS has only occupied this area since the early 1940s. It is important to recognize that major climatic changes have taken place since the end of the Pleistocene and shorter term climate changes such as the wet period in the 1980s and 1990s contrast with the current 10-year drought. It is important for the GTCC EIS to assess the impacts of short term and long term climatic changes because the DOE expects to safely manage these GTCC wastes for up to 10K years during which similar climate changes can be expected.

The current climate description in the GTCC EIS is specific to the present decade-long period of extended drought (a similar one occurred between 1896 and 1906) so this type of drought and the wet period between 1980s and 1990s may be a factor in siting the GTCC facility. An analysis of long term impacts based on current conditions will neither be representative of climate conditions viewed over much longer periods nor applicable to a short climate shift to much wetter conditions.

The climatic effects of both wet and dry periods should be analyzed and incorporated in the GTCC site assessment.

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American Indian Text

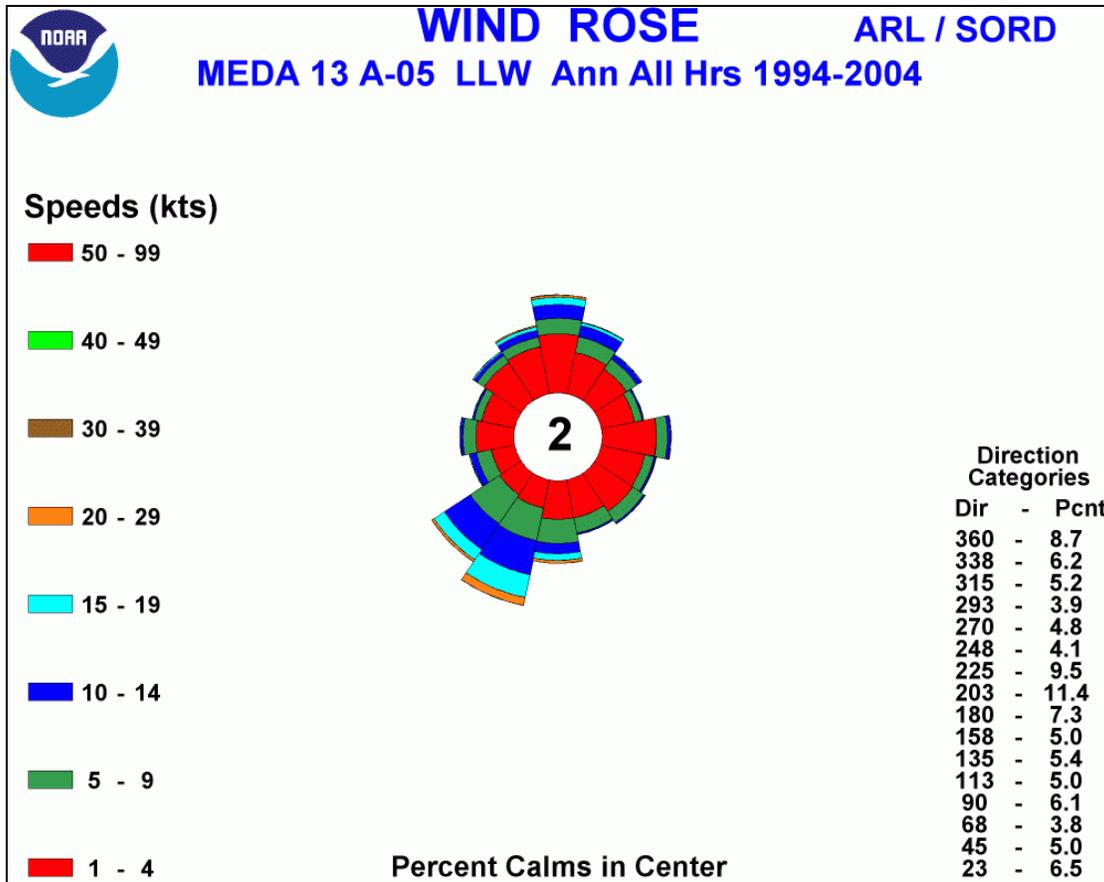
One performance objective in selecting a preferred site is to protect individuals and communities who might occupy the disposal site after active and passive controls are no longer present. These individuals are to be protected from exposure to GTCC radiation while they engage in normal activities such as agriculture, dwelling construction, food acquisition, and ceremony. The CGTO believes that a wetter climate will raise the water table up to or over the GTCC waste site. Nearby wetland plants and animals would absorb radiation and then expose local people. Drinking water from these wetlands will also result in exposure. Indian people visiting the site believe their descendants will live near and use these wetlands as their ancestors did thousands of years ago.

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nighttime winds are generally from the north at the lower elevations during all seasons. These nocturnal winds (“drainage winds”) are disturbed only by the presence of extensive lower clouds or very strong winds aloft. The daytime winds are generally from the south during the warm seasons and from the north during the cool seasons. At the Area 5 station, the wind direction is primarily from the south-southwest and secondarily from the southwest; the wind is more pronounced in spring and fall, as shown in Figure 9.1.1-1 (NOAA 2008). For the period 1981–2001, the annual average wind speed was 2.8 m/s (6.3 mph) at the Area 5 station. Wind speed is the fastest in spring, slower in summer and autumn, and becomes the slowest in winter. During the same period, the peak wind speed was recorded at 30 m/s (67 mph).

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As is typical of an arid climate, NNSS experiences large daily, as well as annual, ranges in temperature. For the 1981–2001 period, the annual average temperature at the Area 5 station was 15.2°C (59.4°F) (NOAA 2008). December was the coldest month, averaging 3.9°C (39.1°F)



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FIGURE 9.1.1-1 Wind Rose at the Area 5 North (A5N) Station at NNSS, 1994–2004
 (Source: NOAA 2008)

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6 and ranging from -5.4 to 13.3°C (22.3 to 55.9°F), and July was the warmest month, averaging
 7 27.5°C (81.5°F) and ranging from 16.6 to 38.4°C (61.8 to 101.1°F). For the same period, the
 8 highest temperature reached was 46.1°C (115°F), and the lowest was -21.1°C (-6°F). The
 9 number of days with a maximum temperature higher than or equal to 32.2°C (90°F) was about
 10 115, while the number of days with a minimum temperature lower than or equal to 0°C (32°F)
 11 was about 114.

12

13 Precipitation occurs mostly in the winter, early spring, and mid-summer. Elevation is not
 14 the only factor in determining the potential for precipitation at NNSS. Some locations at NNSS
 15 get more precipitation because they are in the vicinity of higher terrain (upwind barrier, upslope
 16 enhancement, etc.) (Soule 2006). Average annual precipitation is the lowest (at 12 cm or 5 in.) at
 17 Area 5 and the highest (at 32.6 cm or 12.82 in.) at the Rainier Mesa. The precipitation at NNSS
 18 is mostly in the form of rain, except at high elevations above 1,800 m (6,000 ft) MSL in the
 19 winter months. Snow falls occasionally at all locations at NNSS, but it is relatively rare at
 20 locations below 1,200 m (4,000 ft) MSL.

21

1 NNSS experiences high winds at times, mostly in the spring, associated with the passing
2 of strong cold fronts or with thunderstorms. High winds can also occur in the winter with high
3 pressure over the Great Basin (Soule 2006). Other than these instances, severe weather is
4 uncommon at the NNSS.

5
6 Tornadoes in the area surrounding NNSS are much less frequent and destructive than
7 those in the tornado alley in the central United States. For the period 1950–2008, 75 tornadoes
8 were reported in Nevada, with an average of 1.3 tornadoes per year (NCDC 2008). For the
9 period 1950–2008, a total of 3 tornadoes with an average of less than 0.1 tornado per year were
10 reported in Nye County, including NNSS. However, most tornadoes occurring in the county
11 were relatively weak; all were F0 on the Fujita tornado scale and caused no deaths or injuries.

12 13 14 **9.1.1.2 Existing Air Emissions**

15
16 Title V of the 1990 CAAA authorized the states to implement permit programs in order
17 to regulate emissions of the criteria pollutants. At NNSS, there is one main permit that regulates
18 operations and emissions from various major activities (Wills 2007). Nevada air quality permits
19 specify emission limits for criteria pollutants (except O₃ and lead) that are based on published
20 emission values for other similar industries and on operational data specific to NNSS.

21
22 Annual emissions of criteria pollutants and VOCs from major facility total point and area
23 sources for the year 2002 in Nye County, including NNSS, are presented in Table 9.1.1-1
24 (EPA 2009). (Data for 2002 were the most recent emission inventory data available on the EPA
25 website.) Area sources consist of nonpoint and mobile sources. There are no major point sources
26 nearby, so area sources account for most of the emissions of criteria pollutants and VOCs, except
27 for SO₂. On-road sources are major contributors to the total emissions of NO_x, CO, and VOCs.
28 Miscellaneous sources are major contributors to total emissions of PM₁₀ and PM_{2.5}. Industrial
29 fuel combustion is a major contributor to SO₂ emissions. Nonradiological emissions associated
30 with the activities at NNSS are less than 0.95% of those reported for Nye County (Table 9.1.1-1).

31
32 An estimated 4.15 metric tons or t (4.57 tons) of criteria pollutants were released from
33 the NNSS facilities and equipment that were operational in 2006. The majority of the emissions
34 were NO_x from diesel generators and VOCs from the bulk storage of gasoline (Wills 2007).
35 Table 9.1.1-2 presents data on emissions of criteria pollutants, VOCs, and hazardous air
36 pollutants (HAPs) for the years 2002–2006.

37 38 39 **9.1.1.3 Air Quality**

40
41 The Nevada SAAQS for six criteria pollutants — SO₂, NO₂, CO, O₃, PM₁₀ and PM_{2.5},
42 and lead — are identical to the NAAQS (EPA 2008a; *Nevada Administrative Code* 445B.391),
43 as shown in Table 9.1.1-3. However, no state standards have been established for 8-hour O₃ and
44 PM_{2.5} in Nevada, and the state has a more stringent standard for CO at higher elevations (about
45 1,500 m or 5,000 ft) and for O₃ at Lake Tahoe. In addition, Nevada has adopted standards for
46 H₂S and for visibility.

TABLE 9.1.1-1 Annual Emissions of Criteria Pollutants and Volatile Organic Compounds from Selected Major Facilities and Total Point and Area Source Emissions in Nye County, Including NNSS^a

Emission Category	Emission Rate (tons/yr)					
	SO ₂	NO _x	CO	VOCs	PM ₁₀	PM _{2.5}
Nye County						
NNSS ^b	<i>1.7</i>	<i>23</i>	<i>5.0</i>	<i>2.3</i>	<i>5.0</i>	<i>3.9</i>
	<i>0.72%</i> ^c	<i>2.6%</i>	<i>0.06%</i>	<i>0.16%</i>	<i>0.14%</i>	<i>0.55%</i>
Point sources	120	150	35	93	150	63
Area sources	110	720	7,900	1,400	3,500	630
Total	230	870	7,900	1,500	3,700	700

^a Values are rounded up to two significant figures. Emission data for selected major facilities and total point and area sources are for year 2002.

CO = carbon monoxide; NO_x = nitrogen oxides; PM_{2.5} = particulate matter ≤2.5 μm; PM₁₀ = particulate matter ≤10 μm; SO₂ = sulfur dioxide; VOCs = volatile organic compounds.

^b Values in italics are not added to yield total.

^c Values in this row are emissions as percentages of Nye County total emissions.

Source: EPA (2009)

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The GTCC reference location within NNSS is within Nye County. Currently, the entire county is designated as being in attainment for all criteria pollutants (40 CFR 81.329). However, parts of Clark County, including Las Vegas, which is about 80 km (50 mi) southeast of the GTCC reference location, are designated nonattainment areas for CO, 8-hour O₃, and PM₁₀. NNSS is generally not located downwind of prevailing winds in Las Vegas.

Monitoring data for criteria pollutants (except 8-hour O₃, PM_{2.5}, and lead) are available at Yucca Mountain close to the GTCC reference location (DOE 2002b). The highest concentration levels for SO₂, NO₂, CO, and PM₁₀ around NNSS are less than 45% of their respective standards in Table 9.1.1-3 (DOE 2002b). However, the highest 1-hour O₃ and 24-hour PM_{2.5} concentrations are somewhat higher (around 83% and 91% of their standards, respectively). The highest 8-hour O₃ concentrations exceed the standard in Las Vegas; however, concentrations at NNSS would be lower because NNSS is not located downwind of prevailing winds in Las Vegas.

NNSS and its vicinity are classified as PSD Class II areas. No Class I area exists within 100 km (62 mi) of the GTCC reference location (40 CFR 81.418). Grand Canyon National Park in Arizona and John Muir Wilderness Area in California are the closest, and they are about 200 km (124 mi) from the GTCC reference location. There are no facilities currently operating at NNSS that are subject to PSD regulations.

TABLE 9.1.1-2 Annual Emissions of Criteria Air Pollutants, Volatile Organic Compounds, and Hazardous Air Pollutants at NNSS, 2002–2006^a

Year	Emission Rate (tons/yr)					
	SO ₂	NO _x	CO	VOCs	PM ₁₀	HAPs
2002	1.6	21	4.6	2.1	3.6	0.01
2003	0.76	8.1	1.8	1.2	2.4	0
2004	0.12	1.0	0.24	4.6	0.94	0.41
2005	0.04	0.69	0.15	1.9	0.84	0.05
2006	0.03	2.0	0.43	1.4	0.69	1.9 ^b

^a Values are rounded up to two significant figures.

CO = carbon monoxide; HAPs = hazardous air pollutants;
NO_x = nitrogen oxides; PM₁₀ = particulate matter ≤10 μm;
SO₂ = sulfur dioxide; VOCs = volatile organic compounds.

^b Of all the HAPs, 92% were emitted during chemical spill tests at the Nonproliferation Test and Evaluation Complex, and <0.006% were from lead emitted from all permitted operations.

Source: Wills (2007)

9.1.1.4 Existing Noise Environment

Except for the prohibition of nuisance noise, neither the state of Nevada nor local governments around NNSS have established quantitative noise-limit regulations.

The major noise sources at NNSS include various industrial activities, equipment, and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction and material-handling equipment, vehicles); blasting and testing of explosives; and aircraft operations (DOE 1996). Most NNSS industrial facilities are far enough from the site boundary that noise levels from these sources are not measurable or are barely distinguishable from background levels at the boundary. In the uninhabited desert area, the major sources of noise are natural physical phenomena (e.g., wind, rain, and wildlife activities) and an occasional airplane; the predominant noise source is wind.

No data from environmental noise surveys around the site boundaries near the GTCC reference location were available. A background sound level of 30 dBA is a reasonable estimate for NNSS (DOE 1996). For the general area surrounding NNSS, the countywide L_{dn} based on population density is estimated to be less than 30 dBA in Nye County, similar to the wilderness natural background level (Miller 2002; Eldred 1982).

TABLE 9.1.1-3 National Ambient Air Quality Standards (NAAQS) or Nevada State Ambient Air Quality Standards (SAAQS) and Highest Background Levels Representative of the GTCC Reference Location at NNSS

Pollutant ^a	Averaging Time	NAAQS/SAAQS ^b	Highest Background Level	
			Concentration ^{c,d}	Location (Year) ^e
SO ₂	1-hour	75 ppb	– ^f	–
	3-hour	0.50 ppm	0.002 ppm (0.4%)	Yucca Mtn, Nye Co.
	24-hour	0.14 ppm	0.002 ppm (1.4%)	Yucca Mtn, Nye Co.
	Annual	0.03 ppm	0.002 ppm (6.7%)	Yucca Mtn, Nye Co.
NO ₂	1-hour	0.100 ppm	–	–
	Annual	0.053 ppm	0.002 ppm (4.0%)	Yucca Mtn, Nye Co.
CO	1-hour	35 ppm	0.2 ppm (0.6%)	Yucca Mtn, Nye Co.
	8-hour	9 ppm	0.2 ppm (2.2%)	Yucca Mtn, Nye Co.
O ₃	1-hour	0.12 ppm ^g	0.1 ppm (83%)	Yucca Mtn, Nye Co.
	8-hour	0.075 ppm	0.089 ppm (119%)	Las Vegas, Clark Co. (2005) ^h
PM ₁₀	24-hour	150 µg/m ³	67 µg/m ³ (45%)	Yucca Mtn, Nye Co.
	Annual	50 µg/m ³	12 µg/m ³ (24%)	Yucca Mtn, Nye Co.
PM _{2.5}	24-hour	35 µg/m ³	32 µg/m ³ (91%)	Las Vegas, Clark Co. (2003) ^h
	Annual	15 µg/m ³	10.7 µg/m ³ (71%)	Las Vegas, Clark Co. (2003) ^h
Lead ⁱ	Calendar quarter	1.5 µg/m ³	0.08 µg/m ³ (5.3%)	San Bernardino Co. (2003) ^j
	Rolling 3-month	0.15 µg/m ³	–	–
H ₂ S	1-hour	112 µg/m ³	–	–
Visibility	Observation	Insufficient amount to reduce the prevailing visibility to less than 30 mi (48 km) when humidity is less than 70%	–	–

^a CO = carbon monoxide; H₂S = hydrogen sulfide; NO₂ = nitrogen dioxide; O₃ = ozone; PM_{2.5} = particulate matter ≤2.5 µm; PM₁₀ = particulate matter ≤10 µm; SO₂ = sulfur dioxide.

^b The more stringent standard between the NAAQS and the SAAQS is listed when both are available.

^c Monitored concentrations are the highest arithmetic mean for calendar-quarter lead; the highest for 3-hour and 24-hour SO₂, 1-hour and 8-hour CO, 1-hour O₃, and 24-hour PM₁₀; 4th highest for 8-hour O₃; 98th percentile for 24-hour PM_{2.5}; and arithmetic mean for annual SO₂, NO₂, PM₁₀, and PM_{2.5}.

^d Values in parentheses are monitored concentrations as a percentage of SAAQS or NAAQS.

^e No measurement year was specified for the data collected at Yucca Mountain (DOE 2002b).

^f A dash indicates that no measurement is available.

^g On June 15, 2005, the EPA revoked the 1-hour O₃ standard for all areas except the 8-hour O₃ nonattainment Early Action Compact (EAC) areas (those do not yet have an effective date for their 8-hour designations). The 1-hour standard will be revoked for these areas 1 year after the effective date of their designation as attainment or nonattainment for the 8-hour O₃ standard.

Footnotes continue on next page.

TABLE 9.1.1-3 (Cont.)

- ^h Concentration at NNSS would be lower because it is not located downwind of prevailing winds in Las Vegas.
- ⁱ Used old standard because no data in the new standard format are available.
- ^j This location with the highest observed concentration is not representative of NNSS but is presented to show that this pollutant is not a concern around NNSS.

Sources: DOE (2002b); EPA (2008a, 2009); *Nevada Administrative Code* 445B.391 (refer to <http://ndep.nv.gov/baqp/monitoring/445b391.pdf>)

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3 **9.1.2 Geology and Soils**

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7 **9.1.2.1 Geology**

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10 **9.1.2.1.1 Physiography.** NNSS is located in the southern part of the Great Basin, a
 11 subprovince of the Basin and Range physiographic province (Figure 9.1.2-1). Centered in
 12 Nevada, the Basin and Range province stretches from southern Oregon to western Texas (and
 13 into Mexico) and is made up of parallel north-south-trending faulted mountain ranges separated
 14 by flat alluvium-filled basins. This landscape reflects a complex geological history: uplifting of
 15 crustal rocks, followed by extensional deformation, characterized by block faulting and rotation,
 16 and the development of active volcanic fields. Most of the intermontane basins have no drainage
 17 outlets; as a result, rainwater accumulates in the form of salt lakes or playas (dry lake beds). In
 18 the southern part of the province, drainage from the Las Vegas and Pahranaagat Valleys flows to
 19 the southeast toward the lower Colorado River; Jackass Flats and the Amargosa Desert drain to
 20 Death Valley to the west via the Amargosa River (Hunt 1973; DOE 1996; Winograd and
 21 Thordarson 1975).

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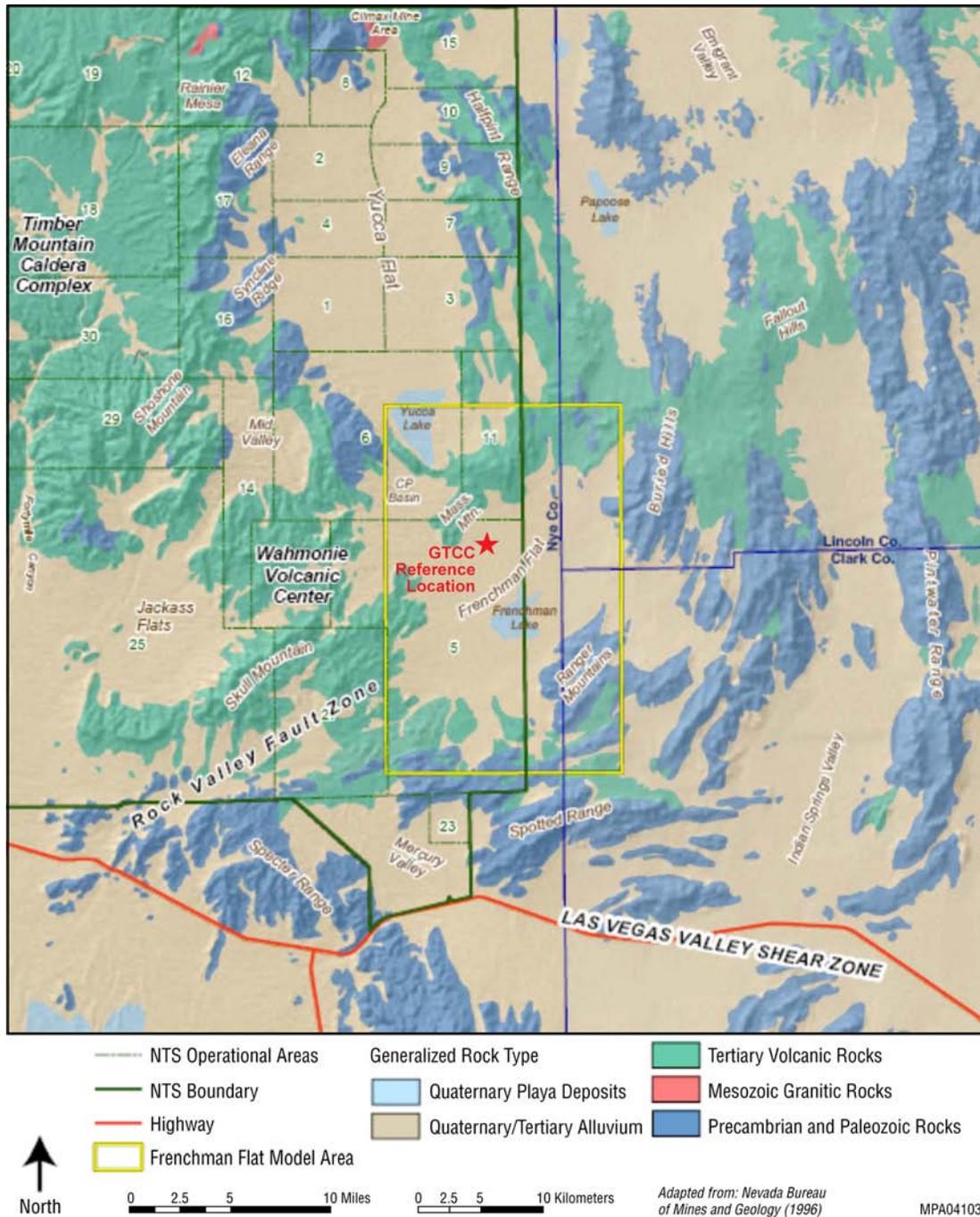
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The natural topography of NNSS has been altered by underground nuclear testing, which
 created craters in Yucca Flat and Frenchman Flat Basins and on Pahute and Rainier Mesas. Other
 activities that have changed the local landscape include shallow detonations (associated with
 Project Plowshare), waste disposal area construction, drainage improvements, road building,
 sand and gravel mining, and underground mining (DOE 1996).



FIGURE 9.1.2-1 Location of NNSS within the Great Basin Desert in the Basin and Range Physiographic Province (Bechtel Nevada 2005a)



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FIGURE 9.1.2-2 Topographic Features of the Frenchman Flat Region
 (Source: Modified from Bechtel Nevada 2005a)

1 **9.1.2.1.3 Site Geology and Stratigraphy.** The highlands surrounding Frenchman Flat
2 are made up of Paleozoic sedimentary rocks and Cenozoic volcanic rocks (tuffs) and tuffaceous
3 sedimentary rocks. Paleozoic rocks are exposed along the south and east edges of the basin and
4 are predominantly carbonates ranging in age from Cambrian to Mississippian. These rocks dip to
5 the south and east away from Frenchman Flat (Bechtel Nevada 2005a).

6
7 Volcanic rocks of Miocene age are typical of the highlands to the north and northwest of
8 the basin. These are rhyolitic tuffs formed by ash deposits from large calderas located 40 km
9 (25 mi) to the northwest of the Frenchman Flat Basin. Miocene age tuffs, lavas, and debris flows
10 of intermediate composition make up the Wahmonie volcanic center to the west of the basin.
11 These rocks dip to the southeast toward Frenchman Flat and are offset in places by numerous
12 normal faults (Bechtel Nevada 2005a).

13
14 Tuffaceous sedimentary rocks are also present along a narrow, linear area corresponding
15 to the topographic axis of the basin. These rocks are exposed along the southern edge and dip
16 north into the basin.

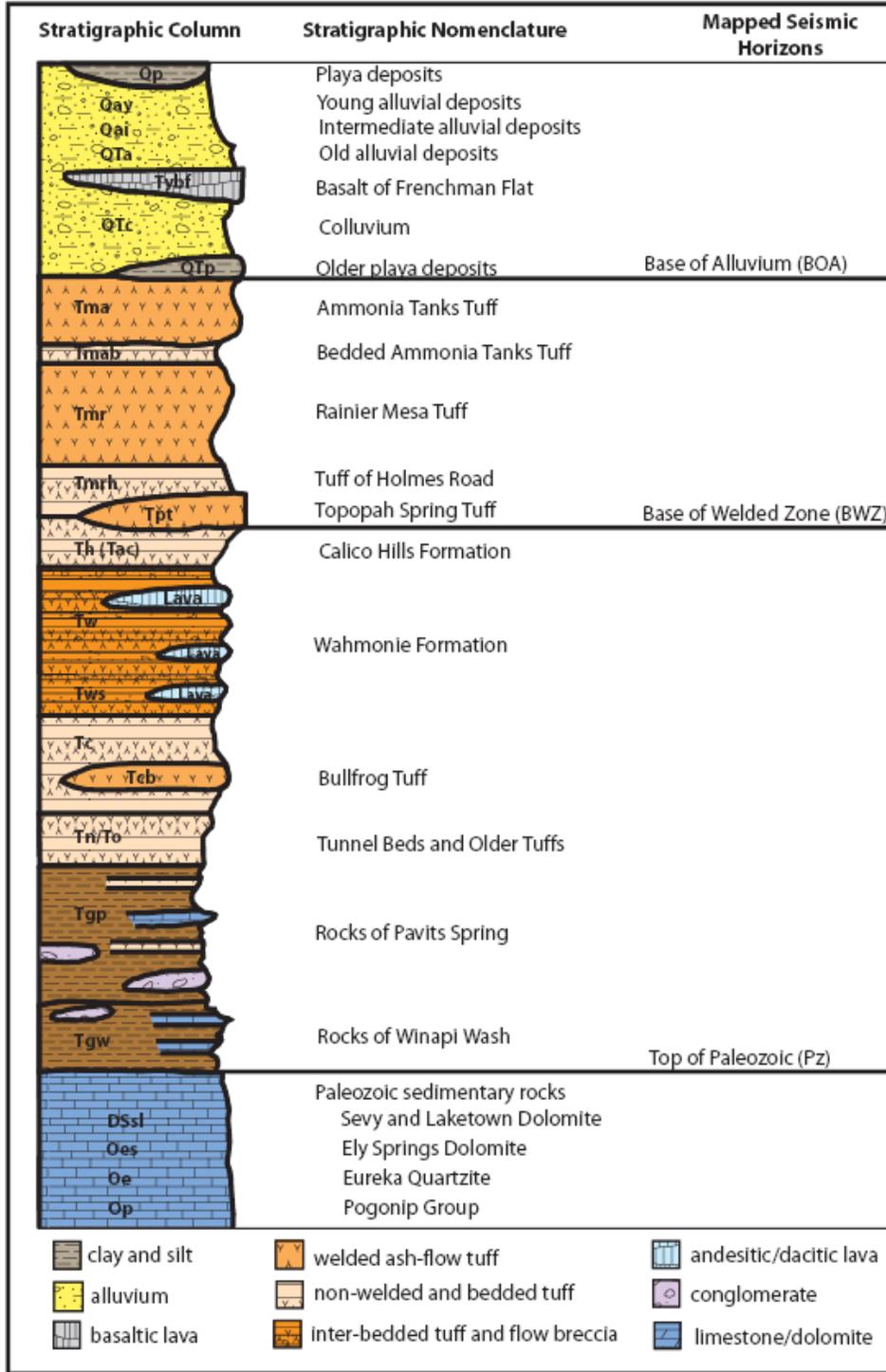
17
18 The GTCC reference location is southeast of the RWMS. It is situated on a thick
19 sequence of Quaternary sediments consisting mainly of alluvial fill typical of the low-lying
20 valleys in the region (Figure 9.1.2-2). The following summary of the stratigraphy at NNSS is
21 based on the work of Winograd and Thordarson (1975), Hoover et al. (1981),
22 Lacznia et al. (1996), and Bechtel Nevada (2005a). Figure 9.1.2-3 presents a stratigraphic
23 column for NNSS and vicinity.

24
25
26 **Precambrian and Paleozoic Units.** In the Paleozoic era, 11,278 m (37,000 ft) of marine
27 sediments were deposited in the Cordilleran geosyncline, an elongated, subsiding trough in the
28 westernmost portion of the North American continent. The part of the trough underlying NNSS
29 and its vicinity, called the miogeosyncline, is made up predominantly of carbonates (limestone
30 and dolomite) and mature clastic sediments (quartzite, conglomerate, argillite, and siltstone).
31 These rocks have a complex history of folding and faulting.

32
33
34 **Mesozoic Units.** Rocks of Mesozoic age consist of several small granitic stocks, dikes,
35 and sills. There are no Mesozoic sedimentary rocks under NNSS or its immediate vicinity.

36
37
38 **Cenozoic Units.** Tertiary volcanic and associated sedimentary rocks are as much as
39 2,591-m (8,500-ft) thick in Frenchman Flat. Volcanic rocks are predominantly ash-flow tuff,
40 ash-fall tuff, and lava flows of rhyolitic, rhyodacitic, and basaltic composition. The tuffs are
41 typically rhyolitic and quartz-latic. Sedimentary rocks derived from these volcanics include
42 conglomerates, tuffaceous sandstones, and freshwater limestones.

43
44 Tertiary and Quaternary deposits in the Frenchman Flat basin include fluvial deposits of
45 coarse- to fine-grained sand, eolian sheets, and dunes, with minor basalt flows.



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FIGURE 9.1.2-3 Stratigraphic Column for NNSS and Vicinity
(Source: Bechtel Nevada 2005b)

1 Alluvium is up to 1,500-m (5,000-ft) thick in the deepest part of the basin. Stratigraphic
2 logs are available for three pilot wells (Ue5PW-1, Ue5PW-2, and Ue5PW-3) shown in
3 Figure 9.1.2-4. These logs indicate that the shallow stratigraphy, both laterally and vertically,
4 is quite variable and discontinuous across the site (typical of alluvial fan depositional
5 environments). For example, in Ue5PW-1, sediments are predominantly well-graded sand with
6 silt with a maximum thickness of 8.2 m (27 ft), underlain by numerous layers of up to 5.2 m
7 (17 ft) of well-graded sand with gravel. Sediments in Ue5PW-2 consist mainly of silty sand with
8 a maximum thickness of 12 m (40 ft), with interbedded layers of gravel and well-graded sand
9 with silt. Silty sand units are fairly massive at depth intervals of 42.7 to 122 m (140 to 400 ft)
10 and 171 to 256 m (560 to 800 ft). In Ue5PW-3, sediments are composed of well-graded sand
11 with silt, with a maximum thickness of 27.4 m (90 ft). At depths of 115.8 to 170.7 m (380 to
12 560 ft), the number of silty sand layers increases; at depths below 171 m (560 ft), the silty
13 sand layer is massive and contains scatter zones of cobbles and boulders (REEC 1994).

14
15

16 **9.1.2.1.4 Seismicity.** NNSS lies within the Walker Lane belt, a northwest-trending
17 seismic zone that extends from eastern California to western Nevada. The active faults in the
18 Walker Lane belt accommodate the strain from the movement of the Pacific plate relative to the
19 North American plate. The seismic zone is characterized by right-lateral strike-slip faults
20 (although some left-lateral faults are present) as well as basin-and-range-style extensional block
21 faults (Bechtel Nevada 2005b; University of Arizona 2008).

22

23 Nevada is among the most seismically active states in the United States. Between 1898
24 and 2005, there were 1,586 documented earthquakes having a magnitude of more than 3.5
25 (Nevada Seismological Laboratory 2008). The largest three earthquakes in Nevada occurred in
26 northern Nevada within a 7-hour period on October 2, 1915. The last tremor had an estimated
27 magnitude of 7.75. The movement created a scarp, about 1.5- to 4.5-m (5- to 15-ft) high and
28 35-km (22-mi) long, parallel to the base of the Sonoma Mountains (USGS 2008).

29

30 From 1950 to 1998, a total of 526 earthquakes of magnitude 4 or greater were
31 documented at or near the NNSS. Researchers have noticed a significant drop in the number of
32 earthquakes since 1992, the year that the moratorium on nuclear testing was established, which
33 suggested a likely connection between earthquakes and the testing that took place in the Pahute
34 Mesa and Yucca Flat areas (Bright et al. 2001).

35

36 From 1950 to 2008, five earthquakes of magnitude 3.5 to 4.2 or greater were documented
37 within 32 km (20 mi) of Frenchman Flat; all were clustered in the Wahmonie volcanic center to
38 the west (Figure 9.1.2-2) (ANSS 2008).

39

40 The three most recent earthquakes in the Frenchman Flat area (also within 32 km [20 mi]
41 and to the west/northwest) occurred in January 2008 and had magnitudes of less than 2
42 (USGS 2008).

43

44 Figure 9.1.2-5 shows the geology and major fault lines (and relative movement along
45 them) in Frenchman Flat and vicinity.

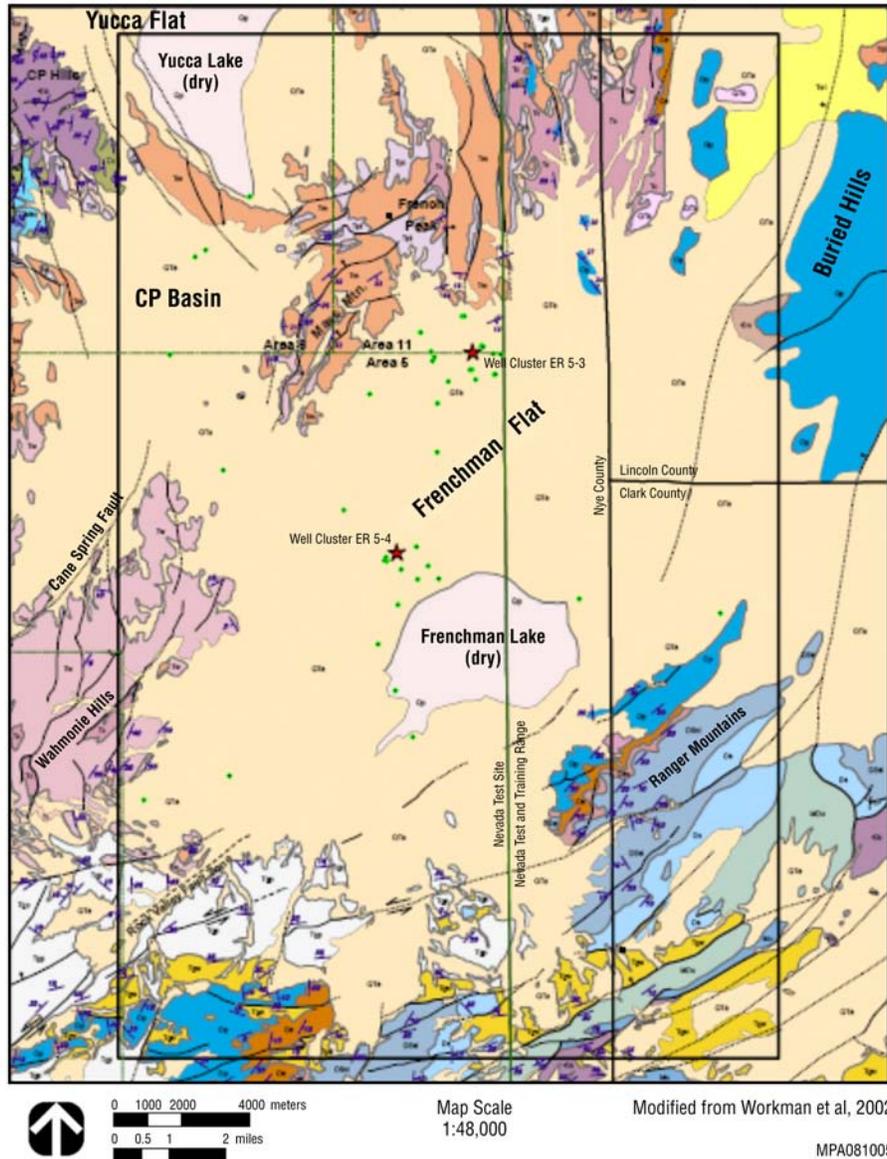
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2 **FIGURE 9.1.2-4 Location of Pilot Wells within Area 5 Radioactive Waste**
3 **Management Site**
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6 In 1995, a probabilistic seismic hazard assessment (PSHA) was conducted for the Device
7 Assembly Facility, located in Area 6 about 16 km (10 mi) northwest of Frenchman Lake. The
8 PSHA determined that the seismic design basis for structures, systems, and components
9 important to safety should be able to withstand the horizontal motion from an earthquake with a
10 return frequency of once in 2,000 years (annual probability of occurrence of 0.0005). The PSHA
11 concluded that a 0.0005-per-year earthquake would produce peak horizontal accelerations of
12 about 30% of gravity (0.30g) for a surface facility. Analysts projected a 50% reduction in ground
13 motion for a subsurface facility within the same area (Ng et al. 1998). A PSHA has not been
14 conducted for the Frenchman Flat area; however, given the similarity in seismic setting and soil
15 conditions, a similar design-basis earthquake would likely be specified.
16
17

18 **9.1.2.1.5 Volcanic Activity.** The NNSS region is situated within the southwestern
19 Nevada volcanic field, which consists of volcanic rocks (tuffs and lavas) of the Timber
20 Mountain-Oasis Valley caldera complex and Silent Canyon and Black Mountain calderas
21 (Figure 9.1.2-6). Two types of fields are present in the NNSS region: (1) large-volume,
22 long-lived fields with a range of basalt types associated with more silicic volcanic rocks



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FIGURE 9.1.2-5 Surface Geologic Map and Seismic Fault Lines at Frenchman Flat (Source: Bechtel Nevada 2005b)

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produced by melting of the lower crust, and (2) small-volume fields formed by scattered basaltic scoria cones during brief cycles of activity, called rift basalts because of their association with extensional structural features. The basalts of the region typically belong to the second group; examples include the basalts of Silent Canyon and Sleeping Butte (Byers et al. 1989; Crowe et al. 1983).

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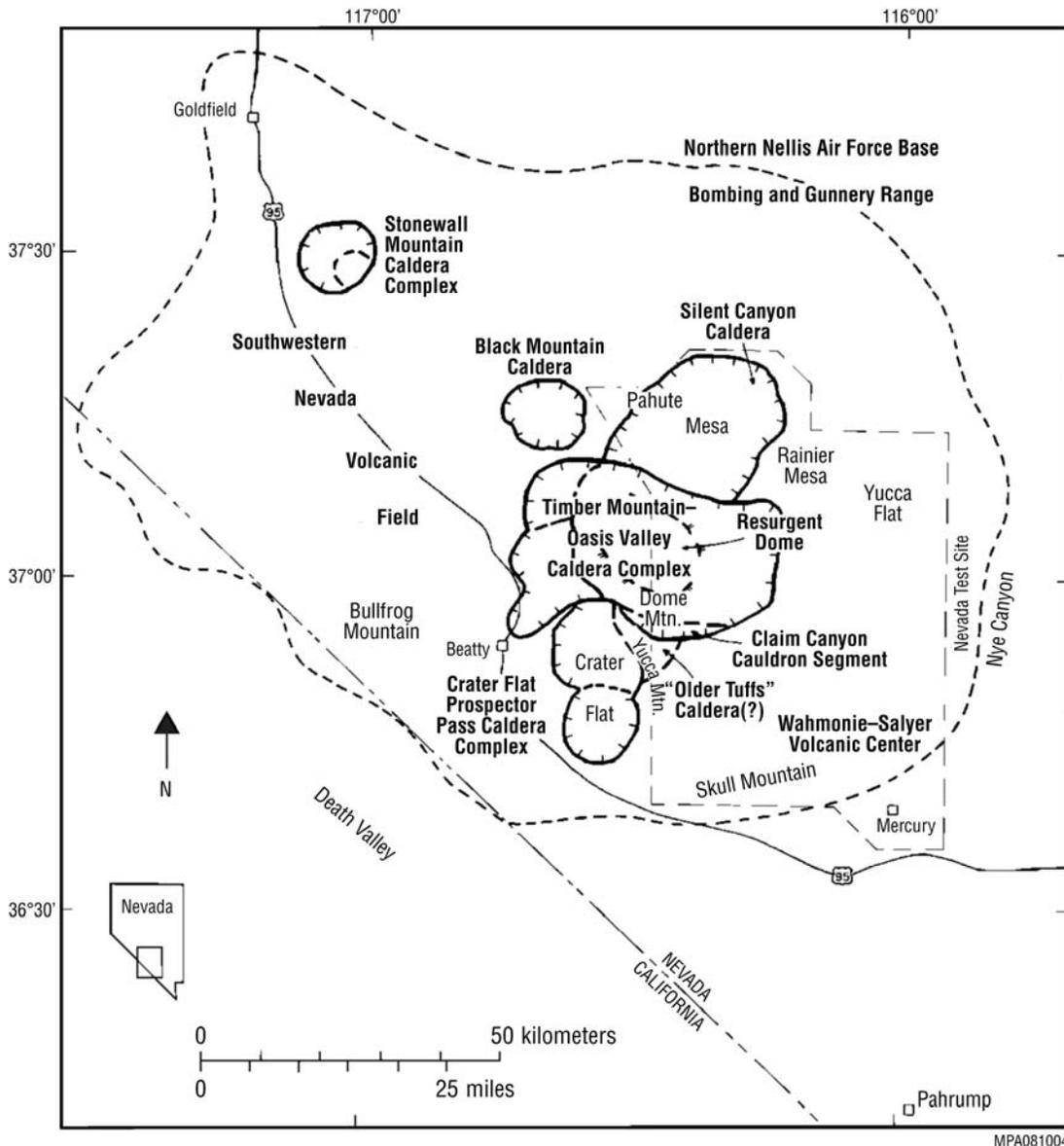
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The oldest basalts in the NNSS region were erupted during the waning stages of silicic volcanism in the southern Great Basin in the Late Miocene and are associated with silicic volcanic centers like Dome Mountain (the first group). Rates of basaltic volcanic activity in the region have been relatively constant but generally low. There has been no silicic volcanism in the

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2 **FIGURE 9.1.2-6 Volcanic Features in the NNSS Region (Byers et al. 1989)**

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4
5 region for the past 5 million years. Current silicic volcanic activity occurs entirely along the
6 margins of the Great Basin.

7
8 Crowe et al. (1983) determined that the annual probability of a volcanic event for the
9 NNSS region is very low ($3.3E-10$ to $4.7E-08$). The volcanic risk at NNSS is associated only
10 with basaltic eruptions; the risk of silicic volcanism is negligible. Perry (2002) cites geologic
11 data that could increase the recurrence rate (and thus the probability of disruption). These include
12 hypothesized episodes of an anomalously high strain rate, the hypothesized presence of a
13 regional mantle hot spot, and new aeromagnetic data that suggest that previously unrecognized
14 volcanoes may be buried in the alluvial-filled basins in the region.

1 **9.1.2.1.6 Slope Stability, Subsidence, and Liquefaction.** No natural factors within
2 Frenchman Flat that would affect the engineering aspects of slope stability have been reported.
3 External factors affecting slope stability relate to the fracturing and ground motion caused by
4 nuclear explosions (DOE 1996).

5
6 Ground stability and the potential for subsidence have not been assessed for Frenchman
7 Flat. While natural factors, like the development of pavement and accumulation of calcium
8 carbonate, enhance ground stability, other factors increase the likelihood of subsidence. These
9 include the presence of readily weathered and/or fractured rocks, a high degree of void space in
10 sediments, and the absence of vegetation.

11
12 Liquefaction of saturated sediments is a potential hazard during or immediately following
13 large earthquakes and underground or surface explosions. There is evidence that paleo-
14 liquefaction has occurred in the NNSS region. Whether soils will liquefy depends on several
15 factors, including the magnitude of the earthquake or explosion, the peak ground velocity, the
16 liquefaction susceptibility of soils, and depth to groundwater.

17 18 19 **9.1.2.2 Soils**

20
21 Soils at NNSS and its vicinity include entisols and aridisols. Entisols form on steep
22 mountain slopes in regions where erosion is active. Aridisols are older, more developed soils;
23 they typically exist on more stable fans and terraces. In the southern portion of the site, including
24 Frenchman Flat, soils are young with little evidence of leaching. These soils tend to be low in
25 organic content and water storage capacity. Grain size varies from coarse near the mountain
26 fronts to fine in the playa areas (typical of alluvial fans); salinity increases significantly in the
27 direction of the playa areas, with the highest level of soluble salts having accumulated in the
28 deeper soil horizons. Most soils are underlain by a hardpan of caliche. Desert pavement occurs in
29 places. Soil loss through wind and water erosion is common, although the erosion rates and
30 susceptibility of soils to erosion have not been defined (DOE 1996; Hoover et al. 1981).

31
32 Soils in portions of Frenchman Flat have been contaminated as a result of nuclear testing
33 and ancillary operations (DOE 1996).

34 35 36 **9.1.2.3 Mineral and Energy Resources**

37
38 Geologic resources at NNSS include industrial minerals, such as silica, bentonite clay,
39 and zeolites, building stone, and aggregate. Although NNSS has been closed to commercial
40 mineral development since the 1940s, several mining districts in the region have been identified
41 and sampled. Economic minerals include gold, silver, mercury, lead, copper, antimony, zinc,
42 arsenic, tungsten, and molybdenum. These are generally found near volcanic centers (e.g., the
43 Timber Mountain caldera complex). Mining districts identified in nuclear testing areas are not
44 considered part of the site's geologic and mineral resources if they are radioactively
45 contaminated. DOE policy does not allow extraction of NNSS mineral resources; however, the
46 policy does require monitoring of geologic features to protect them from impacts due to

American Indian Text

Minerals

The CGTO knows based on previous DOE-sponsored cultural studies that there are many minerals on the NNSS (no complete list available). Indian people visiting the proposed GTCC site identified the following traditional use minerals: (1) Obsidian, (2) chalcedony, (3) Yellow Chert or Jasper, (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other minerals were perceived to be present but not observed because of the limited time and search area.

All minerals are culturally important and have significant roles in many aspects of Indian life. For example, the Chalcedony on the proposed GTCC site would have made an attractive offering which would be acquired here by a ceremonial traveler and then left at the vision quest or medicine site located to the north on top of a volcano like Scrugham Peak. Returning ceremonial travelers would also bring offerings back to where they had acquired offerings, thus the Yellow Chert or Jasper (observed on the GTCC site) which outcrops about 70 miles to the north would be gathered there and returned to the Chalcedony site as an offering.

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American Indian Text

Playas

The CGTO knows, based on cultural studies funded by the DOE on the NNSS and playa-specific studies funded by Nellis Air Force Test and Training Range, that playas occupy a special place in Indian culture. Playas are often viewed as empty and meaningless places by western scientists, but to Indian people playas have a role and often contain special resources that occur no where else. The following text was prepared by the Indian people who visited the proposed GTCC site.

Is a playa a wasteland? According to Indian elders playas were used in traveling or moving to places where work, hunting, pine cutting or gathering of other important foods and medicine could be done. One elder remembers crossing over dry lake beds and traveling around but near the edges and they discussed how provisions were left there and at nearby springs by previous travelers at camping spots. Indian people left caches in playa areas for people who crossed valleys when water and food was scarce. Frenchmen Playa is such a place. Indian people took advantage of traveling through this playa as mountains completely surround this area. The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lake beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member added, to Indian people "water is life. Our water has healing powers." So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

1 construction activities (DOE 1996, 2000). The mining of cinder occurs within the land
2 withdrawal area, about 10 km (6 mi) northwest of Amargosa Valley (DOE 2008a).

3
4 Hydrocarbon resources in the deeper subsurface have not been evaluated at NNSS.
5 However, a recent DOE evaluation of energy resources in the Yucca Mountain withdrawal area
6 to the west found that the potential for economically useful energy resources was low (CRWMS
7 M&O 2000). No occurrences of oil and gas, coal, tar sands, or oil shale have been reported in the
8 region (DOE 1996).

9
10 Geothermal hot springs are common in the region; however, water temperatures may not
11 be adequate for commercial development (DOE 1996). A preliminary assessment conducted by
12 DOE (1994) found that the potential for moderate-temperature geothermal resource development
13 was high.

14 15 16 **9.1.3 Water Resources**

17 18 19 **9.1.3.1 Surface Water**

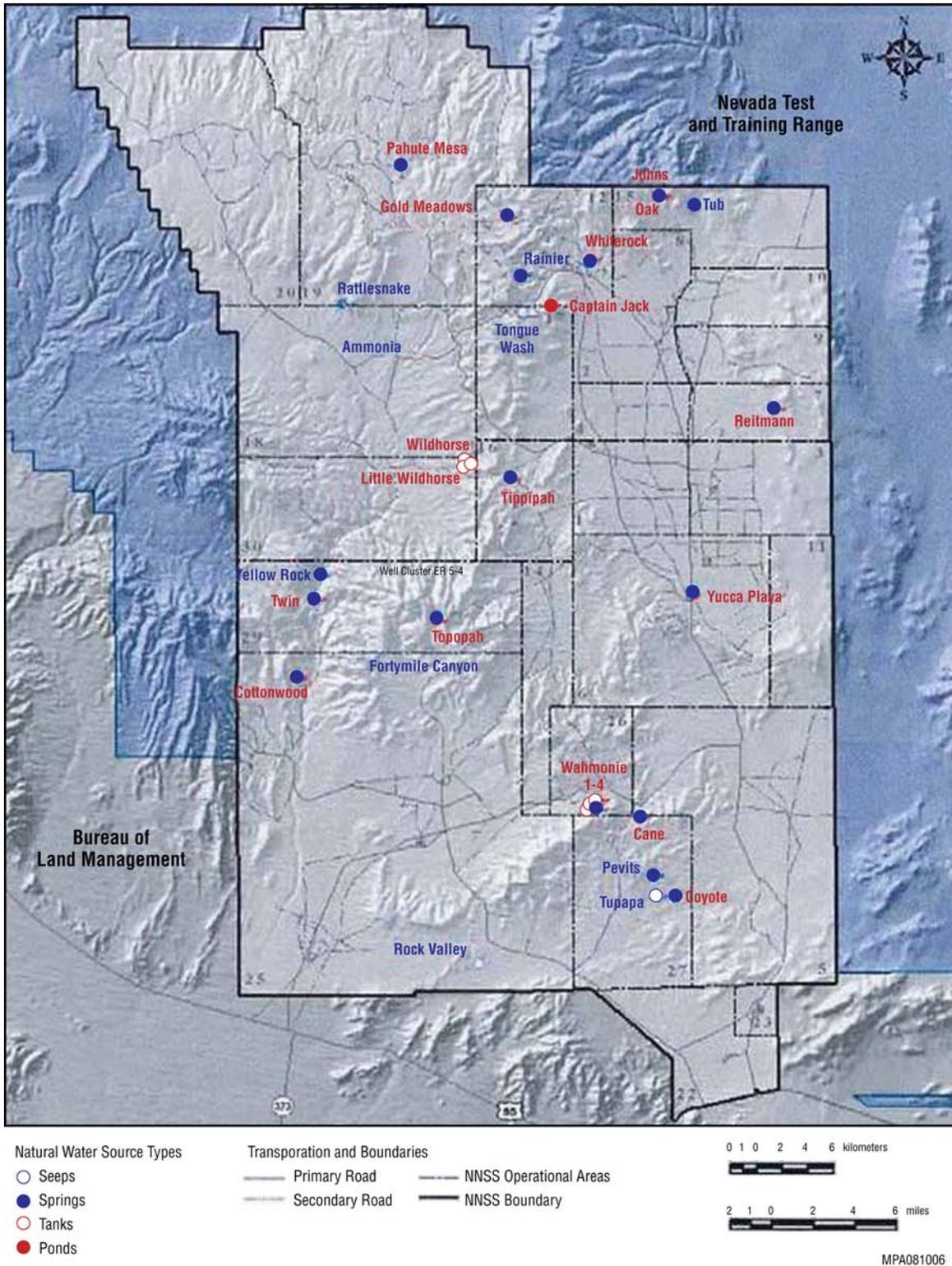
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21
22 **9.1.3.1.1 Rivers and Streams.** The 352,512-ha (870,400-ac) NNSS lies within the Great
23 Basin hydrogeologic province. The province consists of numerous hydrographically closed
24 intermontane basins, such as Frenchman Flat and Yucca Flat, and is characterized by the
25 presence of salt lakes and dry lake beds (playas). Streams in Frenchman Flat are ephemeral,
26 flowing only during precipitation events. Surface water runoff flows through normally dry
27 washes toward the topographically lowest part of the basin, Frenchman Lake (also referred to as
28 Frenchman Playa). Most runoff travels only a short distance before evaporating or infiltrating
29 into the ground.

30
31 There are 24 known seeps or springs on the NNSS, as shown in Figure 9.1.3-1; there are
32 no known springs or seeps within the boundaries of Frenchman Flat (DOE 1996; Bechtel
33 Nevada 2005a). In addition to the springs and seeps, eight streams flow ephemeraly on NNSS.
34 These streams are recharged by snowmelt from nearby mountains and by small amounts of
35 precipitation.

36
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38 **9.1.3.1.2 Surface Water Quality.** Because of the ephemeral nature of surface water on
39 the NNSS, no surface water quality data have been reported (DOE 1996).

40 41 42 **9.1.3.2 Groundwater**

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45 **9.1.3.2.1 Unsaturated Zone.** Groundwater occurs in both the unsaturated (vadose) and
46 saturated (phreatic) zones at NNSS. The depth to groundwater and the thickness of the
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FIGURE 9.1.3-1 Natural Springs and Seeps on NNSS (Source: Bechtel Nevada 2005a)

1 unsaturated zone vary across the site. In the Area 3 Radioactive Waste Management Site
2 (RWMS), located on Yucca Flat within NNSS, the thickness of the vadose zone is about 488 m
3 (1,600 ft), and the water table is assumed to occur in Tertiary tuff, on the basis of data from
4 surrounding boreholes. The tuff-alluvium contact is estimated to occur at a depth of between 300
5 and 460 m (1,000 and 1,500 ft) below the land surface. In the Area 5 RWMS, located on
6 northern Frenchman Flat at the juncture of three coalescing alluvial fans piedmonts, the thickness
7 of the unsaturated zone is 240 m (770 ft) at the southeast corner of the RWMS (at Ue5PW-1),
8 260 m (840 ft) at the northeast corner of the RWMS (at Ue5PW-2), and 270 m (890 ft) to the
9 northwest of the RWMS (at Ue5PW-3) (Bechtel Nevada 2002a).

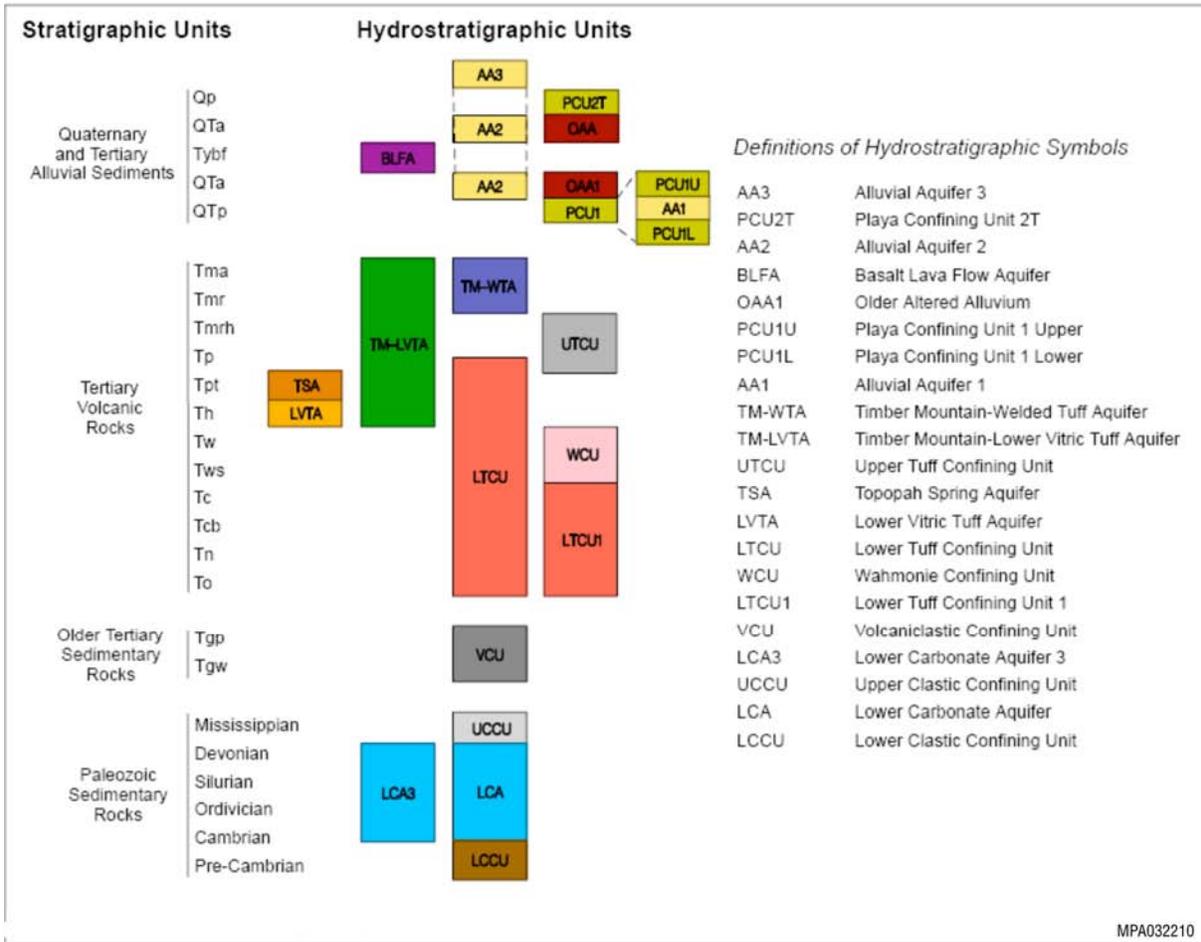
10
11 In the vicinity of the GTCC reference location, the unsaturated zone has a thickness of
12 about 240 m (810 ft) (Bechtel Nevada 2001, 2002a).

13
14
15 **9.1.3.2.2 Aquifer Units.** The sedimentary rocks of the Great Basin compose the
16 principal source of groundwater for the NNSS region. Within this groundwater system, a
17 relatively shallow component, consisting of unconsolidated basin (alluvial) fill, overlies a deeper
18 component, consisting of carbonate rocks (Prudic et al. 1995). Beneath Frenchman Flat, the units
19 from oldest (deepest) to youngest (shallowest) are the lower clastic confining unit, the lower
20 carbonate aquifer, the volcanic aquifer and confining units, and the alluvial aquifer.
21 Figure 9.1.3-2 shows the correlation between the hydrostratigraphic and lithologic units at
22 NNSS.

23
24 The following unit descriptions are taken from Hoover et al. (1981), REEC (1994),
25 Prudic et al. (1995), Laczniak et al. (1996), DOE (1996), Bright et al. (2001), Bechtel Nevada
26 (2002b, 2005a), and Hershey et al. (2005). They include information specific to three monitoring
27

American Indian Text

The CGTO requests an analysis of the hydrological and ecological impacts of the existing water diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE recognizes that this is a very flood prone area, with major flooding episodes occurring about every 23 years. Indian people visiting this site observed that even though the current dike has been built recently and thus not experienced a 23-year flood, it has diverted and consolidated sufficient runoff that a small arroyo has been established. The Indian people visiting this site believe that the existing dike has unnaturally stressed down-slope plants and animals who now do not receive normal sheet runoff. The Indian people visiting the site believe that by concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet runoff because the consolidated runoff moves more quickly and only flows in the new and developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC facility to be established east of the current RWMC then the dike would necessarily have to be extended causing an even greater runoff shadow and an even greater developing arroyo. The desert tortoise in the area will have to move out of this larger runoff shadow and may be concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will expose them to higher levels of radioactivity. The Indian people visiting the site believe that these current and potential impacts should be analyzed, monitored by Indian people, and reported back to the CGTO at the next annual meeting.



1

2 **FIGURE 9.1.3-2 Correlation of Stratigraphic and Hydrostratigraphic Units at NNSS**
 3 **(Source: Bechtel Nevada 2005a)**

4

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6 wells (Ue5PW-1, Ue5PW-2, and Ue5PW-3) and two drill holes (ER-5-3#2 and ER-5-4#2) in
 7 Frenchman Flat (Figure 9.1.2-4). Wells Ue5PW-1 and Ue5PW-2 are completed in the alluvial
 8 aquifer; Well Ue5PW-3 is completed in the Timber Mountain Tuff, a volcanic aquifer. Drill
 9 Hole ER-5-3#2 is located in the northern part of Frenchman Flat; Drill Hole ER-5-4#2 is in the
 10 central part of Frenchman Flat, just to the northwest of Frenchman Lake. Table 9.1.3-1 lists the
 11 hydrostratigraphic data for the monitoring wells; Tables 9.1.3-2 and 9.1.3-3 provide
 12 hydrostratigraphic data for Drill Holes ER-5-3#2 and ER-5-4#2.

13

14

15 **Lower Carbonate Aquifer and Lower Clastic Confining Unit.** The most extensive
 16 hydrostratigraphic units within NNSS and vicinity are the Lower Carbonate Aquifer and the
 17 Lower Clastic Confining Unit. The carbonate rocks of the Lower Carbonate Aquifer are
 18 predominantly dolomite and interbedded limestone, with thin layers of shale and quartzite. They
 19 are the most transmissive hydrostratigraphic unit because of their relatively high solubility in
 20 groundwater and the abundant secondary permeability in fractures caused by tectonic activity in

TABLE 9.1.3-1 Hydrostratigraphic Data from Pilot Wells Ue5PW-1, Ue5PW-2, and Ue5PW-3^{a,b}

Hydrostratigraphic Unit	Top Depth	Base Depth	Top Elevation	Unit Thickness
Ue5PW-1 Alluvial aquifer ^c	0	839 ^d	3,180	839 ^d
Ue5PW-2 Alluvial aquifer ^c	0	919.5 ^d	3,248	919.5 ^d
Ue5PW-3 Alluvial aquifer ^c	0	617	3,298	617
Timber Mountain aquifer	617	955 ^d	2,681	>338

^a The locations of pilot wells Ue5PW-1, Ue5PW-2, and Ue5PW-3 are shown on Figure 9.1.2-4. Well UePW-1 was installed just outside the southeast corner of the RWMS. Wells Ue5PW-2 and UePW-3 were installed on the upgradient side of the RWMS (to the north and northwest).

^b All thicknesses and depths are in feet; all elevations are in feet relative to MSL.

^c Depth to groundwater is 772 ft (Ue5PW-1), 842 ft (Ue5PW-2), and 891 ft (Ue5PW-3). Source: Bechtel Nevada (2002b).

^d Value represents the total depth of the borehole and not the depth or thickness of the unit.

Source: Drellack (1997)

1

2

3 the region. The unit is as thick as 5,000 m (16,400 ft) in places and crops out in the southeastern
4 portion of Frenchman Flat (Stoller-Navarro 2006).

5

6 The Lower Clastic Confining Unit, consisting of quartzite, micaceous quartzite, and
7 siltstone, is impermeable and considered to be the hydrologic basement throughout much of the
8 Death Valley flow system. These rocks are brittle and commonly fractured; however, secondary
9 mineralization has reduced their permeability. The unit has a thickness of about 2,900 m
10 (9,400 ft).

11

12 The predominant direction of groundwater flow within the Lower Carbonate Aquifer is
13 south-southeast. Recharge occurs in high-elevation areas in central Nevada and in the Spring
14 Mountains and Sheep Range in southern Nevada. The major discharge areas are springs in Ash
15 Meadows and Death Valley.

16

17

18 **Volcanic Aquifer and Confining Units.** The volcanic rocks present in the Frenchman
19 Flat Basin are part of the southwest Nevada volcanic field that extends to the west; they consist

TABLE 9.1.3-2 Hydrostratigraphic Data from Drill Hole ER-5-3#2^{a,b}

Hydrostratigraphic Unit ^c	Top Depth	Base Depth	Top Elevation	Unit Thickness
Alluvial aquifer	0	910	3,334.3	910
Basalt lava flow aquifer	910	940	2,424.3	30
Alluvial aquifer	940	1,680	2,394.3	740
Tonopah Spring aquifer	1,680	1,695	1,654.3	15
Alluvial aquifer	1,695	2,060	1,639.3	365
Timber Mountain aquifer	2,060	2,862	1,274.3	802
Tonopah Spring aquifer	2,862	3,024	472.3	162
Timber Mountain aquifer	3,024	3,055	310.3	31
Wahmonie confining unit	3,055	3,796	279.3	741
Lower tuff confining unit	3,796	4,678	-461.7	882
Paleozoic rocks — undifferentiated Pz	4,678	5,683 ^d	-1,343.7	>1,005

^a Drill hole ER-5-3#2 is in the northern portion of Frenchman Flat.

^b All thicknesses and depths are in feet; all elevations are in feet relative to MSL.

^c Depth to groundwater (or vadose zone thickness) is 927 ft.

^d Value represents the total depth of the borehole and not the depth or thickness of the unit.

Source: Bechtel Nevada (2005a)

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TABLE 9.1.3-3 Hydrostratigraphic Data from Drill Hole ER-5-4#2^{a,b}

Hydrostratigraphic Unit ^c	Top Depth	Base Depth	Top Elevation	Unit Thickness
Alluvial aquifer	0	2,312	3,131.7	2,312
Older playa confining unit	2,312	2,702	819.7	390
Alluvial aquifer	2,702	2,707	429.7	5
Older playa confining unit	2,707	2,940	424.7	233
Alluvial aquifer	2,940	3,676	191.7	736
Timber Mountain aquifer	3,676	4,356	-544.3	680
Lower tuff confining unit	4,356	7,000 ^d	-1,224.3	2,644

^a The location of drill hole ER-5-4#2, in the northern portion of Frenchman Flat, is shown in Figure 9.1.2-4.

^b All thicknesses and depths are in feet; all elevations are in feet relative to MSL.

^c Depth to groundwater (or vadose zone thickness) is 708 ft.

^d Value represents the total depth of the borehole and not the depth or thickness of the unit.

Source: Bechtel Nevada (2005a)

3

American Indian Text

The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lake beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member added, to Indian people "water is life. Our water has healing powers." So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

1

2

3 mainly of rhyolitic tuffs and have been subdivided into four units: (1) Timber Mountain Aquifer,
4 Upper Tuff Confining Unit; (2) Topopah Spring Aquifer, Lower Vitric-Tuff Aquifer, Wahmonie
5 Confining Unit; (3) Lower Tuff Confining Unit; and (4) Volcaniclastic Confining Unit. The
6 Lower Tuff Confining Unit separates the underlying carbonate aquifer from the overlying tuff
7 aquifer (Timber Mountain Tuff) and alluvial deposits throughout parts of Frenchman Flat.

8

9

10 Dense rocks with abundant fractures compose the volcanic aquifers; these rocks are
11 typically welded tuff sheets (outside of the calderas) and lava flows and thick welded tuffs
12 (within the calderas). The confining units consist of zeolitically altered nonwelded tuffs,
13 common in the older, deeper parts of the volcanic section. At Frenchman Flat, these units range
14 in thickness from about 610 m (2,000 ft) in the north to more than 910 m (3,000 ft) in the center
15 of the basin.

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The hydraulic conductivity of tuff depends on the degree of welding and the presence of
fractures.

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The hydraulic conductivity of the alluvial aquifer is lower than that of the carbonate
aquifer, but higher than that of the volcanic aquifer. The hydraulic head gradient in most areas of
the alluvial aquifer in Frenchman Flat is relatively flat, less than one foot per mile, except near

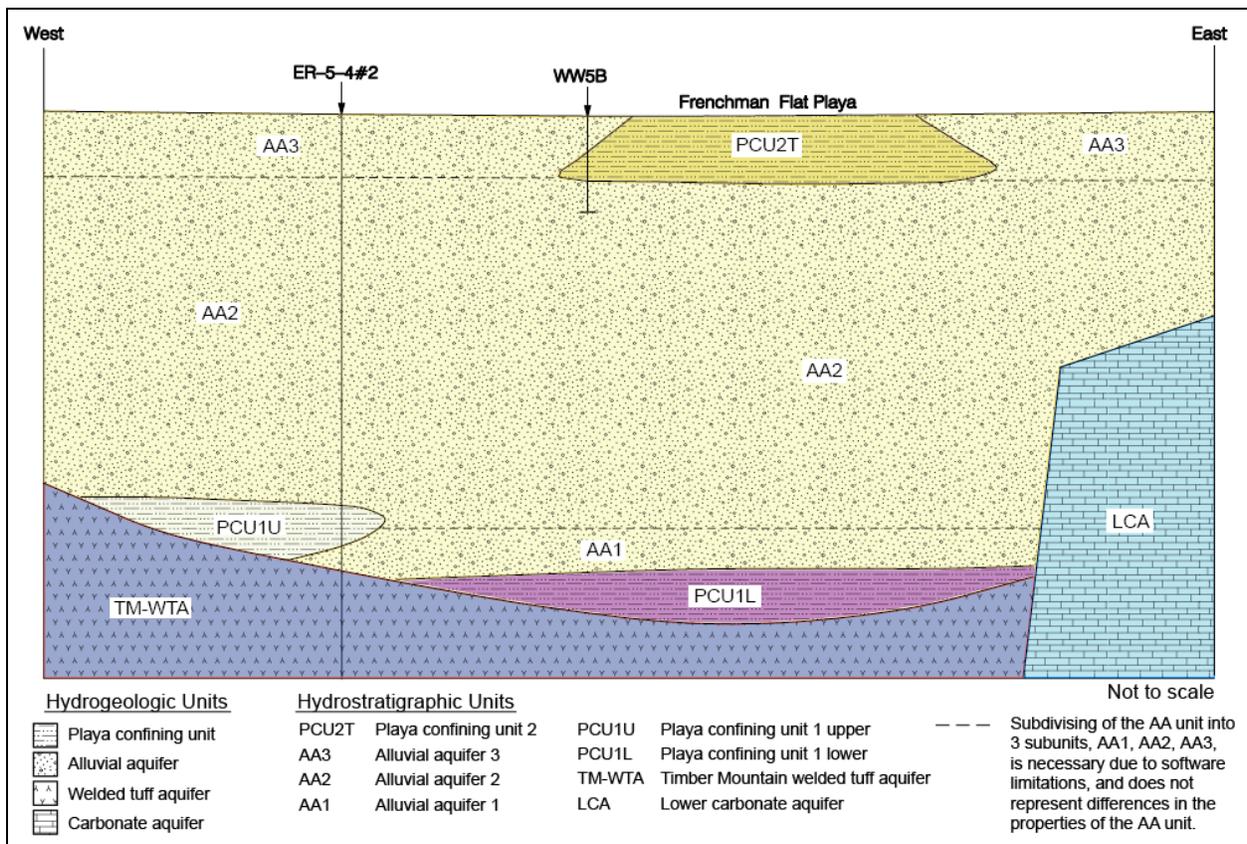
1 the water supply and test wells. Groundwater generally flows northeast. The water table occurs at
 2 a depth of about 283 m (927 ft) in the northern portion of Frenchman Flat (at Drill Hole
 3 ER-5-3#2) and about 216 m (708 ft) in the central portion of the site (at Drill Hole ER-5-4#2).
 4

5 The playa confining unit consists of three separate confining units, including the
 6 youngest one at the surface (at Frenchman Lake) and two older, buried units. Playa deposits are
 7 clayey silt, with intercalated sand and pumice in places. The deposits at Frenchman Lake are
 8 about 150-m (500-ft) thick.
 9

10 In the vicinity of the GTCC reference location, the thickness of the saturated zone is
 11 about 220 m (720 ft) (REEC 1994).
 12

13 Figure 9.1.3-3 is a schematic showing the relationship of the playa confining units and
 14 the alluvial aquifer.
 15

16
 17 **9.1.3.2.3 Groundwater Flow.** Groundwater in the NNSS region flows within several
 18 sub-basins of the Death Valley regional flow system, a major subprovince of the southern Great
 19
 20



21

22 **FIGURE 9.1.3-3 Hydrostratigraphic Cross Section through Central Frenchman Flat Showing the**
 23 **Alluvial Aquifer and Playa Confining Units (Source: Bechtel Nevada 2005a)**
 24

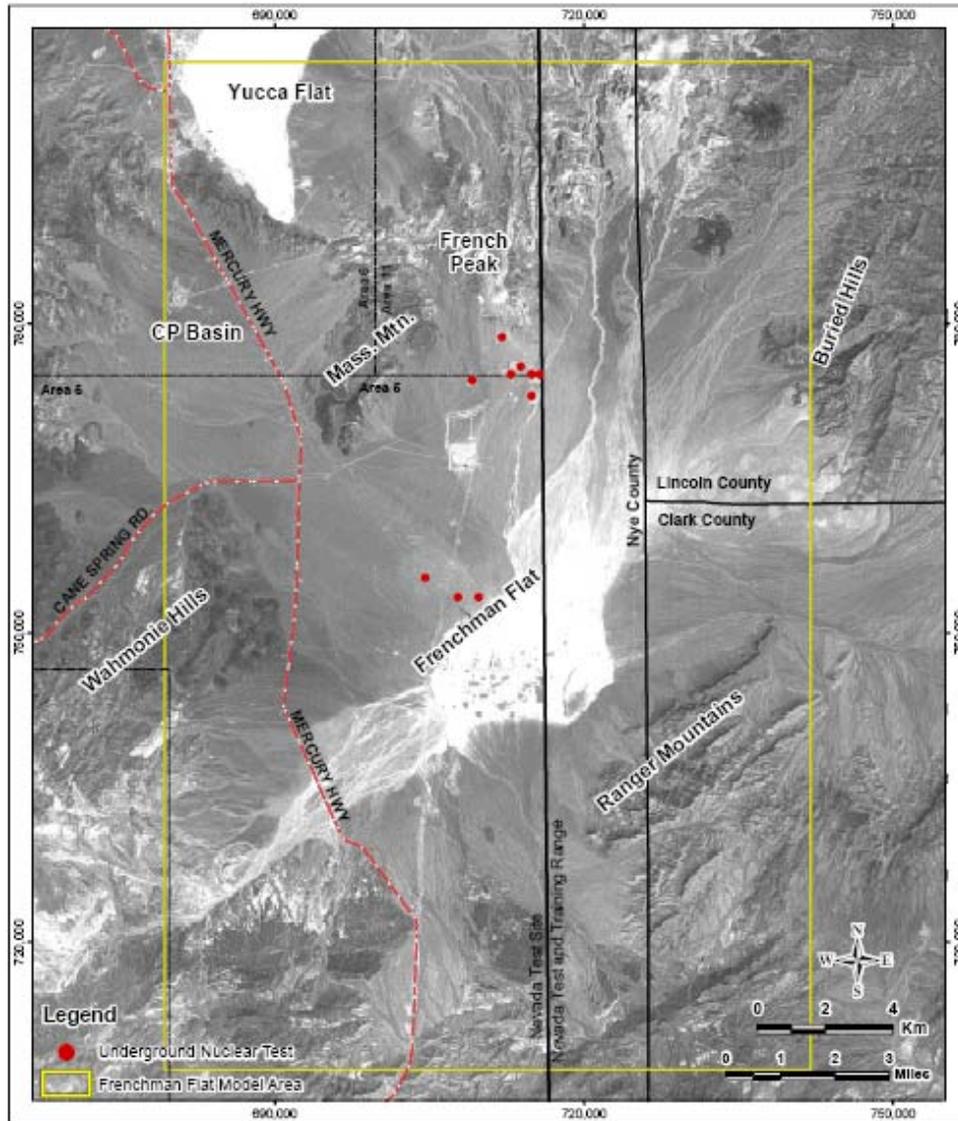
1 Basin (Figure 9.1.3-4). The Death Valley regional flow system covers an area of about
2 40,920 km² (15,800 mi²) of the southern Great Basin, extending from recharge areas in the high
3 mountains of central Nevada to its southernmost areas of discharge in Death Valley, California.
4 The flow system transmits more than 86 million m³ (70,000 ac-ft) of groundwater annually. The
5 largest volume of groundwater flows through a thick sequence of Paleozoic carbonate rocks,
6 occurring at depths greater than 1,370 m (4,500 ft) below Frenchman Flat and referred to as the
7 “central carbonate corridor.” Flow rates in this aquifer may be as high as 30.5 m/d (100 ft/d). The
8 general direction of groundwater flow in these rocks is to the south-southwest (Bechtel Nevada
9 2005a; Laczniaik et al. 1996).

10
11 Depth to groundwater in Frenchman Flat ranges from 283 m (927 ft) in the northern
12 portion of the basin to 216 m (708 ft) in the central portion of Frenchman Flat. Groundwater
13 recharge of the carbonate aquifer occurs mainly via lateral inflow. Most of the groundwater
14 recharge in the alluvial aquifer at Frenchman Flat is due to upflow from the underlying carbonate
15 rock aquifer. There is very little, if any, recharge at the surface in Frenchman Flat. Annual
16 precipitation at Frenchman Flat is less than 25 cm (10 in.), and potential evapotranspiration is
17 five times higher (Clark University 2006). In the vicinity of the GTCC reference location, annual
18 precipitation is estimated to be about 12 cm (5 in.) (National Security Technologies, LLC 2008).
19 Recharge may occur in isolated areas along large drainage washes surrounding the site during
20 precipitation events. Discharge occurs along springs to the southwest; water also leaves the
21 system through evapotranspiration (which has an estimated annual rate of 13 million m³ or
22 10,500 ac-ft) (Laczniaik et al. 1996; Bechtel Nevada 2005a; DeNovio et al. 2006).

23
24
25 **9.1.3.2.4 Groundwater Quality.** Groundwater sampled from monitoring wells in
26 Frenchman Flat has been characterized as a sodium bicarbonate type (Bechtel Nevada 2002a).
27 Overall, groundwater quality within NNSS aquifers is acceptable for human consumption and for
28 industrial and agricultural uses (DOE 1996). Bechtel Nevada (2002a) provides summary tables
29 for water chemistry and water-level measurements taken in 2001 and compares these values with
30 historical measurements. No significant changes due to contamination were detected; hydrologic
31 conditions in the alluvial aquifer below Frenchman Flat were found to be stable.

32
33 A total of 10 underground nuclear tests were conducted at Frenchman Flat in the
34 saturated zone or within 100 m (330 ft) of the water table (Bechtel Nevada 2005a).
35 Figure 9.1.3-4 shows the test area locations in the northern and central parts of Frenchman Flat.
36 With the exception of one of the northern tests, the nuclear tests were conducted within the
37 alluvium (Table 9.1.3-4). Groundwater from Wells Ue5PW-1, Ue5PW-2, and Ue5PW-3 was
38 sampled for gross alpha and gross beta radioactivity in 2001; all values were found to be below
39 the National Primary Drinking Water Standards.

40
41
42 **9.1.3.2.5 Water Use.** DOE operates four groundwater water supply systems at NNSS for
43 its water use and operational support. The number of personnel and amount of water used have
44 fluctuated widely in response to changes in NNSS programs since 1958, when withdrawals were
45 about 200 ac-ft/yr (250,000 m³/yr). Groundwater is withdrawn from six basins (Mercury Valley,
46 Yucca Flat, Frenchman Flat, Buckboard Mesa, Jackass Flat, and Gold Flat). Ten water supply



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FIGURE 9.1.3-4 Locations of Underground Nuclear Testing at Frenchman Flat (Source: Bechtel Nevada 2005a)

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wells, including three (WW-5A, WW-5B, and WW-5C) that are active in Frenchman Flat, are pumped into a system of storage tanks, sumps, and distribution systems. Current annual water use at NNSS is estimated to be about 1.1 billion L (290 million gal), well below the historic demand. Of the six basins tapped for water to support NNSS operations, the maximum historic withdrawal (1,664 ac-ft/yr or 2.1 million m³/yr) was from wells located at Frenchman Flat. Withdrawals are estimated to be about 1% of the total groundwater withdrawals in the Death Valley Regional Flow System (USGS 2007; Moreo et al. 2003; Buqo 2004).

Current groundwater use in Nye County falls into five categories: public water supply systems, domestic wells, mining, agriculture, and federal use. In 1995, total water withdrawals were estimated to be 99,668 ac-ft (123 million m³), with the greatest demands being for

American Indian Text

Indian people have raised in past radioactive waste disposal and transportation studies a range of questions regarding how to protect themselves and their natural resources from exposure to what they call the Angry Rock. The analysis of GTCC waste should address directly these potential impacts and suggest ways to either avoid or mitigate them. The potential impacts to Indian people and their life are significant including potentially blocking the path to the afterlife.

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TABLE 9.1.3-4 List of Underground Nuclear Tests Conducted at Frenchman Flat

Emplacement Hole	Test Name	Date of Test	Yield (kilotons)	Depth of Burial (m [ft])	Static Water Level Depth (m [ft])	Working Point Geology	Estimated Alluvium Thickness (m [ft])
Northern Test Area							
U-5i	Derringer	9/12/1966	7.8	255 (837)	335 (1,100)	Alluvium	305 (1,000)
U-5k	Milk Shake	3/25/1968	<20	265 (868)	286 (939)	Alluvium	500 (1,640)
U-11b	Pin Stripe	4/25/1966	<20	269 (970)	349 (1,146)	Volcanic rocks	58 (190)
U-11c	New Point	12/13/1966	<20	239 (785)	299 (980)	Alluvium	478 (1,570)
U-11e	Diana Moon	8/27/1968	<20	242 (794)	305 (1,000)	Alluvium	366 (1,200)
U-11f	Minute Steak	9/12/1969	<20	265 (868)	302 (990)	Alluvium	427 (1,400)
U-11g	Diagonal Line	11/24/1971	<20	264 (867)	301 (988)	Alluvium	341 (1,120)
Central Test Area							
U-5a	Wishbone	2/18/1965	<20	175 (574)	Not available	Alluvium	590 (1,935)
U-5b	Diluted Water	6/16/1965	<20	193 (632)	213 (700)	Alluvium	400 (1,312)
U-5e	Cambric	5/14/1965	0.75	295 (967)	213 (700)	Alluvium	576 (1,890)

Source: Bechtel Nevada (2005a)

3
4

irrigation (80.0% or 60,233 ac-ft [74 million m³] per year), mining (9.4% or 7,057 ac-ft [8.7 million m³] per year), and domestic use (6.8% or 5,130 ac-ft [6.3 million m³] per year). Water demand is expected to be about 166,000 ac-ft (204 million m³) in 2020 (Buqo 2004).

8
9

Surface water is not a source of drinking water on NNSS. The closest surface water supply used for public consumption is Lake Mead, 160 km (98 mi) to the southeast of Frenchman Flat, which supplies a large portion of the water demand of Las Vegas (DOE 1996).

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9.1.4 Human Health

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Potential radiation exposures of the off-site general public can occur as a result of two main pathways: air transport and ingestion of game animals. The air transport pathway is a result of the resuspension of radioactive materials previously deposited in some areas of NNSS from past nuclear weapons testing activities. The airborne radionuclides can be blown off-site and

19

1 expose the off-site general public through the inhalation and ingestion pathways. There are no
2 likely exposures related to stack emissions of radionuclides at the site.

3
4 Wild animals may be exposed to radioactive materials through ingesting on-site
5 contaminated soils or water (from containment ponds or sewage lagoons). These animals can
6 then be consumed by members of the general public (through hunting and similar activities),
7 resulting in a radiation dose. Drinking contaminated groundwater is not considered a potential
8 exposure pathway because access to the site is restricted, and radioactive contamination has not
9 been detected in off-site sources of groundwater that could be used as potable water supplies.
10 Exposure through direct radiation from radioactive materials processed on-site is also not
11 considered a reasonable exposure pathway for the general public because there are no houses in
12 the vicinity of the site boundary that have elevated levels of radiation.

13
14 Table 9.1.4-1 provides the radiation doses for the off-site general public estimated by
15 using the results from recent environmental monitoring. The highest estimated potential radiation
16 dose to an individual is 2.37 mrem/yr: 1.9 mrem/yr from airborne contamination and
17 0.47 mrem/yr from eating game animals (Wills 2009). This dose is less than 3% of the dose limit
18 of 100 mrem/yr from all exposure pathways set by DOE to protect the general public from the
19 operation of its facilities. The annual collective dose to the 43,000 people living within 80 km
20 (50 mi) of the site (Wills et al. 2005) from natural background and man-made sources of
21 radiation is estimated to be 26,000 person-rem/yr.

22
23 According to the worker radiation exposure data published by DOE (2007c), in
24 2006, 39 workers received measurable doses from on-site activities. A collective dose of
25 1.8 person-rem was recorded, which would result in an average individual dose of 46 mrem/yr.
26 This dose would largely be from external gamma radiation, and to a much lesser extent,
27 inhalation. The potential dose from the water ingestion pathway is expected to be zero, because
28 no contamination was found in the on-site drinking water supply wells (Wills 2009). For
29 comparison, the DOE administrative dose level for a radiation worker is 2 rem/yr (DOE 1994).
30 Use of DOE's ALARA program ensures that worker doses are kept well below applicable
31 standards.

32 33 34 **9.1.5 Ecology**

35
36 NNSS is located within the transition between the Mojave and Great Basin deserts. It is
37 therefore ecologically diverse, since elements of both deserts are present (Wills 2007). More than
38 750 species of vascular plants have been collected at NNSS (Wills 2007). Ten major vegetation
39 alliances have been identified on NNSS; their distributions have been linked to temperature
40 extremes, precipitation, and soil conditions (Wills and Ostler 2001). The vegetation alliances
41 present in the Mojave Desert ecoregion include desert thorn, creosote bush/white bursage, and
42 shadscale/saltbrush/white bursage; those in the Great Basin Desert ecoregion include saltbrush,
43 rabbitbrush, sagebrush, and pinyon pine/sagebrush; and those from the transition ecoregion
44 include burrobrush/wolfberry, Nevada jointfir, and blackbrush (Wills 2007). Four invasive plant
45 species have become important components at NNSS: red brome (*Bromus rubens*), cheatgrass
46 (*Bromus tectorum*), Russian thistle (*Salsola kali*), and barbwire Russian-thistle (*S. paulsenii*).

TABLE 9.1.4-1 Estimated Annual Radiation Doses to Workers and the General Public at NNSS

Receptor	Radiation Source	Exposure Pathway	Annual Dose to individual (mrem/yr)	Annual Dose to population (person-rem/yr)
On-site workers	Groundwater contamination	Water ingestion	0 ^a	
	Airborne radionuclides	Inhalation	1.9 ^b	
	Historical ground deposition and radioactive materials processed	Direct radiation	46 ^c	1.8 ^c
General public	Groundwater/surface water contamination	Water ingestion	0 ^d	
	Game animals	Food ingestion	0.47 ^e	
	On-site waste storage and shipment	Direct radiation	0 ^f	
Worker/public	Natural background radiation and man-made sources		620 ^g	26,600 ^h

^a Sampling results for the underground drinking water supply indicated no contamination caused by man-made radionuclides (Wills 2009), although migration of radionuclides from underground testing areas to on-site monitoring wells probably occurred. In 2008, 4 of the 14 monitoring wells had tritium concentrations (31 to 356 pCi/L) above the detection limit; however, they were well below the drinking water limit of 20,000 pCi/L. No gamma-emitting radionuclides were detected at concentrations above detection limits in 2008. Gross alpha and gross beta levels in all monitoring wells were above detection limits. The radioactivity is most likely from natural sources (Wills 2009).

^b By using the highest average air concentrations of man-made radionuclides at the Schooner monitoring station (Wills 2009), an inhalation dose of 1.9 mrem/yr was estimated for a hypothetical individual residing at this location. No one resides at this location (Wills 2009).

^c In 2006, 39 workers monitored for radiation exposures received measurable doses and the total collective dose for these workers was 1.8 person-rem (DOE 2008b). By distributing the collective dose evenly among the workers, an average individual dose of 46 mrem/yr was obtained.

^d No off-site springs, surface water supplies, or wells had levels of tritium significantly above the detection limit. No gamma-emitting radionuclides were detected. Gross alpha and gross beta radioactivity was below drinking water standards in all potable water sources and was most likely from natural sources (Wills 2009).

^e Dose estimated for ingestion of NNSS game animals assumes that a person consumed 20 cottontail rabbits from near Schooner Crater (Wills 2009). However, because hunting is not allowed on NNSS, it would be highly unlikely for an individual to receive this dose.

^f The TLD monitoring results along the boundary of NNSS showed no excessive dose above the background level, except for the Frenchman Lake region of Area 5 along the southeast boundary (Wills 2009), where a direct radiation dose of 349 mrem/yr (including background) could result from year-round exposure. However, there are no living quarters in this vicinity (Wills 2009).

^g Average dose to a member of the U.S. population as estimated in Report No. 160 of the NCRP (2009).

^h Collective dose to the population of 43,000 within 50 mi (80 km) of NNSS (Wills et al. 2005) from natural background radiation and man-made sources.

American Indian Text

The CGTO knows that radiation can be and is viewed from both a western science and a Native American perspective (See Indian Appendix for more). These alternative and competing perspectives are key for understanding the cultural foundations of American Indian responses to the mining, processing, use, transportation, and disposal of radioactive materials. At some level of analysis from an Indian perspective, all radioactive waste is basically the same problem to Indian people. Subtle differences in classification from a western science perspective of radioactive waste only mask and do not significantly modify the basic cultural problems of radioactive waste for Indian people and their traditional lands.

The Angry Rock is a concept used by Indian people, involved in DOE funded radioactive waste transportation and disposal studies, to quickly summarize the complex cultural problems associated with what happened to this known mineral when it was improperly taken and used by non-Indians. The notion of an Angry Rock is premised on the belief that all of the earth is alive, sentient, speaks Indian, and has agency. When the elements of the earth are approached with respect and asked for the permission before being used they share their power with humans. The reverse occurs when they are taken without permission – they become angry withhold their power and often using it against humans. Thus uranium is an Angry Rock. Uranium has been known and carefully used by spiritual specialists and medicine persons for thousands of years (Lindsay et al. 1968). The following American Indian elder quote from a DOE funded report (Austin 1998) begins to explain this perspective:

We are the only ones who can talk to these things. If we do not make sure that we talk to those things, then they are going to give us more bad harm, because it is already happening throughout the country. Those are the reasons why the Indian people say ... like uranium, for one, uranium was here since the beginning of this Earth, when it was here we knew uranium at one time. And still it is used, but then they got a hold of it and made something else out of it. Now it is a man made thing, and today it accumulates waste from nuclear power plants, it accumulates more, it has its own life. Radiation has said to us at one time "If you use me make sure you tell me before you use me why you are going to use me and what for." And we never said anything to that uranium at all, and we put something else in there with it, which shouldn't belong with it. It gives it more power to eliminate the life, of all living things on this planet of ours. Those are the reasons, why the Indian people always say, and I know because I have been there. The rocks have a voice...

Although from a Western science perspective radiation can be isolated and contained by conventional techniques, the Angry Rock has the power to move and cannot be contained by barriers. Indian people who have dealt with the Angry Rock for thousands of years note that there are traditional ways to deal with uranium, the natural rock, if used by trained Indian specialists, but these may or may not work with the Angry Rock of modern radiation waste.

Songs ... we are the ones who should be talking to those things. Radiation is going to take all of our lives; it is continuously moving over the land. The land don't want it, nobody wants it. And today, we are doing a bad thing by using radiation on each other. Radiation is something that should not be used to kill animal life...

Another elder noted:

And can it be contained? As it's transformed it can be, I think it can be contained physically but not spiritually, and again I think spiritually as it's been altered because it's in that energy field because it's been altered. The spirit, that's where it can do its harm in an altered

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form. It doesn't do any good to anybody. And there you're just in the wrong place in the wrong time, it does influence plants and animals, minerals and air, the spirit of any area it passes through. The reason somebody is sick. I don't think it's necessary to talk about how each one of these is influenced, it just is.

Another elder noted:

As far as the transportation of waste there's a lot of unknowns and we don't know what the consequences are. We know there are many sicknesses that come out from people that have been contaminated by nuclear waste and as far as Indian people go, we show respect to the land, show respect to other people, for the animals, the plants, the rocks. The power of the rock – Just looking at Chemehuevi Mountain, it's a very spiritual mountain from this perspective right here. When I look out towards the mountains and I don't just see a mountain, I see a place of power, I see a place where I can go and meditate and speak with the Creator directly and ask for prayers and blessings for people directly. Just like anything else, you have to give prayers all the time because the creator is here to watch and protect over us. I feel that we wouldn't have come this far if he wasn't here to watch over us and we are here to pray and we are here to protect the other resources.

Another elder said:

I can envision the animals standing back once it goes through for the first time and they recognize that there's a danger that they would move away because of fear. That they would no longer be there and that there's something bad coming down the road and they disperse and move away into different corridors. Kind of like a dust storm, they disperse and move further and further away. I see it from the animals' standpoint, they're a lot smarter than us and they've been doing this for longer than us and their senses are more keen and I think the animals would get back and it would create dead zones throughout the country. Through these corridors or transportation routes of course at the site there will be those that are curious who want to go see.

Another elder said:

I don't know what you would do with this rock if it's angry and this is its way of rebelling, getting back. I think as a Native American I would backstep and ask for forgiveness. Sometimes forgiving is not very easy because there's sacrifices we have to make and there's consequences ... I don't think it can be done as a group, it's an individual thing and each one of us has to go back and ... ask for forgiveness for what has taken place. It's not just only that I think it's going to be more complicated than going out into the mountains and saying, "hey, I'm sorry, I won't do this, I won't do that and I won't bother you anymore. There's a lot of other things that need to be forgiven. The rock is the most precious and it's the largest and it's the one that needs to be forgiven the most. There's a lot of small forgiveness that have to be given before the large rock. I think it's a stepping stone... the rocks are angry, yes, they're striking out saying "don't do this to me, don't touch me, don't let this happen. " In a sense you look at it from a spirituality standpoint, it's the spirits of Mother Earth telling us don't mess with Mother Earth. It remains a matter of debate as to whether traditional means of placating powerful rock-based forces can be used to control or placate radioactive waste. Western scientists have created a problem for Indian people that, despite being very critical to their future, is not easily resolved.

American Indian Text

The CGTO knows that this site (in Area 5) is an ancient playa, surrounded by mountain ranges. The runoff from these ranges serves to maintain the healthy desert floor. Animals frequent this area, there are numerous animals' trails, and these play a significant part in the history of the locality and of the Indian lifestyles. Our ancestors knew that the Creator always provided for them and this site is one of their favorite places to hunt and trap rabbits. We have special leaders that organized large rabbit hunts. Many people participated so this place would be occupied at times by all kinds of our people. Rabbits provided good eating, bones for tool-making, warm blankets, and even games. Indian people refrained from eating coyote, wolves, and birds but these contribute to our stories which tell us how to behave and why we are here. We have many stories and songs that include animals and birds who have human-like antics. From these antics Indian people learn the life lessons to build character to become better persons. So animals and the places where they live contribute to our history and culture.

This culturally central place was used by and important to Indian people from our agricultural and horticultural communities located to the north – near Reese River Valley and Duckwater, to the south – near Ash Meadows, to the southeast – near Indian Springs and Corn Creek, to the east – near the Pahranaagat-Muddy River, and west – near the Oasis Valley. It was also used by people from our agricultural and horticultural communities to the far west in Owens Valley, to the far south near Cottonwood Island and Palo Verde Valley on the Colorado River, to the far southwest at Twenty Nine Palms, to the far east along the Virgin River, Santa Clara River, and Kanab Creeks, to the far north along the Humbolt River and Ruby Valley.

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3 They rapidly invade disturbed sites at NNSS and delay revegetation by native species
4 (Wills and Ostler 2001). The GTCC disposal facility would occur within the Mojave Desert
5 ecoregion and within the creosote bush/white bursage vegetation alliance. The climate in this
6 area is arid, with average annual precipitation of about 12.3 cm (5 in.). Predominant plant species
7 include white bursage (*Ambrosia dumosa*), creosote bush (*Larrea tridentata*), Nevada jointfir
8 (*Ephedra nevadensis*), small flower ratany (*Krameria erecta*), and pale wolf-berry (*Lycium*
9 *pallidum*) (DOE 2002b; Wills and Ostler 2001).

10

11 None of the natural water bodies at NNSS are considered jurisdictional wetlands
12 (Wills 2009). Wetlands on NNSS include cave pools at spring sites, four natural rock depression
13 pools, and two ephemeral ponds. The natural wetlands (e.g., seeps and springs) and human-made
14 water sources (e.g., sumps and sewage lagoons) provide unique habitat areas for vegetation and
15 wildlife at NNSS (Wills 2007). None of the water bodies are in the area of the GTCC reference
16 location.

17

18 Fifty-nine mammal species, including 15 bat species, have been reported from NNSS.
19 Rodents are the most abundant and widespread group of mammals on NNSS (Wills and
20 Ostler 2001), with the long-tailed pocket mouse (*Chaetodipus formosus*) and Merriam's
21 kangaroo rat (*Dipodomys merriami*) being most abundant (DOE 2002b). Larger mammal species
22 include the black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*),
23 mountain cottontail (*S. nuttallii*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra*

1 *americana*), coyote (*Canis latrans*), kit fox (*Vulpes macrotis*), badger (*Taxidea taxus*), bobcat,
 2 and mountain lion (Wills 2007). The mountain lion preys on wild horses (*Equus caballus*), mule
 3 deer, pronghorn, and even the desert tortoise (*Gopherus agassizii*). It also poses a potential threat
 4 to humans on NNSS (National Security Technologies, LLC 2007). Wild horses occur on the
 5 northern portion of NNSS. Between 1999 and 2006, the number of wild horses ranged from 33 to
 6 53 (Wills 2007). No hunting is allowed on NNSS (Wills and Ostler 2001). Most mammals on
 7 NNSS other than rodents are protected by the State of Nevada and managed as either game or
 8 furbearing mammals, and the bat species are considered sensitive species (Wills 2007).

9
 10 Nearly 240 species of birds have been observed at NNSS. Nearly 80% are migrants or
 11 seasonal residents. A total of 36 bird species, including 9 raptors, are considered year-long
 12 residents at NNSS (Wills and Ostler 2001). Twenty-two species of transient waterfowl and
 13 shorebirds have been observed on NNSS. They are observed near springs, well ponds, playas,
 14 and man-made impoundments. Nearly all bird species on NNSS are protected by the Migratory
 15 Bird Treaty Act (Wills 2007).

16
 17 Thirty-four reptile species are known to exist at NNSS: 16 lizard species, 17 snake
 18 species, and the desert tortoise. Four poisonous snakes occur on NNSS. The bullfrog (*Rana*
 19 *catesbeiana*), which is not native to the southwestern United States, is the only amphibian
 20 species that has been identified at NNSS (Wills 2007).

21
 22 There are 30 natural water bodies on NNSS, including 15 springs, 9 seeps, 4 tank sites
 23 (natural rock depressions that catch and hold surface runoff), and 2 ephemeral ponds (Wills and
 24 Ostler 2001). The water bodies total 2.5 ha (6.1 ac) and range from springs and seeps with
 25

American Indian Text

Plants

The CGTO knows based on previous DOE-sponsored ethnobotany studies that there are at least 364 Indian use plants on the NNSS (see Appendix G). Indian people visiting the proposed location of the GTCC facility identified the following traditional use plants: (1) Indian Tea, (2) White Sage or Winter Fat, (3) Indian Rice Grass, (4) Creosote, (5) Wolfberries, (6) Four O'clock, (7) Spiny Hop Sage, (8) Joshua Tree, (9) Daises, (10) Desert Trumpet, (11) Cholla, (12) Globe Mallow, (13) Fuzzy Sage, (14) Tortoise Food plant, (15) Sacred Datura, (16) Wheat Grass, and (17) Lichen. Other plants were present but not identified due to the late season and the dry condition of the plants.

Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony – both social and healing. The characteristics of the plants at the proposed GTCC area are smaller and thinner than in other desert areas where it is wetter. Indian people from elsewhere traveled to this area to gather specific plants because they have stronger characteristics when they grow in dry places. The sage is used for spiritual ceremonies, smudging, and medicine. The Indian rice grass and wheat grass are used for breads and puddings. Joshua trees and Yucca plants are important for hair dye, basketry, foot ware, and rope. Datura is used for hallucinogenic effects during which alternative places can be visited by medicine men. Datura also goes itself to disturbed areas and heals them. The globe mallow had traditional medicine uses, but in recent times is also used for curing European contagious diseases.

American Indian Text

Animals/Insects

The CGTO knows based on previous DOE-sponsored ethnofauna studies that there are at least 170 Indian use animals on the NNSS [see Appendix G]. Indian people visiting the proposed location of the GTCC facility identified the following traditional use animals: (1) Jack Rabbits, (2) Whiptail Lizards, (3) Antelope, (4) Tortoise, (5) Kangaroo Rats, (6) Horned Toad, (7) Rock Wrens, (8) Ravens, (9) Grasshoppers, and (10) Stink Bugs. Other animals (such as snakes, bats, and owls) were perceived to be present but not observed because they primarily emerge at night.

All animals and insects were and are culturally important and the relationships between them, the Earth, and Indian people are represented by the respectful roles they play in the stories of our life then and now. The GRCC valley is where a spiritual journey occurred. It involved Wolf (Tavats in Southern Paiute, Bia esha in Western Shoshone, Wi gi no ki in Owens Valley Paiute) and Coyote (Sinav in Southern Paiute, Duhvo esha in Western Shoshone, Esha in Owens Valley Paiute) and is considered a Creation Story. Only parts of this can be presented here. When Wolf and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious. Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a beautiful Rainbow (Paro wa tsu wu nutuvi in Southern Paiute, Oh ah podo in Western Shoshone, Paduguna in Owens Valley Paiute). When Coyote saw this special privilege he cried to the Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put Coyote as a fine white mist at the bottom of the Rainbow's arch. This story and the spiritual trails discussed in the full version are connected to the Spring Mountains and the large sacred cave in the Pintwater Mountains as well as to lands now called the Nevada National Security Site. This area is the home place of Wolf who is still present and watches over the area and us.

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essentially no surface water area to an area of 2.3 ha (5.7 ac) for Yucca Playa Pond, one of the ephemeral ponds (Wills and Ostler 2001). No natural water bodies are located near the GTCC reference location. Numerous man-made impoundments at several locations throughout NNSS support various operations. Many animals at NNSS, including migratory waterfowl, make use of these water sources (Wills and Ostler 2001). No native fish species occur at NNSS, but several nonnative species have been introduced into some of the man-made ponds (Wills 2007).

10 The federally and state-listed species identified on or adjacent to NNSS are listed in
11 Table 9.1.5-1. No federally protected plant species occur on NNSS. Also, no federal plant
12 species of special concern (e.g., formerly known as Category 2 candidate species) were observed
13 in the GTCC reference location at NNSS (Blomquist et al. 1995). The Death Valley beards-
14 tongue (*Penstemon fruticiformis* var. *armagosae*) is the only state-listed threatened species
15 known to occur on or adjacent to NNSS. However, a number of sensitive plant species that occur
16 on or adjacent to NNSS are on the Nevada Natural Heritage Program (NNHP) Sensitive Plant
17 Taxa List (NNHP 2007). Some of these species are reported from Area 5 (area that contains the
18 GTCC reference location) or from the southern portions of Areas 6 and 11, including the white
19 bear poppy (*Arctomecon merriamii*), black milk-vetch (*Astragalus funereus*), sanicle biscuitroot
20 (*Cymopterus ripleyi* var. *saniculoides*), Beatley's milk-vetch (*Astragalus beatleyae*), and Parish's

TABLE 9.1.5-1 Federally and State-Listed Threatened, Endangered, and Other Special-Status Species on or Adjacent to NNSS

Common Name (Scientific Name)	Status ^a Federal/State
Mosses	
Planoconvex entosthodon (<i>Entosthodon planoconvexus</i>)	-/W, 5 years
Plants	
Beatley's milk-vetch (<i>Astragalus beatleyae</i>)	SC/W, 5 years
Beatley's scorpionflower (<i>Phacelia beatleyae</i>)	SC/W, 5 years
Black milk-vetch (<i>Astragalus funereus</i>)	SC/W, 5 years
Bullfrog Hills peavine (<i>Lathyrus hitchcockianus</i>)	-/W, 5 years
Charleston milk-vetch (<i>Astragalus oophorus</i> var. <i>clokeyanus</i>)	SC/W, 5 years
Clarke phacelia (<i>Phacelia filiae</i>)	-/W, 10 years
Clokey buckwheat (<i>Eriogonum heermannii</i> var. <i>clokeyi</i>)	-/W, 5 years
Death Valley beardstongue (<i>Penstemon fruticiformis</i> var. <i>armagosae</i>)	-/ST, 5 years
Drain buckwheat (<i>Eriogonum concinnum</i>)	-/W, 5 years
Intermountain evening-primrose (<i>Camissonia megalantha</i>)	SC/W, 10 years
Kingston bedstraw (<i>Galium hilendiae</i> ssp. <i>kingstonense</i>)	SC/W, 10 years
Pahute green gentian (<i>Frasera pahutensis</i>)	SC/W, 10 years
Pahute Mesa beardtongue (<i>Penstemon pahutensis</i>)	SC/W, 10 years
Parish's phacelia (<i>Phacelia parishii</i>)	SC/W, 10 years
Pumice alpinegold (<i>Hulsea vestita</i> ssp. <i>inyoensis</i>)	-/W, 10 years
Rock purpusia (<i>Iversia arizonica</i> var. <i>saxosa</i>)	-/W, 5 years
Sanicle biscuitroot (<i>Cymopterus ripleyi</i> var. <i>saniculoides</i>)	SC/-
Weasel phacelia (<i>Phacelia mustelina</i>)	-/W, 10 years
White bear poppy (<i>Arctomecon merriamii</i>)	SC/W, 10 years
Reptiles	
Banded gila monster (<i>Heloderma suspectum cinctum</i>)	SC/S2
Chuckwalla (<i>Sauromalus obesus</i>)	SC/-
Desert tortoise (<i>Gopherus agassizii</i>)	T/Yes
Birds	
Black tern (<i>Chlidonias niger</i>)	SC/-
Ferruginous hawk (<i>Buteo regalis</i>)	SC/Yes
Gray flycatcher (<i>Empidonax wrightii</i>)	SC/-
Lucy's warbler (<i>Vermivora luciae</i>)	SC/-
Peregrine falcon (<i>Falco peregrinus</i>)	SC/Yes
Phainopepla (<i>Phainopepla nitens</i>)	SC/Yes
Western burrowing owl (<i>Athene cunicularia hypugaea</i>)	SC/-
Western least bittern (<i>Ixobrychus exilis hesperis</i>)	SC/Yes
White-faced ibis (<i>Plegadis chihi</i>)	SC/-
Mammals	
Big free-tailed bat (<i>Nyctinomops macrotis</i>)	SC/-
Fringed myotis (<i>Myotis thysanodes</i>)	SC/Yes
Long-eared myotis (<i>Myotis evotis</i>)	SC/-
Long-legged myotis (<i>Myotis volans</i>)	SC/-
Small-footed myotis (<i>Myotis ciliolabrum</i>)	SC/-

TABLE 9.1.5-1 (Cont.)

Common Name (Scientific Name)	Status ^a Federal/State
Mammals (Cont.)	
Spotted bat (<i>Euderma maculatum</i>)	SC/Yes
Townsend's big-eared bat (<i>Corynorhinus townsendii</i>)	SC/Yes
Yuma myotis (<i>Myotis yumanensis</i>)	SC/-

^a S: State rank indicator, based on distribution within Nevada at the lowest taxonomic level.

S2: Imperiled due to rarity or other demonstrable factors.

SC (species of concern): An informal term referring to a species that might be in need of conservation action. This may range from a need for periodic monitoring of populations and threats to the species and its habitat, to the necessity for listing as threatened or endangered. Such species receive no legal protection under the ESA, and use of the term does not necessarily imply that a species will eventually be proposed for listing.

ST (Nevada Natural Heritage Program or NNHP at-risk plant and lichen taxa, threatened): Believed to meet the ESA definition of threatened.

T (threatened): A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

W (NNHP at-risk plant and lichen taxa, watch-list species): Potentially vulnerable to becoming threatened or endangered.

Yes: A species protected under *Nevada Revised Statute 501* (Administration and Enforcement of Nevada Statute Title 45 – Wildlife).

5 years: Monitor a minimum of once every 5 years under the Ecological Monitoring and Compliance Program.

10 years: Monitor a minimum of once every 10 years under the Ecological Monitoring and Compliance Program.

-: Not listed.

Sources: Blomquist et al. (1995); NNHP (2007); Steen et al. (1997); Wills (2007); Wills and Ostler (2001)

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3 phacelia (*Phacelia parishii*) (Blomquist et al. 1995). At least once every five years, known
4 populations of sensitive plant species are surveyed, and their status is evaluated (NNHP 2007).

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The desert tortoise is the only federally listed animal species that resides on NNSS. It inhabits the southern third of NNSS at low estimated densities (i.e., between 0 and 34.7 tortoises/km² [0 and 90/mi²]). In the area of the GTCC reference location, desert tortoise densities range from 3.7 to 17/km² (9.6 to 45/mi²) (Wills 2007). However, densities might be lower because of the close proximity of the GTCC reference location to the RWMS. The bald eagle, recently delisted, is a rare migrant on NNSS (Wills 2007). Two reptile, nine bird, and seven bat species are species of concern on NNSS. The banded gila monster (*Heloderma suspectum cinctum*) was observed only once on NNSS, and no studies of this species on NNSS have been conducted or

1 are planned (Wills and Ostler 2001). Among the bird species of special concern listed in
 2 Table 9.1.5-1, only the burrowing owl resides and breeds on NNSS (Wills and Ostler 2001).

5 **9.1.6 Socioeconomics**

7 Socioeconomic data for NNSS describe an ROI surrounding the site that is composed of
 8 two counties: Clark County and Nye County, Nevada. More than 95% of NNSS workers reside
 9 in these counties (DOE 2002b).

12 **9.1.6.1 Employment**

14 In 2005, total employment in the ROI stood at 796,006 and was expected to reach
 15 942,091 by 2008. Employment grew at an annual average rate of 5.8% between 1995 and 2005
 16 (U.S. Bureau of the Census 2008a). The economy of the ROI is dominated by the trade and
 17 service industries, with employment in these activities currently contributing almost 75% of all
 18 employment (see Table 9.1.6-1). Construction is also a large employer in the ROI, contributing
 19 almost 12% of total ROI employment. ROI employment at NNSS stood at 1,581 in 2001
 20 (DOE 2002b).

TABLE 9.1.6-1 NNSS County and ROI Employment by Industry in 2005

Sector	Nevada		ROI Total	% of ROI Total
	Clark County	Nye County		
Agriculture ^a	335	384	719	0.1
Mining	546	750	1,296	0.2
Construction	92,858	1,126	93,984	11.8
Manufacturing	22,046	211	22,357	2.8
Transportation and public utilities	30,894	191	31,085	3.9
Trade	121,033	1,628	122,661	15.4
Finance, insurance, and real estate	50,963	283	51,246	6.4
Services	468,324	3,949	472,273	59.3
Other	375	10	385	0.0
Total	787,374	8,532	796,006	

^a Source: USDA (2008)

Source: U.S. Bureau of the Census (2008a)

9.1.6.2 Unemployment

Unemployment rates have varied across the counties in the ROI (Table 9.1.6-2). Over the 10-year period 1999–2008, the average rate in Nye County was 6.9%, with a lower rate of 5.1% in Clark County. The average rate in the ROI over this period was 5.1%, slightly higher than the average rate for the state of 5.0%. Unemployment rates for the first two months of 2009 contrasted markedly with rates for 2008 as a whole; in Nye County, the unemployment rate increased to 13.0%, while in Clark County, the rate reached 10.0%. The average rates for both the ROI and state (10.1%) during this period were higher than the corresponding average rates for 2008.

9.1.6.3 Personal Income

Personal income in the ROI stood at almost \$63 billion in 2005 and was expected to reach \$75 billion in 2008, growing at an annual average rate of growth of 6.4% over the period 1995–2005 (Table 9.1.6-3). ROI personal income per capita also rose over the same period and was expected to reach \$36,923 in 2008, compared with \$31,856 in 1995. Per capita incomes were higher in Clark County (\$36,108 in 2005) than elsewhere in the ROI.

9.1.6.4 Population

The population of the ROI was 1,820,232 in 2006 (U.S. Bureau of the Census 2008b) and was expected to reach 2,030,464 by 2008 (Table 9.1.6-4). In 2006, 1,777,539 people were living in Clark County (98% of the ROI total). Over the period 1990–2006, population in the ROI as a whole grew rapidly, with an average growth rate of 5.6%, while the population in Nevada as a whole grew at a rate of 4.6% over the same period.

**TABLE 9.1.6-2 NNSS Average
County, ROI, and State Unemployment
Rates (%) in Selected Years**

Location	1999–2008	2008	2009 ^a
Clark County	5.1	6.7	10.0
Nye County	6.9	9.2	13.0
ROI	5.1	6.8	10.1
Nevada	5.0	6.7	10.1

^a Rates for 2009 are the average for January and February.

Source: U.S. Department of Labor (2009a–d)

TABLE 9.1.6-3 NNSS County, ROI, and State Personal Income in Selected Years

Income	1995	2005	Average Annual Growth Rate (%), 1995–2005	2008 ^a
Clark County				
Total personal income (2006 \$ in millions)	33,142	61,722	6.4	73,529
Personal income per capita (2006 \$)	31,995	36,108	1.2	37,083
Nye County				
Total personal income (2006 \$ in millions)	625	1,199	6.7	1,442
Personal income per capita (2006 \$)	25,893	29,689	1.4	30,263
ROI total				
Total personal income (2006 \$ in millions)	33,767	62,921	6.4	74,971
Personal income per capita (2006 \$)	31,856	35,960	1.2	36,923
Nevada				
Total personal income (2006 \$ in millions)	51,921	89,005	5.5	103,428
Personal income per capita (2006 \$)	32,829	36,896	1.2	37,901

^a Argonne National Laboratory estimates.

Source: DOC (2008)

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TABLE 9.1.6-4 NNSS County, ROI, and State Population in Selected Years

Location	1990	2000	2006	Average Annual Growth Rate (%), 1990–2006	2008 ^a
Clark County	741,459	1,375,738	1,777,539	5.6	1,982,831
Nye County	17,781	35,512	42,693	5.6	47,633
ROI	759,240	1,408,250	1,820,232	5.6	2,030,464
Nevada	1,220,695	1,998,257	2,495,529	4.6	2,728,865

^a Argonne National Laboratory projections.

Sources: U.S. Bureau of the Census (2008b); estimated data for 2006

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9.1.6.5 Housing

Housing stock in the ROI as a whole grew at an annual rate of 5.3% over the period 1990–2000 (Table 9.1.6-5), with total housing units expected to reach 830,175 in 2008. A total of 250,068 new units were added to the existing housing stock in the ROI between 1990 and 2000. On the basis of annual population growth rates, 72,373 housing units in the county were expected to be vacant in 2008; of these, 26,715 were expected to be rental units available to construction workers at the GTCC waste disposal facility.

9.1.6.6 Fiscal Conditions

Construction and operations of a GTCC waste disposal facility could result in increased expenditures for local government jurisdictions, including counties, cities, and school districts. Revenues to support these expenditures would come primarily from state and local sales tax revenues associated with employee spending during construction and operations and be used to support additional local community services currently provided by each jurisdiction. Table 9.1.6-6 presents information on expenditures by the various local government jurisdictions and school districts in the ROI.

9.1.6.7 Public Services

Construction and operations of a GTCC waste disposal facility could require increases in employment in order to provide public safety, fire protection, community, and educational services in the counties, cities, and school districts likely to host relocating construction workers and operations employees. Additional demands could also be placed on local physician services. Table 9.1.6-7 presents data on employment and levels of service (number of employees per 1,000 population) for public safety and general local government services. Table 9.1.6-8 provides data on teachers and level of service, and Table 9.1.6-9 covers physicians.

9.1.7 Environmental Justice

Figures 9.1.7-1 and 9.1.7-2 and Table 9.1.7-1 show the minority and low-income compositions of the total population located in the 80-km (50-mi) buffer around NNSS from Census data for the year 2000 and CEQ guidelines (CEQ 1997). Persons whose incomes fall below the federal poverty threshold are designated as low income. Minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, or multi-racial (with at least one race designated as a minority race under CEQ). Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can

TABLE 9.1.6-5 NNSS County, ROI, and State Housing Characteristics in Selected Years

Type of Housing	1990	2000	2008 ^a
Clark County			
Owner occupied	149,007	302,834	436,470
Rental	138,018	209,419	301,832
Vacant units	30,163	47,546	68,527
Total units	317,188	559,799	806,829
Nye County			
Owner occupied	4,677	10,167	14,896
Rental	1,987	3,142	4,603
Vacant units	1,813	2,625	3,846
Total units	8,477	15,934	23,345
ROI			
Owner occupied	153,684	313,001	451,366
Rental	140,005	212,561	306,436
Vacant units	31,976	50,171	72,373
Total units	325,665	575,733	830,175
Nevada			
Owner occupied	255,388	457,247	728,637
Rental	210,909	293,918	468,367
Vacant units	52,561	76,992	122,689
Total units	518,858	828,157	1,319,693

^a Argonne National Laboratory projections.

Source: U.S. Bureau of the Census (2008b)

TABLE 9.1.6-6 NNSS County, ROI, and State Public Service Expenditures in 2006 (\$ in millions)

Location	Local Government	School District
Clark County	1,454	1,111
Nye County	30	29
ROI total	1,484	1,140
Nevada	12,164	2,707

Source: U.S. Bureau of the Census (2008c)

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TABLE 9.1.6-7 NNSS County, ROI, and State Public Service Employment in 2006

Service	Clark County		Nye County	
	No.	Level of Service ^a	No.	Level of Service ^a
Police protection	2,830	1.6	102	2.4
Fire protection ^b	1,270	0.7	0	0.0
General	16,651	9.4	240	5.6

Service	ROI		Nevada	
	No.	Level of Service ^a	No.	Level of Service ^a
Police protection	2,932	1.6	3,974	1.6
Fire protection	1,270	0.7	2,230	0.9
General	16,891	9.3	71,241	28.5

^a Level of service represents the number of employees per 1,000 persons in each county.

^b Does not include volunteers.

Source: U.S. Bureau of the Census (2008b,c)

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TABLE 9.1.6-8 NNSS County, ROI, and State Education Employment in 2006

Location	No. of Teachers	Level of Service ^a
Clark County	14,862	8.4
Nye County	366	8.6
ROI	15,228	8.4
Nevada	21,744	8.7

^a Level of service represents the number of teachers per 1,000 persons in each county.

Sources: National Center for Educational Statistics (2008); U.S. Bureau of the Census (2008b,c)

TABLE 9.1.6-9 NNSS County, ROI, and State Medical Employment in 2006

Location	No. of Physicians	Level of Service ^a
Clark County	3,873	2.2
Nye County	40	0.9
ROI	3,913	2.2
Nevada	4,791	1.9

^a Level of service represents the number of physicians per 1,000 persons in each county.

Sources: AMA (2006); U.S. Bureau of the Census (2008b)

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American Indian Text

DOE has recognized the need to address environmental justice concerns of the CGTO based on disproportionately high and adverse impacts to their member tribes from DOE NNSS activities. In 1996, the CGTO expressed concerns relating to environmental justice that included (1) damage to Holy Lands, (2) negative health impacts, and (3) lack of access to traditional places that contributes to breakdowns in cultural transmission. In the 2002 NNSS SA, NNSA/NSO concluded that with the selection of the Preferred Alternative, the CGTO would be impacted at a disproportionately high and adverse level consequently creating an environmental justice issue. Since 2002, NNSA/NSO has supported a few ethnographic studies involving the CGTO and culturally important places including in 2004, when NNSA/NSO arranged for tribal representatives to conduct evening ceremonies at Water Bottle Canyon. While the opportunity for the evening ceremony was a significant accommodation, disproportionately high and adverse impacts from DOE NNSS activities continue to affect American Indians. The three environmental justice issues noted by the CGTO need to be addressed.

1

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3 be of any race, this number also includes individuals who also identified themselves as being part
4 of one or more of the population groups listed in the table.

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7 9.1.8 Land Use

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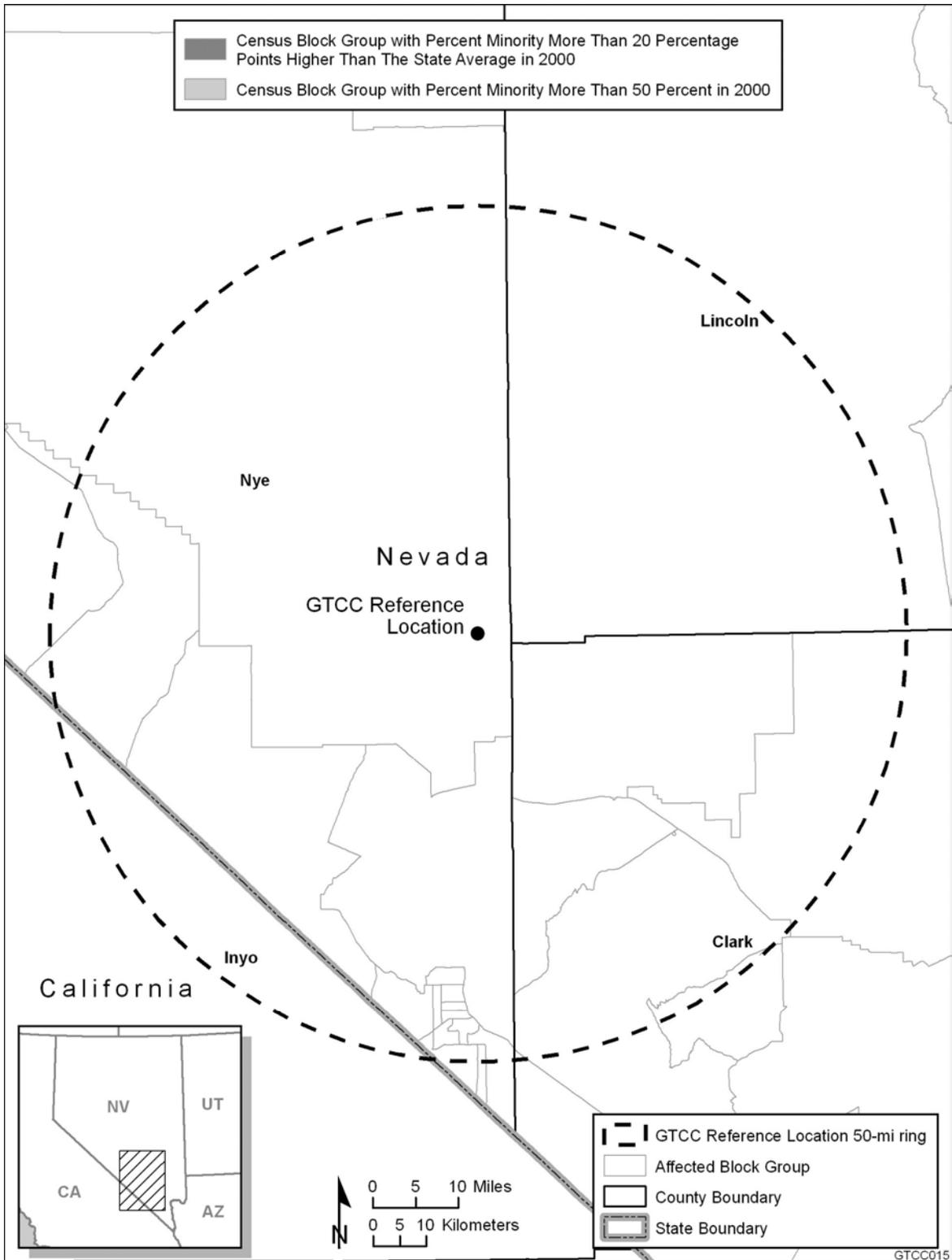
9 NNSS encompasses about 352,512 ha (870,400 ac) (Wills 2007). The site was
10 established in 1950 to permit testing of underground and atmospheric nuclear devices. It is
11 bordered on all sides by federal lands: the Yucca Mountain Project Area on the southwest corner,
12 the Nevada Test and Training Range (NTTR) on the west and north, an area used by both the
13 NTTR and the Desert National Wildlife Range on the east, and BLM-administered lands on the
14 south (Wills 2007).

15

16 DOE's NNSA Nevada Site Office (NNSA/NSO) directs the management and operation
17 of NNSS. The three major missions at NNSS are (1) national security (involving stockpile
18 stewardship, homeland security, and test readiness programs), (2) environmental management
19 (involving the environmental restoration and waste management programs), and (3) stewardship
20 of NNSS (involving the maintenance of facilities and infrastructure to support all NNSS
21 programs and to provide a safe environment for NNSS workers). The primary role of NNSS is to
22 ensure that the existing U.S. stockpile of nuclear weapons remains safe and reliable (Wills 2007).
23 Land use by each of the NNSS missions occurs within zones designated by the land use map
24 depicted in the *NTS Resource Management Plan* as shown in Wills (2007).

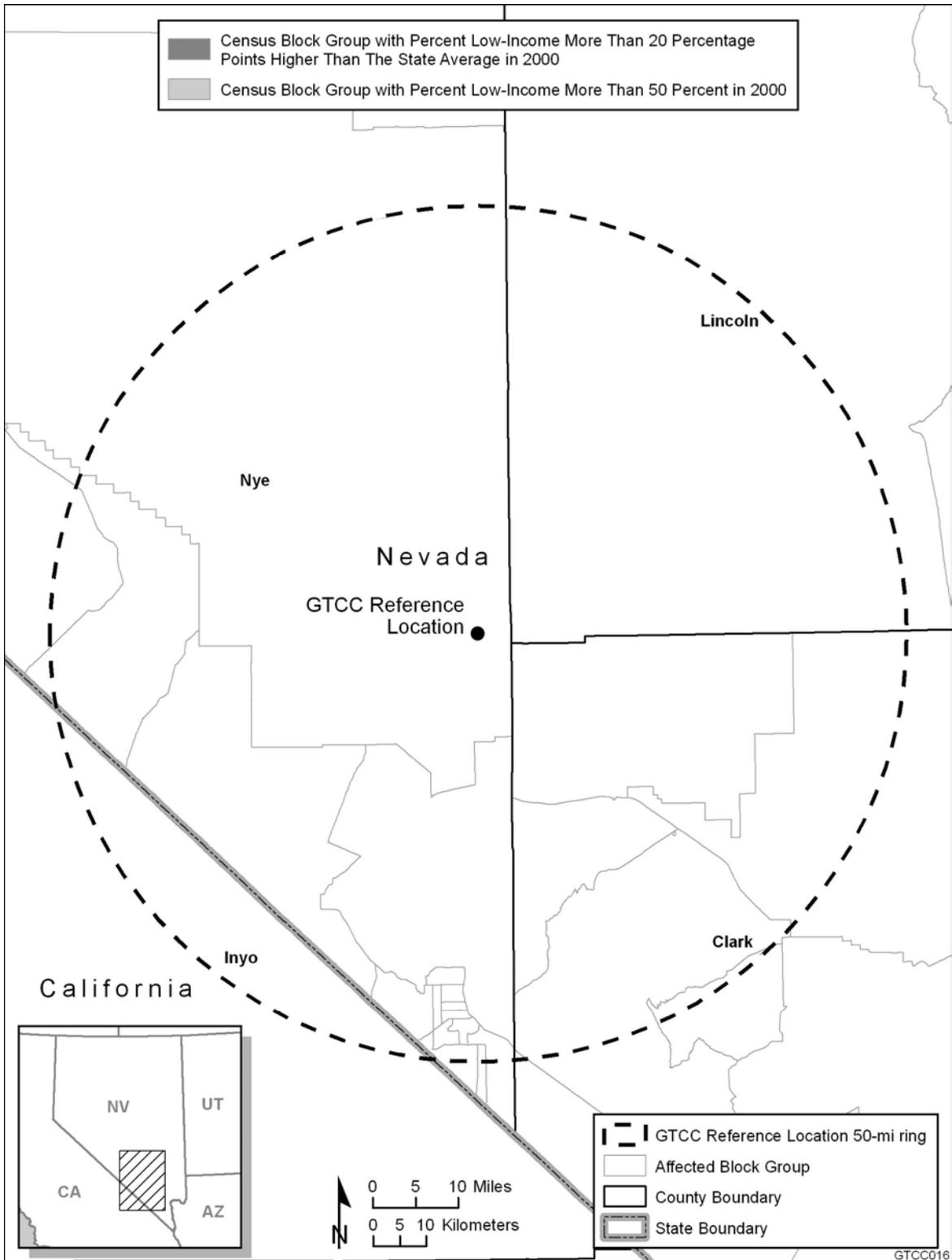
25

26 Two areas (Area 3 and Area 5) support the waste management program at NNSS. The
27 program is designed to safely manage and dispose of LLRW and safely manage and characterize
28 hazardous and TRU wastes for off-site disposal (Wills 2007). The GTCC reference location at
29 NNSS is located within Area 5 and serves as a basis for evaluation. If NNSS is selected, the final
30 location for a disposal facility within Area 5 will be based on further analysis.



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FIGURE 9.1.7-1 Minority Population Concentrations in Census Block Groups within an 80-km (50-mi) Radius of the GTCC Reference Location at NNSS (Source: U.S. Bureau of the Census 2008b)



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FIGURE 9.1.7-2 Low-Income Population Concentrations in Census Block Groups within an 80-km (50-mi) Radius of the GTCC Reference Location at NNSS (Source: U.S. Bureau of the Census 2008b)

TABLE 9.1.7-1 Minority and Low-Income Populations within an 80-km (50-mi) Radius of NNSS

Population	California Block Groups	Nevada Block Groups
Total population	638	37,558
White, Non-Hispanic	503	31,064
Hispanic or Latino	43	3,569
Non-Hispanic or Latino minorities	92	2,925
One race	77	2,059
Black or African American	2	1,074
American Indian or Alaskan Native	63	440
Asian	8	347
Native Hawaiian or other Pacific Islander	4	118
Some other race	0	80
Two or more races	15	866
Total minority	135	6,494
Percent minority	21.2	17.3
Low-income	79	3,770
Percent low-income	12.4	10.0
State percent minority	40.5	24.8
State percent low-income	14.2	10.5

Source: U.S. Bureau of the Census (2008b)

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9.1.9 Transportation

NNSS is situated about 96 km (60 mi) northwest of Las Vegas, Nevada. The major regional road access to the area is from I-15 as it passes through Las Vegas on its journey from Los Angeles (to the southwest) to Salt Lake City, Utah (to the northeast). The site is circled by U.S. and state highways, with US 95 to the south and west, US 6 and SR 375 to the north, and US 93 to the east. Farther from the area, I-80 and I-40 are both major east-west freeways. To the north, I-80 passes through Salt Lake City, Utah, and Reno, Nevada. To the south, I-40 passes through Flagstaff, Arizona, and Barstow, California.

US 95 is a major north-south roadway extending south to the Mexican border and north to the Canadian border. It is, by far, the most frequently used road for direct access to NNSS and is used by more than 95% of the employees working on-site. It is the closest and most direct route to the site for hauling materials and waste, whether hauled directly by trucks or by rail (DOE 1996). It is a four-lane roadway between Las Vegas and the Mercury interchange and within Las Vegas, and it is a two-lane rural highway beyond the Mercury interchange to the north. US 93 is a major north-south roadway across Nevada. It extends from Las Vegas to the Canadian border, intersecting I-80 near the town of Wells, Nevada. It is an all-weather, two-lane, paved roadway. US 6 is an east-west roadway, located to the north of NNSS and the Tonopah Test Range, and it links US 93 and US 95. Nevada SR 375 provides vehicular access to NNSS via a connecting road. It runs northwest along the northeastern boundaries of the site. This

1 stretch of two-lane highway links US 6 and US 93. Traffic counts for these roads are provided in
 2 Table 9.1.9-1.

3

4 The main access to NNSS is the Mercury Highway, which originates at US 95 and
 5 accesses the main gate in Mercury. There is another entrance 8 km (5 mi) to the west of Mercury,
 6 which is a turnoff to Jackass Flats Road; however, this entrance is presently barricaded. NNSS
 7 has restricted access into Area 25 from US 95 at Lathrop Wells Road, approximately 32 km
 8 (20 mi) west of Mercury. A fourth entrance, seldom used, is located in the northeast corner of
 9 NNSS and can be reached from SR 375 (DOE 1996). Access to NNSS is restricted, and guard
 10 stations are located at all entrances, as well as throughout the site (DOE 1996).

11

12

TABLE 9.1.9-1 Traffic Counts in the Vicinity of NNSS

Location	Annual Average Daily Traffic
DOE access road to Mercury from US 95	1,250
US 95	
At SR 157 interchange	11,100
North of Indian Springs, south of DOE access road	3,650
4 mi north of Mercury interchange	3,050
1.5 mi south of SR 373	2,900
0.2 mi north of SR 373	2,550
Milepost 77, between SR 267 and SR 374	2,200
Just south of Goldfield	1,900
South of Tonopah	2,150
US 6	
West of Tonopah	2,000
East of Tonopah and SR 376	590
West of Warm Springs	300
SR 375	
East of Warm Springs	150
West of SR 318	220
US 93	
South of Alamo	1,550
North of I-15 interchange	2,550
I-15	
North of SR 604 interchange	26,100

Source: NDOT (2007)

13

1 On-site, the 1,127-km (700-mi) road network consists of 644 km (400 mi) of paved
2 primary roads and 482 km (300 mi) of unpaved secondary roads (DOE 1996). Most paved
3 roadways are two-way and two-lane with a speed limit of 89 km/h (55 mph) unless posted
4 otherwise. The speed limit in developed areas is 32 km/h (20 mph). The maximum speed limit on
5 dirt roads is 56 km/h (35 mph). In addition, NNSS contains numerous event-related unpaved
6 roads that are not maintained after a test has been conducted. Traffic flow and control throughout
7 NNSS are maintained by conventional stop and yield signs at major intersections. Traffic
8 regulations are enforced by the Nye County Sheriff's Department.

9
10 NNSS does not have direct rail access. The closest access to commercial rail service is in
11 Las Vegas. However, the transportation of inbound LLRW shipments through Las Vegas has
12 been discouraged, especially through the I-15 and US 95 interchange (the "spaghetti bowl")
13 (DOE 2007a), which is subject to heavy traffic congestion. Use of intermodal facilities at either
14 Barstow, California (in San Bernadino County), or Caliente, New Mexico, was recommended in
15 the past because the rail terminals can readily handle additional freight, they keep shipments
16 from more populated areas, and they are near major highways (DOE 1999). Shipment distances
17 by truck from Barstow and Caliente would be approximately 290 km (180 mi) and 550 km
18 (340 mi), respectively. The route from Caliente to NNSS, which is necessarily longer to avoid
19 Las Vegas, circles the site to the north and west (via SR 375, US 6, and US 95) before access
20 at Mercury.

American Indian Text

The area comprising the NNSS is recognized as being traditionally used and occupied for ceremony and subsistence by the Owens Valley Paiutes, Western Shoshone and Southern Paiute for thousands of years. Accordingly, the central feature of subsistence involved agricultural villages located to the east in Pahranaagat Valley, the Muddy River, and the Colorado river, to the south at a series of artesian springs and to the west along Oasis Valley. Farming sites were also located on the NNSS. Permanent non-farm based villages existed on water sources to the north. Seasonal hunting and gathering occurring at various locations in the hinterlands of these agricultural villages including throughout the NNSS. Ceremonial destination locations occur with some frequency atop volcanoes and basalt flows on the NNSS and throughout the region. The pilgrimage trails to these destinations criss-cross the NNSS and are marked with prayer and offering locations both on the NNSS and in the surrounding region.

9.1.10 Cultural Resources

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26
27 NNSS was established in 1950 as part of Nellis Air Force Base to support nuclear and
28 weapons testing. NNSS is located 100 km (65 mi) northwest of Las Vegas, Nevada. NNSS was
29 the site of more than 928 nuclear tests between 1951 and 1992. The eastern portion of the site
30 is an area known as Frenchman Flat, a dry lakebed. It is where the GTCC waste disposal facility
31 reference location is situated. Fourteen atmospheric tests were conducted in Frenchman Flat
32 between 1951 and 1962, and five underground tests were conducted between 1965 and 1968.
33 The first test ever conducted at NNSS occurred in Frenchman Flat. Many of the tests were done

1 to examine the effects of a bomb blast on various objects, including bridges, buildings, and
2 appliances.

3
4 Cultural resource management at NNSS is overseen by the DOE-Nevada Site Office
5 (NV) (DOE 1996). The primary cultural resources support contractor for the site is the Desert
6 Research Institute. Management of cultural resources is guided by two PAs among the DOE-NV,
7 Nevada SHPO, and ACHP. In 1990, one of the agreements established the Long-Range Study
8 Plan for Negating Potential Adverse Effects to Historic Properties on Pahute and Rainier Mesas.
9 These agreements and compliance activities under the NHPA have resulted in the surveying of
10 almost 18,000 ha (45,000 ac). More than 1,700 archaeological sites and roughly 600 historic
11 buildings have been identified on NNSS (DOE 1996). Within Frenchman Flat, 42 archaeological
12 surveys, covering roughly 1,320 ha (3,260 ac), have been conducted. The surveys identified
13 99 archaeological sites, of which 49 are considered eligible for listing on the NRHP. Resources
14 identified included 2 temporary camps, 2 extractive localities, 38 processing localities,
15 52 localities, 1 residential base, 2 historic sites, and 2 sites that are related to nuclear testing
16 (DOE 1996). NNSS is within the Great Basin Cultural Area.

17

American Indian Text

In 1985, the DOE began long-term research to inventory and evaluate American Indian cultural resources on the NNSS. This research was designed to comply with the American Indian Religious Freedom Act (AIRFA), which specified first Amendment of the United States Constitution rights of American Indian people to have access to lands and resources essential in the conduct of their traditional religion. These rights are exercised not only on tribal lands but beyond the boundaries of the reservations.

The research confirmed cultural affiliation of seventeen tribes and organizations representing the Owens Valley Paiute, Western Shoshone and Southern Paiutes. At the completion of the initial research, the DOE initiated government-to-government consultation as a means of actively involving the tribes in new, existing and proposed activities at the NNSS. Due to the complexities associated with the DOE activities, the culturally affiliated tribes aligned themselves together to form the Consolidated Group of Tribes and Organizations (CGTO). Each tribal government represented by the CGTO participates through their designated representatives to convey tribal concerns and perspectives to the DOE while concurrently providing periodic updates back to their respective tribal governments. This regional consultation model has been adapted by most federal agencies in the area and serves as the impetus for continuous tribal consultations through the NNSS American Indian Program.

Accordingly, the CGTO knows, based upon its collective knowledge of Indian culture and past American Indian studies, that American Indian people view cultural resources as being integrated. Thus, systematic studies of a variety of American Indian cultural resources must be conducted before the cultural significance of a place, area or region can be fully assessed. Although some of these studies have been conducted on the NNSS and nearby lands, many studies still need to be completed. In order for Indian people to fully assess the cultural significance of a place and its associated natural and cultural resources, systematic studies must include the following areas to be properly evaluated: ethnoarchaeology, ethnobotany, ethnozology, rock art, traditional cultural properties, ethnogeography and cultural landscapes.

1 The materials found on NNSS come from all of the major prehistoric time periods. The
2 earliest evidence for people on NNSS dates to 10,000 to 8,000 BC in Fortymile Canyon
3 (National Security Technologies 2007). Over the last 12,000 years, there have been periods
4 having both wetter and cooler conditions and dry and hot periods. The archaeological record
5 provides evidence on how people living within the Great Basin, which is the greater cultural area
6 that contains Nevada, reacted to these changes. During wetter periods, evidence indicates that
7 seed and plant use increased and people tended to be more sedentary. In hot dry periods, sites
8 tended to be smaller and more ephemeral.

9
10 During the contact period with Europeans, the two main American Indian groups living
11 in the NNSS region were the Southern Paiute and the Western Shoshone. These groups used
12 resources at various elevations and locations across the landscape. Groups moved in seasonal
13 rounds and collected resources as they became available. A group consisting of members of the
14 Southern Paiute and Western Shoshone known as the Eso were reported to have been living on
15 what was to become NNSS during the late 1870s (Jones and Drollinger 2001). The Eso used
16 winter residential camps near Pahute and Ranier Mesas and at major springs in the area. The
17 Eso were reported to consist of 42 individuals (Jones and Drollinger 2001).

18
19 The earliest record of Europeans on NNSS concerns groups moving across the site en
20 route to various mining areas in the mid-19th century. The first mining claims on NNSS were
21 associated with the Oak Spring Mine in the northern part of NNSS (Fehner and Gosling 2000).
22 Mining reached its peak in the region during the early part of the 20th century (Jones and
23 Drollinger 2001). Cattle and sheep ranching also began to occur on NNSS in the late
24 19th century. Water supply issues restricted these activities so they achieved only moderate
25 success. Some remnants of these activities are still visible on the landscape. For instance, the
26 remains of the boomtown of Wohmonie, which was located southwest of Frenchman Flat near
27 the Hornsilver Mine, are still visible (Fehner and Gosling 2000). The town sprang up in the late
28 1920s after gold and silver deposits were found. However, the town deteriorated quickly when
29 the initial reports were found to be inflated.

30
31 The military began using the area around NNSS in 1941 when Nellis Air Force Base was
32 established. Nine years later, NNSS was chosen as the location for continental bomb tests.
33 Previous tests were conducted in the Pacific; however, the logistics of these tests and
34 vulnerability to spying made a continental test site desirable. After a three-year study, NNSS was
35 chosen. Testing began in 1951 in Frenchman Flat. Testing ceased in 1992 when the Test Ban
36 Treaty was proposed. No testing has taken place on the site since 1992. One of the missions
37 carried out at NNSS is stockpile management of nuclear waste. Several locations in Frenchman
38 Flat are used for storage of radioactive waste.

39
40 Adjacent to the project area in Frenchman Flat is RWMS 5. This facility is a 3,300-ha
41 (8,200-ac) facility for the storage of LLRW. The facility consists of 22 disposal cells. Waste is
42 placed in drums or shipping containers and then stacked in the cells. Once the cell is full, the
43 material is sealed with soil. Area 5 has roughly 290 ha (720 ac) of land available for future waste
44 (Becker et al. 2000).

45

American Indian Text

Views are important cultural resources that contribute to the location and performance of American Indian ceremonialism. Views combine with other cultural resources to produce special places where power is sought for medicine and other types of ceremonies. Views can be of any landscape, but more central viewscapes are experienced from high places, which are often the tops of mountains and the edges of mesas. Indian viewscapes tend to be panoramic and are special when they contain highly diverse topography. The viewscape panorama is further enhanced by the presence of volcanic cones and lava flows. Viewscapes are tied with songscapes and storyscapes, especially when the vantage point has a panorama composed of multiple locations from either song or story. Key to the Indian experience of viewscapes is isolation. Successful performance of ceremonies (whether by individuals or groups) is often commemorated by the building of rock cairns and by storied rocks and paintings. The CGTO tribes recognize the cultural significance of viewscapes and have identified a number of these on the NNSS. The Timber Mountain Caldera contains a number of significant points with different panoramas, including Scrugham Peak-Buckboard Mesa and the Shoshone Mountain massif.

The CGTO knows that American Indian cultural resources include all physical, artifactual, and spiritual aspects of the NNSS. The CGTO has established that formal studies of these aspects of the land should be conducted to identify, assess, mitigate, and manage these resources. These resources should be studied with members of the CGTO recommended for the study. Such studies are termed: (1) Ethnoarchaeology, (2) Ethnobotany, (3) Ethnozoology, (4) Storied Rocks, (5) Traditional Cultural Properties, (6) Ethnogeography, and (7) Cultural Landscapes in the Final Environmental Impact Statement for the Nevada Test Site and Off-site locations in the State of Nevada Volume 1, Appendix G.

The CGTO knows that many of these cultural resources are directly present on the GTCC proposed site, in the Indian Defined Area of Potential Effect, and immediate region surrounding the GTCC site. The Indian people who visited the GTCC site note that their time on-site was insufficient to fully identify, analyze, and evaluate resource that may be present. They recommend one or more of the kinds of resource studies identified above be conducted. Based on their site visit they do know that the area contains important cultural resources including plants, animals, minerals, trails, and portions of cultural landscapes.

Cultural Artifacts and Features

The CGTO knows based on previous DOE-sponsored cultural studies that there are many cultural artifacts and features on the NNSS. Indian people visiting the proposed GTCC site identified the following traditional cultural artifacts and features: (1) Chert Flakes, (2) Rock Alignments, (3) Boulder Grinding Indentation or metate (Mata in Owens Valley, Doso in Western Shoshone, Mada in Southern Paiute), (4) Hand Grinding Stone or mano (Paha or Tusu in Owens Valley, Botoh in Western Shoshone, Mohum in Southern Paiute), (5) Volcanoes, (6) Trails, and (7) Chalcedony, and (8) Yellow Jasper.

Continued on next page

Continued

Artifacts are the evident signs of our ancestors on this land. They are proof that we were here for thousands of years. We were told by our elders never to move artifacts or take them from their place. This is their home because they were left there for us to see and understand the past. We never remove them because they still belong to the ancestors who put them there for us and still watch over them today. Artifacts come from parts of the living earth and are still alive with a right to remain where they were placed. Whether or not there is evidence of being modified, the volcanoes, stones, rocks and trails that we incorporated into our lives are artifacts. These were visited for ceremony, chosen and moved as offerings, and traveled on our journeys and thus were a part of our life, are artifacts of our ancestors that we respect, and are there for future generations.

1
2
3 The GTCC reference location, which is located southeast of the RWMS, contains no
4 significant cultural resources. The area west of the RWMS has been examined for cultural
5 resources. A small portion of this area was surveyed in 1991 as part of the research conducted for
6 a monitoring well project (Holz 1991). The survey identified two isolated artifacts: a single
7 broken piece of pottery and a single thinning flake. Neither site is considered eligible for the
8 NRHP. A larger survey was conducted in 1996 prior to construction of the RWMS. The surveys
9 identified numerous isolated finds and two small prehistoric sites. The sites consisted of several
10 chert flakes and core fragments that represent evidence of expedient reduction activities. None of
11 the sites were recommended as being eligible for listing on the NRHP. The remainder of the area
12 was examined in 2001 as part of the research conducted for an underground test area seismic
13 lines project. While the survey identified numerous cultural resources (prehistoric and historic),
14 none was determined eligible for the NRHP (Jones and Drollinger 2001).

9.1.11 Waste Management

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19 Site management of the waste types generated by the land disposal methods for
20 Alternatives 3 to 5 is discussed in Section 5.3.11.

9.2 ENVIRONMENTAL AND HUMAN HEALTH CONSEQUENCES

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23
24
25 The following sections address the potential environmental and human health
26 consequences for each resource area discussed in Section 9.1.

9.2.1 Climate and Air Quality

27
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29
30
31 This section presents potential climate and air quality impacts from the construction and
32 operations of the disposal facilities (borehole, trench, and vault) at NNSS. Noise impacts are
33 presented in Section 5.3.1.

9.2.1.1 Construction

During the construction period, emissions of criteria pollutants (e.g., SO₂, NO_x, CO, PM₁₀, and PM_{2.5}), VOCs, and the primary greenhouse gas CO₂ would be caused by fugitive dust emissions from earth-moving activities and engine exhaust emissions from heavy equipment and commuter, delivery, and support vehicles. Typically, potential impacts on ambient air quality from exhaust emissions would be smaller than impacts from fugitive dust emissions.

Air emissions of criteria pollutants, VOCs, and CO₂ from construction activities are estimated for the peak year when site preparation and construction of the support facility and some disposal cells would take place. The estimates for PM₁₀ and PM_{2.5} include diesel particulate emissions from the engine exhaust. The estimates are provided in Table 9.2.1-1 for each disposal method. Detailed information on emission factors, assumptions, and emission inventories is available in Appendix D. As shown in the table, total peak-year emission rates are estimated to be rather small when compared with Nye County emission totals. Peak-year emissions for all criteria pollutants (except PM₁₀ and PM_{2.5}) and VOCs would be the highest for

TABLE 9.2.1-1 Peak-Year Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Construction of the Three Land Disposal Facilities at NNSS

Pollutant	Total Emissions (tons/yr) ^a	Construction Emissions (tons/yr)					
		Trench		Borehole		Vault	
SO ₂	236	0.90	(0.38) ^b	3.0	(1.3)	3.2	(1.4)
NO _x	866	8.1	(0.94)	26	(3.0)	31	(3.6)
CO	7,949	3.3	(0.04)	11	(0.14)	11	(0.14)
VOCs	1,444	0.90	(0.06)	2.7	(0.19)	3.6	(0.25)
PM ₁₀ ^c	3,640	5.0	(0.14)	13	(0.36)	8.6	(0.24)
PM _{2.5} ^c	696	1.5	(0.22)	4.1	(0.59)	3.6	(0.52)
CO ₂		670		2,200		2,300	
County ^d	8.88 × 10 ⁵		(0.08)		(0.25)		(0.26)
Nevada ^e	5.46 × 10 ⁷		(0.001)		(0.004)		(0.004)
U.S. ^e	6.54 × 10 ⁹		(0.00001)		(0.00003)		(0.00004)
Worldwide ^e	3.10 × 10 ¹⁰		(0.000002)		(0.000007)		(0.000007)

^a Total emissions in 2002 for Nye County, within which NNSS is located. See Table 9.1.1-1 for criteria pollutants and VOCs.

^b As percent of total emissions.

^c Estimates for GTCC construction include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available; thus county-level emissions were estimated from available state-total CO₂ emissions on the basis of the population distribution.

^e Annual CO₂ emissions in Nevada, the United States, and worldwide in 2005.

Sources: EIA (2008); EPA (2008b, 2009)

1 the vault method because it would consume more materials and resources for construction than
2 would the other two methods. The borehole method would disturb a bigger area, so it is
3 estimated that fugitive dust emissions would be the highest for that method. Peak-year emissions
4 of all pollutants would be the lowest for the trench method, which involves the smallest disturbed
5 area among the disposal methods. In terms of contribution to the emissions total, peak-year
6 emissions of NO_x for the vault method would be the highest, about 3.6% of the county emissions
7 total, while it is estimated that emissions of other criteria pollutants and VOCs would be less
8 than 1.4% of the county emissions total.

9
10 Background concentration levels for PM₁₀ and PM_{2.5} at NNSS are below the standards
11 (less than 91%) (see Table 9.1.1-3). All construction activities at NNSS would occur at least
12 6 km (4 mi) from the site boundary and thus would not contribute much to concentrations at the
13 boundary or at the nearest residence. Construction activities should still be conducted so as to
14 minimize potential impacts of construction-related emissions on ambient air quality.
15 Construction permits typically require fugitive dust control by established standard dust control
16 practices, primarily by watering unpaved roads, disturbed surfaces, and temporary stockpiles.

17
18 One-hour O₃ levels at NNSS are below the standard (about 83%), but
19 8-hour O₃ levels in neighboring Clark County, including Las Vegas, exceed the standard
20 (see Table 9.1.1-3). Nye County, including NNSS, is currently in attainment for O₃
21 (40 CFR 81.329). O₃ precursor emissions from the potential GTCC waste disposal facility
22 from all methods would be relatively small, less than 3.6% and 0.27% of the county total
23 NO_x and VOC emissions, respectively, and would be much lower than those for the regional air
24 shed in which emitted precursors are transported and formed into O₃. In particular, southwesterly
25 winds prevail in the area that includes NNSS (see Figure 9.1.1-1) and neighboring Clark County.
26 Accordingly, potential impacts of O₃ precursor releases from construction on regional O₃ would
27 not be of concern.

28
29 The major air quality concern with respect to emissions of CO₂ is that it is a greenhouse
30 gas, which traps solar radiation reflected from the earth, keeping it in the atmosphere. The
31 combustion of fossil fuels makes CO₂ the most widely emitted greenhouse gas worldwide.
32 CO₂ concentrations in the atmosphere have been continuously increasing; they went from
33 approximately 280 ppm in preindustrial times to 379 ppm in 2005 (a 35% increase). Most of
34 this increase occurred in the last 100 years (IPCC 2007).

35
36 The climatic impact of CO₂ does not depend on the geographic locations of its sources,
37 because CO₂ is stable in the atmosphere and is essentially uniformly mixed; that is, the global
38 total is the important factor with respect to global warming. Therefore, a comparison between
39 U.S. and global emissions and the total emissions from the construction of a disposal facility is
40 useful in understanding whether the CO₂ emissions from the site are significant with respect to
41 global warming. As shown in Table 9.2.1-1, the highest peak-year amount of CO₂ emissions
42 from construction would be 0.26%, 0.004%, and 0.00004% of 2005 county, state, and U.S. CO₂
43 emissions. In 2005, CO₂ emissions in the United States were about 21% of worldwide emissions
44 (EIA 2008). Potential impacts on climate change from construction emissions would be small.

45

1 Appendix D assumes an initial construction period of 3.4 years. The disposal units would
2 be constructed as the waste became available for disposal. The construction phase would extend
3 over more years; thus, emissions for nonpeak years would be lower than peak-year emissions in
4 the table. In addition, construction activities would occur only during daytime hours, when air
5 dispersion is most favorable. Accordingly, potential impacts from construction activities on
6 ambient air quality would be minor and intermittent in nature.

7
8 General conformity applies to federal actions taking place in nonattainment or
9 maintenance areas and is not applicable to the proposed action at NNSS because the area is
10 classified as attainment for all criteria pollutants (40 CFR 81.329).

11 12 13 **9.2.1.2 Operations**

14
15 Criteria pollutants, VOCs, and CO₂ would be released into the atmosphere during
16 operations. These emissions would include fugitive dust emissions from emplacement activities
17 and exhaust emissions from heavy equipment and commuter, delivery, and support vehicles.
18 Estimated annual emissions of criteria pollutants, VOCs, and CO₂ at the facility are presented in
19 Table 9.2.1-2. Detailed information on emission factors, assumptions, and emission inventories
20 is available in Appendix D. As shown in the table, annual emissions are estimated to be higher
21 for operational activities than for construction activities under the trench method. Annual
22 emissions from operations for the trench and vault methods would be greater than those for the
23 borehole method. Compared with annual emissions for counties, including NNSS, the annual
24 emissions of NO_x from the trench and vault methods would be higher than those from the
25 borehole method, about 3% of the emission total, while emissions of other criteria pollutants and
26 VOCs would be about 1.4% of the total or less.

27
28 It is expected that concentration levels from operational activities would remain below
29 the standards. Estimates for the PM₁₀ and PM_{2.5} include diesel particulate emissions. As
30 discussed in the construction section, established fugitive dust control measures, including the
31 watering of unpaved roads, disturbed surfaces, and temporary stockpiles, would be implemented
32 to minimize potential impacts on ambient air quality.

33
34 With regard to regional O₃, precursor emissions of NO_x and VOCs would be comparable
35 to those resulting from construction activities (about 3% and 0.21% of the county emission
36 totals, respectively) and are not anticipated to contribute much to regional O₃ levels. The highest
37 operations-related emissions of CO₂ among the disposal methods would be comparable to the
38 highest construction-related emissions, and thus the potential impacts from operations on climate
39 change would also be negligible.

40
41 PSD regulations are not applicable to the proposed action because the proposed action is
42 not a major stationary source.

TABLE 9.2.1-2 Annual Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Operations of the Three Land Disposal Facilities at NNSS

Pollutant	Total Emissions (tons/yr) ^a	Operation Emissions (tons/yr)					
		Trench		Borehole		Vault	
SO ₂	236	3.3	(1.4) ^b	1.2	(0.51)	3.3	(1.4)
NO _x	866	27	(3.1)	10	(1.2)	27	(3.1)
CO	7,949	15	(0.19)	6.7	(0.08)	15	(0.19)
VOCs	1,444	3.1	(0.21)	1.2	(0.08)	3.1	(0.21)
PM ₁₀ ^c	3,640	2.5	(0.07)	0.91	(0.03)	2.5	(0.07)
PM _{2.5} ^c	696	2.2	(0.32)	0.81	(0.12)	2.2	(0.32)
CO ₂		3,200		1,700		3,300	
County ^d	8.88 × 10 ⁵		(0.36)		(0.19)		(0.37)
Nevada ^e	5.46 × 10 ⁷		(0.006)		(0.003)		(0.006)
U.S. ^e	6.54 × 10 ⁹		(0.00005)		(0.00003)		(0.00005)
Worldwide ^e	3.10 × 10 ¹⁰		(0.00001)		(0.00001)		(0.00001)

^a Total emissions in 2002 for Nye County, within which NNSS is located. See Table 9.1.1-1 for criteria pollutants and VOCs.

^b As percent of total emissions.

^c Estimates for GTCC operations include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available, so county-level emissions were estimated from available state-total CO₂ emissions on the basis of the population distribution.

^e Annual CO₂ emissions in Nevada, the United States, and worldwide in 2005.

Source: EIA (2008); EPA (2008b, 2009)

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9.2.2 Geology and Soils

Direct impacts from land disturbance would be proportional to the total area of land disturbed during site preparation activities (e.g., grading and backfilling) and construction of the GTCC waste disposal facility and related infrastructure (e.g., roads). Land disturbance would include the surface area covered by each disposal method and the vertical displacement of geologic materials for the borehole and trench disposal methods. The increased potential for soil erosion would be an indirect impact from land disturbance at the construction site. Indirect impacts would also result from the use of geologic materials (e.g., aggregate) for facility and new road construction. The impact analysis also considers whether the GTCC action would preclude the future extraction and use of mineral materials or energy resources.

9.2.2.1 Construction

Impacts from disturbing the land surface area would be a function of the disposal method implemented at the site (Table 5.1.1). Of the three disposal facility layouts, the borehole facility layout would have the greatest impact in terms of land area disturbed (44 ha or 110 ac). It would also result in the greatest disturbance with depth (40 m or 130 ft), with boreholes completed in unconsolidated clay, silt, sand, and gravel.

Geologic and soil material requirements are provided in Table 5.3.2-1. Of the three disposal methods, the vault method would require the most material since it would involve the installation of interim and final cover systems. This material would be considered permanently lost. However, none of the three disposal methods are expected to result in adverse impacts on geologic and soil resources at NNSS, since these resources are in abundant supply at the site and in the surrounding area.

No significant changes in surface topography or natural drainages are anticipated in the construction area. However, the disturbance of soil during the construction phase would increase the potential for erosion in the immediate vicinity. This potential would be greatly reduced, however, by the low precipitation rates at NNSS. Also, mitigation measures would be implemented to avoid or minimize the risk of erosion.

The GTCC waste disposal facility would be sited and designed with safeguards to avoid or minimize the risks associated with seismic and volcanic hazards. NNSS is in a seismically active region, and small-magnitude earthquakes (usually less than 3 on the Richter scale) occur frequently in Frenchman Flat.

The annual probability of a volcanic event (basaltic eruption) is considered to be very low. The risk of silicic volcanism is negligible; however, airborne ash might be deposited on-site in the event of a silicic volcanic eruption, since silicic volcanic activity still occurs along the margins of the Great Basin. The potential for other hazards (e.g., subsidence and liquefaction) is also considered to be low.

9.2.2.2 Operations

The disturbance of soil and the increased potential for soil erosion would continue throughout the operational phase as waste was delivered to the site for disposal over time. The potential for soil erosion would be greatly reduced by the low precipitation rates at NNSS. Mitigation measures also would be implemented to avoid or minimize the risk of erosion.

Impacts related to the extraction and use of valuable geologic materials would be low, since only the area within the facility itself would be unavailable for mining, and the potential for oil production and geothermal energy development are considered to be low for the site. NNSS is currently closed to commercial mineral development; activities on-site would not have adverse impacts on the extraction of economic minerals in the surrounding region.

1 **9.2.3 Water Resources**

2

3 Direct and indirect impacts on water resources could occur as a result of water use at the
4 proposed GTCC waste disposal facility during construction and operations. Table 5.3.3-1
5 provides an estimate of the water consumption and discharge volumes for the three land disposal
6 methods. Tables 5.3.3-2 and 5.3.3-3 summarize the impacts from water use (in terms of change
7 in annual water use) on water resources during construction and normal operations, respectively.
8 A discussion of potential impacts during each project phase is presented in the following
9 sections. In addition, contamination due to potential leaching of radionuclides into groundwater
10 from the waste inventory could occur, depending on the post-closure performance of the land
11 disposal facilities discussed in Section 9.2.4.2. However, the potential for mobilization of
12 contaminants to groundwater from all these sources is negligible because of the arid climate, the
13 extensive depth to groundwater (thickness of the vadose zone), and the proven behavior of liquid
14 and vapor fluxes in the vadose zone (primarily upward movement toward the ground surface).

15

16

17 **9.2.3.1 Construction**

18

19 Of the three land disposal methods considered for NNSS, construction of a vault facility
20 would have the greatest water requirement (Table 5.3.3-1). Water demands for construction at
21 NNSS would be met by using groundwater from on-site wells completed in the Great Basin
22 aquifer system. No surface water would be used at the site during construction. As a result, no
23 direct impacts on surface water resources are expected. The potential for indirect surface water
24 impacts related to soil erosion, contaminated runoff, and sedimentation is very low but would be
25 reduced by implementing good industry practices and mitigation measures. Streams at NNSS are
26 ephemeral, and the GTCC reference location is not located on any known floodplains of these
27 waters.

28

29 NNSS uses about 1.1 billion L (290 million gal) of groundwater per year. Construction
30 of the proposed GTCC waste disposal facility would increase the annual water use at NNSS by
31 a maximum of 0.29% (vault method) over the 20-year period that construction would occur.
32 Because withdrawals of groundwater would be relatively small, they would not significantly
33 lower the water table or change the direction of groundwater flow at NNSS. As a result, impacts
34 due to groundwater withdrawals are expected to be negligible.

35

36 Construction activities might change the infiltration rate at the site of the proposed GTCC
37 waste disposal facility, first by increasing the rate as ground would be disturbed in the initial
38 stages of construction and later by decreasing the rate as impermeable materials (e.g., the clay
39 material and geotextile membrane assumed for the cover or cap in the land disposal facility
40 designs) would cover the surface. These changes are expected to be negligible since the area of
41 land associated with the proposed GTCC waste disposal facility (up to 44 ha [110 ac], depending
42 on the disposal method) would be small relative to NNSS. Disposal waste generated during
43 construction of the land disposal facilities would have a negligible impact on the quality of water
44 resources at NNSS. The potential for indirect surface water or groundwater impacts related to
45 spills at the surface would be reduced by implementing good industry practices and mitigation
46 measures.

47

9.2.3.2 Operations

Of the three land disposal facilities considered for NNSS, the trench and vault facilities would require almost the same amount of water for operations, and that amount would be more than the amount required by a borehole facility (Table 5.3.3-1). Water demands for operations at NNSS would be met by using groundwater from on-site wells completed in the Great Basin aquifer system. No surface water would be used at the site during operations. As a result, no direct impacts on surface water resources are expected. The potential for indirect surface water impacts related to soil erosion, contaminated runoff, and sedimentation would be reduced by implementing good industry practices and mitigation measures. Streams at NNSS are ephemeral, and the GTCC reference location is not located on any known floodplains of these waters.

Operations of the proposed GTCC waste disposal facility would increase annual water use at NNSS by a maximum of about 0.48% (trench or vault method). Because withdrawals of groundwater would be relatively small, they would not significantly lower the water table or change the direction of groundwater flow at NNSS. As a result, impacts due to groundwater withdrawals are expected to be negligible.

Disposal of waste (including sanitary waste) generated during operations of the land disposal facilities would have a negligible impact on the quality of water resources at NNSS. The potential for indirect surface water or groundwater impacts related to spills at the surface would be reduced by implementing good industry practices and mitigation measures.

9.2.4 Human Health

Potential impacts on members of the general public and involved workers from the construction and operations associated with the land disposal facilities are discussed in Section 5.3.4. The following sections discuss the impacts from hypothetical facility accidents associated with waste handling activities and the impacts during the post-closure phase. They address impacts on members of the general public who might be affected by these waste disposal activities at the NNSS GTCC reference location, since these impacts would be site dependent.

9.2.4.1 Facility Accidents

Data on the estimated human health impacts from hypothetical accidents at a land GTCC waste disposal facility located at NNSS are shown in Table 9.2.4-1. The accident scenarios are discussed in Section 5.3.4.2.1 and Appendix C. A reasonable range of accidents that included operational events and natural causes was analyzed. The impacts presented for each accident scenario are for the sector with the highest impacts, and no protective measures are assumed; therefore, the impacts represent the maximum expected for such an accident.

The collective population dose includes exposure from inhalation of airborne radioactive material, external exposure from radioactive material deposited on the ground, and ingestion of contaminated crops. The exposure period is considered to last for 1 year immediately following

TABLE 9.2.4-1 Estimated Radiological Human Health Impacts from Hypothetical Facility Accidents at NNSS^a

Accident Number	Accident Scenario	Off-Site Public		Individual ^b	
		Collective Dose (person-rem)	Latent Cancer Fatalities ^c	Dose (rem)	Likelihood of LCF
1	Single drum drops, lid failure in Waste Handling Building	<0.0001	<0.0001	<0.0001	<0.0001
2	Single SWB drops, lid failure in Waste Handling Building	<0.0001	<0.0001	0.00012	<0.0001
3	Three drums drop, puncture, lid failure in Waste Handling Building	<0.0001	<0.0001	<0.0001	<0.0001
4	Two SWBs drop, puncture, lid failure in Waste Handling Building	<0.0001	<0.0001	0.00017	<0.0001
5	Single drum drops, lid failure outside	0.011	<0.0001	0.053	<0.0001
6	Single SWB drops, lid failure outside	0.024	<0.0001	0.12	<0.0001
7	Three drums drop, puncture, lid failure outside	0.019	<0.0001	0.095	<0.0001
8	Two SWBs drop, puncture, lid failure outside	0.033	<0.0001	0.17	0.0001
9	Fire inside the Waste Handling Building, one SWB assumed to be affected	0.47	0.0003	2.4	0.001
10	Single RH waste canister breach	<0.0001	<0.0001	<0.0001	<0.0001
11	Earthquake affects 18 pallets, each with 4 CH drums	0.3	0.0002	1.5	0.0009
12	Tornado, missile hits one SWB, contents released	0.094	<0.0001	0.48	0.0003

^a CH = contact-handled, RH = remote-handled, LCF = latent cancer fatality, SWB = standard waste box.

^b The individual receptor is assumed to be 100 m (330 ft) downwind from the release point. This individual is expected to be a noninvolved worker because there would be no public access within 100 m (330 ft) of the GTCC reference location.

^c LCFs are calculated by multiplying the dose by the health risk conversion factor of 0.0006 fatal cancer per person-rem (see Section 5.2.4.3). Values are rounded to one significant figure.

1 the accidental release. It is recognized that interdiction of food crops would likely occur if a
2 significant release did occur, but many stakeholders are interested in what could happen without
3 interdiction. For the accidents involving CH waste (Accidents 1–9, 11, 12), the ingestion dose
4 accounts for approximately 20% of the collective population dose shown in Table 9.2.4-1.
5 External exposure was found to be negligible in all cases. All exposures were dominated by the
6 inhalation dose from the passing plume of airborne radioactive material downwind of the
7 hypothetical accident immediately following release.

8
9 The highest estimated impact on the general public, 0.47 person-rem, would be from a
10 hypothetical release from an SWB caused by a fire in the Waste Handling Building (Accident 9).
11 This dose is not expected to lead to any additional LCFs in the population. This dose would
12 be to the 22,800 people living to the south of the facility, resulting in an average dose of
13 approximately 0.00002 rem per person. Because this dose would result from internal intake
14 (primarily inhalation, with some ingestion), and because the DCFs used in this analysis are for a
15 50-year CEDE, this dose would be accumulated over the course of 50 years.

16
17 The dose to an individual (expected to be a noninvolved worker because there would be
18 no public access within 100 m [330 ft] of the GTCC reference location) includes exposure from
19 inhalation of airborne radioactive material and 2 hours of exposure to radioactive material
20 deposited on the ground. As shown in Table 9.2.4-1, the highest estimated dose to an individual,
21 2.4 rem, is for Accident 9 from inhalation exposure immediately after the postulated release.
22 This estimated dose is for a hypothetical individual located 100 m (330 ft) to the southeast of the
23 accident location. A maximum annual dose of about 5% of the total individual dose (to the
24 noninvolved worker) would occur in the first year. The increased lifetime probability of a fatal
25 cancer for the individual is approximately 0.1% on the basis of a total dose of 2.4 rem.

26 27 28 **9.2.4.2 Post-Closure**

29
30 The potential radiation dose from airborne releases of radionuclides to the off-site public
31 after the closure of a disposal facility would be small. On the basis of RESRAD-OFFSITE
32 calculation results, no radiation exposure would result from this pathway for the borehole
33 method, and the radiation doses from the trench or vault method would be small. It is estimated
34 that the potential inhalation dose at a distance of 100 m (330 ft) from the disposal facility would
35 be less than 1.8 mrem/yr for trench disposal and less than 0.52 mrem/yr for vault disposal. The
36 potential radiation exposures would be caused mainly by inhalation of radon gas and its short-
37 lived progeny.

38
39 Because of the extremely arid climate, the precipitation rate at NNSS averages only about
40 12 cm/yr (5 in./yr). Evapotranspiration, however, is estimated to be about 1.68 m/yr (5.5 ft/yr),
41 or about 14 times the average precipitation rate (Bechtel Nevada 2001). As a result, water
42 infiltration to the disposal area would be nearly zero (3.0×10^{-5} m/yr was used in the RESRAD-
43 OFFSITE analyses). With an insufficient driving force for leaching, radionuclides are not
44 expected to reach the groundwater table within 100,000 years. Therefore, no radiation exposure
45 to a hypothetical resident farmer living 100 m (330 ft) from the GTCC waste disposal facility is

1 indicated by the calculations performed. Similarly, releases to rivers and springs would not be
2 expected.

5 **9.2.5 Ecology**

7 Section 5.3.5 presents an overview of the potential impacts on ecological resources that
8 could result from the construction and operations and post-closure maintenance of the proposed
9 GTCC waste disposal facility, regardless of the location selected for it. This section evaluates the
10 potential impacts of the facility on the ecological resources at NNSS.

12 The amount of land cleared to dispose of GTCC wastes would be up to 44 ha (110 ac) for
13 borehole disposal, 24 ha (60 ac) for vault disposal, or 20 ha (50 ac) for trench disposal. It is not
14 expected that the initial loss of creosote bush/white bursage vegetation habitat, followed by
15 eventual establishment of low-growth vegetation on the disposal site, would create a long-term
16 reduction in the local or regional ecological diversity.

18 After closure of the GTCC waste disposal facility, the cover would be planted with
19 annual and perennial grasses and forbs. As appropriate, regionally native plants would be used to
20 landscape the disposal site in accordance with “Guidance for Presidential Memorandum on
21 Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped
22 Grounds” (EPA 1995). Because of the extremely arid climate, the establishment of native plant
23 communities would be very difficult. An aggressive revegetation program would be necessary so
24 that nonnative species, such as red brome, cheatgrass, Russian thistle, and barbwire Russian-
25 thistle, would not become established. These species could rapidly invade disturbed sites at
26 NNSS and delay revegetation by native species (Wills and Ostler 2001).

28 Construction of the proposed GTCC waste disposal facility would affect wildlife species
29 that inhabit the area. Small mammals, ground-nesting birds, and reptiles would recolonize the
30 site once a vegetative cover was reestablished. Larger mammals, such as pronghorn, mule deer,
31 coyote, and mountain lion, would probably avoid the area or would be excluded from the
32 disposal facility because of the fencing.

34 Because no aquatic habitats occur within the immediate vicinity of the GTCC reference
35 location, direct impacts on aquatic biota are not expected. DOE would use appropriate erosion-
36 control measures to minimize off-site movement of soils. The GTCC waste disposal facility
37 retention pond is not expected to become a highly productive aquatic habitat. However,
38 depending on the amount of water and length of time that water was retained in the pond, aquatic
39 invertebrates could become established within it. Waterfowl, shorebirds, and other birds might
40 also make use of the retention pond, as would mammal species that might enter the site.

42 As discussed in Section 9.1.5, the desert tortoise is the only federal listed animal species
43 that is resident on NNSS. It inhabits the southern third of NNSS at very low or none to moderate
44 estimated densities (i.e., between 0.0 and 34.7 tortoises/km² [0.0 and 90/mi²]). In the area of the
45 GTCC reference location, desert tortoise densities range from 0.0 to 3.7/km² (0.0 to 9.6/mi²)
46 (William 2009). The RWMS in Area 5 of NNSS is within the exclusion area identified in the

1 1996 programmatic biological opinion since no desert tortoises were observed in that area of
2 Frenchman Flat (DOE 2007b). In the recent programmatic biological opinion (Williams 2009), it
3 was concluded that the implementation of programmatic activities at NNSS is not likely to
4 jeopardize the continued existence of the desert tortoise or adversely modify any designated
5 critical habitat for the species. Mitigation for the loss of desert tortoise habitat is normally
6 required under the terms and conditions of the biological opinion received from the USFWS. In
7 the current programmatic biological opinion, the measures include these: (1) Preactivity surveys
8 will be conducted to determine the presence of the desert tortoise; (2) a tortoise biologist or
9 environmental monitor will be on-site during all phases of project construction; (3) all NNSA,
10 Nevada Site Office, and contractor personnel will complete the Desert Tortoise Conservation
11 Education Program; (4) project personnel will halt activities, if possible, when the continuation
12 of such activities may endanger a desert tortoise or if a tortoise is found on the project site;
13 (5) vehicle traffic will be restricted to existing paved, graded, or utility access roads; (6) vehicles
14 will be driven within posted speed limits on existing roads and will not exceed 15 mph within
15 project boundaries (any tortoise observed in harm's way on a paved road will be moved off the
16 road in the direction it was going); (7) a litter-control program will be implemented during
17 outdoor program activities that will include the use of covered, raven-proof trash receptacles;
18 disposal of edible trash in trash receptacles following the end of each work day; and disposal of
19 trash in a designated sanitary landfill at the end of each work week; and (8) a habitat reclamation
20 plan will be submitted to the USFWS that describes the methods for stabilizing and revegetating
21 the site (William 2009). It is expected that DOE would enact the terms and conditions of the
22 programmatic biological condition (Williams 2009) to minimize effects on the desert tortoise
23 when constructing and operating the GTCC waste disposal facility.
24

25 The preferred breeding habitat for the burrowing owl on NNSS is in areas most likely
26 to be developed for new projects or to be remediated because of past disturbances. Project
27 construction activities on NNSS could destroy burrowing owl burrows or directly kill owls.
28 Historically, DOE's activities have had only minimal adverse effects on burrowing owls at
29 NNSS (Hall et al. 2003). Since 1990, only one bird was killed from being hit by a vehicle; and
30 since 1979, only two unoccupied burrows were destroyed by project activities. Hall et al. (2003)
31 recommends a buffer zone of 60 m (197 ft) around active burrowing owl burrows at NNSS,
32 within which human activity (e.g., walking and driving) should be limited. Klute et al. (2003)
33 recommends that human activities should be prohibited within 200 m (660 ft) of nest burrows in
34 Idaho and Washington. At construction sites in Nevada's Mojave Desert region, the USFWS
35 (2007) recommends a buffer with a radius of at least 76 m (250 ft) be placed around a burrow
36 within which no construction should occur. Some activities at NNSS (e.g., emplacing culverts
37 and pipes, building roads, digging pits and channels, and building mounds) have benefited
38 burrowing owls by increasing the number of available burrows and by increasing opportunities
39 for predators to dig burrows in altered soil (Wills and Ostler 2001; Hall et al. 2003). In the later
40 case, the burrowing owls indirectly benefit because they use abandoned predator burrows
41 (Hall et al. 2003).
42

43 Pre-activity biological surveys are conducted at proposed project sites where disturbance
44 may occur. The goal of these surveys is to minimize adverse impacts on important plant and
45 animal species and their associated habitat, on important biological resources (e.g., bird nest sites
46 and desert tortoise burrows), and on wetlands (Wills 2007). Therefore, if any other special-status

1 species from the GTCC reference location were identified, appropriate steps would be taken to
2 minimize impacts on those species.

3
4 The overall objective of the ecological monitoring and compliance program at NNSS is
5 to protect the biological resources at NNSS while supporting the mission of DOE in operating
6 the site (Hall et al. 2003). This objective is met by developing procedures that ensure that NNSS
7 activities comply with state and federal wildlife and environmental protection regulations.
8 Therefore, impacts on ecological resources from a GTCC waste disposal facility would be
9 minimized and mitigated.

10 11 12 **9.2.6 Socioeconomics**

13 14 15 **9.2.6.1 Construction**

16
17 The potential socioeconomic impacts from constructing a GTCC waste disposal facility
18 and support buildings at NNSS would be small for all disposal methods. Construction activities
19 would create direct employment of 47 people (borehole method) to 145 people (vault method) in
20 the peak construction year and an additional 51 indirect jobs (borehole and trench methods) to
21 137 indirect jobs (vault method) in the ROI (Table 9.2.6-1). Construction activities would
22 constitute less than 1% of total ROI employment in the peak year. Construction of a disposal
23 facility would produce between \$4.3 million in income (borehole method) and \$12.8 million in
24 income (vault method) in the peak year of construction.

25
26 In the peak year of construction, between 10 people (borehole method) and 32 people
27 (vault method) would in-migrate to the ROI (Table 9.2.6-1) as a result of employment on-site.
28 In-migration would have only a marginal effect on population growth and would require less
29 than 1% of vacant rental housing in the peak year. No significant impact on public finances
30 would occur as a result of in-migration, and no new local public service employees would be
31 required to maintain existing levels of service in the various local public service jurisdictions in
32 the ROI. In addition, on-site employee commuting patterns would have a small to moderate
33 impact on levels of service in the local transportation network surrounding the site.

34 35 36 **9.2.6.2 Operations**

37
38 The potential socioeconomic impacts from operating a GTCC waste disposal facility
39 would be small for all disposal methods. Operational activities would create about 38 direct jobs
40 (borehole method) to 51 direct jobs (vault method) annually and an additional 31 indirect jobs
41 (borehole method) to 36 indirect jobs (vault method) in the ROI (Table 9.2.6-1). The waste
42 facility would also produce between \$4.1 million in income (borehole method) and \$5.1 million
43 in income (vault method) annually during operations.

44
45 No more than one person would move to the area at the beginning of operations
46 (Table 9.2.6-1). In-migration would have only a marginal effect on population growth and would

TABLE 9.2.6-1 Effects of GTCC Facility Construction and Operations on Socioeconomics at the ROI for NNSS^a

Impact Category	Trench		Borehole		Vault	
	Construction	Operation	Construction	Operation	Construction	Operation
Employment (number of jobs)						
Direct	62	48	47	38	145	51
Indirect	51	35	51	31	137	36
Total	113	83	98	69	282	87
Income (\$ in millions)						
Direct	2.0	3.2	1.7	2.6	5.9	3.4
Indirect	2.6	1.6	2.6	1.5	6.9	1.7
Total	4.6	4.8	4.3	4.1	12.8	5.1
Population (number of new residents)	14	1	10	1	32	1
Housing (number of units required)	7	1	5	0	16	1
Public finances (% impact on expenditures)						
Cities and counties ^b	<1	<1	<1	<1	<1	<1
Schools ^c	<1	<1	<1	<1	<1	<1
Public service employment (number of new employees)						
Local government employees ^d	0	0	0	0	0	0
Teachers	0	0	0	0	0	0
Traffic (impact on current levels of service)	Small	Small	Small	Small	Moderate	Small

^a Impacts shown are for waste facility and support buildings in the peak year of construction and the first year of operations.

^b Includes impacts that would occur in the cities of Henderson, Las Vegas, and North Las Vegas and in Clark and Nye Counties.

^c Includes impacts that would occur in Clark and Nye County school districts.

^d Includes police officers, paid firefighters, and general government employees.

1 require less than 1% of vacant owner-occupied housing during facility operations. No significant
2 impact on public finances would occur as a result of in-migration, and no new local public
3 service employees would need to be hired in order to maintain existing levels of service in the
4 various local public service jurisdictions in the ROI. In addition, on-site employee commuting
5 patterns would have only a small impact on levels of service in the local transportation network
6 surrounding the site.

9 **9.2.7 Environmental Justice**

12 **9.2.7.1 Construction**

14 No radiological risk and only very low chemical exposure and risk are expected during
15 construction of a trench, borehole, or vault disposal facility. Chemical exposure during
16 construction would be limited to airborne toxic air pollutants at less than standard levels and
17 would not result in any adverse health impacts. Since the impacts of each facility on the health of
18 the general population within the 80-km (50-mi) assessment area during construction would be
19 negligible, impacts from the construction of each facility on the minority and low-income
20 population would not be significant.

23 **9.2.7.2 Operations**

25 Because incoming GTCC waste containers would only be consolidated for placement in
26 trench, borehole, and vault facilities, with no repackaging necessary, there would be no
27 radiological impacts on the general public during operations and no adverse health effects on the
28 general population. Because the health impacts from routine operations on the general public
29 would be negligible, it is expected that there would be no disproportionately high and adverse
30 impact on minority and low-income population groups within the 80-km (50-mi) assessment
31 area. Subsequent NEPA analysis to support any GTCC implementation would have to consider
32 any unique exposure pathways (such as subsistence fish, vegetation, or wildlife consumption or
33 well water use) to determine any additional potential health and environmental impacts.

36 **9.2.7.3 Accidents**

38 A GTCC waste release at each of the facilities could cause LCFs in the surrounding area.
39 However, it is highly unlikely that such an accident would occur. Therefore, the risk to any
40 population, including low-income and minority communities, is considered to be low. In the
41 unlikely event of a GTCC waste release at a disposal facility, the communities most likely to be
42 affected would not be minority or low-income, given the demographics within 80 km (50 mi) of
43 the GTCC reference location.

45 If an accident producing significant contamination did occur, appropriate measures
46 would be taken to ensure that the impacts on low-income and minority populations would be

1 minimized. The extent to which low-income and minority population groups would be affected
2 would depend on the amount of material released and the direction and speed at which airborne
3 material was dispersed from any of the facilities by the wind. Although the overall risk would be
4 very small, the greatest short-term risk of exposure following an airborne release and the greatest
5 1-year risk would be to the population groups residing to the southeast of the site. Airborne
6 releases following an accident would likely have a larger impact on the area than would an
7 accident that released contaminants directly into the soil surface. A surface release entering local
8 steams could temporarily interfere with subsistence activities being carried out by low-income
9 and minority populations within a few miles downstream of the site.

10
11 Monitoring of contaminant levels in soil and surface water following an accident would
12 provide the public with information on the extent of any contaminated areas. Analysis of
13 contaminated areas to decide how to control the use of areas having a high health risk would
14 reduce the potential impact on local residents.

15 16 17 **9.2.8 Land Use**

18
19 Section 5.3.8 presents an overview of the potential land use impacts that could result
20 from a GTCC waste disposal facility regardless of the location selected for it. This section
21 evaluates the potential impacts from a GTCC waste disposal facility on land use at NNSS. The
22 amount of land altered for the disposal facility would be up to 44 ha (110 ac) for boreholes, 24 ha
23 (60 ac) for vaults, or 20 ha (50 ac) for trenches.

24
25 The GTCC reference location at NNSS is located southeast of the RWMS. Therefore, the
26 area designated for a GTCC waste disposal facility would be integrated into the radioactive
27 waste management zone. The GTCC reference location is located within an area designated as a
28 reserved zone, where defense-related activities are generally conducted (DOE 1996). Therefore,
29 land use in the area occupied by the GTCC disposal facility would be changed from a reserved
30 zone to a radioactive waste management zone. Land use on areas surrounding NNSS would not
31 be affected. Future land use activities that would be permitted within or immediately adjacent to
32 the GTCC reference location would be limited to those that would not jeopardize the integrity of
33 the facility, create a security risk, or create a worker or public safety risk.

34 35 36 **9.2.9 Transportation**

37
38 The transportation of GTCC LLRW and GTCC-like waste necessary for the disposal of
39 all such waste at NNSS was evaluated. As discussed in Section 5.3.9, transportation of all cargo
40 by both truck and rail modes as separate options is considered for the purposes of this EIS.
41 Transportation impacts are expected to be the same for disposal in boreholes, trenches, or vaults
42 because the same type of transportation packaging would be used regardless of the disposal
43 method chosen. Moreover, additional environmental impacts could also result from the
44 construction of a rail spur at NNSS since one does not currently exist.

1 As discussed in Appendix C, Section C.9, three impacts from transportation were
2 calculated: (1) collective population risks during routine conditions and accidents
3 (Section 9.2.9.1), (2) radiological risks to the highest exposed individual during routine
4 conditions (Section 9.2.9.2), and (3) consequences to individuals and populations after the most
5 severe accidents involving a release of radioactive or hazardous chemical material
6 (Section 9.2.9.3).

7
8 Radiological impacts during routine conditions are a result of human exposure to the low
9 levels of radiation near the shipment. The regulatory limit established in 49 CFR 173.441
10 (Radiation Level Limitations) and 10 CFR 71.47 (External Radiation Standards for All
11 Packages) to protect the public is 0.1 mSv/h (10 mrem/h) at 2 m (6 ft) from the outer lateral sides
12 of the transport vehicle. This dose rate corresponds roughly to 14 mrem/h at 1 m (3 ft). As
13 discussed in Appendix C, Section C.9.4.4, the external dose rate for CH shipments to NNSS is
14 assumed to be 0.5 and 1.0 mrem/h at 1 m (3 ft) for truck and rail shipments, respectively. For
15 shipments of RH waste, the external dose rate is assumed to be 2.5 and 5.0 mrem/h at 1 m (3 ft)
16 for truck and rail shipments, respectively. These assignments are based on shipments of similar
17 types of waste. Dose rates for rail shipments are approximately double those for truck shipments
18 because rail shipments are assumed to have twice the number of waste packages as a truck
19 shipment. Impacts from accidents are dependent on the amount of radioactive material in a
20 shipment and on the fraction that is released if an accident occurs. The parameters used in the
21 transportation accident analysis are described further in Appendix C, Section C.9.4.3.

22 23 24 **9.2.9.1 Collective Population Risk**

25
26 The collective population risk is a measure of the total risk posed to society as a whole by
27 the actions being considered. For a collective population risk assessment, the persons exposed
28 are considered as a group; no individual receptors are specified. Exposure to four different
29 groups are considered: (1) persons living and working along the transportation routes,
30 (2) persons sharing the route, (3) persons at stops along the route, and (4) transportation crew
31 members. The collective population risk is used as the primary means of comparing various
32 options. Collective population risks are calculated for cargo-related causes for routine
33 transportation and accidents. Vehicle-related risks are independent of the cargo in the shipment
34 and are only calculated for traffic accidents (fatalities caused by physical trauma).

35
36 Estimated impacts from the truck and rail options are summarized in Tables 9.2.9-1 and
37 9.2.9-2, respectively. For the truck option, it was estimated that about 12,600 shipments resulting
38 in about 48 million km (30 million mi) of travel would cause no LCFs for truck crew members or
39 members of the public. One fatality directly related to accidents is expected. No LCFs from
40 routine transport are estimated for the rail option, consisting of approximately 5,010 railcar
41 shipments resulting in about 21 million km (13 million mi) of travel. However, one fatality from
42 accidents could occur.

TABLE 9.2.9-1 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Truck for Disposal at NNSS^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c
			Routine Crew	Dose Risk (person-rem)				LCFs ^d		Physical Accident Fatalities	
				Routine Public				Accident ^e	Crew		Public
				Off-Link	On-Link	Stops	Total				
Group 1											
GTCC LLRW											
Activated metals - RH											
Past BWRs	20	77,500	0.81	0.02	0.11	0.14	0.28	0.00016	0.0005	0.0002	0.0015
Past PWRs	143	458,000	4.8	0.11	0.67	0.84	1.6	0.00073	0.003	0.001	0.009
Operating BWRs	569	2,120,000	22	0.52	3.1	3.9	7.5	0.0027	0.01	0.005	0.044
Operating PWRs	1,720	5,810,000	60	1.5	8.5	11	21	0.008	0.04	0.01	0.12
Sealed sources - CH											
Cesium irradiators - CH	240	665,000	0.28	0.051	0.37	0.48	0.9	0.0032	0.0002	0.0005	0.015
Other Waste - CH	5	11,400	0.0048	0.00073	0.0062	0.0082	0.015	<0.0001	<0.0001	<0.0001	0.00024
Other Waste - RH	54	218,000	2.2	0.062	0.32	0.4	0.78	<0.0001	0.001	0.0005	0.0046
GTCC-like waste											
Activated metals - RH	38	72,700	0.76	0.014	0.1	0.13	0.25	<0.0001	0.0005	0.0002	0.0033
Sealed sources - CH	1	2,770	0.0012	0.00021	0.0015	0.002	0.0037	<0.0001	<0.0001	<0.0001	<0.0001
Other Waste - CH	69	268,000	0.11	0.025	0.15	0.19	0.37	0.00077	<0.0001	0.0002	0.0051
Other Waste - RH	1,160	4,470,000	46	1.1	6.5	8.2	16	0.0018	0.03	0.009	0.086

TABLE 9.2.9-1 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c
			Dose Risk (person-rem)					LCFs ^d			
			Routine Crew	Routine Public			Accident ^e	Crew	Public	Physical Accident Fatalities	
				Off-Link	On-Link	Stops					
Group 2											
GTCC LLRW											
Activated metals - RH											
New BWRs	202	652,000	6.8	0.14	0.93	1.2	2.3	0.00091	0.004	0.001	0.014
New PWRs	833	2,780,000	29	0.72	4.1	5.1	9.9	0.0035	0.02	0.006	0.057
Additional commercial waste	1,990	8,070,000	84	1.9	12	15	28	<0.0001	0.05	0.02	0.15
Other Waste - CH	139	563,000	0.24	0.052	0.32	0.41	0.78	0.0025	0.0001	0.0005	0.011
Other Waste - RH	3,790	15,300,000	160	3.7	22	28	54	0.00068	0.09	0.03	0.29
GTCC-like waste											
Other Waste - CH	44	165,000	0.069	0.015	0.094	0.12	0.23	0.00034	<0.0001	0.0001	0.0032
Other Waste - RH	1,400	5,590,000	58	1.3	8.1	10	20	0.0019	0.03	0.01	0.11
Total Groups 1 and 2	12,600	47,800,000	470	11	68	85	160	0.048	0.3	0.1	0.94

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

TABLE 9.2.9-2 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Rail for Disposal at NNSS^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts							Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)				Accident ^e	LCFs ^d		Physical Accident Fatalities
				Routine Public					Crew	Public	
				Off-Link	On-Link	Stops	Total				
Group 1											
GTCC LLRW											
Activated metals - RH											
Past BWRs	7	27,600	0.21	0.059	0.0038	0.081	0.14	0.00037	0.0001	<0.0001	0.0017
Past PWRs	37	127,000	0.99	0.27	0.018	0.4	0.69	0.0015	0.0006	0.0004	0.0057
Operating BWRs	154	636,000	4.8	1.3	0.086	1.9	3.3	0.0033	0.003	0.002	0.019
Operating PWRs	460	1,830,000	14	3.7	0.24	5.6	9.6	0.011	0.008	0.006	0.059
Sealed sources - CH											
Cesium irradiators - CH	120	410,000	0.94	0.22	0.016	0.51	0.75	0.0002	0.0006	0.0005	0.0098
Other Waste - CH	3	8,270	0.02	0.0045	0.0004	0.012	0.017	<0.0001	<0.0001	<0.0001	0.00027
Other Waste - RH	27	125,000	0.92	0.25	0.018	0.37	0.64	<0.0001	0.0006	0.0004	0.0033
GTCC-like waste											
Activated metals - RH	11	24,300	0.22	0.037	0.0027	0.079	0.12	<0.0001	0.0001	<0.0001	0.0025
Sealed sources - CH	1	3,420	0.0078	0.0019	0.00013	0.0043	0.0063	<0.0001	<0.0001	<0.0001	<0.0001
Other Waste - CH	35	146,000	0.32	0.13	0.009	0.19	0.33	0.00015	0.0002	0.0002	0.0044
Other Waste - RH	579	2,460,000	18	5.1	0.34	7.5	13	0.00033	0.01	0.008	0.072

TABLE 9.2.9-2 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c
			Routine Crew	Dose Risk (person-rem)					LCFs ^d		Physical Accident Fatalities
				Routine Public				Accident ^e	Crew	Public	
				Off-Link	On-Link	Stops	Total				
Group 2											
GTCC LLRW											
Activated metals - RH											
New BWRs	54	216,000	1.6	0.37	0.027	0.68	1.1	0.0014	0.001	0.0006	0.0073
New PWRs	227	912,000	6.9	1.9	0.11	2.8	4.8	0.0038	0.004	0.003	0.028
Additional commercial waste	498	2,160,000	16	4.6	0.31	6.6	11	<0.0001	0.01	0.007	0.066
Other Waste - CH	70	303,000	0.66	0.28	0.019	0.4	0.69	0.00049	0.0004	0.0004	0.0092
Other Waste - RH	1,900	8,270,000	61	17	1.2	25	44	<0.0001	0.04	0.03	0.25
GTCC-like waste											
Other Waste - CH	22	95,200	0.21	0.083	0.0054	0.12	0.21	<0.0001	0.0001	0.0001	0.0026
Other Waste - RH	702	3,040,000	23	6.4	0.43	9.3	16	0.0003	0.01	0.01	0.09
Total Groups 1 and 2	5,010	21,200,000	150	42	2.8	62	110	0.024	0.09	0.06	0.64

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

9.2.9.2 Highest-Exposed Individuals during Routine Conditions

During the routine transportation of radioactive material, specific individuals could be exposed to radiation in the vicinity of a shipment. Risks to these individuals for a number of hypothetical exposure-causing events were estimated. The receptors include transportation workers, inspectors, and members of the public exposed during traffic delays, while working at a service station, or while living or working near a destination site. The assumptions about exposure are given in Section C.9.2.2 of Appendix C, and transportation impacts are provided in Section 5.3.9. The scenarios for exposure are not meant to be exhaustive; they were selected to provide a range of representative potential exposures. On a site-specific basis, if someone was living or working near the NNSS entrance and was present for all 12,600 truck or 5,010 rail shipments projected, that individual's estimated dose would be approximately 0.5 or 1.0 mrem, respectively, over the course of more than 50 years. The individual's associated lifetime risk of LCF would then be 3×10^{-7} or 6×10^{-7} for truck or rail shipments, respectively.

9.2.9.3 Accident Consequence Assessment

Whereas the collective accident risk assessment considers the entire range of accident severities and their related probabilities, the accident consequence assessment assumes that an accident of the highest severity category has occurred. The consequences, in terms of committed dose (rem) and LCFs for radiological impacts, were calculated for both exposed populations and individuals in the vicinity of an accident. Because the exact location of such a transportation accident is impossible to predict and is thus not specific to any one site, generic impacts were assessed, as presented in Section 5.3.9.

9.2.10 Cultural Resources

No cultural resources are known within the project area. The only resources that could possibly be present are those associated with traditional cultural properties and other resources of concern to American Indian tribes. If the GTCC reference location was chosen for development, the Section 106 process of the NHPA would be followed for consulting with federally recognized tribes. The Section 106 process requires that the location and any ancillary locations that would be affected by the project be investigated for the presence of cultural resources prior to disturbance. Areas geographically remote from the project area that could be used for site activities would require investigation.

No impacts on cultural resources are expected from construction, operations, decommissioning, or post-closure activities at the project site, since no cultural resources have been identified in the project area. Of the three land waste disposal methods, the borehole method would have the greatest potential to affect cultural resources, if any, because of the larger acreage needed. Potential visual impacts would be minimal compared with those from the other disposal methods, because the majority of the disposal facility would be below grade. If any activities occurred in a location remote from the GTCC reference location identified southeast of

1 the RWMS, additional investigation would be required. If significant cultural resource sites were
2 found, the effect of the project on these significant resources would be assessed.

3
4 Because the trench method would require only 20 ha (50 ac) for the facility, the potential
5 for impacts is less for this method than for the other two disposal methods being considered. No
6 known cultural resources are present within the project area; therefore, no impacts on cultural
7 resources are expected. Visual impacts on cultural resources would need to be considered during
8 all phases of the project; however, no known visually sensitive resources are located in the
9 vicinity of the project area. No impacts on cultural resources are expected from any phase of the
10 project.

11
12 Unlike the other two land disposal methods being considered, the vault method requires
13 large amounts of soil to cover the waste. Potential impacts on cultural resources could occur
14 during the removal and hauling of the soil required for this method. Impacts on cultural resources
15 would need to be considered for the soil extraction locations. It is assumed that the soil used for
16 the cover would not be excavated from within the GTCC reference location southeast of the
17 RWMS. The NHPA Section 106 process would be followed for all reference locations utilized
18 for the project. Although there are no known visually sensitive resources near the GTCC
19 reference location, visual impacts would be considered during all phases of the project.

20 21 22 **9.2.11 Waste Management**

23
24 The construction of the land disposal facilities would generate small quantities of waste
25 in the form of hazardous and nonhazardous solids and hazardous and nonhazardous liquids.
26 Waste generated from operations would include small quantities of solid LLRW (e.g., spent
27 HEPA filters) and nonhazardous solid waste (including recyclable wastes). These waste types
28 would either be disposed of on-site or sent off-site for disposal. No impacts on waste
29 management programs at NNSS are expected from the waste that could be generated from the
30 construction and operations of the land disposal methods. Section 5.3.11 provides a summary
31 of the waste handling programs at NNSS for the waste types generated.

32 33 34 **9.3 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES AND** 35 **HUMAN HEALTH IMPACTS**

36
37 The potential environmental consequences from the disposal of GTCC LLRW and
38 GTCC-like waste under Alternatives 3 and 4 are summarized by resource area as follows:

39
40 *Air quality.* Potential impacts from construction and operations on ambient air quality
41 would be negligible or minor at most. It is estimated that during construction and operations,
42 total peak-year emissions of criteria pollutants, VOCs, and CO₂ would be small. The highest
43 emissions associated with the vault method would be about 3.6% of Nye County's emissions
44 total for NO_x. O₃ levels in Nye County are currently in attainment; O₃ precursor emissions from
45 construction and operational activities would be relatively small, less than 3.6% and 0.27% of
46 NO_x and VOC emissions, respectively, and much lower than those in the regional air shed.

1 During construction and operations, maximum CO₂ emissions would be negligible. All
2 construction activities would occur within about 6 km (4 mi) of the site boundary and would not
3 contribute significantly to concentrations at the boundary or at the nearest residence. Fugitive
4 dust emissions during construction and operations would be controlled by best management
5 practices. Activities during decommissioning would be similar to those during construction but
6 on a more limited scale and for a more limited duration. Potential impacts on ambient air quality
7 therefore would be correspondingly less from decommissioning than from construction.

8
9 **Noise.** The highest composite noise during construction would be about 92 dBA at 15 m
10 (50 ft) from the source. Noise levels at 690 m (2,300 ft) from the source would be below the
11 EPA guideline of 55 dBA as the L_{dn} for residential zones. This distance is well within the NNSS
12 boundary, and there are no residences within this distance. Noise generated from operations
13 would be less than that from construction. No groundborne vibration impacts are anticipated,
14 since low-vibration-generating equipment would be used and since there are no residences or
15 vibration-sensitive buildings in the area.

16
17 **Geology.** No adverse impacts from the extraction and use of geologic and soil resources
18 are expected, nor are any significant changes in surface topography or natural drainages
19 expected. Boreholes (40 m or 130 ft) would be completed in unconsolidated material. The
20 potential for erosion would be reduced by the low precipitation rates and further reduced by best
21 management practices.

22
23 **Water resources.** Construction of a vault facility would require the most water. Water
24 demands for construction at NNSS would be met by using groundwater from on-site wells
25 completed in the Great Basin aquifer system. No surface water would be used at the site during
26 construction; therefore, no direct impacts on surface water are expected. Indirect impacts on
27 surface water would be reduced by implementing good industry practices and mitigation
28 measures. Construction and operations of the proposed GTCC waste disposal facility would
29 increase the annual water use at NNSS by a maximum of about 0.3% (vault) and 0.5% (trench).
30 These increases would not significantly lower the water table or change the direction of
31 groundwater flow; therefore, impacts due to groundwater withdrawals are expected to be
32 negligible. Because of the extremely arid climate at NNSS, the rate of infiltration is insufficient
33 to cause leaching of radionuclides to the water table (within 100,000 years). As a result, no
34 impacts on groundwater quality and no indirect impacts on surface water quality (as a result of
35 aquifer discharges) are expected.

36
37 **Human health.** Worker impacts from operations would mainly be those from the
38 radiation doses associated with handling of the wastes. The annual radiation dose commitment
39 would be 2.6 person-rem/yr for boreholes, 4.6 person-rem for trenches, and 5.2 person-rem/yr for
40 vaults. These worker doses are not expected to result in any LCFs (see Section 5.3.4.1.1). The
41 maximum dose to any individual worker would not exceed the DOE administrative control level
42 of 2 rem/yr for operations. It is expected that the maximum dose to any individual worker over
43 the entire project would not exceed a few rem.

44
45 The worker impacts from accidents would be associated with the physical injuries and
46 possible fatalities that could result from construction and waste handling activities. It is estimated

1 that the annual number of lost workdays due to injuries and illnesses during disposal operations
2 would range from 1 (for the borehole method) to 2 (for the trench and vault methods), and no
3 fatalities would result from construction and waste handling accidents (see Section 5.3.4.2.2).
4 These injuries would not be associated with the radioactive nature of the wastes but simply be
5 those expected to occur in any construction project of this size.

6
7 With regard to the general public, no measurable doses are expected to occur during
8 waste disposal operations at the site, given the solid nature of the wastes and the distance of
9 waste handling activities from potentially affected individuals. It is estimated that the highest
10 dose to an individual from an accident involving the waste packages before their disposal (from a
11 fire affecting an SWB) would be 2.4 rem and not result in any LCFs. The total dose to the
12 affected population from such an event is estimated to be 0.47 person-rem. Because of the
13 extremely arid climate (and an infiltration rate of essentially zero), contamination from
14 groundwater is not projected to reach a nearby hypothetical resident farmer within the first
15 10,000 years after the disposal facility closes, so this individual would receive no incremental
16 radiation dose from disposal of these wastes.

17
18 **Ecological resources.** The initial loss of creosote bush/white bursage habitat, followed by
19 the eventual establishment of low-growth vegetation, would not create a long-term reduction in
20 the local or regional ecological diversity. After closure, the cover would become vegetated with
21 annual and perennial grasses and forbs. Construction of the GTCC waste disposal facility would
22 affect wildlife species inhabiting the site; however, small mammals, ground-nesting birds, and
23 reptiles would recolonize the site once vegetative cover was reestablished. Larger mammals,
24 such as pronghorn, coyote, and mountain lion, would likely avoid the area or be excluded by
25 fencing.

26
27 There are no natural aquatic habitats or wetlands within the immediate vicinity of the
28 GTCC reference location; however, depending on the amount of water in the retention pond and
29 length of retention, certain species (e.g., aquatic invertebrates, waterfowl, shorebirds, and
30 mammals) could become established.

31
32 The desert tortoise is the only federally listed species that is a resident at NNSS. It
33 inhabits the southern third of the site at low estimated densities. Mitigation for loss of the desert
34 tortoise is normally required under the terms and conditions of the 1996 Biological Opinion
35 (Mendoza 1996); however, since the area adjacent to the RWMS is not considered suitable
36 habitat for the desert tortoise, it is not subject to the requirements of the Opinion. Project
37 construction activities could destroy the burrows of western burrowing owls or directly kill
38 them. Adverse impacts would be minimized by conducting biological surveys in the project
39 area and identifying mitigation measures accordingly.

40
41 **Socioeconomics.** Impacts would be small. Construction would create direct employment
42 for up to 145 people (vault method) in the peak construction year and 137 indirect jobs (vault
43 method) in the ROI. The annual average employment growth rate would increase by <1%. The
44 GTCC waste disposal facility would produce about \$12.8 million in income in the peak
45 construction year. Up to 32 people would in-migrate to the ROI as a result of employment
46 on-site; in-migration would have only a marginal effect on population growth and require less

1 than 1% of vacant housing in the peak year. Impacts from operating a land disposal facility
2 would also be small, creating as many as 51 direct jobs (vault method) annually and an
3 additional 36 indirect jobs (vault method) in the ROI; the facility would produce up to
4 \$5.1 million in income annually during operations.

5
6 **Environmental justice.** Because health impacts on the general population within the
7 80-km (50-mi) assessment area during construction and operations would be negligible, no
8 impacts on minority and low-income populations as a result of construction and operations of a
9 GTCC waste disposal facility are expected.

10
11 **Transportation.** Transporting all the waste to NNSS by truck would result in
12 approximately 12,600 shipments involving a total of 48 million km (30 million mi) of travel.
13 Transporting all the waste by rail would require 5,010 railcar shipments involving 21 million km
14 (13 million mi) of travel. It is estimated that no LCFs would occur to the public or crew members
15 for either mode of transportation, but one fatality from accidents could occur.

16
17 **Land use.** The GTCC waste disposal facility would be integrated into the radioactive
18 waste management zone of the Area 5 RWMS. This area currently supports defense-related
19 activities.

20
21 **Cultural resources.** No known cultural resources are located within the project area.
22 Potential resources are those associated with cultural properties or resources of concern to
23 American Indian tribes. The borehole method has the greatest potential to affect cultural
24 resources because of its 44-ha (110-ac) land requirement. The amount of land needed to employ
25 this method is twice the amount needed to construct a vault or trench. No impacts are expected
26 from construction, operations, or post-closure activities since no cultural resources have been
27 identified in the project area. Section 106 of the NHPA would be followed to determine the
28 impact of the project on significant cultural resources, as needed. Local tribes would be
29 consulted to ensure no traditional cultural properties were affected by the project.

30
31 **Waste management.** The wastes that could be generated from construction and
32 operations of the land waste disposal facilities are not expected to affect current waste
33 management programs at NNSS.

34 35 36 **9.4 CUMULATIVE IMPACTS**

37
38 Section 5.4 presents the methodology for the cumulative impacts analysis. In the analysis
39 that follows, impacts of the proposed action are considered in combination with the impacts of
40 past, present, and reasonably foreseeable future actions. This section begins with a description of
41 reasonably foreseeable future actions at NNSS, including those that are ongoing, under
42 construction, or planned for future implementation. Past and present actions are generally
43 accounted for in the affected environment section (Section 9.1).

1 9.4.1 Reasonably Foreseeable Future Actions

2

3 Reasonably foreseeable future actions at NNSS are summarized in the following sections.
4 These actions were identified primarily from a review of the *Draft Supplemental Analysis for the*
5 *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the*
6 *State of Nevada* (2008 NTS SA; DOE 2008c). These actions are planned, under construction, or
7 ongoing and may not be inclusive of all actions at the site. However, they should provide an
8 adequate basis for determining potential cumulative impacts at NNSS.

9

10

11 9.4.1.1 Defense Programs-Related Facilities and Activities

12

13 The key ongoing activities related to NNSS defense programs evaluated in the final
14 NTS EIS (DOE 1996) and the 2002 NTS SA (DOE 2002a) include maintaining readiness to
15 conduct full-scale nuclear testing; conducting underground nuclear weapons testing; handling
16 damaged and foreign nuclear weapons; and conducting dynamic experiments, including
17 subcritical experiments. The status of these activities is provided in Table 3-1 of the
18 2008 NTS SA (DOE 2008c). New facilities and activities initiated since the final NTS EIS
19 and the 2002 NTS SA were prepared include the following:

20

- 21 • *Joint Actinide Shock Physics Experimental Research (JASPER) Facility*. The
22 JASPER Facility, constructed in 1999, conducts shock physics experiments on
23 special nuclear material and other actinide materials. As many as 24 special
24 material shots could be conducted each year; more than 24 plutonium
25 experiments have been conducted since the 2002 NTS SA (DOE 2002a). The
26 facility generates small quantities of TRU (DOE 2008c).
- 27
- 28 • *Baker Site Facility*. The Baker Site Facility, located in NNSS Area 27, was
29 constructed to stage, assemble, and store explosives used at various approved
30 NNSS locations, including the Big Explosives Experimental Facility and the
31 JASPER Facility. The Baker Site Facility was referred to as the Nevada
32 Energetic Materials Operations Facility in the 2002 NTS SA (DOE 2002a).
- 33
- 34 • *Device Assembly Facility (DAF)*. The multistructure DAF assembles,
35 disassembles or modifies, stages, and component-tests nuclear devices and
36 high explosives.
- 37
- 38 • *Big Explosives Experimental Facility (BEEF)*. Research at the BEEF involves
39 experiments on explosive pulsed-power technology and on advanced-shaped
40 charges for augmented conventional weapons and render-safe technologies.
41 The facility has been modified to perform high-explosives pulsed-power
42 experiments; these modifications are not expected to increase the potential
43 size of detonations or change the amount or type of materials involved in
44 detonations beyond those analyzed in the 2002 NTS SA (DOE 2002a).

45

- 1 • *Atlas Facility*. The Atlas Facility was relocated from LANL and conducted
2 pulsed-power experiments on macroscopic targets until it was placed in cold
3 stand-by mode in 2006. The relocation of the facility was evaluated in an
4 environmental assessment and a FONSI (DOE 2001).
5
- 6 • *U1a Complex*. The U1a Complex is an underground laboratory of horizontal
7 tunnels, mined at the base of a vertical shaft about 960 ft (290 m) below the
8 surface; it has several fixed and temporary metal buildings and instrument
9 trailers on the surface. Upgrades to the facility would continue as needed to
10 support program activities. Since June 2007, 22 subcritical experiments and
11 12 smaller special nuclear material recovery experiments have been conducted
12 at the U1a Complex. The NNSA has plans to install a large-bore powder gun
13 in the complex. The gun would be used to fire a large projectile into fixed
14 special nuclear material targets. Experiments at the U1a Complex could
15 become more complex with time, potentially using larger quantities of special
16 nuclear material, although limits on special material quantities would not be
17 exceeded during future subcritical experiments.
18
- 19 • *Emplacement hole subcritical experiments*. Emplacement hole experiments
20 are similar to the subcritical experiments described for the U1a Complex,
21 except that they are performed in vertical emplacement holes, similar to those
22 used for underground testing.
23
- 24 • *G-Tunnel improvised nuclear device program*. The U12g Tunnel, also known
25 as the G-Tunnel, is part of an ongoing program (as of 2007) that makes use of
26 the tunnel to stage and minimally assess a damaged nuclear weapon or
27 improvised nuclear device, should one be recovered.
28
- 29 • *Tonopah Test Range Fire Experiment Facility open burn experiments*. Open
30 burn experiments at the Tonopah Test Range Fire Experiment Facility would
31 involve the construction of a fire and thermal testing facility at either NNSA or
32 the Tonopah Test Range. To date, these experiments have not been conducted,
33 but the NNSA plans to do a NEPA review and analysis if these experiments
34 become necessary in the future.
35

36 More in-depth descriptions of these facilities and activities can be found in the 2008 NTS SA
37 (DOE 2008c); some are also described in the appendices of the final NTS EIS (DOE 1996).
38

39 40 **9.4.1.2 Non-Defense Research and Development Program-Related Facilities and** 41 **Activities** 42

43 Ongoing non-defense R&D activities at NNSA are conducted by the NNSA, universities,
44 industry, and other federal agencies. Among these are the establishment of a solar enterprise
45 zone, an alternate fuel demonstration project, and an environmental research park. The status of
46 these activities (and others that were either cancelled or are inactive) is provided in Table 3-4 of

1 the 2008 NTS SA (DOE 2008c). New R&D activities initiated since the final NTS EIS and the
2 2002 NTS SA were prepared include the following:

- 3
4 • *Nonproliferation Test and Evaluation Complex*. Known originally as the
5 Liquefied Gaseous Fuels Spill Test Facility and then as the HazMat Spill
6 Center, the Nonproliferation Test and Evaluation Complex continues to
7 support the Work-for-Others Program by conducting research on the behavior
8 and safety aspects of chemical handling and releases, including releases due to
9 explosive detonations.
- 10
11 • *Nevada Environmental Research Center*. Two research facilities operated by
12 the Desert Research Institute and the University of Nevada (Las Vegas and
13 Reno) — the Nevada Desert Free Air Carbon Dioxide Enrichment Facility
14 and the Mojave Global Change Facility — conduct research on the impact
15 of elevated CO₂ levels on the Mojave Desert ecosystem and research on the
16 effects of climate change. These facilities are part of the Nevada
17 Environmental Research Park at NNSS.
- 18
19 • *Solar power plant*. A utility-scale, commercial solar power plant has been
20 proposed for the Solar Enterprise Zone at NNSS Area 22. It would be
21 developed and constructed over the next 3 to 5 years. The plant would use
22 concentrated solar power (Fresnel lens/trough type) and could produce up to
23 200 MW of electricity. Power would be transmitted through the Mercury
24 substation and existing transmission lines, with upgrades as needed.

25 26 27 **9.4.1.3 Work-for-Others Program-Related Facilities and Activities**

28
29 The Work-for-Others Program provides management, direction, and oversight for
30 ongoing work for the U.S. Department of Defense, the U.S. Department of Homeland Security,
31 law enforcement agencies, and others. These programs usually involve high-hazard operations,
32 operations with nuclear material, training, and other activities through which NNSS can support
33 national security missions. The status of these activities is provided in Table 3-5 of the 2008
34 NTS SA (DOE 2008c). New work-for-others facilities and activities initiated since the final
35 NTS EIS and the 2002 NTS SA were prepared include the following:

- 36
37 • *Weapons of Mass Destruction Emergency Responder Training Program*. The
38 Weapons of Mass Destruction Emergency Responder Training Program was
39 transferred to the Federal Emergency Management Agency in 2006. Its
40 mission is to enhance the capacity of state and local agencies to respond to
41 weapons of mass destruction incidents through coordinated training,
42 equipment acquisition, technical assistance, and support of state and local
43 exercise planning. NNSA/NSO Mobile Training Teams provide training at
44 NNSS or at NNSA/NSO facilities in Las Vegas for the program.
- 45

- 1 • *Defense Threat Reduction Agency (DTRA) Hard Target Defeat Program.* The
2 Hard Target Defeat Program is a multi-year testing program that demonstrates
3 the capability to detect, identify, and characterize a target and then to disrupt,
4 neutralize, or destroy it. Through this program, DTRA evaluates alternative
5 capabilities by using various platforms (both ground and air) against a variety
6 of different target configurations representing different geographic scenarios.
7 To date, tests have been conducted in NNSS Areas 12 and 16.
8
- 9 • *U.S. Military development and training for counter-terrorism and national
10 security defense.* The NNSA/NSO supports the U.S. Department of Defense in
11 developing methods for engaging or neutralizing an adversary in a variety of
12 topographical environments, making use of the restricted-access and high
13 desert terrain at NNSS. The U.S. Air Force also conducts military operations
14 in the restricted air space above NNSS and the Tonopah Test Range. It uses
15 NNSS mainly as a transition corridor for Nevada Test and Training Range air
16 traffic at altitudes greater than 14,000 ft (4,300 m). Future military uses could
17 include R&D, testing, evaluation, and integration of training and exercises
18 with unmanned aerial vehicles and/or unmanned aircraft systems.
19
- 20 • *Aerial Operations Facility.* The Aerial Operations Facility operates and tests a
21 variety of unmanned aerial vehicles. The facility was evaluated most recently
22 in October 2004 to identify the potential impacts from constructing a new
23 runway, hangars, and operations buildings and from performing infrastructure
24 upgrades to accommodate an increase in personnel (DOE 2004a).
25
- 26 • *National Center for Combating Terrorism.* Construction of the National
27 Center for Combating Terrorism was completed in 2006. The center provides
28 a system of facilities and capabilities that include R&D, testing, evaluation,
29 exercises, training, and intelligence support. The impacts of the program were
30 evaluated in the 2003 NTS SA (DOE 2003).
31
- 32 • *Nonproliferation Test and Evaluation Complex.* Known originally as the
33 Liquefied Gaseous Fuels Spill Test Facility and then as the HazMat Spill
34 Center, the Nonproliferation Test and Evaluation Complex serves as a
35 chemical and biological test center. It conducts research on the behavior and
36 safety aspects of chemical handling and releases, including releases due to
37 explosive detonations. Capabilities were expanded in 2002 to address national
38 needs for emergency response and counter-terrorism training. Capabilities
39 were expanded again in 2004 to include tests and experiments involving the
40 release of biological simulants and low concentrations of chemicals at various
41 NNSS locations (under the Work-for-Others Program).
42
- 43 • *Activities using biological simulants and releases of chemicals.* These
44 activities involve chemical release tests designed to assess risks from
45 accidental releases of hazardous and biohazardous materials, provide data on
46 sensor development, and provide first responder training. DOE completed an

1 EA for this facility in June 2004 (DOE 2004b). To date, there have been an
2 average of 8 to 16 campaigns per year with approximately 10 testing days per
3 campaign.
4

- 5 • *Radiological/Nuclear Countermeasures Test and Evaluation Complex*. The
6 Radiological/Nuclear Countermeasures Test and Evaluation Complex is
7 currently under construction. The complex is located in Area 6 south of the
8 Device Assembly Facility. Testing and evaluation activities will include
9 prototype detector testing; evaluation systems testing and evaluation;
10 performance standards validation; demonstration of prototype detectors,
11 systems, and performance standards; verified threat demonstration; concept of
12 operations evaluation and verification; and training. DOE completed an EA
13 for this facility in August 2004 (DOE 2004c).
14

15 16 **9.4.1.4 Radioactive Waste Disposal Facilities** 17

18 Two active disposal facilities are located within the boundary of NNSS: Area 3 and
19 Area 5 of the RWMS. Area 5 is located in the southeastern section of NNSS in Frenchman Flat,
20 within a topographically closed basin. Area 3 is located about 24 km (15 mi) north of Area 5 in
21 the Yucca Flat basin, also a closed basin. Operations at these facilities began in the 1960s. Both
22 facilities are shallow-land disposal facilities; Area 5 uses engineered shallow-land burial cells to
23 dispose of packaged waste, and Area 3 uses subsidence craters formed from underground testing
24 of nuclear weapons to dispose of packaged and unpackaged bulk waste. Originally, the waste
25 that was being disposed of was generated by nuclear weapons research, development, and testing
26 conducted at NNSS. Now the waste comes from environmental cleanup activities at NNSS and
27 other DOE sites. There are 34 disposal cells within a 160-acre (65-ha) area at Area 5 RWMS;
28 24 cells have been closed. To date, approximately 510,000 m³ (18 million ft³) of low-level and
29 mixed low-level waste has been disposed of in Area 5.
30

31 Area 3 covers 49 ha (120 ac) and includes a total of seven craters, representing five cells,
32 designated for LLRW disposal operations. The current inventory of waste at Area 3 is about
33 570,000 m³ (20 million ft³). Available open capacity in the two developed cells is approximately
34 28,000 m³ (6.7 million ft³). Capacity in the remaining craters is approximately 280,000 m³
35 (10 million ft³). The Area 3 RWMS is in cold standby. If low-level waste volumes would
36 significantly increase or if a specific low-level waste shipment campaign would be better
37 disposed of at the facility, then the Area 3 RWMS would be used.
38

39 40 **9.4.1.5 Environmental Restoration Program-Related Activities** 41

42 The Environmental Restoration Program continues to assess and remediate DOE-
43 contaminated sites to ensure compliance with all applicable environmental regulations and
44 statutes and to ensure protection of public and worker safety and health. The program addresses
45 three “sub-project” areas: underground test area, soils media, and industrial sites (formerly
46 referred to as corrective active units). Remedial actions include the closure of the

1 decontamination and decommissioning facilities and DTRA (formerly the Defense Nuclear
2 Agency) sites and the characterization and remediation of sub-projects at the Tonopah Test
3 Range. The responsibility for characterization and remediation at two NNSS areas, the Central
4 Nevada Test Area and the Project Shoal Area, was transferred to DOE's Office of Legacy
5 Management, which will oversee environmental restoration and NEPA documentation
6 (DOE 2008c). The status of all these activities is provided in Table 3-3 of the 2008 NTS SA
7 (DOE 2008c).

10 **9.4.1.6 Future Projects at NNSS**

11
12 Future projects at NNSS are related to the proposed Complex Transformation, which
13 identifies NNSS as an alternative site for the following facilities and activities:

- 14 • Consolidated Plutonium Center;
- 15
- 16 • Consolidated Weapons Program special nuclear material storage;
- 17
- 18 • Consolidated hydrotesting, originally proposed as the Advanced Hydrotest
19 Facility in DOE (2002a);
- 20
- 21 • Consolidated major environmental testing on nuclear weapons components;
- 22
- 23 • NNSA flight test operations currently performed at the Tonopah Test Range;
24 and
- 25
- 26 • Consolidated Nuclear Production Center.
- 27

28
29 The Notice of Availability (73 FR 2023) for the draft Complex Transformation Supplemental
30 Programmatic EIS was published on January 11, 2008. The Complex Transformation will not
31 include NNSA's original proposal to build a modern pit facility, as evaluated in the 2002 NTS
32 SA (DOE 2002a).

35 **9.4.2 Cumulative Impacts from the GTCC Proposed Action at NNSS**

36
37 Potential impacts of the proposed action are considered in combination with the impacts
38 of past, present, and reasonably foreseeable future actions. The impacts from Alternatives 3 to 5
39 at NNSS are described in Section 9.2 and summarized in Section 9.3. These sections indicate that
40 the potential impacts from the proposed action (construction and operations of a borehole,
41 trench, or vault facility) would be small for all the resources evaluated. On the basis of the total
42 impacts (including the reasonably foreseeable future actions summarized in Section 9.4.1), the
43 incremental potential impacts from the GTCC proposed action are not expected to contribute
44 substantially to cumulative impacts on the various resource areas evaluated for NNSS. For
45 example, the land area requirement of about 44 ha (110 ac) is a fraction of the projected 2,351 ha
46 (5,800 ac) of new ground disturbance that is indicated in the NTS EIS (DOE 1996). In addition,

1 the GTCC reference location would be located in an area that is already used for disposal of
2 other types of waste. The estimated dose to the worker population from GTCC LLRW and
3 GTCC-like waste disposal operations (2.6 to 5.2 person-rem) would be less than the worker
4 population doses from other LLRW activities at NNSS. For example, a worker population dose
5 of 386 person-rem is estimated under the maximum impact alternative in the Complex
6 Transformation EIS (DOE 2008b). The estimates of human health impacts from post-closure
7 activities at the GTCC waste disposal facility indicate there would be very low doses within
8 10,000 years after closure (i.e., doses would be lower than the 8 mrem/yr at 250 years after
9 closure at Area 3 and the 6 mrem/yr at 250 years after closure at Area 5 (Shott et al. 2000;
10 Bechtel Nevada 2001). Finally, follow-on NEPA evaluations and documents prepared to support
11 any further considerations of siting a new borehole, trench, or vault disposal facility at NNSS
12 would provide more detailed analyses of site-specific issues, including cumulative impacts.
13
14

15 **9.5 SETTLEMENT AGREEMENTS AND CONSENT ORDERS FOR NNSS**

16
17 A review of existing settlement agreements and consent orders for NNSS did not identify
18 any that would contain requirements that would be triggered by Alternatives 3 to 5 for this EIS.
19
20

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10 SAVANNAH RIVER SITE: AFFECTED ENVIRONMENT AND CONSEQUENCES OF ALTERNATIVES 4 AND 5

This chapter provides an evaluation of the affected environment, environmental and human health consequences, and cumulative impacts from the disposal of GTCC LLRW and GTCC-like waste under Alternative 4 (in a new trench disposal facility) and Alternative 5 (in a new vault disposal facility) at SRS. Alternative 3 (disposal in a new borehole disposal facility) is not evaluated for SRS primarily because of the shallow depth to groundwater conditions prevalent there. Alternative 3 is described in Section 5.6.1. Environmental consequences that are common to all the sites for which Alternatives 4 and 5 are evaluated (including SRS) are discussed in Chapter 5 and not repeated in this chapter. Impact assessment methodologies used for this EIS are described in Appendix C. Federal and state statutes and regulations and DOE Orders relevant to SRS are discussed in Chapter 13 of this EIS.

10.1 AFFECTED ENVIRONMENT

This section discusses the affected environment for the various environmental resource areas evaluated for the GTCC reference location at SRS. The GTCC reference location is situated on an upland ridge within the Tinker Creek drainage, about 3.2 km (2 mi) to the northeast of the Z-Area in the north-central portion of SRS (see Figure 10.1-1). The reference location shown was selected primarily for evaluation purposes for this EIS. The actual location would be identified on the basis of follow-on evaluations if and when it is decided to locate a GTCC waste disposal facility at SRS.

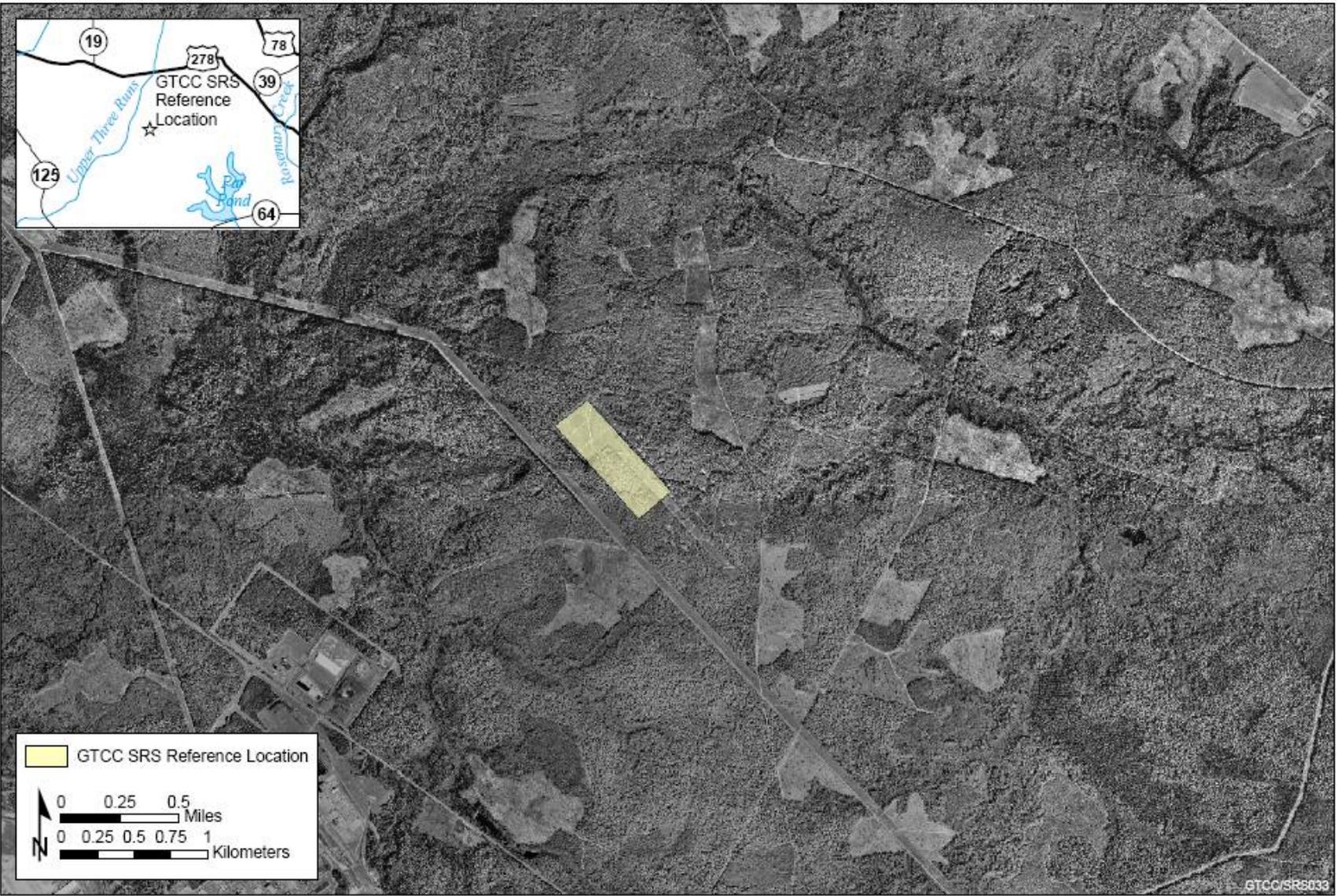
10.1.1 Climate, Air Quality, and Noise

10.1.1.1 Climate

South Carolina is located between the southern slopes of the Appalachian Mountains and the Atlantic Ocean. It has a long coastline along which the warm Gulf Stream current flows. During the summer, weather in South Carolina is dominated by a maritime tropical air mass known as the Bermuda high. Passing over the Gulf Stream, it brings warm and moist air inland from the ocean (SCSCO 2007). As the air comes inland, it rises and forms localized thunderstorms, resulting in maximum precipitation. The mountains to the north and west tend to block or delay many cold air masses approaching from those directions, thus making the winters somewhat milder. The area around SRS has a temperate climate, characterized by long, humid summers and short, mild winters (DCS 2002).

The annual average wind speed is 2.5 m/s (5.7 mph) at Bush Field, which is located in Augusta, Georgia, about 31 km (19 mi) west-northwest of the GTCC reference location (NCDC 2008a). Wind speed is higher in winter and spring, with the highest speed being 2.9 m/s (6.5 mph) in spring, and it is lower in summer and autumn, with the lowest speed being 2.2 m/s

10-2

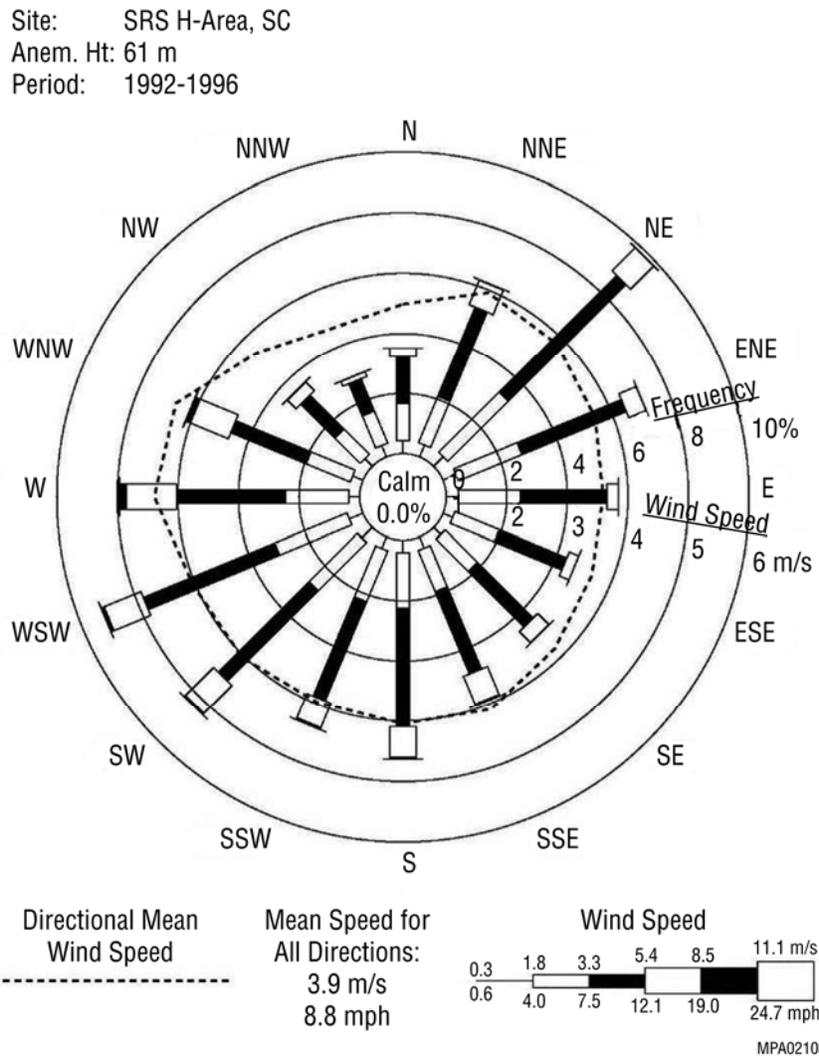


1

2 **FIGURE 10.1-1 GTCC Reference Location at SRS**

1 (5.0 mph) in autumn. Overall, the prevailing wind direction is from the west, albeit it is not
 2 prominent. Monthly prevailing wind directions vary, being mostly from west-northwest in
 3 November through March, from south to southeast in April through August, and from north-
 4 northeast in September and October.

6 A wind rose at the 61-m (200-ft) meteorological tower in the H-Area at SRS for the
 7 5-year period of 1992 through 1996 is presented in Figure 10.1.1-1. There is no prominent wind
 8 direction at SRS; about 30% of the time, the wind blows from the northeast quadrant, and about
 9 40% of the time, it blows from southwest quadrant. The annual average wind speed is about
 10 3.9 m/s (8.8 mph), and the wind speed is relatively uniform with the wind direction. The wind
 11 patterns are different at Bush Field and at the on-site H-Area meteorological tower; the pattern at
 12 Bush Field is representative of the surface wind, which is considerably affected by surface



15

16 **FIGURE 10.1.1-1 Wind Rose at the 61-m (200-ft) Level for the SRS**
 17 **H-Area Meteorological Tower, South Carolina, 1992–1996 (Source:**
 18 **Arnett and Mamatey 2000)**

19

1 friction, and the pattern at the tower is representative of general upper wind. On-site wind
2 patterns reflect the presence and orientation of the Appalachian Mountains somewhat, and they
3 generally run in a general northeast-southwest direction.
4

5 For the last 30-year period, the annual average temperature at Bush Field has been 17.3°C
6 (63.2°F) (NCDC 2008a). January is the coldest month, averaging 7.1°C (44.8°F), and July is the
7 warmest month, averaging 27.1°C (80.8°F). During the last 57 years, the highest temperature
8 was 42.2°C (108°F), and the lowest was -18.3°C (-1°F). The number of days with a maximum
9 temperature higher than or equal to 32.2°C (90°F) is about 75, while days with a minimum
10 temperature lower than or equal to 0°C (32°F) number about 52.
11

12 Generally, precipitation is ample in all parts of the state. Annual precipitation at Bush
13 Field averages about 113.2 cm (44.58 in.) (NCDC 2008a). Precipitation is light in autumn,
14 increases in winter and spring, and peaks in summer. Measurable precipitation of 0.025 cm
15 (0.01 in.) or more occurs on an average of 109 days per year. Measurable snow is a rarity, and, if
16 it occurs, remains on the ground for only a short time. Light snow typically occurs from
17 December through February, and the annual average snowfall in the area is about 3.6 cm
18 (1.4 in.).
19

20 Severe weather occurs in South Carolina occasionally in the form of violent
21 thunderstorms and tornadoes (Ruffner 1985). Thunderstorms are common in the summer
22 months, but the really violent ones generally accompany the squall lines and active cold fronts of
23 spring. Strong thunderstorms usually bring high winds, hail, and considerable lightning, and they
24 sometimes spawn a tornado.
25

26 Tornadoes are rare in the area surrounding SRS, and they are less frequent and
27 destructive than those in the tornado alley in the central United States. For the period 1950–2008,
28 878 tornadoes were reported in South Carolina, with an average of 15.1 tornadoes per year
29 (NCDC 2008b). For the same period, a total of 93 tornadoes, at an average of 1.6 tornadoes per
30 year, were reported in the SRS area; 57 occurred in the three counties encompassing SRS, and
31 36 occurred in the neighboring counties in Georgia (Burke, Richmond, and Screven). However,
32 most tornadoes occurring in those counties were relatively weak (i.e., 91 tornadoes were less
33 than or equal to F2 on the Fujita tornado scale, and two were F3). Nine tornadoes caused damage
34 on SRS, one of which had estimated wind speeds as high as 67 m/s (150 mph). None caused
35 damage to buildings on SRS (DCS 2002).
36

37 Tropical storms or hurricanes affect South Carolina about once every other year. Most do
38 little damage and affect only the outer coastal plains, decreasing rapidly in intensity as they move
39 inland. Those that do move far inland can cause considerable flooding (Ruffner 1985). Between
40 1851 and 2007, 28 major storms (4 hurricanes and 24 tropical storms) passed within 80 km
41 (50 mi) of the GTCC reference location (NOAA 2008). Most hurricanes had been downgraded to
42 tropical storms or tropical depressions before reaching SRS, which is located approximately
43 160 km (100 mi) inland. The only hurricane-force winds measured at SRS were associated with
44 Hurricane Gracie on September 29, 1959, when wind speeds of 34 m/s (75 mph) were measured
45 at the F-Area (DCS 2002).
46
47

10.1.1.2 Existing Air Emissions

The CAA of 1970 and CAAA of 1990 provide the basis for protecting and maintaining ambient air quality. The EPA delegated implementation and enforcement authority for the CAA to the State of South Carolina. The air pollution control rules developed and administered by the South Carolina Department of Health and Environmental Control (SCDHEC) are designed to ensure compliance with the CAA. The SCDHEC Air Permit Program is the primary driver by which emission sources are reported to and regulated by the State. Operating permits are legally enforceable documents that permitting authorities issue to air pollution sources after the source has begun to operate. In particular, a Title V permit is required for large stationary sources, such as power plants or major industrial facilities.

The SRS currently has two Title V (or Part 70 Air Quality Permit) operating permits: one including all SRS emission sources, and one for the 484-D Powerhouse (WSRC 2007a).¹

The primary emission sources of criteria air pollutants and/or air toxics are the coal-fired powerhouse boiler in the D-Area, No. 2 oil-fired package steam generating boilers (those in the K-Area and portable units), fuel-oil-fired water heaters, and the biomass-fired and fuel-oil-fired boilers in the A-Area (WSRC 2007a). Other emissions include those from diesel-fired equipment (including portable air compressors, generators, and emergency cooling water pumps), several soil vapor extraction units, two air strippers, coal piles and coal processing facilities, vehicle traffic, controlled burning of forestry areas, and temporary emissions from construction-related activities.

Annual emissions from major facility sources and total point and area sources of criteria pollutants and VOCs in year 2002 in Aiken, Allendale, and Barnwell Counties, South Carolina, which encompass SRS, are presented in Table 10.1.1-1 (EPA 2008a). Data for 2002 are the most recent emission inventory data available on the EPA website. Area sources consist of nonpoint and mobile sources. Annual emissions are much higher in Aiken County than in Allendale and Barnwell Counties for both source categories and pollutant types because it has many industrial facilities and Interstate 20 (I-20). Point sources account for most of the SO₂ emissions, and point and area sources are equally attributable to NO_x emissions. Area sources are major contributors to CO, VOC, PM₁₀, and PM_{2.5}. Emissions of criteria pollutants except CO and of VOCs from two South Carolina Electric and Gas (SCE&G) coal-fired power stations in Urquhart and in the SRS D-Area in Aiken County were predominant for point source emissions in three counties.

Annual emissions of criteria pollutants and VOCs for the period 2003–2005 were estimated by SRS and are presented in Table 10.1.1-2 (WSRC 2007a). Recently, emissions of several pollutants, notably SO₂ and NO_x, increased significantly. During the 2006 annual air compliance inspection, all SRS permitted sources were found to be in compliance with their respective permit conditions and limits, and all required reports were determined to have been submitted to SCDHEC within specified time limits.

¹ On February 1, 2006, Washington Savannah River Company (WSRC) assumed operational responsibility from South Carolina Electric and Gas (SCE&G), which had operated the facility for DOE under a separate contract since 1995.

TABLE 10.1.1-1 Annual Emissions of Criteria Pollutants and Volatile Organic Compounds from Selected Major Facilities and Total Point and Area Source Emissions in Counties Encompassing SRS^a

Emission Category	Emission Rates (tons/yr)					
	SO ₂	NO _x	CO	VOCs	PM ₁₀	PM _{2.5}
Aiken County						
<i>SCE&G Urquhart Power Station^b</i>	<i>13,724</i>	<i>4,374</i>	<i>123</i>	<i>15.1</i>	<i>858</i>	<i>668</i>
	<i>67.85%^c</i>	<i>28.68%</i>	<i>0.21%</i>	<i>0.14%</i>	<i>8.76%</i>	<i>23.13%</i>
	<i>66.30%</i>	<i>25.23%</i>	<i>0.17%</i>	<i>0.10%</i>	<i>6.27%</i>	<i>16.87%</i>
<i>SCE&G SRS Area-D Powerhouse^d</i>	<i>3,830</i>	<i>2,479</i>	<i>40.5</i>	<i>3.3</i>	<i>429</i>	<i>315</i>
	<i>18.93%</i>	<i>16.26%</i>	<i>0.07%</i>	<i>0.03%</i>	<i>4.38%</i>	<i>10.91%</i>
	<i>18.50%</i>	<i>14.30%</i>	<i>0.05%</i>	<i>0.02%</i>	<i>3.14%</i>	<i>7.95%</i>
<i>Westinghouse: Savannah River Site</i>	<i>272</i>	<i>325</i>	<i>117</i>	<i>10.6</i>	<i>25.0</i>	<i>18.7</i>
	<i>1.34%</i>	<i>2.13%</i>	<i>0.20%</i>	<i>0.10%</i>	<i>0.26%</i>	<i>0.65%</i>
	<i>1.31%</i>	<i>1.87%</i>	<i>0.16%</i>	<i>0.07%</i>	<i>0.18%</i>	<i>0.47%</i>
Point sources	18,634	8,569	775	1,055	1,724	1,291
Area sources	1,595	6,681	57,779	9,934	8,067	1,597
Total	20,229	15,250	58,555	10,989	9,791	2,888
Allendale County						
Point sources	47.6	25.1	14.2	112	25.8	13.4
Area sources	113	807	8,143	1,896	1,917	651
Total	161	832	8,157	2,008	1,943	664
Barnwell County						
Point sources	68.2	73.2	19.5	217	16.1	14.5
Area sources	242	1,181	7,427	1,881	1,928	393
Total	310	1,254	7,447	2,098	1,944	408
Three-county total	20,700	17,336	74,159	15,095	13,678	3,960

^a Emission data for selected major facilities and for total point and area sources are for year 2002. CO = carbon monoxide, NO_x = nitrogen oxides, PM_{2.5} = particulate matter ≤2.5 μm, PM₁₀ = particulate matter ≤10 μm, SO₂ = sulfur dioxide, VOCs = volatile organic compounds.

^b Data in italics are not added to yield totals.

^c The top and bottom rows with % signs show emissions as percentages of Aiken County total emissions and three-county total emissions, respectively.

^d On February 1, 2006, WSRC assumed operational responsibility from SCE&G, which had operated the facility for DOE under a separate contract since 1995.

Source: EPA (2009)

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TABLE 10.1.1-2 Annual Emissions of Criteria Pollutants and Volatile Organic Compounds Estimated by SRS for the Period 2003–2005^a

Year	Emission Rate (tons/yr)								Gaseous Fluorides (as HF)
	SO ₂	NO _x	CO	O ₃ (VOCs)	PM ₁₀	PM _{2.5}	Lead	Total PM	
2003	536	266	2,290	93.3	118	NC ^b	0.558	302	0.114
2004	2,150	4,240	982	544	189	NC	0.158	489	0.139
2005	6,970	7,180	1,030	548	571	477	0.174	928	0.143

^a CO = carbon monoxide, HF = hydrogen fluoride, NO_x = nitrogen oxides, O₃ = ozone, PM = particulate matter, PM_{2.5} = particulate matter ≤2.5 μm, PM₁₀ = particulate matter ≤10 μm, SO₂ = sulfur dioxide, VOCs = volatile organic compounds.

^b NC = not calculated.

Source: WSRC (2007a)

10.1.1.3 Air Quality

The South Carolina SAAQS for six criteria pollutants — SO₂, NO₂, CO, O₃, PM₁₀ and PM_{2.5}, and lead — are almost the same as the NAAQS (EPA 2008a; Flynn 2007), as shown in Table 10.1.1-3. In addition, the State has adopted standards for gaseous fluorides (expressed as HF) and has still retained the annual standard for total suspended particulates (TSP), which used to be one of criteria pollutants but was replaced by PM₁₀ in 1987 (SCDHEC 2004).

The GTCC reference location (which is within SRS, mostly in Aiken and Barnwell Counties and with a much smaller section in Allendale County) is situated in the Augusta (Georgia)-Aiken (South Carolina) Interstate Air Quality Control Region (AQCR). Currently, the entire AQCR is designated as being in attainment for all criteria pollutants (40 CFR 81.311 and 81.341).

Under existing regulations, SRS is not subject to on-site monitoring requirements for ambient air quality; however, the site is required to demonstrate compliance with various air quality standards (WSRC 2007a). To accomplish this compliance, air dispersion modeling was conducted during 2006 for new emission sources or modified sources as part of the sources' construction permitting process. The modeling analysis indicated that SRS air emission sources were in compliance with all applicable regulations.

The highest concentration levels of criteria pollutants (such as SO₂, NO₂, CO, TSP, PM₁₀, and lead) around SRS are less than or equal to 49% of their respective standards in Table 10.1.1-3 (EPA 2009; SCDHEC 2008), except for O₃, which exceeded the applicable standard, and PM_{2.5}, which was 97% of the applicable standard. Both pollutants are primarily of regional concern. Monitoring data in Jackson, Aiken County, showed that concentration levels for O₃ and PM_{2.5} vary from year to year. It is hard to determine any trend for PM_{2.5}

TABLE 10.1.1-3 National Ambient Air Quality Standards (NAAQS) or South Carolina State Ambient Air Quality Standards (SAAQS) and Highest Background Levels Representative of the GTCC Reference Location at SRS, 2003–2007

Pollutant ^a	Averaging Time	NAAQS/ SAAQS ^b	Highest Background Level	
			Concentration ^{c,d}	Location (Year)
SO ₂	1-hour	75 ppb	– ^e	–
	3-hour	0.50 ppm	0.019 ppm (3.8)	Barnwell Co. (2004)
	24-hour	0.14 ppm	0.007 ppm (5.0)	Barnwell Co. (2003)
	Annual	0.03 ppm	0.002 ppm (6.7)	Barnwell Co. (2007)
NO ₂	1-hour	0.100 ppm	–	–
	Annual	0.053 ppm	0.004 ppm (7.5)	Jackson, Aiken Co. (2007)
CO	1-hour	35 ppm	3.0 ppm (8.6)	Columbia, Richland Co. (2004)
	8-hour	9 ppm	2.3 ppm (26)	Columbia, Richland Co. (2004)
O ₃	1-hour	0.12 ppm ^f	0.101 ppm (84)	Jackson, Aiken Co. (2007)
	8-hour	0.075 ppm	0.082 ppm (109)	Jackson, Aiken Co. (2007)
TSP	Annual geometric mean	75 µg/m ³	35.9 (49)	Cayce, Lexington Co. (2003)
PM ₁₀	24-hour	150 µg/m ³	56 µg/m ³ (37)	Barnwell Co. (2006)
	Annual	50 µg/m ³	–	–
PM _{2.5}	24-hour	35 µg/m ³	34 µg/m ³ (97)	Jackson, Aiken Co. (2004)
	Annual	15.0 µg/m ³	14.5 µg/m ³ (97)	Jackson, Aiken Co. (2006)
Lead ^g	Calendar quarter	1.5 µg/m ³	0.00 µg/m ³ (0.0)	Aiken Co. (2003)
	Rolling 3 month	0.15 µg/m ³	–	–
Gaseous fluorides (as HF)	12 hours	3.7 µg/m ³ h	–	–
	24 hours	2.9 µg/m ³ h	–	–
	1 week	1.6 µg/m ³ h	–	–
	1 month	0.8 µg/m ³ h	–	–

^a CO = carbon monoxide, HF = hydrogen fluoride, NO₂ = nitrogen dioxide, O₃ = ozone, PM_{2.5} = particulate matter ≤2.5 µm, PM₁₀ = particulate matter ≤10 µm, SO₂ = sulfur dioxide, TSP = total suspended particulates.

^b The more stringent standard between the NAAQS and the SAAQS is listed when both are available.

^c Monitored concentrations are the highest arithmetic mean for calendar-quarter lead; 2nd-highest for 3-hour and 24-hour SO₂, 1-hour and 8-hour CO, 1-hour O₃, and 24-hour PM₁₀; 4th-highest for 8-hour O₃; 98th percentile for 24-hour PM_{2.5}; arithmetic mean for annual SO₂, NO₂, PM₁₀, and PM_{2.5}; geometric mean for annual TSP.

^d Values in parentheses are monitored concentrations as a percentage of SAAQS or NAAQS.

Footnotes continue on next page.

TABLE 10.1.1-3 (Cont.)

e A dash indicates that no measurement is available.

f On June 15, 2005, the EPA revoked the 1-hour O₃ standard for all areas except the 8-hour O₃ nonattainment Early Action Compact (EAC) areas (those do not yet have an effective date for their 8-hour designations). The 1-hour standard will be revoked for these areas 1 year after the effective date of their designation as attainment or nonattainment for the 8-hour O₃ standard.

g Used old standard because no data in the new standard format are available.

h Arithmetic average.

Sources: 40 CFR 52.21; EPA (2008a, 2009); Flynn (2007); SCDHEC (2004, 2008)

1

2

3 concentrations because data were limited (for 2004–2006 only), but there was a general
4 downward trend in O₃ concentrations during the period 1997–2006 (SCDHEC 2008). Measured
5 concentration levels for TSP in the neighboring county of SRS were consistently less than 50%
6 of the SAAQS, and no recent measurement data were available for hydrogen fluoride.

7

8

9 SRS and its vicinity are classified as PSD Class II areas. No Class I areas are located
10 within 100 km (62 mi) of the GTCC reference location. The nearest Class I area is the Cape
11 Romain National Wildlife Refuge, about 190 km (120 mi) east of the GTCC reference location;
12 it is the only Class I area in South Carolina (40 CFR 81.426). The facilities at SRS have not been
13 required to obtain a PSD permit (DCS 2002).

13

14

15 **10.1.1.4 Existing Noise Environment**

16

17 Aiken County has quantitative noise-limit ordinances by frequency band, as shown in
18 Table 10.1.1-4, although the States of South Carolina and Georgia do not.

19

20

21 Similar to those at any other industrial site, major noise sources in active areas at SRS
22 include industrial facilities and equipment (e.g., cooling systems, transformers, engines, vents,
23 paging systems), construction and materials-handling equipment, and vehicles. Noise impacts on
24 the general public arise primarily from transportation of people and materials to and from the site
25 by vehicles, helicopters, and trains (DCS 2002).

25

26

27 SRS is located in a rural setting, and no residences and sensitive receptors (e.g., schools,
28 hospitals) are located in the immediate vicinity of the GTCC reference location. Most SRS
29 activities are far enough from the site boundaries and any neighboring communities, and trees
30 and other vegetation in-between tend to attenuate sound considerably, so the associated noise
31 levels at the boundary are not measurable or are barely distinguishable from background levels.
32 A noise survey was conducted in the SRS area in 1989 and 1990 (NUS Corporation 1990).
33 Seven off-site locations were selected along major routes used by SRS employees entering and
leaving the site. Summer L_{dn} levels ranged from 62 to 72 dBA; winter L_{dn} levels ranged from

TABLE 10.1.1-4 Maximum Allowable Noise Levels in Aiken County, South Carolina

Frequency Band (Hz)	Maximum Allowable Sound Pressure Levels at Property Boundary (dB)	
	Residential	Nonresidential
0–75	72	79
75–150	67	74
150–300	59	66
300–600	52	59
600–1,200	46	53
1,200–2,400	40	47
2,400–4,800	34	41
4,800–10,000	32	39

Source: County of Aiken (2008)

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51 to 70 dBA. Measured L_{dn} levels at three on-site locations were in a range of 54–62 dBA in summer and 37–59 dBA in winter. These levels for a typical rural environment primarily result from the traffic and/or bird and insect noise. For the general area surrounding SRS, the countywide L_{dn} levels based on population density are estimated to be 36, 38, and 43 dBA for Allendale, Barnwell, and Aiken Counties, respectively, typical of rural areas (Miller 2002; Eldred 1982).

10.1.2 Geology and Soils

10.1.2.1 Geology

10.1.2.1.1 Physiography. SRS is located on the Aiken Plateau of the Upper Atlantic Coastal Plain physiographic province, about 40 km (25 mi) southeast of the fall line, an erosional scarp that separates the crystalline rocks of the Piedmont province to the west from the sedimentary rocks of the Atlantic Coastal Plain (Figure 10.1.2-1). The Coastal Plain is underlain by a wedge of seaward-dipping unconsolidated and poorly consolidated sediments deposited during a series of sea transgressions and regressions and reflecting a variety of depositional environments, including fluvial, deltaic, and shallow marine. The sediments increase in thickness from zero at the fall line to more than 1,219 m (4,000 ft) near the South Carolina coast. At SRS, Coastal Plain sediments range in thickness from about 183 to 366 m (600 to 1,200 ft) (Hunt 1973; Aadland et al. 1995; Denham 1995; Fallaw and Price 1992).

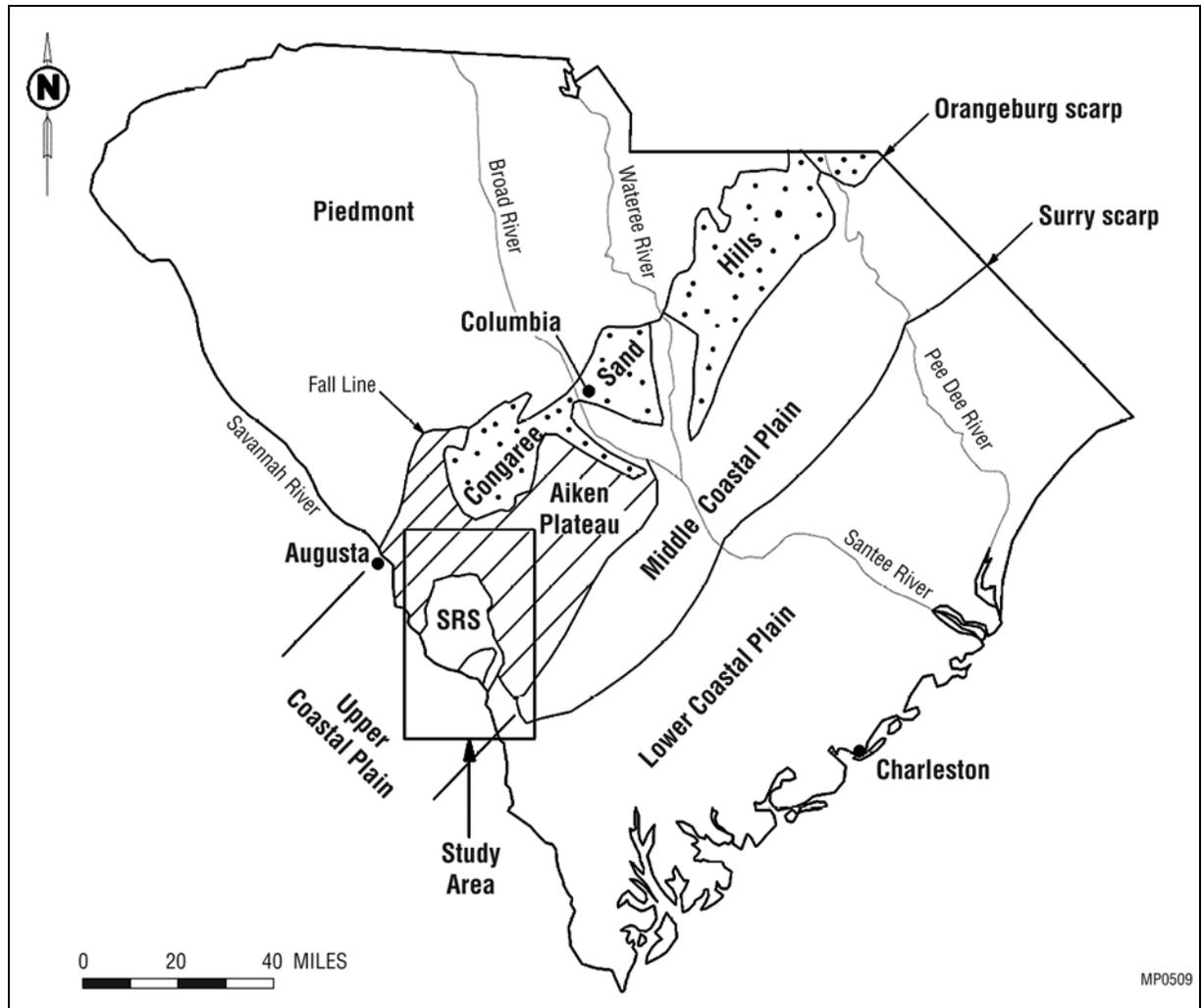


FIGURE 10.1.2-1 Location of SRS on the Atlantic Coastal Plain near the Fall Line
 (Source: Wyatt et al. 2000)

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The Aiken Plateau is bounded by the Savannah and Congaree Rivers. It is highly dissected and characterized by broad interfluvial areas with narrow, steep-sided valleys. Regional dip is to the southeast; the plateau slopes from an elevation of approximately 200 m (650 ft) above mean sea level (MSL) at the fall line to an elevation of about (250 ft MSL) on its southeast edge. It is typically well drained, although poorly drained sinks and depressions occur in topographically high areas (above 75 m MSL [250 ft MSL]). Because SRS is situated near the Piedmont province, its relief is greater than near-coastal areas, with on-site elevations ranging from 128 m MSL (420 ft MSL) near the Aiken Gate House on Road 2 to about 24.4 m MSL (80 ft MSL) where Steel Creek enters the Savannah River (Aadland et al. 1995; Denham 1995; Rogers 1990).

The Congaree Sand Hills region of the Coastal Plain province stretches across the base of the Piedmont province at the fall line, just to the north and northeast of the Aiken Plateau

1 (Figure 10.1.2-1). The hills are composed of sandy soils and are typically gently sloping with
2 rounded summits. The sand hills are remnants of ancient coastal dunes deposited during an
3 episode of sea regression (Aadland et al. 1995).

4
5
6 **10.1.2.1.2 Topography.** The GTCC reference location is situated on a broad upland area
7 typical of the Aiken Plateau. The elevation is fairly flat, ranging from about 90 to 100 m (300 to
8 330 ft) MSL, with an average slope of less than 4%. The upland area extends to the south but
9 drops off steeply to the north, east, and west. Slopes range from 10% to 40% along the narrow
10 valleys between the upland area and the floodplains along nearby Mill Creek, McQueen Branch,
11 Tinker Creek, and Upper Three Runs.

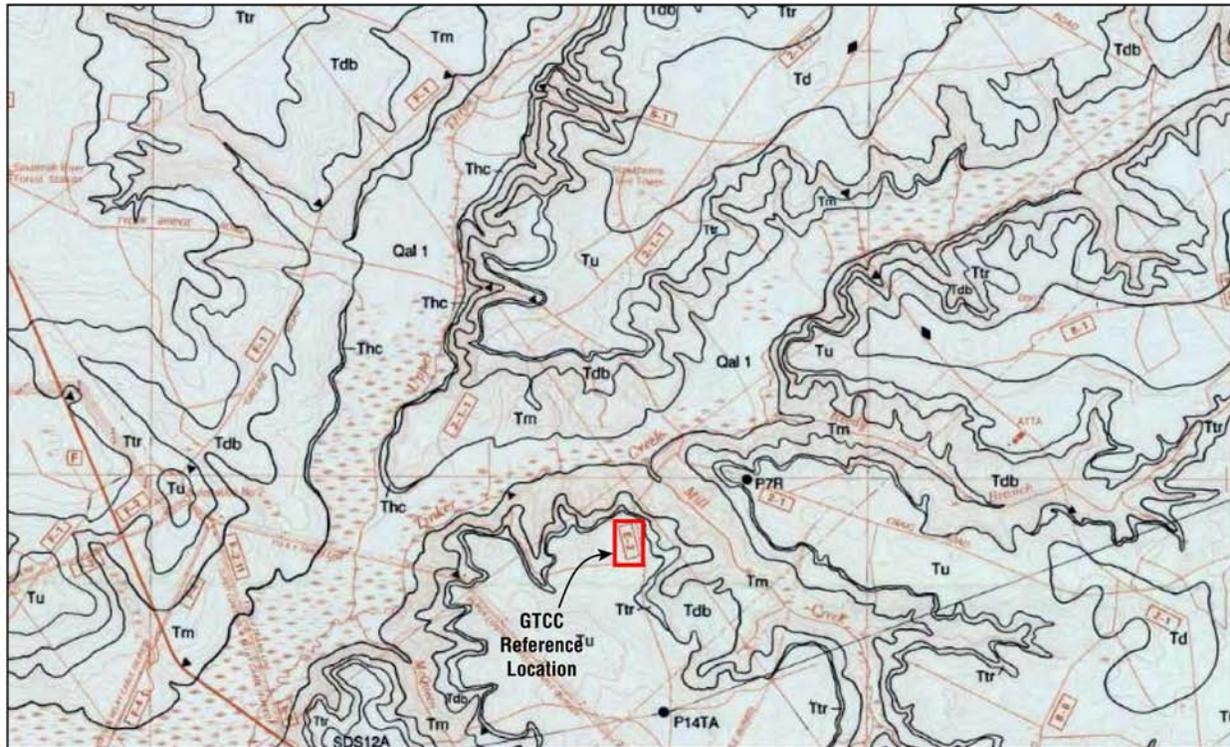
12
13
14 **10.1.2.1.3 Site Geology and Stratigraphy.** Coastal Plain sediments at SRS consist of
15 sand, silt, clay, limestone, and conglomerate ranging in age from Late Cretaceous to Holocene.
16 These sediments are underlain by Paleozoic metamorphic rocks (gneiss and schist, with lesser
17 amounts of quartzite) that have been intruded by somewhat younger Paleozoic granitic plutons.
18 In the southeastern portion of SRS, coastal plain sediments have a thickness of up to 366 m
19 (1,200 ft) and rest unconformably on (Mesozoic Triassic) age rocks in the Dunbarton basin
20 (Fallaw and Price 1995; Prowell 1996).

21
22 The GTCC reference location is about 32 km (2 mi) to the east-northeast of the Z-Area, in
23 the north-central portion of SRS. It is situated on an upland ridge overlooking Tinker Creek to
24 the north, on unconsolidated Tertiary sediments (Tobacco Road sand; Figure 10.1.2-2). Tertiary
25 deposits make up a majority of surface exposures and most of the shallow subsurface rocks at
26 SRS. These deposits represent marine (deltaic) and marginal marine (fluvial) depositional
27 environments typical of the Coastal Plain province (Prowell 1996).

28
29 The following summary of stratigraphy at the SRS is based on the work of
30 Fallaw et al. (1992), Fallaw and Price (1995), Prowell (1996), and Wyatt et al. (2000).
31 Figure 10.1.2-2 shows the geology of the area surrounding the GTCC reference location.
32 Figure 10.1.2-3 presents a stratigraphic column for the SRS and vicinity.

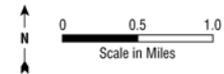
33
34
35 **Paleozoic and Triassic Basement Rock.** Igneous and metamorphic rocks of the
36 Piedmont and Blue Ridge provinces are the source of sediments in the Coastal Plain. Rocks
37 similar to those exposed in the Piedmont province underlie the Coastal Plain sediments at the
38 SRS. These include metamorphic rocks (slate, phyllite, schist, gneiss), volcanic and
39 metavolcanic rocks, and intrusive rocks (granite) of Paleozoic age that formed during several
40 orogenic episodes in the Appalachians.

41
42 The southeastern portion of SRS is underlain by rocks of the Triassic Newark Supergroup
43 in Dunbarton Basin. The Dunbarton Basin is a Triassic-Jurassic rift basin filled with lithified
44 terrigenous and lacustrine sediments (predominantly conglomerate, sandstone, siltstone, and
45 mudstone), with minor amounts of mafic volcanic and intrusive rock.



Qal 1 Alluvium (Holocene): Fine to very coarse quartz sand in a sparse clay matrix
 Td Dune sand (Pliocene?): Medium, angular, moderately sorted tan quartz sand
 Tu Upland unit (Miocene?): Characterized by three lithofacies: 1) crossbedded gravel and poorly sorted sand, 2) crossbedded, fine to very coarse sand with clay clasts and feldspar grains, and 3) brightly colored, massive sandy clay
 Ttr Tobacco Road Sand (Oligocene? and Eocene): Poorly to moderately sorted, angular to subangular, fine to very coarse quartz sand
 Tdb Dry Branch Formation (Eocene): Calcareous clay, clay, thinly interbedded sand and clay, and sand in a coarsening-upward sequence

Tm McBean Formation (Eocene): White to buff, fossiliferous sandy limestone and calcareous sand, and dark-olive-green marl; well-preserved shells of gastropods and pelecypods common
 Thc Huber and Congaree Formations, undivided (Eocene): Huber Formation is fine to very coarse, poorly sorted, angular quartz sand in a matrix of white kaolin; Congaree Formation is moderately to well-sorted, fine to coarse, subangular to subrounded quartz sand in a buff to light-gray clay matrix with small quantities of very fine, dark heavy minerals and white mica.



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2 **FIGURE 10.1.2-2 Geologic Map of the GTCC Reference Location at SRS (Source: Adapted from**
 3 **Prowell 1996)**

4

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6

7 The surface of the Paleozoic rocks and Triassic sediments was leveled by erosion over
 8 time, forming the basement rock over which Coastal Plain sediments were deposited. The
 9 surface of the basement rock dips about 9.5 m/km (50 ft/mi) to the southeast at SRS.

9

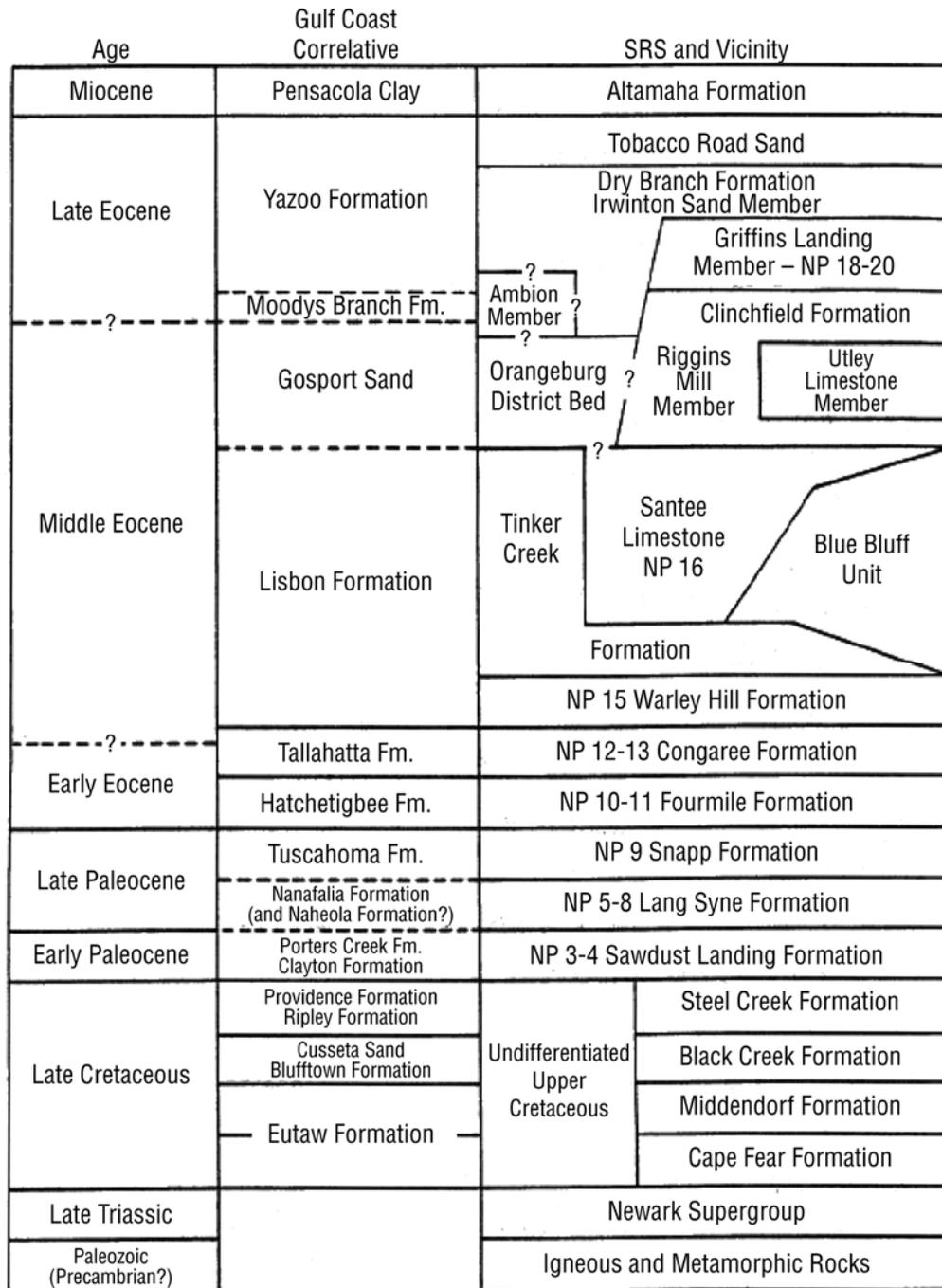
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12 **Upper Cretaceous Sediments.** Upper Cretaceous sediments overlie Paleozoic basement
 13 rock or lower Mesozoic (Triassic) rocks throughout SRS. The Upper Cretaceous section is
 14 divided into four units (from older to younger): Cape Fear Formation, Middendorf Formation,
 15 Black Creek Group, and Steel Creek Formation. Its thickness at SRS ranges from 120 m (400 ft)
 16 at the site's northwestern boundary to 240 m (800 ft) at the southeastern boundary. The
 17 sediments are typical of braided stream deposits, consisting predominantly of poorly
 18 consolidated, clay-rich, fine- to medium-grained micaceous sand, sandy clay, and gravels,
 19 suggesting a high relief in the Appalachians during this time.

19

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FIGURE 10.1.2-3 Stratigraphic Column for SRS and Vicinity
(Source: Adapted from Fallaw and Price 1995)

1 **Tertiary (Paleocene, Eocene and Miocene) Sediments.** Tertiary sediments range in age
2 from Early (Lower) Paleocene to Miocene. These sediments consist predominantly of light-
3 colored, kaolinitic, coarse-grained, cross-bedded quartz sands, micaceous sands, and kaolin, and
4 they were deposited in fluvial to marine shelf environments.

5
6
7 **Quaternary Deposits.** SRS lies within the interfluvial area between the Savannah and
8 Salkahatchie Rivers; its drainage systems consist entirely of streams that are tributaries of the
9 Savannah River. Fluvial terraces are preserved above the modern floodplain along the river and
10 some of its major tributaries. These features, along with colluvial and alluvial deposits, make up
11 the Quaternary section at SRS.

12
13
14 **10.1.2.1.4 Seismicity.** Earthquakes have been recorded in both the Piedmont and Coastal
15 Plain provinces of South Carolina. Most of the seismicity in the Piedmont province has been
16 associated with reservoirs in northwestern and central South Carolina. The largest earthquake in
17 the Piedmont occurred in Union County in 1913 (with a modified Mercalli intensity of VI to VIII
18 and an estimated body wave magnitude of 4.5), about 150 km (93 mi) north of SRS
19 (Stephenson 1992; DOE 2002).

20
21 Seismicity in the Coastal Plain occurs in three distinct zones: Middleton Place-
22 Summerville seismic zone (MPSSZ), about 20 km (12 mi) northwest of Charleston; Bowman
23 seismic zone (BSZ), about 60 km (37 mi) northwest of the MPSSZ; and Adams Run seismic
24 zone (ARSZ), about 30 km (19 mi) southwest of the MPSSZ. Earthquakes also occur in spatially
25 isolated areas of the Coastal Plain. The largest earthquake in the southeastern United States
26 occurred in the South Carolina Coastal Plain in 1886 (with a measured body wave magnitude
27 of 6.7); its epicenter was about 20 to 30 km (12 to 19 mi) northwest of Charleston in the MPSSZ.
28 The Charleston area is considered the most seismically active region in the Coastal Plain
29 province, and it is the most significant source of seismicity affecting SRS (Stephenson 1992).

30
31 Figure 10.1.2-4 shows the major fault lines (and relative movement along them) at SRS,
32 based on the work of Stephenson and Stieve (1992) and Wike et al. (1996). The lines shown are
33 projections to the ground surface; the actual faults do not reach the ground surface (most are
34 several hundred feet bgs). The Upper Three Runs fault (a Paleozoic fault located in the
35 crystalline rock below the Coastal Plain sediments) crosses SRS about 1.6 km (1 mi) to the north
36 and west of E-Area.

37
38 None of the fault systems at SRS is considered “capable” (as defined in 10 CFR Part 100)
39 because there has been no movement along these faults that can be traced to the ground surface
40 in the past 35,000 years (DOE 2002).

41
42 The locations of earthquakes at SRS are also shown on Figure 10.1.2-4. They include the
43 most recent earthquake, which occurred on October 8, 2001, near Upper Three Runs Creek,
44 about 2.5 km (1.6 mi) north of the GTCC reference site. It had a body wave magnitude of
45 2.6 and a focal depth of about 3.9 km (2.4 mi). Three earthquakes with magnitudes ranging from
46 2.0 to 2.6 occurred before this 2001 event and after the SRS seismic recording network was

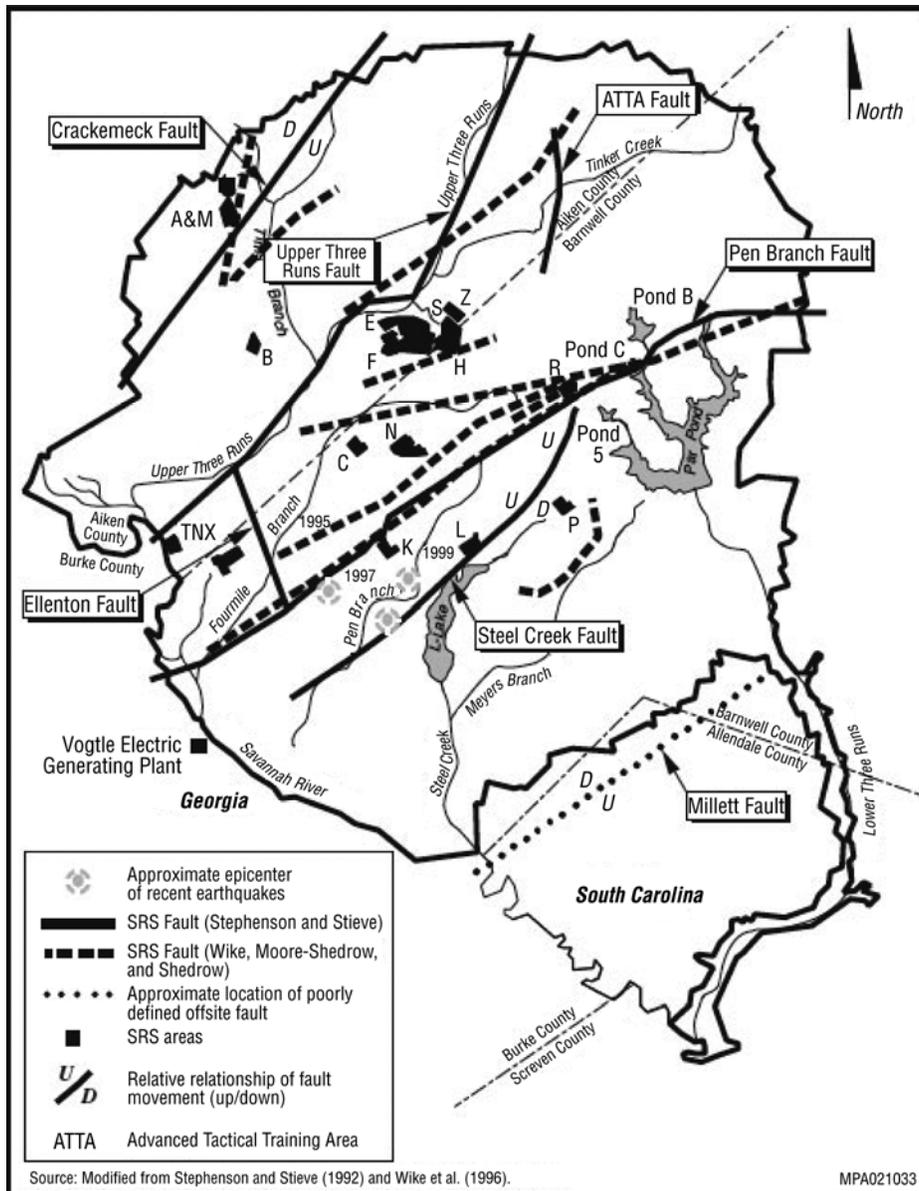


FIGURE 10.1.2-4 Seismic Fault Lines and Locations of On-Site Earthquakes at SRS (Source: Adapted from DOE 2002)

installed in 1976; all were clustered near the south-central region of SRS (Stevenson and Talwani 2004; DOE 2002). Also, a 3.2-magnitude earthquake occurred on August 8, 1993, near Aiken, South Carolina, about 19 km (12 mi) to the north of the SRS north boundary. It was felt most strongly in Couchton, South Carolina (Stevenson and Talwani 2004).

Probabilistic seismic hazard assessments conducted since the late 1960s have determined the seismic design basis for SRS reactors to be 0.20g peak horizontal ground acceleration. These assessments have estimated the annual probability of exceeding the design basis to be within a range of 0.002 to 0.00005 (once every 500 to 20,000 years) (Stephenson 1992).

1 **10.1.2.1.5 Volcanic Activity.** There are no active volcanoes in the vicinity of SRS.
2
3

4 **10.1.2.1.6 Slope Stability, Subsidence, and Liquefaction.** No natural factors at the
5 GTCC reference location have been reported that would affect the engineering aspects of slope
6 stability, as long as the facility is built at some distance from the edge of the upland ridge to the
7 north, east, and west. The upland area itself is fairly flat, with a slope of generally less than 4%.
8

9 The Santee Formation (Figure 10.1.2-3) comprises a soil zone of marine origin occurring
10 at depths of 30 to 70 m (100 to 250 ft) across SRS. This zone has locally high concentrations of
11 calcium carbonate and is characterized by a stronger matrix of material through which weak
12 zones, referred to as “soft zones,” are interspersed. Soft zones occur in the saturated zone and are
13 generally stable under static conditions (showing minimal carbonate dissolution). However, load
14 increases that could result from a seismic event could lead to subsidence, especially in areas
15 where the soft zone is thick and laterally extensive. It is not known whether soft zones exist
16 below the GTCC reference site (Aadland et al. 1999; WSRC 2000).
17

18 Liquefaction of saturated sediments is a potential hazard during or immediately after
19 large earthquakes. Whether soils will liquefy depends on several factors, including the magnitude
20 of the earthquake, peak ground velocity, liquefaction susceptibility of soils, and depth to
21 groundwater. Previous studies at other SRS sites (e.g., F-Area) found the liquefaction
22 susceptibility of soils to be low because of their low clay content and liquid limit and because
23 earthquakes at SRS historically do not have the shear wave velocities required to subject soils to
24 liquefaction (WSRC 2000). Lewis et al. (2004) also report that the liquefaction potential for soils
25 at SRS is very low; soil strength is attributed to factors such as aging and over-consolidation.
26

27 **10.1.2.2 Soils**

28 The undisturbed soils within the study area are predominantly sands, and they overlie a
29 substratum of loamy sand or sandy clay loam. These soils tend to be low in organic content and
30 water storage capacity. Upland soils (Ailey and Lakeland sands) are gently sloping (0 to 6%) and
31 well to excessively drained. These soils have a permeability that ranges from low to high and a
32 low erosion hazard rating. Soils on the southeastern banks of Upper Three Runs Creek and
33 Tinker Creek (Troup and Lucy sands) occur on steep slopes (15 to 25%) and are well drained.
34 These soils are moderately permeable and have a moderate erosion hazard rating (Rogers 1990).
35
36
37

38 **10.1.2.3 Mineral and Energy Resources**

39 There are no reported mineral or energy resources being developed within the boundaries
40 of SRS. Economic mineral resources in South Carolina include gold, copper, lead, zinc, silver,
41 titanium, rare earths, zirconium, tin, refractory minerals, lithium, mica, and feldspar minerals.
42 Industrial resources include clay, limestone, sand, gravel, crushed rock, building stone, slate, and
43 aggregate.
44
45
46
47

10.1.3 Water Resources

10.1.3.1 Surface Water

10.1.3.1.1 Rivers and Streams. The major surface water systems and their 100-year floodplains at the 800-km² (310-mi²) SRS are shown in Figure 10.1.3-1. SRS streams and the Savannah River are classified as “freshwater,” which is defined as surface water that is suitable (1) for primary and secondary contact recreation, (2) as a source of drinking water after conventional treatment, (3) for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora, and (4) for industrial and agricultural uses. None of these water features are classified as Wild and Scenic.

The largest river in the area is Savannah River, which forms the southwestern border of SRS for about 32 km (20 mi). It is formed by the confluence of the Tugaloo and Seneca Rivers in northeast Georgia. The Savannah River watershed drains about 27,388 km² (10,547 mi²) and encompasses western South Carolina, eastern Georgia, and a small portion of southwestern North Carolina. It forms the boundary between Georgia and South Carolina. At SRS, flow within the Savannah River averages about 283 cms (10,000 cfs) (DOE 2002; Wike et al. 2006).

Five upstream reservoirs — Jocassee, Keowee, Hartwell, Richard B. Russell, and Strom Thurmond/Clarks Hill — moderate the effects of droughts and low flows on downstream water quality and accompanying impacts on aquatic and wildlife resources that depend on the river (DOE 1997, 2002; Wike et al. 2006).

Upstream of SRS, the Savannah River supplies domestic and industrial water for Augusta, Georgia, and for North Augusta, South Carolina. The river also receives sewage treatment plant effluents from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and from a variety of SRS operations through permitted stream discharges. About 209 river km (130 river mi) downstream, the river supplies domestic and industrial water for the Port Wentworth (Savannah, Georgia) water treatment plant at River Mile 29 and for Beaufort and Jasper Counties in South Carolina at River Mile 39.2. Georgia Power’s Vogtle Electric Generating Plant withdraws an average of 1.3 cms (46 cfs) for cooling and returns an average of 0.35 cms (12 cfs). Also, SCE&G’s Urquhart Steam Generating Station at Beech Island, South Carolina, withdraws approximately 7.4 cms (261 cfs) of once-through cooling water (DOE 1997, 2002).

There are five SRS tributaries that discharge directly into the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs (Figure 10.1.3-1). A sixth tributary, Pen Branch, discharges to the Savannah River floodplain swamp. All these streams flow to the south/southwest, descending 15.2 to 61 m (50 to 200 ft) before discharging into the river. These streams have historically received effluent from SRS operating areas; they are not commercial sources of water.

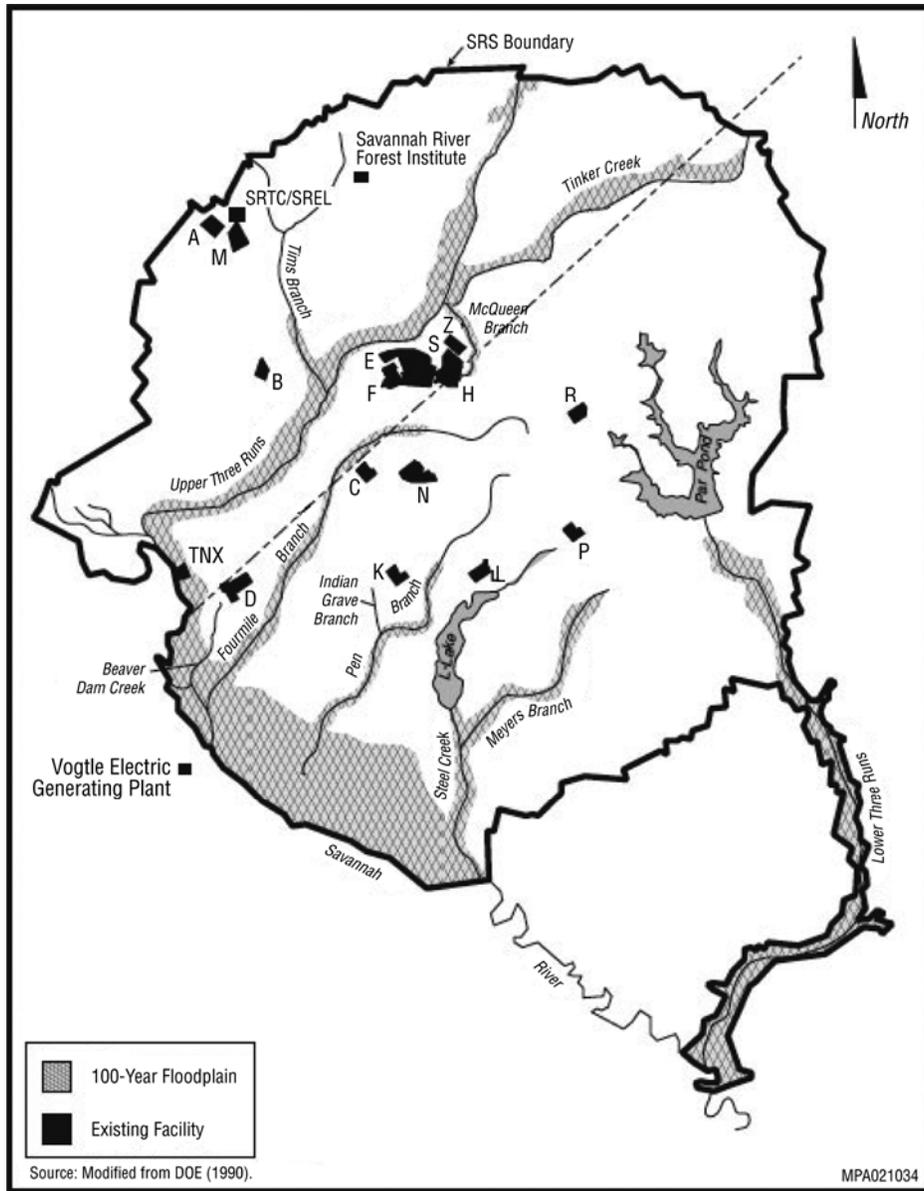


FIGURE 10.1.3-1 Major Surface Water Stream Systems and the 100-Year Floodplain at SRS (Source: DOE 2002)

1 E-Area is situated between F-Area and H-Area on a divide that separates the drainage
2 into the Upper Three Runs Creek to the north (with its tributaries Tinker Creek, McQueen
3 Branch, Crouch Branch, and Tims Branch) and Fourmile Branch to the south. The upper aquifer
4 zone of the Upper Three Runs Aquifer crops out and seeps along both the Upper Three Runs and
5 Fourmile Branch (DOE 2002; Wike et al. 2006). The GTCC reference location at SRS is situated
6 a short distance northeast of Z-Area, which is located about 5 km (3 mi) northeast of E-Area.

7
8 Z-Area is located just west of McQueen Branch, near the confluence of McQueen Branch
9 and Upper Three Runs Creek. McQueen Branch is joined by the Tinker Branch on SRS. Tinker
10 Branch then joins Upper Three Runs Creek about 50 km (31 mi) downstream of the
11 McQueen/Tinker Creek confluence. McQueen Branch is typical of the streams in the area; it has
12 a small gradient, a predominantly sandy substrate, little gravel, and no cobble or bedrock
13 (Sheldon and Meffe 1994).

14
15
16 **10.1.3.1.2 Upper Three Runs Creek.** Upper Three Runs Creek, the longest of the SRS
17 streams, is a large, blackwater stream just north of the General Separations Area (GSA). The
18 GSA is a 40-km² (15-mi²) region in central SRS that includes the E-, F-, H-, S-, and Z-Areas
19 (Figure 10.1.3-1). A blackwater stream has a dark color attributable to tannins released from the
20 decomposition of leaves and acids released from heavily organic soils (North Augusta 2004).
21 The creek is about 40-km (25-mi) long, with its lower 28 km (17 mi) being within the boundaries
22 of SRS. It drains an area of about 545 km² (209 mi²) and flows to the southwest, discharging
23 directly into the Savannah River. Its two significant tributaries are Tinker Creek, the largest, and
24 Tims Branch. Upper Three Runs Creek receives more water from underground sources than do
25 other SRS streams, and it is the only stream with headwaters that arise off-site (near Aiken,
26 South Carolina) (DOE 2002; Wike et al. 2006).

27
28 The creek receives various NPDES-permitted effluents (either directly or through its
29 tributaries), including cooling water, blowdown, stormwater, lab drains, air stripper discharge,
30 steam condensate, M-Area wastes, process water, neutralization wastewater, and F/H-Area
31 Effluent Treatment Project (ETP) wastewater. It is the only major tributary that has not received
32 thermal discharges. The F/H-Area ETP discharges to the creek just downstream of the Road C
33 bridge (DOE 2002; Wike et al. 2006; Mast and Turk 1999).

34
35 Stream flow was monitored between 1974 and 2002 at three locations on Upper Three
36 Runs Creek, including two on-site locations (Road A [Station 02197315] and Road C
37 [Station 02197310]). Annual discharge at the stations at Road C between 1975 and 2002 (based
38 on a water year, which lasts from October of one year through September of the next year)
39 averaged 5.78 cms (204.2 cfs), with a range of 3.45 cms (121.8 cfs) in 2002 to 8.34 cms
40 (294.5 cfs) in 1995. At Road A station, it averaged 6.63 cms (234.3 cfs), with a range of
41 3.68 cms (130.0 cfs) in 2002 to 8.21 cms (289.8 cfs) in 1991 (USGS 2007). Neither station is
42 currently monitored; no data after September 2002 are available (Wike et al. 2006).

1 **10.1.3.1.3 Fourmile Branch.** Fourmile Branch is a blackwater stream that originates to
2 the south of the GSA. It is about 24-km (15-mi) long. The stream drains an area of about 57 km²
3 (22 mi²) and flows to the southwest, discharging through a main delta channel into the Savannah
4 River. A small portion of its discharge flows west and enters Beaver Dam Creek. When the
5 Savannah River floods, water from Fourmile Branch flows south along the northern boundary of
6 a floodplain swamp and joins Pen Branch and Steel Creek (DOE 2002; Wike et al. 2006).

7
8 Fourmile Branch receives various NPDES-permitted effluents from the F-, H-, and
9 C-Areas and Central Shops. Discharges from the C Reactor ceased after it shut down in 1985.
10 (Prior to that, thermal discharges of reactor cooling water were discharged to Castor Creek, a
11 tributary to Fourmile Branch.) Effluent discharges from the Central Sanitary Wastewater
12 Treatment Facility (CSWTF) began in 1995.

13
14 Stream flow was monitored between 1974 and 2002 at two locations on Fourmile Branch
15 (Site No. 7 [Station 02197342], just upstream of Castor Creek, and Road A-12.2
16 [Station 02197344]). Annual discharge at Site No. 7 between 1975 and 2002 (based on a water
17 year) averaged 0.47 cms (16.5 cfs), with a range of 0.19 cms (6.78 cfs) in 2002 to 0.93 cms
18 (32.7 cfs) in 1991. Annual discharge at Road A-12.2 between 1986 (when C Reactor discharges
19 were discontinued) and 2002 (based on a water year) averaged 0.90 cms (31.9 cfs), with a range
20 of 0.30 cms (10.6 cfs) in 2002 to 1.79 cms (63.1 cfs) in 1991 (USGS 2007). Neither station is
21 currently monitored; no data after September 2002 are available (Wike et al. 2006).

22
23 Both Fourmile Branch and Upper Three Runs Creek at SRS are prone to flooding.
24 Upstream reservoirs, additional tributaries, and crossing conduits complicate floodplain analyses.
25 However, a 100-year floodplain has been produced for the site (Figure 10.1.3-1). Flood potential
26 is greatest along the southwestern boundary of the site along the Savannah River. The potential
27 for flooding in the E-Area and nearby Z-Area is small; any flooding would occur on the north
28 side of Upper Three Runs Creek and along McQueen Branch.

29
30
31 **10.1.3.1.4 Reservoirs.** There are two reservoirs at SRS: L Lake and Par Pond
32 (Figure 10.1.3-1). Both ponds are located south of the GSA. L Lake is in the south-central
33 portion of the site. It was formed in 1985 by damming the headwaters of Steel Creek about
34 7.2 km (4.5 mi) above its mouth. Its average width is about 0.64 km (0.40 mi), reaching a
35 maximum of about 1.3 km (0.8 mi). At its normal pool elevation of 58 m (190 ft) MSL, the dam
36 impounds about 31 million m³ (1,100 million ft³) of water. L Lake gains water via groundwater
37 flow at its upstream end and loses water to the groundwater system along its downstream
38 shorelines (Wike et al. 2006).

39
40 Par Pond is a 1,012-ha (2,500-ac) reactor-cooling reservoir created in 1958 by
41 constructing an earthen dam, Cold Dam, across Lower Three Runs Creek (Wike et al. 2006). It
42 was constructed to augment the cooling system for the P and R Reactors. Par Pond's capacity is
43 85,900 ac-ft (3,742 million ft³); normal storage is 54,400 ac-ft (2,370 million ft³). Maximum
44 discharge from Cold Dam is 66 cms (2,340 cfs) (Find Lakes 2008). The pond runs along the
45 course of Poplar Branch, Joyce Branch, and the upper reach of the Lower Three Runs drainage

1 system. The reservoir surface elevation fluctuates between 61.0 and 59.4 m (200 and 195 ft)
2 MSL.

3
4
5 **10.1.3.1.5 Other Surface Water.** Other surface waters at SRS include the Savannah
6 River swamp, wetlands, and Carolina Bays. The SRS Savannah River swamp borders 16 km
7 (10 mi) of SRS and has an average width of about 2.2 km (1.4 mi). About 3,800 ha (9,400 ac) of
8 the Savannah River swamp lie within SRS between Upper Three Runs Creek and Steel Creek. A
9 levee and embankment run along the east side of the Savannah River. Breaches in the levee
10 allow water from Beaver Dam Creek, Fourmile Branch, and Steel Creek to flow to the river. The
11 combined discharges of Steel Creek and Pen Branch enter the river near the southeast edge of the
12 swamp. During periods of high water, river water overflows the levee and floods the swamp. The
13 river begins to overflow into the swamp when river elevations reach between 27 and 28 m
14 (89 and 92 ft) above MSL or at flows of about 433 cms (15,300 cfs). During flooding, the water
15 from SRS streams flows through the swamp parallel to the river and enters the river downstream
16 of Steel Creek (Wike et al. 2006). There are no wetlands in the vicinity of Z-Area.

17
18
19 **10.1.3.1.6 Surface Water Quality.** Contamination in the Upper Three Runs Creek and
20 Fourmile Branch watersheds is related to operational areas F and H and has been listed in the
21 *Federal Facility Agreement for the Savannah River Site* (WSRC 1993). Table 10.1.3-1
22 summarizes the water quality of Upper Three Runs Creek and Fourmile Branch for 1998.

23
24 Tritium, the predominant radionuclide detected above background levels in SRS streams,
25 was observed at all stream locations in 2006 except the Upper Three Runs Creek control point
26 and Site X-008 near T-Area. In 2006, tritium concentrations generally declined in all site
27 streams, except in Steel Creek, where they remained stable. In 2006, tritium concentrations in
28 Upper Three Runs Creek and Fourmile Branch were 189 and 650 pCi/L, respectively. Tritium
29 measured in the Savannah River below SRS in 2006 was 3,830 pCi/L. No detectable
30 concentrations of Co-60 were observed in any of the five major SRS streams. The maximum
31 concentration of Cs-137 in Fourmile Branch was 34.9 pCi/L; for Upper Three Runs Creek, the
32 maximum Cs-137 concentration was 5.0 pCi/L. Maximum gross beta measurements taken in
33 2006 at Upper Three Runs Creek and Fourmile Branch were 2.84 and 35.1 pCi/L, respectively.
34 Gross alpha values, at the same time, were 1.59 and 14.0 pCi/L, respectively (WSRC 2007a).

35
36 Cs-137 and Co-60 were the only man-made gamma-emitting radionuclides observed in
37 river and stream sediments. The highest Cs-137 concentration in streams, 497 pCi/g, was
38 detected in sediment from R Canal; the lowest levels were below detection at several locations.
39 The highest level found on the river, 0.486 pCi/g, was measured at River Mile 129. Co-60 was
40 detected in stream sediment at a concentration of 0.441 pCi/g at the R Canal location — the only
41 location where Co-60 was detected. Sr-89 and Sr-90 were above the minimum detectable
42 concentrations in sediment at six stream locations. The maximum detected value was 0.37 pCi/g
43 at the Fourmile Branch at the Road A-7 location. Pu-238 was detected in sediment during 2006
44 at all stream locations and at four river locations. The results ranged from a maximum of
45 0.139 pCi/g at FM-A7 to below detection at several locations. Pu-239 was detected in sediment

TABLE 10.1.3-1 Water Quality Data for Upper Three Runs Creek and Fourmile Branch in 1998

Parameter ^a	Unit of Measure	Fourmile Branch (FM-6) Average	Upper Three Runs (U3R-4) Average	Water Quality Criterion, ^b MCL, ^c or DCG ^d
Aluminum	mg/L	0.285 ^e	0.294 ^e	0.087
Cadmium	mg/L	NR ^f	NR	0.00066
Calcium	mg/L	NR	NR	NA ^g
Ce-137	pCi/L	4.74	0.67	120 ^d
Chromium	mg/L	ND ^h	ND	0.011
Copper	mg/L	0.006	ND	0.0065
Dissolved oxygen	mg/L	8.31	6.3	≥5
Iron	mg/L	0.717	0.547	1
Lead	mg/L	0.18	0.011	0.0013
Magnesium	mg/L	NR	NR	0.3
Manganese	mg/L	0.045	0.026	1
Mercury	mg/L	0.0002	ND	0.000012
Nickel	mg/L	ND	ND	0.088
Nitrate (as nitrogen)	mg/L	1.29	0.26	10 ^{c1}
pH	pH	6.4	5.8	6–8.5
Pu-238	pCi/L	0.003	ND	1.6 ^d
Pu-239	pCi/L	0.001	0.005	1.2 ^d
Sr-89 and Sr-90	pCi/L	6.79	0.04	8 ^{c2}
Suspended solids	mg/L	3.9	5.9	NA
Temperature ⁱ	°C	20.2	18.8	32.2
Tritium	pCi/L	1.9×10 ⁵	4.2×10 ³	20,000 ^{c2}
U-234	pCi/L	0.69	0.093	20 ^d
U-235	pCi/L	0.053	0.046	24 ^d
U-238	pCi/L	0.84	0.11	24 ^d
Zinc	mg/L	0.019	0.02	0.059

^a Parameters DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

^b Water quality criterion is “aquatic, chronic toxicity” unless otherwise indicated.

^c MCL = maximum contaminant level: State Primary Drinking Water Regulations.
c1 = Chapter 61-58.5 (b)(2)h of Arnett and Mamatey (1999); c2 = Chapter 61-58.5(h)(2)b of Arnett and Mamatey (1999).

^d DCG = DOE derived concentration guides for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water MCL is based on 4 mrem per year, the value listed is 4% of DCG.

^e Concentration exceeded water quality criterion; however, these criteria are for comparison only. Water quality criteria are not legally enforceable.

^f NR = not reported.

^g NA = not applicable.

^h ND = not detected.

ⁱ Shall not be increased more than 2.8°C (5°F) above natural temperature conditions or exceed a maximum of 32.2°C (90°F) as a result of the discharge of heated liquids, unless an appropriate temperature criterion mixing zone has been established.

Sources: Arnett and Mamatey (1999); DOE (2002)

1 at most stream locations and four river locations. The maximum value was 0.182 pCi/g, also
2 found at FM-A7. U-234, U-235, and U-238 were detected at most locations (WSRC 2007a).

3
4 At every site, most nonradiological water quality parameters and metals were detected in
5 at least one sample. Only three samples had detectable pesticides/herbicides in 2006. These
6 results continue to indicate that SRS discharges are not significantly affecting the water quality
7 of the on-site streams or the river. The maximum mercury concentration for Fourmile Branch in
8 2006 was 0.022 µg/L; the maximum aluminum concentration was 0.023 mg/L. No detectable
9 pesticides or herbicides were found. In 2006, maximum concentrations of mercury and
10 aluminum in Tims Branch (a tributary of Upper Three Runs Creek) were 0.02 µg/L and
11 0.5 mg/L, respectively. As was the case for Fourmile Branch, no detectable pesticides or
12 herbicides were found (WSRC 2007a).

13
14 In 2006, as in the previous five years, no pesticides or herbicides were found to be above
15 the quantitation limits in sediment samples from SRS surface waters. Results from metal
16 analyses for 2006 also were comparable to those of the previous five years (WSRC 2007a).

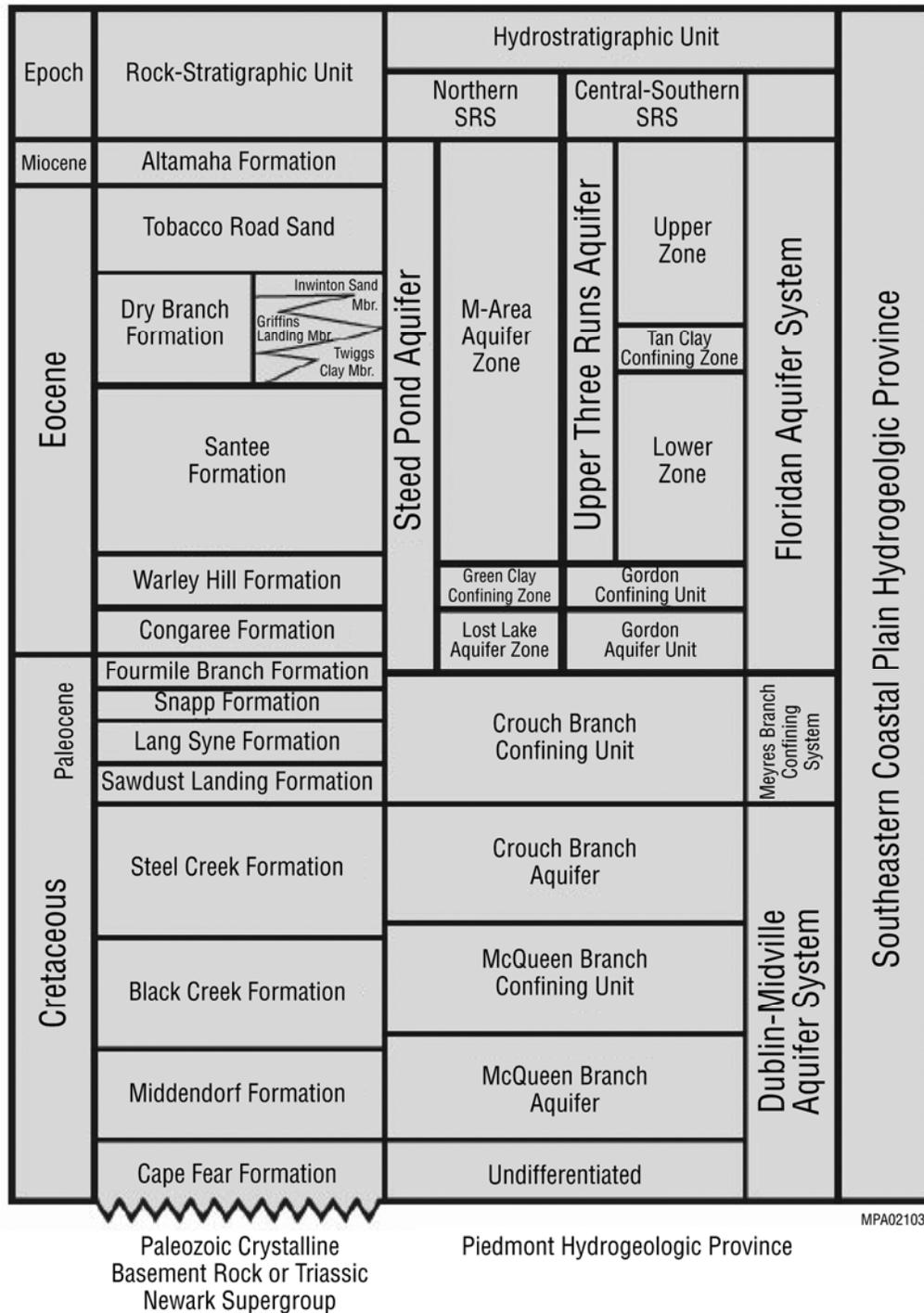
17 18 19 **10.1.3.2 Groundwater**

20
21
22 **10.1.3.2.1 Unsaturated Zone.** Groundwater at SRS occurs in both unsaturated (vadose)
23 and saturated (phreatic) zones. In topographically high areas, the thickness of the unsaturated
24 zone can reach 30 m (100 ft); in regions adjacent to streams, the thickness of the unsaturated
25 zone can be small and varies from zero to tens of feet.

26
27
28 **10.1.3.2.2 Aquifer Units.** The sand and clay sediments of the Atlantic Coastal Plain are
29 the principal source of groundwater for SRS. These sediments are collectively referred to as the
30 Southeastern Coastal Plain hydrogeologic province. Beneath the GSA, there are two major
31 aquifer systems — the overlying Floridan Aquifer System and the underlying Dublin-Midville
32 Aquifer System — separated by the Meyers Branch Confining System. Figure 10.1.3-2 shows
33 the hydrostratigraphic units within these systems at SRS and their relationship to the lithologic
34 units described in Section 10.1.2.1, based on the nomenclature established by
35 Aadland et al. (1995).

36
37 The following unit descriptions are taken from Aadland et al. (1995), Denham (1995),
38 Harris et al. (1998), Flach and Harris (1999), Wyatt et al. (2000), and WSRC (2007a) and
39 include information specific to two reference wells, P-27 and P-28, located near the GTCC
40 reference location.

41
42
43 **Floridan Aquifer System.** The Floridan Aquifer System consists of a thick sequence of
44 Paleocene to Miocene sands with minor amounts of gravel, clay, and limestone deposited in a
45 marine environment. The aquifer system is divided into the overlying Upper Three Runs Aquifer
46 and the underlying Gordon Aquifer, separated by the Gordon Confining Unit.



Source: Modified from Aadland et al. (1995) and Fallaw and Price (1995).

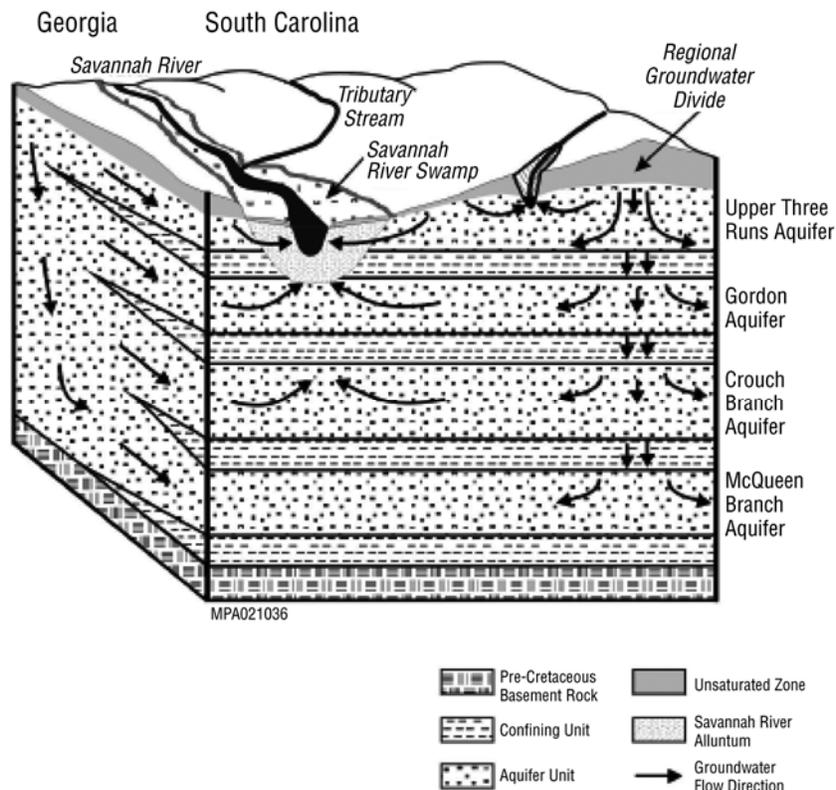
FIGURE 10.1.3-2 Hydrogeologic Units at SRS (Source: WSRC 2007a)

- 1
- 2
- 3
- 4

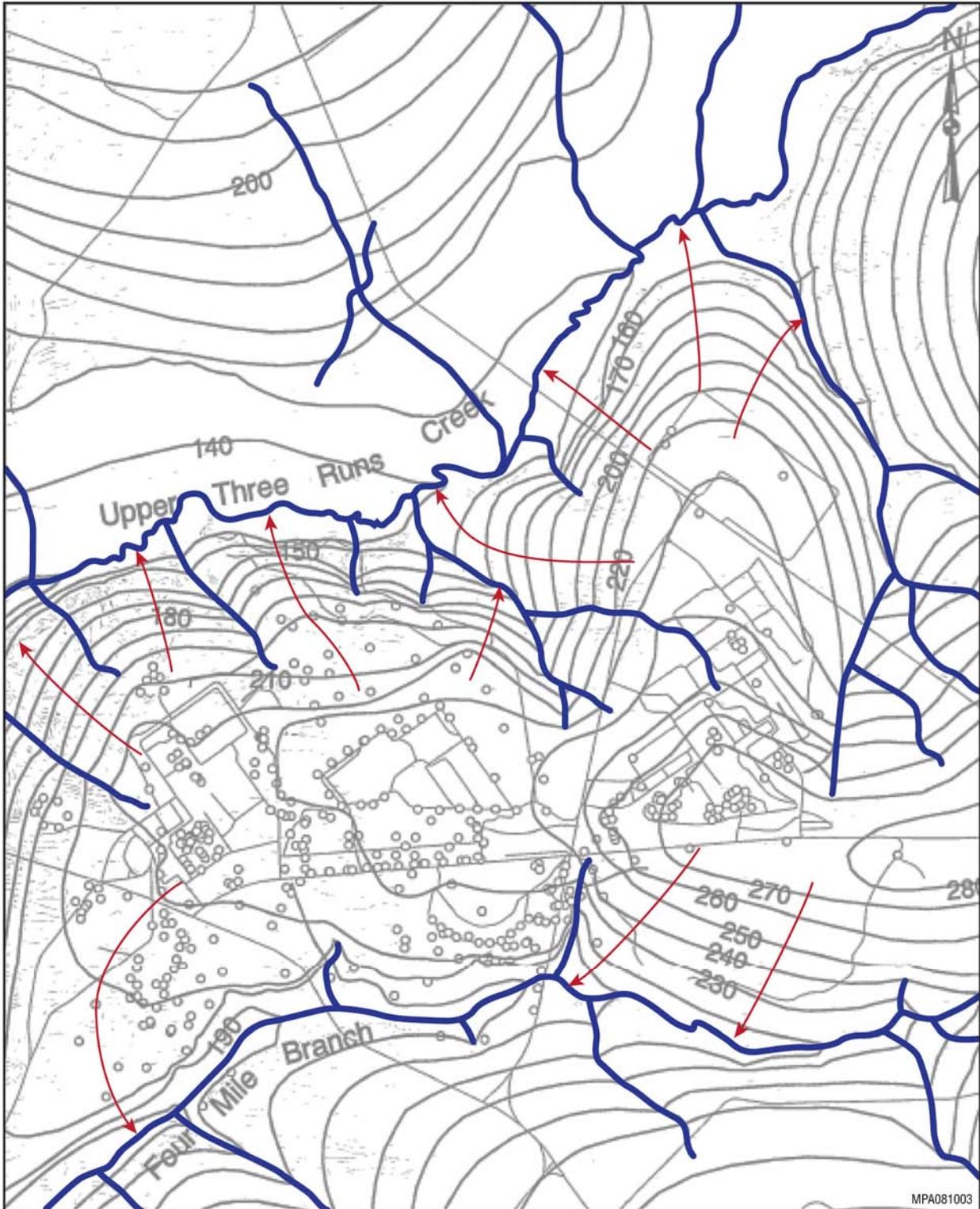
1 **Upper Three Runs Aquifer Unit.** The Upper Three Runs Aquifer Unit occurs between
 2 the water table and the Gordon Confining Unit (Figure 10.1.3-2). It includes all the strata above
 3 the Warley Hill Formation and the Blue Bluff Member of the Santee Limestone. The aquifer is
 4 defined by the hydrogeologic properties of the sediments penetrated in Reference Well P-27. In
 5 this well, the aquifer is about 40.2-m (132-ft) thick and consists mainly of quartz sand and clayey
 6 sand of the Tinker/Santee Formation; sand with interbedded tan to gray clay of the Dry Branch
 7 Formation; and sand, pebbly sand, and minor clay beds of the Tobacco Road Formation.
 8 Calcareous sand, clay, and limestone occur throughout the GSA.

9
 10 The hydraulic head distribution within the Upper Three Runs Aquifer is controlled by the
 11 location and depth of incisement of streams that dissect the area. The incisement of streams
 12 divides the interstream areas of the water table aquifer into “groundwater islands” that behave
 13 independently, with their own unique recharge and discharge areas. Head distribution tends to
 14 follow the topography; higher heads occur in the interstream areas and decline in the direction of
 15 the bounding streams. Groundwater divides are present near the center of the interstream areas
 16 (Figure 10.1.3-3). Water table elevations range from 76 m (250 ft) MSL to the northwest of
 17 E-Area (Figure 10.1.3-4) and to about 30 m (100 ft) MSL near the Savannah River.

18
 19 The porosity and permeability of the Upper Three Runs Aquifer are variable across SRS
 20 and are reduced by the presence of interstitial silt and clay and poorly sorted sediments.



23
 24 **FIGURE 10.1.3-3 Groundwater Flow System at SRS**
 25 (Source: WSRC 2007a)



1

2 **FIGURE 10.1.3-4** Water Table Elevation in the Vicinity of the General Separations Area at SRS
3 (Source: modified from Hiergesell 1998)

4

1 High-permeability zones occur beneath the GSA and may locally increase the movement of
2 groundwater.

3

4 The aquifer is divided into two aquifer zones — an upper aquifer zone and a lower
5 aquifer zone — separated by the tan clay confining zone. The upper aquifer zone consists of sand
6 and clayey sand with minor intercalated clay layers. The lower aquifer zone is predominantly
7 fine-grained, well-sorted sand and clayey sand. The tan clay confining zone, which has an
8 average thickness of about 3.4 m [11 ft] beneath the GSA, is leaky across most of the site and
9 absent in places.

10

11 In the vicinity of the GTCC reference location, the thickness of the Upper and Lower
12 Three Runs Aquifer is approximately 28 m (92 ft). This value represents the mean of the range of
13 site-specific data (15.5 to 40.2 m [51 to 132 ft]), including thicknesses from the upper and lower
14 aquifer zones and the tan clay confining zone (Cook et al. 2004).

15

16 Recharge of the water table in the upper aquifer zone occurs by infiltration from the land
17 surface. The upper aquifer zone has a downward potential; groundwater leaking across the tan
18 clay recharges the lower aquifer zone. Most of the water then moves laterally toward the
19 bounding streams; the remainder flows vertically downward across the Gordon Confining Unit
20 into the Gordon Aquifer.

21

22

23 **Gordon Confining Unit.** The Gordon Confining Unit consists of clayey sand and clay of
24 the Warley Hill Formation and clayey, micritic limestone of the Blue Bluff Member of the
25 Santee Limestone. The clay is stiff to hard and commonly fissile. Glauconite is a common
26 constituent and imparts a distinctive greenish cast to the sediment; hence, the informal name of
27 “green clay” was given to this unit (Hiergesell et al. 2000). Thicknesses measured by
28 Aadland et al. (1995) in GSA Wells P-27 and P-28 were 2.1 m (7 ft) and 5.5 m (18 ft),
29 respectively. Wyatt et al. (2000) notes that the confining unit thickens (up to 25 m [85 ft]) to the
30 southeast.

31

32

33 **Gordon Aquifer.** The Gordon Aquifer is the basal unit of the Floridan Aquifer System. It
34 consists of all the saturated strata that occur between the Gordon Confining Unit and the Crouch
35 Branch Confining Unit. The strata are the sandy parts of the Snapp Formation and the overlying
36 Fourmile and Congaree Formations. Thin clay layers and stringers occur in places but are
37 discontinuous across SRS. Thicknesses measured by Aadland et al. (1995) in GSA Wells P-27
38 and P-28 were 24 m (77 ft) and 23 m (75 ft), respectively.

39

40 Recharge occurs via precipitation in outcrop areas and by leakage from overlying and
41 underlying aquifers (upward potential occurs along streams that incise the Upper Three Runs
42 Aquifer). Discharge areas are the swamps and marshes along Upper Three Runs Creek and the
43 Savannah River. The aquifer is under confined to semiconfined conditions.

44

45

1 **Meyers Branch Confining System.** The Meyers Branch Confining System corresponds
2 to clay and interbedded sand of the uppermost Steel Creek Formation and clay and laminated
3 shale of the Sawdust Landing, Lang Syne, and Snapp Formations. The clay in these formations
4 tends to be thick and relatively continuous. The Crouch Branch Confining Unit is the sole unit
5 making up the Meyers Branch Confining System. It ranges in thickness from about 17 to 56 m
6 (57 to 184 ft) and dips about 3.0 m/km (16 ft/mi) to the southeast. The unit has an upper and
7 lower confining zone composed of clay and sandy clay beds, separated by a middle sand zone of
8 clayey sand and sand.

9
10 Groundwater in the confining system has an upward potential mainly because of the deep
11 incisement by the Savannah River and Upper Three Runs Creek into the overlying Gordon
12 Aquifer (Figure 10.1.3-3).

13
14
15 **Dublin-Midville Aquifer System.** The Dublin-Midville Aquifer System includes all the
16 Cretaceous sediments from the Middendorf Formation up to the sand beds in the lower part of
17 the Steel Creek Formation. The aquifer system ranges in thickness from about 76 to 168 m
18 (250 to 550 ft) and dips about 3.8 m/km (20 ft/mi) to the southeast. At GSA Well P-27, the
19 aquifer system is about 154 m (505 ft) thick.

20
21 The Dublin-Midville Aquifer System is divided into the overlying Crouch Branch
22 Aquifer and the underlying McQueen Branch Aquifer. These aquifers are separated by the
23 McQueen Branch Confining Unit. The Crouch Branch Aquifer ranges in thickness from 30 to
24 107 m (100 to 350 ft) and thins significantly to the east. Sediments are mainly sand, muddy sand,
25 and gravelly sand with thin, discontinuous layers of sandy clay and sandy mud. High-
26 permeability zones occur near the Pen Branch Fault (Gellici et al. 1994).

27
28 The McQueen Branch Confining Unit consists of interbedded, silty, sandy clay, and sand
29 beds of the middle portion of the Black Creek Formation. At GSA Well P-27, the confining unit
30 is 17-m (55-ft) thick and occurs between elevations of –100 to –117 m (–329 to –384 ft) MSL.
31 Clay makes up about 82% of the total thickness of the unit.

32
33 The McQueen Branch Aquifer Unit underlies the confining unit. At GSA Well P-27, the
34 aquifer system is about 62-m (203-ft) thick and occurs between elevations of –117 to –180 m
35 (–384 to –587 ft) MSL. It dips 4.7 m/km (25 ft/mi) to the southeast. Sand makes up about 90%
36 of the total thickness of this unit.

37
38
39 **10.1.3.2.2 Groundwater Flow.** Upon entering the saturated zone at the water table,
40 water moves predominantly in a horizontal direction toward local discharge zones along the
41 headwaters and midsections of streams, while some of the water moves into the deeper aquifers.
42 The water lost to successively deeper aquifers also migrates laterally within those units toward
43 the more distant regional discharge zones. These are typically located along the major streams
44 and rivers in the area, such as the Savannah River discharge zones. Groundwater flow within
45 these units is extremely slow when compared with surface water flow. Groundwater velocities of

1 aquitards and aquifers are also different; they range from several inches to several feet per year
 2 in aquitards and from tens to hundreds of feet per year in aquifers (WSRC 2007a).

3

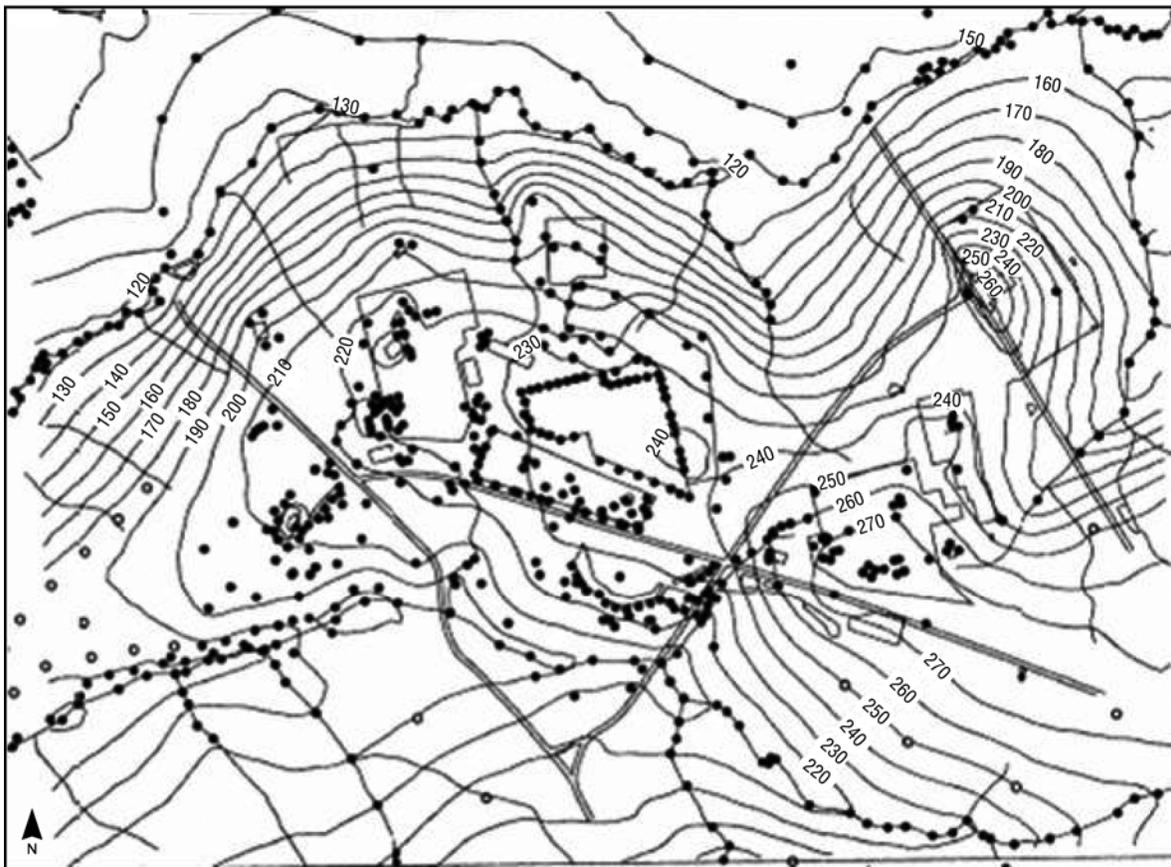
4 By using a simplified model for a number of pumping scenarios on SRS (i.e., advection
 5 only), Cherry (2006) demonstrated that transriver contaminant transport from recharge areas in
 6 the central SRS (D- and K-Areas) to receptors in Georgia could occur within 80 to 1,100 years.
 7 The shortest time of travel was for particles moving vertically from the base of the Upper Three
 8 Runs Aquifer and then laterally through the Gordon Aquifer beneath the Savannah River to
 9 discharge points in Georgia. The transit times do not include the time required for groundwater
 10 to migrate vertically downward across the uppermost aquifer and do not include other processes,
 11 such as the radioactive decay of tritium. Actual travel times could be up to several decades
 12 longer than what is reported. SRS continues to maintain and sample Georgia monitoring wells
 13 annually. In 2006, none of the tritium results exceeded 1,000 pCi/L; EPA's MCL for tritium is
 14 20,000 pCi/L (WSRC 2007a).

15

16 Measured hydraulic head distributions in the upper aquifer (water table) zone of the
 17 Upper Three Runs Aquifer and the deeper Gordon Aquifer are shown in Figures 10.1.3-5 and
 18 10.1.3-6, respectively; they are based on the work of Flach and Harris (1999).

19

20

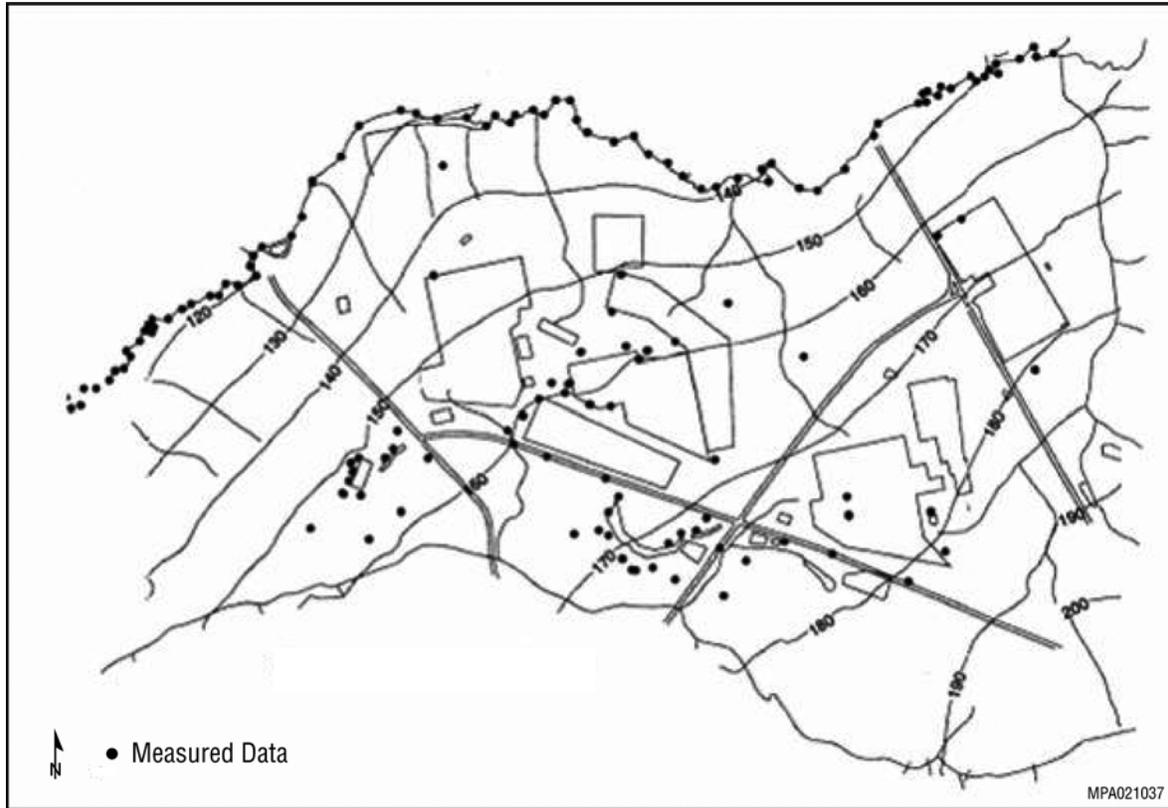


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21

22 **FIGURE 10.1.3-5 Measured Hydraulic Head (in feet) in the Upper Aquifer Zone of the Three**
 23 **Runs Aquifer (Source: Flach and Harris 1999)**

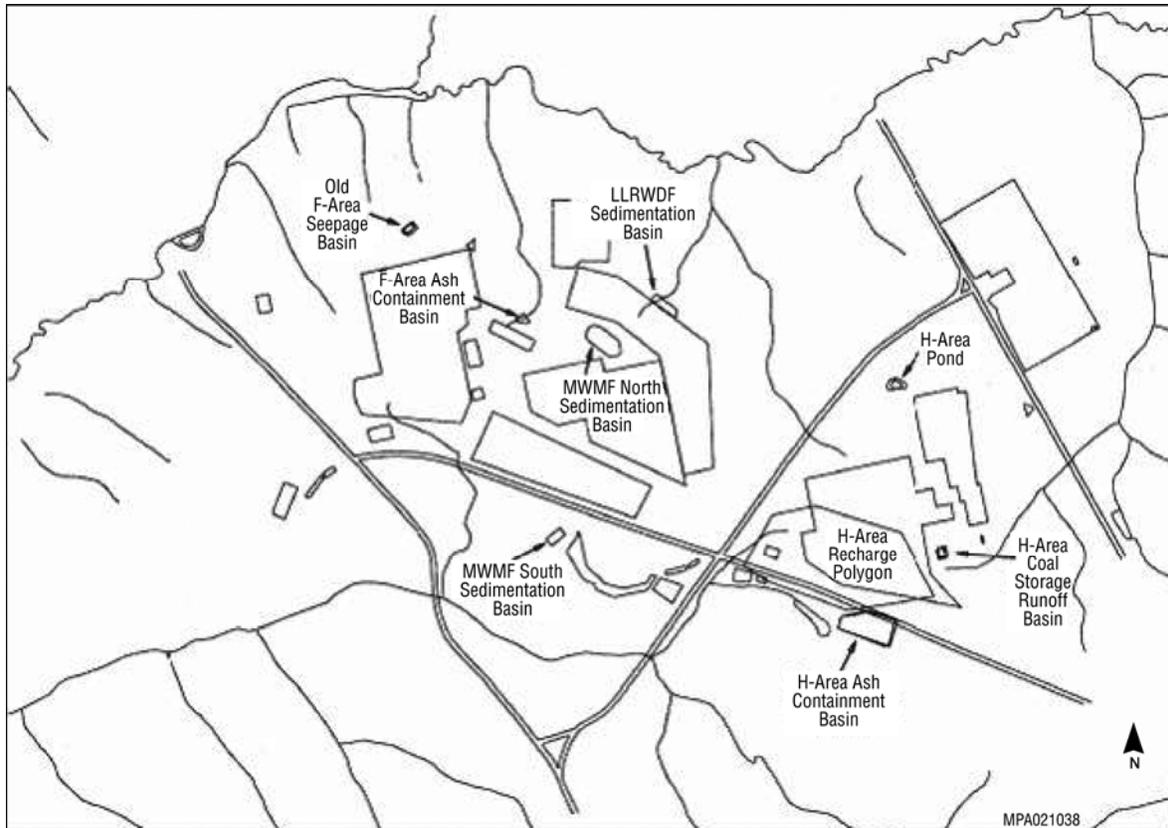
24



1
2 **FIGURE 10.1.3-6 Measured Hydraulic Head (in feet) in the Gordon Aquifer (Source: Flach**
3 **and Harris 1999)**

4
5
6 Natural recharge for the water table aquifers (i.e., the Upper Three Runs Creek Aquifer
7 and Gordon Aquifer) is primarily the result of infiltration of local rainfall at the land surface.
8 Recharge areas for the deeper aquifers are updip of SRS, near the fall line, although some
9 recharge areas are located at the northernmost edge of the site. Natural recharge over the GSA
10 travels as deep as the Gordon Aquifer before discharging to Upper Three Runs Creek, Fourmile
11 Branch, McQueen Branch, or a tributary of these. Artificial recharge occurs as a result of
12 infiltration within man-made basins and ponds (as shown in Figure 10.1.3-7) and the various
13 process, domestic, storm, and wastewater systems.

14
15
16 **10.1.3.2.3 Groundwater Quality.** The water in Coastal Plain sediments is generally of
17 good quality and suitable for municipal and industrial use with only minimum treatment needed.
18 The water is generally soft, slightly acidic (pH of 4.9 to 7.7), and low in dissolved and suspended
19 solids. High dissolved iron concentrations occur in some aquifers. Groundwater is the only
20 source of domestic water at SRS, and, where necessary, it is treated to raise the pH and remove
21 the iron (WSRC 2007a).
22



1
2 **FIGURE 10.1.3-7 Sources of Artificial Groundwater Recharge within the General**
3 **Separations Area (Source: Flach and Harris 1999)**
4
5

6 Industrial solvents, metals, tritium, and other constituents used or generated at SRS have
7 contaminated the shallow aquifers beneath 5% to 10% of SRS. Groundwater contamination has
8 not been detected outside SRS boundaries. In the general separations and waste management
9 areas (E-, F-, H-, S-, and Z-Areas), located in the center of the site, groundwater is contaminated
10 with VOCs (mainly TCE and PCE), radionuclides, metals, and other constituents. These areas
11 encompass many smaller and, in some cases, overlapping groundwater plumes. The shallow
12 groundwater in the southern portion of the E-, F-, and H-Areas discharges to Four Mile Creek
13 and its tributaries; in the northern portion of these areas, the shallow groundwater discharges to
14 Upper Three Runs Creek and its tributaries. The S- and Z-Areas are located on the groundwater
15 divide between Upper Three Runs Creek and its tributaries to the west (ATSDR 2007).
16 Groundwater flow below the Z-Area is to the northeast toward McQueen Branch (DOE 2002).
17 Table 10.1.3-2 lists maximum groundwater concentration exceedances for the Z-Area prior to
18 2002.
19

TABLE 10.1.3-2 Summary of Groundwater Exceedances for Z-Area Prior to 2002

Analyte	Concentration ($\mu\text{Ci/mL}$)	Regulatory Limit ($\mu\text{Ci/mL}$)
Gross alpha	9.77×10^{-8}	1.5×10^{-8}
Nonvolatile beta	5.26×10^{-8}	5.0×10^{-8}
Ra-226	7.78×10^{-9}	5.0×10^{-9}
Ra-228	8.09×10^{-9}	5.0×10^{-9}
Radium, total alpha emitting	5.55×10^{-8}	5.0×10^{-9}
Ruthenium-106	3.08×10^{-8}	3.0×10^{-8}

Source: DOE (2002)

10.1.3.3 Water Use

SRS is the largest self-supplied industrial consumer of groundwater in South Carolina; it used about 14.8 million L/d (3.9 million gal/d) in 2006. Drinking and process water are supplied by a network of approximately 40 wells across the site; 8 of these wells are dedicated to the domestic water system (there are treatment facilities at A-, D-, and K-Areas). The wells range in capacity from 760 to 5,700 L/min (200 to 1,500 gpm). Most groundwater production is from the deep Crouch Branch and McQueen Aquifers, with a few lower-capacity wells pumping from the shallower Gordon Aquifer and the lower zone of the Upper Three Runs Aquifer. Every major operating area at SRS has groundwater-producing wells. The amount of water pumped at SRS has decreased significantly since 1986, when the pump rate was as high as 41 million L/d (11 million gal/d), owing to the consolidation of the domestic water system completed in 1997 (DOE 2002; WSRC 2007a).

Regional domestic water supplies are primarily drawn from the shallow aquifers, including the Gordon Aquifer and the Upper Three Runs Aquifer. The municipal and industrial water supplies in Aiken County come from the deeper Crouch Branch and McQueen Aquifers. In Barnwell and Allendale Counties, municipal water supplies are drawn from the Gordon Aquifer and overlying units that thicken to the southeast. In 2005, Aiken County ranked as the 16th largest public water suppliers in South Carolina, with an average pump rate of 33.3 million L/d (8.8 million gal/d) and a per capita use of about 890 L/d (235 gal/d) (DOE 2002; Newcome 2005).

10.1.4 Human Health

Potential radiation exposures to the off-site general public residing in the vicinity of SRS would be a relatively small fraction of the dose limit of 100 mrem/yr set by DOE to protect the public from the operations of its facilities (DOE Order 5400.5). The dose to the highest-exposed individual is estimated to be 0.12 mrem/yr under normal operating conditions (SRNS 2009). This

1 dose is composed of the dose from airborne releases of radionuclides (0.04 mrem/yr) and
2 0.08 mrem contributed by exposures associated with waterborne releases of radionuclides. For
3 the waterborne component, about 38% of the dose is from Cs-137 (mainly from fish ingestion),
4 24% is from H-3 (mainly from drinking water), 19% is from ingestion of unspecified alpha
5 emitters, 11% is from ingestion of Pu-238, and less than 3% is from all other radionuclides.
6

7 There are other unlikely situations under which the radiation dose incurred by the off-site
8 general public could be higher. For example, an individual could hunt in the Savannah River
9 Swamp on the privately owned Creek Plantation (which contains the highest concentrations of
10 radioactive contamination in soil). If this individual hunted for 120 hours per year at that
11 location, he or she could incur a radiation dose of 2.9 mrem/yr from direct radiation, soil
12 ingestion, and inhalation of resuspended dust particles. If the hunter consumed a deer harvested
13 at that location, which is assumed to be sufficient to meet all of an individual's requirements for
14 meat for a year, the hunter might incur another dose of 5.7 mrem/yr (SRNS 2009). This estimate
15 was obtained by using the average measured Cs-137 concentration in the flesh of all deer
16 harvested in 2008. Table 10.1.4-1 provides the radiation doses estimated for the different
17 exposure scenarios; the footnotes provide more detailed explanations regarding the methods used
18 to develop these dose estimates.
19

20 According to the 2006 worker radiation exposure data published in DOE (2007), a total
21 of 2,387 workers received measurable doses. A collective total dose of 107.2 person-rem was
22 recorded, resulting in an average individual dose of 45 mrem/yr. This collective total dose is
23 based on 1.12 person-rem from internal exposure and 106.1 person-rem from external exposure.
24 Only 25 workers had measurable internal radiation doses. In 2006, less than 1% of the
25 2,387 workers with measurable doses received a total dose greater than 500 mrem/yr. For
26 comparison, the primary DOE radiation dose limit for workers is 5 rem/yr (10 CFR Part 835),
27 with an administrative control limit of 2 rem/yr (DOE 1994). Use of DOE's ALARA program
28 ensures that worker doses are kept well below applicable standards.
29
30

31 **10.1.5 Ecology**

32

33 A Natural Resources Management Plan (USFS 2005) was prepared for SRS. It covers all
34 natural resource operations, including management, education, and research programs. For
35 natural resource management purposes, SRS is divided into six management areas (USFS 2005).
36 The GTCC waste disposal facility would be located within the 15,558-ha (38,444-ac) Industrial
37 Core Management Area. The primary objective in this area is to support facilities and site
38 missions, with other important objectives being promoting conservation and restoration,
39 providing research and educational opportunities, and generating the sale of forest products
40 (USFS 2005). Natural resource management programs conducted within SRS include (1) habitat,
41 population, invasive species, threatened species, and endangered species management; (2) forest
42 products harvesting and silviculture management; (3) secondary roads, boundary, and trails
43 management; (4) watershed management; (5) fire management; (6) DOE research set-aside
44 areas; and (7) research (USFS 2005). In 1972, SRS was designated as the first National
45 Environmental Research Park (NERP). Significant components of the NERP include the 30 DOE
46 research set-aside areas that total 5,568 ha (14,005 ac). These areas are representative habitats

TABLE 10.1.4-1 Estimated Annual Radiation Doses to Workers and the General Public at SRS

Receptor	Radiation Source	Exposure Pathway	Annual Dose to Individual (mrem/yr)	Annual Dose to Population (person-rem/yr)
On-site workers	Radioactive materials handled in operations	Inhalation and ingestion	45 ^a	1.12 ^a
	Radioactive materials handled in operations	Direct radiation	44 ^b	106.1 ^b
General public	Airborne release	Submersion; inhalation; ingestion of plant foods (contaminated through deposition), meat, and milk; direct radiation from deposition	0.04 ^c	1.8 ^d
		Surface water contamination	Ingestion of water	0.04 ^e
		Ingestion of fish	0.011 ^f	
		Ingestion of leafy and nonleafy vegetables, meat, and milk (resulting from irrigation)	0.1 ^g	
	Swamp soil	External radiation, soil ingestion, and dust inhalation (from hunting activities)	2.9 ^h	
	Wildlife animals	Ingestion of deer or hog	5.7/7.7 ⁱ	
Worker/public	Natural background radiation and man-made sources		620 ^j	442,370 ^k

- ^a In 2006, among the workers monitored for internal exposure, 25 had measurable doses. A collective dose of 1.12 person-rem was recorded, which would give an average internal dose of about 45 mrem per worker (DOE 2007).
- ^b In 2006, 2,387 workers received measurable doses. The total collective dose for these workers was 107.2 person-rem (DOE 2007). After subtracting the collective dose of internal exposure from the total collective dose and distributing the remaining dose evenly among the workers, an average individual external dose of 44 mrem/yr was obtained.
- ^c Radiation dose was calculated with MAXDOSE-SR, a computer code developed to demonstrate compliance with DOE environmental orders at SRS. Estimated airborne releases of diffuse and fugitive materials were used with meteorological data in the calculation (SRNS 2009).
- ^d The collective dose was estimated with POPDOSE-SR by using the population data within 80 km (50 mi) around the SRS. The population size is about 713,500 (SRNS 2009). Like MAXDOSE-SR, POPDOSE-SR was developed to demonstrate compliance with DOE environmental orders at SRS. The collective dose estimated with CAP88-PC was 4.6 person-rem; however, a site-specific study indicated that the assumptions used by POPDOSE-SR matched site conditions better than those used by CAP88-PC (SRNS 2009).

Footnotes continue on next page.

TABLE 10.1.4-1 (Cont.)

-
- ^e The dose corresponds to drinking 730 L/yr (190 gal/yr) of water supplied by the public water treatment plant (BJSWA Chelsea, BJSWA Purrysburg, and Savannah I&D) (WSRC 2007a). The potential dose was calculated by using the measured tritium concentration in surface water and calculated concentrations of other radionuclides on the basis of monitored liquid effluent discharge rates along with data on the river flow rate.
- ^f The dose corresponds to eating 19 kg (42 lb) of catfish caught exclusively from the mouth of Upper Three Runs (SRNS 2009). The potential dose resulted mainly from Cs-137, of which the concentration in the flesh of fish caught from the river was measured and used in the dose calculation.
- ^g The dose was calculated by assuming that contaminated Savannah River water was used for irrigation. A land area of 400 ha (1,000 ac) was assumed to be devoted to each of the four major food types: vegetation, leafy vegetation, milk, and meat (SRNS 2009).
- ^h The dose corresponded to hunting for 120 hours in Savannah River Swamp soil on the privately owned Creek Plantation that had the highest soil contamination in 2008 (SRNS 2009). The radiation dose was calculated by using the RESRAD computer code (Yu et al. 2000). The potential dose corresponding to fishing activities would be less; a dose of 0.28 mrem/yr was calculated, assuming an exposure duration of 250 hours per year on the South Carolina bank of the Savannah River near the mouth of Steel Creek (SRNS 2009).
- ⁱ The dose was calculated on the basis of the average concentration of Cs-137 measured in all deer (2.40 pCi/g) or hogs (2.91 pCi/g) harvested from SRS during 2008. The deer or hogs were assumed to constitute the entire meat diet of the hunter (SRNS 2009). For a fisherman, the potential dose would be much lower; a dose of 0.4 mrem/yr was reported for the consumption of catfish at the mouth of Upper Three Runs in SRNS (2009).
- ^j Average dose to a member of the U.S. population as estimated in Report No. 160 of the National Council on Radiation Protection and Measurements (NCRP 2009).
- ^k Collective dose to the population of 713,500 within 80 km (50 mi) of the SRS from natural background radiation and man-made sources.

1 that DOE has preserved for ecological research. They are protected from public intrusion and
2 most site-related activities (DOE 2002).

3
4 SRS is in the transition area between the northern oak-hickory-pine forest and the
5 southern mixed forest. It therefore contains species common to both forest types. About 90% of
6 SRS contains upland pine, hardwood, and mixed (pines and hardwoods) forests and bottomland
7 hardwood forests. The loblolly-longleaf-slash pine (*Pinus taeda*, *P. palustris*, *P. elliotii*)
8 community covers about 65% of the site (DOE 1997). More than 1,300 plant species have been
9 reported from SRS (Wike et al. 2006).

10
11 The GTCC reference location would be situated in an area dominated by stands of
12 loblolly and slash pine. Understory species in the pine stands include black cherry (*Prunus*
13 *serotina*), oaks (*Quercus* spp.), and persimmon (*Diospyros virginiana*). The site area also has
14 small pockets of upland hardwood stands of white oak (*Quercus alba*), southern red oak
15 (*Quercus falcata*), and hickory (*Carya* spp.). Ground cover at the site includes Japanese
16 honeysuckle (*Lonicera japonica*), greenbrier (*Smilax* spp.), muscadine grape (*Vitis rotundifolia*),
17 spotted wintergreen (*Chimaphila maculata*), and various grasses, legumes, and composites
18 (DOE 1997).

19
20 More than 19,830 ha (49,000 ac) of wetlands occur on SRS (DOE 1997). They are widely
21 distributed throughout the site, making up more than 20% of the site. Wetlands present include
22 bottomland hardwood forests, cypress-tupelo swamp forests, floodplains, creeks, impoundments,
23 and more than 300 Carolina bays (naturally occurring pond formations that cover about 445 ha
24 [1,100 ac] of SRS) and wetland depressions. The Savannah River Swamp is a major wetland area
25 that borders the Savannah River and covers about 3,800 ha (9,400 ac) of SRS (DOE 1997). No
26 wetlands occur within the GTCC reference location.

27
28 Wildlife species that occur at SRS include 55 species of mammals, 255 species of birds,
29 and 104 species of reptiles and amphibians (Wike et al. 2006). More than 150 species have been
30 documented as using developed areas on SRS, with most species using landscaped areas away
31 from buildings or other structures (Mayer and Wike 1997). White-tailed deer, feral hog, and
32 American beaver populations are controlled through selective harvests, including public hunts
33 for deer and boars. Concern has been expressed that the nine-banded armadillos may disturb and
34 possibly breach waste unit closure caps, which could result in increased rainwater infiltration
35 (Wike et al. 2006).

36
37 Bird species likely to occur within the pine-dominated forests of the GTCC reference
38 location include Carolina wren (*Thryothorus ludovicianus*), wood thrush (*Hylocichla mustelina*),
39 northern mockingbird (*Mimus polyglottus*), eastern towhee (*Pipilo erythrophthalmus*), pine
40 warbler (*Dendroica pinus*), prairie warbler (*D. discolor*), red-eyed vireo (*Vireo olivaceus*),
41 red-bellied woodpecker (*Melanerpes carolinus*), yellow-shafted flicker (*Colaptes auratus*
42 *auratus*), sharp-shinned hawk (*Accipiter striatus*), eastern screech owl (*Megascops asio*),
43 northern bobwhite (*Colinus virginianus*), and wild turkey (*Meleagris gallopavo*) (DOE 1997).

44
45 The Savannah River is the major aquatic habitat in the SRS vicinity. SRS also contains
46 more than 50 man-made ponds, including two large water bodies: the 1,012-ha (2,500-ac) Par

1 Pond and the 405-ha (1,000-ac) L Lake. These water bodies were created by damming Lower
2 Three Runs Creek and Steel Creek, respectively. More than 80 species of fish have been
3 identified on SRS, including commercial and recreational species (NRC 2005). The designated
4 area for the GTCC reference location is within Upper Three Runs Creek watershed. Tinker, Mill,
5 and McQueen Creeks are the bodies of water that are closest to the site (Figure 10.1.3-1).
6 Minnow and sunfish species dominate the fish population in Upper Three Runs, while shiners,
7 madtoms, and darters occur within the tributary streams (DOE 1997).

8
9 The federally and state-listed species identified from Aiken County are listed in
10 Table 10.1.5-1. No designated critical habitat for any federally threatened or endangered species
11 occurs within the area designated for the GTCC reference location (DOE 1997). The Eastern
12 indigo snake (*Drymarchon couperi*, federally threatened), while not known to occur in Aiken
13 County (SCDNR 2009), may be present in the county. Major natural resource management
14 actions on SRS are aimed at habitat management for the red-cockaded woodpecker (*Picoides*
15 *borealis*).

16 17 18 **10.1.6 Socioeconomics**

19
20 Socioeconomic data for SRS describes an ROI surrounding the site composed of four
21 counties: Columbia County and Richmond County in Georgia and Aiken County and Barnwell
22 County in South Carolina. More than 80% of SRS workers reside in these counties (NRC 2005).

23 24 25 **10.1.6.1 Employment**

26
27 In 2005, total employment in the ROI stood at 174,509, and it was expected to decrease
28 to 171,670 by 2008. Employment grew at an annual average rate of 0.4% between 1995 and
29 2005 (U.S. Bureau of the Census 2008a). The economy of the ROI is dominated by the trade and
30 service industries, with employment in these activities currently contributing more than 64% of
31 all employment (see Table 10.1.6-1). The manufacturing sector is also a significant employer in
32 the ROI, with 20% of total ROI employment. Employment at SRS was 13,616 in 2000
33 (NRC 2005).

34 35 36 **10.1.6.2 Unemployment**

37
38 Unemployment rates have varied across the counties in the ROI (Table 10.1.6-2). Over
39 the 10-year period 1999–2008, the average rate in Richmond County was 8.6%, with lower rates
40 in Barnwell County (5.7%), Columbia County (5.2%), and Aiken County (3.6%). The average
41 rate in the ROI over this period was 5.8%, higher than the average rate for Georgia (4.6%) and
42 the same as that for South Carolina (5.8%). Unemployment rates for the first two months of 2009
43 contrasted markedly with rates for 2008 as a whole; in Richmond County, the unemployment
44 rate increased to 16.9%, while in Barnwell County, the rate reached 9.6%, and in Columbia
45 County, it reached 9.0%. The average rates for the ROI (10.5%) and for Georgia (11.0%) and

TABLE 10.1.5-1 Federally and State-Listed Threatened, Endangered, and Other Special-Status Species in Aiken County, South Carolina

Common Name (Scientific Name)	Status ^a Federal/State
Plants	
Harperella (<i>Ptilimnium nodosum</i>)	E/-
Relict trillium (<i>Trillium reliquum</i>)	E/-
Smooth coneflower (<i>Echinacea laevigata</i>)	E/-
Fishes	
Shortnose sturgeon (<i>Acipenser brevirostrum</i>)	E/SE
Amphibians	
Gopher frog (<i>Rana capito</i>)	-/SE
Reptiles	
Eastern indigo snake (<i>Drymarchon couperi</i>)	T/-
Gopher tortoise (<i>Gopherus polyphemus</i>)	-/SE
Spotted turtle (<i>Clemmys guttata</i>)	-/ST
Birds	
Bald eagle (<i>Haliaeetus leucocephalus</i>)	-/SE
Red-cockaded woodpecker (<i>Picoides borealis</i>)	E/SE
Mammals	
Rafinesque's big-eared bat (<i>Plecotus rafinesquii</i>)	-/SE

^a E (endangered): A species in danger of extinction throughout all or a significant portion of its range.

SE (state endangered): An animal species or subspecies whose prospects of survival or recruitment in South Carolina are in jeopardy.

ST (state threatened): An animal species likely to be classified as state endangered within the foreseeable future throughout all or a significant portion of its South Carolina range.

T (threatened): A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

-: Not listed.

Source: SCDNR (2006)

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South Carolina (9.3%) during this period were higher than the corresponding average rates for 2008.

10.1.6.3 Personal Income

9 Personal income in the ROI stood at almost \$14 billion in 2005 and was expected to
10 reach \$14.7 billion in 2008, growing at an annual average rate of growth of 2.0% over the period

TABLE 10.1.6-1 SRS County and ROI Employment by Industry in 2005

Sector	Georgia		South Carolina		ROI Total	% of ROI Total
	Columbia County	Richmond County	Aiken County	Barnwell County		
Agriculture ^a	116	143	508	306	1,073	0.6
Mining	60	76	175	0	308	0.2
Construction	2,862	3,426	2,469	129	8,886	5.1
Manufacturing	3,972	10,087	17,345	2,790	34,194	20.0
Transportation and public utilities	326	2,060	2,446	120	4,952	2.8
Trade	5,910	13,905	7,536	1,103	28,454	16.3
Finance, insurance, and real estate	5,976	4,431	1,720	172	12,299	7.0
Services	10,448	52,579	19,299	1,976	84,302	48.3
Other	7	10	14	10	41	0.0
Total	29,677	86,717	51,512	6,606	174,509	

^a USDA (2008).

Source: U.S. Bureau of the Census (2008a)

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TABLE 10.1.6-2 SRS Average County, ROI, and State Unemployment Rates (%) in Selected Years

Location	1999–2008	2008	2009 ^a
Columbia County, Georgia	5.2	6.0	9.0
Richmond County, Georgia	8.6	11.4	16.9
Aiken County, South Carolina	3.6	4.7	6.6
Barnwell County, South Carolina	5.7	7.0	9.6
ROI	5.8	7.3	10.5
Georgia	4.6	6.2	11.0
South Carolina	5.8	6.9	9.3

^a Rates for 2009 are the average for January and February.

Source: U.S. Department of Labor (2009a–d)

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1995–2005 (Table 10.1.6-3). ROI personal income per capita also rose in the 1990s and was expected to reach \$30,120 in 2008, compared to \$29,693 in 1995. Per capita incomes are higher in Columbia County (\$36,464 in 2005) than elsewhere in the ROI.

10.1.6.4 Population

The population of the ROI was 455,096 in 2000 (U.S. Bureau of the Census 2008b) and was expected to reach 488,343 by 2008 (Table 10.1.6-4). In 2006, 194,398 people were living in

TABLE 10.1.6-3 SRS County, ROI, and State Personal Income in Selected Years

Income	1995	2005	Average Annual Growth Rate (%), 1995–2005	2008 ^a
Columbia County				
Total personal income (2006 \$ in millions)	2,555	3,774	4.0	4,193
Personal income per capita (2006 \$)	31,355	36,464	1.5	36,939
Richmond County				
Total personal income (2006 \$ in millions)	4,795	5,318	1.0	5,423
Personal income per capita (2006 \$)	23,974	27,395	1.3	27,813
Aiken County				
Total personal income (2006 \$ in millions)	3,598	4,402	2.0	4,623
Personal income per capita (2006 \$)	26,504	29,335	1.0	29,601
Barnwell County				
Total personal income (2006 \$ in millions)	548	491	-1.1	469
Personal income per capita (2006 \$)	24,494	21,067	-1.5	19,831
ROI total				
Total personal income (2006 \$ in millions)	11,496	13,985	2.0	14,709
Personal income per capita (2006 \$)	26,150	29,693	1.3	30,120
Georgia				
Total personal income (2006 \$ in millions)	210,143	291,429	3.3	317,789
Personal income per capita (2006 \$)	28,675	31,911	1.1	32,431
South Carolina				
Total personal income (2006 \$ in millions)	94,831	123,998	2.7	132,847
Personal income per capita (2006 \$)	25,298	29,197	1.4	29,945

^a Argonne National Laboratory estimates.

Source: DOC (2008)

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Richmond County (41% of the ROI total), and 151,800 people (32% of the total) resided in Aiken County. Over the period 1990–2006, population in the ROI as a whole grew slightly, with an average growth rate of 1.1% and a higher-than-average growth in Columbia County (3.1%). Population in Georgia as a whole grew at a rate of 2.3% over the same period; and in South Carolina, the population grew at a rate of 1.3%.

10.1.6.5 Housing

12 Housing stock in the ROI as a whole grew at an annual rate of 1.4% over the period
13 1990–2000 (Table 10.1.6-5), with total housing units expected to reach 200,883 in 2008. A total

TABLE 10.1.6-4 SRS County, ROI, and State Population in Selected Years

Location	1990	2000	2006	Average Annual Growth Rate (%), 1990–2006	2008 ^a
Georgia					
Columbia County	66,031	89,287	106,887	3.1	113,520
Richmond County	189,719	199,775	194,398	0.2	194,991
South Carolina					
Aiken County	120,991	142,556	151,800	1.4	156,166
Barnwell County	20,293	23,478	23,265	0.9	23,666
ROI total	397,034	455,096	476,350	1.1	488,343
Georgia	6,512,602	8,186,453	9,363,941	2.3	9,798,773
South Carolina	3,501,155	4,012,012	4,321,249	1.3	4,436,434

^a Argonne National Laboratory projections based on the average growth rate from 1990–2006.

Sources: U.S. Bureau of the Census (2008b); estimated data for 2006

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3 of 29,658 new units were added to the existing housing stock in the ROI between 1990 and 2000.
4 On the basis of annual population growth rates, there were expected to be 19,180 vacant housing
5 units in the county in 2008, of which 5,202 were expected to be rental units available to
6 construction workers at the proposed facility.
7
8

9 **10.1.6.6 Fiscal Conditions**

10
11 Construction and operations of a GTCC waste disposal facility could result in increased
12 expenditures for local government jurisdictions, including counties, cities, and school districts.
13 Revenues to support these expenditures could come primarily from state and local sales tax
14 revenues associated with employee spending during construction and operations and be used to
15 support additional local community services currently provided by each jurisdiction.
16 Table 10.1.6-6 presents information on expenditures by the various local government
17 jurisdictions and school districts in the ROI.
18
19

20 **10.1.6.7 Public Services**

21
22 Construction and operations of a GTCC waste disposal facility could require increases in
23 employment in order to provide public safety, fire protection, community, and educational
24 services in the counties, cities, and school districts likely to host relocating construction workers
25 and operations employees. Additional demands could also be placed on local physician services.
26 Table 10.1.6-7 presents data on employment and levels of service (number of employees per
27 1,000 population) for public safety and general local government services. Table 10.1.6-8
28 provides data on teachers and level of service, and Table 10.1.6-9 covers physicians.
29

TABLE 10.1.6-5 SRS County, ROI, and State Housing Characteristics in Selected Years

Type of Housing	1990	2000	2008 ^a
Columbia County			
Owner occupied	17,322	25,557	32,493
Rental	4,519	5,563	7,073
Vacant units	1,904	2,201	2,798
Total units	23,745	33,321	42,364
Richmond County			
Owner occupied	38,762	42,840	41,814
Rental	29,913	31,080	30,336
Vacant units	8,613	8,392	8,191
Total units	77,288	82,312	80,341
Aiken County			
Owner occupied	33,491	42,036	46,049
Rental	11,392	13,551	14,845
Vacant units	4,383	6,400	7,011
Total units	49,266	61,987	67,905
Barnwell County			
Owner occupied	5,194	6,810	6,864
Rental	1,906	2,211	2,229
Vacant units	754	1,170	1,179
Total units	7,854	10,191	10,272
ROI total			
Owner occupied	94,769	117,243	127,221
Rental	47,730	52,405	54,482
Vacant units	15,654	18,163	19,180
Total units	158,153	187,811	200,883
Georgia			
Owner occupied	1,536,759	2,029,154	2,534,442
Rental	829,856	977,215	1,220,555
Vacant units	271,803	275,368	343,939
Total units	2,638,418	3,281,737	4,098,936
South Carolina			
Owner occupied	878,704	1,107,617	1,332,991
Rental	379,340	426,237	512,966
Vacant units	166,111	219,816	264,543
Total units	1,424,155	1,753,670	2,110,500

^a Argonne National Laboratory projections.

Source: U.S. Bureau of the Census (2008b)

TABLE 10.1.6-6 SRS County, ROI, and State Public Service Expenditures in 2006 (\$ in millions)

Location	Local Government	School District
Georgia		
Columbia County	47.2	92.1
Richmond County	109.3	170.6
South Carolina		
Aiken County	79.3	107.6
Barnwell County	18.7	21.4
ROI total	254.5	391.7
Georgia	37,933	12,498
South Carolina	15,504	5,380

Source: U.S. Bureau of the Census (2008c)

10.1.7 Environmental Justice

Figures 10.1.7-1 and 10.1.7-2 and Table 10.1.7-1 show the minority and low-income compositions of the total population located in the 80-km (50-mi) buffer around SRS from Census Bureau data for the year 2000 and from CEQ guidelines (CEQ 1997). Persons whose incomes fall below the federal poverty threshold are designated as low income. Minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, or multi-racial (with at least one race designated as a minority race under CEQ). Individuals identifying themselves as Hispanic or Latino are included in the table as a separate entry. However, because Hispanics can be of any race, this number also includes individuals who also identified themselves as being part of one or more of the population groups listed in the table.

10.1.8 Land Use

SRS occupies about 80,130 ha (198,000 ac) within a generally rural area. Existing land use at SRS can be characterized under three main categories: (1) 73% is undeveloped/forest, (2) 22% is wetlands/water, and (3) 5% is developed (NRC 2005). The developed areas of the site contain production and support facilities, infrastructure, R&D, and waste management facilities to meet SRS's mission of serving the nation through safe, secure, cost-effective management of the U.S. nuclear stockpile, nuclear materials, and the environment. The remainder of SRS is primarily forest and wetlands (DOE 2002; USFS 2005). Most of the forested areas are pine forests managed by the USFS through an interagency agreement with DOE. In 1972, the entire site was designated as a NERP. A little more than 5,666 ha (14,000 ac) within 30 set-aside areas have been established on SRS to be used exclusively for nondestructive environmental research coordinated by the University of Georgia's Savannah River Ecology Laboratory (Davis and

TABLE 10.1.6-7 SRS County, ROI, and State Public Service Employment in 2006

Service	Columbia County		Richmond County		Aiken County	
	No.	Level of Service ^a	No.	Level of Service ^a	No.	Level of Service ^a
Police protection	224	2.1	491	2.5	255	1.7
Fire protection ^b	150	1.4	318	1.6	150	1.0
General	715	6.7	1,522	7.8	1,055	6.9

Service	Barnwell County		ROI		Georgia	
	No.	Level of Service ^a	No.	Level of Service ^a	No.	Level of Service ^a
Police protection	56	2.4	1,026	2.2	19,170	2.0
Fire protection	0	0.0	618	1.3	10,411	1.1
General	258	11.1	3,550	7.5	351,702	37.6

Service	South Carolina					
	No.	Level of Service ^a				
Police protection	8,799	2.0				
Fire protection	4,680	1.1				
General	159,019	36.8				

^a Level of service represents the number of employees per 1,000 persons in each county.

^b Does not include volunteers.

Sources: U.S. Bureau of the Census (2008b,c)

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3 Janecek 1997). None of the set-aside areas are located near the GTCC reference location. Public
 4 use of the site is limited primarily to controlled hunts and science literacy programs (DOE 2002).
 5 Fishing also is allowed within the Crackerneck Wildlife Management Area.

6

7

8 The *Savannah River Future Use Plan* (DOE 1998, as cited in DOE 2002) states as policy
 9 that (1) SRS boundaries will remain unchanged and the land shall remain under ownership of the
 10 federal government, consistent with the site's designation as a NERP; (2) residential use of all
 11 SRS land is prohibited; and (3) the integral site model that incorporates three planning zones
 12 (industrial, industrial support, and restricted public uses) will be utilized. The land between
 13 Upper Three Runs Creek and Fourmile Branch (which includes the designated area for the
 14 GTCC reference location) is considered to be within the industrial land use category
 15 (DOE 2002).

15

16

17

For natural resources management purposes, SRS has been divided into six management
 areas on the basis of existing biological and physical conditions, operations capability, and

TABLE 10.1.6-8 SRS County, ROI, and State Education Employment in 2006

Location	No. of Teachers	Level of Service ^a
Georgia		
Columbia County	1,321	12.4
Richmond County	2,245	11.6
South Carolina		
Aiken County	1,608	10.6
Barnwell County	336	14.6
ROI total	5,510	11.6
Georgia	108,535	11.6
South Carolina	48,212	11.2

^a Level of service represents the number of teachers per 1,000 persons in each county.

Sources: National Center for Educational Statistics (2008); U.S. Bureau of the Census (2008b,c)

TABLE 10.1.6-9 SRS County, ROI, and State Medical Employment in 2006

Location	No. of Physicians	Level of Service ^a
Georgia		
Columbia County	260	1.7
Richmond County	14	0.6
South Carolina		
Aiken County	749	7.0
Barnwell County	1,232	6.3
ROI total	2,255	4.7
Georgia	19,143	2.0
South Carolina	9,100	2.1

^a Level of service represents the number of physicians per 1,000 persons in each county.

Sources: AMA (2006); U.S. Bureau of the Census (2008b)

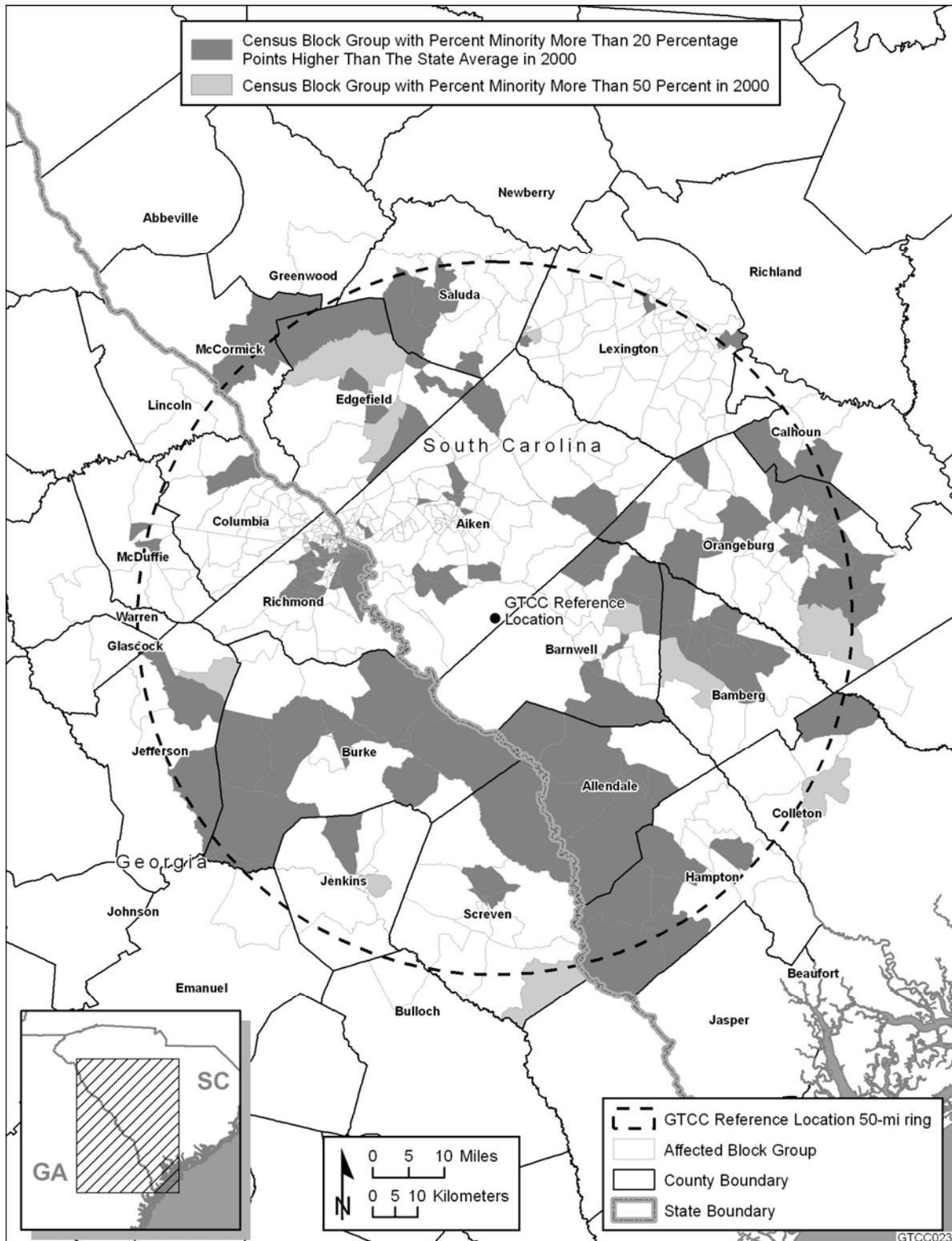
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suitability for mission objectives. These areas are the (1) 15,558-ha (38,444-ac) Industrial Core Management Area, (2) 35,289-ha (87,200-ac) Red-Cockaded Woodpecker Management Area, (3) 19,061-ha (47,100-ac) Supplemental Red-Cockaded Woodpecker Management Area, (4) 4,532-ha (11,200-ac) Crackerneck Wildlife Management Area and Ecological Reserve, (5) 4,047-ha (10,000-ac) Savannah River Swamp Management Area, and (6) 1,781-ha (4,400-ac) Lower Three Runs Corridor Management Area (USFS 2005). The GTCC reference location is located within the Supplemental Red-Cockaded Woodpecker Management Area. The goal of protecting the red-cockaded woodpecker has a strong influence on natural resource decisions in this management area. Natural resource management in this area is designed to promote conservation and restoration, provide research and educational opportunities, and generate revenue from the sale of forest products (USFS 2005).

Forest and agricultural lands are the predominant lands bordering the SRS site (NRC 2005). Various industrial, manufacturing, medical, and farming operations occur near SRS (DOE 2005).

10.1.9 Transportation

Vehicular access to SRS is provided by South Carolina SRs 19, 64, and 125 and by US 278. SR 19 runs north from the site through New Ellenton toward Aiken, approximately 16 km (10 mi) from the northern border of SRS. SR 64 runs in an easterly direction from the site toward Barnwell. SR 125 runs through the site in a southeasterly direction between North Augusta and Allendale, passing through Beech Island and Jackson. US 278 also runs through the



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FIGURE 10.1.7-1 Minority Population Concentrations in Census Block Groups within an 80-km (50-mi) Radius of the GTCC Reference Location at SRS (Source: U.S. Bureau of the Census 2008b)

TABLE 10.1.7-1 Minority and Low-Income Populations within an 80-km (50-mi) Radius of SRS

Population	Georgia Block Groups	South Carolina Block Groups
Total population	381,808	402,799
White, Non-Hispanic	210,569	246,056
Hispanic or Latino	9,356	8,093
Non-Hispanic or Latino minorities	161,883	148,650
One race	157,240	145,541
Black or African American	149,323	142,142
American Indian or Alaskan Native	917	1,350
Asian	6,150	1,702
Native Hawaiian or other Pacific Islander	316	68
Some other race	534	279
Two or more races	4,643	3,109
Total minority	171,239	156,743
Percent minority	44.8	38.9
Low-income	62,469	64,573
Percent low-income	16.4	16.0
State percent minority	34.9	32.8
State percent low-income	13.0	14.1

Source: U.S. Bureau of the Census (2008b)

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3 site between North Augusta and Barnwell in a southeasterly direction. SR 781 connects US 278
4 with Williston to the northeast of the site. Annual traffic counts for local roads are provided in
5 Table 10.1.9-1.

6

7 On-site, SRS has approximately 210 km (130 mi) of primary roads and 1,800 km
8 (1,100 mi) of secondary roads to handle the site's transportation needs (DOE 2005). About
9 20,000 vehicle trips per day (employees driving to and from work as well as driving between site
10 areas) occur on-site to support shipments of materials and obtain access to test wells, utility lines,
11 research sites, and natural resource management activities (DOE 2005).

12

13 The railroad infrastructure at SRS consists of 53 km (33 mi) of track for deliveries of
14 foreign fuel shipments, movement of material and equipment on-site, and deliveries of materials
15 for construction projects (DOE 2005). Rail service to SRS is provided by CSX Transportation.

16

17

18 **10.1.10 Cultural Resources**

19

20 Research on the archaeological resources at SRS has been ongoing since 1973. The
21 Savannah River Archaeological Research Program (SRARP) of the South Carolina Institute of
22 Archaeology and Anthropology, University of South Carolina, has been the primary group
23 involved in the research. The SRARP has been involved in identifying cultural resources at the

TABLE 10.1.9-1 Traffic Counts in the Vicinity of SRS

Location	Average Daily Traffic Volume
US 278 West of SR 302	4,400
Between SR 125 and SR 302	7,100
North of the city of Barnwell	6,800
Between SR 300 and US 301	3,900
SR 3 Near US 278	1,350
Between SR 125 and US 301	900
SR 19 In the vicinity of US 78	7,200
North of New Ellenton at Medwell Hill Rd.	13,200
SR 125 In Aiken County near Barnwell County line	3,200
South of site boundary	2,100
West of SR 3	1,650
SR 302 SR 125 to US 278	1,150
North of US 278	5,400
SR 118 to SR 19	22,400

Source: SCDOT (2007)

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3 site and developing management documents for maintaining them there. In 1999, the DOE
4 Savannah River Operations Office, South Carolina SHPO, and ACHP developed a Programmatic
5 Agreement to define how the site will consider the resources under its jurisdiction.

6

7 Cultural resources at SRS include archaeological sites, historic structures, and traditional
8 cultural properties. Two main prehistoric periods have been defined for the region in which SRS
9 is located. Each of these periods is divided into subsets of early, middle, and late. The older
10 period is the Archaic, which spans the period between 8000 and 1000 B.C. The subsets of the
11 Archaic are Early (8000 to 6000 B.C.), Middle (6000 to 3000 B.C.), and Late (3000 to
12 1000 B.C.). In general, the Archaic period is characterized by variable weather patterns, which,
13 in turn, greatly affected the density and distribution of people across the continent. The next
14 major period is the Woodland period (1000 B.C to A.D. 1100). The Woodland period is defined
15 by major changes in subsistence strategies, such as the introduction of agriculture and the bow
16 and arrow for more efficient hunting. During the Woodland period, populations continued to
17 grow, and the first large-scale permanent settlements are found. It was during the Woodland
18 Period that pottery was first widely produced. A final prehistoric period noted in the SRS region
19 is the Mississippian period, which extends from A.D. 1100 to 1450.

20

21 European settlement of the area began during the colonial period between 1730 and 1780
22 and was focused along major waterways, such as the Savannah River and its tributaries. During
23 the 1700s and early 1800s, this pattern of concentration of settlements along rivers persisted.
24 Early farms used the richer soils along the rivers and focused on subsistence farming, with only
25 surpluses being sold. During the 19th century, the situation began to change, with more cash
26 crops, such as cotton, being grown. A relatively small amount of slave labor was employed.
27 Settlement patterns did not begin changing until after the Civil War. The introduction of the

1 railroads, which relieved the dependence on rivers for transportation, was a major factor in the
2 land use changes (Cabak et al. 1996). After the Civil War, the tenant farming and share cropper
3 systems began to take hold in the region. The Depression of the 1930s caused many people to
4 leave the region for urban centers. After World War II, the increased mechanization of farming
5 also resulted in people leaving the region as larger land holdings became common.

6
7 The Savannah River Project was established in 1950 by the AEC. The plant was operated
8 by E.I. duPont de Nemours and Company, Inc., to produce basic materials for use in the
9 manufacture of nuclear weapons. The plant site was constructed between 1951 and 1956. The
10 site consisted of five nuclear reactors, two large chemical separation plants, a tritium processing
11 facility, a heavy-water extraction plant, a uranium fuel processing facility, a fuel and target
12 fabrication facility, and a waste management facility. The contract to operate and manage the
13 operations switched to the Westinghouse Savannah River Company in 1989. The name of the
14 facility changed from the Savannah River Project to Savannah River Site in 1989 as well.

15
16 There are more than 850 archaeological sites known on the SRS property (NRC 2005).
17 Of these 850 sites, 67 have been determined potentially eligible for listing on the *National*
18 *Register*. Prehistoric sites at SRS include village sites, base camps, limited activity sites,
19 quarries, and workshops. Historic sites at SRS include farmsteads, tenant dwellings, mills,
20 plantations, slave quarters, rice farm dikes, dams, cattle pens, ferry locations, churches, schools,
21 towns, cemeteries, commercial buildings, and roads. Roughly 400 historic sites have been
22 documented at SRS. No architectural surveys have been conducted at SRS. Numerous
23 specialized facilities at SRS have the potential to be considered eligible for the NRHP.

24
25 A predictive model for the presence of cultural resources was developed during the 1970s
26 for SRS. The model identifies three zones of archaeological sensitivity. Zone 1 has the highest
27 potential for having numerous large archaeological sites. Zone 2 has moderate potential, and
28 Zone 3 has the lowest potential (DOE 1997). The GTCC reference location is in Zone 3.

29
30 Traditional cultural properties are locations that are important to a group for maintaining
31 its cultural identity. While these resources are most often related to Native Americans, they can
32 be associated with other groups as well. The Apalachee, Cherokee, Chicksaw, Creek, Shawnee,
33 Westo, and Yuchi all have traditional ties to the SRS property. The Yuchi Tribal Organization,
34 the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town
35 Confederacy have expressed interest in the SRS property with regard to it containing traditional
36 religious locations. The Yuchi Tribal Organization and the National Council of Muskogee Creek
37 expressed concern about plants that they use in traditional ceremonies that can be found on SRS
38 land.

39 40 41 **10.1.11 Waste Management**

42
43 Site management of the waste types generated by the land disposal methods for
44 Alternatives 4 and 5 are discussed in Section 5.3.11.

10.2 ENVIRONMENTAL AND HUMAN HEALTH CONSEQUENCES

The potential impacts from the construction, operations, and post-closure of the trench (Alternative 4) and vault (Alternative 5) disposal methods are presented in this section for the resource areas evaluated. The affected environment for each resource area is described in Section 10.1. The GTCC reference location for SRS is shown in Figure 10.1-1.

10.2.1 Climate and Air Quality

This section discusses potential climate and air quality impacts from the construction and operations of each of the two disposal methods (trench and vault) at SRS. Noise impacts are presented in Section 5.3.1.

10.2.1.1 Construction

During the construction period, emissions of criteria pollutants (SO₂, NO_x, CO, PM₁₀, and PM_{2.5}), VOCs, and the primary greenhouse gas CO₂ would be caused by fugitive dust emissions from earth-moving activities and engine exhaust emissions from heavy equipment and commuter, delivery, and support vehicles. Typically, the potential impacts from exhaust emissions on ambient air quality would be smaller than those from fugitive dust emissions. Accordingly, only the potential impacts of fugitive PM₁₀ and PM_{2.5} emissions from construction activities on ambient air quality are discussed.

Air emissions of criteria pollutants, VOCs, and CO₂ from construction activities were estimated for the peak year when site preparation and construction of the support facility and some disposal cells would take place. Estimates for PM₁₀ and PM_{2.5} include diesel particulate emissions. The estimates are provided in Table 10.2.1-1 for each disposal method. Detailed information on emission factors, assumptions, and emission inventories is available in Appendix C. As shown in the table, total peak-year emission rates are estimated to be rather small when compared with emission totals for all three counties encompassing SRS (Aiken, Allendale, and Barnwell Counties). Peak-year emissions for all criteria pollutants and VOCs would be higher for the vault method, which would consume more materials and resources for vault construction and disturb more areas than would the trench method. In terms of absolute value and contribution to the emissions total, the peak-year emissions of NO_x for the vault method would be the highest, about 0.18% of the three-county emissions total, while it is estimated that other criteria pollutants and VOCs would be less than 0.03% of the three-county emissions total.

The highest background concentration levels for PM_{2.5} in the area approached the standards (around 97%) (see Table 10.1.1-3). Construction activities would occur at least 14 km (9 mi) from the site boundary and thus would not be likely to result in exceedances of the standards. However, construction activities would still be conducted in a manner that would minimize potential impacts of construction-related emissions on ambient air quality. Also, construction permits typically require fugitive dust control by means of established standard dust

TABLE 10.2.1-1 Peak-Year Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Construction of the Trench and Vault Disposal Facilities at SRS

Pollutant	Total Emissions (tons/yr) ^a	Construction Emissions (tons/yr)	
		Trench (%) ^b	Vault (%) ^b
SO ₂	20,700	0.90 (<0.01)	3.2 (0.02)
NO _x	17,336	8.1 (0.05)	31 (0.18)
CO	74,159	3.3 (<0.01)	11 (0.01)
VOCs	15,095	0.90 (0.01)	3.6 (0.02)
PM ₁₀ ^c	13,678	5.0 (0.04)	8.6 (0.06)
PM _{2.5} ^c	3,960	1.5 (0.04)	3.6 (0.09)
CO ₂		670	2,300
County ^d	4.25 × 10 ⁶	(0.02)	(0.05)
South Carolina ^e	9.62 × 10 ⁷	(0.0007)	(0.002)
U.S. ^e	6.54 × 10 ⁹	(0.00001)	(0.00004)
World ^e	3.10 × 10 ¹⁰	(0.000002)	(0.000007)

^a Total emissions in 2002 for all three counties encompassing SRS (Aiken, Allendale, and Barnwell Counties). See Table 10.1.1-1 for criteria pollutants and VOCs.

^b Numbers in parentheses are percent of total emissions.

^c Estimates for GTCC construction include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available, so county-level emissions were estimated from available state total CO₂ emissions on the basis of population distribution.

^e Annual CO₂ emissions in South Carolina, the United States, and worldwide in 2005.

Source: EIA (2008); EPA (2008b, 2009)

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3 control practices, primarily by watering unpaved roads, disturbed surfaces, and temporary
4 stockpiles.

5

6 Although O₃ levels in the area exceeded the standard (about 109%) (see Table 10.1.1-3),
7 the three counties encompassing SRS are currently in attainment for O₃ (40 CFR 81.341).

8 O₃ precursor emissions from the proposed GTCC waste disposal facility for both methods would
9 be relatively small (less than 0.18% and 0.02% of the three-county total NO_x and VOC

10 emissions, respectively), and they would be much lower than those for the regional air shed in
11 which emitted precursors are transported and formed into O₃. Accordingly, potential impacts of
12 O₃ precursor releases from construction on regional O₃ would not be of concern.

13

14 The major air quality concern with respect to emissions of CO₂ is that it is a greenhouse
15 gas, which traps solar radiation reflected from the earth, keeping it in the atmosphere. The
16 combustion of fossil fuels makes CO₂ the most widely emitted greenhouse gas worldwide. CO₂
17 concentrations in the atmosphere have continuously increased from approximately 280 ppm in

1 preindustrial times to 379 ppm in 2005, a 35% increase, and most of this increase has occurred in
2 the last 100 years (IPCC 2007).

3
4 The climatic impact of CO₂ does not depend on the geographic location of its sources
5 because CO₂ is stable in the atmosphere and is essentially uniformly mixed; that is, the global
6 total is the important factor with respect to global warming. Therefore, a comparison between
7 U.S. and global emissions and the total emissions from the construction of a disposal facility is
8 useful in understanding whether CO₂ emissions from the site would be significant with respect to
9 global warming. As shown in Table 10.2.1-1, the highest peak-year amount of CO₂ emissions
10 from construction would be less than 0.05%, 0.002% and 0.00004%, respectively, of 2005
11 county, state, and U.S. CO₂ emissions. In 2005, CO₂ emissions in the United States were about
12 21% of worldwide emissions (EIA 2008). Emissions from construction would be less than
13 0.00001% of global emissions. Potential impacts on climate change from construction emissions
14 would be small.

15
16 Appendix D assumes an initial construction period of 3.4 years. The disposal units would
17 be constructed as the waste became available for disposal. The construction phase would extend
18 over more years; thus, emissions in nonpeak years would be lower than peak-year emissions in
19 the table. In addition, construction activities would occur only during daytime hours, when air
20 dispersion is most favorable. Accordingly, potential impacts from construction activities on
21 ambient air quality would be minor and intermittent in nature.

22
23 General conformity applies to federal actions taking place in nonattainment or
24 maintenance areas and is not applicable to the proposed action at SRS because the area is
25 classified as being in attainment for all criteria pollutants (40 CFR 81.341).

26 27 28 **10.2.1.2 Operations**

29
30 Criteria pollutants, VOCs, and CO₂ would be released into the atmosphere during
31 operations. These emissions would include fugitive dust emissions from emplacement activities
32 and exhaust emissions from heavy equipment and commuter, delivery, and support vehicles.
33 Estimated annual emissions of criteria pollutants, VOCs, and CO₂ at the facility are presented in
34 Table 10.2.1-2. Detailed information on emission factors, assumptions, and emission inventories
35 is available in Appendix C. As shown in the table, annual emissions from operations are
36 estimated to be higher than those from construction under the trench method; estimates for PM₁₀
37 and PM_{2.5} include diesel particulate emissions. Except for PM₁₀ emissions, the emission
38 estimates for the vault method are about the same for the construction and operations phases.
39 Compared with annual emissions for counties encompassing SRS, annual NO_x emissions for
40 both the trench and vault methods are about 0.15% of the total emissions, while emissions of
41 other criteria pollutants and VOCs are about 0.02% of the total.

42
43 Concentration levels from operational activities, except O₃ and PM_{2.5} concentrations, are
44 expected to remain well below the standards. Estimates for PM₁₀ and PM_{2.5} include diesel
45 particulate emissions. As discussed in the construction section, established fugitive dust control

TABLE 10.2.1-2 Annual Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Operations of the Trench and Vault Disposal Facilities at SRS

Pollutant	Total Emissions (tons/yr) ^a	Operation Emissions (tons/yr)			
		Trench (%) ^b		Vault (%) ^b	
SO ₂	20,700	3.3	(0.02)	3.3	(0.02)
NO _x	17,336	27	(0.16)	27	(0.16)
CO	74,159	15	(0.02)	15	(0.02)
VOCs	15,095	3.1	(0.02)	3.1	(0.02)
PM ₁₀ ^c	13,678	2.5	(0.02)	2.5	(0.02)
PM _{2.5} ^c	3,960	2.2	(0.06)	2.2	(0.06)
CO ₂		3,200		3,300	
County ^d	4.25 × 10 ⁶		(0.08)		(0.08)
South Carolina ^e	9.62 × 10 ⁷		(0.003)		(0.003)
U.S. ^e	6.54 × 10 ⁹		(0.00005)		(0.00005)
World ^e	3.10 × 10 ¹⁰		(0.00001)		(0.00001)

^a Total emissions in 2002 for all three counties encompassing SRS (Aiken, Allendale, and Barnwell Counties). See Table 10.1.1-1 for criteria pollutants and VOCs.

^b Numbers in parentheses are percent of total emissions.

^c Estimates for GTCC operations include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available, so county-level emissions were estimated from available state total CO₂ emissions on the basis of population distribution.

^e Annual CO₂ emissions in South Carolina, the United States, and worldwide in 2005.

Source: EIA (2008); EPA (2008b, 2009)

1
2 measures (primarily the watering of unpaved roads, disturbed surfaces, and temporary
3 stockpiles) would be implemented to minimize potential impacts on ambient air quality.
4

5 With regard to regional O₃, precursor emissions of NO_x and VOCs would be comparable
6 to those resulting from construction activities (about 0.16% and 0.02% of the three-county
7 emission totals, respectively) and are not anticipated to contribute much to regional O₃ levels.
8 The highest emissions of CO₂ among the disposal methods would be comparable to the highest
9 construction-related emissions; thus, their potential impacts on climate change would also be
10 negligible.

11
12 PSD regulations are not applicable to the proposed action because the proposed action is
13 not a major stationary source.
14
15

1 **10.2.2 Geology and Soils**

2

3 Direct impacts from land disturbance would be proportional to the total area of land
4 disturbed during site preparation activities (e.g., grading and backfilling) and construction of the
5 GTCC waste disposal facility and related infrastructure (e.g., roads). Land disturbance would
6 include the surface area covered for both the trench and vault disposal methods and the vertical
7 displacement of geologic materials for the trench disposal method (the borehole disposal method
8 is not evaluated for SRS). The increased potential for soil erosion would be an indirect impact
9 from land disturbance at the construction site. Indirect impacts would also result from the
10 consumption of geologic materials (e.g., aggregate) for facility and other associated
11 infrastructure construction. The impact analysis also considers whether the proposed action
12 would preclude the future extraction and use of mineral materials or energy resources.

13

14

15 **10.2.2.1 Construction**

16

17 Impacts from disturbing the land surface area would be a function of the disposal method
18 (trench or vault) implemented at the site, but the impacts from the two methods would be
19 comparable. Geologic and soil material requirements are listed in Table 5.3.2-1. The vault
20 facility would require the most material since it would involve the installation of interim and
21 final cover systems. This material would be considered permanently lost. However, neither of the
22 disposal methods is expected to result in adverse impacts on geologic and soil resources at SRS,
23 since these resources are in abundant supply in South Carolina.

24

25 No significant changes in surface topography or natural drainages are anticipated in the
26 construction area. However, the disturbance of soil during the construction phase would increase
27 the potential for erosion in the immediate vicinity. Mitigation measures would be implemented to
28 avoid or minimize the risk of erosion.

29

30 The GTCC waste disposal facility would be sited and designed with safeguards to avoid
31 or minimize the risks associated with seismic hazards. SRS is in a seismically active region, and
32 small-magnitude earthquakes occur regularly. There is no volcanic risk for SRS. The potential
33 for other hazards (e.g., subsidence and liquefaction) is considered to be low.

34

35

36 **10.2.2.2 Operations**

37

38 The disturbance of soil and the increased potential for soil erosion would continue
39 throughout the operations phase as waste was delivered to the site for disposal over time.
40 Mitigation measures would be implemented to avoid or minimize the risk of erosion.

41

42 Impacts related to the extraction and use of valuable geologic materials are expected to be
43 low, since mineral and energy development does not occur within the boundary of SRS.

44

45

10.2.3 Water Resources

Direct and indirect impacts on water resources could result from water use at the proposed GTCC waste disposal facility during construction and operations. Table 5.3.3-1 provides an estimate of the water consumption and discharge volumes for the land disposal methods; Tables 5.3.3-2 and 5.3.3-3 summarize the water use impacts (in terms of change in annual water use) on water resources from construction and operations, respectively. A discussion of potential impacts during each project phase is presented in the following sections. In addition, contamination due to potential leaching of radionuclides from the waste inventory into groundwater could occur, depending on the post-closure performance of the trench and vault disposal facilities discussed in Section 10.2.4.2.

10.2.3.1 Construction

Of the two land disposal methods considered for SRS, construction of a vault facility would have the higher water requirement (Table 5.3.3-1). Water demands for construction at SRS would be met by using groundwater from on-site wells. (Wells at the SRS currently draw from the deep Crouch Branch and McQueen Aquifers, with a few lower-capacity wells pumping from the shallower Gordon Aquifer and the lower zone of the Upper Three Runs Aquifer.) No surface water would be used at the site during construction. As a result, no direct impacts on surface water resources are expected. The potential for indirect surface water impacts on the Savannah River and its tributaries related to soil erosion, contaminated runoff, and sedimentation would be reduced by implementing good industry practices and mitigation measures. The GTCC reference location is not within the 100-year floodplain of Fourmile Branch or Upper Three Run Creek.

Currently, SRS uses about 5.3 billion L (1.4 billion gal) of groundwater per year. Construction of the proposed GTCC waste disposal facility would increase the annual water use at SRS by a maximum of about 0.06% (vault method) over the 20-year period that construction would occur. Because withdrawals of groundwater would be relatively small, they would not significantly lower the water table or change the direction of groundwater flow at SRS. As a result, impacts due to groundwater withdrawals are expected to be negligible.

Construction activities could potentially change the infiltration rate at the site of the proposed GTCC waste disposal facility, first by increasing the rate as ground would be disturbed in the initial stages of construction and then by decreasing the rate as impermeable materials (e.g., the clay material and geotextile membrane assumed for the cover or cap in the land disposal facility designs) would cover the surface. These changes are expected to be negligible since the area of land associated with the proposed GTCC waste disposal facility (up to 25 ha [60 ac], depending on the disposal method) is small relative to the SRS land area.

Disposal of waste (including sanitary waste) generated during construction of the trench or vault disposal facility would have a negligible impact on the quality of water resources at SRS (see Sections 5.3.11 and 10.2.11). The potential for indirect surface water or groundwater

1 impacts related to spills at the surface would be reduced by implementing good industry
2 practices and mitigation measures.

3 4 5 **10.2.3.2 Operations**

6
7 The two land disposal methods considered for SRS would have the same water
8 requirement (Table 5.3.3-1). Water demands for operations at SRS would be met by using
9 groundwater from on-site wells. No surface water would be used at the site during operations. As
10 a result, no direct impacts on surface water resources are expected. The potential for indirect
11 surface water impacts related to soil erosion, contaminated runoff, and sedimentation would be
12 reduced by implementing good industry practices and mitigation measures.

13
14 Operations of the proposed GTCC waste disposal facility would increase the annual
15 water use at SRS by a maximum of about 0.1% (trench or vault method). Because withdrawals of
16 groundwater would be relatively small, they would not significantly lower the water table or
17 change the direction of groundwater flow at SRS. As a result, impacts due to groundwater
18 withdrawals are expected to be small.

19
20 Disposal of waste (including sanitary waste) generated during operations of the trench or
21 vault disposal facility would have a negligible impact on the quality of water resources at SRS
22 (see Sections 5.3.11 and 10.2.11). The potential for indirect impacts on surface water or
23 groundwater related to spills at the surface would be reduced by implementing good industry
24 practices and mitigation measures.

25 26 27 **10.2.4 Human Health**

28
29 Potential impacts on members of the general public and on involved workers from the
30 construction and operations of the waste disposal facilities are expected to be comparable for all
31 of the sites evaluated in this EIS for the land disposal methods, and these impacts are described
32 in Section 5.3.4. The following sections discuss the impacts from hypothetical facility accidents
33 associated with waste handling activities and the impacts during the post-closure phase. They
34 address impacts on members of the general public who might be affected by these waste disposal
35 activities at the SRS GTCC reference location, since these impacts would be site dependent.

36 37 38 **10.2.4.1 Facility Accidents**

39
40 Data on the estimated human health impacts from hypothetical accidents at a GTCC
41 waste disposal facility located at SRS are provided in Table 10.2.4-1. The accident scenarios are
42 discussed in Section 5.3.4.2.1 and Appendix C. A reasonable range of accidents that includes
43 operational events and natural causes is analyzed. The impacts presented for each accident
44 scenario are for the sector with the highest impacts, and no protective measures are assumed;
45 therefore, they represent maximum impacts expected for such an accident.

TABLE 10.2.4-1 Estimated Radiological Human Health Impacts from Hypothetical Facility Accidents at SRS^a

Accident Number	Accident Scenario	Off-Site Public		Individual ^b	
		Collective Dose (person-rem)	Latent Cancer Fatalities ^c	Dose (rem)	Likelihood of LCF ^c
1	Single drum drops, lid failure in Waste Handling Building	0.001	<0.00001	0.0001	<0.00001
2	Single SWB drops, lid failure in Waste Handling Building	0.002	<0.00001	0.0002	<0.00001
3	Three drums drop, puncture, lid failure in Waste Handling Building	0.002	<0.00001	0.0002	<0.00001
4	Two SWBs drop, puncture, lid failure in Waste Handling Building	0.003	<0.00001	0.0003	<0.00001
5	Single drum drops, lid failure outside	1	0.0006	0.095	0.00006
6	Single SWB drops, lid failure outside	2.2	0.001	0.22	0.0001
7	Three drums drop, puncture, lid failure outside	1.8	0.001	0.17	0.0001
8	Two SWB drops, puncture, lid failure outside	3.1	0.002	0.3	0.0002
9	Fire inside the Waste Handling Building, one SWB assumed to be affected	45	0.03	4.3	0.003
10	Single RH waste canister breach	<0.001	<0.00001	<0.00001	<0.00001
11	Earthquake, affects 18 pallets, each with 4 CH drums	29	0.02	2.7	0.002
12	Tornado, missile hits one SWB, contents released	8.9	0.005	0.86	0.0005

^a CH = contact-handled, RH = remote-handled, LCF = latent cancer fatality, SWB = standard waste box.

^b The individual receptor is assumed to be 100 m (330 ft) downwind from the release point. This individual is expected to be a noninvolved worker because there would be no public access within 100 m (330 ft) of the GTCC reference location.

^c LCFs are calculated by multiplying the dose by the health risk conversion factor of 0.0006 fatal cancer per person-rem (see Section 5.2.4.3). Values are rounded to one significant figure.

1 The collective population dose includes exposure from inhalation of airborne radioactive
2 material, external exposure from radioactive material deposited on the ground, and ingestion of
3 contaminated crops. The exposure period is considered to last for 1 year immediately following
4 the accidental release. It is recognized that interdiction of food crops would likely occur if a
5 significant release did occur, but this assessment conservatively addresses what could happen
6 without interdiction. For the accidents involving CH waste (Accidents 1–9, 11, 12), the ingestion
7 dose accounts for approximately 20% of the collective population dose shown in Table 10.2.4-1.
8 External exposure is negligible in all cases. All exposures are dominated by the inhalation dose
9 from the passing plume of airborne radioactive material downwind of the hypothetical accident
10 immediately following release.

11
12 The highest estimated impact on the general public, 45 person-rem, would be from a
13 hypothetical release from a SWB caused by a fire in the Waste Handling Building (Accident 9).
14 This dose is not expected to lead to any additional LCFs in the population. This dose would be
15 released to the 263,000 people living to the west-northwest of the facility, resulting in an average
16 dose of less than 0.0002 rem per person. Because this dose would be from internal intake
17 (primarily inhalation, with some ingestion) and because the DCFs used in this analysis are for a
18 50-year CEDE, this dose would be accumulated over the course of 50 years.

19
20 The dose to an individual (expected to be a noninvolved worker because there would be
21 no public access within 100 m [330 ft] of the GTCC reference location) includes exposure from
22 inhalation of airborne radioactive material and 2 hours of exposure to radioactive material
23 deposited on the ground. As shown in Table 10.2.4-1, the highest estimated dose to an
24 individual, 4.3 rem, would result from Accident 9 from inhalation exposure immediately after the
25 postulated release. This estimated dose is for a hypothetical individual located 100 m (330 ft) to
26 the north of the accident location. As discussed above, the estimated dose of 4.3 rem would be
27 accumulated over a 50-year period after intake and would not result in any symptoms of acute
28 radiation syndrome. A maximum annual dose of about 5% of the total dose would occur in the
29 first year. The increased lifetime probability of a fatal cancer for this individual is approximately
30 0.3% on the basis of a total dose of 4.3 rem.

31

32

33 **10.2.4.2 Post-Closure**

34

35 The potential radiation dose from airborne releases of radionuclides to the off-site public
36 after the closure of either the trench or vault disposal facility would be small. RESRAD-
37 OFFSITE calculation results indicate that the potential inhalation dose at a distance of 100 m
38 (330 ft) from the disposal facility is estimated to be less than 1.8 mrem/yr for trench disposal and
39 0.52 mrem/yr for vault disposal. The potential radiation exposure would be caused mainly by
40 inhalation of radon gas and its short-lived progeny.

41

42 At SRS, the climate is generally humid, with an average annual precipitation rate of about
43 1.2 m/yr (3.9 ft/yr). The natural water infiltration rate to deeper soils is estimated to be about
44 0.38 m/yr (1.2 ft/yr), which is much larger than the natural infiltration rate estimated for other
45 sites considered in this EIS. As a result, more radionuclides would be carried to the groundwater
46 table in a shorter period of time. It is estimated that within 10,000 years, the peak annual

1 radiation dose associated with the use of contaminated groundwater from disposal of the entire
2 GTCC waste inventory at SRS by a hypothetical resident farmer living 100 m (330 ft) from the
3 disposal facility would be 1,300 mrem/yr for the vault method and 1,700 mrem/yr for the trench
4 method (see Table 10.2.4-2).

5
6 The peak annual doses are calculated to occur quite quickly for SRS because the water
7 infiltration rate is so high there. The maximum annual dose would occur about 54 years (for the
8 vault method) and 29 years (for the trench method) after failure of the engineered cover and
9 barriers. These times represent the time after failure of the engineered barriers (including the
10 cover), which is assumed to begin 500 years after closure of the disposal facility. The exposure
11 pathways related to the use of contaminated groundwater considered in this analysis include the
12 ingestion of contaminated groundwater, soil, plants, meat, and milk; external radiation; and the
13 inhalation of radon gas and its short-lived progeny.

14
15 The peak annual doses and LCF risks given in Tables 10.2.4-2 and 10.2.4-3 to the
16 hypothetical resident farmer (from use of potentially contaminated groundwater within the first
17 10,000 years after closure of the disposal facility) are those associated with the disposal of the
18 entire GTCC waste inventory by using the vault and trench disposal methods. In these tables, the
19 annual doses and LCF risks contributed by each waste type (i.e., dose and risk for each waste
20 type at the time or year when the peak dose or risk for the entire inventory is observed) to the
21 peak dose and risk are also tabulated. The doses and LCF risks presented for the various waste
22 types do not necessarily represent the peak dose and LCF risk of the waste type itself when it is
23 considered on its own. Tables E-22 through E-25 in Appendix E present peak doses for each
24 waste type when considered on its own. Because these peak doses generally occur at different
25 times, the results should not be summed to obtain total doses for comparison with those
26 presented in Table 10.2.4-2 (although for some cases, these sums might be close to those
27 presented in the site-specific chapters).

28
29 The radiation doses are largely associated with the GTCC-like Other Waste - RH; GTCC
30 LLRW Other Waste - RH contributes about one-fourth of the peak annual dose. Activated metals
31 also contribute a measurable amount to the peak dose and LCF risk for each disposal method.

32
33 It is calculated that within 100 years after a breach of the engineered barriers (including
34 cover), C-14, Tc-99, I-129, and Np-237 would reach the groundwater table and a well installed
35 by the hypothetical resident farmer. These radionuclides are highly soluble in water, a
36 characteristic that could lead to potentially significant groundwater concentrations and
37 subsequently high doses and LCF risks to this hypothetical receptor. Additional radionuclides
38 that would contribute to the groundwater dose within 10,000 years include Ni-59, Ni-63, Ra-226,
39 Am-241, and Th-230. Of these five radionuclides, it is calculated that Ni-59, Ni-63, and Ra-226
40 would reach the groundwater table and a well located 100 m (330 ft) downgradient of the
41 disposal facility, while the radiation doses attributable to Am-241 and Th-230 would largely be
42 those associated with the decay products of these two radionuclides (Np-237 and Ra-226).

43
44 Figure 10.2.4-1 is a temporal plot of the doses associated with the use of contaminated
45 groundwater for the vault and trench disposal methods for a period extending to 10,000 years,
46 and Figure 10.2.4-2 shows these results to 100,000 years. Note that the time scale in

TABLE 10.2.4-2 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater within 10,000 Years of Disposal at the GTCC Reference Location at SRS^a

Disposal Technology/ Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual Dose from Entire Inventory
	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	
Vault disposal									1,300 ^b
Group 1 stored	2.0	-	0.0	1.3	0.21	0.0	15	1,000	
Group 1 projected	30	0.0	-	0.039	0.53	0.0	4.2	3.6	
Group 2 projected	14	0.0	6.5	230	-	-	8.3	18	
Trench disposal									1,700 ^b
Group 1 stored	2.2	-	0.0	1.0	0.24	0.0	31	1,100	
Group 1 projected	33	0.0	-	0.031	0.60	0.0	8.7	2.9	
Group 2 projected	16	0.0	13	460	-	-	17	31	

^a These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a hyphen means there is no inventory for that waste type. The values given in this table represent the annual doses to the hypothetical resident farmer at the time of peak annual dose from the entire GTCC waste inventory. These contributions do not represent the maximum doses that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses that could result from each of the waste types are presented in Tables E-22 through E-25 in Appendix E.

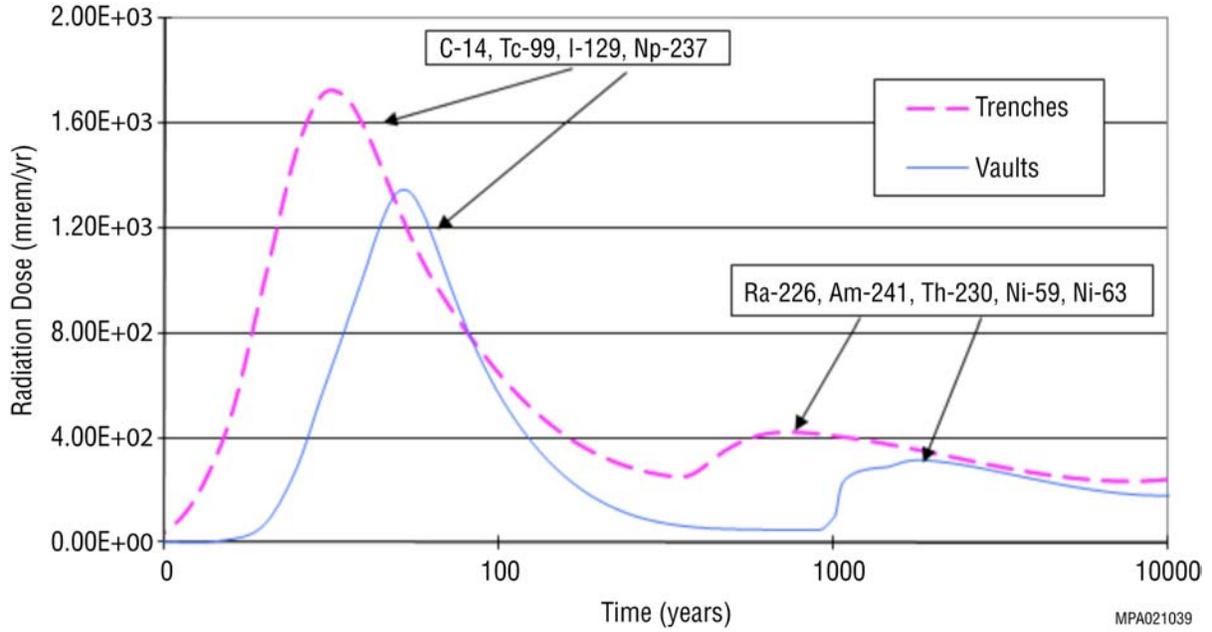
^b The times for the peak annual doses of 1,300 mrem/yr for vaults and 1,700 mrem/yr for trenches were calculated to be about 54 years and 29 years, respectively, for disposal of the entire GTCC waste inventory. These times represent the time after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual doses from the specific waste types at the time of these peak doses. The primary contributors to the dose are GTCC LLRW Other Waste - RH and GTCC-like Other Waste - RH. The primary radionuclides causing this dose would be C-14, Tc-99, I-129, and Np-237.

TABLE 10.2.4-3 Estimated Peak Annual LCF Risks from the Use of Contaminated Groundwater within 10,000 Years of Disposal at the GTCC Reference Location at SRS^a

Disposal Technology/ Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual LCF Risk from Entire Inventory
	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	
Vault disposal									8E-04 ^b
Group 1 stored	1E-06	-	0E+00	8E-07	1E-07	0E+00	9E-06	6E-04	
Group 1 projected	2E-05	0E+00	-	2E-08	3E-07	0E+00	3E-06	2E-06	
Group 2 projected	9E-06	0E+00	4E-06	1E-04	-	-	5E-06	1E-05	
Trench disposal									1E-03 ^b
Group 1 stored	1E-06	-	0E+00	6E-07	1E-07	0E+00	2E-05	7E-04	
Group 1 projected	2E-05	0E+00	-	2E-08	4E-07	0E+00	5E-06	2E-06	
Group 2 projected	9E-06	0E+00	8E-06	3E-04	-	-	1E-05	2E-05	

^a These annual LCF risks are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to one significant figure, and a hyphen means there is no inventory for that waste type. The values given in this table represent the annual LCF risks to the hypothetical resident farmer at the time of peak annual LCF risk from the entire GTCC waste inventory. These contributions do not represent the maximum LCF risks that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum LCF risks that could result from each waste type individually generally occur at different times than the peak annual LCF risk from the entire inventory.

^b The times for the peak annual LCF risks of 8E-04 for vaults and 1E-03 for trenches were calculated to be about 54 years and 29 years, respectively, for disposal of the entire GTCC waste inventory. These times represent the time after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual LCF risks from the specific waste types at the time of peak LCF risks. The primary contributors to the LCF risk are GTCC LLRW Other Waste - RH and GTCC-like Other Waste - RH. The primary radionuclides causing this risk would be C-14, Tc-99, I-129, and Np-237.

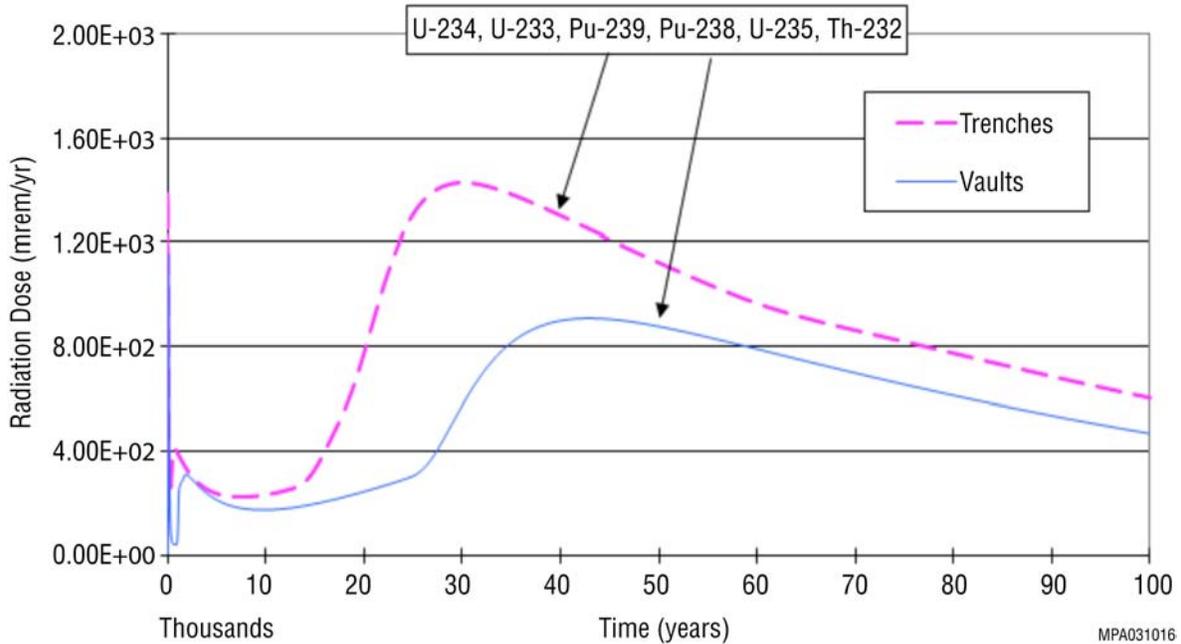


1

2 **FIGURE 10.2.4-1 Temporal Plot of Radiation Doses Associated with the Use of**
3 **Contaminated Groundwater within 10,000 Years of Disposal for the Trench and Vault**
4 **Disposal Methods at SRS**

5

6



7

8 **FIGURE 10.2.4-2 Temporal Plot of Radiation Doses Associated with the Use of**
9 **Contaminated Groundwater within 100,000 Years of Disposal for the Trench and Vault**
10 **Disposal Methods at SRS**

11

12

1 Figure 10.2.4-1 is logarithmic, while the time scale in Figure 10.2.4-2 is linear. A logarithmic
2 time scale was used in the first figure to better illustrate the projected radiation doses to a
3 hypothetical resident farmer in the first 10,000 years.

4

5 As shown in Figure 10.2.4-2, a number of additional actinides (mainly isotopes of
6 uranium, plutonium, and thorium) would contribute to the groundwater dose thousands of years
7 after closure and last over a very long duration. The peak annual doses from these radionuclides
8 would occur about 30,000 years following closure of the trench disposal facility and about
9 40,000 years following closure of the vault facility. These maximum doses are lower than those
10 that are predicted to occur within the first 10,000 years by the RESRAD-OFFSITE computer
11 code.

12

13 The results given here are assumed to be conservative because the location selected for
14 the residential exposure is 100 m (330 ft) from the edge of the disposal facility. Use of a longer
15 distance, which might be more realistic for the sites being evaluated, would significantly lower
16 these estimated doses (i.e., by as much as 70%). A sensitivity analysis performed to determine
17 the effect of a distance longer than 100 m (330 ft) is presented in Appendix E.

18

19 These analyses assume that engineering controls would be effective for 500 years
20 following closure of the disposal facility. This means that essentially no infiltrating water would
21 reach the wastes from the top of the disposal units during the first 500 years. It is assumed that
22 after 500 years, the engineered barriers would begin to degrade, allowing infiltrating water to
23 come in contact with the disposed-of wastes. For purposes of analysis in the EIS, it is assumed
24 that the amount of infiltrating water that would contact the wastes would be 20% of the site-
25 specific natural infiltration rate for the area, and that the water infiltration rate around and
26 beneath the disposal facilities would be 100% of the natural rate for the area. This approach is
27 conservative because it is expected that the engineered systems (including the disposal facility
28 cover) would last longer than 500 years, even in the absence of active maintenance measures.

29

30 It is assumed that the Other Waste would be stabilized with grout or other material and
31 that this stabilizing agent would be effective for 500 years. Consistent with the assumptions used
32 for engineering controls, no credit was taken in this analysis for the effectiveness of this
33 stabilizing agent after 500 years. That is, it is assumed that any water that would contact the
34 wastes after 500 years would be able to leach radioactive constituents from the disposed-of
35 materials. These radionuclides could then move with the percolating groundwater to the
36 underlying groundwater system. This assumption is conservative because grout or other
37 stabilizing materials could retain their integrity for longer than 500 years.

38

39 Sensitivity analyses performed relative to these assumptions indicate that if a higher
40 infiltration rate to the top of the disposal facilities was assumed, the doses would increase in a
41 linear manner from those presented. Conversely, the doses would decrease in a linear manner
42 with lower infiltration rates. This finding indicates the need to ensure good cover is placed over
43 the closed disposal units. Also, the doses would be lower if it was assumed that the grout would
44 last for a longer time. Because of the long-lived nature of the radionuclides associated with some
45 of the GTCC LLRW and GTCC-like waste, any stabilization effort (such as grouting) would

1 have to be effective for longer than 5,000 years in order to substantially reduce doses that could
2 result from potential future leaching of the disposed-of waste.

3
4 The radiation doses presented in the post-closure assessment in this EIS are intended to
5 be used for comparing the performance of each land disposal method at each site evaluated. The
6 results indicate that the use of robust engineering designs and redundant measures (e.g., types
7 and thicknesses of covers and long-lasting grout) in the disposal facility could delay the potential
8 release of radionuclides and could reduce any releases to very low levels, thereby minimizing
9 potential groundwater contamination and associated human health impacts in the future. DOE
10 will consider the potential doses to the hypothetical farmer and other factors in developing the
11 preferred alternative as discussed in Section 2.9.

12 13 14 **10.2.5 Ecology**

15
16 Section 5.3.5 presents an overview of the potential impacts on ecological resources that
17 could result from the construction, operations, and post-closure maintenance of the GTCC waste
18 disposal facility regardless of the location selected for the facility. This section evaluates the
19 potential impacts of the facility on the ecological resources at SRS.

20
21 Initial loss of mostly upland pine and some hardwood forest habitats, followed by
22 eventual establishment of low-growth vegetation on the disposal site, are not expected to create a
23 long-term reduction in the regional ecological diversity. After closure of the GTCC waste
24 disposal facility, the cover would be planted with annual and perennial grasses and forbs. As
25 appropriate, regionally native plants would be used to landscape the disposal site in accordance
26 with “Guidance for Presidential Memorandum on Environmentally and Economically Beneficial
27 Landscape Practices on Federal Landscaped Grounds” (EPA 1995).

28
29 Clearing of forest habitat for the GTCC waste disposal facility could result in a localized
30 loss of wildlife species that occupy forest habitats. White-tailed deer could also lose a source of
31 mast and potential cover against weather extremes. Species that might occur at the GTCC waste
32 disposal facility once vegetation became established include species that are currently found on
33 urban areas near SRS. However, fencing of the disposal site would lessen the potential for mid-
34 to large-size mammals to enter the area. Some wildlife species might frequent the area between
35 the forest and GTCC reference location (field/forest-edge habitat) (Peterson et al. 2005). Species
36 more dependent on forested habitat or more sensitive to disturbance (e.g., wood warblers and
37 vireos) would probably be permanently displaced from the GTCC reference location
38 (DOE 1997).

39
40 Wildlife-vehicle collisions stemming from increased traffic associated with construction
41 and operations of the GTCC waste disposal facility would result in mortality of some wildlife
42 species. Population-level impacts are not expected from these losses since these species are
43 common throughout SRS (DOE 1997).

44
45 Because no aquatic or wetland habitats occur within the immediate vicinity of the GTCC
46 reference location, direct impacts on aquatic and wetland biota are not expected. DOE would use

1 appropriate erosion control measures to minimize off-site movement of soil. The GTCC waste
2 disposal facility retention pond is not expected to become a highly productive aquatic habitat.
3 However, depending on the amount of water and length of time that water would be retained
4 within the pond, aquatic invertebrates could become established within it. Waterfowl, shorebirds,
5 and other birds might also make use of the retention pond, as would amphibian, reptile, and
6 mammal species that might enter the site.

7
8 Several of the federally and state-listed or special-status species listed in Table 10.1.5-1
9 could occur at the GTCC reference location. However, the area of forested habitat that would be
10 disturbed by construction would be small relative to the overall area of such habitat on SRS.
11 Also, mitigation measures would minimize the potential for adverse impacts on these species.
12 Therefore, construction of the GTCC disposal facility would have a small to negligible impact on
13 the populations of special-status species at SRS.

14
15 The GTCC reference location does not contain red-cockaded woodpecker nesting or
16 foraging areas that are utilized by the birds; however, it does contain unoccupied habitat
17 approaching suitable age that could be utilized by the species (DOE 1997). Forest removal
18 during construction of the facility would eliminate only about 0.1% of the Supplemental Red-
19 Cockaded Woodpecker Management Area at SRS. This small reduction is not expected to have
20 an effect on the population of the red-cockaded woodpecker at SRS (USFS 2005).

21
22 No other threatened or endangered species occur on the GTCC reference location. The
23 site could establish a vegetative cover that could provide habitat suitable for the smooth
24 coneflower (*Echinacea laevigata*) (i.e., abundant sunlight with little competition in the
25 herbaceous layer). Habitats at SRS that provide suitable habitat for that species include open
26 woods, cedar barrens, roadsides, clearcuts, and transmission line ROWs (DOE 1997). DOE
27 would continue to review the site during construction and operations to ensure that no adverse
28 impacts on listed species were occurring.

29
30 Among the goals of the waste management mission at DOE sites is to maintain disposal
31 facilities in a manner that protects the environment and complies with regulations (DOE 2002).
32 Therefore, impacts associated with the GTCC waste disposal facility that could affect ecological
33 resources would be minimized and mitigated.

34 35 36 **10.2.6 Socioeconomics**

37 38 39 **10.2.6.1 Construction**

40
41 The potential socioeconomic impacts from constructing a GTCC waste disposal facility
42 and support buildings at SRS would be relatively small for both the trench and vault disposal
43 methods. Construction activities would create direct employment of 62 people (trench method)
44 to 145 people (vault method) in the peak construction year and an additional 64 indirect jobs
45 (trench method) to 168 indirect jobs (vault method) in the ROI (Table 10.2.6-1). Construction
46 activities would constitute less than 1% of the total ROI employment in the peak year. A GTCC

TABLE 10.2.6-1 Effects of GTCC Waste Disposal Facility Construction and Operations on Socioeconomics at the ROI for SRS^a

Impact Category	Trench		Vault	
	Construction	Operations	Construction	Operations
Employment (number of jobs)				
Direct	62	48	145	51
Indirect	64	43	168	45
Total	126	91	313	96
Income (\$ in millions)				
Direct	2.3	3.2	6.2	3.4
Indirect	2.5	1.6	6.5	1.6
Total	4.8	4.8	12.7	5.0
Population (number of new residents)	27	2	64	2
Housing (number of units required)	14	1	32	1
Public finances (% impact on expenditures)				
Cities and counties ^b	<1	<1	<1	<1
Schools ^c	<1	<1	<1	<1
Public service employment (number of new employees)				
Local government employees ^d	0	0	1	0
Teachers	0	0	1	0
Traffic (impact on current levels of service)	Small	Small	Moderate	Small

^a Impacts shown are for waste facility and support buildings in the peak year of construction and the first year of operations.

^b Includes impacts that would occur in the cities of Aiken, Jackson, New Ellenton, North Augusta, Wagener, Barnwell, Blackville, Williston, Grovetown, Harlem, Augusta, Blyth, and Hephzibah; in Aiken and Barnwell Counties in South Carolina; and in Columbia and Richmond Counties in Georgia.

^c Includes impacts that would occur in Aiken County, Barnwell Additional Voluntary Contribution, Barnwell #19, Barnwell #29, Barnwell #45, Columbia, and Richmond County School Districts.

^d Includes police officers, paid firefighters, and general government employees.

1
2
3

1 waste disposal facility would produce between \$4.8 million in income (trench method) and
2 \$12.7 million in income (vault method) in the peak year of construction.

3
4 In the peak year of construction, between 27 people (trench) and 64 people (vault
5 method) would in-migrate to the ROI (Table 10.2.6-1), as a result of employment on-site.
6 In-migration would have only a marginal effect on population growth and would require less
7 than 1% of vacant rental housing in the peak year. No significant impact on public finances
8 would occur as a result of in-migration, and no new local public service employees would be
9 required to maintain existing levels of service in the various local public service jurisdictions in
10 the ROI. In addition, on-site employee commuting patterns would have a small to moderate
11 impact on levels of service in the local transportation network surrounding the site.

12 13 14 **10.2.6.2 Operations**

15
16 The potential socioeconomic impacts from operating a GTCC waste disposal facility
17 would be relatively small for both the trench and vault disposal methods. Operational activities
18 would create about 48 direct jobs (trench method) to 51 direct jobs (vault method) annually and
19 an additional 43 indirect jobs (trench method) to 45 indirect jobs (vault method) in the ROI
20 (Table 10.2.6-1). A GTCC waste disposal facility would also produce between \$4.8 and
21 \$5.0 million in income annually during operations.

22
23 Two people would move to the area at the beginning of operations (Table 10.2.6-1).
24 However, in-migration would have only a marginal effect on population growth and would
25 require less than 1% of vacant owner-occupied housing during facility operations. No significant
26 impact on public finances would occur as a result of in-migration, and no new local public
27 service employees would be required to maintain existing levels of service in the various local
28 public service jurisdictions in the ROI. In addition, on-site employee commuting patterns would
29 have a small impact on levels of service in the local transportation network surrounding the site.

30 31 32 **10.2.7 Environmental Justice**

33 34 35 **10.2.7.1 Construction**

36
37 No radiological risks and only very low chemical exposure and risk are expected during
38 construction of the trench and vault methods. Chemical exposure during construction would be
39 limited to airborne toxic air pollutants at less than standard levels and would not result in any
40 adverse health impacts. Because the health impacts of each facility on the general population
41 within the 80-km (50-mi) assessment area during construction would be negligible, impacts from
42 the construction of each facility on the minority and low-income populations would not be
43 significant.

10.2.7.2 Operations

Because incoming GTCC waste containers would only be consolidated for placement in trench and vault facilities, with no repackaging necessary, there would be no radiological impacts on the general public during disposal operations and no adverse health impacts on the general population. In addition, no surface releases that might enter local streams or interfere with subsistence activities by low-income or minority populations would occur. Because the health impacts from routine operations on the general public would be negligible, it is expected that there would be no disproportionately high and adverse impact on minority and low-income population groups within the 80-km (50-mi) assessment area. Subsequent NEPA analysis to support any GTCC implementation would consider any unique exposure pathways (such as subsistence fish, vegetation, or wildlife consumption, or well water use) to determine any additional potential health and environmental impacts.

10.2.7.3 Accidents

A release of GTCC waste at either of the disposal facilities could cause radiation exposures and the risk of LCFs in the surrounding area. However, it is highly unlikely that such an accident would occur. Therefore, the risk to any population, including low-income and minority communities, is considered to be low. In the unlikely event of a release of GTCC waste at a waste disposal facility, the communities most likely to be affected could be minority or low-income, given the demographics within 80 km (50 mi) of the GTCC reference location.

In the event that an accident producing significant contamination occurred, appropriate measures would be taken to ensure that the impacts on low-income and minority populations were minimized. The extent to which low-income and minority population groups would be affected would depend on the amount of material released and the direction and speed at which airborne material was dispersed from any of the facilities by the wind. Although the overall risk would be very small, the greatest short-term risk of exposure following an airborne release and the greatest one-year risk would be to the population groups residing to the west-northwest of the GTCC reference location because of the prevailing wind direction. Airborne releases following an accident would likely have a larger impact on the area than would an accident that released contaminants directly into the soil surface. A surface release entering local streams could temporarily interfere with subsistence activities being carried out by low-income and minority populations within a few miles downstream of the site.

Monitoring of contaminant levels in soil and surface water following an accident would provide the public with information on the extent of any contaminated areas. Analysis of contaminated areas to decide how to control the use of high-health-risk areas would reduce the potential impact on local residents.

1 **10.2.8 Land Use**

2
3 Section 5.3.8 presents an overview of the potential impacts on land use that could result
4 from the GTCC waste disposal facility regardless of the location selected for the facility. This
5 section evaluates the potential impacts from the GTCC waste disposal facility on land use at
6 SRS.

7
8 The GTCC reference location is situated in an area designated as a forest timber unit
9 (DOE 1997). The site would be redesignated to accommodate the GTCC waste disposal facility
10 and be considered a developed site. Marketable timber on the site would be removed and sold.
11 As mentioned in Section 10.2.5, forest removal during construction of the facility would
12 eliminate about 0.1% of the Supplemental Red-Cockaded Woodpecker Management Area at
13 SRS. Land use on areas surrounding SRS would not be affected. Future land use activities that
14 would be permitted within or immediately adjacent to the GTCC waste disposal facility would be
15 limited to those that would not jeopardize the integrity of the facility, create a security risk, or
16 create a worker or public safety risk.

17 18 19 **10.2.9 Transportation**

20
21 The transportation of GTCC LLRW and GTCC-like waste necessary for the disposal of
22 all waste at SRS was evaluated. As discussed in Section 5.3.9, transportation of all cargo is
23 considered for both truck and rail modes of transport as separate options for the purposes of this
24 EIS. Transportation impacts are expected to be the same for disposal in trenches or vaults
25 because the same type of transportation packaging would be used regardless of the disposal
26 method.

27
28 As discussed in Appendix C, the impacts of transportation were calculated in three areas:
29 (1) collective population risks during routine conditions and accidents (Section 10.2.9.1),
30 (2) radiological risks to individuals receiving the highest impacts during routine conditions
31 (Section 10.2.9.2), and (3) consequences to individuals and populations after the most severe
32 accidents involving a release of a radioactive or hazardous chemical material (Section 10.2.9.3).

33
34 Radiological impacts during routine conditions are a result of human exposure to the low
35 levels of radiation near the shipment. The regulatory limit established in 49 CFR 173.441
36 (Radiation Level Limitations) and 10 CFR 71.47 (External Radiation Standards for All
37 Packages) to protect the public is 0.1 mSv/h (10 mrem/h) at 2 m (6 ft) from the outer lateral sides
38 of the transport vehicle. This dose rate corresponds roughly to 14 mrem/h at 1 m (3 ft). As
39 discussed in Appendix C, Section C.9.4.4, the external dose rates for CH shipments to SRS are
40 assumed to be 0.5 and 1.0 mrem/h at 1 m (3 ft) for truck and rail shipments, respectively. For
41 shipments of RH waste, the external dose rates are assumed to be 2.5 and 5.0 mrem/h at 1 m
42 (3 ft) for truck and rail shipments, respectively. These assignments are based on shipments of
43 similar types of waste. Dose rates from rail shipments are approximately double the rates for
44 truck shipments because rail shipments are assumed to have twice the number of waste packages
45 as a truck shipment. Impacts from accidents depend on the amount of radioactive material in a

1 shipment and the fraction that is released if an accident occurs. The parameters used in the
2 transportation accident analysis are described further in Appendix C, Section C.9.4.3.

3 4 5 **10.2.9.1 Collective Population Risk**

6
7 The collective population risk is a measure of the total risk posed to society as a whole by
8 the actions being considered. For a collective population risk assessment, the persons exposed
9 are considered as a group, without specifying individual receptors. Exposures to four different
10 groups are considered: (1) persons living and working along the transportation routes,
11 (2) persons sharing the route, (3) persons at stops along the route, and (4) transportation crew
12 members. The collective population risk is used as the primary means of comparing various
13 options. Collective population risks are calculated for cargo-related causes for routine
14 transportation and accidents. Vehicle-related risks are independent of the cargo in the shipment
15 and are calculated only for traffic accidents (fatalities caused by physical trauma).

16
17 Estimated impacts from the truck and rail options are summarized in Tables 10.2.9-1 and
18 10.2.9-2, respectively. For the truck option, it is estimated that about 12,600 shipments resulting
19 in about 18 million km (11 million mi) of travel would cause no LCFs in the truck crew members
20 or members of the public. One fatality directly related to accidents is expected. No LCFs are
21 estimated for the rail option, with approximately 5,010 railcar shipments resulting in about
22 8 million km (5 million mi) of travel. However, one fatality from accidents could occur.

23 24 25 **10.2.9.2 Highest-Exposed Individuals during Routine Conditions**

26
27 During the routine transportation of radioactive material, specific individuals might be
28 exposed to radiation in the vicinity of a shipment. Risks to these individuals for a number of
29 hypothetical exposure-causing events were estimated. The receptors included transportation
30 workers, inspectors, and members of the public exposed during traffic delays, while working at a
31 service station, or while living and/or working near a destination site. The assumptions about
32 exposure are given in Appendix C, and transportation impacts are provided in Section 5.3.9. The
33 scenarios for exposure are not meant to be exhaustive; they were selected to provide a range of
34 representative potential exposures. On a site-specific basis, if someone was living or working
35 near the SRS entrance and present for all 12,600 truck or 5,010 rail shipments projected, that
36 individual's estimated dose would be approximately 0.5 or 1.0 mrem, respectively, over the
37 course of more than 50 years. The individual's associated lifetime LCF risk would then be
38 3×10^{-7} or 6×10^{-7} for truck or rail shipments, respectively.

39 40 41 **10.2.9.3 Accident Consequence Assessment**

42
43 Whereas the collective accident risk assessment considers the entire range of accident
44 severities and their related probabilities, the accident consequence assessment assumes that an
45 accident of the most severe category has occurred. The consequences, in terms of committed
46 dose (rem) and LCFs for radiological impacts, were calculated for both exposed populations and

TABLE 10.2.9-1 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Truck for Disposal at SRS^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)				Accident ^e	Latent Cancer Fatalities ^d		Physical Accident Fatalities	
				Routine Public					Crew	Public		
				Off-Link	On-Link	Stops	Total					
Group 1												
GTCC LLRW												
Activated metals - RH												
Past BWRs	20	39,000	0.41	0.023	0.067	0.072	0.16	0.00022	0.0002	<0.0001	0.0011	
Past PWRs	143	331,000	3.4	0.18	0.56	0.61	1.3	0.0015	0.002	0.0008	0.0082	
Operating BWRs	569	778,000	8.1	0.44	1.3	1.4	3.2	0.0035	0.005	0.002	0.023	
Operating PWRs	1,720	2,500,000	26	1.3	4.2	4.6	10	0.01	0.02	0.006	0.069	
Sealed sources - CH												
Cesium irradiators - CH	240	325,000	0.14	0.073	0.21	0.23	0.52	0.0044	<0.0001	0.0003	0.0089	
Other Waste - CH	5	11,200	0.0047	0.0018	0.0068	0.008	0.017	<0.0001	<0.0001	<0.0001	0.00027	
Other Waste - RH	54	39,700	0.41	0.026	0.065	0.073	0.16	<0.0001	0.0002	<0.0001	0.0016	
GTCC-like waste												
Activated metals - RH	38	107,000	1.1	0.039	0.17	0.2	0.4	<0.0001	0.0007	0.0002	0.003	
Sealed sources - CH	1	1,350	0.00057	0.0003	0.00089	0.00097	0.0022	<0.0001	<0.0001	<0.0001	<0.0001	
Other Waste - CH	69	110,000	0.046	0.022	0.068	0.079	0.17	0.001	<0.0001	0.0001	0.0036	
Other Waste - RH	1,160	1,570,000	16	0.84	2.5	2.9	6.3	0.0019	0.01	0.004	0.053	

TABLE 10.2.9-1 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)				Accident ^e	Latent Cancer Fatalities ^d		Physical Accident Fatalities	
				Routine Public					Crew	Public		
				Off-Link	On-Link	Stops	Total					
Group 2												
GTCC LLRW												
Activated metals - RH												
New BWRs	202	293,000	3	0.15	0.48	0.54	1.2	0.0012	0.002	0.0007	0.0075	
New PWRs	833	1,160,000	12	0.54	1.9	2.1	4.5	0.0043	0.007	0.003	0.032	
Additional commercial waste	1,990	2,940,000	31	1.6	4.7	5.4	12	<0.0001	0.02	0.007	0.1	
Other Waste - CH	139	205,000	0.086	0.043	0.13	0.15	0.32	0.0026	<0.0001	0.0002	0.0071	
Other Waste - RH	3,790	5,170,000	53	2.8	8.3	9.5	21	0.00056	0.03	0.01	0.18	
GTCC-like waste												
Other Waste - CH	44	44,800	0.019	0.01	0.029	0.032	0.072	0.00035	<0.0001	<0.0001	0.0015	
Other Waste - RH	1,400	1,920,000	20	1	3.1	3.5	7.7	0.0016	0.01	0.005	0.066	
Total Groups 1 and 2	12,600	17,800,000	170	9.2	28	32	69	0.072	0.1	0.04	0.57	

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

TABLE 10.2.9-2 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Rail for Disposal at SRS^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Dose Risk (person-rem)							Latent Cancer Fatalities ^d		Physical Accident Fatalities
			Routine Crew	Routine Public				Accident ^e	Crew	Public		
				Off-Link	On-Link	Stops	Total					
Group 1												
GTCC LLRW												
Activated metals - RH												
Past BWRs	7	16,600	0.14	0.07	0.0037	0.069	0.14	0.00054	<0.0001	<0.0001	0.0019	
Past PWRs	37	92,700	0.79	0.38	0.021	0.38	0.78	0.0025	0.0005	0.0005	0.0074	
Operating BWRs	154	234,000	2.4	1	0.05	1.2	2.3	0.0039	0.001	0.001	0.018	
Operating PWRs	460	734,000	7.4	3	0.15	3.6	6.7	0.01	0.004	0.004	0.054	
Sealed sources - CH												
Cesium irradiators - CH	120	214,000	0.6	0.33	0.014	0.39	0.73	0.00024	0.0004	0.0004	0.01	
Other Waste - CH	3	7,800	0.019	0.013	0.00058	0.013	0.026	<0.0001	<0.0001	<0.0001	0.00051	
Other Waste - RH	27	29,000	0.35	0.11	0.0037	0.17	0.29	<0.0001	0.0002	0.0002	0.0032	
GTCC-like waste												
Activated metals - RH	11	33,000	0.27	0.09	0.0046	0.12	0.21	<0.0001	0.0002	0.0001	0.003	
Sealed sources - CH	1	1,780	0.005	0.0027	0.00011	0.0033	0.0061	<0.0001	<0.0001	<0.0001	<0.0001	
Other Waste - CH	35	65,500	0.18	0.11	0.0051	0.12	0.24	<0.0001	0.0001	0.0001	0.0046	
Other Waste - RH	579	936,000	9.3	3.8	0.17	4.2	8.2	0.00019	0.006	0.005	0.066	

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TABLE 10.2.9-2 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)					Latent Cancer Fatalities ^d		Physical Accident Fatalities	
				Off-Link	Routine Public			Accident ^e	Crew	Public		
					On-Link	Stops	Total					
Group 2												
GTCC LLRW												
Activated metals - RH												
New BWRs	54	86,000	0.86	0.35	0.015	0.4	0.77	0.00059	0.0005	0.0005	0.006	
New PWRs	227	341,000	3.5	1.2	0.056	1.7	3	0.0029	0.002	0.002	0.021	
Additional commercial waste	498	883,000	8.5	3.7	0.17	3.8	7.7	<0.0001	0.005	0.005	0.067	
Other Waste - CH	70	124,000	0.35	0.22	0.01	0.23	0.46	0.00029	0.0002	0.0003	0.0094	
Other Waste - RH	1,900	3,160,000	31	13	0.57	14	28	<0.0001	0.02	0.02	0.25	
GTCC-like waste												
Other Waste - CH	22	26,300	0.088	0.05	0.0022	0.058	0.11	<0.0001	<0.0001	<0.0001	0.0018	
Other Waste - RH	702	1,150,000	11	4.8	0.22	5.1	10	0.00017	0.007	0.006	0.085	
Total Groups 1 and 2	5,010	8,320,000	78	33	1.5	36	70	0.024	0.05	0.04	0.62	

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

1 individuals in the vicinity of an accident. Because the exact location of such a transportation
2 accident is impossible to predict and thus not specific to any one site, generic impacts were
3 assessed, as presented in Section 5.3.9.

6 **10.2.10 Cultural Resources**

8 The GTCC reference location at SRS is situated northeast of Zone Z along the Aiken and
9 Barnwell County line. The location is in Archaeological Zone 3, which means it has a low
10 potential for containing cultural resources. The project area was partially examined for the
11 presence of archaeological material in 1986, and no materials were found at that time
12 (Brooks et al. 1986). The remaining portion was examined in 1996 by the Savannah River
13 Archaeological Research Program. The survey identified seven archaeological sites: one
14 prehistoric lithic scatter and six late 19th and early 20th century homesteads. It is not known if
15 any of these sites have been evaluated for listing on the NRHP. The seven archaeological sites
16 found in the project area would require evaluation for listing on the NRHP. If any archaeological
17 site was found to be eligible for listing and could not be avoided, then appropriate mitigation
18 would be developed. Mitigation would be determined through consultation with the South
19 Carolina SHPO and the appropriate Native American tribes. Before projects could begin, Native
20 American tribes would need to be contacted to determine if they had any concerns about the
21 location chosen for the project. Native Americans have indicated that resources of concern to
22 them are present on SRS.

24 The land disposal methods evaluated (trench and vault) have the potential to affect
25 cultural resources as a result of the ground clearing needed for construction. Potential impacts
26 from the trench method would be less than those from the vault method. The vault method also
27 requires large amounts of soil to cover the waste. The location for soil extraction has not been
28 chosen. Potential impacts on cultural resources could occur during the removal and hauling of
29 the soil required for this method. Depending on the location chosen for excavating the soil for
30 the cover, the impacts could be greater from this component of the project than from construction
31 of the disposal facility. Impacts on cultural resources would need to be considered for the soil
32 extraction locations. The NHPA Section 106 process would be followed for all project locations.

34 Minimal impacts are expected from operational and post-closure activities because no
35 new ground-disturbing activities are anticipated; most impacts would occur during construction.
36 If any of the eligible archaeological sites were avoided during construction, they would require
37 consideration during any operational or post-closure activities. In the event that any post-
38 construction activities would affect an eligible archaeological site, mitigation for the impacts
39 would be developed in consultation with the SHPO and the appropriate Native American tribes.
40 Tribal consultation might be necessary, depending on the status of resources of concern to the
41 tribe near the project area.

10.2.11 Waste Management

The construction of either of the land disposal facilities (trench or vault) would generate small quantities of hazardous and nonhazardous solids and hazardous and nonhazardous liquids. Waste generated from operations would include small quantities of solid LLRW (e.g., spent HEPA filters) and nonhazardous solid waste (including recyclable wastes). These waste types would either be disposed of on-site or sent off-site for disposal. It is likely that no impacts on waste management programs at SRS would result from the waste that might be generated from the construction and operation of the land disposal methods. Section 5.3.11 provides a summary of the waste handling programs at SRS for the waste types generated.

10.3 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES AND HUMAN HEALTH IMPACTS

The potential environmental consequences from the disposal of GTCC LLRW and GTCC-like waste under Alternatives 3 and 4 are summarized by resource area as follows:

Air quality. The potential impacts from construction and operations at SRS on ambient air quality would be negligible. Under the trench method, peak-year emissions of all criteria pollutants, VOCs, and CO₂ would be lowest during construction but highest during operations. The highest emissions associated with the trench and vault methods would be about 0.18% of the three-county emissions total for NO_x. O₃ levels in the three counties encompassing SRS are currently in attainment; O₃ precursor emissions from construction and operational activities would be relatively small — less than 0.18% and 0.03% of NO_x and VOC emissions, respectively, and much lower than those for the regional air shed. CO₂ emissions during construction and operations would be negligible. All construction and operational activities would occur at least 14 km (9 mi) from the site boundary and would not contribute much to concentrations at the boundary or the nearest residence.

Noise. The highest composite noise during construction would be about 91 dBA at 15 m (50 ft) from the source. Noise levels at 610 m (2,000 ft) from the source would be below the EPA guidelines. This distance is well within the SRS boundary, and there are no residences within this distance. Noise generated during operations would be less than noise during construction.

Geology. No adverse impacts from the extraction and use of geologic and soil resources are expected, nor are any significant changes in surface topography or natural drainages expected. The potential for erosion would be reduced by best management practices.

Water resources. Construction of a vault facility would have a higher water requirement than the trench option. Water demands for construction at SRS would be met by using groundwater from on-site wells. No surface water would be used at the site during construction; therefore, no direct impacts on surface water are expected. Indirect impacts on surface water would be reduced by implementing good industry practices and mitigation measures. Construction of the proposed GTCC waste disposal facility would increase the annual water use

1 at SRS by a maximum of about 0.06% (vault method), and operations would increase it by a
2 maximum of about 0.1% (trench or vault method). Since these increases would not significantly
3 lower the water table or change the direction of groundwater flow, impacts due to groundwater
4 withdrawals are expected to be negligible. Water demands during the decommissioning phase at
5 SRS would be smaller than those during construction, and there would be no water demands
6 during the post-closure period. Groundwater could become contaminated with some
7 radionuclides during the post-closure period; indirect impacts on surface water could occur as a
8 result of aquifer discharges to springs and rivers.

9

10 **Human health.** The impacts on workers from operations would be mainly those from the
11 radiation doses associated with handling the wastes. It is estimated that the annual radiation dose
12 would be 4.6 person-rem/yr for the trench method and 5.2 person-rem/yr for the vault method.
13 Neither of these doses are expected to result in any LCFs (see Section 5.3.4.1.1). The maximum
14 dose to any individual worker would not exceed the DOE administrative control level (2 rem/yr)
15 for site operations. It is expected that the maximum dose to any individual workers over the
16 entire project would not exceed a few rem.

17

18 The worker impacts from accidents would be associated with the physical injuries and
19 possible fatalities that could result from construction and waste handling accidents. It is
20 estimated that the annual number of lost workdays due to injuries and illnesses would be 2 for
21 both the trench and vault methods, and no fatalities would result from construction and waste
22 handling accidents (see Section 5.3.4.2.2). These injuries would not be associated with the
23 radioactive nature of the wastes but would simply be those expected to occur in any construction
24 project of this size.

25

26 It is not expected that the general public would receive any measurable doses during
27 waste disposal operations, given the solid nature of the wastes and the distance of waste handling
28 activities from potential affected individuals. The highest dose to an individual from an accident
29 involving the waste packages prior to disposal (from a fire affecting an SWB) is estimated to be
30 4.3 rem and to not result in any LCFs. The total dose to the affected population from such an
31 event is estimated to be 45 person-rem. The peak annual dose to a hypothetical nearby receptor
32 (resident farmer) who resides 100 m (330 ft) from the edge of the disposal site in the first
33 10,000 years after closure of the disposal facility is estimated to be 1,700 mrem/yr under the
34 trench method and 1,300 mrem/yr under the vault method. These doses would be mainly from
35 GTCC LLRW Other Waste - RH and GTCC-like Other Waste - RH and would occur about
36 29 years (for the trench method) and 54 years (for the vault method) following failure of the
37 engineered cover and barriers.

38

39 **Ecological resources.** The initial loss of upland pine and some hardwood forest habitats,
40 followed by eventual establishment of low-growth vegetation, would not create a long-term
41 reduction in the local or regional ecological diversity. Wildlife-vehicle collisions stemming from
42 increased traffic associated with the facility would contribute to losses; however, population-
43 level impacts are not expected. After closure, the cover would become vegetated with annual and
44 perennial grasses and forbs. Clearing of forest habitat for construction of the GTCC waste
45 disposal facility could result in localized loss of wildlife species. White-tailed deer could also
46 lose a source of mast and potential cover against weather extremes. Fences at the site would

1 lessen the potential for mid-sized to large mammals to enter the site. There are no natural aquatic
2 habitats within the immediate vicinity of the GTCC reference location; however, depending on
3 the amount of water in the retention pond and length of retention, certain species (e.g., aquatic
4 invertebrates, waterfowl, shorebirds, and mammals) could become established. Several state-
5 listed and special-status species occur within the project area. Impacts on these species would
6 likely be small, since the area of habitat disturbance would be small relative to the overall area of
7 such habitat at SRS. Forest removal during construction would eliminate about 0.1% of the
8 Supplemental Red-Cockaded Woodpecker Management Area; population-level impacts are not
9 expected.

10
11 **Socioeconomics.** Impacts would be small. Construction would create direct employment
12 for 145 people (vault method) in the peak construction year and 168 indirect jobs (vault method)
13 in the ROI; the annual average employment growth rate would increase by less than 0.1 of a
14 percentage point. The waste facility would produce up to \$12.7 million in income (vault method)
15 in the peak construction year. Up to 64 people would in-migrate to the ROI as a result of
16 employment on-site; in-migration would have only a marginal effect on population growth and
17 require less than 1% of vacant housing in the peak year. Impacts from operating the facility
18 would also be small, creating up to 51 direct jobs (vault method) and up to 45 indirect jobs (vault
19 method) in the ROI annually. The disposal facility would produce up to \$5 million in income
20 annually during operations.

21
22 **Environmental justice.** Because health impacts on the general population within the
23 80-km (50-mi) assessment area during construction and operations would be negligible, no
24 impacts on minority and low-income populations as a result of the construction and operation of
25 a GTCC waste disposal facility are expected.

26
27 **Land use.** The GTCC reference location would be in an area designated as a forest timber
28 unit. This area could be reclassified to accommodate the GTCC waste disposal facility and be
29 considered a developed site. Marketable timber on the site would have to be removed and could
30 be sold.

31
32 **Transportation.** Shipment of all waste to SRS by truck would result in approximately
33 12,600 shipments involving a total distance of 18 million km (11 million mi). To ship all waste
34 by rail would require 5,010 railcar shipments involving 8 million km (5 million mi) of travel. It
35 is estimated that no LCFs would occur to the public or crew members for either mode of
36 transportation, but one fatality from accidents could occur.

37
38 **Cultural resources.** There are seven archaeological sites within the GTCC reference
39 location area at SRS; these sites would require evaluation for listing on the NRHP. Mitigation for
40 eligible sites would be determined through consultation with the South Carolina SHPO and
41 appropriate tribes. Of the two disposal methods considered, the trench method has the least
42 potential to affect cultural resources (especially during the construction phase) because it has the
43 smallest land requirement. Impacts at the source location for soil to cover a vault facility would
44 also be considered.

45

1 **Waste management.** The waste that could be generated from the construction and
2 operations of the land disposal methods is not expected to affect current waste management
3 programs at SRS.
4
5

6 **10.4 CUMULATIVE IMPACTS**

7

8 Section 5.4 presents the methodology for the cumulative impacts analysis. In the analysis
9 that follows, impacts of the proposed action are considered in combination with the impacts of
10 past, present, and reasonably foreseeable future actions. This section begins with a description of
11 reasonably foreseeable future actions at SRS, including those that are ongoing, under
12 construction, or planned for future implementation. Past and present actions are generally
13 accounted for in the affected environment section (Section 10.1).
14
15

16 **10.4.1 Reasonably Foreseeable Future Actions**

17

18 Reasonably foreseeable actions at SRS are summarized in the following sections. These
19 actions were identified primarily from a review of the EIS on the construction and operation of
20 the proposed Mixed Oxide (MOX) Fuel Fabrication Facility at SRS (NRC 2005). The actions
21 listed are planned, under construction, or ongoing and may not be inclusive of all actions at the
22 site. However, they should provide an adequate basis for determining potential cumulative
23 impacts at SRS.
24
25

26 **10.4.1.1 Mixed Oxide Fuel Fabrication Facility**

27

28 In 1999, DOE signed a contract with a consortium (now called Shaw AREVA MOX
29 Services, LLC) to design, build, and operate a MOX Fuel Fabrication Facility in the F-Area at
30 the center of SRS. The facility is a major component of a U.S. program to dispose of surplus
31 weapons-usable plutonium. The 55,742-m² (600,000-ft²) facility consists of two major sections.
32 The first is a five-level section where weapons-usable material will be cleaned and purified via
33 aqueous polishing; the second section is where fabrication will take place. Current material needs
34 for the facility's construction include 129,974 m³ (170,000 yd³) of concrete, 31,751 metric tons
35 or t (35,000 tons) of reinforcing steel, 914,400 linear m (3 million linear ft) of power and control
36 cable, and 128 km (80 mi) of piping. Once operational, the facility will be capable of converting
37 3.5 t (3.9 tons) of weapons-grade plutonium into MOX fuel assemblies each year (NNSA 2008).
38

39 The NRC is responsible for licensing the facility. On March 30, 2005, it issued a
40 construction authorization (NRC 2008). As of 2008, the \$4.8 billion facility employed more than
41 1,000 workers, and it will employ at least 1,000 workers for the next two decades. Construction
42 is expected to last into 2016 (Blanchard 2008).
43
44
45

10.4.1.2 Spent Nuclear Fuel Management

1
2
3 SRS, as an important component of the U.S. nonproliferation program, provides for the
4 safe receipt and interim storage of irradiated SNF assemblies from domestic and foreign test and
5 research reactors. The first off-site fuel was received and stored in February 1997. Since then,
6 fuel has been stored in wet storage facilities. Disassembly basins are located in all five of SRS's
7 reactor areas. Currently, only L-Basin still contains and receives fuel material. Thousands more
8 assemblies are expected to be received and stored in L-Basin in the coming decade. The SNF
9 stored and received at L-Basin may be transferred to H-Canyon for disposition off-site or to INL
10 for storage pending disposition (SRS 2007; DOE 2008).

10.4.1.3 Highly Enriched Uranium

11
12
13 In 1996, DOE published a ROD (61 FR 40619, August 1996) to blend HEU at SRS to
14 4% low-enriched uranium (LEU). Processing the uranium from weapons-usable HEU to LEU
15 makes the material less attractive and supports U.S. nuclear nonproliferation goals. In its HEU
16 blend-down program, SRS blended down approximately 16.7 t (18.4 tons) of HEU into 260.5 t
17 (287.2 tons) of LEU through the site's H-canyon chemical separation facility. This material was
18 provided to the TVA via an Interagency Agreement with DOE. The TVA processed the material
19 into reactor fuel for use in two commercial reactors at the Browns Ferry Nuclear Plant, which
20 produces commercial electrical power in Athens, Alabama. DOE and TVA intend to extend the
21 Interagency Agreement and continue downblending weapons-usable uranium to a
22 non-proliferable form for use in power reactors (DOE 1996, 2002; Savannah River Operations
23 Office 2006).

10.4.1.4 Tritium Extraction Facility

24
25
26
27
28 The SRS's Tritium Extraction Facility (TEF) became fully operational in 2007. The
29 facility, located in H-Area, extracts tritium from target-bearing rods irradiated in commercial
30 light water reactors. Its purpose is to ensure a sustainable supply of tritium for the U.S. nuclear
31 weapons stockpile (WSRC 2008).

32
33
34
35 The TEF consists of three major structures: the Remote Handling Building (RHB),
36 Tritium Processing Building (TPB), and Tritium Support Building (TSB). The RHB is
37 approximately 18-m (60-ft) high, 26-m (86-ft) wide, and 66-m (215-ft) long. It has a truck
38 receiving area, cask decontamination area, tritium-producing burnable absorber rods, waste
39 preparation area, furnaces, hot maintenance area, and glove boxes for extraction pumps and
40 tanks. It also has an overhead crane and RH equipment. The TBP provides preliminary
41 purification of the extracted gases. It is a single-story facility, approximately 38-m (125-ft) wide
42 by 47-m (155-ft) long, and is built above ground. The TPB houses the main control room, crane
43 control room, and miscellaneous rooms for gas analysis and radiation control activities. The TSB
44 houses management and support staff; it also has change rooms, maintenance support areas, and
45 a loading dock (WSRC 2008).

1 The facility was staffed by about 600 workers during construction and has an operations
2 staff of about 100 permanent employees. Shipments of the irradiated rods are received at TEF. In
3 addition, the NNSA is evaluating the optimum mode of operations for the TEF; it will be based
4 on the most efficient use of SRS resources and the changing demands for new tritium to support
5 the nuclear weapons stockpile (WSRC 2008).

6 7 8 **10.4.1.5 Salt Waste Processing Facilities** 9

10 Salt waste processing facilities at SRS use two removal processes: the actinide removal
11 process (ARP) and the modular caustic side solvent extraction unit (MCU). Removing the salt
12 waste, which fills approximately 90% of the tank space in the SRS tank farms, is a major step
13 toward closing SRS's 49 high-level radioactive waste tanks that currently contain about
14 136 million L (36 million gal) of waste. ARP and MCU together make up the interim salt
15 disposition processing system, which decontaminates radioactive salt waste from SRS's waste
16 storage tanks to be safely dispositioned. SRS first received radioactive salt waste solution for
17 processing at the ARP and MCU facilities in April 2008, and it completed a successful test run as
18 the facilities were brought on line in a deliberate, sequenced process to ensure safe operations. In
19 combination with the Saltstone Production Facility and Saltstone Disposal Facility, this approach
20 would treat, decontaminate, and dispose of radioactive salt waste removed from SRS storage
21 tanks (SRS 2008). The Salt Waste Processing Facility (SWPF) is currently being constructed at
22 SRS to treat and immobilize the tank high-level radioactive waste. The SWPF will separate the
23 low-activity and high-activity waste fractions, with the former being solidified in a grout form in
24 the existing Saltstone Production and Disposal Facilities and disposed of on-site in large vaults.
25 The SWPF is scheduled to begin operations in FY 2014 and will replace the ARP and MCU.

26 27 28 **10.4.1.6 Tank Closure** 29

30 DOE has considered alternatives for closing the 49 high-level radioactive waste tanks and
31 associated equipment at SRS, such as evaporator systems, transfer pipelines, diversion boxes,
32 and pump pits. DOE needs to close these tanks to reduce human health and safety risks at and
33 near the waste tanks and to reduce the eventual introduction of contaminants into the
34 environment. DOE has selected the preferred alternative identified in its waste tank closure EIS
35 (DOE 2002), "Stabilize Tanks — Fill with Grout," to help develop and implement the process
36 for closing the tanks and associated equipment at SRS. Following bulk waste removal (as
37 described in Section 11.4.12.5 of DOE 2002), DOE will clean the tanks if necessary to meet the
38 performance objectives contained in the general closure plan and the tank-specific closure
39 module, and then fill the tanks with grout (DOE 2002; WSRC 2007b).

40 41 42 **10.4.1.7 Defense Waste Processing Facility** 43

44 The Defense Waste Processing Facility (DWPF) converts the liquid nuclear waste
45 currently stored at SRS into a solid glass form suitable for long-term storage and disposal. It is
46 the largest such plant in the world. The glassification process, called vitrification, immobilizes

1 radioactivity in glass, thereby reducing the risks associated with the continued storage of liquid
2 nuclear wastes at SRS, and it prepares the waste for ultimate disposal in a federal repository.
3 About 136 million L (36 million gal) of liquid nuclear wastes (in sludge and salt forms) are now
4 stored in 49 underground waste tanks at SRS; the majority of this waste will be vitrified at the
5 DWPF (WSRC 2007c).

6

7 The DWPF vitrifies sludge from waste by mixing a sandlike borosilicate glass, called frit,
8 with the waste and then heating it in a ceramic melter. The molten glass-waste mixture is poured
9 into stainless-steel canisters to cool and harden. Each canister is 3-m (10-ft) tall and 0.6 m (2 ft)
10 in diameter; a filled canister weighs about 2.3 t (5,000 lb). Canisters are welded shut and then
11 sent to storage buildings at SRS, where they are lowered into an underground, reinforced,
12 concrete vault. SRS has the capacity to safely store about 4,400 canisters, a number that
13 represents about 16 to 20 years of canisters at current production rates (although more storage
14 buildings could be built if necessary) (WSRC 2007c).

15

16 Construction of the DWPF began in late 1983, and operations began in March 1996. The
17 DWPF is projected to produce more than 5,000 canisters by the year 2019 (WSRC 2007c).

18

19

20 **10.4.2 Cumulative Impacts from the GTCC Proposed Action at SRS**

21

22 Potential impacts of the proposed action are considered in combination with the impacts
23 of past, present, and reasonably foreseeable future actions. The summary of environmental
24 impacts in Section 10.3 indicates that the potential impacts from the GTCC EIS proposed action
25 (construction and operations of either a trench or vault disposal facility) would be small for all
26 the resource areas evaluated. On the basis of the total impacts (including the reasonably
27 foreseeable future actions summarized in Section 10.4.1) reported in NUREG 1767 (NRC 2005),
28 the additional potential impacts from a GTCC proposed action would not result in the
29 exceedance of any of the thresholds discussed in that report. For example, the annual levels of
30 the criteria pollutants related to air quality reported in NUREG 1767 ranged from 32% (NO₂) to
31 52% (PM₁₀) of the SAAQS standards. It is estimated that the GTCC proposed action would
32 result in no more than 0.16% of the total emissions in the surrounding counties. The highest NO₂
33 level reported for the surrounding counties of 0.004 ppm is 7.5% of the 0.053-ppm SAAQS
34 standard, and the county level at 56 µg/m³ is 37% of the 150-µg/m³ PM₁₀ SAAQS standard.

35

36 A potential long-term impact from a GTCC action would be the groundwater
37 radionuclide concentrations that could result if the integrity of the facility did not remain intact in
38 the distant future. The human health evaluation for the post-closure phase of the proposed action
39 indicates that as much as 1,700 mrem/yr could be incurred by the hypothetical resident farmer
40 assumed to be 100 m (330 ft) from the edge of the disposal facility in about 29 years (trench
41 method) to 54 years (vault method) after failure of the cover and engineered barrier, which is
42 assumed to begin 500 years after the closure of the disposal facility. The estimates are primarily
43 attributable to the GTCC-like RH waste (primary radionuclide contributors include C-14, Tc-99,
44 I-129, and Np-237). The analysis took credit for engineered barriers incorporated to prolong the
45 protectiveness of the facility. The sensitivity analysis that was performed for this EIS indicates
46 that the doses could be reduced more if the receptor was assumed to be farther away from the

1 facility. An annual review of the performance assessment and composite analysis for the E-Area
2 low-level waste facility indicated that the calculated maximum dose to a hypothetical future
3 member of the public would be about 14 mrem/yr (Millings 2009; Swingle 2008). Finally,
4 follow-on NEPA evaluations and documents prepared to support any further considerations of
5 siting a new trench or vault disposal facility at SRS would provide more detailed analyses of site-
6 specific issues, including cumulative impacts.

9 **10.5 SETTLEMENT AGREEMENTS AND CONSENT ORDERS FOR SRS**

10
11 A review of existing settlement agreements and consent orders for SRS did not identify
12 any that would contain requirements that would be affected by Alternatives 4 and 5 for this EIS.

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11 WASTE ISOLATION PILOT PLANT VICINITY: AFFECTED ENVIRONMENT AND CONSEQUENCES OF ALTERNATIVES 3, 4, AND 5

This chapter provides an evaluation of the affected environment, environmental and human health consequences, and cumulative impacts from the disposal of GTCC LLRW and GTCC-like waste under Alternative 3 (in a new borehole disposal facility), Alternative 4 (in a new trench disposal facility), and Alternative 5 (in a new vault disposal facility) at the WIPP Vicinity reference locations. Alternatives 3 to 5 are described in Section 5.1. Environmental consequences common to the sites for which Alternatives 3 to 5 are evaluated (including the WIPP Vicinity locations) are discussed in Chapter 5 and not repeated in this chapter. Impact assessment methodologies used for this EIS are described in Appendix C. Federal and state statutes and regulations and DOE Orders relevant to the WIPP Vicinity locations are discussed in Chapter 13 of this EIS.

11.1 AFFECTED ENVIRONMENT

This section discusses the affected environment for the various environmental resource areas evaluated for the GTCC reference locations at the WIPP Vicinity. One reference location is in Section 27 (inside the WIPP Land Withdrawal Boundary [WIPP LWB]), and the other is in Section 35 (on a parcel of land managed by the BLM just outside the WIPP LWB) (see Figure 11.1-1). Both the reference locations are located within T22S, R31E. These reference locations were selected primarily for evaluation purposes for this EIS. The actual location or locations would be identified on the basis of follow-on evaluations if and when it is decided to locate a land disposal facility at the WIPP Vicinity.

11.1.1 Climate, Air Quality, and Noise

Climate, air quality, and noise conditions at the WIPP Vicinity reference locations (within Sections 27 and 35) are similar to the conditions at the WIPP site described in Section 4.2.1 because of their proximity to each other, so the descriptions are not repeated here.

11.1.2 Geology and Soils

The WIPP Vicinity reference locations occupy two 2.6-km² (1-mi²) or 260-ha (640-ac) parcels: Section 27, which is inside the WIPP LWB, and Section 35, which is outside and immediately adjacent to the southeast corner of the WIPP repository site. Given the close proximity of the WIPP Vicinity reference locations to the WIPP repository site, their regional geologic setting and stratigraphy at the reference locations can be inferred from the extensive data on the WIPP site that are summarized in Section 4.2.2. The text that follows summarizes the site stratigraphy on the basis of the work discussed in Powers (2009), with an emphasis on near-surface formations (above the Rustler Formation) in the vicinity of Sections 27 and 35.

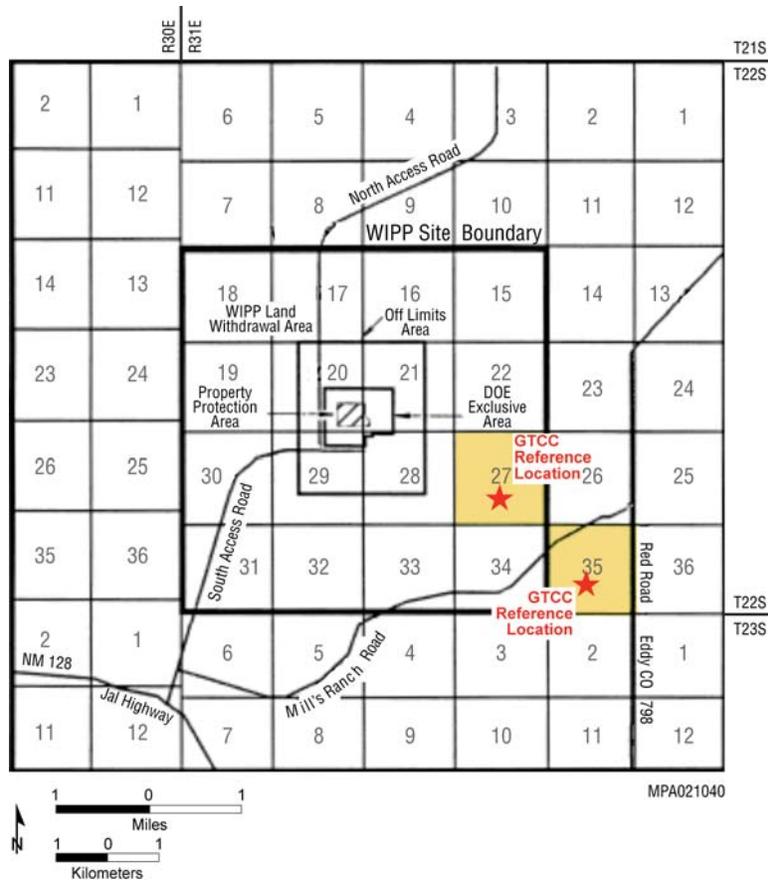


FIGURE 11.1-1 WIPP Vicinity GTCC Reference Locations

The topography across the WIPP Vicinity reference locations exhibits some broad valley forms, possibly indicating areas of concentrated surface runoff and integrated drainages during prolonged rainfall events. Sand dunes are present, but likely thinner and more uniform than local dune fields. Calcrete¹ exposures appear as heavily vegetated semicircular features on aerial photos of Section 35. These are thought to represent intradune areas that focus water drainage and enhance vegetation growth, causing degradation of the underlying calcrete and creating slight topographic depressions. These surface features, however, have no relationship to dissolution or subsidence of deeper evaporite units.

The WIPP Vicinity reference locations are situated on Quaternary age alluvium, playa lake deposits, and semi-stabilized and active dune sands. These deposits compose the majority of surface exposures and most of the shallow subsurface sediments in the WIPP Vicinity region. Just below these deposits is a fairly continuous mantle of caliche (called the Mescalero). The Mescalero caliche is a well-lithified alluvial deposit of chalky, finely crystalline limestone that is fairly continuous across the WIPP site and can be up to 1.8-m (6-ft) thick. It thickens and is more indurated to the east of the site near Sections 27 and 35. There is a caliche borrow pit

¹ Calcrete is a conglomerate of surficial gravel and sand that is cemented by carbonate material.

1 near the southeast corner of Section 35; deposits in the pit indicate the Mescalero is thick and
2 indurated enough to be quarried. Overlying the Mescalero is the Berino soil, a thick, reddish,
3 semiconsolidated sand containing little carbonate, ranging in thickness from centimeters (inches)
4 to 0.3 to 0.6 m (1 to 2 ft).

5
6 The top of the Dewey Lake Formation is at least 15-m (50-ft) deep across both
7 Sections 27 and 35, with depths of more than 30 m (100 ft) expected in Section 27. The
8 overlying Santa Rosa Formation likely occurs within 11 m (35 ft) of the ground surface
9 across both sections, with shallower depths (less than 3 m [10 ft]) expected along the eastern
10 portion of Section 27 and possibly all of Section 35. The Gatuña Formation thins to the east
11 and may be absent along much of the eastern portion of both sections.

12
13 No natural factors within the WIPP Vicinity reference locations that would affect the
14 engineering aspects of slope stability or subsidence have been reported. The presence of the
15 Mescalero caliche is generally considered to be an indicator of surface stability (DOE 1997).

16
17 Liquefaction of saturated sediments is a potential hazard during or immediately following
18 large earthquakes. Whether soils will liquefy depends on several factors, including the magnitude
19 of the earthquake, peak ground velocity, susceptibility of soils to liquefaction, and depth to
20 groundwater. No surface displacement or faulting younger than early Permian has been reported
21 at WIPP, indicating that tectonic movement since then, if any, has not been noteworthy. No
22 mapped Quaternary (last 1.9 million years) or Holocene (last 10,000 years) faults exist closer to
23 the site than the western escarpment of the Guadalupe Mountains, about 100 km (60 mi) to the
24 west-southwest (DOE 1997). The strongest earthquake on record within 290 km (180 mi) of the
25 site was the Valentine, Texas, earthquake of August 16, 1931 (DOE 1997), with an estimated
26 Richter magnitude of 6.4. From 1974 to 2006, recorded earthquakes within a 300-km (184-mi)
27 radius of WIPP ranged from magnitude 2.3 to 5.7 (USGS 2010).

28
29

30 **11.1.3 Water Resources**

31

32 Given the close proximity of the WIPP Vicinity reference locations to the WIPP
33 repository site, the hydrological conditions at the reference locations can be inferred from the
34 extensive amount of information available on the WIPP site, which is summarized in
35 Section 4.2.3. The discussions that are most relevant to the WIPP Vicinity reference locations are
36 those on surface water (Section 4.2.3.1) and those on the aquifer units above the Salado
37 Formation (Section 4.2.3.2.1).

38

39

40 **11.1.4 Human Health**

41

42 The two WIPP Vicinity GTCC reference locations are Section 27 (within the WIPP
43 LWB) and Section 35 (adjacent to the WIPP LWB). The following discussion is based on current
44 operations at WIPP and assumed to be applicable to both reference locations.

45

1 Radiation exposures of the off-site general public could occur as a result of three
2 pathways: (1) air transport, (2) water ingestion, and (3) ingestion of game animals. Of these
3 three pathways, only the air pathway is considered to be credible. Elevated concentrations
4 of radionuclides have not been detected in groundwater or game animals in the site vicinity.
5 In 2008, the whole body dose to the highest-exposed individual from airborne releases was
6 estimated to be less than 9.05×10^{-6} mrem/yr (DOE 2009). This individual was assumed to
7 reside 7.5 km (4.6 mi) west-northwest of the site. A hypothetical individual residing at the site
8 fence line in the northwest sector was estimated to receive a whole body dose of less than
9 7.14×10^{-4} mrem/yr. These values are well below the dose limit of 100 mrem/yr from all
10 exposure pathways set by DOE to protect the general public from the operation of its facilities.
11

12 In 2008, the collective dose to the 101,017 people living within 80 km (50 mi) of WIPP
13 was calculated to be 2.72×10^{-5} rem/yr (DOE 2008). If this dose was distributed uniformly to all
14 individuals living within 80 km (50 mi) of the site, the average dose to each person would be
15 about 2.69×10^{-7} mrem/yr. This is an extremely small fraction of the average dose of
16 620 mrem/yr to members of the general public from exposure to natural background and
17 man-made sources of radiation (NCRP 2009).
18
19

20 **11.1.5 Ecology**

21
22 The description of ecological resources at the WIPP Vicinity reference locations is
23 similar to the description of these resources at the WIPP site, which is provided in Section 4.2.5.
24
25

26 **11.1.6 Socioeconomics**

27
28 Socioeconomic data for the WIPP Vicinity cover the ROI surrounding the reference
29 locations, which is composed of two counties in New Mexico: Eddy County and Lea County.
30 The majority of workers associated with the waste disposal facility at either of the WIPP Vicinity
31 reference locations would reside in these counties (DOE 1997). The socioeconomic data are the
32 same as the data presented in Section 4.2.6 for the WIPP repository.
33
34

35 **11.1.7 Environmental Justice**

36
37 Because of the proximity of the WIPP Vicinity reference locations to the WIPP
38 repository, the effects on environmental justice are the same as those presented for the WIPP
39 repository site under Alternative 2. Figures 4.2.7-1 and 4.2.7-2 and Table 4.2.7-1 show the
40 minority and low-income compositions of the total population located in the 80-km (50-mi)
41 buffer from Census Bureau data for the year 2000 (U.S. Bureau of the Census 2008) and from
42 CEQ guidelines (CEQ 1997). Persons whose incomes fall below the federal poverty threshold
43 are designated as low income. Minority persons are those who identify themselves as Hispanic or
44 Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian
45 or other Pacific Islander, or multi-racial (with at least one race designated as a minority race
46 under CEQ). Individuals who identify themselves as Hispanic or Latino are included in the table

1 as a separate entry. However, because Hispanics can be of any race, this number also includes
2 individuals who also identify themselves as being part of one or more of the population groups
3 listed in the table.

6 **11.1.8 Land Use**

8 The primary land use within the WIPP Vicinity reference location Section 35 is for oil
9 and gas production. The land use description for the WIPP site contains further information
10 applicable to land use within the WIPP site area (including for Section 27) (see Section 4.2.8).
11 Figures 11.1.8-1 and 11.1.8-2 show potash leases in the vicinity of WIPP and the WIPP Vicinity
12 reference locations, and a map of oil wells within 1.6 km (1 mi) of the WIPP LWB, respectively.
13 There are no potash leases on Sections 27 and 35. There is an oil well on Section 35.

16 **11.1.9 Transportation**

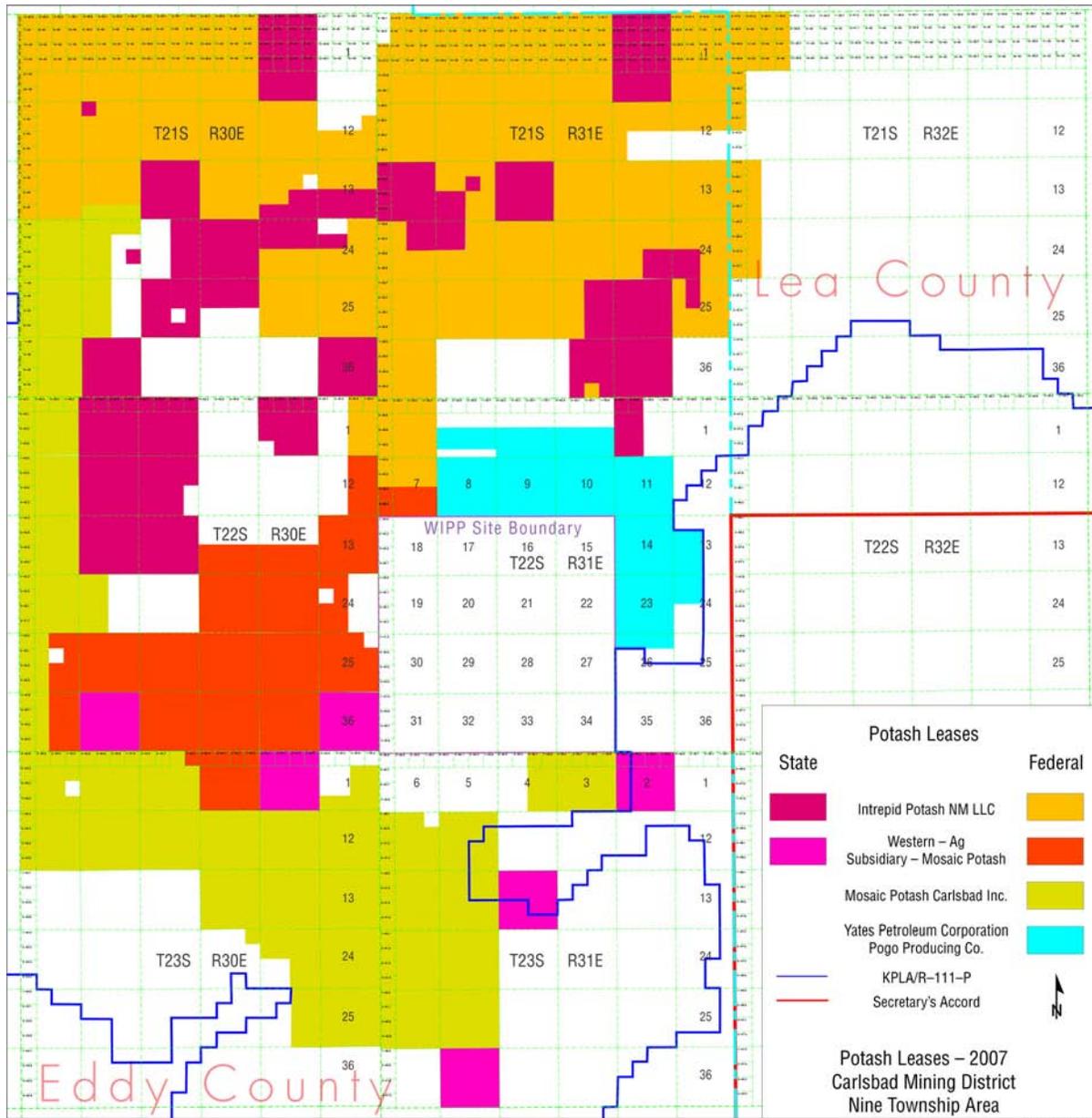
18 Highway access to the WIPP region is by US 285 (north-south) or US 62/180 (northeast-
19 southwest). Both highways pass through Carlsbad, New Mexico. Situated 40 km (25 mi) east of
20 Carlsbad, WIPP can be reached from US 62/180 to the north and from New Mexico SR 128 to
21 the south. The North Access Road from US 62/180 is about 21 km (13 mi) in length and is
22 restricted to official WIPP business or to DOE and BLM personnel, permittees, licensees, or
23 lessees (DOE 2002a). The South Access Road is Eddy County Road 802 originating at SR 128.
24 General public access on Eddy County Road 802 can be restricted at the Off-Limits Area
25 boundary if it is determined that there would be a significant safety risk to WIPP personnel
26 (DOE 2002a). Average daily traffic on the access roads is estimated to be 800 vehicles on the
27 North Access Road and 400 vehicles on the South Access Road (NMED 2007).

29 Rail access to the WIPP Vicinity locations is provided by a rail line that connects with a
30 spur of the Burlington Northern Santa Fe Railroad near Mosaic Potash's Nash Draw Mine,
31 10 km (6 mi) southwest of the site (DOE 2002a).

34 **11.1.10 Cultural Resources**

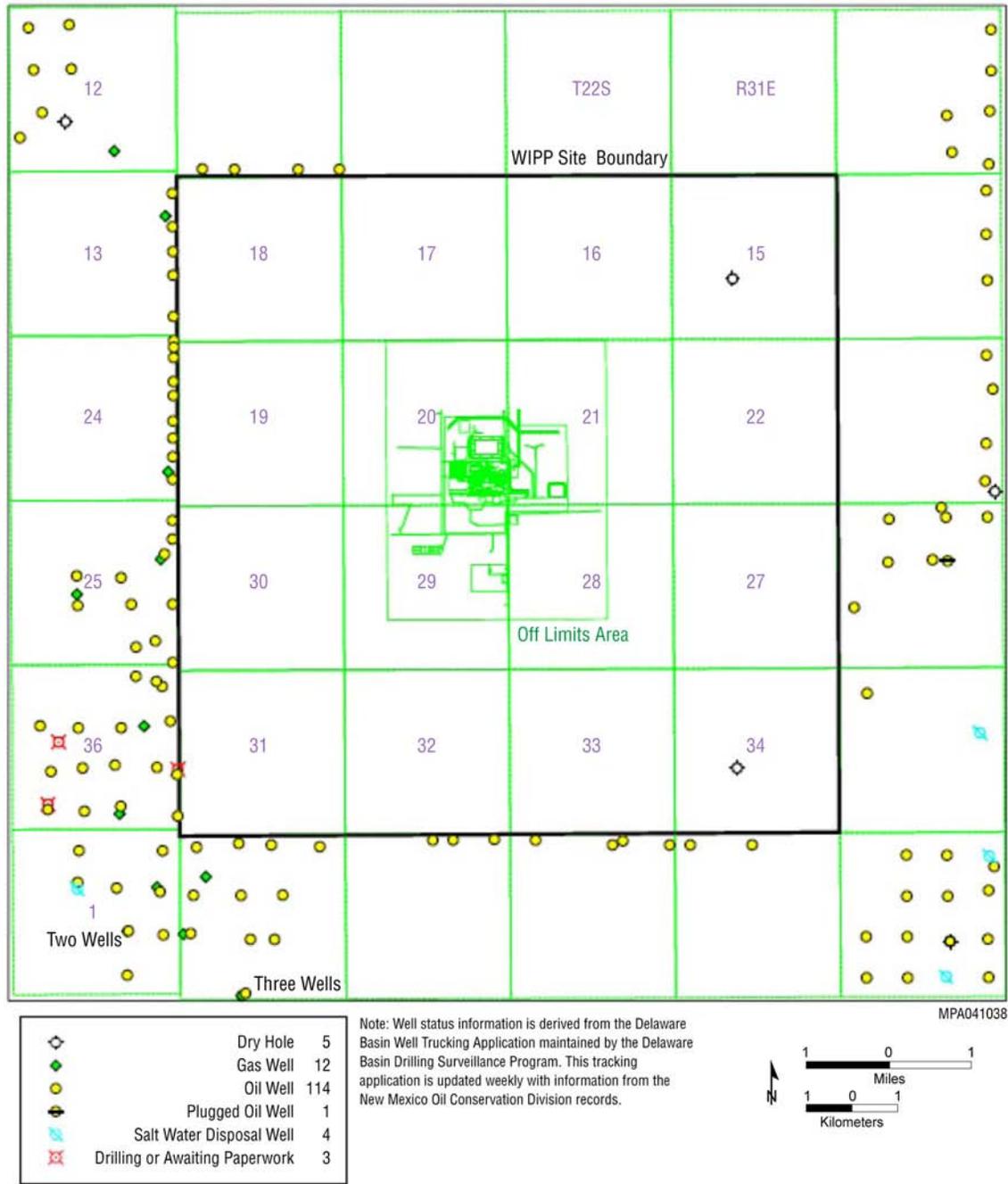
36 Roughly 1,370 ha (3,380 ac) of the 4,140 ha (10,240 ac) managed by WIPP have been
37 surveyed for cultural resources. The surveys identified approximately 60 archaeological sites and
38 90 isolated finds (DOE 2006). The largest survey was done in 1987 by Mariah and Associates.
39 The 1987 survey examined portions of 45 sections surrounding the WIPP facility (DOE 2002a).

41 People have been living in the desert southwest for more than 10,000 years. Prehistoric
42 people tended to live nomadic lifestyles, collecting resources from different areas at different
43 times of the year (DOE 2002a). Most prehistoric archaeological sites in the WIPP area represent
44 short-term use. In the mid 1500s, the Jumano and Apachean people used the area. They collected
45 goods seasonally and traded with nearby Puebloan people. The Spanish were the first Europeans
46 to cross what would become southeastern New Mexico. In historic times, the region was only



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FIGURE 11.1.8-1 Potash Leases in the Vicinity of WIPP (as of 2007)



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FIGURE 11.1.8-2 Map of Oil Wells within 1.6 km (1 mi) of WIPP Land Withdrawal Boundary

1 lightly populated because of a lack of resources. Some ranching took place on the WIPP property
2 during the 1940s and 1950s. Evidence of these activities is still visible in some locations.
3

4 The WIPP Vicinity reference location in Section 27 is in the WIPP LWB, and Section 35
5 is located on BLM-managed land just to the southeast of the WIPP LWB. The majority of
6 Section 27 (T22S, R31E) and the majority of Section 35 (T22S, R31E) have not been examined
7 for the presence of cultural resources. However, some cultural resource surveys were undertaken,
8 and archaeological sites were found in both sections. In Section 27, a cultural resource survey
9 was done for a proposed haul road. The survey identified Site 32632. The site consists of a
10 surface artifact scatter of prehistoric materials. The site appears to represent a short-term
11 occupation site that was revisited several times. On the basis of the pot sherds found at the site,
12 the resource dates to the Jornada Mogollon period (A.D. 900 to 1450) (Hunt 1994). Site 32632
13 was recommended as being potentially eligible for listing on the NRHP. Site 32632 is the only
14 cultural resource currently known to be within Section 27.
15

16 Section 35 was surveyed on several occasions in anticipation of development. Currently
17 there are seven known cultural resources located in Section 35. Of the seven resources, only one,
18 54373, is currently recommended as being potentially eligible for listing on the NRHP. Another
19 site, 83670, has been very heavily impacted by past activities and no longer requires
20 consideration.
21

22 A review of cultural resource information for the region revealed that the Maroon Cliffs
23 Archaeological District is located northeast of WIPP. It is the closest archaeological district to
24 the reference locations. The 4,770-ha (11,780-ac) district contains evidence of habitation ranging
25 from the Archaic period (5000 B.C.) to the Jornada Mogollon (A.D. 900 to 1450) (BLM 1988).
26 Pit houses have been reported among the archaeological sites documented at this location. The
27 district includes a wide variety of topographic features. The district is located roughly 11 km
28 (7 mi) northwest of the project area.
29
30

31 **11.1.11 Waste Management**

32

33 Currently no waste management activities are being conducted at the WIPP Vicinity
34 reference location in Section 35. It is expected that at the WIPP Vicinity reference location in
35 Section 27, the waste management activities for the WIPP repository could accommodate the
36 waste types generated by the land disposal methods (Alternatives 3 to 5), as discussed in
37 Section 5.3.11.
38
39

40 **11.2 ENVIRONMENTAL AND HUMAN HEALTH CONSEQUENCES**

41

42 The potential impacts from the construction, operations, and post-closure of the land
43 disposal methods (borehole, trench, and vault) are presented in this section for the resource areas
44 evaluated. The discussion of the affected environment for the WIPP Vicinity locations is
45 presented in Section 11.1 (and Section 4.2 for some resource areas, as indicated). The WIPP

1 Vicinity locations are shown in Figure 11.1-1. The following sections address the potential
2 environmental and human health consequences for each resource area discussed in Section 11.1.

5 **11.2.1 Climate and Air Quality**

7 This section presents potential climate and air quality impacts that could result from
8 construction, operations, decommissioning, and post-closure of each of the three land disposal
9 alternatives (borehole, trench, and vault) at either of the WIPP Vicinity locations. Noise impacts
10 are presented in Section 5.3.1.

13 **11.2.1.1 Construction**

15 During the construction period, emissions of criteria pollutants (such as SO₂, NO_x, CO,
16 PM₁₀, and PM_{2.5}), VOCs, and the primary greenhouse gas CO₂ would be caused by fugitive
17 dust emissions from earth-moving activities and engine exhaust emissions from heavy equipment
18 and commuter, delivery, and support vehicles. Typically, potential impacts from exhaust
19 emissions on ambient air quality would be smaller than those from fugitive dust emissions.

21 Air emissions of criteria pollutants, VOCs, and CO₂ from construction activities were
22 estimated for the peak year, when site preparation and construction of support facilities and some
23 disposal cells would take place. The estimates are provided in Table 11.2.1-1 for each disposal
24 method. Detailed information on emission factors, assumptions, and emission inventories is
25 presented in Appendix D. As shown in the table, it is estimated that total peak-year emission
26 rates would be rather small when compared with the Eddy County emissions total. Peak-year
27 emissions for all criteria pollutants (except PM₁₀ and PM_{2.5}) and VOCs would be the highest for
28 the vault method, the construction of which would consume more materials and resources than
29 would construction of the other two methods. The borehole method would disturb more area, so
30 its fugitive dust emissions are estimated to be the highest. Peak-year emissions of all pollutants
31 would be the lowest for the trench method, which would disturb the smallest area among the
32 disposal methods. In terms of contribution to the emissions total, the peak-year emissions of NO_x
33 under the vault method would be the highest, about 0.37% of the total county emissions, while
34 emissions of other criteria pollutants and VOCs would be 0.08% or less of the county emissions
35 total.

37 Background concentration levels for PM₁₀ and PM_{2.5} at the WIPP Vicinity reference
38 locations are well below the standards (less than 59% of SAAQS); estimates for PM₁₀ and PM_{2.5}
39 include diesel particulate emissions (Table 4.2.1-2). Construction at the WIPP Vicinity locations
40 could occur within a few tens of meters of the boundary of both sections. Under unfavorable
41 dispersion conditions, high concentrations of PM₁₀ or PM_{2.5} are expected and could exceed the
42 standards at the location boundaries, although such exceedances would be rare. Construction
43 activities would not contribute much to concentrations at the expected nearest residence. These
44 activities would be conducted to minimize the potential impacts of related emissions on ambient
45 air quality. In so doing, where appropriate, fugitive dust would be controlled by established,

TABLE 11.2.1-1 Peak-Year Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Construction of the Three Land Disposal Facilities at the WIPP Vicinity

Pollutant	Total Emissions (tons/yr) ^a	Construction Emissions (tons/yr)					
		Trench		Borehole		Vault	
SO ₂	7,783	0.90	(0.01) ^b	3.0	(0.04)	3.2	(0.04)
NO _x	8,437	8.1	(0.10)	26	(0.31)	31	(0.37)
CO	25,725	3.3	(0.01)	11	(0.04)	11	(0.04)
VOCs	8,222	0.90	(0.01)	2.7	(0.03)	3.6	(0.04)
PM ₁₀ ^c	27,327	5.0	(0.02)	13	(0.05)	8.6	(0.03)
PM _{2.5} ^c	4,744	1.5	(0.03)	4.1	(0.09)	3.6	(0.08)
CO ₂		670		2,200		2,300	
County ^d	1.85×10^6		(0.04)		(0.12)		(0.12)
New Mexico ^e	6.50×10^7		(0.001)		(0.003)		(0.004)
U.S. ^e	6.54×10^9		(0.00001)		(0.00003)		(0.00004)
Worldwide ^e	3.10×10^{10}		(0.000002)		(0.000007)		(0.000007)

^a Total emissions in 2002 for Eddy County, in which WIPP is located. See Table 4.2.1-1 for criteria pollutants and VOCs.

^b As percent of total emissions.

^c Estimates for GTCC construction include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available, so county-level emissions were estimated from available state total CO₂ emissions on the basis of the population distribution.

^e Annual CO₂ emissions in New Mexico, the United States, and worldwide in 2005.

Sources: EIA (2008); EPA (2008, 2009)

1

2

3 standard dust control practices, primarily by watering unpaved roads, disturbed surfaces, and
4 temporary stockpiles, as stipulated in the construction permits.

5

6 Although O₃ levels in Carlsbad, about 42 km (26 mi) west of the WIPP site area, have
7 exceeded the standard (see Table 4.2.1-2), Eddy County, including the WIPP Vicinity GTCC
8 reference locations, is currently in attainment for O₃ (40 CFR 81.332). The WIPP Vicinity
9 GTCC reference locations are located far from any major cities, and O₃ precursor emissions
10 from a disposal facility under all three methods would be relatively small, 0.37% or less and
11 0.04% or less of the county total NO_x and VOC emissions, respectively. The O₃ precursor
12 emissions would be much lower than those from the regional air shed in which emitted
13 precursors are transported and formed into O₃. Accordingly, potential impacts of O₃ precursor
14 releases from construction on regional O₃ would not be of concern.

15

16 The major air quality concern with respect to emissions of CO₂ is that it is a greenhouse
17 gas, which traps solar radiation reflected from the earth, keeping it in the atmosphere. The
18 combustion of fossil fuels makes CO₂ the most widely emitted greenhouse gas worldwide.

1 CO₂ concentrations in the atmosphere have continuously increased, going from approximately
2 280 ppm in preindustrial times to 379 ppm in 2005, a 35% increase. Most of this increase has
3 occurred in the last 100 years (IPCC 2007).

4
5 The climatic impact of CO₂ does not depend on the geographic location of its sources
6 because CO₂ is stable in the atmosphere and is essentially uniformly mixed; that is, the global
7 total is the important factor with respect to global warming. Therefore, a comparison between
8 U.S. and global emissions and the total emissions from the construction of a disposal facility is
9 useful in understanding whether CO₂ emissions from the site are significant with respect to
10 global warming. As shown in Table 11.2.1-1, the highest peak-year amount of CO₂ emissions
11 from construction would be under 0.12%, 0.004%, and 0.00004% of 2005 county, state, and U.S.
12 CO₂ emissions, respectively. In 2005, CO₂ emissions in the United States were about 21% of
13 worldwide emissions (EIA 2008). Potential impacts on climate change from construction
14 emissions would be small.

15
16 An initial construction period of 3.4 years is assumed (see Appendix D). Because the
17 disposal units would be constructed as the waste became available for disposal, the construction
18 phase would be extended over more years. Emissions would thus be lower in nonpeak years than
19 in the peak year, as presented in Table 11.2.1-1. In addition, construction activities would occur
20 only during daytime hours, when air dispersion is most favorable. Accordingly, potential impacts
21 from construction activities on ambient air quality would be minor and intermittent.

22
23 General conformity applies to federal actions taking place in nonattainment or
24 maintenance areas and is not applicable to the proposed action at the WIPP Vicinity locations
25 because the area is classified as being in attainment for all criteria pollutants (40 CFR 81.332).

26 27 28 **11.2.1.2 Operations**

29
30 Criteria pollutants, VOCs, and CO₂ would be released into the atmosphere during
31 operations. These emissions would include fugitive dust emissions from emplacement activities
32 and exhaust emissions from heavy equipment and commuter, delivery, and support vehicles.
33 Estimates of annual emissions of criteria pollutants, VOCs, and CO₂ at the facility are presented
34 in Table 11.2.1-2. Detailed information on emission factors, assumptions, and emission
35 inventories is available in Appendix D. As shown in the table, annual operational emissions are
36 estimated to be lower than those from construction under the borehole method. Annual emissions
37 from operations are about the same for the trench and vault methods but higher than those for the
38 borehole method. Compared with annual emissions for Eddy County, annual emissions of NO_x
39 for the trench and vault methods would be the highest, about 0.32% of the county total, while
40 emissions of other criteria pollutants and VOCs would be about 0.06% or less.

41
42 Except for O₃ and particulates, concentration levels from operational activities are
43 expected to remain well below the standards. Estimates for PM₁₀ and PM_{2.5} include diesel
44 particulate emissions. However, although lower than their impacts during construction, fugitive
45 dust emissions during operations (emplacement of waste) could exceed the standards under
46 unfavorable meteorological conditions. Established fugitive dust control measures (primarily

TABLE 11.2.1-2 Annual Emissions of Criteria Pollutants, Volatile Organic Compounds, and Carbon Dioxide from Operations of the Three Land Disposal Facilities at the WIPP Vicinity

Pollutant	Total Emissions (tons/yr) ^a	Operation Emissions (tons/yr)					
		Trench		Borehole		Vault	
SO ₂	7,783	3.3	(0.04) ^b	1.2	(0.02)	3.3	(0.04)
NO _x	8,437	27	(0.32)	10	(0.12)	27	(0.32)
CO	25,725	15	(0.06)	6.7	(0.03)	15	(0.06)
VOCs	8,222	3.1	(0.04)	1.2	(0.01)	3.1	(0.04)
PM ₁₀ ^c	27,327	2.5	(0.01)	0.91	(0.003)	2.5	(0.01)
PM _{2.5} ^c	4,744	2.2	(0.05)	0.81	(0.02)	2.2	(0.05)
CO ₂		3,200		1,700		3,300	
County ^d	1.85 × 10 ⁶		(0.17)		(0.09)		(0.18)
New Mexico ^e	6.50 × 10 ⁷		(0.005)		(0.003)		(0.005)
U.S. ^e	6.54 × 10 ⁹		(0.00005)		(0.00003)		(0.00005)
Worldwide ^e	3.10 × 10 ¹⁰		(0.00001)		(0.00001)		(0.00001)

^a Total emissions in 2002 for Eddy County, in which WIPP is located. See Table 4.2.1-1 for criteria pollutants and VOCs.

^b As percent of total emissions.

^c Estimates for GTCC operations include diesel particulate emissions.

^d Emission data for the year 2005. Currently, data on CO₂ emissions at the county level are not available, so county-level emissions were estimated from available state total CO₂ emissions on the basis of the population distribution.

^e Annual CO₂ emissions in New Mexico, the United States, and worldwide in 2005.

Sources: EIA (2008); EPA (2008, 2009)

1

2

3 watering unpaved roads, disturbed surfaces, and temporary stockpiles) would be implemented to
4 minimize potential impacts on ambient air quality.

5

6 With regard to regional O₃, precursor emissions of NO_x and VOCs during operations
7 would be comparable to those during construction (about 0.32% and 0.04% of the county total,
8 respectively) and are not anticipated to contribute much to regional O₃ levels. The highest
9 emissions of CO₂ among the three disposal methods would be comparable to the highest
10 construction-related emissions, and thus their potential impacts on climate change would also be
11 negligible. PSD regulations are not applicable to the proposed action because the proposed action
12 is not a major stationary source.

13

14

15 11.2.2 Geology and Soils

16

17 Direct impacts from land disturbance would be proportional to the total area of land
18 disturbed during site preparation activities (e.g., grading and backfilling) and construction of the

1 waste disposal facility and related infrastructure. Land disturbance would include the surface
2 area covered for each disposal method and the vertical displacement of geologic materials for the
3 borehole and trench disposal methods. The increased potential for soil erosion would be an
4 indirect impact of land disturbance at the construction site. Indirect impacts would also result
5 from the consumption of geologic materials (e.g., aggregate) for facility and new road
6 construction. The impact analysis also considers whether the proposed action would preclude the
7 future extraction and use of mineral materials or energy resources.

10 **11.2.2.1 Construction**

11
12 Land surface area disturbance impacts would be a function of the disposal method
13 implemented at the site (Table 5.1-1). Of the three disposal facility layouts, the borehole facility
14 layout would result in the greatest impact in terms of land area disturbed (44 ha or 110 ac). It
15 also would result in the greatest disturbance with depth 40 m (130 ft), with boreholes completed
16 in unconsolidated sand, silt, clay, caliche, and evaporites.

17
18 Geologic and soil material requirements are provided in Table 5.3.2-1. Of the three
19 disposal facilities, the vault facility would require the most material since it would involve the
20 installation of cover systems that use soil material. This material would be considered
21 permanently lost. However, none of the three disposal methods are expected to result in adverse
22 impacts on geologic and soil resources in the WIPP Vicinity reference locations, since these
23 resources are in abundant supply at the site and in the surrounding area.

24
25 No significant changes in surface topography or natural drainages are anticipated in the
26 construction area. However, the disturbance of soil during the construction phase would increase
27 the potential for erosion in the immediate vicinity. This potential would be greatly reduced by the
28 low precipitation rates in the WIPP Vicinity. Mitigation measures also would be implemented to
29 avoid or minimize the risk of erosion.

30
31 The GTCC waste disposal facility would be sited and designed with safeguards to avoid
32 or minimize the risks associated with seismic and volcanic hazards. The WIPP Vicinity is in a
33 seismically active region, and small-magnitude earthquakes (usually less than 3 on the Richter
34 scale) occur frequently. Larger-magnitude earthquakes are probable at the site. New facilities in
35 the WIPP Vicinity would be sited and designed with safeguards to avoid or minimize the risks
36 associated with seismic hazards. The annual probability of a volcanic event is considered to be
37 very low, since the nearest volcanic field is in northwestern New Mexico, and the volcanoes
38 within this field are dormant. The potential for liquefaction and subsidence are also considered to
39 be low, given the deep water table and low precipitation rates in the area.

42 **11.2.2.2 Operations**

43
44 The disturbance of soil and the increased potential for soil erosion would continue
45 throughout the operational phase, because waste would be delivered to the site for disposal over
46 time. The potential for soil erosion would be greatly reduced by the low precipitation rates at the

1 WIPP Vicinity reference locations. Mitigation measures would also be implemented to avoid or
2 minimize the risk of erosion.

3

4 Impacts related to the extraction and use of valuable geologic materials are expected to be
5 low, since only the area within the facility itself would be unavailable for mining or drilling. The
6 WIPP Vicinity reference locations are currently closed to commercial mineral development;
7 however, oil and gas production is currently taking place in Section 35, and potash mining does
8 occur at other sections (especially to the north and southwest). Waste disposal activities in
9 Section 35 would not have adverse impacts on the extraction of economic minerals in the
10 surrounding region.

11

12

13 **11.2.3 Water Resources**

14

15 Direct and indirect impacts on water resources could occur as a result of water use at the
16 proposed GTCC waste disposal facility during construction and operations. Table 5.3.3-1
17 provides an estimate of the water consumption and discharge volumes for the three land disposal
18 methods; Tables 5.3.3-2 and 5.3.3-3 summarize the impacts from water use (in terms of change
19 in annual water use) on water resources that would occur during construction and normal
20 operations, respectively. A discussion of potential impacts during each project phase is presented
21 in the following sections. In addition, contamination due to potential leaching of radionuclides
22 from the waste inventory into groundwater could occur, depending on the post-closure
23 performance of the land disposal facilities discussed in Section 11.2.4.2.

24

25

26 **11.2.3.1 Construction**

27

28 Of the three types of land waste disposal facilities considered for the WIPP Vicinity
29 reference locations, a vault facility would require the greatest amount of water during
30 construction (Table 5.3.3-1). Water demands for construction at the WIPP Vicinity reference
31 locations would be met by using groundwater piped in from off-site wells within the city of
32 Carlsbad's water supply system. There are no surface water bodies at the site, and no surface
33 water would be used during construction. As a result, no direct or indirect impacts on surface
34 water resources are expected. The WIPP Vicinity reference locations are not located within
35 100-year or 500-year floodplains.

36

37 Currently, no water is used at the WIPP Vicinity reference locations. The Carlsbad
38 Double Eagle South Well Field supplies water to the WIPP repository site to the south; its annual
39 water production is about 1.4 million L (360 million gal). Construction of the proposed GTCC
40 waste disposal facility would increase the pumpage for the Double Eagle water system by a
41 maximum of about 0.24% (vault method) (Table 5.3.3-2). Because increased withdrawals of
42 groundwater would be relatively small, they would be easily accommodated by the Double Eagle
43 water system. The 61-cm (24-in.) pipeline that carries water from this water system to the WIPP
44 repository site has the capacity to transport the increased volume of water effectively. The
45 increase in the water volume needed would be relatively small, and impacts on the water table
46 elevation and any change in the direction of groundwater flow would be negligible.

47

1 Disposal of waste (including sanitary waste) generated during construction of the land
2 disposal facilities would have a negligible impact on the quality of water resources at the WIPP
3 Vicinity locations. The potential for indirect surface water or groundwater impacts related to
4 spills at the surface would be reduced by implementing good industry practices and mitigation
5 measures.

6 7 8 **11.2.3.2 Operations** 9

10 Of the three land waste disposal facilities considered for the WIPP Vicinity reference
11 locations, the trench and vault facilities would require the most water during operations
12 (Table 5.3.3-1). Water demands for operations at the WIPP Vicinity reference locations would be
13 met by using groundwater from the Carlsbad water supply system. There are no surface water
14 bodies at the site, and no surface water would be used during operations. As a result, no direct or
15 indirect impacts on surface water resources are expected. The GTCC WIPP Vicinity reference
16 locations are not located within 100-year or 500-year floodplains.

17
18 Operations of the proposed GTCC waste disposal facility would increase the overall
19 demand on the Double Eagle water system by about 0.39% (Table 5.3.3-3). Because withdrawals
20 of groundwater would be relatively small, they would be easily accommodated by the Double
21 Eagle water system. The increased water demand would slightly lower the existing water table
22 below the well fields. However, because the volume increase would be relatively small, impacts
23 on the water table elevation and any change in the direction of groundwater flow would be
24 negligible.

25
26 Disposal of waste (including sanitary waste) generated during operations of the land
27 disposal facilities would have a negligible impact on the quality of water resources at the WIPP
28 Vicinity reference locations. The potential for indirect surface water or groundwater impacts
29 related to spills at the surface would be reduced by implementing good industry practices and
30 mitigation measures.

31 32 33 **11.2.4 Human Health** 34

35 Potential impacts on members of the general public and the involved workers from the
36 construction and operations associated with the land disposal facilities are expected to be
37 comparable for all of the sites evaluated in this EIS for the land disposal methods. These impacts
38 are discussed in Section 5.3.4. The following sections discuss the impacts from hypothetical
39 facility accidents associated with waste handling activities and the impacts during the long-term
40 post-closure phase. They address impacts on members of the general public who might be
41 affected by these waste disposal activities at the WIPP Vicinity reference locations, since these
42 impacts would be site dependent but are expected to be the same for both sections (27 and 35).

11.2.4.1 Facility Accidents

1
2
3 Data on the estimated human health impacts from hypothetical accidents at a land GTCC
4 waste disposal facility located at a WIPP Vicinity reference location are provided in
5 Table 11.2.4-1. The accident scenarios are discussed in Section 5.3.4.2.1 and Appendix C. A
6 reasonable range of accidents that included operational events and natural causes was analyzed.
7 The impacts presented for each accident scenario are for the sector with the highest impacts, and
8 no protective measures are assumed; therefore, the impacts represent the maximum expected for
9 such an accident.

10
11 The collective population dose includes exposure from inhalation of airborne radioactive
12 material, external exposure from radioactive material deposited on the ground, and ingestion of
13 contaminated crops. The exposure period is considered to last for 1 year immediately following
14 the accidental release. It is recognized that interdiction of food crops would likely happen if a
15 significant release did occur, but many stakeholders are interested in what could happen without
16 interdiction. For the accidents involving CH waste (see Accidents 1–9, 11, and 12 on
17 Table 11.2.4-1), the ingestion dose accounted for about 20% of the collective population dose
18 shown in Table 11.2.4-1. External exposure was found to be negligible in all cases. All
19 exposures were dominated by the inhalation dose from the passing plume of airborne radioactive
20 material downwind of the hypothetical accident immediately following release.

21
22 The highest estimated impact on the general public, 7.0 person-rem, would be from a
23 hypothetical release from an SWB caused by a fire in the Waste Handling Building (Accident 9).
24 The Waste Handling Building discussed in Chapter 11 is hypothetical and does not refer to the
25 Waste Handling Building or WHB that currently exists at the nearby WIPP geologic repository
26 facility. Such a dose is not expected to lead to any additional LCFs in the population. This dose
27 would be to the 28,800 people living west of the facility, resulting in an average dose of about
28 0.0002 rem per person. Because this dose would be from internal intake (primarily inhalation,
29 with some ingestion) and because the DCFs used in this analysis are for a 50-year CEDE, this
30 dose would be accumulated over the course of 50 years.

31
32 The dose to an individual (expected to be a noninvolved worker) includes exposure from
33 inhalation of airborne radioactive material and 2 hours of exposure to radioactive material
34 deposited on the ground. As shown in Table 11.2.4-1, the highest estimated dose to an
35 individual, 7.5 rem, would be for Accident 9 from inhalation exposure immediately after the
36 postulated release. This estimated dose would be to a hypothetical individual located 100 m
37 (330 ft) north-northeast or east-southeast of the accident location. As discussed above, the
38 estimated dose of 7.5 rem would be accumulated over a 50-year period after intake; it is not
39 expected that it would result in symptoms of acute radiation syndrome. A maximum annual dose
40 of about 5% of the total dose would occur in the first year. The increased lifetime probability of a
41 fatal cancer for this individual would be about 0.5% on the basis of a total dose of 7.5 rem.
42

TABLE 11.2.4-1 Estimated Radiological Human Health Impacts from Hypothetical Facility Accidents at the WIPP Vicinity Reference Locations^a

Accident No.	Accident Scenario	Off-Site Public		Individual ^b	
		Collective Dose (person-rem)	Latent Cancer Fatalities ^c	Dose (rem)	Likelihood of LCF ^c
1	Single drum drops, lid failure in Waste Handling Building	0.00015	<0.0001	0.00017	<0.0001
2	Single SWB drops, lid failure in Waste Handling Building	0.00035	<0.0001	0.00038	<0.0001
3	Three drums drop, puncture, lid failure in Waste Handling Building	0.00027	<0.0001	0.0003	<0.0001
4	Two SWBs drop, puncture, lid failure in Waste Handling Building	0.00049	<0.0001	0.00053	<0.0001
5	Single drum drops, lid failure outside	0.15	<0.0001	0.17	<0.0001
6	Single SWB drops, lid failure outside	0.35	0.0002	0.38	0.0002
7	Three drums drop, puncture, lid failure outside	0.27	0.0002	0.3	0.0002
8	Two SWBs drop, puncture, lid failure outside	0.49	0.0003	0.53	0.0003
9	Fire inside the Waste Handling Building, one SWB assumed to be affected	7	0.004	7.5	0.005
10	Single RH waste canister breach	<0.0001	<0.0001	<0.0001	<0.0001
11	Earthquake affects 18 pallets, each with 4 CH drums	4.3	0.003	4.8	0.003
12	Tornado, missile hits one SWB, contents released	1.4	0.0008	1.5	0.0009

^a CH = contact-handled, RH = remote-handled, LCF = latent cancer fatality, SWB = standard waste box. The Waste Handling Building discussed in this chapter is hypothetical and does not refer to the Waste Handling Building or WHB that currently exists at the nearby WIPP geologic repository facility.

^b The individual receptor is assumed to be 100 m (330 ft) downwind from the release point. This individual is expected to be a noninvolved worker.

^c LCFs are calculated by multiplying the dose by the health risk conversion factor of 0.0006 fatal cancer per person-rem (see Section 5.2.4.3). LCF values are rounded to one significant figure.

11.2.4.2 Post-Closure

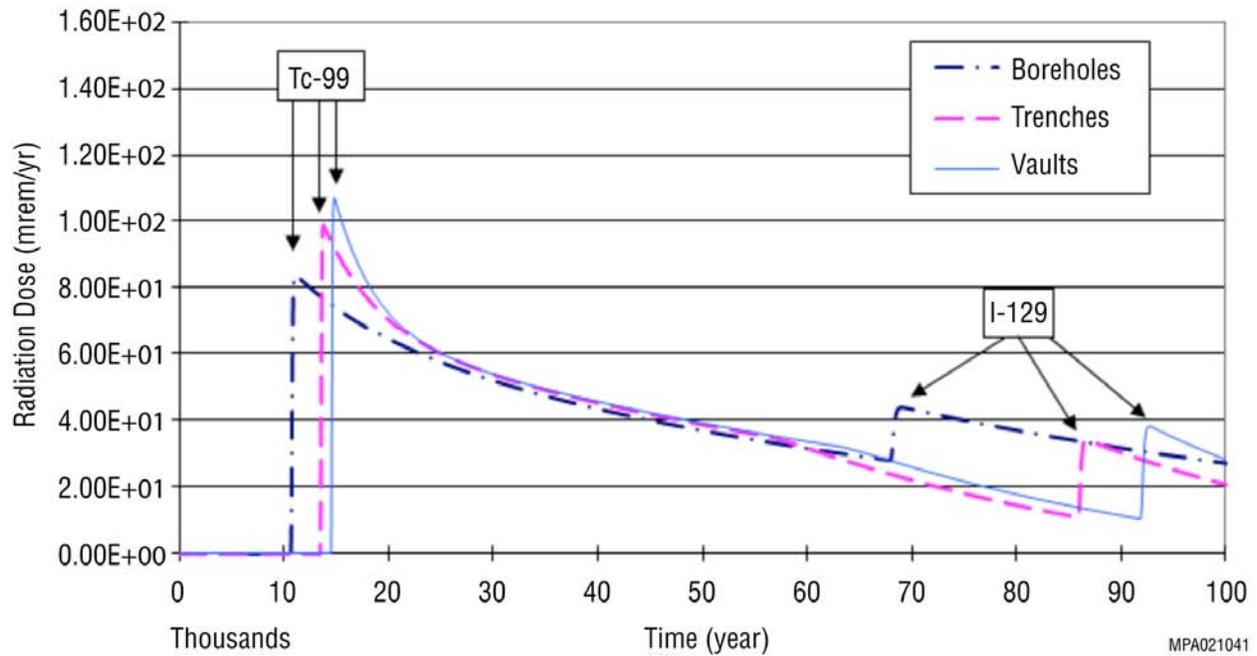
1 **11.2.4.2 Post-Closure**
2
3 The potential radiation dose from airborne releases of radionuclides to the off-site public
4 after the closure of a waste disposal facility would be small. RESRAD-OFFSITE calculation
5 results indicate that there would be no measurable exposure from this pathway from a borehole
6 facility. Small radiation exposures are estimated to occur from use of the trench and vault
7 disposal methods. The potential inhalation dose at a distance of 100 m (330 ft) from the disposal
8 facility is estimated to be less than 1.8 mrem/yr for trench disposal and 0.52 mrem/yr for vault
9 disposal. The potential radiation exposures would be caused mainly by inhalation of radon gas
10 and its short-lived progeny.

11
12 The use of boreholes would provide better protection against potential exposures from
13 airborne releases of radionuclides because of the greater depth of cover material involved. The
14 top of the waste placement zone of the boreholes would be 30 m (100 ft) bgs, and this depth of
15 overlying soil would inhibit the diffusion of radon gas, CO₂ gas (containing C-14), and tritium
16 (H-3) water vapor to the atmosphere above the disposal area. However, because the distance to
17 the groundwater table would be closer under the borehole method than under the trench and vault
18 methods, radionuclides that leached out from wastes in the boreholes would reach the
19 groundwater table in a shorter time than would radionuclides that leached out from a trench or
20 vault disposal facility.

21
22 On the basis of the RESRAD-OFFSITE calculation results, within 10,000 years, no
23 radiation exposure would be incurred by a hypothetical resident farmer living 100 m (330 ft)
24 from the disposal facility as a result of using groundwater. Potential exposure could occur after
25 10,000 years and would be caused mainly by I-129 and Tc-99 that reached the groundwater
26 table. Transport times needed by other radionuclides to reach the groundwater table would be
27 longer than 100,000 years as a result of their greater retardation in the soil.

28
29 Figure 11.2.4-1 shows the temporal plot of the radiation doses associated with the use
30 of contaminated groundwater for a time frame extended to 100,000 years under the three
31 land disposal methods. The late occurrence of radiation exposure associated with the use of
32 contaminated groundwater is attributed to a small natural water infiltration rate (0.2 cm/yr or
33 0.08 in./yr) and a deep groundwater table of about 150 m (500 ft). The peak annual doses
34 are calculated to be 84 mrem/yr for use of boreholes, 99 mrem/yr for use of trenches, and
35 110 mrem/yr for use of the vault disposal method. These peak annual doses are estimated to
36 occur in about 11,000 years, 14,000 years, and 15,000 years for the borehole, trench, and vault
37 methods, respectively. Most of this dose would be from Tc-99 and associated with the
38 GTCC LLRW activated metal waste and GTCC-like Other Waste - RH. There is a high degree
39 of uncertainty associated with results like these, which are for such a long time of analysis.

40
41 The results given here are assumed to be conservative because the location selected for
42 the residential exposure is 100 m (330 ft) from the edge of the disposal facility. Use of a longer
43 distance, which might be more realistic for the sites being evaluated, would significantly lower
44 these estimated doses (i.e., by as much as 70%). A sensitivity analysis performed to determine
45 the effect of a distance longer than 100 m (330 ft) is presented in Appendix E.



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1

2 **FIGURE 11.2.4-1 Temporal Plot of Radiation Doses Associated with the Use of Contaminated**
 3 **Groundwater within 100,000 Years of Disposal for the Three Land Disposal Methods at the**
 4 **WIPP Vicinity**

5

6

7

8 These analyses assume that engineering controls would be effective for 500 years
 9 following closure of the disposal facility. This means that essentially no infiltrating water would
 10 reach the wastes from the top of the disposal units during the first 500 years. It is assumed that
 11 after 500 years, the engineered barriers would begin to degrade, allowing infiltrating water to
 12 come in contact with the disposed-of wastes. For purposes of analysis in the EIS, it is assumed
 13 that the amount of infiltrating water that would contact the wastes would be 20% of the site-
 14 specific natural infiltration rate for the area, and that the water infiltration rate around and
 15 beneath the disposal facilities would be 100% of the natural rate for the area. This approach is
 16 assumed to be conservative because it is expected that the engineered systems (including the
 17 disposal facility cover) would last longer than 500 years, even in the absence of active
 18 maintenance measures.

18

19

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It is assumed that the Other Waste would be stabilized with grout or other material and that this stabilizing agent would be effective for 500 years. Consistent with the assumptions used for engineering controls, no credit was taken for the effectiveness of this stabilizing agent after 500 years in this analysis. That is, it is assumed that any water that would contact the wastes after 500 years would be able to leach radioactive constituents from the disposed-of materials. These radionuclides could then move with the percolating groundwater to the underlying groundwater system. This scenario is assumed to be conservative because grout or other stabilizing materials could retain their integrity for longer than 500 years.

The radiation doses presented in the post-closure assessment in this EIS are intended to be used for comparing the performance of each land disposal method at each site evaluated. The

1 results indicate that the use of robust engineering designs and redundant measures (e.g., types
2 and thicknesses of covers and long-lasting grout) in the disposal facility could delay the potential
3 release of radionuclides and could reduce any releases to very low levels, thereby minimizing
4 potential groundwater contamination and associated human health impacts in the future. DOE
5 will consider the potential doses to the hypothetical farmer and other factors in developing the
6 preferred alternative, as discussed in Section 2.9.

9 **11.2.5 Ecology**

10
11 Section 5.3.5 presents an overview of the potential impacts on ecological resources from
12 the construction, operations, and post-closure maintenance of the GTCC waste disposal facility,
13 regardless of the location selected for the facility. This section evaluates the potential impacts of
14 the GTCC waste disposal facility on the ecological resources at the WIPP Vicinity reference
15 locations at Sections 27 and 35.

16
17 It is not expected that the initial loss of shrub-dominated sand dune habitat, followed by
18 the eventual establishment of low-growth vegetation on the disposal site, would create a long-
19 term reduction in the local or regional ecological diversity. After closure of the GTCC waste
20 disposal site, the cover would be planted with annual and perennial grasses and forbs. As
21 appropriate, regionally native plants would be used to landscape the disposal site in accordance
22 with “Guidance for Presidential Memorandum on Environmentally and Economically Beneficial
23 Landscape Practices on Federal Landscaped Grounds” (EPA 1995). Priority would be given to
24 native plant species that are conducive to soil stabilization and to wildlife needs. A revegetation
25 program would also be recommended in order to minimize the potential for nonnative species to
26 become established at the site.

27
28 Since wetlands do not occur within the area of the WIPP Vicinity reference locations,
29 direct impacts on wetlands from construction, operations, and post-closure of the GTCC waste
30 disposal facility would not occur. However, wetland plants could potentially develop along the
31 borders of the GTCC waste disposal facility retention pond, and depending on the slope of the
32 pond margins and the amount and length of time that the pond would retain water, the shoreline
33 areas of the pond might function in a manner similar to that of a natural emergent wetland.

34
35 DOE’s objectives for managing wildlife habitat within the WIPP land withdrawal area
36 include the protection and maintenance of (1) crucial habitats for big game, upland game birds,
37 and raptors; (2) crucial habitats for nongame species of special interest and concern to state or
38 federal agencies; and (3) habitats for federally or state-listed species identified as inhabiting the
39 land within the WIPP LWB (DOE 2002a). DOE’s objectives for managing wildlife habitat at the
40 WIPP Vicinity reference locations would be similar.

41
42 Because no aquatic habitats occur within the immediate area of the WIPP Vicinity
43 reference locations, impacts on aquatic biota are not expected. DOE would use appropriate
44 erosion control measures to minimize off-site movement of soils. The GTCC waste disposal
45 facility stormwater retention pond is not expected to become a highly productive aquatic habitat.
46 However, depending on the amount of water and length of time that water would be retained in

1 the pond, aquatic invertebrates could become established within it. Waterfowl, shorebirds, and
2 other birds might also make use of the retention pond, as would mammal species that might enter
3 the site.

4
5 None of the endangered, threatened, and other special-status species listed in
6 Table 4.2.5-1 have been observed in the WIPP Vicinity (DOE 1997). However, favorable habitat
7 for the lesser prairie-chicken (*Tympanuchus pallidicinctus*), a federal candidate species, does
8 occur within the WIPP Vicinity reference locations, although Section 35 appears to provide a
9 less favorable habitat than do the sections north of it (BLM 2008). One measure for minimizing
10 potential impacts on wildlife is the establishment of periods during which off-site field activities
11 may not be performed during the species' breeding season. Also, special seed mixes for
12 replanting disturbed areas identified by BLM are used where possible to preserve lesser prairie-
13 chicken habitat (BLM 2008). Similar measures would be enacted for the GTCC waste disposal
14 facility. Because only a small proportion of the sand dune habitat within the area would be
15 affected by the GTCC waste disposal facility, it is not expected that there would be a population-
16 level impact on the lesser prairie-chicken.

17
18 Among the goals of the waste management mission at DOE sites is to maintain disposal
19 facilities in a manner that protects the environment and complies with regulations (DOE 2002b).
20 Therefore, potential impacts on ecological resources from the GTCC waste disposal facility
21 would be minimized and mitigated.

22 23 24 **11.2.6 Socioeconomics**

25 26 27 **11.2.6.1 Construction**

28
29 The potential socioeconomic impacts from constructing a GTCC waste disposal facility
30 would be small for all disposal methods. Construction activities would create direct employment
31 of 47 people (borehole method) to 145 people (vault method) in the peak construction year and
32 an additional 58 indirect jobs (trench method) to 152 indirect jobs (vault method) in the ROI
33 (Table 11.2.6-1). Construction activities would constitute less than 1% of the total ROI
34 employment in the peak year. A GTCC waste disposal facility would produce between
35 \$4.4 million in income (trench method) and \$11.7 million in income (vault method) in the peak
36 year of construction.

37
38 In the peak year of construction, between 41 people (borehole method) and 127 people
39 (vault method) would in-migrate to the ROI (Table 11.2.6-1) as a result of employment on-site.
40 In-migration would have only a marginal effect on population growth and would require up to
41 2% of vacant housing in the peak year. No significant impact on public finances would occur as
42 a result of in-migration; up to four local public service employees would be required to maintain
43 existing levels of service in the various local public service jurisdictions in the ROI. In addition,
44 on-site employee commuting patterns would have a small to moderate impact on levels of
45 service in the local transportation network surrounding the site.

TABLE 11.2.6-1 Effects of GTCC Waste Disposal Facility Construction and Operations on Socioeconomics at the ROI for the WIPP Vicinity^a

Impact Category	Trench		Borehole		Vault	
	Construction	Operations	Construction	Operations	Construction	Operations
Employment (number of jobs)						
Direct	62	48	47	38	145	51
Indirect	58	37	78	32	152	38
Total	120	85	125	70	297	89
Income (\$ in millions)						
Direct	2.2	3.2	1.9	2.6	6.0	3.4
Indirect	2.2	1.3	3.3	1.2	5.7	1.4
Total	4.4	4.5	5.2	3.8	11.7	4.8
Population (number of new residents)	55	4	41	3	127	4
Housing (number of units required)	27	2	21	2	63	2
Public finances (% impact on expenditures)						
Cities and counties ^b	<1	<1	<1	<1	<1	<1
Schools ^c	<1	<1	<1	<1	<1	<1
Public service employment (number of new employees)						
Local government employees ^d	1	0	1	0	2	0
Teachers	1	0	1	0	2	0
Traffic (impact on current levels of service)	Small	Small	Small	Small	Moderate	Small

^a Impacts shown are for waste facility and support buildings in the peak year of construction and the first year of operation.

^b Includes impacts that would occur in the cities of Artesia, Carlsbad, Loving, Eunice, Hobbs, Jal, Lovington, and Tatum and in Eddy and Lea Counties.

^c Includes impacts that would occur in the Artesia, Carlsbad, Loving, Eunice, Hobbs, Jal, Lovington, and Tatum school districts.

^d Includes police officers, paid firefighters, and general government employees.

11.2.6.2 Operations

The potential socioeconomic impacts from operating a GTCC waste disposal facility would be small for all disposal methods. Operational activities would create about 38 direct jobs (borehole method) to 51 direct jobs (vault method) annually and an additional 32 indirect jobs (borehole method) to 38 indirect jobs (vault method) in the ROI (Table 11.2.6-1). A GTCC waste disposal facility would also produce between \$3.8 million in income (borehole method) and \$4.8 million in income (vault method) annually during operations.

Three to four people would move to the area at the beginning of operations (Table 11.2.6-1). However, in-migration would have only a marginal effect on population growth and would require less than 1% of vacant owner-occupied housing during facility operations. No significant impact on public finances would occur as a result of in-migration, and no new local public service employees would need to be hired in order to maintain existing levels of service in the various local public service jurisdictions in the ROI. In addition, on-site employee commuting patterns would have only a small impact on levels of service in the local transportation network surrounding the site.

11.2.7 Environmental Justice

11.2.7.1 Construction

No radiological risks and only very low chemical exposure and risk are expected during construction of a trench, borehole, or vault facility. Chemical exposure during construction would be limited to airborne toxic air pollutants at less than standard levels and would not result in any adverse health impacts. Since the health impacts from each facility on the general population within the 80-km (50-mi) assessment area during construction would be negligible, impacts from construction of each facility on the minority and low-income population would not be significant.

11.2.7.2 Operations

Because incoming GTCC waste containers would only be consolidated for placement in trench, borehole, and vault facilities, with no repackaging necessary, there would be no radiological impacts on the general public during operations, nor would there be any adverse health effects on the general population. In addition, no surface releases that might enter local streams or interfere with subsistence activities by low-income or minority populations would occur. Because the health impacts of routine operations on the general public would be negligible, it is expected that there would be no disproportionately high and adverse impacts on minority or low-income population groups within the 80-km (50-mi) assessment area. Subsequent NEPA analysis to support any GTCC implementation would consider any unique exposure pathways (such as subsistence fish, vegetation, or wildlife consumption or well water use) to determine any additional potential adverse health and environmental impacts.

11.2.7.3 Accidents

A GTCC waste release at any of the facilities could cause LCFs in the surrounding area. However, it is highly unlikely that such an accident would occur. Therefore, the risk to any population, including low-income and minority communities, is considered to be low. In the unlikely event of a release from the GTCC waste facility, the communities most likely to be affected could be minority or low-income, given the demographics within 80 km (50 mi) of the WIPP Vicinity reference locations.

If an accident that produced significant contamination occurred, appropriate measures would be taken to ensure that the impacts on low-income and minority populations would be minimized. The extent to which low-income and minority population groups would be affected would depend on the amount of material released and the direction and speed at which airborne material was dispersed from any of the facilities by the wind. Although the overall risk would be very small, the greatest short-term risk of exposure following an airborne release and the greatest one-year risk would be to the population groups residing to the west of the site (see Section 11.2.4.1. Airborne releases following an accident would likely have a larger impact on the area than would an accident that released contaminants directly into the soil surface.

Monitoring of contaminant levels in soil and surface water following an accident would provide the public with information on the extent of any contaminated areas. Analysis of contaminated areas to decide how to control the use of high-health-risk areas would reduce the potential impact on local residents.

11.2.8 Land Use

Section 5.3.8 presents an overview of the potential land use impacts that could result from the GTCC waste disposal facility, regardless of the location selected for the facility. This section evaluates the potential impacts from the GTCC waste disposal facility on land use at the WIPP Vicinity reference locations.

Use of the WIPP Vicinity reference location Section 27 would have to be considered against requirements described in the WIPP Land Withdrawal Act (LWA). Use of the WIPP Vicinity reference location Section 35 for disposal of GTCC wastes would alter the current land use of up to 44 ha (110 ac) from multiple use to use by a waste disposal facility. DOE would consider existing lease holders in determining implementability at Section 35. A loss of about 0.2% of a 22,493-ha (55,581-ac) grazing allotment would also occur.

As was the case for the WIPP repository, the land (in Section 35) would be permanently withdrawn from all forms of entry, appropriation, and disposal under the public land laws and reserved for uses associated with the purposes of the GTCC waste disposal facility. DOE would prepare a land management plan, as appropriate, and provide opportunities for the public and for federal, state, and local agencies to participate in the land use planning. Land use on areas surrounding the WIPP Vicinity locations is not expected to be affected. Future land use activities that would be permitted within or immediately adjacent to the GTCC waste disposal facility

1 would be limited to those that would not jeopardize the integrity of the facility, create a security
2 risk, or create a worker or public safety risk.

5 **11.2.9 Transportation**

7 The transportation impacts of all GTCC LLRW and GTCC-like waste for disposal at the
8 WIPP Vicinity reference locations was evaluated. As discussed in Section 5.2.9, transportation of
9 all cargo is considered for both truck and rail modes of transport as separate options for the
10 purposes of this EIS. Transportation impacts are expected to be the same for the borehole, trench,
11 and vault methods because the same type of transportation packaging would be used regardless
12 of the disposal method. In addition, it is expected that impacts for both Sections 27 and 35 would
13 be the same because the transportation routes would be similar.

15 As discussed in Appendix C, Section C.9, the impacts of transportation were calculated in
16 three areas: (1) collective population risks during routine conditions and accidents
17 (Section 11.2.9.1), (2) radiological risks to individuals receiving the highest impacts during
18 routine conditions (Section 11.2.9.2), and (3) consequences to individuals and populations after
19 the most severe accidents involving a release of radioactive or hazardous chemical material
20 (Section 11.2.9.3).

22 Radiological impacts during routine conditions are a result of human exposure to the low
23 levels of radiation near the shipment. The regulatory limit established in 49 CFR 173.441
24 (Radiation Level Limitations) and 10 CFR 71.47 (External Radiation Standards for All
25 Packages) to protect the public is 0.1 mSv/h (10 mrem/h) at 2 m (6 ft) from the outer lateral sides
26 of the transport vehicle. This dose rate corresponds roughly to 14 mrem/h at 1 m (3 ft). As
27 discussed in Appendix C, Section C.9.4.4, the external dose rates for CH shipments to the WIPP
28 Vicinity locations are assumed to be 0.5 and 1.0 mrem/h at 1 m (3 ft) for truck and rail
29 shipments, respectively. For shipments of RH waste, the external dose rates are assumed to be
30 2.5 and 5.0 mrem/h at 1 m (3 ft) for truck and rail shipments, respectively. These assignments are
31 based on shipments of similar types of waste. Dose rates from rail shipments are approximately
32 double the rates for truck shipments because rail shipments are assumed to have twice the
33 number of waste packages as a truck shipment. Impacts from accidents depend on the amount of
34 radioactive material in a shipment and the fraction that is released if an accident occurs. The
35 parameters used in the transportation accident analysis are described further in Appendix C,
36 Section C.9.4.3.

39 **11.2.9.1 Collective Population Risk**

41 The collective population risk is a measure of the total risk posed to society as a whole by
42 the actions being considered. For a collective population risk assessment, the persons exposed
43 are considered as a group, without specifying individual receptors. Exposures to four different
44 groups are considered: (1) persons living and working along the transportation routes,
45 (2) persons sharing the route, (3) persons at stops along the route, and (4) transportation crew
46 members. The collective population risk is used as the primary means of comparing various

1 options. Collective population risks are calculated for cargo-related causes for routine
2 transportation and accidents. Vehicle-related risks are independent of the cargo in the shipment
3 and are only calculated for traffic accidents (fatalities caused by physical trauma).
4

5 Estimated impacts from the truck and rail options are summarized in Tables 11.2.9-1 and
6 11.2.9-2, respectively. For the truck option, it is estimated that approximately 12,600 shipments
7 involving about 36 million km (23 million mi) of travel would cause no LCFs to truck crew
8 members or members of the general public. One fatality related to accidents is expected. No
9 LCFs are estimated for the rail option, involving approximately 5,010 railcar shipments and
10 about 14 million km (9 million mi) of travel. However, one fatality from accidents could occur.
11

12 13 **11.2.9.2 Highest-Exposed Individuals during Routine Conditions** 14

15 During the routine transportation of radioactive material, specific individuals might be
16 exposed to radiation in the vicinity of a shipment. Risks to these individuals for a number of
17 hypothetical exposure-causing events were estimated. The receptors include transportation
18 workers, inspectors, and members of the public exposed during traffic delays, while working at a
19 service station, or while living and or working near a destination site. The assumptions about
20 exposure are given in Appendix C, and transportation impacts are provided in Section 5.3.9. The
21 scenarios for exposure are not meant to be exhaustive; they were selected to provide a range of
22 representative potential exposures. On a site-specific basis, if someone was living or working
23 near the entrance to the WIPP Vicinity locations and present for all 12,600 truck or 5,010 rail
24 shipments projected, that individual's estimated dose would be approximately 0.5 or 1.0 mrem,
25 respectively, over the course of more than 50 years. The individual's associated lifetime LCF
26 risk would then be 3×10^{-7} or 6×10^{-7} for truck or rail shipments, respectively.
27

28 29 **11.2.9.3 Accident Consequence Assessment** 30

31 Whereas the collective accident risk assessment considers the entire range of accident
32 severities and their related probabilities, the accident consequence assessment assumes that an
33 accident of the highest severity category has occurred. The consequences, in terms of committed
34 dose (rem) and LCFs for radiological impacts, were calculated for both exposed populations and
35 individuals in the vicinity of an accident. Because the exact location of such a transportation
36 accident is impossible to predict and thus is not specific to any one site, generic impacts were
37 assessed, as presented in Section 5.3.9.
38

39 40 **11.2.10 Cultural Resources** 41

42 Eight cultural resources have been identified in Section 27 (T22S, R31E) and Section 35
43 (T22S, R31E); one is in Section 27, and seven are in Section 35. Neither section has been fully
44 examined for the presence of cultural resources. Most of the cultural resources being discovered
45 appear to be the remains of camps that show the evidence of food preparation.

TABLE 11.2.9-1 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Truck for Disposal at the WIPP Vicinity Reference Locations^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts							Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)				Accident ^e	Latent Cancer Fatalities ^d		Physical Accident Fatalities
				Routine Public					Crew	Public	
				Off-Link	On-Link	Stops	Total				
Group 1											
GTCC LLRW											
Activated metals - RH											
Past BWRs	20	63,300	0.66	0.027	0.1	0.12	0.24	0.00022	0.0004	0.0001	0.0015
Past PWRs	143	407,000	4.2	0.16	0.64	0.75	1.5	0.0012	0.003	0.0009	0.0091
Operating BWRs	569	1,550,000	16	0.57	2.4	2.8	5.8	0.0039	0.01	0.003	0.035
Operating PWRs	1,720	4,170,000	43	1.5	6.4	7.7	16	0.011	0.03	0.009	0.095
Sealed sources - CH	209	360,000	0.15	0.031	0.2	0.26	0.49	0.017	<0.0001	0.0003	0.0091
Cesium irradiators - CH	240	413,000	0.17	0.036	0.23	0.3	0.56	0.0028	0.0001	0.0003	0.01
Other Waste - CH	5	603	0.00025	<0.0001	0.00032	0.00043	0.00077	<0.0001	<0.0001	<0.0001	<0.0001
Other Waste - RH	54	150,000	1.5	0.062	0.23	0.28	0.57	<0.0001	0.0009	0.0003	0.0034
GTCC-like waste											
Activated metals - RH	38	85,800	0.89	0.021	0.12	0.16	0.3	<0.0001	0.0005	0.0002	0.0035
Sealed sources - CH	1	1,720	0.00072	0.00015	0.00096	0.0012	0.0023	<0.0001	<0.0001	<0.0001	<0.0001
Other Waste - CH	69	211,000	0.088	0.029	0.12	0.15	0.3	0.00097	<0.0001	0.0002	0.0044
Other Waste - RH	1,160	3,370,000	35	1.2	5.1	6.2	12	0.0022	0.02	0.007	0.07

TABLE 11.2.9-1 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts							Vehicle-Related Impacts ^c	
			Routine Crew	Dose Risk (person-rem)				Accident ^e	Latent Cancer Fatalities ^d		Physical Accident Fatalities
				Routine Public					Crew	Public	
				Off-Link	On-Link	Stops	Total				
Group 2											
GTCC LLRW											
Activated metals - RH											
New BWRs	202	348,000	3.6	0.099	0.51	0.64	1.3	0.00077	0.002	0.0008	0.0083
New PWRs	833	1,940,000	20	0.7	3	3.6	7.2	0.0049	0.01	0.004	0.044
Additional commercial waste	1,990	6,200,000	64	2.2	9.4	11	23	<0.0001	0.04	0.01	0.13
Other Waste - CH	139	433,000	0.18	0.06	0.26	0.31	0.63	0.003	0.0001	0.0004	0.009
Other Waste - RH	3,790	11,500,000	120	4.2	17	21	43	0.0008	0.07	0.03	0.24
GTCC-like waste											
Other Waste - CH	44	117,000	0.049	0.016	0.069	0.084	0.17	0.0004	<0.0001	0.0001	0.0025
Other Waste - RH	1,400	4,210,000	43	1.5	6.4	7.7	16	0.0022	0.03	0.009	0.088
Total Groups 1 and 2	12,600	35,600,000	350	12	52	64	130	0.051	0.2	0.08	0.76

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

TABLE 11.2.9-2 Estimated Collective Population Transportation Risks for Shipment of GTCC LLRW and GTCC-Like Waste by Rail for Disposal at the WIPP Vicinity Reference Locations^a

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Dose Risk (person-rem)							Latent Cancer Fatalities ^d		Physical Accident Fatalities
			Routine Crew	Routine Public				Accident ^e	Crew	Public		
				Off-Link	On-Link	Stops	Total					
Group 1												
GTCC LLRW												
Activated metals - RH												
Past BWRs	7	21,300	0.17	0.056	0.0033	0.077	0.14	0.00035	0.0001	<0.0001	0.0017	
Past PWRs	37	103,000	0.86	0.27	0.016	0.39	0.67	0.0014	0.0005	0.0004	0.006	
Operating BWRs	154	422,000	3.5	1.1	0.062	1.7	2.8	0.0025	0.002	0.002	0.018	
Operating PWRs	460	1,200,000	10	3.4	0.18	4.8	8.4	0.0081	0.006	0.005	0.055	
Sealed sources - CH												
Cesium irradiators - CH	120	217,000	0.61	0.19	0.0097	0.44	0.64	0.00013	0.0004	0.0004	0.0071	
Other Waste - CH	3	2,740	0.011	0.0025	0.00017	0.0083	0.011	<0.0001	<0.0001	<0.0001	<0.0001	
Other Waste - RH	27	85,600	0.68	0.27	0.012	0.33	0.61	<0.0001	0.0004	0.0004	0.0025	
GTCC-like waste												
Activated metals - RH	11	23,400	0.21	0.051	0.0028	0.1	0.16	<0.0001	0.0001	<0.0001	0.0024	
Sealed sources - CH	1	1,810	0.0051	0.0016	<0.0001	0.0037	0.0053	<0.0001	<0.0001	<0.0001	<0.0001	
Other Waste - CH	35	99,700	0.24	0.11	0.0066	0.18	0.29	0.00011	0.0001	0.0002	0.0036	
Other Waste - RH	579	1,670,000	14	4.5	0.25	6.7	11	0.00024	0.008	0.007	0.061	

TABLE 11.2.9-2 (Cont.)

Waste	No. of Shipments	Total Distance (km)	Cargo-Related ^b Radiological Impacts								Vehicle-Related Impacts ^c	
			Dose Risk (person-rem)							Latent Cancer Fatalities ^d		Physical Accident Fatalities
			Routine Crew	Routine Public			Accident ^e	Crew	Public			
				Off-Link	On-Link	Stops				Total		
Group 2												
GTCC LLRW												
Activated metals - RH												
New BWRs	54	113,000	1	0.32	0.017	0.5	0.84	0.00058	0.0006	0.0005	0.0052	
New PWRs	227	569,000	4.9	1.7	0.08	2.3	4.1	0.0033	0.003	0.002	0.026	
Additional commercial waste	498	1,450,000	12	3.8	0.23	6	10	<0.0001	0.007	0.006	0.054	
Other Waste - CH	70	203,000	0.49	0.23	0.014	0.36	0.6	0.00035	0.0003	0.0004	0.0076	
Other Waste - RH	1,900	5,550,000	45	15	0.85	23	38	<0.0001	0.03	0.02	0.2	
GTCC-like waste												
Other Waste - CH	22	64,300	0.15	0.078	0.0039	0.11	0.19	<0.0001	<0.0001	0.0001	0.0023	
Other Waste - RH	702	2,040,000	17	5.4	0.31	8.3	14	0.00022	0.01	0.008	0.076	
Total Groups 1 and 2	5,010	14,000,000	110	36	2.1	55	94	0.018	0.07	0.06	0.53	

^a BWR = boiling water reactor, PWR = pressurized water reactor, CH = contact-handled, RH = remote-handled.

^b Cargo-related impacts are impacts attributable to the radioactive nature of the material being transported.

^c Vehicle-related impacts are impacts independent of the cargo in the shipment.

^d LCFs were calculated by multiplying the dose by the health risk conversion factor of 6×10^{-4} fatal cancer per person-rem (see Section 5.2.4.3).

^e Dose risk is a societal risk and is the product of accident probability and accident consequence.

1 If this location was chosen for development, the NHPA Section 106 process for
2 considering the impact of the project on significant cultural resources would be followed. The
3 Section 106 process requires the facility location and any ancillary locations that would be
4 affected by the project to be investigated for the presence of cultural resources prior to
5 disturbance. If the project occurred near one of the known resources, additional research would
6 be needed to determine if the resource was eligible for listing on the NRHP. If it was, all impacts
7 on the resource would need to be mitigated. Avoidance is always the preferred mitigation
8 measure.

9
10 The borehole method has the greatest potential to affect cultural resources because of its
11 44-ha (110-ac) land requirement. The amount of land needed to employ this method is almost
12 twice the amount needed to construct the vault or the trench method. The majority of the impacts
13 on cultural resources are expected to occur during the construction phase. On the basis of
14 previous research in the region, it is expected that some isolated prehistoric artifacts and possibly
15 some larger prehistoric cultural resources would be found in the project area. One prehistoric site
16 is known within the project area, and it has yet to be evaluated for listing on the NRHP. If
17 additional archaeological sites were identified, they would require evaluation for listing on the
18 NRHP.

19
20 Unlike the other two methods being considered, the vault method requires large amounts
21 of soil to cover the waste. Impacts on cultural resources could occur during the removal and
22 hauling of the soil required for this method. Impacts on cultural resources would need to be
23 considered for the soil extraction locations. The NHPA Section 106 process would be followed
24 for all locations. Potential impacts on cultural resources from the operations of the vault method
25 could be comparable to those expected from the borehole method. While the actual footprint
26 would be smaller for the vault method, additional land would be disturbed to obtain the soil for
27 the cover. Most impacts on significant cultural resources could be mitigated through data
28 recovery, but avoidance is the preferred mitigation. The appropriate mitigation would be
29 determined through consultation with the New Mexico SHPO and the appropriate Native
30 American tribes. These tribes would be consulted to ensure that no traditional cultural properties
31 that could be disturbed were located in the project area.

32
33 It is expected that activities associated with construction, operations, and post-closure
34 would have a minimal impact on cultural resources. No new ground-disturbing activities are
35 expected to occur in association with operations and post-closure activities.

36 37 38 **11.2.11 Waste Management**

39
40 The construction of the land disposal facilities would generate small quantities of
41 hazardous and nonhazardous solids and hazardous and nonhazardous liquids. Waste generated
42 from operations would include small quantities of solid LLRW (e.g., spent HEPA filters) and
43 nonhazardous solid waste (including recyclable wastes). These wastes could be sent off-site for
44 disposal; therefore, no impacts from the waste generated from the construction and operations of
45 the land disposal methods are expected. Section 5.3.11 summarizes the management and

1 handling procedures that could be followed for the waste that might be generated by the land
2 disposal facilities at the WIPP Vicinity.

5 **11.3 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES AND** 6 **HUMAN HEALTH IMPACTS**

7
8 The potential environmental consequences from Alternatives 3, 4, and 5 discussed in
9 Section 11.2 are summarized by resource area as follows:

10
11 **Air quality.** Total peak-year emission rates are estimated to be rather small when
12 compared with the Eddy County total emissions. Peak-year emissions for all criteria pollutants
13 (except PM₁₀ and PM_{2.5}) would be small. Construction at the WIPP Vicinity GTCC reference
14 locations could occur within less than 100 m (330 ft) of the site boundary. Under unfavorable
15 dispersion conditions, high concentrations of PM₁₀ or PM_{2.5} could occur and exceed the
16 standards at the site boundary, although such exceedances would be rare. Compared with annual
17 emissions for Eddy County, annual emissions of NO_x for the vault method during construction
18 would be the highest, about 0.37% of the county total, while emissions of other criteria pollutants
19 and VOCs would be about 0.06% or less. Except for O₃ and particulates, concentration levels
20 from operational activities are expected to remain well below the standards. During operations,
21 fugitive dust emissions could exceed the standards under unfavorable meteorological conditions.

22
23 **Noise.** The highest composite noise level during construction would be about 92 dBA at
24 15 m (50 ft) from the source. Noise levels at 690 m (2,300 ft) from the source would be below
25 the EPA guideline of 55 dBA as L_{dn} for residential zones. There would be no residences within
26 this distance. Noise generated during operations would be less than noise during construction.
27 No impacts from groundborne vibration are anticipated because the generating equipment would
28 not be high-vibration equipment and because there are no residences or vibration-sensitive
29 buildings nearby.

30
31 **Geology.** During the construction phase, the borehole facility footprint would result in the
32 greatest impact in terms of land area disturbed (44 ha or 110 ac). It also would result in the
33 greatest disturbance with depth, 40 m (130 ft), with boreholes being completed in unconsolidated
34 sand, silt, clay, caliche, and evaporites. No adverse impacts from extraction or use of geologic
35 and soil resources are expected. No significant changes in surface topography or natural
36 drainages would occur. The potential for erosion would be reduced because of the low
37 precipitation rates at the WIPP Vicinity and further reduced by best management practices.

38
39 **Water resources.** Construction of a vault facility and operations of a vault or trench
40 facility would have the highest water requirement. Water demands for construction at the WIPP
41 Vicinity reference locations would be met by using groundwater from the Carlsbad Double Eagle
42 water system. There are no surface water bodies at the site, and no surface water would be used
43 during construction; therefore, no direct or indirect impacts on surface water are expected.
44 Construction and operations of the proposed GTCC waste disposal facility would increase the
45 pumpage for the Double Eagle water system by a maximum of about 0.24% and 0.39%,
46 respectively. This volume increase would be relatively small, and impacts would be negligible. It

1 is expected that there would be no water demands during the post-closure period. Because of the
2 low infiltration rates and deep water table, groundwater would not likely become contaminated
3 with radionuclides for more than 50,000 years for all three disposal methods.
4

5 **Human health.** The worker impacts from operations would mainly be those from the
6 radiation doses associated with handling and disposing of the wastes. The annual radiation dose
7 would be 2.6 person-rem/yr for boreholes, 4.6 person-rem/yr for trenches, and 5.2 person-rem/yr
8 for vaults. These worker doses are not expected to result in any LCFs (Section 5.3.4.1.1). The
9 maximum dose to any individual worker would not exceed the DOE administrative control level
10 (of 2 rem/yr) for site operations. It is expected that the maximum dose to any individual workers
11 over the entire project would not exceed a few rem.
12

13 The worker impacts from accidents would be associated with the injuries and illnesses
14 during disposal operations and possible fatalities that could occur from construction and waste
15 handling activities. The annual number of lost workdays due to injuries and illnesses would
16 range from 1 (for boreholes) to 2 (for trenches and vaults), and no fatalities would occur from
17 construction and waste handling accidents (see Section 5.3.4.2.2). These injuries would not be
18 associated with the radioactive nature of the wastes but would simply be those that are expected
19 to occur in any construction project of this size.
20

21 For the general public, no measurable doses are expected to occur during waste disposal
22 at the site during operations, given the solid nature of the wastes and the distance of waste
23 handling activities from potentially affected individuals. The highest dose to an individual from
24 an accident involving the waste packages prior to disposal (from a fire impacting an SWB) is
25 estimated to be 7.5 rem and would not result in any LCFs. The total dose to the affected
26 population from such an event is estimated to be 7.0 person-rem (see Table 11.2.4-1).
27 Groundwater contamination is not projected to reach a nearby hypothetical resident farmer
28 located 100 m (330 ft) from the edge of the disposal facility within the first 10,000 years, so this
29 individual would receive no incremental radiation dose from disposal of these wastes from this
30 potential exposure pathway.
31

32 **Ecology.** Initial loss of shrub-dominated sand dune habitat, followed by the eventual
33 establishment of low-growth vegetation on the disposal site, is not expected to create a long-term
34 reduction in the local or regional ecological diversity. No aquatic habitats occur within the
35 immediate vicinity of the GTCC reference locations at the WIPP Vicinity; hence, impacts on
36 aquatic biota are not expected. No endangered, threatened, and other special-status species have
37 been observed in the WIPP Vicinity area (DOE 1997). However, favorable habitat for the lesser
38 prairie-chicken (*Tympanuchus pallidicinctus*), a federal candidate species, does occur within the
39 WIPP Vicinity area (BLM 2008).
40

41 **Socioeconomics.** Impacts associated with construction and operations of the land
42 disposal facilities would be small. Construction would create direct employment for up to
43 145 people (vault method) in the peak construction year and up to 152 additional indirect jobs
44 (vault method) in the ROI; the annual average employment growth rate would increase by less
45 than 0.1 of a percentage point. The waste facility would produce up to \$11.7 million in income in
46 the peak construction year (vault method). Up to 127 people would in-migrate to the ROI as a

1 result of employment on-site; in-migration would have only a marginal effect on population
2 growth and require less than 2% of vacant housing in the peak year. Impacts from operating the
3 facility would also be small, creating up to 51 direct jobs annually (vault method) and up to
4 38 additional indirect jobs (vault method) in the ROI. The disposal facility would produce up to
5 \$4.8 million in income annually during operations.

6
7 **Environmental justice.** Because health impacts on the general population within the
8 80-km (50-mi) assessment area during construction and operations would be negligible, no
9 impacts on minority and low-income populations as a result of the construction and operation of
10 a GTCC waste disposal facility are expected.

11
12 **Land use.** The GTCC WIPP Vicinity Section 27 reference location is located within the
13 WIPP LWB and is therefore subject to the WIPP LWA requirements. WIPP Vicinity Section 35
14 reference location is located within a multiple use area and contains oil and gas leases. A loss of
15 0.2% of a 22,493-ha (55,581-ac) grazing allotment would occur, and a portion of Section 35
16 would be altered to a waste disposal area.

17
18 **Transportation.** Shipment of all waste to the WIPP Vicinity by truck would result in
19 approximately 12,600 shipments involving a total distance of 36 million km (23 million mi).
20 Shipment of all waste by rail would involve 5,010 railcar shipments totaling 14 million km
21 (9 million mi) of travel. It is estimated that no LCFs would occur to the public or crew members
22 for either mode of transportation, but one fatality from an accident could occur. For comparison,
23 since starting operations in 1999, WIPP has received more than 8,500 truck shipments of defense
24 TRU waste.

25
26 **Cultural resources.** The majority of the impacts on cultural resources are expected to
27 occur during the construction phase. On the basis of previous research in the region, it is
28 expected that some isolated prehistoric artifacts and possibly some larger prehistoric cultural
29 resources would be found in the project area. One known prehistoric site is within the WIPP
30 Vicinity reference location and has yet to be evaluated for listing on the NRHP. If additional
31 archaeological sites were identified, they would require evaluation for listing on the NRHP.
32 Section 106 of the NHPA would be followed to determine the impacts of disposal facility
33 activities on significant cultural resources, as needed. Local tribes would be consulted to ensure
34 that no traditional cultural properties were affected by the project.

35
36 **Waste management.** The wastes that might be generated from the construction and
37 operations of the land disposal methods could be sent off-site for disposal as commercial waste
38 management facilities became available.

39 40 41 **11.4 CUMULATIVE IMPACTS**

42
43 Potential impacts of the proposed action are considered in combination with the impacts
44 of past, present, and reasonably foreseeable future actions. Section 5.4 presents the methodology
45 for the cumulative impacts analysis. The analysis provided below begins with a description of
46 reasonably foreseeable future actions at the WIPP Vicinity locations, including those that are

1 ongoing, under construction, or planned for future implementation. Past and present actions are
2 generally accounted for in the affected environment section (Section 11.1). Impacts of the
3 proposed action are considered in combination with the impacts of past, present, and reasonably
4 foreseeable future actions.

5
6 Aside from the adjacent operating WIPP repository, the primary use of land within 16 km
7 (10 mi) of the WIPP Vicinity locations is grazing, with lesser amounts of land used for oil and
8 gas extraction and potash mining. Most of this land is managed and owned by BLM. Two
9 ranches are located within 16 km (10 mi) of the WIPP site. The closest town, Loving,
10 New Mexico, is about 29 km (18 mi) away. Most of the land within 50 km (30 mi) of the WIPP
11 Vicinity locations is owned by either the federal government or the State of New Mexico. At the
12 time of the preparation of this EIS, there were no known plans for large actions on BLM land.

13
14 The land use described above, in combination with the low potential impacts
15 discussed in Section 11.2, indicate that the contribution from the construction, operations, and
16 post-closure phases of the proposed action to cumulative impacts at the WIPP Vicinity locations
17 and the nearby WIPP geologic repository would be small and would not have a significant
18 cumulative impact on area air quality, geology and soils, water resources, ecology,
19 socioeconomics, environmental justice, cultural resources, and land use. The post-closure
20 performance analysis incorporating the emplacement of the GTCC waste at the adjacent WIPP
21 repository (as discussed in Section 4.3.4) indicated that releases to the environment (if any)
22 would be negligible. Combining these releases with the results discussed in Section 11.2.4,
23 which indicates that potential post-closure radionuclide releases to the groundwater in
24 Sections 27 and 35 would also be small, indicates that cumulative human health impacts at the
25 WIPP Vicinity would not be significant.

26
27 On June 15, 2005, the NRC staff issued the *Environmental Impact Statement for the*
28 *Proposed National Enrichment Facility in Lea County, New Mexico* (NRC 2005). This facility
29 was constructed and is now in operation. It is located about 60 km (37 mi) east of the WIPP
30 Vicinity reference locations (town of Eunice). The distance from the WIPP Vicinity reference
31 locations — in combination with NRC staff findings (as reported in the EIS for that action
32 [NRC 2005]) that stated that environmental impacts from this enrichment facility would be small
33 to moderate — indicate that cumulative impacts from the possible GTCC waste disposal
34 activities at the WIPP Vicinity reference locations in combination with the enrichment facility
35 operations would be small and not result in significant cumulative impacts for all resource areas
36 evaluated (including human health and transportation). Finally, follow-on NEPA evaluations and
37 documents prepared to support any further considerations of siting a new borehole, trench, or
38 vault disposal facility at the WIPP Vicinity reference locations would provide more detailed
39 analyses of site-specific issues, including cumulative impacts.

40 41 42 **11.5 STATUTORY AND REGULATORY PROVISIONS RELEVANT TO THE EIS**

43
44 Siting a vault, trench, or borehole facility for GTCC waste inside the WIPP LWA
45 boundary (i.e., Section 27) would be subject to the limits of the WIPP LWA (as discussed for
46 WIPP in Section 4.7); therefore, federal legislation to develop such facilities would be required.

1 Siting a vault, trench, or borehole facility on BLM-administered land outside the WIPP LWB
2 (i.e., Section 35) would require a land withdrawal in accordance with DOI regulations at
3 40 CFR Part 2300, “Land Withdrawals.”

6 **11.6 REFERENCES FOR CHAPTER 11**

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12 GENERIC DISPOSAL FACILITIES ON NONFEDERAL LANDS

This chapter provides an evaluation of the human health consequences from the disposal of GTCC LLRW and GTCC-like waste under Alternative 3 (use of a new borehole disposal facility), Alternative 4 (use of a new trench disposal facility), and Alternative 5 (use of a new vault disposal facility) at generic nonfederal (commercial) sites in the United States. The evaluation focuses on the human health consequences after closure of the disposal facilities in order to provide information for comparison with the other alternatives presented in this EIS.

In a Request for Information in the *FedBizOpps* on July 1, 2005, DOE solicited technical capability statements from commercial vendors that might be interested in constructing and operating a GTCC waste disposal facility. Although several commercial vendors expressed an interest, no vendors provided specific information on disposal locations and methods for analysis in the EIS in response to the *FedBizOpps* request at that time, nor have any since that time. Including a generic commercial facility in the EIS would allow DOE to make a programmatic determination regarding the disposal of GTCC LLRW and GTCC-like waste in such a facility. Should one or more commercial facilities be identified at a later time, DOE would conduct further NEPA reviews, as appropriate.

Because the evaluation is for generic sites, an evaluation of impacts on the remaining resource areas (including potential human health impacts from disposal facility accidents; see list in Section 2 and Figure 2.1) is not included; it is more appropriate that the analyses of these resource areas be based on site-specific information. That is, region-wide input parameters would not result in meaningful information on which subsequent decisions could be based when determining where to implement a GTCC waste disposal facility. However, it can be gleaned from the results of Alternatives 3 to 5 for the federal sites (found in Chapters 6 to 11 of this EIS) that the potential impacts on these resource areas from using the borehole, trench, or vault methods for disposing of GTCC wastes at a commercial site could be similarly small and that the potential long-term impacts on human health could provide a differentiating factor when considering the preferred alternative for GTCC waste disposal. These impacts are thus the focus of this chapter.

Alternatives 3 to 5 are described in Section 5.1, and the environmental consequences from these alternatives that are common to the federal sites are evaluated in Chapter 5. These impacts would also be generally applicable to commercial facility sites and thus are not repeated here. Impact assessment methodologies used for this EIS are described in Appendix C.

12.1 APPROACH FOR ANALYZING THE GENERIC COMMERCIAL SITES

The analysis here covers four generic sites, one in each of the four major geographic regions of the country coinciding with the four NRC regions (see Figure 1.4-2). These four generic sites are referred to as Regions I, II, III and IV, and they include the same states as those addressed by the corresponding NRC regions. That is, Region I covers the Northeastern states,

1 Region II the Southeastern states, Region III the Midwestern states, and Region IV the Western
2 states.

3

4 The RESRAD-OFFSITE computer code was used to address the post-closure impacts at
5 the four generic sites in a manner similar to that done for the federal sites. This allows for a
6 direct comparison of the results given in this chapter with those given in Chapters 6 through 11.
7 The RESRAD-OFFSITE input parameters describing the setting for each of the four generic
8 sites, including its soil properties and hydrological characteristics, were developed from
9 information used in similar analyses (Poe 1998; Toblin 1998, 1999), and these are presented in
10 Appendix E (see Tables E-19 and E-20).

11

12 One of the most important parameters in this evaluation is the depth to groundwater in
13 these four regions. These depths were determined to be as follows from using the references
14 given above (see Table E-19 in Appendix E): Region I (3.4 m or 11 ft), Region II (13 m or 44 ft),
15 Region III (2.2 m or 7 ft), and Region IV (55 m or 180 ft). On the basis of these groundwater
16 depths, a vault facility could be used in each of the four regions, while trenches could be used in
17 only two regions (II and IV), and boreholes could be used only in Region IV. Otherwise, the
18 GTCC wastes would be disposed of in the existing water table by using the three facility designs
19 and the depths to groundwater given above. Note that using this combination of disposal
20 methods and geographic regions allows for a comparison of using trenches in the two regions in
21 which the DOE sites considered in this EIS are located (i.e., in Regions II and IV). None of the
22 federal sites considered in this EIS are located in Regions I or III.

23

24 The choice of disposal methods assessed in this chapter for the four geographic regions is
25 meant to provide additional information to allow for an informed decision on the best approach
26 for disposing of GTCC wastes. There may be locations in Regions I, II, and III that could
27 accommodate use of the borehole method. However, without specific sites and characterization
28 information, this EIS limits the evaluation to Region IV, where the depth to groundwater would
29 be generally compatible with use of the borehole method on a regional basis. The same limitation
30 applies with regard to the use of trenches, but in this case, the evaluation is limited to Regions II
31 and IV. There are likely to be some locations in Regions I and III where the depth to
32 groundwater is greater, so that the trench method could be used to effectively dispose of GTCC
33 wastes, should any proposals for a commercial facility in those regions be identified at a later
34 time. However, these two regions generally have shorter distances to groundwater than do
35 Regions II and IV. The vault method is considered to be applicable in all four regions, since this
36 method is largely above grade and involves the greatest distance between the bottom of the
37 disposed-of wastes and the groundwater.

38

39 It is assumed that all of the GTCC wastes would be disposed of at each regional
40 site/disposal method combination, as was assumed for the analyses conducted at the federal sites.
41 The results are presented in the same manner as that used for the federal sites in order to provide
42 information that could be useful when the preferred alternative is being developed.

43

44 For this analysis, it is assumed that the conceptual designs of the disposal facilities
45 (borehole, trench, and vault) would be the same as those presented in Section 5.1. Hence, the
46 assumptions about the engineered controls and waste stabilization practices are also similar to

1 those assumptions for the federal sites evaluated in this EIS (in Chapters 6 through 11). The
2 natural water infiltration rates were taken to be those assumed in the *Draft Environmental Impact*
3 *Statement on 10 CFR Part 61 “Licensing Requirements for Land Disposal of Radioactive*
4 *Waste”* (Vol. 4, Appendix J, Table J.5, in NUREG-0782; see NRC 1981). They are 0.074 m/yr
5 for Region I, 0.18 m/yr for Region II, 0.05 m/yr for Region III, and 0.001 m/yr for Region IV. In
6 addition, it is assumed that the integrity of the engineered covers and waste containers would
7 begin to degrade after 500 years. At that time, an amount of water that is equivalent to 20% of
8 the natural infiltration rate would enter the waste containers and leach radionuclides from the
9 waste materials. The assumption of a water infiltration rate that is 20% of the natural infiltration
10 rate for the area is consistent with the assumption used in the analyses of waste disposal at the
11 federal sites evaluated in this EIS. A summary of the assumptions used to generate the results
12 presented in this chapter is presented in Appendix E.

13
14

15 **12.2 HUMAN HEALTH IMPACTS FROM CONSTRUCTION AND OPERATION OF** 16 **THE LAND DISPOSAL FACILITIES AT THE GENERIC COMMERCIAL SITES**

17

18 The human health impacts on workers and the general public at these generic commercial
19 facilities during disposal facility construction and waste disposal operations are expected to be
20 similar to those at the federal sites considered in this EIS. These impacts are expected to be
21 mainly the occupational doses from waste disposal operations; no off-site releases are expected
22 because the waste packages would contain the radioactive materials and because monitoring of
23 the site and nearby vicinity would identify the need for any corrective actions. It is possible that
24 the public could be exposed to external gamma radiation from wastes being stored at the site
25 prior to disposal if individuals were to venture close enough to these wastes, but such exposures
26 are expected to be low and not result in any significant LCF risk. In addition, there would be
27 security measures at the facility to ensure that an individual could not gain unauthorized or
28 inadvertent access to the wastes.

29

30 It is expected that the doses to the general public in the vicinity of a hypothetical
31 commercial disposal facility during disposal operations would be well below the dose limit of
32 100 mrem/yr set by DOE and the NRC for radiation protection purposes for reasons described
33 below. Engineering controls would likely be effective in limiting releases of contaminants to the
34 environment, and the site perimeter would be monitored to ensure the effectiveness of these
35 controls. Even though the commercial disposal facility would be licensed by the NRC, it is
36 expected that the facility would adhere to limits that are comparable to those set by DOE for its
37 operations to control radiation exposures. The DOE radiation dose limits for members of the
38 general public are given in DOE Order 5400.5, and the NRC requirements are given in
39 Subpart D of 10 CFR Part 20.

40

41 Individuals working at a commercial disposal facility would be routinely monitored for
42 radiation exposure. The worker doses would be kept below applicable radiation dose standards.
43 DOE has established a primary radiation dose standard of 5 rem/yr to workers for its operations
44 (10 CFR Part 835), and the NRC has the same occupational dose limit in Subpart C
45 of 10 CFR Part 20. In addition, DOE has set an administrative control level of 2 rem/yr for all
46 DOE activities, and it requires contractors to develop a similar level for specific activities that is

1 consistent with this requirement. The contractor administrative control level is generally not
2 expected to exceed 1.5 rem/yr, and for many activities, the level should be 500 mrem/yr or less.
3 The NRC would be expected to impose similar limits to control occupational doses at a
4 hypothetical commercial site for disposing of GTCC wastes. External gamma exposure would be
5 the primary exposure pathway for workers.

6
7 The specific monitoring and maintenance program to be used at a commercial GTCC
8 waste disposal site would be prescribed by the NRC as part of the licensing process. Such a
9 program would be designed to provide effective control of any releases from the site and would
10 include ALARA considerations. The potential impacts on members of the general public and
11 involved workers from the construction and operations of land disposal facilities for GTCC
12 wastes are discussed in Section 5.3.4. The impacts at a commercial disposal facility are expected
13 to be comparable to those at a DOE site, because similar procedures are expected to be used to
14 operate the facility. The impacts presented in Section 5.3.4 for construction and operations are
15 therefore applicable to commercial disposal facilities as well as to DOE sites, and these are not
16 repeated here.

17
18 Although all appropriate health and safety procedures and requirements for use of a
19 commercial GTCC waste disposal facility would be met, it is possible that accidents could occur
20 that could injure workers and result in the off-site release of radioactive materials. It is expected
21 that the impacts on workers from accidents would be similar to those estimated for use of federal
22 sites, as given in Table 5.3.4-2. That is, less than one fatality is predicted to occur during
23 construction and operations, but a number of injuries could occur. The numbers of lost workdays
24 due to nonfatal injuries and illness during construction activities are estimated to be 16 for use of
25 boreholes, 49 for use of trenches, and 150 for use of vaults. About one to two lost workdays
26 could occur annually during operational activities.

27
28 The impact from accidents involving the release of radioactive materials to off-site
29 locations would depend on the local meteorology and location of nearby individuals. While these
30 factors are very much site-dependent, the radiation doses and LCF risks to a nearby individual
31 would generally be expected to be comparable to those predicted for use of federal sites. The
32 highest dose to an individual (expected to be a noninvolved worker) for the various federal sites
33 evaluated in the EIS ranges from 2.4 to 16 rem, with the highest LCF risk being 0.009. This
34 individual is assumed to be located 100 m (330 ft) from an accident involving a fire to an SWB.
35 The dose to the impacted population in the downwind sector from such an accident would not
36 result in any LCFs.

37 38 39 **12.3 POST-CLOSURE PERIOD HUMAN HEALTH IMPACTS FROM THE LAND** 40 **DISPOSAL FACILITIES AT THE GENERIC COMMERCIAL SITES**

41
42 The major differentiating factor for these four geographic regions is related to the impacts
43 that could occur during the post-closure period. These are related to the potential release of
44 contaminants to the environment and the subsequent exposure to nearby individuals. Because it
45 is assumed that the site would not be monitored for the long term, there would be no worker
46 doses during this time period. Also, although airborne releases could occur, it is expected that the

1 overlying cover system and the dispersion of any released radionuclides by the wind would
2 greatly decrease the air concentrations. Hence, the highest doses are expected to be those
3 associated with the migration of radionuclides to groundwater and their subsequent use by
4 members of the general public. For this assessment, the exposed individual is assumed to be a
5 hypothetical resident farmer located 100 m (330 ft) downgradient from the disposal facility. This
6 assessment is the same as that done for the federal sites considered in this EIS.

7
8 It is assumed that following closure of the disposal facility, the engineering controls
9 incorporated into the disposal facility design would degrade and begin to fail, allowing water to
10 infiltrate into the wastes. This infiltration could result in the leaching of contaminants from the
11 packaged wastes over time. These contaminants could move downward with the infiltrating
12 water to the underlying groundwater system and eventually migrate to a well being used to
13 supply potable water. Should this scenario occur, it is possible that an individual could be
14 exposed to relatively high concentrations of radionuclides and incur significant radiation doses.
15 This scenario, which was developed by using the RESRAD-OFFSITE computer code, is
16 evaluated in this section, and it represents an upper bound to the long-term doses and LCF risks
17 that are reasonably expected to occur if a commercial facility was constructed for disposal of
18 GTCC wastes.

19
20 The potential radiation dose from the airborne release of radionuclides to off-site
21 members of the public after closure of a disposal facility would be small. Estimates developed
22 by using RESRAD-OFFSITE indicate that there would be no measurable exposure from this
23 pathway for the borehole method. Small radiation exposures are estimated for the trench and
24 vault methods. The potential inhalation dose at a distance of 100 m (330 ft) from the disposal
25 facility is estimated to be less than 1.8 mrem/yr for trench disposal and 0.52 mrem/yr for vault
26 disposal. The potential radiation exposures would result mainly from the inhalation of radon gas
27 and its short-lived progeny.

28
29 The borehole method would provide better protection against potential exposures from
30 airborne releases of radionuclides because of the greater depth of the cover material. For the use
31 of boreholes, the wastes would be emplaced 30 to 40 m (100 to 130 ft) bgs, and the depth of
32 overlying soil would inhibit the diffusion of radon gas, CO₂ gas (containing C-14), and tritium
33 (H-3) water vapor to the atmosphere above the disposal area. However, because the distance to
34 the groundwater table from boreholes would be shorter than the distance from trenches or vaults,
35 radionuclides that leached out from the wastes in boreholes would reach the groundwater table in
36 a shorter time than those from wastes in trenches or vaults. This would mean there would be less
37 time for radioactive decay to occur before the radionuclides reached the environment.

38
39 For this assessment, the entire GTCC waste inventory is assumed to be disposed of at a
40 single commercial facility in each of the four geographic regions. Representative parameters
41 were chosen for each site so that the RESRAD-OFFSITE computer code could be used to
42 address the movement of radioactive contaminants from these GTCC wastes to the nearby
43 environment (see Appendix E). It is assumed that engineering controls (the integrity of
44 stabilizing agents in the Other Waste type and the disposal facility cover) would prevent or
45 minimize water infiltration into the wastes for the first 500 years following closure of
46 the disposal facility. This practice would allow time for the short-lived radionuclides to decay

1 to innocuous levels. It is further assumed that after the first 500 years, the facility covers would
2 still be effective in reducing water infiltration to the top of the facility (i.e., 80% reduction is
3 assumed).

4
5 Calculations indicate that within 10,000 years, radionuclides would reach the
6 groundwater table and a well installed by a hypothetical resident farmer located a distance of
7 100 m (330 ft) from the downgradient edge of a disposal facility in Regions I, II, and III.
8 Radionuclides are not predicted to reach this hypothetical well within 10,000 years in Region IV
9 for any of the three disposal methods. This assumption reflects the more arid climate and greater
10 depth to groundwater in the Western United States. However, calculations indicate that
11 radionuclides would reach the groundwater table and this hypothetical well after 10,000 years,
12 and these results are discussed below.

13
14 The results of these modeling calculations are given in Tables 12.3-1 through 12.3-6 and
15 in Figures 12.3-1 through 12.3-7. The tables provide the peak annual doses and LCF risks
16 associated with use of contaminated groundwater resulting from the disposal of the entire GTCC
17 waste inventory at a commercial disposal facility in Regions I, II, and III. The tables show the
18 contributions from the different waste types to the peak annual doses and LCFs at the time of
19 peak impact, and the figures illustrate the radionuclides that provide most of the annual dose and
20 LCF risk. Since the calculations indicate that disposal of GTCC LLRW and GTCC-like waste in
21 a borehole, trench, or vault facility in Region IV would not reach the groundwater table in
22 10,000 years, tables summarizing the peak annual doses and LCF risks are not provided for this
23 region. However, the radiation doses out to 100,000 years for these three disposal methods in
24 Region IV are shown in Figure 12.3-7. The major dose contributor in all four regions is GTCC-
25 like Other Waste - RH. The primary radionuclides causing this dose are generally C-14, I-129,
26 and isotopes of uranium and plutonium.

27
28 Because the radionuclide mixes are different for each waste type (i.e., activated metals,
29 sealed sources, and Other Waste), the peak annual doses and LCF risks do not necessarily occur
30 at the same time for each waste type. In addition, the peak annual doses and LCF risks for the
31 entire GTCC waste inventory considered as a whole could be different from those for the
32 individual waste types. The results presented in Tables 12.3-1 through 12.3-6 are for the entire
33 GTCC waste inventory, and the contributions of the individual waste types given in these tables
34 are those that occur at the time of the peak annual doses and LCF risks for the entire inventory.

35
36 The estimated doses and LCF risks for the hypothetical resident farmer scenario
37 evaluated to assess the post-closure impacts for GTCC waste disposal at a commercial facility
38 are presented in two ways in this EIS. The first presents the peak annual doses and LCF risks
39 when disposal of the entire GTCC waste inventory is considered. These are provided in
40 Tables 12.3-1 through 12.3-6. The second presents the peak annual doses for each waste type
41 considered on its own. These results are presented in Tables E-22 through E-25 in Appendix E.
42 The first set of results could be used as the basis for comparing the performance of each site and
43 land disposal method if the entire GTCC waste inventory was going to be disposed of at one site
44 by using one method. The second set could be used as the basis for comparing the performance
45 of each site and each land disposal method when the disposal of each of the three waste types is
46 being considered.

TABLE 12.3-1 Estimated Peak Annual Dose (in mrem/yr) from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in Region I^a

Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual Dose from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									12,000 ^b
Group 1 stored	0.0	–	0.0	7.2	0.026	0.0	400	370	
Group 1 projected	2.8	400	–	0.22	0.065	0.0	110	9,700	
Group 2 projected	1.3	0.0	71	210	–	–	230	440	

^a These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the vault disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. The values given in this table represent the annual doses to the hypothetical resident farmer at the time of peak annual dose from the entire GTCC waste inventory. These contributions do not represent the maximum doses that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses that could result from each of the waste types are presented in Tables E-22 through E-25 in Appendix E. Region I is composed of the Northeastern states (see Figure 1.4-2).

^b The time for the peak annual dose of 12,000 mrem/yr for disposal of the entire GTCC waste inventory was calculated to be about 49 years after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual doses from the specific waste types at the time of the peak annual dose (i.e., at 49 years following failure of the cover and engineered barriers). The primary contributor to the dose is GTCC-like Other Waste - RH, and the primary radionuclides causing this dose are C-14, I-129, and uranium and plutonium isotopes.

TABLE 12.3-2 Estimated Peak Annual LCF Risk from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in Region I^a

Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual LCF Risk from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									7E-03 ^b
Group 1 stored	0E+00	–	0E+00	4E-06	2E-08	0E+00	2E-04	2E-04	
Group 1 projected	2E-06	2E-04	–	1E-07	4E-08	0E+00	7E-05	6E-03	
Group 2 projected	8E-07	0E+00	4E-05	1E-04	–	–	1E-04	3E-04	

^a These annual LCF risks are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the vault disposal facility. All values are given to one significant figure, and a dash means there is no inventory for that waste type. The values given in this table represent the annual LCF risks to the hypothetical resident farmer at the time of peak annual LCF risk from the entire GTCC waste inventory. These contributions do not represent the maximum LCF risks that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum LCF risks that could result from each waste type individually generally occur at different times than the peak annual LCF risk from the entire inventory. Region I is composed of the Northeastern states (see Figure 1.4-2).

^b The time for the peak annual LCF risk of 7E-03 for disposal of the entire GTCC waste inventory was calculated to be about 49 years after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual LCF risks from the specific waste types at the time of the peak annual LCF risk (i.e., at 49 years following failure of the cover and engineered barriers). The primary contributor to the LCF risk is GTCC-like Other Waste - RH, and the primary radionuclides causing this risk are C-14, I-129, and uranium and plutonium isotopes.

TABLE 12.3-3 Estimated Peak Annual Dose (in mrem/yr) from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault or Trench Disposal Facility in Region II^a

Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual Dose from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									1,200 ^b
Group 1 stored	0.86	–	0.0	0.0	0.12	0.0	11	940	
Group 1 projected	13	0.0	–	0.0	0.29	0.0	3.1	0.0	
Group 2 projected	6.2	0.0	5.3	210	–	–	6.2	13	
Trench disposal									1,200 ^b
Group 1 stored	1.1	–	0.0	0.0	0.15	0.0	14	950	
Group 1 projected	17	0.0	–	0.0	0.38	0.0	0.39	0.0	
Group 2 projected	8.1	0.0	6.6	210	–	–	7.8	12	

^a These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. The values given in this table represent the annual doses to the hypothetical resident farmer at the time of peak annual dose from the entire GTCC waste inventory. These contributions do not represent the maximum doses that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses that could result from each of the waste types are presented in Tables E-22 through E-25 in Appendix E. Region II is composed of the Southeastern states (see Figure 1.4-2).

^b The times for the peak annual doses of 1,200 mrem/yr for disposal of the entire GTCC waste inventory using the vault and trench methods were calculated to be about 100 and 34 years, respectively, after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported from the other entries in this table represent the annual doses for the specific waste types at the time of the peak annual dose (i.e., at 100 and 34 years following failure of the cover and engineered barriers for the vault and trench methods, respectively). For both cases, the primary contributor to the dose is GTCC-like Other Waste - RH, and the primary radionuclides causing this dose are C-14 and I-129.

TABLE 12.3-4 Estimated Peak Annual LCF Risk from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault or Trench Disposal Facility in Region II^a

Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual LCF Risk from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									7E-04 ^b
Group 1 stored	5E-07	–	0E+00	0E+00	7E-08	0E+00	7E-06	6E-04	
Group 1 projected	8E-06	0E+00	–	0E+00	2E-07	0E+00	2E-06	0E+00	
Group 2 projected	4E-06	0E+00	3E-06	1E-04	–	–	4E-06	8E-06	
Trench disposal									7E-04 ^b
Group 1 stored	7E-07	–	0E+00	0E+00	9E-08	0E+00	8E-06	6E-04	
Group 1 projected	1E-05	0E+00	–	0E+00	2E-07	0E+00	2E-07	0E+00	
Group 2 projected	5E-06	0E+00	4E-06	1E-04	–	–	5E-06	7E-06	

^a These annual LCF risks are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the vault disposal facility. All values are given to one significant figure, and a dash means there is no inventory for that waste type. The values given in this table represent the annual LCF risks to the hypothetical resident farmer at the time of peak annual LCF risk from the entire GTCC waste inventory. These contributions do not represent the maximum LCF risks that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum LCF risks that could result from each waste type individually generally occur at different times than the peak annual LCF risk from the entire inventory. Region II is composed of the Southeastern states (see Figure 1.4-2).

^b The time for the peak annual LCF risk of 7E-04 for disposal of the entire GTCC waste inventory was calculated to be about 100 and 34 years, respectively, after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual LCF risks from the specific waste types at the time of the peak annual LCF risk (i.e., at 100 and 34 years following failure of the cover and engineered barriers for the vault and trench methods, respectively). The primary contributor to the LCF risk is GTCC-like Other Waste - RH, and the primary radionuclides causing this risk are C-14 and I-129.

TABLE 12.3-5 Estimated Peak Annual Dose (in mrem/yr) from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in Region III^a

Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual Dose from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									530 ^b
Group 1 stored	11	–	0.0	0.0	0.16	0.0	4.7	410	
Group 1 projected	18	0.0	–	0.0	0.39	0.0	1.4	0.017	
Group 2 projected	7.8	0.0	2.1	83	–	–	2.5	5.2	

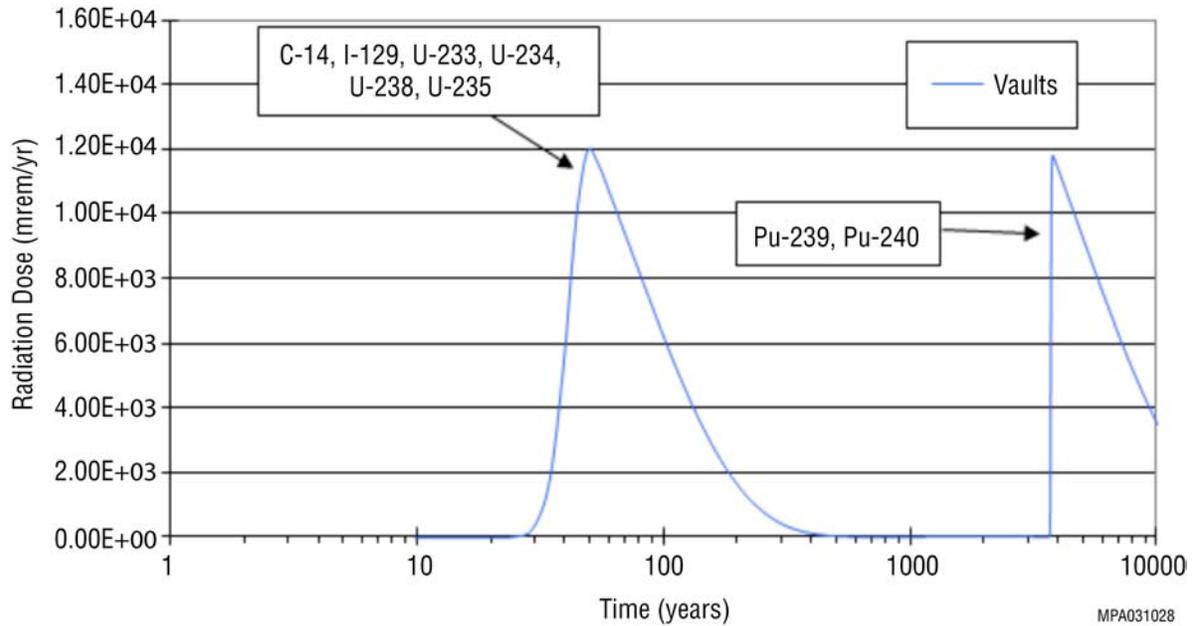
^a These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the vault disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. The values given in this table represent the annual doses to the hypothetical resident farmer at the time of peak annual dose from the entire GTCC waste inventory. These contributions do not represent the maximum doses that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses that could result from each of the waste types are presented in Tables E-22 through E-25 in Appendix E. Region III is composed of the Midwestern states (see Figure 1.4-2).

^b The time for the peak annual dose of 530 mrem/yr for disposal of the entire GTCC waste inventory was calculated to be about 69 years after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual doses from the specific waste types at the time of the peak annual dose (i.e., at 69 years following failure of the cover and engineered barriers). The primary contributor to the dose is GTCC-like Other Waste - RH, and the primary radionuclides causing this dose are C-14 and I-129.

TABLE 12.3-6 Estimated Peak Annual LCF Risk from the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in Region III^a

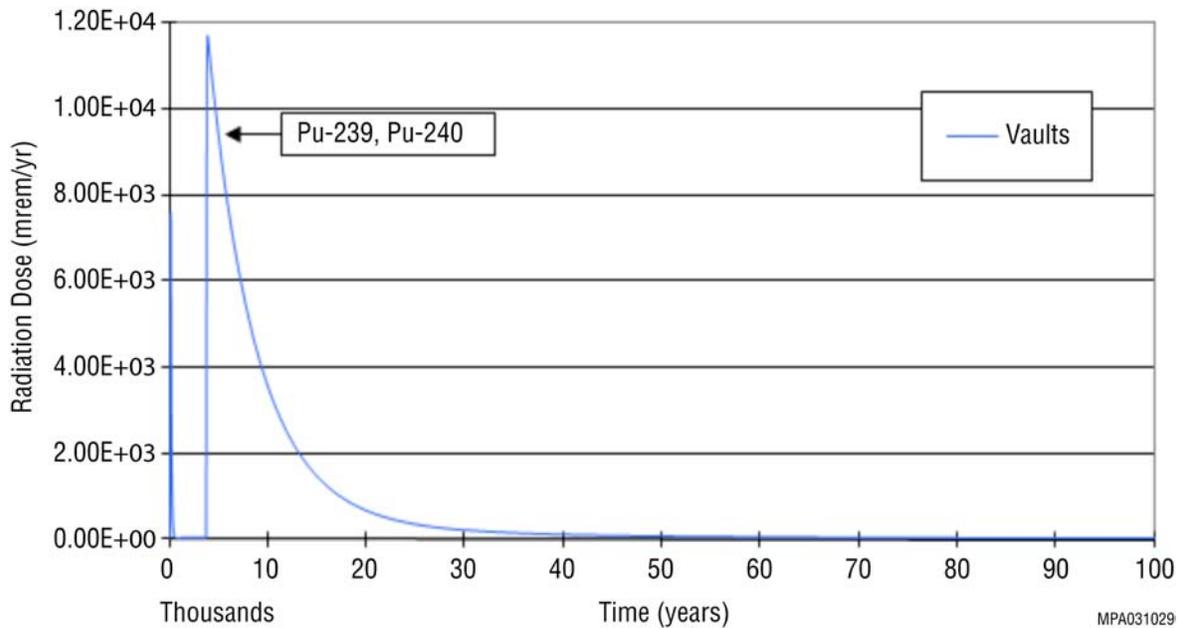
Disposal Technology/Waste Group	GTCC LLRW				GTCC-Like Waste				Peak Annual LCF Risk from Entire Inventory
	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	Activated Metals - RH	Sealed Sources - CH	Other Waste - CH	Other Waste - RH	
Vault disposal									3E-04 ^b
Group 1 stored	7E-07	–	0E+00	0E+00	9E-08	0E+00	3E-06	2E-04	
Group 1 projected	1E-05	0E+00	–	0E+00	2E-07	0E+00	8E-07	1E-08	
Group 2 projected	5E-06	0E+00	1E-06	5E-05	–	–	2E-06	3E-06	

- ^a These annual LCF risks are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the vault disposal facility. All values are given to one significant figure, and a dash means there is no inventory for that waste type. The values given in this table represent the annual LCF risks to the hypothetical resident farmer at the time of peak annual LCF risk from the entire GTCC waste inventory. These contributions do not represent the maximum LCF risks that could result from each of these waste types separately. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum LCF risks that could result from each waste type individually generally occur at different times than the peak annual LCF risk from the entire inventory. Region III is composed of the Midwestern states (see Figure 1.4-2).
- ^b The time for the peak annual LCF risk of 3E-04 for disposal of the entire GTCC waste inventory was calculated to be about 69 years after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility). The values reported for the other entries in this table represent the annual LCF risks from the specific waste types at the time of the peak annual LCF risk (i.e., at 69 years following failure of the cover and engineered barriers). The primary contributor to the LCF risk is GTCC-like Other Waste - RH, and the primary radionuclides causing this risk are C-14 and I-129.



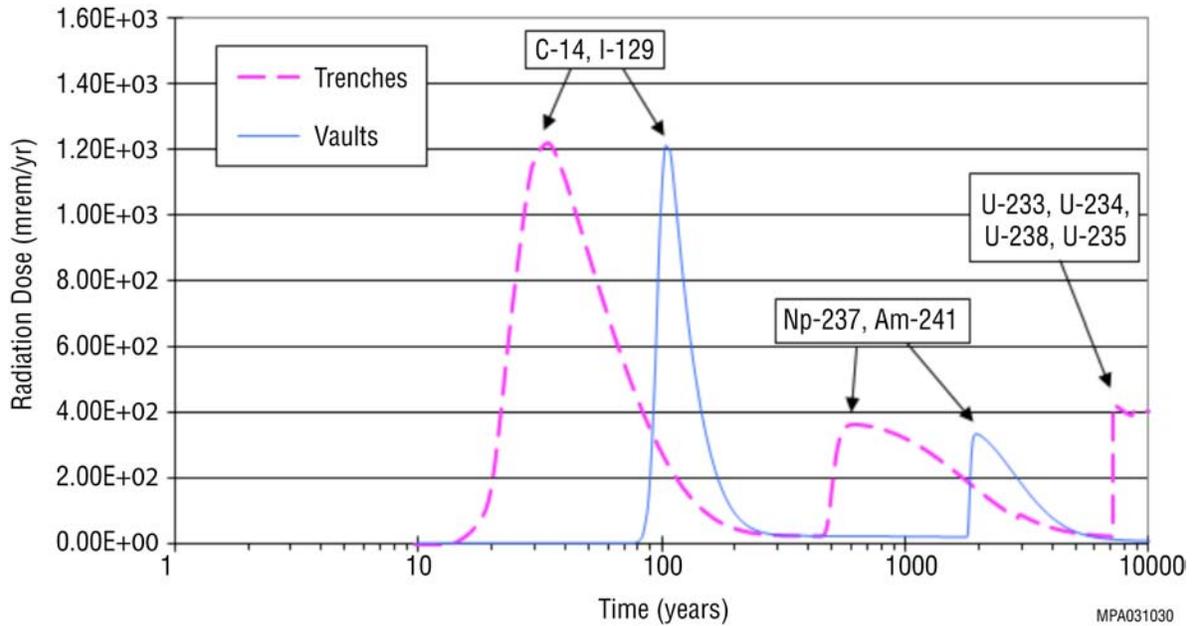
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2
3
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5
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FIGURE 12.3-1 Temporal Plot of Radiation Doses Associated with the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in Region I



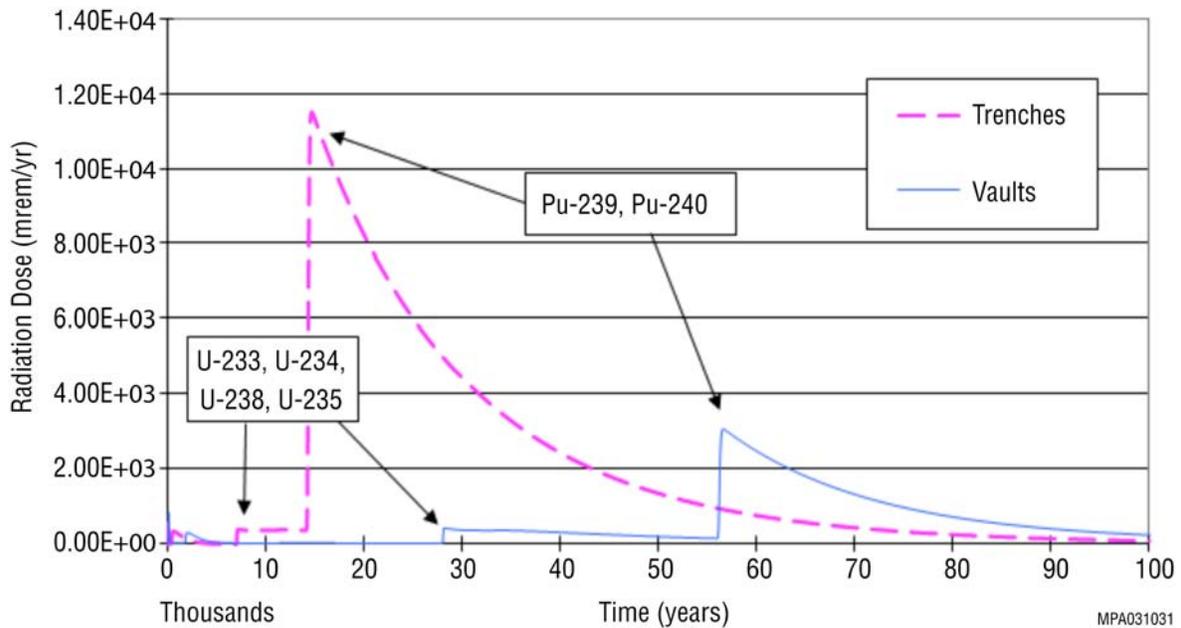
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FIGURE 12.3-2 Temporal Plot of Radiation Doses Associated with the Use of Contaminated Groundwater within 100,000 Years of Disposal in a Commercial Vault Disposal Facility in Region I



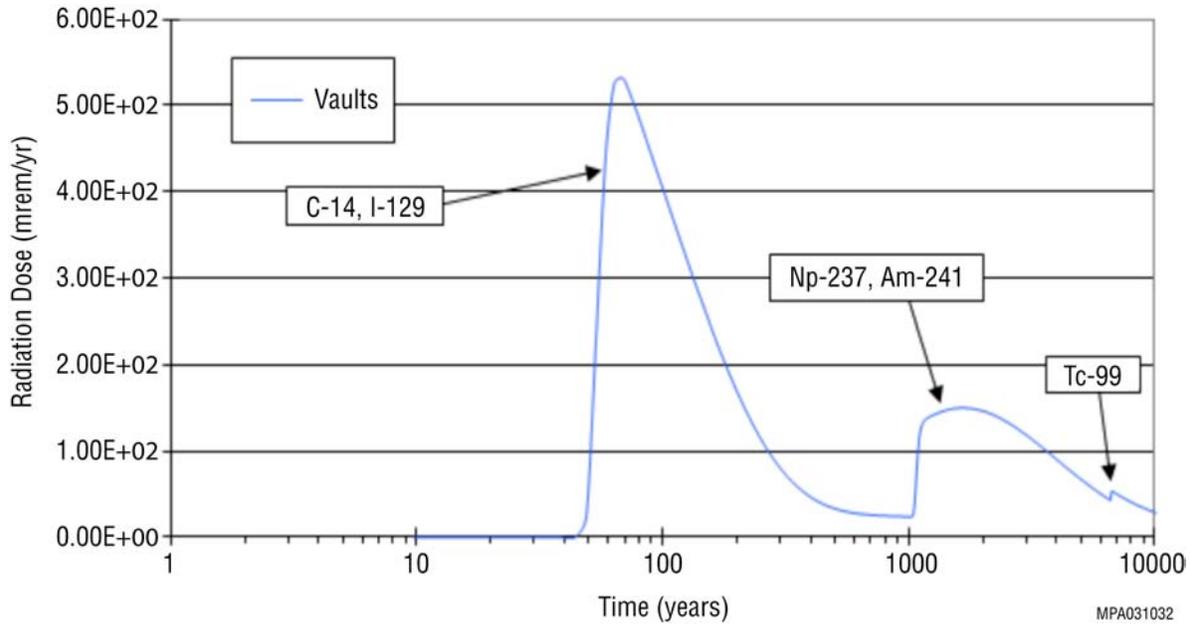
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FIGURE 12.3-3 Temporal Plot of Radiation Doses Associated with the Use of Contaminated Groundwater within 10,000 Years of Disposal in a Commercial Vault or Trench Disposal Facility in Region II



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FIGURE 12.3-4 Temporal Plot of Radiation Doses Associated with the Use of Contaminated Groundwater within 100,000 Years of Disposal in a Commercial Vault or Trench Disposal in Region II

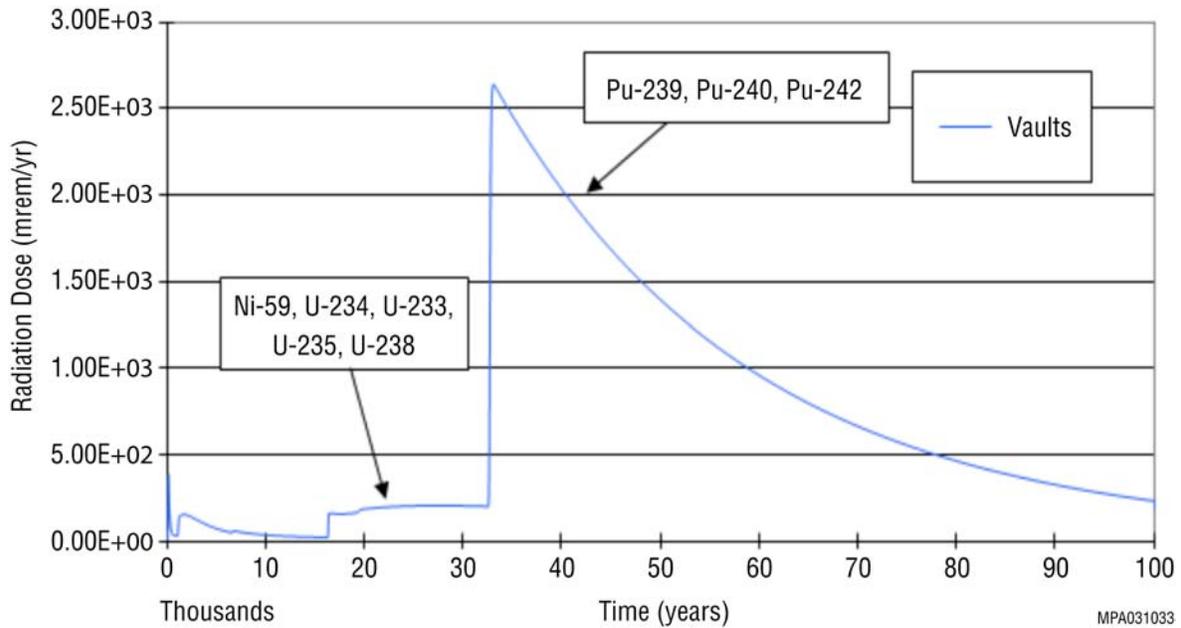


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2 **FIGURE 12.3-5 Temporal Plot of Radiation Doses Associated with the Use of Contaminated**
 3 **Groundwater within 10,000 Years of Disposal in a Commercial Vault Disposal Facility in**
 4 **Region III**

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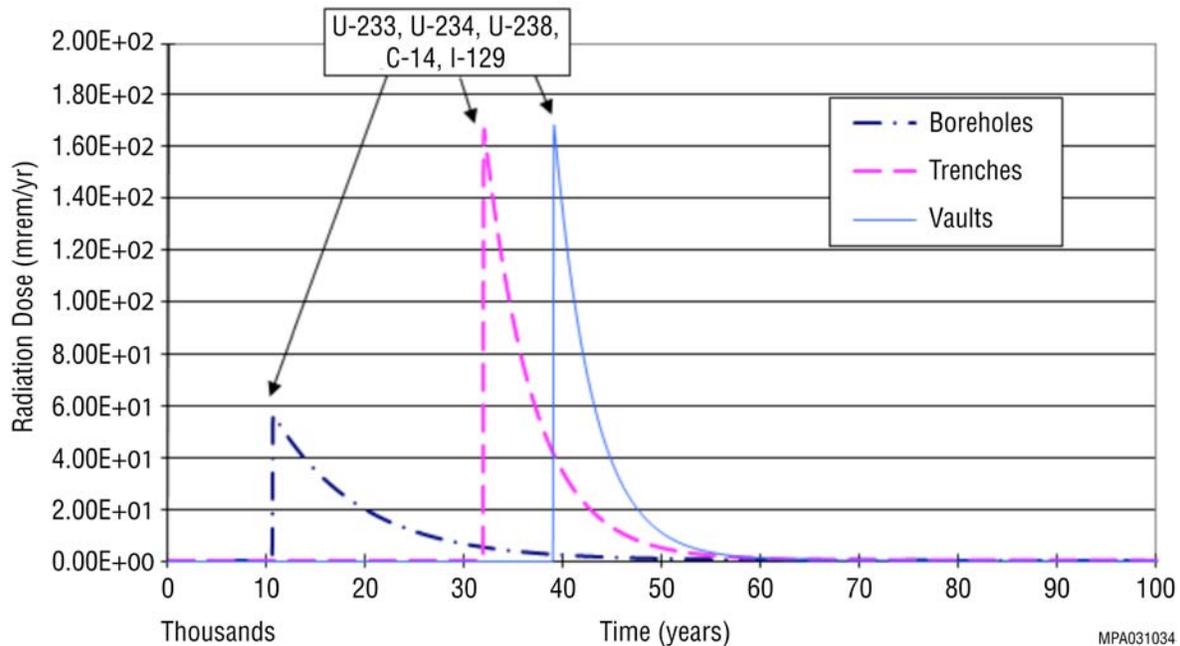


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8 **FIGURE 12.3-6 Temporal Plot of Radiation Doses Associated with the Use of Contaminated**
 9 **Groundwater within 100,000 Years of Disposal in a Commercial Vault Disposal Facility in**
 10 **Region III**

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1

2 **FIGURE 12.3-7 Temporal Plot of Radiation Doses Associated with the Use of Contaminated**
 3 **Groundwater within 100,000 Years of Disposal in a Commercial Borehole, Trench, or Vault**
 4 **Disposal Facility in Region IV**

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6

7 Figures 12.3-1, 12.3-3, and 12.3-5 are temporal plots of the annual doses associated with
 8 the use of contaminated groundwater for a time period that extends to 10,000 years in Regions I,
 9 II, and III, respectively. Figures 12.3-2, 12.3-4, 12.3-6, and 12.3-7 show these results for a period
 10 that extends to 100,000 years in all four geographic regions. Note that the time scale in the
 11 figures illustrating the results to 10,000 years is logarithmic, while it is linear in the figures
 12 illustrating the results to 100,000 years. A logarithmic time scale was used in the figures that
 13 extend the results to 10,000 years to better show the projected radiation doses to a hypothetical
 14 resident farmer shortly after closure of the disposal facility.

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25 C-14, I-129, and uranium are relatively soluble in water. (All are assumed to have a
 26 distribution coefficient [K_d] value of $0 \text{ cm}^3/\text{g}$; K_d measures the partitioning of radionuclides
 27 to the soil particles relative to the liquid in soil columns.) This solubility could lead to potentially
 28 significant groundwater doses to the resident farmer. The exposure pathways considered in this
 29 analysis include the ingestion of contaminated groundwater, soil, plants, meat, and milk;

1 external radiation; and the inhalation of radon gas and its short-lived progeny. Except for the
2 ingestion of contaminated groundwater, all pathways result from using the contaminated
3 groundwater for irrigation and feeding livestock. The doses in Region I are the highest of the
4 doses in the four regions, largely because of (1) the more humid environment there, (2) the
5 generally shorter distance to groundwater there than in the other three regions, and (3) the
6 assumed low K_{ds} for several important radionuclides.

7
8 Two disposal methods (vault and trench) are evaluated for Region II. The peak annual
9 dose within 10,000 years from the use of either of these two methods to dispose of the entire
10 GTCC waste inventory was calculated to be 1,200 mrem/yr. This dose would occur at about
11 100 years for the vault method and 34 years for the trench method after failure of the cover and
12 engineered barriers (which is assumed to begin 500 years after closure of the disposal facility).
13 These doses would be largely due to C-14 and I-129 (see Figure 12.3-3). A larger annual dose
14 was calculated to occur after 10,000 years from plutonium isotopes. This dose was calculated to
15 be 12,000 mrem/yr at 15,000 years in the future for trenches, and 3,000 mrem/yr at 57,000 years
16 for vaults (see Figure 12.3-4).

17
18 The peak annual doses in Region III from vault disposal of the entire GTCC waste
19 inventory are lower than those in Regions I and II. The peak annual dose within 10,000 years
20 was calculated to be 530 mrem/yr, and this dose occurs about 69 years after failure of the cover
21 and engineered barriers (which is assumed to begin 500 years after closure of the disposal
22 facility). This dose would also be largely due to C-14 and I-129 (see Figure 12.3-5). A larger
23 annual dose was calculated to occur in Region III after 10,000 years from plutonium isotopes.
24 This dose was calculated to be 2,600 mrem/yr and to occur about 33,000 years in the future
25 (see Figure 12.3-6).

26
27 The peak annual doses are lowest in Region IV. It is predicted that radionuclides would
28 not reach the groundwater table and the well of a hypothetical resident farmer within the first
29 10,000 years following disposal because of the much lower water infiltration rate assumed for
30 this region than for the other three regions. However, it was calculated that radionuclides would
31 reach the groundwater table after 10,000 years. The peak annual doses were calculated to be
32 170 mrem/yr for use of vaults and trenches, and 57 mrem/yr for use of boreholes. These peak
33 doses are estimated to occur at about 39,000, 32,000, and 11,000 years in the future for these
34 three disposal methods, respectively. These doses would mainly result from uranium isotopes,
35 C-14, and I-129 (see Figure 12.3-7). These results illustrate that as the distance to
36 the groundwater table increases (from boreholes to trenches to vaults), the length of time it
37 takes for the radionuclides to reach the groundwater table also increases.

38
39 As can be seen by these results, the maximum radiation doses are relatively high for all
40 regions except Region IV. This result is expected because the use of an arid site would likely
41 result in lower doses from the groundwater pathway than would the use of a more humid site.
42 The modeling approach used here is assumed to be conservative; the use of a longer distance to a
43 hypothetical receptor might be more realistic and would be evaluated as part of the NRC
44 licensing process.

45

1 The highest radiation doses and LCF risks occur in Region I. A disposal facility in this
2 region is expected to be in a generally humid environment, and the distance to the groundwater
3 table is expected to be relatively short. These properties of a humid site are expected to result in
4 higher radiation doses, higher LCF risks, and doses and risks that would occur at an earlier time
5 than those at more arid sites, such as those expected in Region IV.

6
7 The results given here are assumed to be conservative because the location selected for
8 the residential exposure is 100 m (330 ft) from the edge of the disposal facility. Use of a longer
9 distance, which might be more realistic for the sites being evaluated, would significantly lower
10 the estimated doses (i.e., by as much as 70%). A sensitivity analysis performed to determine the
11 effect of a distance longer than 100 m (330 ft) is presented in Appendix E.

12
13 These analyses assume that engineering controls would be effective for 500 years
14 following closure of the disposal facility. This means that essentially no infiltrating water would
15 reach the wastes from the top of the disposal units during the first 500 years. It is assumed that
16 after 500 years, the engineered barriers would begin to degrade, allowing infiltrating water to
17 come in contact with the disposed-of wastes. For purposes of analysis in this EIS, it is assumed
18 that the amount of infiltrating water that would contact the wastes would be 20% of the
19 site-specific natural infiltration rate for the area, and that the water infiltration rate around and
20 beneath the disposal facilities would be 100% of the natural rate for the area. This approach is
21 considered to be conservative because the engineered systems (including the disposal facility
22 cover) are expected to last significantly longer than 500 years, even in the absence of active
23 maintenance measures.

24
25 It is assumed that the Other Waste would be stabilized with grout or other material and
26 that this stabilizing agent would be effective for 500 years. Consistent with the assumptions used
27 for engineering controls, no credit was taken for the effectiveness of this stabilizing agent after
28 500 years in this analysis. That is, it is assumed that any water that would contact the wastes after
29 500 years would be able to leach radioactive constituents from the disposed-of materials. These
30 radionuclides could then move with the percolating groundwater to the underlying groundwater
31 system. This assumption is considered to be conservative because grout or other stabilizing
32 materials could retain their integrity for longer than 500 years.

33
34 Sensitivity analyses performed relative to these assumptions indicate that if a higher
35 infiltration rate to the top of the disposal facilities was assumed, the doses would increase in a
36 linear manner from those presented. Conversely, they would decrease in a linear manner with
37 lower infiltration rates. This finding indicates the need to ensure a good cover over the closed
38 disposal units. Also, the doses would be lower if the grout was assumed to last for a longer time.
39 Because of the long-lived nature of the radionuclides associated with the GTCC LLRW and
40 GTCC-like waste, any stabilization effort (such as grouting) would have to be effective for
41 longer than 5,000 years in order to substantially reduce doses that could result from potential
42 future leaching of the disposed-of waste.

43
44 The radiation doses presented in the post-closure assessment in this EIS are intended to
45 be used for comparing the performance of each land disposal method at each site evaluated. The
46 results indicate that the use of robust engineering designs and redundant measures in the disposal

1 facility could delay the potential release of radionuclides and could reduce the release to very
2 low levels, thereby minimizing potential groundwater contamination and associated human
3 health impacts in the future. DOE will consider the potential doses to the hypothetical farmer and
4 other factors in developing the preferred alternative as discussed in Section 2.9.

5

6

7 **12.4 REFERENCES FOR CHAPTER 12**

8

9 NRC (U.S. Nuclear Regulatory Commission), 1981, *Draft Environmental Impact Statement on*
10 *10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste,"*

11 NUREG-0782, Vol. 4, Appendices G–Q.

12

13 Poe, W.L., Jr., 1998, *Regional Binning for Continued Storage of Spent Nuclear Fuel and High-*
14 *Level Wastes*, Jason Technologies, Las Vegas, Nev.

15

16 Toblin, A.L., 1998, *Near Field Groundwater Transport and Gardener Dose Consequence*, Tetra
17 Tech NUS, Gaithersburg, Md.

18

19 Toblin, A.L., 1999, *Radionuclide Transport and Dose Commitment from Drinking Water from*
20 *Continued Storage and Degradation of Spent Nuclear Fuel and High Level Waste Materials*
21 *under Loss of Institutional Control*, Tetra Tech NUS, Gaithersburg, Md.

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13 APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter presents the laws, regulations, and other requirements that could impact implementation of the GTCC LLRW and GTCC-like waste disposal alternatives and the No Action Alternative described in this EIS. Federal environmental, cultural, and health and safety laws and regulations are summarized in Section 13.3; Executive Orders in Section 13.4; DOE Orders in Section 13.5; and state environmental laws, regulations, and agreements in Section 13.6. Radioactive material packaging and transportation laws and regulations are discussed in Section 13.7. Consultations with federal, state, and local agencies and federally recognized American Indian Nations are discussed in Section 13.8.

13.1 INTRODUCTION

The NOI announcing the preparation of this EIS states that DOE, in the EIS, will describe the statutory and regulatory requirements for the disposal alternatives and whether legislation or regulatory modifications may be needed for their implementation. This chapter identifies and summarizes the major federal and state laws and environmental requirements that could impact the implementation of the No Action Alternative and the alternatives for disposing of GTCC LLRW and GTCC-like wastes as described in the EIS and the NOI, and it describes some of the statutory or regulatory modifications that may be necessary to implement the disposal alternatives.

A number of federal environmental laws affect environmental protection, health, safety, compliance, and consultation at every location discussed in this EIS. In addition, certain environmental requirements have been delegated to state authorities for enforcement and implementation. Furthermore, state legislatures have adopted laws to protect health and safety and the environment. It is DOE policy to conduct its operations in a manner that ensures the protection of public health, safety, and the environment through compliance with all applicable federal and state laws, regulations, orders, and other requirements.

The various disposal alternatives analyzed in this EIS involve either the operation of an existing DOE facility or the construction and operation of new DOE or commercial facilities, and the transportation of materials. Actions required to comply with statutes, regulations, and other federal and state requirements may depend on whether a facility is newly built or is incorporated in whole or in part into an existing facility and whether a facility is owned and operated by DOE or by a commercial entity. Requirements vary among alternatives and states. The disposal sites considered in this EIS are located in the following states: Idaho (INL), Nevada (NNSS), New Mexico (LANL, WIPP, and WIPP Vicinity), South Carolina (SRS), and Washington (Hanford Site). Disposal could also occur on land withdrawn for the WIPP, land in the public domain, or privately held land not yet identified.

13.2 BACKGROUND

Requirements governing the management of radioactive waste arise primarily from the following sources: Congress, federal agencies, Executive Orders, legislatures of the affected states, and state agencies. In general, federal statutes establish national policies, create broad legal requirements, and authorize federal agencies to create regulations that conform to the statutes. Detailed implementation of these statutes is delegated to various federal agencies such as DOE, the U.S. Department of Transportation (DOT), and the EPA. For many environmental laws under EPA jurisdiction, state agencies may be delegated responsibility for the majority of program implementation activities, such as permitting and enforcement, but the EPA usually retains oversight of the delegated program.

Some applicable laws, such as NEPA, the Endangered Species Act (ESA), and the Emergency Planning and Community Right-to-Know Act, require specific reports and/or consultations rather than permits. Other applicable laws, such as CERCLA and the Federal Insecticide, Fungicide, and Rodenticide Act, establish general requirements that must be satisfied during site operation and closeout.

Executive Orders establish policies and requirements for federal agencies. They do not have the general applicability of statutes or regulations.

State statutes implement and supplement federal laws for protection of air and water quality and may address solid waste management programs; locally rare or endangered species; and local resource, historic, and cultural values.

Except for generic disposal facilities on nonfederal lands, the sites being considered for the disposal of GTCC LLRW and GTCC-like wastes are located on property controlled by DOE or other agencies of the federal government. DOE has authority to regulate the health and safety aspects of its nuclear facilities operations and certain environmental activities at its sites. The Atomic Energy Act of 1954, as amended, is the principal authority for DOE's regulatory activities. DOE exercises its regulatory authority primarily through the use of DOE directives and regulations.

13.3 APPLICABLE FEDERAL LAWS AND REGULATIONS

This section describes the federal environmental, cultural, safety, and health laws and several regulations that could apply to the No Action Alternative and the alternatives for disposal of GTCC LLRW and GTCC-like wastes described in the EIS. Section 13.3.1 describes the federal laws that could apply; Section 13.3.2 describes the federal laws and regulations specific to each disposal alternative and whether statutory or regulatory modifications may be necessary to effectuate the alternative. Section 13.3.3 provides descriptions of the federal laws and regulations applicable to the No Action Alternative.

1 **13.3.1 Laws of General Applicability**

2

3 The laws described in this section are those that could be applicable to the disposal
4 methodologies and sites assessed in this EIS and the No Action Alternative.

5

6

7 **American Indian Religious Freedom Act of 1978 (42 USC 1996).** This Act
8 (abbreviated AIRFA) reaffirms American Indian religious freedom under the First Amendment
9 and sets U.S. policy to protect and preserve the inherent and constitutional right of American
10 Indians to believe, express, and exercise their traditional religions. The Act requires that federal
11 actions avoid interfering with access to sacred locations and traditional resources that are integral
12 to the practice of tribal religions.

13

14

15 **Antiquities Act of 1906, as amended (16 USC 431 to 433).** This Act protects historic
16 and prehistoric ruins, monuments, and antiquities, including paleontological resources, on
17 federally controlled lands from appropriation, excavation, injury, and destruction without
18 permission.

19

20

21 **Archaeological and Historic Preservation Act of 1974, as amended (16 USC 469 to**
22 **469c).** This Act provides for the preservation of historical and archaeological data (including
23 relics and specimens) that might otherwise be irreparably lost or destroyed as the result of federal
24 actions. Under the law, federal agencies must notify the Secretary of Interior whenever they find
25 that a federal project may cause loss or destruction of significant scientific, prehistoric, or
26 archeological data.

27

28

29 **Archaeological Resources Protection Act of 1979, as amended (16 USC 470 et seq.).**
30 This Act requires a permit for any excavation or removal of archaeological resources from
31 federal or American Indian lands. Excavations must be undertaken for the purpose of furthering
32 archaeological knowledge in the public interest, and resources removed remain the property of
33 the United States.

34

35

36 **Atomic Energy Act of 1954 (42 USC 2011 et seq.).** The Atomic Energy Act (AEA)
37 provides the statutory framework for DOE and NRC regulation of nuclear material and activities,
38 including management of radioactive waste. DOE exercises regulatory authority over activities
39 conducted by DOE or on its behalf. NRC and Agreement States exercise regulatory authority
40 over activities conducted in the commercial sector through licensing regulations. The Act
41 authorizes DOE to set radiation protection standards for itself and its contractors at DOE nuclear
42 facilities. An extensive system of standards and requirements has been established through DOE
43 regulations and directives to protect health and minimize danger to life and property from
44 activities under DOE's jurisdiction. Requirements for environmental protection, safety, and
45 health are implemented at DOE sites primarily through contractual mechanisms that establish the
46 applicable DOE requirements for management and operating contractors.

47

1 Under the Act’s respective authorities granted to the DOE and the NRC, radioactive
2 waste generated or owned by DOE and disposed of at DOE facilities is not subject to the NRC’s
3 classification system for low-level radioactive waste or its definition of GTCC LLRW. Except as
4 specifically provided by law, DOE facilities are not subject to NRC licensing requirements.
5
6

7 **Bald and Golden Eagle Protection Act of 1973, as amended (16 USC 668 through**
8 **668d).** The Bald and Golden Eagle Protection Act, as amended, makes it unlawful to take,
9 pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere
10 in the United States. The U.S. Department of Interior (DOI) regulates activities that might
11 adversely affect bald and golden eagles.
12
13

14 **Clean Air Act of 1970, as amended (42 USC 7401 et seq.).** The Clean Air Act (CAA) is
15 intended to “protect and enhance the quality of the nation’s air resources so as to promote the
16 public health and welfare and the productive capacity of its population.” Section 118 of the Act
17 requires that each federal agency with jurisdiction over any property or facility engaged in any
18 activity that might result in the discharge of air pollutants comply with “all Federal, state,
19 interstate, and local requirements” with regard to the control and abatement of air pollution.
20

21 Section 109 directs the EPA to set NAAQS for criteria pollutants. These standards were
22 established for PM, SO₂, CO, O₃, NO₂, and lead. Section 111 of the Act requires the
23 establishment of national standards of performance for new or modified stationary sources of
24 atmospheric pollutants, and Section 160 requires that specific emission increases be evaluated
25 prior to permit approval to prevent significant deterioration of air quality. Specific standards for
26 releases of hazardous air pollutants (including radionuclides) are required per Section 112.
27 Radionuclide emissions from DOE facilities are regulated under the NESHAP Program under
28 40 CFR Part 61.
29
30

31 **Clean Water Act of 1972, as amended (33 USC 1251 et seq.).** This Act (abbreviated
32 CWA) provides water quality standards for the nation’s waterways, guidelines and limitations
33 for effluent discharges from point-source discharges, and the NPDES permit program that is
34 administered by the EPA. Sections 401 through 405 of the Water Quality Act of 1987 added
35 Section 402(p) to the CWA, which requires the EPA to establish regulations for permits for
36 stormwater discharges associated with industrial activities. Section 404 of the CWA requires
37 permits for the discharge of dredge or fill materials into navigable waters.
38
39

40 **Comprehensive Environmental Response, Compensation, and Liability Act of 1980**
41 **(42 USC 9604; also known as Superfund).** This Act (abbreviated CERCLA) provides authority
42 for federal and state governments to respond directly to hazardous substance incidents. The Act
43 requires reporting of spills, including radioactive spills, to the National Response Center.
44
45

1 **Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)**. The Endangered
2 Species Act (ESA) provides a program for the conservation of threatened and endangered
3 species and the ecosystems on which those species rely. The Act is intended to prevent the
4 further decline of endangered and threatened species and to restore those species and their
5 critical habitats. Section 7 requires federal agencies to ensure that any action authorized, funded,
6 or carried out by them is not likely to jeopardize the continued existence of listed species or
7 modify their critical habitat.

8
9
10 **Emergency Planning and Community Right-to-Know Act of 1986 (USC 11001**
11 **et seq.; also known as SARA Title III)**. This Act (abbreviated EPCRA) requires emergency
12 planning and notice to communities and government agencies concerning the presence and
13 release of specific chemicals. Under Subtitle A of the Act, federal facilities are required to
14 provide information, such as inventories of specific chemicals used or stored and releases that
15 occur from these sites, to the state emergency response commission and to the local emergency
16 planning committee to ensure that emergency plans are sufficient to respond to unplanned
17 releases of hazardous substances.

18
19
20 **Energy Policy Act of 2005 (P.L. 109-58)**. This Act requires DOE to prepare a report on
21 the cost and schedule to complete an EIS and ROD for permanent disposal of GTCC. It also
22 requires DOE to, prior to making a final decision on the disposal alternative or alternatives to be
23 implemented, submit to Congress a report that describes all disposal alternatives under
24 consideration and includes all information required in a 1987 DOE report to Congress related to
25 the safe disposal of GTCC. The Act further requires that DOE await action by Congress before
26 making a final decision on the disposal alternative or alternatives to be implemented.

27
28
29 **Federal Insecticide, Fungicide, and Rodenticide Act of 1947, as amended (7 USC 136**
30 **et seq.)**. This Act (abbreviated FIFRA) regulates the use, registration, and disposal of several
31 classes of pesticides to ensure that they are applied in a manner that protects the public, workers,
32 and the environment. Implementing regulations include recommended procedures for the
33 disposal and storage of pesticides and worker protection standards.

34
35
36 **Fish and Wildlife Coordination Act of 1934, as amended (16 USC 661 et seq.)**. The
37 Fish and Wildlife Coordination Act promotes effective planning and cooperation among federal,
38 state, public, and private agencies for the conservation and rehabilitation of the nation's fish and
39 wildlife. The Act requires consultation with the USFWS and state authorities whenever a federal
40 action involves impounding, diverting, channel deepening, or otherwise controlling or modifying
41 the waters of any stream or other body of water.

42
43
44 **Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021**
45 **et seq.)**. This Act (LLRWPA) provides that the federal government is responsible for the
46 disposal of LLRW with concentrations of radionuclides that exceed the NRC-established limits

1 for Class C radioactive waste (i.e., greater-than-Class C or GTCC LLRW). The Act specifies that
2 GTCC LLRW that results from activities licensed by the NRC is to be disposed of in an NRC-
3 licensed facility that has been determined to be adequate to protect public health and safety. NRC
4 regulations state that GTCC LLRW is generally not acceptable for near-surface disposal and
5 must be disposed of in a geologic repository unless alternative methods of disposal are proposed
6 to and approved by the NRC. The NRC regulations state that there may be some instances where
7 waste with concentrations greater than permitted for Class C would be acceptable for near-
8 surface disposal with special processing or design. Unless specifically provided by law, NRC
9 does not have authority to license and regulate facilities operated by or on behalf of DOE. DOE
10 believes the LLRWPA is best read to require that, if DOE disposes of GTCC LLRW in a non-
11 DOE facility, the facility must be licensed by NRC explicitly for the purpose of GTCC LLRW
12 disposal. DOE does not believe the LLRWPA limits DOE to using only non-DOE facilities for
13 GTCC LLRW disposal. However, legislation may be needed to clarify whether a GTCC LLRW
14 disposal facility owned or operated by or on behalf of DOE must be licensed by the NRC and, if
15 so, to authorize NRC to license such a facility.

16

17

18 **Migratory Bird Treaty Act of 1918, as amended (16 USC 703 et seq.).** This Act, as
19 amended, is intended to protect birds that have common migration patterns between the
20 United States and Canada, Mexico, Japan, and Russia. The Act stipulates that it is unlawful at
21 any time, by any means, or in any manner to “kill any migratory bird unless and except as
22 permitted by regulation.”

23

24

25 **National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.).** This
26 Act (abbreviated NEPA) establishes a national policy promoting awareness of the consequences
27 of human activity on the environment and consideration of environmental impacts during the
28 planning and decision-making stages of a project. It requires federal agencies to prepare an EIS
29 for “major Federal actions significantly affecting the quality of the human environment.”

30

31

32 **National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.).** This
33 Act (abbreviated NHPA) provides that sites with significant national historic value be placed on
34 the NRHP, maintained by the Secretary of the Interior. Section 106 of the Act requires a federal
35 agency to determine whether its proposed undertaking is the type of activity that could affect
36 historic properties. If so, the agency must consult with the appropriate SHPO or Tribal Historic
37 Preservation Officer. If an adverse effect is found, the consultation often ends with the execution
38 of a Memorandum of Agreement that indicates how the adverse effect will be resolved.

39

40

41 **Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001).**

42 This Act (abbreviated NAGPRA) establishes a means for American Indians to request the return
43 or repatriation of human remains and other cultural items presently held by federal agencies or
44 federally assisted museums or institutions. The Act also contains provisions regarding the
45 intentional excavation and removal of, inadvertent discovery of, and illegal trafficking in
46 American Indian human remains and cultural items. The law requires the establishment of a

1 review committee with monitoring and policymaking responsibilities, the development of
2 regulations for repatriation, and the development of procedures to handle unexpected discoveries
3 of graves or grave goods during activities on federal or tribal lands. All federal agencies that
4 manage land and/or are responsible for archaeological collections obtained from their lands or
5 generated by their activities must comply with the Act.
6
7

8 **Noise Control Act of 1972, as amended (42 USC 4901 et seq.).** Section 4 of the Noise
9 Control Act of 1972, as amended, directs all federal agencies to carry out “to the fullest extent
10 within their authority” programs within their jurisdictions in a manner that furthers a national
11 policy of promoting an environment free from noise jeopardizing health and welfare.
12
13

14 **Paleontological Resources Preservation Act of 2009 (16 USC 470aaa et seq.).** This
15 Act promotes the preservation and use of paleontological resources on federal lands by
16 prohibiting the following: (1) taking or damaging paleontological resources located on federal
17 lands without a permit or permission, (2) selling or purchasing such resources received from
18 federal lands, and (3) submitting false records or identification for such resources removed from
19 federal lands.
20
21

22 **Pollution Prevention Act of 1990 (42 USC 13101 et seq.).** This Act establishes a
23 national policy for waste management and pollution control. Source reduction is given first
24 preference, followed by environmentally safe recycling, then by treatment, and finally by
25 disposal.
26
27

28 **Resource Conservation and Recovery Act of 1976, as amended (42 USC 6901**
29 **et seq.).** Under this Act (abbreviated RCRA), which amended the Solid Waste Disposal Act of
30 1965, the EPA defines and identifies hazardous waste; establishes standards for its
31 transportation, treatment, storage, and disposal; and requires permits for persons engaged in
32 hazardous waste activities. Section 3006 of RCRA allows states to establish and administer these
33 permit programs with EPA approval. The Federal Facility Compliance Act of 1992
34 (42 USC 6961 et seq.) amended RCRA to require that all federal agencies having jurisdiction
35 over a solid waste facility or disposal site, or engaged in the management of solid or hazardous
36 waste, are subject to all applicable federal, state, and local laws, regulations, and ordinances
37 addressing solid and hazardous waste.
38
39

40 **Safe Drinking Water Act of 1974, as amended (42 USC 300(f) et seq.).** The primary
41 objective of the Safe Drinking Water Act (SDWA) is to protect the quality of public drinking
42 water supplies and sources of drinking water. The implementing regulations, administered by the
43 EPA unless delegated to states, establish standards applicable to public water systems. These
44 regulations include maximum contaminant levels (including those for radioactivity) in public
45 water systems that have at least 15 service connections used by year-round residents or that
46 regularly serve at least 25 year-round residents.
47

1 **Toxic Substances Control Act of 1976 (15 USC 2601 et seq.)**. This Act (abbreviated
2 TSCA) provides the EPA with the authority to require testing of chemical substances entering
3 the environment and to regulate them as necessary. The law complements and expands existing
4 toxic substance laws such as Section 112 of the CAA and Section 307 of the CWA. TSCA
5 requires compliance with inventory reporting and chemical control provisions of the legislation
6 to protect the public from the risks of exposure to chemicals.

9 **13.3.2 Statutes and Regulations Specific to the Disposal Alternatives**

10
11 This section describes the major statutes and regulations that impact implementation of
12 the geologic and nongeologic disposal alternatives considered in this EIS. It also describes
13 statutory or regulatory modifications that might be necessary for GTCC LLRW and GTCC-like
14 waste disposal to occur.

17 **13.3.2.1 Geologic Disposal**

18
19 The statute that governs disposal at WIPP is the Waste Isolation Pilot Plant Land
20 Withdrawal Act.

21
22
23 **Waste Isolation Pilot Plant Land Withdrawal Act, as amended (P.L. 102-579)**. This
24 Act withdrew land from the public domain for the purpose of creating and operating WIPP, the
25 geologic repository in New Mexico designated as the national disposal site for TRU waste
26 generated by atomic energy defense activities. The Act defines the characteristics and amount of
27 waste that will be disposed of at the facility and stipulates that TRU waste must be transported to
28 WIPP in NRC-certified shipping containers. The Act exempts waste to be disposed at WIPP
29 from the RCRA land disposal restrictions.

30
31 The WIPP Land Withdrawal Act (LWA) authorizes the EPA to issue regulations
32 regarding the disposal of TRU radioactive waste at WIPP. The EPA exercises this regulatory
33 authority through 40 CFR Part 191, “Environmental Radiation Protection Standards for
34 Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive
35 Wastes.” WIPP-specific disposal regulations are specified in 40 CFR Part 194, “Criteria for the
36 Certification and Re-Certification of the Waste Isolation Pilot Plant’s Compliance with the
37 40 CFR Part 191 Disposal Regulations.”

38
39 The WIPP LWA limits the use of WIPP to the disposal of TRU waste generated by
40 atomic defense activities. In addition, it established certain limits on the surface dose rate, total
41 volume, total radioactivity (curies), and maximum activity level (curies per liter averaged over
42 the volume of the canister) for waste received at WIPP. The total capacity for disposal of TRU
43 waste established under the WIPP LWA is 175,675 m³ (6.2 million ft³). The Consultation and
44 Cooperative Agreement with the State of New Mexico (1981) established a total RH TRU
45 capacity of 7,080 m³ (250,000 ft³), with the remaining capacity for CH TRU at 168,500 m³
46 (5.95 million ft³). In addition, the WIPP LWA limits the total radioactivity of RH waste to

1 5.1 million curies. For comparison, the GTCC LLRW and GTCC-like CH volume, RH volume,
2 and RH total radioactivity are approximately 6,650 m³ (235,000 ft³), 5,050 m³ (178,000 ft³), and
3 157 million curies, respectively. On the basis of emplaced and anticipated waste volumes, the
4 disposal of all GTCC LLRW and GTCC-like waste at WIPP would exceed the limits for RH
5 volume and RH total activity. The majority of the GTCC LLRW and GTCC-like RH volume is
6 from the Other Waste category (e.g., DOE non-defense TRU), and activated metal waste
7 contributes most of the RH activity. The WIPP LWA also limits disposal in WIPP to defense-
8 generated TRU waste. Therefore, the implementation of the WIPP alternative for all GTCC
9 LLRW and GTCC-like waste would require modification of the WIPP LWA to authorize
10 acceptance of non-defense and non-TRU waste, an increase in the disposal capacity limit for RH
11 total curies, and a change to the Consultation and Cooperative Agreement to authorize an
12 increase in the total volume of all RH TRU waste. In addition, a corresponding modification of
13 the facility's RCRA permit with the New Mexico Environment Department, a modification to
14 the Agreement for Consultation and Cooperation between U.S. Department of Energy and the
15 State of New Mexico for the Waste Isolation Pilot Plant (updated April 18, 1988), which sets
16 limits (identified above) on the total volume of RH TRU received at WIPP, and compliance
17 certification with the EPA might be required. RH GTCC LLRW and GTCC-like waste would be
18 packaged in shielded containers and would not exceed the surface dose and curies-per-liter limits
19 for RH waste in the WIPP LWA. The Low-Level Radioactive Waste Policy Amendment Act
20 (LLRWPA) requires that GTCC waste be disposed of in a facility licensed by the NRC.
21 Because the LLRWPA specifies that GTCC LLRW be disposed of in a facility licensed by the
22 NRC, implementation of the WIPP alternative may also require legislative changes in order for
23 WIPP to be utilized as a disposal facility for GTCC LLRW consistent with the LLRWPA.

24 25 26 **13.3.2.2 Nongeologic Disposal**

27
28 Statutes applicable to nongeologic disposal of GTCC LLRW and GTCC-like wastes
29 include the Low-Level Radioactive Waste Policy Amendments Act of 1985, Atomic Energy Act
30 of 1954, WIPP Land Withdrawal Act, and Federal Land Policy and Management Act.

31
32
33 **Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021**
34 **et seq.).** This Act (LLRWPA) provides that the federal government is responsible for the
35 disposal of LLRW with concentrations of radionuclides that exceed the NRC-established limits
36 for Class C radioactive waste (i.e., greater-than-Class C or GTCC LLRW). The Act specifies that
37 GTCC LLRW that results from activities licensed by the NRC is to be disposed of in an NRC-
38 licensed facility that has been determined to be adequate to protect public health and safety. NRC
39 regulations state that GTCC LLRW is generally not acceptable for near-surface disposal and
40 must be disposed of in a geologic repository unless alternative methods of disposal are proposed
41 to and approved by the NRC. The NRC regulations state that there may be some instances where
42 waste with concentrations greater than permitted for Class C would be acceptable for near-
43 surface disposal with special processing or design. Unless specifically provided by law, NRC
44 does not have authority to license and regulate facilities operated by or on behalf of DOE. DOE
45 believes the LLRWPA is best read to require that, if DOE disposes of GTCC LLRW in a non-
46 DOE facility, the facility must be licensed by NRC explicitly for the purpose of GTCC LLRW

1 disposal. DOE does not believe the LLRWPA limits DOE to using only non-DOE facilities for
2 GTCC LLRW disposal. However, legislation may be needed to clarify whether a GTCC LLRW
3 disposal facility owned or operated by or on behalf of DOE must be licensed by NRC and if so,
4 to authorize NRC to license such a facility.
5
6

7 **Atomic Energy Act of 1954 (42 USC 2011 et seq.).** The Atomic Energy Act (AEA)
8 provides the statutory framework for DOE and NRC regulation of nuclear material and activities,
9 including management of radioactive waste. DOE exercises regulatory authority over activities
10 conducted by DOE or on its behalf. NRC and Agreement States exercise regulatory authority
11 over activities conducted in the commercial sector through licensing regulations. The Act
12 authorizes DOE to set radiation protection standards for itself and its contractors at DOE nuclear
13 facilities. An extensive system of standards and requirements has been established through DOE
14 regulations and directives to protect health and minimize danger to life and property from
15 activities under DOE's jurisdiction. Requirements for environmental protection, safety, and
16 health are implemented at DOE sites primarily through contractual mechanisms that establish the
17 applicable DOE requirements for management and operating contractors.
18
19

20 **Waste Isolation Pilot Plant Land Withdrawal Act, as Amended (P.L. 102-579).** Two
21 locations in the WIPP Vicinity are considered for the disposal of GTCC waste in an above-grade
22 vault, near-surface trench, or intermediate-depth borehole: (1) property inside the WIPP LWB
23 and (2) property on BLM-administered land outside and adjacent to the WIPP Land Withdrawal
24 Boundary (LWB). Siting a vault, trench, or borehole facility for GTCC waste inside the WIPP
25 LWB would be subject to the limits of the WIPP LWA (as discussed for WIPP); therefore,
26 federal legislation to develop such facilities would be required. Siting a vault, trench, or borehole
27 facility on BLM-administered land outside the WIPP LWB would require a land withdrawal in
28 accordance with DOI regulations at 40 CFR 2300, "Land Withdrawals."
29

30 **Federal Land Policy and Management Act, as amended (43 USC 1701 et seq.).** The
31 Federal Land Policy and Management Act (FLPMA) is applicable to the alternatives to dispose
32 of GTCC LLRW and GTCC-like wastes in a new trench facility or borehole facility on
33 government property in the vicinity of WIPP. Use of that land for a permanent radioactive waste
34 disposal facility would require that it be withdrawn from the public domain, under the FLPMA,
35 as was done for the WIPP land withdrawal.
36
37

38 **13.3.2.3 Laws and Regulations Specific to the No Action Alternative** 39 40

41 **Atomic Energy Act of 1954 (42 USC 2011 et seq.).** The Atomic Energy Act (AEA)
42 provides the statutory framework for DOE and NRC regulation of nuclear material and activities,
43 including management of radioactive waste. DOE exercises regulatory authority over activities
44 conducted by DOE or on its behalf. NRC and Agreement States exercise regulatory authority
45 over activities conducted in the commercial sector through licensing regulations. The Act
46 authorizes DOE to set radiation protection standards for itself and its contractors at DOE nuclear

1 facilities. An extensive system of standards and requirements has been established through DOE
2 regulations and directives to protect health and minimize danger to life and property from
3 activities under DOE’s jurisdiction. Requirements for environmental protection, safety, and
4 health are implemented at DOE sites primarily through contractual mechanisms that establish the
5 applicable DOE requirements for management and operating contractors.

6
7 Under the No Action Alternative, GTCC LLRW from commercial nuclear reactors would
8 continue to be stored on-site at NRC-licensed facilities pursuant to 10 CFR Part 50, “Domestic
9 Licensing of Production and Utilization Facilities.” These licenses are issued for a 40-year term
10 and can be renewed. Alternatively, or in the event that a facility with a Part 50 license is going
11 through decommissioning or has been decommissioned, GTCC LLRW would be stored in an
12 independent spent fuel storage installation (ISFSI) licensed in accordance with 10 CFR Part 72,
13 “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level
14 Radioactive Waste, and Reactor-Related Greater-Than-Class C Waste.” Licenses issued for
15 ISFSIs have a 20-year term and can be renewed. Sealed sources would remain at generator or
16 other licensee sites. Other Waste would continue to be stored and managed at generator or other
17 interim storage sites.

18
19 Under the No Action Alternative, GTCC-like wastes would continue to be stored in
20 accordance with DOE’s existing authorities and DOE directives.

21
22
23 **Low-Level Radioactive Waste Policy Amendments Act of 1985 (42 USC 2021**
24 **et seq.).** This Act (LLRWPA) provides that the federal government is responsible for the
25 disposal of LLRW with concentrations of radionuclides that exceed the NRC-established limits
26 for Class C radioactive waste (i.e., greater-than-Class C or GTCC LLRW). The Act specifies that
27 GTCC LLRW that results from activities licensed by the NRC is to be disposed of in an NRC-
28 licensed facility that has been determined to be adequate to protect public health and safety. NRC
29 regulations state that GTCC LLRW is generally not acceptable for near-surface disposal and
30 must be disposed of in a geologic repository unless alternative methods of disposal are proposed
31 to and approved by the NRC. The NRC regulations state that there may be some instances where
32 waste with concentrations greater than permitted for Class C would be acceptable for near-
33 surface disposal with special processing or design. Unless specifically provided by law, NRC
34 does not have authority to license and regulate facilities operated by or on behalf of DOE. DOE
35 believes the LLRWPA is best read to require that, if DOE disposes of GTCC LLRW in a non-
36 DOE facility, the facility must be licensed by NRC explicitly for the purpose of GTCC LLRW
37 disposal. DOE does not believe the LLRWPA limits DOE to using only non-DOE facilities for
38 GTCC LLRW disposal. However, legislation may be needed to clarify whether a GTCC LLRW
39 disposal facility owned or operated by or on behalf of DOE must be licensed by the NRC and, if
40 so, to authorize NRC to license such a facility.

41 42 43 **13.4 APPLICABLE EXECUTIVE ORDERS**

44
45 This section identifies environmental-, health-, and safety-related Executive Orders
46 applicable to the GTCC LLRW and GTCC-like waste disposal alternatives and the No Action
47 Alternative discussed in this EIS.

1 **Executive Order 11514 (Protection and Enhancement of Environmental Quality,**
2 **March 5, 1970), as amended by Executive Order 11991 (May 24, 1977).** This Order requires
3 federal agencies to continually monitor and control their activities in order to (1) protect and
4 enhance the quality of the environment and (2) develop procedures to ensure the fullest
5 practicable provision of timely public information and understanding of the federal plans and
6 programs that might have potential environmental impacts so that the views of interested parties
7 can be obtained. DOE issued regulations at 10 CFR Part 1021 and DOE Order 451.1B to ensure
8 compliance with this Order.

9
10
11 **Executive Order 11593 (Protection and Enhancement of the Cultural Environment,**
12 **May 13, 1971).** This Order directs federal agencies to locate, inventory, and nominate qualified
13 properties under their jurisdiction or control to the NRHP. The federal agencies are also to
14 initiate procedures to provide for the maintenance, rehabilitation, or restoration of sites on the
15 NRHP.

16
17
18 **Executive Order 11988 (Floodplain Management, May 24, 1977).** This Order,
19 implemented by DOE in 10 CFR Part 1022, requires federal agencies to establish procedures to
20 ensure that the potential effects of flood hazards and floodplain management are considered for
21 any action undertaken in a floodplain, and that floodplain impacts be avoided to the extent
22 practicable.

23
24
25 **Executive Order 11990 (Protection of Wetlands, May 24, 1977).** This Order directs
26 federal agencies to avoid new construction in wetlands unless there is no practicable alternative
27 and unless the proposed action includes all practicable measures to minimize harm to wetlands
28 that might result from such use. DOE requirements for complying with procedures for reviewing
29 wetlands activity are in 10 CFR Part 1022.

30
31
32 **Executive Order 12088 (Federal Compliance with Pollution Control Standards,**
33 **October 13, 1978, as amended by Executive Order 12580, Superfund Implementation,**
34 **January 23, 1987).** This Order directs federal agencies to comply with applicable administrative
35 and procedural pollution control standards established by, but not limited to, the CAA, Noise
36 Control Act, CWA, SDWA, TSCA, and RCRA.

37
38
39 **Executive Order 12656 (Assignment of Emergency Preparedness Responsibilities,**
40 **November 18, 1988).** This Order assigns emergency preparedness responsibilities to federal
41 departments and agencies.

42
43
44 **Executive Order 12699 (Seismic Safety of Federal and Federally Assisted or**
45 **Regulated New Building Construction, January 5, 1990).** This Order requires federal agencies
46 to reduce risks to occupants of buildings owned, leased, or purchased by the federal government

1 or buildings constructed with federal assistance and to persons who would be affected by failures
2 of federal buildings in earthquakes; improve the capability of existing federal buildings to
3 function during or after an earthquake; and reduce earthquake losses of public buildings, all in a
4 cost-effective manner. Each federal agency responsible for the design and construction of a
5 federal building shall ensure that the building is designed and constructed in accordance with
6 appropriate seismic design and construction standards.

7
8
9 **Executive Order 12898 (Federal Actions to Address Environmental Justice in**
10 **Minority Populations and Low-Income Populations, February 11, 1994).** This Order requires
11 each federal agency to identify and address any disproportionately high and adverse human
12 health or environmental effects of its programs, policies, and activities on minority and low-
13 income populations.

14
15
16 **Executive Order 13007 (Indian Sacred Sites, May 24, 1996).** This Order directs
17 federal agencies that are managing federal lands — to the extent that is practicable, permitted by
18 law, and not clearly inconsistent with essential agency functions — to (1) accommodate access
19 to and ceremonial use of Indian sacred sites by Indian religious practitioners and (2) avoid
20 adversely affecting the physical integrity of such sacred sites.

21
22
23 **Executive Order 13045 (Protection of Children from Environmental Health Risks**
24 **and Safety Risks, April 21, 1997), as amended by Executive Order 13229 (October 9, 2001).**
25 This Order requires each federal agency to make it a high priority to identify and assess
26 environmental health risks and safety risks that may disproportionately affect children and to
27 ensure that its policies, programs, activities, and standards address disproportionate risks to
28 children that result from environmental health risks or safety risks.

29
30
31 **Executive Order 13112 (Invasive Species, February 3, 1999).** This Order requires
32 federal agencies to prevent the introduction of invasive species; to provide for their control; and
33 to minimize their economic, ecological, and human health impacts.

34
35
36 **Executive Order 13175 (Consultation and Coordination with Indian Tribal**
37 **Governments, November 6, 2000).** This Order requires federal agencies to consult, to the
38 greatest extent practicable and to the extent permitted by law, with tribal governments prior to
39 taking actions that affect federally recognized tribal governments. Federal agencies must also
40 assess the impact of federal government plans, projects, programs, and activities on tribal trust
41 resources and assure that tribal government rights and concerns are considered during the
42 development of such plans, projects, programs, and activities.

43
44
45 **Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory**
46 **Birds, January 10, 2001).** This Order requires each federal agency that takes actions that have,

1 or are likely to have, a measurable negative effect on migratory bird populations to develop and
2 implement, by 2003, an MOU with the USFWS that shall promote the conservation of migratory
3 bird populations.
4
5

6 **Executive Order 13423 (Strengthening Federal Environmental, Energy, and**
7 **Transportation Management, January 26, 2007).** This Order requires federal agencies to lead
8 by example in advancing the nation's energy security and environmental performance by
9 achieving specific goals in the following areas: energy efficiency, greenhouse gas reduction,
10 renewable energy use, reduction in water consumption, acquisition of environmentally preferable
11 products, reduction in the use of toxic and hazardous chemicals and materials, high-performance
12 and sustainable building, reduction in petroleum use, use of alternative fuel, and electronics
13 management. Federal agencies are also required to maintain cost-effective waste prevention and
14 recycling programs at their facilities.
15
16

17 **Executive Order 13514 (Federal Leadership in Environmental, Energy, and**
18 **Economic Performance, October 5, 2009).** This Order builds upon Executive Order 13423 by
19 establishing quantitative goals for water use reduction, waste diversion, and the purchase of
20 environmentally preferable products and services and by requiring that federal agencies develop
21 and achieve agency-specific targets for reducing greenhouse gas emissions.
22
23

24 **13.5 APPLICABLE U.S. DEPARTMENT OF ENERGY DIRECTIVES**

25

26 The AEA authorizes DOE to establish standards to protect health and minimize the
27 dangers to life or property from activities under DOE's jurisdiction. The major DOE directives
28 pertaining to the alternatives in this EIS are described below.
29
30

31 **DOE Order 144.1, *American Indian Tribal Government Interactions and Policy***
32 **(January 16, 2009).** This order communicates departmental, programmatic, and field
33 responsibilities for interacting with American Indian governments; transmits DOE's American
34 Indian and Alaska Native Tribal Government Policy, including its guiding principles; and
35 transmits the framework for implementation of the policy.
36
37

38 **DOE Order 151.1C, *Comprehensive Emergency Management System* (November 2,**
39 **2005).** This Order establishes policy and assigns and describes roles and responsibilities for the
40 DOE Emergency Management System. The Emergency Management System provides the
41 framework for development, coordination, control, and direction of all emergency planning,
42 preparedness, readiness assurance, response, and recovery actions.
43
44

45 **DOE Order 231.1A, *Environment, Safety, and Health Reporting* (August 19, 2003;**
46 **Change 1, June 3, 2004).** This Order establishes responsibilities and requirements to ensure the

1 timely collection, reporting, analysis, and dissemination of information on environmental, safety,
2 and health issues as required by law or regulations or as needed to ensure that DOE is kept fully
3 informed on a timely basis about events that could adversely affect the health and safety of the
4 public or the workers, the environment, the intended purpose of DOE facilities, or the credibility
5 of DOE.
6
7

8 **DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital***
9 ***Assets (July 28, 2006)***. This Order provides project management direction for the acquisition of
10 capital assets that are delivered on schedule, within budget, and fully capable of meeting mission
11 performance standards; safeguards and security standards; and environmental, safety, and health
12 standards.
13

14
15 **DOE Order 414.1C, *Quality Assurance (June 17, 2005)***. The Order establishes
16 principles to ensure that products and services meet or exceed customers' expectations and to
17 achieve quality assurance for all work.
18

19
20 **DOE Order 420.1B *Facility Safety (December 22, 2005)***. This Order establishes facility
21 safety requirements related to nuclear safety design, criticality safety, fire protection, and the
22 mitigation of hazards related to natural phenomena.
23

24
25 **DOE Order 425.1C, *Startup and Restart of Nuclear Facilities (March 13, 2003)***. This
26 Order establishes requirements for the startup of new nuclear facilities and for the restart of
27 existing nuclear facilities that have been shut down. The requirements specify a readiness review
28 process that must demonstrate that it is safe to start (or restart) the subject facility. The facility
29 must be started (or restarted) only after documented independent reviews of readiness have been
30 conducted and after the approvals specified in the Order have been received.
31

32
33 **DOE Order 430.1B, *Real Property Asset Management (September 24, 2003;***
34 ***Change 1, February 8, 2008)***. This Order establishes a corporate, holistic, and performance-
35 based approach to real property life-cycle asset management that links real property asset
36 planning, programming, budgeting, and evaluation to program mission projections and
37 performance outcomes. This Order also identifies requirements and establishes reporting
38 mechanisms and responsibilities for real property asset management.
39

40
41 **DOE Order 430.2B, *Departmental Energy, Renewable Energy and Transportation***
42 ***Management (February 27, 2008)***. The Order implements Executive Order 13423 and provides
43 the goals, requirements, and responsibilities for managing DOE energy use, buildings, and
44 vehicle fleets.
45
46

1 **DOE Order 433.1A, *Maintenance Management Program for DOE Nuclear Facilities***
2 **(February 13, 2007)**. This Order defines the safety management program required for the
3 maintenance and reliable performance of structures, systems, and components that are part of the
4 safety basis required at DOE Hazard Category 1, 2, and 3 nuclear facilities.
5
6

7 **DOE Order 435.1, *Radioactive Waste Management (July 9, 1999, Change 1,***
8 **August 28, 2001, Certified, January 1, 2007)**. This Order and its associated manual and
9 guidance establish responsibilities and requirements for the management of DOE high-level
10 radioactive waste, TRU waste, LLRW, and the radioactive component of mixed waste. These
11 documents provide detailed radioactive waste management requirements, including those related
12 to waste that is incidental to reprocessing determinations; waste characterization, certification,
13 treatment, storage, and disposal; and radioactive waste facility design and closure.
14
15

16 **DOE Order 440.1B, *Worker Protection Program for DOE (Including National***
17 ***Nuclear Security Administration) Federal Employees (May 17, 2007)***. This Order establishes
18 the framework for an effective worker protection program that reduces or prevents injuries,
19 illnesses, and accidental losses by providing DOE and NNSA federal employees with safe and
20 healthful workplaces.
21
22

23 **DOE Order 450.1A, *Environmental Protection Program (June 4, 2008)***. This Order
24 requires implementation of sound stewardship practices that are protective of the air, water, land,
25 and other natural and cultural resources impacted by DOE operations, and by which DOE
26 cost-effectively meets or exceeds compliance with applicable environmental, public health, and
27 resource protection requirements.
28
29

30 **DOE Order 451.1B, *National Environmental Policy Act Compliance Program***
31 **(October 26, 2000; Change 1, September 28, 2001)**. This Order establishes internal
32 requirements and responsibilities for implementing NEPA, the CEQ Regulations Implementing
33 the Procedural Provisions of NEPA (40 CFR Parts 1500–1508), and the DOE NEPA
34 Implementing Procedures (10 CFR Part 1021). Establishing these requirements and
35 responsibilities ensures efficient and effective implementation of DOE’s NEPA responsibilities
36 through teamwork, controlling the cost and time for the NEPA process, and maintaining quality.
37
38

39 **DOE Order 460.1B, *Packaging and Transportation Safety (April 4, 2003)***. This Order
40 sets forth DOE policy and assigns responsibilities for the proper packaging and transportation of
41 DOE off-site shipments, on-site transfers of hazardous materials, and modal transport.
42
43

44 **DOE Order 460.2A, *Departmental Materials Transportation and Packaging***
45 ***Management (December 22, 2004)***. This Order requires DOE operations to be conducted in
46 compliance with all applicable international, federal, state, local, and tribal laws, rules, and

1 regulations governing materials transportation that are consistent with federal regulations, unless
2 exemptions or alternatives are approved. This Order also states that it is DOE policy that
3 shipments comply with the DOT regulations at 49 CFR Parts 100 through 185, except those that
4 infringe upon maintenance of classified information.

5
6
7 **DOE Order 470.2B, *Independent Oversight and Performance Assurance Program***
8 **(October 31, 2002).** This Order establishes the Independent Oversight Program that is designed
9 to enhance DOE safeguards and security; cyber security; emergency management; and
10 environment, safety, and health programs by providing DOE and contractor managers, Congress,
11 and other stakeholders with an independent evaluation of the adequacy of DOE policy and the
12 effectiveness of line management performance in these and other critical functions.

13
14
15 **DOE Order 470.4A, *Safeguards and Security Program* (May 25, 2007).** This Order
16 establishes responsibilities for the DOE Safeguards and Security Program and the managerial
17 framework for implementing DOE policy on integrated safeguards and security management.

18
19
20 **DOE Order 5400.5, *Radiation Protection of the Public and the Environment***
21 **(February 8, 1990; Change 2, January 7, 1993).** This Order establishes standards and
22 requirements for DOE operations for protection of members of the public and the environment
23 against undue risk from radiation. It is DOE policy to implement legally applicable radiation
24 protection standards and to consider and adopt, as appropriate, recommendations by authoritative
25 organizations, such as NCRP and ICRP. It is also DOE policy to adopt and implement standards
26 generally consistent with those of the NRC for DOE facilities and activities not subject to NRC
27 licensing authority.

28
29
30 **DOE Order 5480.20A, *Personnel Selection, Qualification, and Training Requirements***
31 **for DOE Nuclear Facilities (November 15, 1994; Change 1, July 12, 2001).** This Order
32 establishes the selection, qualification, and training requirements for DOE contractor personnel
33 involved in the operation, maintenance, and technical support of DOE nuclear reactors and
34 nonreactor nuclear facilities. DOE objectives under this Order are to ensure the development and
35 implementation of contractor-administered training programs that provide consistent and
36 effective training for personnel at DOE nuclear facilities. The Order contains minimum
37 requirements that must be included in training and qualification programs.

38 39 40 **13.6 STATE ENVIRONMENTAL LAWS, REGULATIONS, AND AGREEMENTS**

41
42 Certain environmental requirements have been delegated to state authorities for
43 implementation and enforcement. It is DOE policy to conduct its operations in an
44 environmentally safe manner that complies with all applicable laws, regulations, and standards,
45 including state laws and regulations. A list of state environmental laws, regulations, and

1 agreements potentially applicable to the GTCC LLRW disposal alternatives and the No Action
2 Alternative discussed in this EIS is provided in Table 13.6-1.

3 4 5 **13.7 RADIOACTIVE MATERIAL PACKAGING AND TRANSPORTATION** 6 **REGULATIONS**

7
8 DOE has broad authority under the AEA to regulate all aspects of activities involving
9 radioactive materials that are undertaken by DOE or on its behalf, including the transportation of
10 radioactive materials. DOE exercises this authority to regulate certain DOE shipments, such as
11 shipments undertaken by governmental employees or shipments involving special circumstances.
12 In most cases that do not involve national security, DOE utilizes commercial carriers that
13 undertake shipments of DOE material under the same terms and conditions as commercial
14 shipments. These shipments are subject to regulation by DOT and other entities, as appropriate.
15 As a matter of policy, all DOE shipments are undertaken in accordance with the requirements
16 and standards that apply to comparable commercial shipments, except where there is a
17 determination that national security or another critical interest requires different action. In
18 implementing this policy, DOE cooperates with federal, state, local, and tribal entities and
19 utilizes existing expertise and resources to the extent practicable. In all cases, DOE will achieve
20 a level of protection that meets or exceeds the level of protection associated with comparable
21 commercial shipments.

22
23 DOT and NRC have the primary responsibility for federal regulations governing
24 commercial radioactive material transportation. The Hazardous Materials Transportation Act of
25 1975, as amended (49 U.S.C. 5105, et seq.), requires DOT to establish regulations for the safe
26 transportation of hazardous materials in commerce (including radioactive materials). Title 49 of
27 the CFR contains DOT standards and requirements for the packaging, transporting, and handling
28 of radioactive materials for all modes of transportation. DOT's Hazardous Materials Regulations,
29 or HMR, on the transportation of hazardous and radioactive materials can be found in 49 CFR
30 Parts 171 through 180. In addition, the requirements for motor carrier transportation can be
31 found in 49 CFR Parts 350 through 399, and the requirements for transportation by rail can be
32 found in 49 CFR Parts 200 through 268. The NRC sets additional design and performance
33 standards for packages that carry materials with higher levels of radioactivity. The NRC
34 regulations pertaining to radioactive materials transportation are found in 10 CFR Part 71. These
35 regulations include detailed requirements for certification testing of packaging designs. This
36 certification testing involves a variety of conditions such as heating, free dropping onto an
37 unyielding surface, immersing in water, dropping the package onto a vertical steel bar, and
38 checking gas tightness.

39
40 The transportation casks used to transport radioactive material are subject to numerous
41 inspections and tests. These tests are designed to ensure that cask components are properly
42 assembled and meet applicable safety requirements. Tests and inspections are clearly identified
43 in the Safety Analysis Report for Packaging and/or the Certificate of Compliance for each cask.
44 Casks are loaded and inspected by registered users in compliance with approved quality
45 assurance programs. Operations involving the casks are conducted in compliance with
46 10 CFR 71.91. Reports of defects or accidental mishandling are submitted to the NRC.

TABLE 13.6-1 State Requirements That Might Apply to GTCC LLRW and GTCC-Like Waste Disposal

Law/Regulation/Agreement	Citation	Requirements
Idaho		
Idaho Environmental Protection and Health Act	<i>Idaho Code</i> (IC), Title 39, Health and Safety, Chapter 1, Department of Health and Welfare, Sections 39–105	Provides for development of air pollution control permitting regulations.
Rules for the Control of Air Pollution in Idaho	Idaho Administrative Procedures Act (IDAPA) 58, Department of Environmental Quality, Title 1, Chapter 1 (58.01.01)	Enforces national ambient air quality standards.
Idaho Water Pollution Control Act	IC, Title 39, Chapter 36, Water Quality	Establishes a program to enhance and preserve the quality and value of water resources.
Water Quality Standards and Wastewater Treatment Requirements	IDAPA 58.01.02	Establishes water quality standards and wastewater treatment requirements.
Transportation of Hazardous Waste	IC, Title 18, Crimes and Punishment, Chapter 39, Highways and Bridges, Section 18-3905; IC, Title 49, Motor Vehicles, Chapter 22, Hazardous Materials/Hazardous Waste Transportation Enforcement	Regulates transportation of hazardous materials/hazardous waste on highways.
Idaho Hazardous Waste Management Act	IC, Title 39, Chapter 44, Hazardous Waste Management	Requires permit prior to construction or modification of a hazardous waste disposal facility.
Rules and Standards for Hazardous Waste	IDAPA 58.01.05	Requires permit prior to construction or modification of a hazardous waste disposal facility.
Various Acts Regarding Fish and Game	IC, Title 36, Fish and Game, Chapter 9, Protection of Fish, Chapter 11, Protection of Animals and Birds, and Chapter 24, Species Conservation	Requires consultation with responsible agency.
Endangered Species Act	IC, Title 67, State Government and State Affairs, Chapter 8, Executive and Administrative Officers, Section 67-818	Requires consultation with the Department of Fish and Game.
Rules for Classification and Protection of Wildlife	IDAPA 13, Department of Fish and Game, 13.01.06	Requires consultation with the Department of Fish and Game.

1

TABLE 13.6-1 (Cont.)

Law/Regulation/Agreement	Citation	Requirements
Idaho Historic Preservation Act	IC, Title 67, Chapter 46, Preservation of Historic Sites	Requires consultation with responsible local governing body.
Agreement in Principle between the Shoshone-Bannock Tribes and DOE	December 10, 2002	Establishes understanding and commitment between the tribes and DOE.
Idaho Site Treatment Plan and Consent Order for Federal Facility Compliance Plan	November 1, 1995 (issued to INEEL [now INL] and Argonne National Laboratory-West [now Materials and Fuels Complex])	Addresses compliance with the Federal Facility Compliance Act issues by implementing the INL Site Treatment Plan.
Nevada		
<i>Nevada Revised Statutes: Air Emission Controls</i>	Chapter 445B	Addresses operating permits for the control of gaseous and particulate emissions from construction and operations.
<i>Nevada Revised Statutes: Water Controls</i>	Chapter 445A	Sets conditions for issuance of variances and exemptions, temporary permits, stormwater discharge permits, and NPDES permits.
<i>Nevada Revised Statutes: Adjudication of Vested Water Rights, Appropriation of Public Waters, Underground Water and Wells</i>	Chapter 534	Sets requirements for establishing state water rights for use of public waters of the state, which include underground waters.
<i>Nevada Revised Statutes: State Fire Marshal</i>	Chapter 477	Addresses permits for storage of hazardous materials in quantities above those the Uniform Fire Code specifies.
<i>Nevada Revised Statutes: Hazardous Materials</i>	Chapter 459	Sets requirements for management and disposal of hazardous waste.
<i>Nevada Revised Statutes: Protection and Preservation of Timbered Lands, Trees, and Flora</i>	Chapter 527	Protects the indigenous flora of the State of Nevada.
<i>Nevada Revised Statutes: Hunting, Fishing, and Trapping; Miscellaneous Protective Measures</i>	Chapter 503	Addresses procedures for the classification and protection of wildlife.

TABLE 13.6-1 (Cont.)

Law/Regulation/Agreement	Citation	Requirements
New Mexico		
New Mexico Air Quality Control Act	<i>New Mexico Statutes Annotated</i> (NMSA), Chapter 74, Environmental Improvement, Article 2, Air Pollution, and Implementing Regulations at <i>New Mexico Administrative Code</i> (NMAC) Title 20, Environmental Protection, Chapter 2, Air Quality	Establishes air quality standards and requires a permit prior to construction or modification of an air contaminant source. Also requires an operating permit for major producers of air pollutants and imposes emission standards for hazardous air pollutants.
New Mexico Radiation Protection Act	NMSA, Chapter 74, Article 3, Radiation Control	Establishes state requirements for worker protection.
New Mexico Water Quality Act	NMSA, Chapter 74, Article 6, Water Quality, and Implementing Regulations found in NMAC, Title 20, Chapter 6, Water Quality	Establishes water quality standards and requires a permit prior to the construction or modification of a water discharge source.
New Mexico Groundwater Protection Act	NMSA, Chapter 74, Article 6B, Groundwater Protection	Establishes state standards for protection of groundwater from leaking underground storage tanks.
New Mexico Solid Waste Act	NMSA, Chapter 74, Article 9, Solid Waste Act, and Implementing Regulations found in NMAC Title 20, Environmental Protection, Chapter 9, Solid Waste	Requires a permit prior to construction or modification of a solid waste disposal facility.
New Mexico Hazardous Waste Act	NMSA, Chapter 74, Article 4, Hazardous Waste, and Implementing Regulations found in NMAC Title 20, Environmental Protection, Chapter 4, Hazardous Waste	Establishes permit requirements for construction, operation, modification, and closure of a hazardous waste management facility and establishes state standards for cleanup of releases from leaking underground storage tanks.
Endangered Plant Species	NMAC, Title 19, Chapter 21, Endangered Plants (Revised December 3, 2001)	Establishes plant species list and rules for collection.
Environmental Oversight and Monitoring Agreement	Agreement in Principle (AIP) between DOE and the State of New Mexico	Provides DOE support for state activities in environmental oversight, monitoring, access, and emergency response.

TABLE 13.6-1 (Cont.)

Law/Regulation/Agreement	Citation	Requirements
Environmental Improvement Act	NMSA 1978, Sections 74-1-1 through 74-1-15; NMAC, 20.5.1 through 20.5.17, August 15, 2003	Modifies aboveground tank regulations to include requirements for the registration, installation, modification, repair, closure, or removal of aboveground storage tanks, as well as for detecting releases, recordkeeping, and financial responsibility in the State of New Mexico.
Environmental Oversight and Monitoring Agreement	Agreement in Principle between DOE and the State of New Mexico	Provides DOE support for state activities in environmental oversight, monitoring, access, and emergency response.
New Mexico Cultural Properties Act	NMSA, Chapter 18, Libraries and Museums, Article 6, Cultural Properties	Establishes the State Historic Preservation Office and requirements to prepare an archaeological and historic survey and consult with the State Historic Preservation Office.
New Mexico Hazardous Chemicals Information Act	NMSA, Chapter 74, Article 4E-1, Hazardous Chemicals Information	Implements the hazardous chemical information and toxic release reporting requirements of the Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III) for covered facilities.
South Carolina		
South Carolina Pollution Control Act	<i>South Carolina (SC) Code Annotated</i> , Section 48-1-10, et seq.	Addresses permits for construction and alteration of wastewater treatment facilities; PSD permits; and Title V Operating Permits for new or existing sources that are major, subject to NESHAP, New Source Performance Standards (NSPS), or affected under the Acid Rain Program.
Safe Drinking Water Act	<i>SC Code</i> , Section 44-55-10	Addresses public Water System Permits for the construction, modification, expansion, and operation of public water systems.
Hazardous Waste Management Act	<i>SC Code</i> , Section 44-56-10	Addresses permits for facilities that will store hazardous wastes beyond the allowed accumulation periods, treat hazardous wastes, or dispose of hazardous wastes.

TABLE 13.6-1 (Cont.)

Law/Regulation/Agreement	Citation	Requirements
South Carolina Atomic Energy and Radiation Control Act	SC Regulations R.61-63	Addresses license to receive, use, possess, transfer, or dispose of radioactive material.
Underground Storage Tank Control Regulations	SC RCRA Regulations R.61-92	Addresses underground storage tank installation and operation permits.
South Carolina Occupational Safety and Health Standards for General Industry and Public Sector Marine Terminals	Chapter 71	Addresses identification, evaluation, and control of the hazards of processes involving a flammable liquid or gas, hydrocarbon fuel, or highly hazardous chemical at or above the specified threshold quantity.
Washington		
Washington State Hazardous Waste Management Act	<i>Revised Code of Washington (RCW)</i> 70.105	Regulates the disposal of hazardous wastes; implements waste reduction and prevention programs.
Washington Clean Air Act	RCW 70.94	Authorizes an operating permit program, civil penalties, administrative enforcement provisions; covers toxics and hazardous air pollutants for new sources and modifications to existing sources.
The Washington State Department of Health regulations, Radiation Protection — Air Emissions	<i>Washington Administrative Code (WAC)</i> 246–247	Provides standards and permit requirements for the emission of radionuclides to the atmosphere from DOE facilities.
Washington State Environmental Policy Act	RCW 43.21C	Provides for the evaluation of proposals, which may be conditioned or denied through the permit process, on the basis of environmental considerations.
Model Toxics Control Act	RCW 70.105D	Regulates releases of hazardous substances caused by past activities and potential and ongoing releases of hazardous substances from current activities.
Water Pollution Control Act	RCW 90.48	Establishes a permit system to license and control the discharge of pollutants into waters of the state.

TABLE 13.6-1 (Cont.)

Law/Regulation/Agreement	Citation	Requirements
Washington State Department of Health licensing requirements	WAC 246-247	Provides licensing requirements for new sources of radioactive emissions.

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3 **13.8 CONSULTATIONS**

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5 Certain laws, such as the ESA, Fish and Wildlife Coordination Act, and NHPA, require
6 consultation and coordination by DOE with other governmental entities, including other federal
7 agencies, state and local agencies, and federally recognized American Indian governments. In
8 addition, the DOE American Indian and Alaska Native Government Policy requires DOE to
9 consult with any American Indian or Alaska Native Tribal Government with regard to any
10 property to which the tribe attaches religious or cultural importance that might be affected by a
11 DOE action.

12

13 Most of these consultations are related to biotic resources, cultural resources, and
14 American Indian rights. Biotic resource consultations generally pertain to the potential for
15 activities to disturb sensitive species or habitats. Cultural resource consultations relate to the
16 potential for disruption of important cultural resources and archaeological sites. American Indian
17 consultations are concerned with the potential for impacts on any rights and interests, including
18 the disturbance of ancestral American Indian sites, and sacred sites, traditional and religious
19 practices of American Indians, and natural resources of importance to American Indians.

20

21 DOE consults with the appropriate SHPOs, as required by NEPA and Section 106 of
22 NHPA; the USFWS, as required by the ESA of 1973, the Bald and Golden Eagle Protection Act,
23 and the Migratory Bird Treaty Act; and the appropriate state regulators, as required by state laws
24 or regulations.

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37 Group 1 and 2 wastes (Sections 1.4.1, 2.8.1, 3.2, Appendix B, Appendix Section E.5;
38 Figures 4.3.4-2, 4.3.2-3, 4.3.4-4, E-3 to E-9; Tables 1.4.1-2, 4.1.4-1, 5.1-3, 12.3-1 to 12.3-6,
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 6 inventory (Appendix B)
 7 Alternative 1 (No Action) consequences (Sections 3.5.1, 3.5.2, 3.5.3)
 8 types, quantities, radioactivity (Section 1.4.1; Table 1.4.1-2)
 9 **GTRI/OSRP** (Sections 1.4.1.2, 1.4.3.4, 1.6.1, 2.1, 2.9.1, 3.1, 3.2.2, 3.5.2, Appendix
 10 Section B.3.2)
 11
 12 **H**
 13
 14 Hanford Site (Section 1.4.3.2, Chapter 6)
 15 highest-exposed individual
 16 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.3.9.2,
 17 6.2.9.2, 7.2.9.2, 8.2.9.2, 9.2.9.2, 10.2.10.2, 11.2.11.2)
 18 common consequences for Alternatives 3 to 5 (Section 5.3.9.2)
 19 methodology (Appendix Section C.9.2.2)
 20 housing
 21 approach, assumptions, methodology (Section 5.2.6, Appendix Section C.6.3)
 22 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.6.5, 4.3.6,
 23 6.1.6.5, 6.2.6, 7.1.6.5, 7.2.6, 8.1.6.5, 8.2.6, 9.1.6.5, 9.2.6, 10.1.6.5, 10.2.6, 11.1.6,
 24 11.2.6)
 25 common consequences for Alternatives 3 to 5 (Section 5.3.6)
 26 comparison of consequences across alternatives (Section 2.7.6)
 27 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 28 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 29 human health
 30 approach, assumptions, methodology (Section 5.2.4, Appendix Section C.1.1)
 31 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.4, 4.3.4,
 32 6.1.4, 6.2.4, 7.1.4, 7.2.4, 8.1.4, 8.2.4, 9.1.4, 9.2.4, 10.1.4, 10.2.4, 11.1.4, 11.2.4)
 33 at generic sites (Section 12.2)
 34 common consequences for Alternatives 3 to 5 (Section 5.3.4)
 35 comparison of consequences across alternatives (Section 2.7.4)
 36 post-closure (long-term) impacts (Appendix E, Section 12.4)
 37 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 38 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 39
 40 **I**
 41
 42 Idaho National Laboratory (INL) (Section 1.4.3.3, Chapter 7)
 43 impact assessment methodologies (Appendix C)
 44 inadvertent human intruder (Sections 2.9.2.1, 5.5)
 45 institutional controls/control period, *see also* short-term impacts (Sections 3.5, 5.6)
 46

- 1 intentional destructive acts (Sections 2.7.4.3, 4.3.4.4, 5.3.4.4)
 2 irreversible and irretrievable commitment of resources (Sections 4.6, 5.4)
 3
 4 **J, K**
 5
 6 No entries
 7
 8 **L**
 9
 10 land use
 11 approach, assumptions, methodology (Section 5.2.8, Appendix Section C.8)
 12 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.8, 4.3.8,
 13 6.1.8, 6.2.8, 7.1.8, 7.2.8, 8.1.8, 8.2.8, 9.1.8, 9.2.8, 10.1.8, 10.2.8, 11.1.8, 11.2.8)
 14 common consequences for Alternatives 3 to 5 (Section 5.3.8)
 15 comparison of consequences across alternatives (Section 2.7.8)
 16 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 17 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 18 latent cancer fatality (LCF) risks (Tables 3.5-2, 5.3.4-4, 6.2.4-3, 7.2.4-3, 8.2.4-3, 10.2.4-3,
 19 12.3-2, 12.3-4, 12.3-6)
 20 laws (Section 2.9.3.3, Chapter 14)
 21 institutional controls (Section 5.6)
 22 settlement agreements and consent orders (Sections 6.5, 7.5, 8.5, 9.5, 10.5)
 23 statutory and regulatory provisions (Sections 4.7, 11.6)
 24 leaching (Appendix Sections E.2.2, E.3.2)
 25 long-term impacts (Section 3.5, Appendix E)
 26 Los Alamos National Laboratory (LANL) (Section 1.4.3.4, Chapter 8)
 27 low-income populations
 28 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.7, 4.3.7,
 29 6.1.7, 6.2.7, 7.1.7, 7.2.7, 8.1.7, 8.2.7, 9.1.7, 9.2.7, 10.1.7, 10.2.7, 11.1.7, 11.2.7)
 30
 31 **M**
 32
 33 maps of DOE sites (Figures 1.4.3-1 and 2 for WIPP, 1.4.3-4 for Hanford, 1.4.3-5 for INL,
 34 1.4.3-6 for LANL, 1.4.3-7 for NNSS, 1.4.3-8 for SRS, and 1.4.3-9 for WIPP Vicinity)
 35 mineral and energy resources
 36 approach, assumptions, methodology (Section 5.2.2, Appendix Section C.3)
 37 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.2.2, 4.3.6,
 38 6.1.2.3, 6.2.3, 7.1.2.3, 7.2.3, 8.1.2.3, 8.2.3, 9.1.2.3, 9.2.3, 10.1.2.3, 10.2.3, 11.1.3,
 39 11.2.3)
 40 common consequences for Alternatives 3 to 5 (Section 5.3.2)
 41 comparison of consequences across alternatives (Section 2.7.2)
 42 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 43 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 44 minority populations
 45 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.7, 4.3.7,
 46 6.1.7, 6.2.7, 7.1.7, 7.2.7, 8.1.7, 8.2.7, 9.1.7, 9.2.7, 10.1.7, 10.2.7, 11.1.7, 11.2.7)
 47

- 1 **N**
2
3 NAAQS (National Ambient Air Quality Standards), *see* air quality
4 NEPA (National Environmental Policy) (Sections 1.3 to 1.6, Appendix Section A.1;
5 Figures 1.5-1, A-1; Tables 5.2.10-1, A-2)
6 Nevada National Security Site (NNSS) (Section 1.4.3.5, Chapter 9)
7 Nevada Test Site (NTS), *see* Nevada National Security Site (NNSS)
8 No Action Alternative, *see* Alternative 1
9 noise
10 Alternative 2 (Sections 4.2.1.3, 4.3.1.2)
11 approach, assumptions, methodology (Section 5.2.1.2, Appendix Section C.1.2)
12 comparison of consequences across alternatives (Section 2.7.1)
13 existing environment at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
14 (Sections 6.1.1.4, 7.1.1.4, 8.1.1.4, 9.1.1.4, 10.1.1.4, 11.1.1)
15 nonradiological impacts (Sections 2.7.9, 4.3.4.1.2, 5.2.4.4, 5.2.9, Appendix Section C.4.1)
16 Nuclear Regulatory Commission (Sections 1.1, 1.4, 2.9, 12.2, 13, Appendices A, C)
17
18 **O**
19
20 operations
21 at all DOE sites (Section 5.1.4.2)
22 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.1.4, 4.3.3.2,
23 4.3.4.1, 4.3.7.2, 6.2, 7.2, 8.2, 9.2, 10.2, 11.2)
24 at generic sites (Section 12.2)
25 estimates (Appendix D, especially Sections D.5.2, D.6.2, D.7.2, D.8.2, D.9.2)
26 considerations for preferred alternative (Sections 2.9.2.2, 2.9.2.4)
27 Other Waste
28 consequences for No Action Alternative (Sections 3.5.3, 3.5.6)
29 description (Section 1.4.1.3)
30 inventories (Appendix B)
31 management practices (Sections 3.2.3, 3.3.3)
32
33 **P**
34
35 personal income
36 approach, assumptions, methodology (Section 5.2.6, Appendix Section C.6.1)
37 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.6.3, 4.3.6,
38 6.1.6.3, 6.2.6, 7.1.6.3, 7.2.6, 8.1.6.3, 8.2.6, 9.1.6.3, 9.2.6, 10.1.6.3, 10.2.6, 11.1.6,
39 11.2.6)
40 common consequences for Alternatives 3 to 5 (Section 5.3.6)
41 comparison of consequences across alternatives (Section 2.7.6)
42 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
43 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
44

- 1 pollutant emissions
2 annual at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Tables 4.3.1-1,
3 4.3.1-2, 6.1.1-1, 6.1.1-2, 7.1.1-1, 7.1.1-2, 8.1.1-1, 8.1.1-2, 9.1.1-1, 9.1.1-2, 10.1.1-1,
4 10.1.2-2, 11.1.1-1, 11.1.1-2
5 population
6 approach, assumptions, methodology (Section 5.2.6, Appendix Section C.6.2)
7 at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Sections 4.2.6.4, 4.3.6,
8 6.1.6.4, 6.2.6, 7.1.6.4, 7.2.6, 8.1.6.4, 8.2.6, 9.1.6.4, 9.2.6, 10.1.6.4, 10.2.6, 11.1.6,
9 11.2.6)
10 common consequences for Alternatives 3 to 5 (Section 5.3.6)
11 comparison of consequences across alternatives (Section 2.7.6)
12 summary of impacts at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity
13 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
14 post-closure (Sections 2.9.2.3, 5.3.4.3, 12.3, Appendix E)
15 at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Sections 4.3.4.3,
16 6.2.4.2, 7.2.4.2, 8.2.4.2, 9.2.4.2, 10.2.4.2, 11.2.4.2)
17 preferred alternative (Section 2.9)
18 preparers (Appendix I)
19 proposed action (Section 1.2)
20 public scoping process (Section 1.5, Appendix A)
21 public services
22 approach, assumptions, methodology (Section 5.2.6, Appendix Section C.6.4)
23 at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Sections 4.2.6.7, 4.3.6,
24 6.1.6.7, 6.2.6, 7.1.6.7, 7.2.6, 8.1.6.7, 8.2.6, 9.1.6.7, 9.2.6, 10.1.6.7, 10.2.6, 11.1.6,
25 11.2.6)
26 common consequences for Alternatives 3 to 5 (Section 5.3.6)
27 comparison of consequences across alternatives (Section 2.7.6)
28 summary of impacts at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity
29 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
30 purpose and need for agency action (Section 1.1)
31
32 **Q**
33
34 No entries
35
36 **R**
37
38 radiation or radiological doses, *see* doses
39 radiological impacts (Section 5.2.4.3, Appendix E)
40 release rates (Sections 2.8.3, 2.8.4, 5.3.4.3, Appendix Sections E.2.3, E.3.3); *see* doses
41 rail transportation, *see* transportation
42 regional disposal sites, *see* generic disposal sites
43 regulations, *see* laws
44

- 1 remote-handled waste (Appendix B)
 2 description and inventory (Section 1.4.1)
 3 Alternative 1 (Chapter 3)
 4 transportation and packaging (Appendix D.2.2)
 5 routine conditions (Sections 2.7.9, 2.9.3.1, 4.2.9.1, 5.3.9)
 6 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.9.1,
 7 4.3.9.2, 6.2.9.2, 7.2.9.2, 8.2.9.2, 9.2.9.2, 10.2.9.2, 11.2.9.2)
 8
 9 **S**
 10
 11 Savannah River Site (SRS) (Section 1.4.3.6, Chapter 10)
 12 sealed sources
 13 consequences for No Action Alternative (Sections 3.5.2, 3.5.5)
 14 description (Section 1.4.1.2)
 15 inventories (Appendix B)
 16 management practices (Sections 3.2.2, 3.3.2)
 17 short-term impacts
 18 socioeconomics
 19 approach, assumptions, methodology (Section 5.2.6, Appendix Section C.6.2)
 20 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.6, 4.3.6,
 21 6.1.6, 6.2.6, 7.1.6, 7.2.6, 8.1.6, 8.2.6, 9.1.6, 9.2.6, 10.1.6, 10.2.6, 11.1.6, 11.2.6)
 22 common consequences for Alternatives 3 to 5 (Section 5.3.6)
 23 comparison of consequences across alternatives (Section 2.7.6)
 24 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 25 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 26 soils
 27 approach, assumptions, methodology (Section 5.2.2, Appendix Section C.2)
 28 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.2, 4.3.2,
 29 6.1.2.2, 6.2.2, 7.1.2.2, 7.2.6, 8.1.2.2, 8.2.2, 9.1.2.2, 9.2.2, 10.1.2.2, 10.2.2, 11.1.2,
 30 11.2.2)
 31 common consequences for Alternatives 3 to 5 (Section 5.3.2)
 32 comparison of consequences across alternatives (Section 2.7.2)
 33 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 34 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 35 soil/water distribution coefficients to do
 36 special-status species, *see* ecology
 37 surface water
 38 approach, assumptions, methodology (Section 5.2.3, Appendix C.3)
 39 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.3.1, 4.3.3,
 40 6.1.3.1, 6.2.3, 7.1.3.1, 7.2.3, 8.1.3.1, 8.2.3, 9.1.3.1, 9.2.3, 10.1.3.1, 10.2.3, 11.1.3, 11.2.3)
 41 common consequences for Alternatives 3 to 5 (Section 5.3.3)
 42 comparison of consequences across alternatives (Section 2.7.3)
 43 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
 44 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
 45
 46

- 1 **T**
2
3 terrestrial ecology (wildlife and vegetation), *see* ecology
4 threatened species, *see* ecology
5 traffic (Section 5.3, Appendix Section C.6.5)
6 counts at WIPP, Hanford, INL, LANL, NNS, SRS (Tables 4.3.6-1, 6.1.9-1, 7.1.9-1,
7 8.1.9-2, 9.1.9-1, 10.1.9-1)
8 transportation
9 approach, assumptions, methodology, risk analysis (Section 5.2.9, Appendix sections
10 C.9, D.2, D.8)
11 at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Sections 4.2.9, 4.3.9,
12 6.1.9, 6.2.9, 7.1.9, 7.2.9, 8.1.9, 8.2.9, 9.1.9, 9.2.9, 10.1.9, 10.2.9, 11.1.9, 11.2.9)
13 common consequences for Alternatives 3 to 5 (Section 5.3.9)
14 comparison of consequences across alternatives (Section 2.7.9)
15 summary of impacts at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity
16 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
17 transuranic waste
18 definition (Section 1.4.1 text box)
19 trench disposal, *see* Alternative 4
20 tribal consultations (Sections 1.8, 2.7.7, 2.9.3.2, 5.2.10, 13.8, Appendix G)
21 Consolidated Group of Tribes and Organizations (Chapter 9, NNS)
22 CTUIR or Umatilla (Chapter 6, Hanford)
23 Nez Perce (Chapter 6, Hanford)
24 Pueblo (Chapter 8, LANL)
25 Wanapum (Chapter 6, Hanford)
26 truck transportation, *see* transportation
27
28 **U**
29
30 uncertainties (Section 2.8, Appendix Section C.9.5)
31 unemployment
32 approach, assumptions, methodology (Section 5.2.6, Appendix C.6.2)
33 at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity (Sections 4.2.6.2, 4.3.6,
34 6.1.6.2, 6.2.6, 7.1.6.2, 7.2.6, 8.1.6.2, 8.2.6, 9.1.6.2, 9.2.6, 10.1.6.2, 10.2.6, 11.1.6,
35 11.2.6)
36 common consequences for Alternatives 3 to 5 (Section 5.3.6)
37 comparison of consequences across alternatives (Section 2.7.6)
38 summary of impacts at WIPP, Hanford, INL, LANL, NNS, SRS, and WIPP Vicinity
39 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
40 U.S. Nuclear Regulatory Commission (*see* Nuclear Regulatory Commission)
41 utility consumption (Tables % 4-2, D-11, D-12)
42
43 **V**
44
45 vault disposal, *see* Alternative 5
46 vegetation, *see* ecology
47

- 1 **W**
2
3 Waste Isolation Pilot Plant (WIPP) (Section 1.4.3.1, Chapter 4)
4 waste generation times (Section 3.4.2, Appendix Section B.4)
5 waste inventories (Appendix B); see GTCC-like waste and GTCC LLRW
6 waste management
7 approach, assumptions, methodology (Section 5.2.11, Appendix C.11)
8 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.11, 4.3.11,
9 6.1.11, 6.2.11, 7.1.11, 7.2.11, 8.1.11, 8.2.11, 9.1.11, 9.2.11, 10.1.11, 10.2.11, 11.1.11,
10 11.2.11)
11 common consequences for Alternatives 3 to 5 (Section 5.3.11)
12 comparison of consequences across alternatives (Section 2.7.11)
13 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
14 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
15 water resources
16 approach, assumptions, methodology (Section 5.2.3, Appendix C.3)
17 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.3, 4.3.3,
18 6.1.3, 6.2.3, 7.1.3, 7.2.3, 8.1.3, 8.2.3, 9.1.3, 9.2.3, 10.1.3, 10.2.3, 11.1.3, 11.2.3)
19 common consequences for Alternatives 3 to 5 (Section 5.3.3)
20 comparison of consequences across alternatives (Section 2.7.3)
21 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
22 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
23 water use
24 approach, assumptions, methodology (Section 5.2.3, Appendix C.3)
25 at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity (Sections 4.2.3.3, 4.3.3,
26 6.1.3.3, 6.2.3, 7.1.3, 7.2.3, 8.1.3, 8.2.3, 9.1.3, 9.2.3, 10.1.3.3, 10.2.3, 11.1.3, 11.2.3)
27 common consequences for Alternatives 3 to 5 (Section 5.3.3)
28 comparison of consequences across alternatives (Section 2.7.3)
29 summary of impacts at WIPP, Hanford, INL, LANL, NNSS, SRS, and WIPP Vicinity
30 (Sections 4.4, 6.3, 7.3, 8.3, 9.3, 10.3, 11.3)
31 wildlife, *see* ecology
32 wetlands, *see* ecology
33 WIPP Vicinity (Section 1.4.3.7, Chapter 11)
34
35 **X, Y, Z**
36
37 No entries
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APPENDIX A:

SUMMARY OF THE PUBLIC SCOPING PROCESS FOR THE GTCC LLRW AND GTCC-LIKE WASTE ENVIRONMENTAL IMPACT STATEMENT

A.1 PUBLIC SCOPING

The U.S. Department of Energy (DOE) issued the Advance Notice of Intent (ANOI) to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class C Low-Level Radioactive Waste on May 11, 2005 (*Federal Register*, Volume 70, page 24775 [70 FR 24775]), and it issued the Notice of Intent (NOI) for the Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement (GTCC EIS) on July 23, 2007 (72 FR 40135). A printing correction was issued on July 31, 2007 (72 FR 41819). The NOI announced nine public scoping meetings and a comment period that would last from July 23 through September 21, 2007.

The issuance of the ANOI and NOI marked the start of the National Environmental Policy Act (NEPA) process for the GTCC EIS that included opportunities for public participation. Figure A-1 illustrates the major steps that are being taken by DOE in preparing the GTCC EIS and indicates the public participation steps in this process. The ANOI that DOE had issued on May 11, 2005 (70 FR 24775), invited preliminary comments on the potential scope of the EIS. Those comments are discussed in the NOI.

DOE conducted scoping meetings to support the GTCC EIS at the locations and on the dates shown in Table A-1. The number of people who attended these meetings is also presented. The scoping meeting locations were selected on the basis of the proposed alternatives identified by DOE in the NOI for the GTCC EIS. Transcripts for all nine meetings have been posted on the GTCC EIS website at <http://www.gtcceis.anl.gov>.

Public scoping comments for the NOI were received through several means: (1) submittal of the comment form on the GTCC EIS website, (2) e-mail through the website or directly to the document manager, (3) mailed letters and faxes to the document manager, (4) oral comments at the public scoping meetings, and (5) written comments submitted at the public scoping meetings. A total of 249 individual comments were received and can be read on the GTCC EIS website.

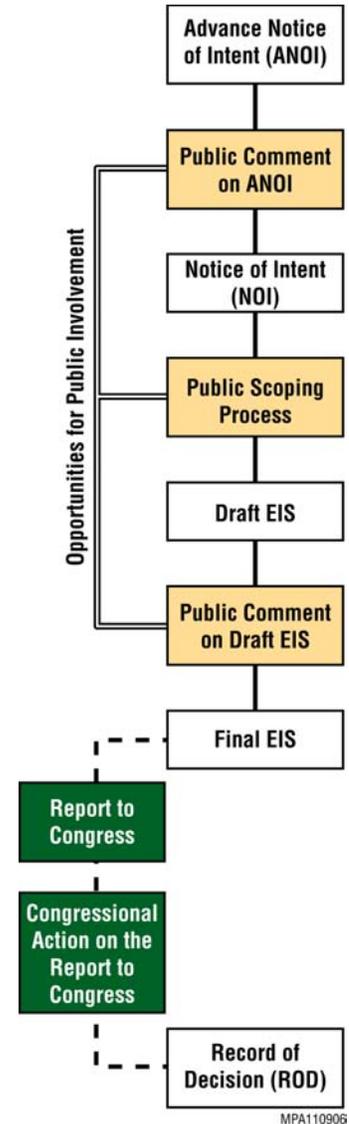


FIGURE A-1 GTCC EIS NEPA Process

TABLE A-1 Public Scoping Meeting Locations, Dates, and Attendance

Location	Date	Attendance
Carlsbad, New Mexico	August 13, 2007	60
Los Alamos, New Mexico	August 14, 2007	42
Oak Ridge, Tennessee	August 22, 2007	23
North Augusta, South Carolina	August 23, 2007	32
Troutdale, Oregon	August 27, 2007	72
Pasco, Washington	August 28, 2007	35
Idaho Falls, Idaho	August 30, 2007	17
Las Vegas, Nevada	September 4, 2007	28
Washington, D.C.	September 10, 2007	25
Total		334

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All public scoping comments were reviewed and considered to identify the issues to be addressed in the EIS. These comments are presented in Tables A-2 and A-3. The issues identified in these comments are divided into two categories: those that are within the scope of the EIS and those that are outside the scope. The issues that were determined to be within the scope of the EIS and the rationale for this determination are presented in Table A-2, with additional clarifying information as appropriate. Issues that were considered to be outside the scope of the EIS are presented in Table A-3, along with the rationale for this determination. The issues considered within the scope have been incorporated into the EIS analyses.

TABLE A-2 Public Scoping Issues within the Scope of the EIS

Public Scoping Issue	Rationale
1. Alternatives	
1A. Disposal of GTCC low-level radioactive waste (LLRW) and GTCC-like waste at the sites proposed in the NOI should not be considered because these sites are still undergoing cleanup. In addition, these sites either have regulatory conditions or site characteristics (e.g., geology) that make them unsuitable for consideration in the EIS.	The basis for proposing the sites to be considered in the NOI and evaluated in the EIS was their mission compatibility, in the sense that all of these sites have radioactive waste disposal operations as part of their current missions. These sites are thus considered viable for analysis for disposal of this waste in the EIS. The scope of the EIS includes the identification of potential disposal sites and the evaluation of the feasibility and effectiveness of these sites for hosting a safe disposal facility for GTCC LLRW and GTCC-like waste.
1B. The preferred alternative for disposal of GTCC LLRW and GTCC-like waste should be a geologic repository.	Disposal at the Waste Isolation Pilot Plant (WIPP) is one of the alternatives evaluated in this EIS. In addition, DOE is evaluating alternative methods of disposal (i.e., borehole, trench, and vault disposal). NRC regulations governing disposal of GTCC LLRW contemplate that nongeologic disposal alternatives may be approved (see Title 10, Section 61.55, in the <i>Code of Federal Regulations</i> ; 10 CFR 61.55(a)(2)(iv)).
1C. WIPP should be removed as a potential disposal site for evaluation in the EIS because there are legislative limitations on the types of waste this facility can receive (specifically, it can receive only defense-related transuranic [TRU] waste). At a minimum, the EIS should acknowledge that use of WIPP for this purpose is outside the limits of what can be disposed of at WIPP, and additional legal processes and stakeholder involvement would be necessary before WIPP could be used for disposal of GTCC LLRW and GTCC-like waste.	The EIS covers the full range of reasonable disposal sites, including WIPP. Council on Environmental Quality (CEQ) and DOE guidance requires that EISs evaluate the range of reasonable alternatives, notwithstanding statutory or regulatory requirements. The EIS describes the statutory and regulatory requirements for WIPP and the other disposal alternatives and discusses whether legislation or regulatory modifications might be needed to implement these alternatives.
1D. The proposed Yucca Mountain repository should not be included as one of the alternatives in the EIS. There are many indications suggesting that this repository will not even open.	DOE has not included the Yucca Mountain repository as an alternative in this EIS. The Administration has determined that developing a permanent repository for high-level waste and spent nuclear fuel at Yucca Mountain, Nevada, is not a workable option and that the project should be terminated. No funding has been requested in the fiscal year 2011 budget for the Yucca Mountain project. Therefore, because a repository for high-level waste and spent nuclear fuel at Yucca Mountain has been determined not to be a workable option and will not be developed, co-disposal at a Yucca Mountain repository is not a reasonable alternative.

TABLE A-2 (Cont.)

Public Scoping Issue	Rationale
2. Inventory	
<p>2A. What is GTCC-like waste and why is DOE including the GTCC-like waste inventory in the scope of this EIS? The EIS should include a clear definition of GTCC LLRW and GTCC-like waste to ensure the GTCC-like wastes are indeed comparable to GTCC LLRW and that additional wastes are not added to this inventory in the future. How has comparable waste been generated and disposed of in the past?</p>	<p>GTCC-like waste is LLRW and TRU waste owned or generated by DOE that has characteristics similar to GTCC LLRW and may not have a path to disposal. DOE is responsible for disposing of both GTCC LLRW and GTCC-like waste, and DOE considers it to be cost effective to develop a joint solution for both of these similar types of waste. This EIS provides a clear definition of the wastes being addressed in the scope of this assessment. The majority of the DOE LLRW has an identified path to disposal at existing DOE facilities, but some DOE LLRW and TRU waste does not. It is this waste that DOE has included in the EIS. The majority of the GTCC-like waste is TRU waste that may not meet the criteria for disposal at WIPP. DOE's use of the term GTCC-like waste does not have the effect of creating a new classification of radioactive waste. This waste remains classified as LLRW and TRU waste under DOE Order 435.1, and it is subject to all applicable disposal requirements for LLRW and TRU waste under that order and applicable law. Comparable wastes (resulting from reactor decommissioning projects) have historically been disposed of by shallow land burial at DOE sites (LLRW) and at WIPP (TRU waste generated by atomic energy defense activities) in accordance with applicable statutes, regulations, and policies.</p>
<p>2B. More detailed characterization information should be provided on the waste inventory, including the source of the waste, its location (by state), and its specific characteristics. In addition, the errors in Table 1 of the NOI made it difficult to understand the scope of the waste inventory. It is not clear how the volumes and activities for stored and projected waste were developed, and the distinction between what is considered stored versus what is considered projected is not clear either. The sources of information and important assumptions used to develop this information should be provided in the EIS, along with an indication of the accuracy of the estimates.</p>	<p>The GTCC EIS and the supporting technical documents provide sufficient characterization information on the wastes to allow for a comparative analysis of the environmental impacts associated with disposal of these wastes. Details on the approach used to develop the inventory information are provided in this EIS and in supporting documents, including the identification of relevant references. The Draft EIS provides information on the current location of GTCC waste generators (e.g., Table B-2 in Appendix B).</p>
<p>2C. The time frame for developing the inventory should be extended to address nuclear power plants that may be constructed in the future.</p>	<p>The time frame corresponds to wastes currently available for disposal as well as those that are reasonably expected to be generated in the near future, consistent with NEPA requirements. Since the issuance of the July 23, 2007, NOI, DOE has updated the inventory to include potential GTCC LLRW from the proposed construction of 33 new commercial power reactors as identified by the U.S. Nuclear Regulatory Commission (NRC).</p>

TABLE A-2 (Cont.)

Public Scoping Issue	Rationale
2D. The EIS should include waste that will be generated by the Global Nuclear Energy Partnership (GNEP) in its scope.	DOE is not evaluating potential GTCC and GTCC-like waste from the GNEP in this EIS. DOE announced via a <i>Federal Register</i> notice (74 FR 31017) on June 29, 2009, that it has decided to cancel preparation of the GNEP Programmatic EIS because DOE is no longer pursuing domestic commercial reprocessing, which was the primary focus of the prior Administration's domestic GNEP program.
2E. The EIS should identify the quantity of mixed waste requiring disposal and identify the process for working with the U.S. Environmental Protection Agency (EPA) and respective state agencies to manage these wastes.	The GTCC LLRW and GTCC-like waste inventory includes a very small volume of mixed waste that may require disposal. It is assumed that the generator of the waste will treat it to remove the hazardous waste characteristic or obtain a waiver de-listing it from the appropriate regulatory authority so that the waste is no longer regulated as mixed waste. No mixed GTCC LLRW or GTCC-like waste is assumed to be disposed of in the facilities being evaluated in the EIS. The quantity of potential mixed waste is about 170 m ³ (6,000 ft ³).
2F. Concentration averaging should not be used to reduce the amount of GTCC LLRW and GTCC-like waste addressed in the EIS.	Generators of LLRW may use concentration averaging as allowed by NRC regulations (10 CFR 61.55(a)(8)) and associated guidance. The waste inventory estimates developed by DOE for the EIS assumed concentration averaging was used for the sealed sources to determine how much of this waste was GTCC LLRW and how much was GTCC-like waste. This approach was taken consistent with NRC guidance, and it eliminated the lower-activity sealed sources from the waste inventory. The sealed sources represent less than 2% of the total activity in the GTCC LLRW and GTCC-like waste. Use of this approach has a very minor impact on the results presented in the EIS.
3. Impacts	
3A. The EIS should evaluate cumulative impacts from multiple actions (in addition to the impacts from disposal of GTCC LLRW and GTCC-like waste) occurring at the sites proposed for consideration.	Cumulative impacts associated with nearby actions at the various potential disposal sites are addressed in the EIS, consistent with CEQ and DOE NEPA guidance.
3B. Environmental issues, such as transportation impacts associated with routine (incident-free) activities and accidents, worker risks, public health risks, cultural resources, effects on local economies, environmental justice, irreversible and irretrievable commitments of resources, and other impacts, should be addressed in the EIS on a site-specific basis.	All of these issues are addressed in the EIS.
3C. Conceptual designs, drawings, and site layouts of the disposal technologies should be included in the EIS and used to perform the EIS analyses.	This information is included in the EIS and supporting documents.

TABLE A-2 (Cont.)

Public Scoping Issue	Rationale
3D. The time frame for conducting the EIS is not sufficient to allow for an adequate assessment of environmental impacts as required by NEPA, including receipt and evaluation of input from the general public and outside experts. Public involvement is a very important component of the NEPA process.	The amount of time to prepare the EIS is sufficient to perform a credible assessment of environmental impacts as required by NEPA. DOE agrees that public involvement is a very important component of this process and has provided sufficient time for stakeholder input consistent with CEQ and DOE NEPA regulations and policies.
3E. The impacts of sabotage or acts of terrorism on the disposal facility or facilities and the use of the waste materials to make dirty bombs should be evaluated.	This evaluation was performed and is included in this EIS in Sections 4.3.4.4 and 5.3.4.4.
3F. What is the scope of the EIS and evaluation endpoints (e.g., period of time with respect to risk of release)? The EIS should identify long-term monitoring requirements for the disposal sites.	The scope of the EIS addresses all aspects associated with disposal of GTCC LLRW and GTCC-like waste. Impacts are evaluated at the various time periods associated with the actions needed to safely dispose of these wastes. The long-term impacts on groundwater are evaluated for 10,000 years or to the point of maximum dose, whichever is longer. The EIS identifies the need for long-term monitoring of disposal sites, as appropriate. However, specific long-term monitoring requirements would be determined as part of the regulatory approval process for a GTCC disposal facility.
3G. The EIS needs to discuss how water quality standards will be met at the point of compliance for the life of the project, especially at sites having shallow groundwater tables.	The EIS addresses potential water quality impacts for the life of the project at all potential waste disposal sites.
3H. The life-cycle costs for each alternative should be provided in the EIS and should address all aspects of the project, including construction, waste disposal operations, and site closure. These estimates need to include long-term surveillance and maintenance costs. A conceptual timeline for these activities should also be included in the EIS.	Estimated annual costs for construction and operations of the conceptual designs being evaluated are included in this EIS. Estimated life-cycle costs are not included, because information on long-term surveillance and maintenance is not currently available, since these aspects of the project should be addressed within the context of a preferred alternative, which has not been identified.
	A timeline is not included, since a timeline is not needed to compare the relative merits of the alternatives, and it is much too early in the process to have this type of detailed information. A conceptual timeline will be developed after a record of decision (ROD) that selects a disposal alternative or alternatives to be implemented has been issued.
3I. The EIS should incorporate available site-specific data for the generic commercial facility evaluations. In addition, the evaluation of the disposal of GTCC LLRW and GTCC-like waste in boreholes for all sites being evaluated should be based on actual site data, given the past poor results achieved with boreholes.	Site-specific data were used to identify the important parameters necessary to site and operate a disposal facility for GTCC wastes at arid and humid generic sites. The analyses of the various disposal technologies (including the use of boreholes) in the EIS were based on actual site data to the extent necessary to provide defensible evaluations. A site-specific evaluation would be done in a subsequent NEPA review as appropriate.

TABLE A-2 (Cont.)

Public Scoping Issue	Rationale
<p>3J. The radiological risk analyses should be based on conservative assumptions, since the risks associated with radiation exposure are greater than those estimated years ago. It is possible that the true hazard is still not fully recognized. The most recent scientific information should be used for the EIS analyses, including the information given in Report No. VII on the Biological Effects of Ionizing Radiation (BEIR VII) (see National Research Council, 2006, <i>Health Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII Phase 2</i>, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, Washington, D.C., published by The National Academies Press, Washington, D.C.).</p>	<p>Conservative assumptions that still allow for a realistic comparison of alternatives were used in the radiological dose calculations presented in the EIS. Recent scientific information (including that given in BEIR VII) was consulted to confirm that the approaches used in the EIS are appropriate.</p>
<p>4. Tribal Concerns</p>	
<p>4A. Consultation with tribal nations should be initiated early in the process.</p>	<p>Consultations with the various tribal nations have been initiated and are ongoing, as reflected in this EIS.</p>
<p>4B. The existence of Native American ancestral lands, particularly at Los Alamos National Laboratory (LANL) and Idaho National Laboratory (INL), need to be honored. These lands have been used by Native Americans for a wide range of cultural activities for many years, and these uses have been guaranteed by treaties with the United States. Use of these sites for disposal of GTCC LLRW and GTCC-like waste could have a negative impact on these uses.</p>	<p>The presence of the Native Americans in the vicinity of the potential disposal sites is addressed in the EIS.</p>
<p>5. Other</p>	
<p>5A. An EIS does not need to be prepared by DOE because other EIS documents already address this waste.</p>	<p>Under the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA), Public Law 99-240, the Federal Government is responsible for the disposal of GTCC LLRW. In Section 631 of the Energy Policy Act of 2005, Congress directed DOE to designate an entity within DOE to have responsibility for completing activities needed to provide a facility for GTCC LLRW disposal and to provide an estimate of the cost and schedule to complete an EIS and ROD for a permanent disposal facility for the GTCC LLRW. DOE had not previously prepared an EIS document that evaluates the range of GTCC LLRW disposal alternatives.</p>

TABLE A-2 (Cont.)

Public Scoping Issue	Rationale
5B. "GTCC-like waste" should be included in the title of the EIS to make the scope of the document clearer. Also, the comment period on the Draft EIS should be extended to at least 90 days.	The title of the EIS reflects this comment. The public comment period for the Draft EIS is 120 days.
5C. All relevant information should be posted on the project website, including all public scoping comments, the Draft EIS, all reference documents used to prepare the EIS, and previous NEPA documents on radioactive wastes.	All documents having direct relevance to this EIS have been included on the project website. However, it is neither appropriate nor reasonable to include all references used to prepare the EIS or other reports addressing radioactive wastes on this website. These additional documents can be obtained separately for review.
5D. The NOI is not clear with regard to the purpose and scope of the EIS and does not meet NEPA requirements. Additional information describing the waste inventory should have been included in the NOI.	The NOI was prepared in a manner consistent with DOE's policy for NEPA compliance and contains all relevant information on the scope of the EIS. The NOI meets CEQ and DOE NEPA requirements. Additional information describing the waste inventory has been included in the EIS and supporting documents.
5E. Mitigative measures should be identified in the NOI and addressed in the EIS.	Information on measures to mitigate environmental impacts has been included in the EIS after the identification and evaluation of these impacts.
5F. Timely identification of a disposal facility for GTCC LLRW and GTCC-like waste should be considered important in order to not impede desired nuclear power production. The NOI has sufficiently identified the options for evaluation, and DOE is the appropriate agency to conduct the process described in the NOI.	Comment noted. The EIS presents evaluations of the options described in the NOI.
5G. The EIS should identify all federal and nonfederal agencies and any jurisdictional authority by law and/or special expertise. Also, the EIS should address all pertinent regulatory issues and standards, including NRC regulation of a facility at a DOE site.	The EPA is a cooperating agency on the EIS because of its expertise in radiation protection. The NRC is a commenting agency. Pertinent regulatory issues and standards associated with disposal of GTCC LLRW and GTCC-like waste are addressed in the EIS.

TABLE A-3 Public Scoping Issues outside the Scope of the EIS

Public Scoping Issue	Rationale
1. Alternatives	
1A. In addition to considering disposal at WIPP in the EIS, efforts should be initiated to site and construct a new geologic repository for GTCC LLRW and GTCC-like waste in case this repository is not acceptable.	The relatively small volume of GTCC LLRW and GTCC-like waste does not support the need to identify a new geologic repository to dispose of these materials.
1B. Hardened on-site storage (HOSS) should be added to the alternatives evaluated in the EIS. In addition, HOSS should be the preferred alternative.	HOSS and other approaches for storing waste beyond the No Action Alternative are considered to be outside the scope of this EIS. Consistent with the LLRWPA and Section 631 of the Energy Policy Act of 2005, DOE plans to complete an EIS and a ROD for a permanent disposal facility for this waste, not for long-term storage options. In addition, the No Action Alternative evaluates storage of this waste consistent with ongoing practices.
1C. Alternatives for treating the GTCC LLRW and GTCC-like waste should be considered in the EIS, including compaction, vitrification, transmutation, and blending with lower-activity materials.	DOE considers the treatment of GTCC waste to be outside the scope of this EIS. DOE's responsibility is limited to disposal under the LLRWPA, Public Law 99-240. For some waste streams, the EIS assumes the waste would be grouted to retard leaching of radionuclides.
1D. Recycling of the waste or other beneficial uses should also be considered in the EIS.	Recycling or other beneficial use of this waste is considered to be outside the scope of this EIS, since recycling and the beneficial reuse of the material would have been considered before the material was designated as waste. Under the LLRWPA, Public Law 99-240, the federal government is responsible for the disposal of GTCC LLRW. Accordingly, the EIS is limited to the consideration of disposal alternatives.
1E. Additional disposal options, including the use of uranium mines, underground nuclear weapons test cavities, and deep sea burial, should be considered in the EIS.	A range of reasonable disposal options that are consistent with the radioactive characteristics of these wastes was developed for consideration in the EIS. DOE does not consider the use of uranium mines, underground nuclear weapons test cavities, and deep sea burial to be reasonable alternatives. The United States and other countries banned disposal of radioactive waste at sea in 1993 in an amendment to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention 1972). DOE does not believe it is reasonable to dispose of GTCC LLRW and GTCC-like waste in uranium mines or underground nuclear weapons test cavities because of the potential cost and time it would take to develop these alternatives in comparison to the relatively small amount of waste.

TABLE A-3 (Cont.)

Public Scoping Issue	Rationale
2. Inventory	
2A. The EIS should include disposal options for Class B and Class C LLRW in its scope.	Inclusion of Class B and Class C LLRW is beyond the scope of this EIS. DOE is responsible under the LLRWPA, Public Law 99-240, for the disposal of GTCC LLRW and DOE wastes. States and Compacts are responsible for the disposal of Class A, B, and C LLRW.
In addition, the GTCC LLRW inventory needs to be expanded to address the disposal and possible consolidation and concentration of Class B and Class C LLRW by commercial nuclear utilities, resulting in additional GTCC LLRW.	The waste inventory is based on the best available information on GTCC LLRW, and it considers utility waste resulting from decommissioning activities. Data on the GTCC LLRW that might be generated by the concentration and consolidation of Class B and Class C LLRW are difficult to ascertain at this time because of the speculative nature of these events. The uncertainty that would be introduced in the EIS process by including this potential volume is not warranted.
2B. Additional radioactive wastes should not continue to be produced until there is a waste disposal solution for these materials.	This issue is outside the scope of the EIS, which is limited to the evaluation of the potential environmental impacts from using various disposal options for GTCC LLRW and GTCC-like waste.
3. Impacts	
3A. The EIS should address impacts from future climate change on the longevity of the disposal sites.	The EIS provides a comparative analysis of various waste disposal sites, including a geologic repository and several land disposal methods. The EIS analyzes the land disposal sites to help compare the feasibility of implementing the conceptual disposal designs at these sites. For purposes of analysis, the EIS makes simplifying assumptions about disposal site conditions, including the assumption that disposal site parameters sensitive to climate would remain unchanged for long periods of time. This enables a meaningful comparison of the impacts of climate on-site performance (e.g., arid and humid disposal sites). Further considerations of climate change on the longevity of a given disposal site could be addressed in follow-on analyses that would provide site-specific information on the preferred site or disposal location.
3B. The EIS should address the increased sensitivity of children, the elderly, pregnant women, and women in general to radiation exposure. The analysis should not be based on a reference man but on the reference family concept. In addition to radiation doses, estimates of the cancer risks should be provided in the EIS to allow for a comparison to EPA carcinogenic risk standards.	The concerns with regard to the increased sensitivity of various elements of the population are noted. The EIS presents a comparative analysis of the potential radiation doses and latent cancer fatality (LCF) risks to members of the general public from use of the various disposal alternatives presented in the EIS. As such, the level of detail requested here is not necessary for the purposes of this EIS, and the hazards associated with management of these wastes are presented in terms of the annual dose and LCF risk to a potentially exposed adult receptor.

TABLE A-3 (Cont.)

Public Scoping Issue	Rationale
<p>3C. All radiation-related human health effects (including heart disease and hereditary effects) and not just cancer should be addressed in the EIS. In addition, the effects of radiation exposure on plants and animals should be considered in the EIS.</p>	<p>As noted in the response to the previous comment, the results presented in the EIS are given in terms of annual radiation dose and LCF risk to a hypothetically exposed member of the general public. Fatal cancer is the primary health risk of concern. Additional health effects beyond cancer, including cardiovascular disease and hereditary effects, can occur in individuals exposed to radiation, as noted in this comment. However, these additional health effects are not quantified in the EIS. The risk of cardiovascular disease has been shown to increase in persons exposed to high therapeutic doses of radiation and also in atomic bomb survivors exposed to more modest doses (National Research Council 2006). However, there is no direct evidence of increased risk of noncancer diseases at low doses, such as those that could occur to members of the general public under the alternatives evaluated in this EIS. Also, the risk of hereditary effects from radiation exposure is generally attributable to gamma irradiation of the reproductive organs. In contrast, most of the dose to the general public in the long term is a result of long-lived radionuclides having alpha and beta radiations. As noted in BEIR VII (National Research Council 2006), the risk of heritable disease is sufficiently small that it has not been detected in humans, even in thoroughly studied irradiated populations, such as those of Hiroshima and Nagasaki. The risk of cancer fatality was determined to be a reasonable means of comparing alternatives in the EIS.</p> <p>Radiation health effects are discussed in the EIS, and LCF risks are calculated by using a risk factor of 0.0006 LCF per rem from Federal Guidance Report (FGR) 13 issued by the EPA in 1999 (<i>Cancer Risk Coefficients for Environmental Exposure to Radionuclides</i>, EPA 402-R-99-001). Scientific research has indicated that the protection of human health from radiation also serves to protect plants and animals. Hence, the radiation doses to and resultant health impacts on plants and animals are not quantified in the EIS.</p>
<p>3D. Risk assessment should be used to evaluate impacts and support the decision-making process; site-specific information should be used to the extent it is available. This assessment should be based on the most recent scientific information (including that provided in BEIR VII), and results should be presented in terms most people can understand.</p>	<p>Data on the radiation doses and LCF risks associated with all aspects of managing the GTCC LLRW and GTCC-like wastes are included in the EIS. The data cover the radiological impacts on workers who might come in contact with these wastes as well as on members of the general public, and they cover all aspects of the alternatives, including transportation of the wastes to the potential disposal sites and the long-term risks from radionuclide migration to groundwater.</p>

TABLE A-3 (Cont.)

Public Scoping Issue	Rationale
<p>3E. The EIS needs to address the risks associated with chemical contaminants in the GTCC LLRW and GTCC-like wastes and also with chemical wastes at the potential disposal sites as part of the cumulative impacts assessment.</p>	<p>The analysis in this EIS did not address potential chemical releases from the wastes; it was limited to radioactive constituents only. The radioactive hazards of these wastes are expected to exceed those associated with any chemical that might be present. The impacts presented for the radioactive contaminants are expected to bound those that could occur from any hazardous chemicals in the waste.</p>
<p>4. Tribal Concerns</p>	
<p>4A. Tribal nations should be provided with the opportunity to participate in the preparation of the EIS (including writing sections of it).</p>	<p>Tribal perspective narratives provided by various tribal nations have been incorporated into the EIS.</p>
<p>5. Other</p>	
<p>5A. A programmatic EIS should be prepared rather than this site-specific EIS, which addresses numerous sites. There are a multitude of broad programmatic issues that need resolution before a specific site and disposal technology can be identified for this waste. This approach would better meet NEPA requirements and allow for better public participation. Site-specific NEPA analyses could be tiered from this programmatic EIS.</p>	<p>This EIS has been scoped to provide adequate environmental information to support the decision-making process to identify an appropriate site(s) and technology(s) to dispose of a limited amount of GTCC LLRW and GTCC-like waste. If appropriate, DOE would conduct further NEPA review, tiered from this EIS, before implementing decisions.</p>
<p>5B. Further research on and/or investigation of other treatment and disposal technologies currently being developed should be considered to ensure that these wastes are managed safely. The hazards posed by GTCC LLRW and GTCC-like waste are comparable to those from high-level radioactive wastes and should be managed in a similar manner.</p>	<p>DOE does not believe further research on treatment and disposal technologies is needed to ensure that these wastes are safely managed and that their disposal complies with the LLRW PAA, Public Law 99-240, which makes the federal government responsible for the disposal of GTCC LLRW.</p>
<p>5C. A screening process should be included in the EIS to identify the preferred alternative on the basis of a preset list of objectives and relevant criteria. This would clearly identify the rationale for selecting a specific site and technology for disposing of GTCC LLRW and GTCC-like waste. It is important to recognize that the two land disposal technologies may not be applicable at all candidate sites.</p>	<p>The screening process proposed here is not typically included in NEPA documents. The NOI (72 FR 40135) identified the basis for identifying alternative disposal locations and disposal methods to analyze in the EIS. DOE provides an evaluation of the use of the three land disposal methods at the various sites to determine their applicability at these locations, and it provides an evaluation of disposal in a geologic repository at WIPP. DOE has summarized factors to be considered in developing a preferred alternative in Section 2.9 of the EIS.</p>
<p>5D. Additional topics, including future uses of nuclear power, the purchase and use of land for other activities, and the provision of funding to local and state governments for independent monitoring, should be addressed in this EIS.</p>	<p>Topics such as these are outside the scope of the EIS, which is limited to the consideration of disposal alternatives for GTCC LLRW and GTCC-like waste.</p>

TABLE A-3 (Cont.)

Public Scoping Issue	Rationale
<p>5E. Disposal fees to be shouldered by the waste generators should be established according to the actual costs of waste management and administration. This program should not be allowed to become another subsidy for the nuclear power industry.</p>	<p>The evaluation of costs or fees associated with the disposal of waste at the future GTCC LLRW disposal facility is outside the scope of this EIS. However, the LLRWPAA, Public Law 99-240, specifies that options should be identified “for ensuring that the beneficiaries of the activities resulting in the generation of waste [GTCC LLRW] bear all reasonable costs of disposing of such wastes....” DOE issued a Report to Congress in 1987 titled <i>Recommendations for the Management of Greater-Than-Class C Low-Level Radioactive Waste</i> that discussed funding options. In accordance with Section 631 of EAct 2005, this information will be updated and included in a report to Congress on disposal alternatives under consideration by DOE.</p>

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APPENDIX B:**GTCC LLRW AND GTCC-LIKE WASTE INVENTORIES**

This appendix provides detailed information on the inventories (volumes and radionuclide activities) of the wastes addressed in this environmental impact statement (EIS) for disposal alternatives for greater-than-Class C (GTCC) low-level radioactive waste (LLRW) and GTCC-like waste. Preliminary inventories were provided in the July 23, 2007, Notice of Intent (NOI) to prepare this EIS, and the bases of these estimates were described in a report prepared by Sandia National Laboratories entitled *Greater-Than-Class C Low-Level Radioactive Waste and DOE Greater-Than-Class C-Like Waste Inventory Estimates* (Sandia 2007). This report was issued in July 2007. Additional details on this inventory are provided in a subsequent report entitled *Basis Inventory for Greater-Than-Class-C Low-Level Radioactive Waste Environmental Impact Statement Evaluations*, Task 3.2 Report, Revision 1, which was issued in May 2008 (Sandia 2008).

These two reports were prepared to update GTCC LLRW estimates previously developed for the U.S. Department of Energy (DOE 1994). The inventory estimates reported in 1994 were limited to GTCC LLRW and did not consider GTCC-like waste. A third report was prepared by Argonne National Laboratory (Argonne) to summarize the information in these two documents and supplement or update information. This report is entitled *Supplement to Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste Inventory Reports* (Argonne 2010). This appendix provides a summary of the waste inventory data needed for this EIS on the basis of information contained in the three inventory reports described above.

As described in Section 1.4.1 of the EIS, wastes are placed in one of two groups for purposes of analysis. Group 1 consists of wastes that were already generated and are in storage or projected to be generated by existing facilities, such as commercial nuclear power plants. Group 2 consists of wastes that might be generated from proposed future activities, including several DOE projects, two planned molybdenum-99 (Mo-99) production projects, and new nuclear power plants that have not yet been licensed by the U.S. Nuclear Regulatory Commission (NRC) or constructed.

The estimated waste volumes and total radionuclide activities for the wastes in Groups 1 and 2 are shown in Table B-1 and are summarized as follows. The total waste volume in Group 1 is estimated to be 5,300 m³ (190,000 ft³) and contains a total of 110 megacuries (MCi) of radionuclide activity, mainly from the decommissioning of commercial nuclear power reactors currently in operation.

Group 2 has an estimated waste volume of 6,400 m³ (230,000 ft³) and contains a total activity of 49 MCi. Some of this waste is associated with the West Valley Site. A total of 980 m³ (35,000 ft³) of GTCC-like wastes are associated with decommissioning the West Valley Site (exclusive of the NRC-licensed disposal area [NDA] and state-licensed disposal area [SDA]), and an additional 4,300 m³ (150,000 ft³) of GTCC LLRW could be generated should a decision be made to exhume the NDA and SDA. As for Group 1 GTCC wastes, the radionuclide activity

TABLE B-1 Summary of Group 1 and Group 2 GTCC LLRW and GTCC-Like Waste Packaged Volumes and Radionuclide Activities^a

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m ³)	Activity (MCi) ^b	Volume (m ³)	Activity (MCi)	Volume (m ³)	Activity (MCi)
Group 1						
GTCC LLRW						
Activated metals (BWRs) ^c - RH	7.1	0.22	200	30	210	31
Activated metals (PWRs) - RH	51	1.1	620	76	670	77
Sealed sources (Small) ^d - CH	– ^{e,f}	–	1,800	0.28	1,800	0.28
Sealed sources (Cs-137 irradiators) - CH	–	–	1,000	1.7	1,000	1.7
Other Waste ^g - CH	42	0.000011	–	–	42	0.000011
Other Waste - RH	33	0.0042	1.0	0.00013	34	0.0043
Total	130	1.4	3,700	110	3,800	110
GTCC-like waste						
Activated metals - RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources (Small) - CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste - CH	430	0.016	310	0.0062	740	0.022
Other Waste - RH	520	0.096	200	0.17	720	0.26
Total	960	0.34	510	0.18	1,500	0.52
Total Group 1	1,100	1.7	4,200	110	5,300	110
Group 2						
GTCC LLRW						
Activated metals (BWRs) - RH	–	–	73	11	73	11
Activated metals (PWRs) - RH	–	–	300	37	300	37
Activated metals (Other) - RH	–	–	740	0.14	740	0.14
Sealed sources - CH	–	–	23	0.000020	23	0.000020
Other Waste - CH	–	–	1,600	0.024	1,600	0.024
Other Waste - RH	–	–	2,300	0.51	2,300	0.51
Total	–	–	5,000	49	5,000	49
GTCC-like waste						
Activated metals - RH	–	–	–	–	–	–
Sealed sources - CH	–	–	–	–	–	–
Other Waste - CH	–	–	490	0.012	490	0.012
Other Waste - RH	–	–	870	0.48	870	0.48
Total	–	–	1,400	0.49	1,400	0.49
Total Group 2	–	–	6,400	49	6,400	49

TABLE B-1 (Cont.)

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m ³)	Activity (MCi) ^b	Volume (m ³)	Activity (MCi)	Volume (m ³)	Activity (MCi)
Groups 1 and 2						
GTCC LLRW						
Activated metals - RH	59	1.4	1,900	160	2,000	160
Sealed sources - CH	–	–	2,900	2.0	2,900	2.0
Other Waste - CH	42	0.00091	1,600	0.024	1,600	0.024
Other Waste - RH	33	0.0042	2,300	0.51	2,300	0.51
Total	130	1.4	8,700	160	8,800	160
GTCC-like waste						
Activated metals - RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources - CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste - CH	430	0.016	800	0.02	1,200	0.036
Other Waste - RH	520	0.096	1,100	0.65	1,600	0.75
Total	960	0.34	1,900	0.67	2,800	1.0
Total Groups 1 and 2	1,100	1.7	11,000	160	12,000	160

^a All values have been rounded to two significant figures. Some totals may not equal sum of individual components because of independent rounding. BWR = boiling water reactor, CH = contact-handled (waste), PWR = pressurized water reactor, RH = remote-handled (waste).

^b MCi means megacurie or 1 million curies.

^c There are two types of commercial nuclear reactors in operation in the United States, BWRs and PWRs. Different factors were used to estimate the volumes and activities of activated metal wastes for these two types of reactors.

^d Sealed sources may be physically small but have high concentration of radionuclides.

^e There are sealed sources currently possessed by NRC licensees that may become GTCC LLRW when no longer needed by the licensee. Due to the lack of information on the current status of the sources (i.e., whether they are in use, waste, etc.), the estimated volume and activity of these sources are included in the projected inventory.

^f A dash means that there is no value for that entry.

^g Other Waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metals, filters, resins, soil, solidified sludges, and other materials.

1 in the Group 2 wastes results mainly from the decommissioning of new commercial nuclear
2 power reactors.

3
4 The GTCC wastes associated with decontamination and decommissioning of the West
5 Valley Site are in both Group 1 and Group 2. Group 1 wastes are all GTCC-like wastes and
6 result from past and ongoing decontamination activities at the site. Some of the wastes are
7 already in storage, and others are being generated by decontamination of the Main Plant Process
8 Building (MPPB) to make it ready for demolition. Group 2 wastes are all projected wastes from
9 potential future decommissioning activities. These wastes include GTCC-like wastes from
10 decommissioning of the MPPB and the Waste Tank Farm (WTF). Group 2 GTCC wastes would
11 also be generated should a decision be made to exhume the wastes from the NDA and SDA as
12 part of future decommissioning activities.

13
14 The volume of GTCC-like wastes associated with the West Valley Site from wastes
15 already in storage, ongoing decontamination of the MPPB, and the future decommissioning of
16 the MPPB and WTF is estimated to be about 2,200 m³ (78,000 ft³). Of this total, about 1,300 m³
17 (46,000 ft³) is in Group 1 and 980 m³ (35,000 ft³) is in Group 2. An additional 4,300 m³
18 (150,000 ft³) of GTCC LLRW and GTCC-like wastes could be generated by the exhumation of
19 the NDA and SDA at the site as part of future decommissioning activities. Most of the GTCC
20 waste from these disposal areas would be GTCC LLRW, with 31 m³ (1,100 ft³) from the NDA
21 being GTCC-like waste. The 31 m³ (1,100 ft³) of GTCC-like waste is included with the volume
22 of GTCC LLRW from the NDA and SDA for purposes of analysis in the EIS.

23
24 The total estimated volume of mixed waste in Group 1 is about 170 m³ (6,000 ft³), which
25 represents less than 4% of the total volume Group 1 waste. About 120 m³ (4,200 ft³) of this total
26 is GTCC-like mixed waste currently in storage at the West Valley Site. Current information is
27 insufficient to allow a reasonable estimate of the amount of Group 2 waste that could be mixed
28 waste. Most of the Group 1 mixed waste is GTCC-like waste; only 4 m³ (140 ft³) is GTCC
29 LLRW (Sandia 2007). Available information indicates that much of this waste is characteristic
30 hazardous waste as regulated under the Resource Conservation and Recovery Act (RCRA);
31 therefore, this EIS assumes that for the land disposal methods, the generators will treat the waste
32 to render it nonhazardous under federal and state laws and requirements. The Waste Isolation
33 Pilot Plant (WIPP), however, can accept mixed waste, as provided in the WIPP Land Withdrawal
34 Act (LWA).

35
36 The DOE planned plutonium-238 (Pu-238) production project is estimated to produce
37 380 m³ (13,000 ft³) of Group 2 GTCC-like wastes with a total activity of 0.094 MCi. Many of
38 the radionuclides in these wastes have short half-lives (three years or less) that will not have an
39 impact on long-term management decisions. For purposes of analysis in the EIS, it is assumed
40 that the Pu-238 production wastes will be stored for three years at the facilities generating these
41 wastes prior to shipment to the disposal site. The total activity in these wastes given here
42 includes radioactive decay for three years.

43
44 Waste associated with the future production of Mo-99 is also included in the GTCC EIS
45 inventory. Two organizations are currently planning to produce Mo-99 for medical uses in the
46 near future: Babcock & Wilcox Company (B&W) and the Missouri University Research Reactor

1 (MURR). The B&W concept uses a homogenous solution reactor termed the Medical Isotope
2 Production System (MIPS). The MIPS is estimated to produce an annual volume of 5 m³
3 (180 ft³) of GTCC LLRW containing a total activity of about 3,700 curies (Ci). It is assumed that
4 the GTCC LLRW produced by MIPS would be stored at the generating site for three years prior
5 to shipment to the disposal facility to allow the short-lived radionuclides to decay. An annual
6 activity of 3,700 Ci for MIPS reflects three years of radioactive decay.

7
8 Use of the MURR involves irradiating solid targets containing low-enriched uranium in
9 the research reactor and processing the targets to extract Mo-99. This process is estimated to
10 produce an annual volume of 0.46 m³ (16 ft³) of GTCC LLRW containing a total activity of
11 about 3,100 Ci. As was the case for MIPS, it is assumed that these wastes would be stored at the
12 generating site for three years prior to shipment to the disposal facility, and the activity given
13 here reflects that decay. For purposes of analysis in the EIS, these two processes are both
14 assumed to begin operation in the next few years and to operate for 71 years (to 2083). The total
15 volume of GTCC LLRW produced over this time frame for these two Mo-99 production projects
16 is estimated to be about 390 m³ (14,000 ft³) and contain 0.48 MCi of activity.

17
18 As discussed in Section 1.4.1, the GTCC LLRW and GTCC-like wastes are considered to
19 be in one of three waste types: activated metals, sealed sources, or Other Waste. The waste
20 inventory includes wastes already generated and in storage (stored inventory), as well as wastes
21 estimated to be generated in the future (projected inventory). All three types of waste (activated
22 metals, sealed sources, and Other Waste) are currently in storage at sites licensed by the NRC or
23 Agreement States and at certain DOE sites.

24 25 26 **B.1 SUMMARY OF WASTE VOLUMES**

27
28 Table B-1 provides a summary of the packaged waste volumes for the Group 1 and 2
29 wastes being addressed in this EIS. Some of the Group 1 wastes have already been generated and
30 are in storage, and the rest would be generated in the future. All Group 2 wastes would be
31 generated in the future. Table B-2 identifies the locations where GTCC LLRW and GTCC-like
32 wastes are currently being stored or would be generated in the future. Additional information for
33 GTCC-like wastes is presented in Table B-3. This information is described in more detail in
34 Argonne (2010).

35
36 The GTCC LLRW is stored at NRC or Agreement State licensee locations, including at
37 commercial storage facilities at a number of sites across the United States. Most of the activated
38 metal GTCC LLRW is stored at commercial nuclear power plants. Figure 3.1-1 shows the
39 locations of the currently operating nuclear power plants, most of which are located east of the
40 Mississippi River. GTCC LLRW sealed sources are stored at medical facilities and hospitals,
41 industrial facilities, universities, and commercial storage and staging locations. Two facilities are
42 currently being used to store GTCC LLRW Other Waste (in Virginia and Texas). All of these
43 facilities are operated in accordance with applicable requirements.

44
45 A comparison of the volumes and radionuclide activities of GTCC LLRW and GTCC-
46 like waste with the annual volumes and activity of LLRW generated in the United States and

TABLE B-2 Storage and Generator Locations of the GTCC LLRW and GTCC-Like Wastes Addressed in This EIS^a

Waste Type	GTCC LLRW	GTCC-Like
Group 1		
Activated metals - RH	Various states (see Figure 3.1-1)	INL (Idaho) ORR (Tennessee)
Sealed sources - CH	Various states	LANL (New Mexico)
Other Waste - CH	Babcock and Wilcox (Virginia) Waste Control Specialists (Texas)	West Valley Site (New York) INL (Idaho) Babcock and Wilcox (Virginia)
Other Waste - RH	Virginia and Texas	West Valley Site (New York) INL (Idaho) ORR (Tennessee) Babcock and Wilcox (Virginia)
Group 2		
Activated metals - RH	Various states	–
Sealed sources - CH	West Valley Site (New York)	–
Other Waste - CH	West Valley Site (New York)	West Valley Site (New York) ORR (Tennessee)
Other Waste - RH	West Valley Site (New York) Missouri University Research Reactor (Missouri) Babcock and Wilcox (Virginia)	West Valley Site (New York) ORR (Tennessee)

^a Other waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metal, filters, resins, soil, solidified sludges, and other materials. A dash means no volume for that waste type. INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, ORR = Oak Ridge Reservation.

1

2

3 with high-level waste and spent nuclear fuel is shown in Figure B-1. As can be seen in this
4 figure, GTCC waste represents a very small fraction of the total volume of LLRW generated
5 annually, but it has significantly greater activity.

6

7 This information is presented in detail in a number of tables that describe the types of
8 waste packages that were used to evaluate waste handling and transportation impacts. These
9 tables do not mean to imply that these waste packages would actually be used for such purposes
10 once a disposal site was selected. Rather, these packages are representative of those that could be
11 used, and they were chosen herein solely for the purpose of evaluating environmental impacts
12 associated with the various disposal alternatives being addressed in this EIS.

13

14

15 **B.2 SUMMARY OF RADIONUCLIDE ACTIVITIES**

16

17 The radionuclide activities in the wastes were developed by using information provided
18 by the DOE Operations and Field Offices in response to a data call, using information provided
19 in databases, and conducting a review of documents on GTCC LLRW and transuranic (TRU)
20 waste prepared by DOE and NRC. Radionuclide information for the two planned Mo-99 projects

TABLE B-3 Sources of the GTCC-Like Wastes Addressed in This EIS^a

Waste Type	Site ^b	Stored Volume (m ³)	Projected Volume (m ³)
Group 1			
Activated metals - RH	INL	3.3	6.6
	ORR	2.9	– ^c
Sealed sources - CH	LANL	0.21	0.62
Other Waste - CH	West Valley Site ^d	400	310
	INL	31	–
	B&W	3.4	–
Other Waste - RH	West Valley Site ^d	480	63
	INL	19	–
	ORR	4.0	130
	B&W	15	0.60
Total		960	510
Group 2			
Activated metals - RH	–	–	–
Sealed sources - CH	–	–	–
Other Waste - CH	West Valley Site	–	220
	ORR	–	260
Other Waste - RH	West Valley Site	–	760
	ORR	–	120
Total		–	1,400

^a All values have been rounded to two significant figures. Some totals may not equal sum of individual components because of independent rounding. B&W = Babcock & Wilcox Company (Lynchburg, Va.), CH = contact-handled (waste), INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, ORR = Oak Ridge Reservation, RH = remote-handled (waste).

^b These are the sites where the wastes are currently being stored or would be generated in the future.

^c A dash means that there is no value for that entry.

^d These volumes were provided by the DOE Waste Valley Site Office and assumed waste repackaging with volume reduction prior to disposal. These wastes are associated with decontamination activities at the West Valley Site. Because of the assumed volume reduction, the volumes presented in this GTCC EIS are less than those presented in the Final EIS for the West Valley Site (DOE 2010a).

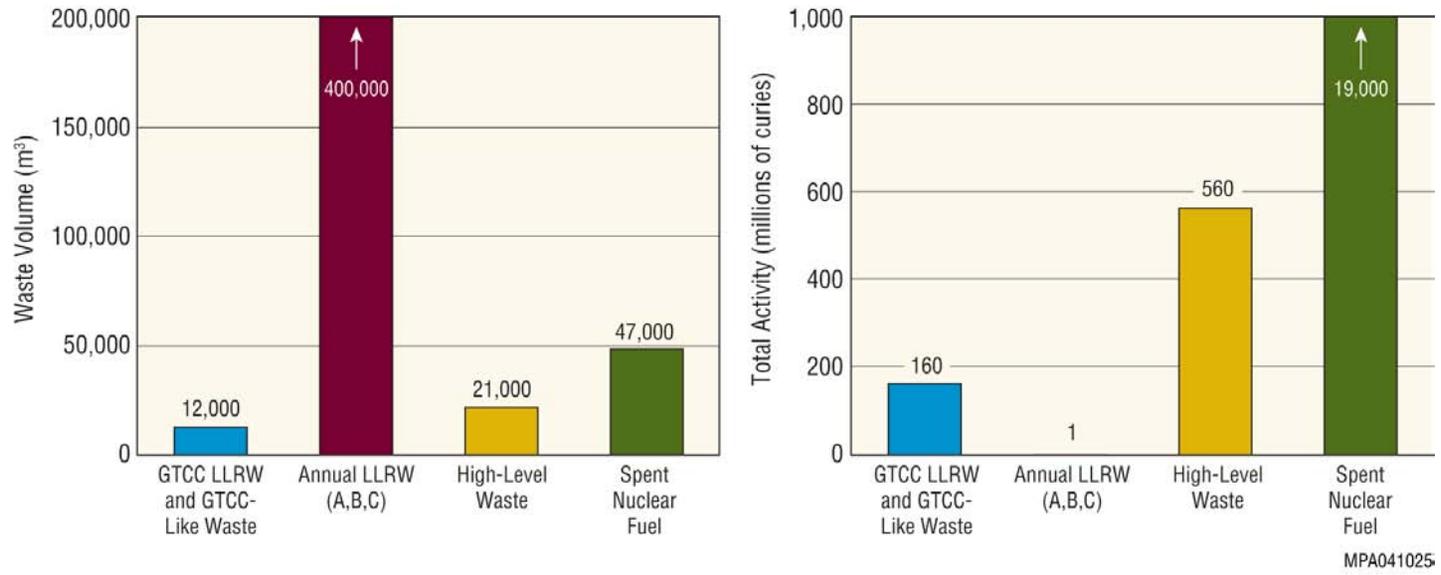


FIGURE B-1 Comparison of GTCC Waste with Other Radioactive Wastes

1 and the DOE Pu-238 production project was provided by the organizations planning to
2 implement these projects in the future.

3

4 The radionuclides present in GTCC LLRW and GTCC-like waste can generally be placed
5 in three categories: neutron activation products, radioactive fission products, and actinides
6 (i.e., radionuclides that are higher than actinium in the Chart of the Nuclides). The main source
7 of activity in activated metals is neutron activation products, while fission products and actinides
8 are the main radionuclides present in sealed sources and Other Waste. Fission products and some
9 actinides are also present in relatively low concentrations in activated metals. The actinides
10 include TRU radionuclides, and many of these are present in GTCC-like Other Waste.

11

12 Radionuclide profiles were used to develop estimates of the total curies of each
13 radionuclide that would be present in the various waste streams, and then the individual waste
14 streams were summed to obtain estimates of the total activities in the various GTCC LLRW and
15 GTCC-like waste types. The three reports identified on page B-1 (Sandia 2007, 2008;
16 Argonne 2010) can be consulted to evaluate these results in more detail for the individual waste
17 streams. This information was used to address the impacts associated with the handling,
18 transportation, and disposal of these wastes in this EIS.

19

20 A summary of the radionuclide activities in the Group 1 and Group 2 GTCC waste is
21 provided in Tables B-4 through B-7. The radionuclides in these tables are those expected to be
22 most prevalent or significant in evaluating the radiological impacts from the various disposal
23 alternatives considered in the EIS. The radionuclide activities given in this appendix for stored
24 wastes account for radioactive decay to 2019, while the activities for projected wastes are those
25 expected to be present when the wastes are generated and available for disposal. In addition, the
26 radionuclide activities for the GTCC wastes in the two disposal areas at the West Valley Site
27 were decay-corrected to 2019 for purposes of analysis in this EIS.

28

29 The radionuclide activities for Group 1 GTCC LLRW and GTCC-like waste are
30 summarized in Tables B-4 through B-6. Table B-4 contains the total (stored and projected)
31 activities for GTCC LLRW and GTCC-like waste, which are divided into the stored activities
32 (Table B-5) and projected activities (Table B-6). The Group 2 activities are given separately in
33 the same format in Table B-7. All of the Group 2 wastes would be generated in the future; there
34 are no stored Group 2 wastes.

35

36 Most of the radionuclide activity in the wastes being addressed in this EIS is associated
37 with the neutron activation products in commercial nuclear reactors (i.e., GTCC LLRW activated
38 metals). The sealed sources contribute a relatively small amount to the total radionuclide activity,
39 with the exception of cesium-137 (Cs-137), which has a half-life of about 30 years. While the
40 total activity of the Other Waste is significantly lower than that of the activated metal waste,
41 much of this activity is attributable to long-lived TRU radionuclides. These long-lived
42 radionuclides are important in evaluating the viability of various disposal alternatives in this EIS.

43

44 To provide additional perspective on these radionuclide activities, the key properties of
45 the major radionuclides discussed in this appendix are given in Table B-8. This table identifies
46 the major modes of decay for the 44 radionuclides given in Tables B-4 through B-7, along with

TABLE B-4 Radionuclide Activity (in curies) of Group 1 GTCC LLRW and GTCC-Like Waste^a

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Hydrogen-3	6.8×10^3	–	–	–	–	2.3×10^5	–	–	1.7×10^{-1}	1.6×10^1
Carbon-14	2.3×10^4	–	–	–	5.8×10^{-3}	6.8×10^2	–	–	1.3×10^1	1.0×10^2
Manganese-54	4.9×10^4	–	–	–	9.6×10^{-3}	2.8×10^{-5}	–	–	4.7×10^{-3}	4.8×10^1
Iron-55	4.0×10^7	–	–	–	6.3×10^{-4}	1.7×10^2	–	–	5.7	8.2
Nickel-59	1.3×10^5	–	–	–	1.1×10^{-1}	3.1	–	–	7.6×10^{-2}	1.6×10^2
Cobalt-60	5.0×10^7	–	–	–	8.7	4.7×10^3	–	–	4.1×10^{-3}	1.2×10^3
Nickel-63	1.8×10^7	–	–	–	5.3	8.0×10^2	–	–	2.5×10^{-2}	9.4×10^3
Strontium-90	1.2×10^4	–	–	–	1.5×10^3	–	–	–	6.6×10^1	3.6×10^4
Molybdenum-93	1.1×10^2	–	–	–	–	–	–	–	–	–
Niobium-94	6.0×10^2	–	–	–	–	1.3×10^{-2}	–	–	5.2×10^{-5}	9.8×10^{-2}
Technetium-99	4.5×10^3	–	–	–	7.6×10^{-1}	–	–	–	3.2×10^{-1}	1.7×10^2
Iodine-129	1.9	–	–	–	–	–	–	–	9.7×10^{-5}	2.7
Cesium-137	1.3×10^4	–	1.7×10^6	5.7	2.0×10^3	–	–	–	6.5×10^1	3.9×10^4
Promethium-147	–	–	–	–	–	–	–	–	1.4×10^{-3}	5.6
Samarium-151	–	–	–	–	–	–	–	–	2.9×10^{-3}	1.7×10^{-1}
Europium-152	–	–	–	–	–	6.6×10^2	–	–	3.1×10^{-3}	6.8×10^2
Europium-154	–	–	–	–	–	6.0	–	–	1.9×10^{-1}	2.2×10^2
Europium-155	–	–	–	–	–	7.1×10^{-1}	–	–	3.1×10^{-4}	9.2×10^1
Lead-210	–	–	–	–	5.1×10^{-9}	–	–	–	3.6×10^{-6}	2.3×10^{-9}
Radium-226	–	–	–	–	–	–	–	–	4.3	–
Actinium-227	–	–	–	–	–	–	–	–	3.3×10^{-2}	1.6×10^{-9}
Radium-228	–	–	–	–	–	–	–	–	2.3×10^{-1}	–
Thorium-229	–	–	–	–	8.8×10^{-4}	–	–	–	2.2	7.4×10^{-2}
Thorium-230	–	–	–	–	8.9×10^{-6}	–	–	–	4.1×10^{-1}	2.7×10^{-2}
Protactinium-231	–	–	–	–	–	–	–	–	1.1×10^{-5}	1.3×10^{-8}
Thorium-232	–	–	–	–	–	–	–	–	2.8×10^{-1}	6.8×10^{-1}
Uranium-232	–	–	–	–	–	–	–	–	2.3×10^1	1.9
Uranium-233	–	–	–	–	6.0×10^{-1}	–	–	–	9.4	7.9×10^2
Uranium-234	–	–	–	–	–	–	–	–	4.4×10^1	1.6
Uranium-235	–	–	–	–	5.2×10^{-3}	–	–	–	1.6×10^{-1}	3.5×10^{-1}
Uranium-236	–	–	–	–	–	–	–	–	5.4×10^{-2}	7.9×10^{-1}
Neptunium-237	–	–	–	–	3.2×10^{-3}	–	–	–	1.1	1.5

TABLE B-4 (Cont.)

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Uranium-238	–	–	–	–	–	–	–	–	9.1×10^{-2}	1.1×10^1
Plutonium-238	8.8×10^{-1}	1.2×10^5	–	–	1.8×10^1	–	–	–	1.3×10^3	1.5×10^3
Plutonium-239	4.5×10^3	8.4×10^3	–	–	2.5×10^1	–	–	–	9.0×10^2	2.9×10^3
Plutonium-240	–	–	–	–	7.5	–	2.2×10^1	–	7.1×10^2	1.8×10^3
Plutonium-241	2.5×10^1	–	–	–	6.2×10^2	–	–	–	1.4×10^4	1.7×10^4
Americium-241	6.4×10^1	1.5×10^5	–	5.0	6.6×10^1	–	–	–	4.4×10^3	5.3×10^3
Plutonium-242	–	–	–	–	2.3×10^{-3}	–	–	–	4.5	3.9
Americium-243	–	–	–	–	4.7×10^{-3}	–	3.5×10^{-1}	–	3.4×10^1	8.6×10^1
Curium-243	–	–	–	–	–	–	–	–	7.6×10^{-2}	2.2
Curium-244	–	2.2×10^1	–	–	5.2	–	5.4×10^1	–	1.8	1.1×10^3
Curium-245	–	–	–	–	–	–	–	–	2.0×10^{-9}	3.4×10^2
Curium-246	–	–	–	–	–	–	–	–	1.9×10^{-11}	5.4×10^1

^a The approach used to develop these activities is given in Argonne (2010) and the references cited therein. The activities represent values at the time the wastes are projected to be available for disposal and are given to two significant figures. Separate estimates were developed for GTCC LLRW and GTCC-like waste. A dash means there is no value for that entry. CH = contact-handled (waste), RH = remote-handled (waste).

^b All of the activated metal wastes are expected to be RH waste.

^c All of the sealed source wastes are expected to be CH waste, with the possible exception of two americium-241/beryllium sources.

TABLE B-5 Radionuclide Activity (in curies) of Stored Group 1 GTCC LLRW and GTCC-Like Waste^a

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Hydrogen-3	1.6×10^2	-	-	-	-	2.3×10^5	-	-	1.1×10^{-1}	1.6×10^1
Carbon-14	1.4×10^3	-	-	-	5.6×10^{-3}	2.0×10^2	-	-	1.0×10^1	1.0×10^2
Manganese-54	9.2×10^{-3}	-	-	-	9.4×10^{-3}	2.8×10^{-5}	-	-	2.3×10^{-6}	4.2×10^{-3}
Iron-55	3.4×10^4	-	-	-	6.1×10^{-4}	1.7×10^2	-	-	9.9×10^{-1}	8.2
Nickel-59	7.8×10^3	-	-	-	1.1×10^{-1}	6.0×10^{-1}	-	-	5.9×10^{-2}	1.6×10^2
Cobalt-60	3.5×10^5	-	-	-	8.4	8.5×10^2	-	-	4.0×10^{-3}	3.1×10^2
Nickel-63	9.6×10^5	-	-	-	5.2	1.9×10^2	-	-	2.5×10^{-2}	9.4×10^3
Strontium-90	4.7×10^2	-	-	-	1.5×10^3	-	-	-	8.6	2.9×10^4
Molybdenum-93	7.4	-	-	-	-	-	-	-	-	-
Niobium-94	4.1×10^1	-	-	-	-	1.8×10^{-3}	-	-	5.2×10^{-5}	9.8×10^{-2}
Technetium-99	2.8×10^2	-	-	-	7.3×10^{-1}	-	-	-	2.4×10^{-1}	1.7×10^2
Iodine-129	1.2×10^{-1}	-	-	-	-	-	-	-	4.9×10^{-5}	2.7
Cesium-137	5.5×10^2	-	-	5.7	2.0×10^3	-	-	-	5.0	3.0×10^4
Promethium-147	-	-	-	-	-	-	-	-	1.4×10^{-3}	5.6
Samarium-151	-	-	-	-	-	-	-	-	2.9×10^{-3}	1.7×10^{-1}
Europium-152	-	-	-	-	-	6.6×10^2	-	-	3.1×10^{-3}	6.0×10^{-4}
Europium-154	-	-	-	-	-	6.0	-	-	1.1×10^{-1}	1.7×10^1
Europium-155	-	-	-	-	-	7.1×10^{-1}	-	-	3.1×10^{-4}	7.9×10^{-1}
Lead-210	-	-	-	-	4.9×10^{-9}	-	-	-	3.6×10^{-6}	2.2×10^{-9}
Radium-226	-	-	-	-	-	-	-	-	3.4	-
Actinium-227	-	-	-	-	-	-	-	-	2.4×10^{-2}	1.6×10^{-9}
Radium-228	-	-	-	-	-	-	-	-	1.1×10^{-1}	-
Thorium-229	-	-	-	-	8.5×10^{-4}	-	-	-	1.7	7.4×10^{-2}
Thorium-230	-	-	-	-	8.6×10^{-6}	-	-	-	3.2×10^{-1}	2.7×10^{-2}
Protactinium-231	-	-	-	-	-	-	-	-	1.1×10^{-5}	1.3×10^{-8}
Thorium-232	-	-	-	-	-	-	-	-	2.2×10^{-1}	6.8×10^{-1}
Uranium-232	-	-	-	-	-	-	-	-	1.8×10^1	1.9
Uranium-233	-	-	-	-	5.8×10^{-1}	-	-	-	7.3	1.7×10^1
Uranium-234	-	-	-	-	-	-	-	-	3.4×10^1	1.6
Uranium-235	-	-	-	-	5.0×10^{-3}	-	-	-	1.5×10^{-1}	3.5×10^{-1}
Uranium-236	-	-	-	-	-	-	-	-	4.2×10^{-2}	7.9×10^{-1}

TABLE B-5 (Cont.)

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Neptunium-237	-	-	-	-	3.1 × 10 ⁻³	-	-	-	1.0	1.5
Uranium-238	-	-	-	-	-	-	-	-	7.0 × 10 ⁻²	1.8
Plutonium-238	4.7 × 10 ⁻²	-	-	-	1.8 × 10 ¹	-	-	-	1.0 × 10 ³	7.5 × 10 ²
Plutonium-239	2.8 × 10 ²	-	-	-	2.4 × 10 ¹	-	-	-	7.0 × 10 ²	2.7 × 10 ³
Plutonium-240	-	-	-	-	7.3	-	-	-	5.6 × 10 ²	1.7 × 10 ³
Plutonium-241	6.4 × 10 ⁻¹	-	-	-	6.0 × 10 ²	-	-	-	9.6 × 10 ³	1.6 × 10 ⁴
Americium-241	3.8	-	-	5.0	6.4 × 10 ¹	-	-	-	3.6 × 10 ³	5.3 × 10 ³
Plutonium-242	-	-	-	-	2.2 × 10 ⁻³	-	-	-	3.5	3.9
Americium-243	-	-	-	-	4.6 × 10 ⁻³	-	-	-	2.7 × 10 ¹	8.6 × 10 ¹
Curium-243	-	-	-	-	-	-	-	-	5.3 × 10 ⁻²	1.8
Curium-244	-	-	-	-	5.0	-	6.0	-	1.2	3.8 × 10 ¹
Curium-245	-	-	-	-	-	-	-	-	2.0 × 10 ⁻⁹	3.4 × 10 ²
Curium-246	-	-	-	-	-	-	-	-	1.9 × 10 ⁻¹¹	5.4 × 10 ¹

^a The approach used to develop these activities is given in Argonne (2010) and the references cited therein. The activities represent values at the time the wastes are projected to be available for disposal and are given to two significant figures. Separate estimates were developed for GTCC LLRW and GTCC-like waste. A dash means there are no values for that entry. CH = contact-handled (waste), RH = remote-handled (waste).

^b All of the activated metal wastes are expected to be RH waste.

^c All of the sealed source wastes are expected to be CH waste, with the possible exception of two americium-241/beryllium sources.

TABLE B-6 Radionuclide Activity (in curies) of Projected Group 1 GTCC LLRW and GTCC-Like Waste^a

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Hydrogen-3	6.7×10^3	-	-	-	-	-	-	-	5.7×10^{-2}	-
Carbon-14	2.1×10^4	-	-	-	1.7×10^{-4}	4.9×10^2	-	-	3.0	1.4×10^{-2}
Manganese-54	4.9×10^4	-	-	-	2.9×10^{-4}	-	-	-	4.7×10^{-3}	4.8×10^1
Iron-55	4.0×10^7	-	-	-	1.9×10^{-5}	-	-	-	4.7	1.1×10^{-5}
Nickel-59	1.2×10^5	-	-	-	3.3×10^{-3}	2.5	-	-	1.7×10^{-2}	2.0×10^{-3}
Cobalt-60	5.0×10^7	-	-	-	2.6×10^{-1}	3.8×10^3	-	-	9.8×10^{-5}	8.8×10^2
Nickel-63	1.7×10^7	-	-	-	1.6×10^{-1}	6.1×10^2	-	-	-	9.5×10^{-2}
Strontium-90	1.1×10^4	-	-	-	4.6×10^1	-	-	-	5.7×10^1	7.3×10^3
Molybdenum-93	1.0×10^2	-	-	-	-	-	-	-	-	-
Niobium-94	5.5×10^2	-	-	-	-	1.1×10^{-2}	-	-	-	-
Technetium-99	4.2×10^3	-	-	-	2.3×10^{-2}	-	-	-	8.7×10^{-2}	2.1
Iodine-129	1.8	-	-	-	-	-	-	-	4.8×10^{-5}	6.6×10^{-5}
Cesium-137	1.3×10^4	-	1.7×10^6	-	6.0×10^1	-	-	-	6.0×10^1	9.5×10^3
Promethium-147	-	-	-	-	-	-	-	-	-	-
Samarium-151	-	-	-	-	-	-	-	-	-	-
Europium-152	-	-	-	-	-	-	-	-	-	6.8×10^2
Europium-154	-	-	-	-	-	-	-	-	7.5×10^{-2}	2.0×10^2
Europium-155	-	-	-	-	-	-	-	-	-	9.1×10^1
Lead-210	-	-	-	-	1.5×10^{-10}	-	-	-	-	9.1×10^{-11}
Radium-226	-	-	-	-	-	-	-	-	9.5×10^{-1}	-
Actinium-227	-	-	-	-	-	-	-	-	9.5×10^{-3}	-
Radium-228	-	-	-	-	-	-	-	-	1.2×10^{-1}	-
Thorium-229	-	-	-	-	2.6×10^{-5}	-	-	-	4.9×10^{-1}	1.6×10^{-5}
Thorium-230	-	-	-	-	2.7×10^{-7}	-	-	-	8.8×10^{-2}	1.6×10^{-7}
Protactinium-231	-	-	-	-	-	-	-	-	-	-
Thorium-232	-	-	-	-	-	-	-	-	6.2×10^{-2}	-
Uranium-232	-	-	-	-	-	-	-	-	5.5	5.6×10^{-3}
Uranium-233	-	-	-	-	1.8×10^{-2}	-	-	-	2.1	7.8×10^2
Uranium-234	-	-	-	-	-	-	-	-	9.6	2.4×10^{-3}
Uranium-235	-	-	-	-	1.5×10^{-4}	-	-	-	4.1×10^{-3}	3.1×10^{-4}
Uranium-236	-	-	-	-	-	-	-	-	1.2×10^{-2}	-

TABLE B-6 (Cont.)

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources ^c		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Neptunium-237	–	–	–	–	9.5×10^{-5}	–	–	–	1.1×10^{-2}	3.1×10^{-2}
Uranium-238	–	–	–	–	–	–	–	–	2.2×10^{-2}	8.8
Plutonium-238	8.3×10^{-1}	1.2×10^5	–	–	5.4×10^{-1}	–	–	–	2.9×10^2	7.5×10^2
Plutonium-239	4.2×10^3	8.4×10^3	–	–	7.4×10^{-1}	–	–	–	2.0×10^2	2.0×10^2
Plutonium-240	–	–	–	–	2.2×10^{-1}	–	2.2×10^1	–	1.6×10^2	3.4×10^1
Plutonium-241	2.4×10^1	–	–	–	1.8×10^1	–	–	–	4.6×10^3	1.0×10^2
Americium-241	6.0×10^1	1.5×10^5	–	–	2.0	–	–	–	7.1×10^2	6.0×10^1
Plutonium-242	–	–	–	–	6.8×10^{-5}	–	–	–	9.8×10^{-1}	4.1×10^{-5}
Americium-243	–	–	–	–	1.4×10^{-4}	–	3.5×10^{-1}	–	7.5	8.4×10^{-5}
Curium-243	–	–	–	–	–	–	–	–	2.3×10^{-2}	3.4×10^{-1}
Curium-244	–	2.2×10^1	–	–	1.5×10^{-1}	–	4.8×10^1	–	5.9×10^{-1}	1.1×10^3
Curium-245	–	–	–	–	–	–	–	–	–	–
Curium-246	–	–	–	–	–	–	–	–	–	–

^a The approach used to develop these activities is given in Argonne (2010) and the references cited therein. The activities represent values at the time the wastes are projected to be available for disposal and are given to two significant figures. Separate estimates were developed for GTCC LLRW and GTCC-like waste. A dash means there are not values for that entry. CH = contact-handled (waste), RH = remote-handled (waste).

^b All of the activated metal wastes are expected to be RH waste.

^c All of the sealed source wastes are expected to be CH waste, with the possible exception of two americium-241/beryllium sources.

TABLE B-7 Radionuclide Activity (in curies) of Group 2 GTCC LLRW and GTCC-Like Waste^a

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources		Other Waste	
		Actinides	Nonactinides	CH	RH		Actinides	Nonactinides	CH	RH
Hydrogen-3	3.6×10^3	–	–	2.0×10^2	1.9×10^2	–	–	–	1.1×10^{-1}	1.7×10^{-1}
Carbon-14	1.0×10^4	–	–	4.4	1.5×10^2	–	–	–	5.9	9.0
Manganese-54	2.3×10^4	–	–	–	1.8×10^{-7}	–	–	–	9.4×10^{-3}	1.4×10^{-2}
Iron-55	1.8×10^7	–	–	3.9×10^{-1}	3.1	–	–	–	9.4	1.4×10^1
Nickel-59	5.4×10^4	–	–	3.3×10^{-2}	2.1	–	–	–	3.3×10^{-2}	5.1×10^{-2}
Cobalt-60	2.3×10^7	–	–	6.5	4.8×10^1	–	–	–	2.0×10^{-4}	3.0×10^{-4}
Nickel-63	7.5×10^6	–	–	3.7	1.8×10^2	–	–	–	–	–
Strontium-90	1.3×10^4	–	–	2.8	1.0×10^5	–	–	–	6.1	5.1×10^4
Molybdenum-93	4.7×10^1	–	–	–	5.5×10^{-5}	–	–	–	–	–
Niobium-94	2.7×10^2	–	–	1.0×10^{-3}	2.8×10^{-2}	–	–	–	–	–
Technetium-99	1.9×10^3	–	–	1.0×10^{-3}	1.7×10^1	–	–	–	1.3×10^{-1}	3.2
Iodine-129	2.1	–	–	2.9×10^{-3}	5.4×10^{-2}	–	–	–	–	3.8×10^{-3}
Cesium-137	2.3×10^4	–	–	2.2×10^1	1.1×10^5	–	–	–	3.3	3.4×10^5
Promethium-147	1.1×10^{-1}	–	–	–	1.7×10^5	–	–	–	–	4.4×10^3
Samarium-151	1.7×10^2	–	–	–	2.4×10^3	–	–	–	–	–
Europium-152	3.3×10^{-1}	–	–	–	1.1	–	–	–	–	–
Europium-154	1.8×10^1	–	–	–	5.9×10^1	–	–	–	1.5×10^{-1}	2.3×10^{-1}
Europium-155	7.0×10^{-1}	–	–	–	2.0×10^3	–	–	–	–	–
Lead-210	3.3×10^{-7}	–	–	–	5.1×10^{-7}	–	–	–	–	–
Radium-226	1.5×10^{-6}	–	–	–	2.5×10^{-6}	–	–	–	1.9	2.9
Actinium-227	1.1×10^{-2}	–	–	–	1.8×10^{-2}	–	–	–	1.9×10^{-2}	2.9×10^{-2}
Radium-228	3.2×10^{-4}	–	–	–	5.6×10^{-4}	–	–	–	2.4×10^{-1}	3.6×10^{-1}
Thorium-229	1.2×10^{-2}	–	–	–	2.2×10^{-2}	–	–	–	9.8×10^{-1}	1.5
Thorium-230	1.3×10^{-4}	–	–	–	2.4×10^{-4}	–	–	–	1.8×10^{-1}	2.7×10^{-1}
Protactinium-231	3.0×10^{-2}	–	–	–	5.2×10^{-2}	–	–	–	–	–
Thorium-232	3.2×10^{-3}	–	–	–	5.6×10^{-3}	–	–	–	1.2×10^{-1}	1.9×10^{-1}
Uranium-232	1.4	–	–	–	2.9	–	–	–	1.1×10^1	1.7×10^1
Uranium-233	3.8	–	–	–	7.4	–	–	–	4.1	6.4
Uranium-234	2.0×10^{-1}	–	–	9.7×10^{-3}	3.9×10^{-1}	–	–	–	1.9×10^1	2.9×10^1
Uranium-235	7.2×10^{-2}	–	–	4.8×10^{-4}	3.7	–	–	–	8.0×10^{-3}	1.4×10^{-2}
Uranium-236	1.1×10^{-1}	–	–	–	4.4×10^{-1}	–	–	–	2.4×10^{-2}	3.6×10^{-2}

TABLE B-7 (Cont.)

Radionuclide	GTCC LLRW					GTCC-Like Waste				
	Activated Metals ^b	Sealed Sources ^c		Other Waste		Activated Metals ^b	Sealed Sources		Other Waste	
		Actinides	Nonactinides	CH ^d	RH		Actinides	Nonactinides	CH	RH
Neptunium-237	6.7×10^{-2}	–	–	3.4×10^{-9}	9.9×10^{-2}	–	–	–	2.2×10^{-2}	2.3
Uranium-238	8.4×10^{-1}	–	–	1.0×10^{-2}	3.1	–	–	–	3.9×10^{-2}	7.3×10^{-2}
Plutonium-238	1.3×10^2	–	–	2.1×10^4	2.1×10^2	–	–	–	5.7×10^2	1.9×10^3
Plutonium-239	2.1×10^3	–	–	4.9×10^1	4.5×10^2	–	–	–	4.0×10^2	6.4×10^2
Plutonium-240	1.6×10^2	–	–	4.5×10^1	2.4×10^2	–	–	–	3.2×10^2	5.1×10^2
Plutonium-241	2.5×10^3	–	–	2.7×10^3	3.9×10^3	–	–	–	9.3×10^3	1.5×10^4
Americium-241	7.2×10^2	–	–	1.2×10^{-2}	1.0×10^3	–	–	–	1.4×10^3	2.6×10^3
Plutonium-242	1.4×10^{-1}	–	–	4.4×10^{-2}	2.0×10^{-1}	–	–	–	2.0	3.0
Americium-243	1.1	–	–	6.8×10^{-4}	6.8×10^{-1}	–	–	–	1.5×10^1	2.3×10^1
Curium-243	1.4×10^{-1}	–	–	7.4×10^{-6}	2.4×10^{-1}	–	–	–	3.9×10^{-2}	3.9
Curium-244	8.0	–	–	4.9×10^{-3}	5.3	–	–	–	1.0	9.1×10^1
Curium-245	8.0×10^{-4}	–	–	–	1.3×10^{-3}	–	–	–	–	–
Curium-246	6.4×10^{-5}	–	–	–	1.1×10^{-4}	–	–	–	–	–

^a There is a large degree of uncertainty in the schedules and plans for the projects that will generate these wastes. The approach used to develop these activities is given in Argonne (2010) and the references cited therein. The activities represent values at the time the wastes are projected to be available for disposal and are given to two significant figures. Separate estimates were developed for GTCC LLRW and GTCC-like waste. All of these wastes will be generated in the future, and there are no Group 2 GTCC-like activated metal and sealed source wastes. A dash means there is no value for that entry. CH = contact-handled (waste), RH = remote-handled (waste).

^b All of the activated metal wastes are expected to be RH waste.

^c The radionuclide activities for the small volume of sealed sources in the SDA are included with the activities reported for the GTCC LLRW Other Waste - RH category.

TABLE B-8 Key Properties of the Major Radionuclides Addressed in This EIS^a

Radionuclide	Half-Life	Specific Activity (Ci/g)	Decay Mode	Radiation Energy per Decay (MeV)		
				Alpha (α)	Beta (β)	Photon (γ)
Actinium-227 ^b	22 yr	73	α, β	0.068	0.016	<0.001
<i>Thorium-227 (99%)</i>	<i>19 days</i>	<i>31,000</i>	<i>α</i>	<i>5.9</i>	<i>0.053</i>	<i>0.11</i>
<i>Francium-223 (1%)</i>	<i>22 min</i>	<i>39 million</i>	<i>β</i>	<i>-</i>	<i>0.40</i>	<i>0.059</i>
<i>Radium-223</i>	<i>11 days</i>	<i>52,000</i>	<i>α</i>	<i>5.7</i>	<i>0.076</i>	<i>0.13</i>
<i>Radon-219</i>	<i>4.0 s</i>	<i>13 billion</i>	<i>α</i>	<i>6.8</i>	<i>0.0063</i>	<i>0.056</i>
<i>Polonium-215</i>	<i>0.0018 s</i>	<i>30 trillion</i>	<i>α</i>	<i>7.4</i>	<i><0.001</i>	<i><0.001</i>
<i>Lead-211</i>	<i>36 min</i>	<i>25 million</i>	<i>β</i>	<i>-</i>	<i>0.46</i>	<i>0.051</i>
<i>Bismuth-211</i>	<i>2.1 min</i>	<i>420 million</i>	<i>α</i>	<i>6.6</i>	<i>0.010</i>	<i>0.047</i>
<i>Thallium-207</i>	<i>4.8 min</i>	<i>190 million</i>	<i>β</i>	<i>-</i>	<i>0.49</i>	<i>0.0022</i>
Americium-241	430 yr	3.5	α	5.5	0.052	0.033
Americium-243	7,400 yr	0.20	α	5.3	0.022	0.056
<i>Neptunium-239</i>	<i>2.4 days</i>	<i>230,000</i>	<i>β</i>	<i>-</i>	<i>0.26</i>	<i>0.17</i>
Carbon-14	5,700 yr	4.5	β	-	0.049	-
Cesium-137	30 yr	88	β	-	0.19	-
<i>Barium-137m (95%)^c</i>	<i>2.6 min</i>	<i>540 million</i>	<i>IT</i>	<i>-</i>	<i>0.065</i>	<i>0.60</i>
Cobalt-60	5.3 yr	1,100	β	-	0.097	2.5
Curium-243	29 yr	52	α	5.8	0.14	0.13
Curium-244	18 yr	82	α	5.8	0.086	0.0017
Curium-245	8,500 yr	0.17	α	5.4	0.065	0.096
Curium-246	4,700 yr	0.31	α	5.4	0.0080	0.0015
Europium-152	13 yr	180	β, EC	-	0.14	1.2
Europium-154	8.8 yr	270	β	-	0.29	1.2
Europium-155	5.0 yr	470	β	-	0.063	0.061
Hydrogen-3	12 yr	9,800	β	-	0.0057	-
Iodine-129	16 million yr	0.00018	β	-	0.064	0.025
Iron-55	2.7 yr	2,400	EC	-	0.0042	0.0017
Lead-210	22 yr	77	β	-	0.038	0.0048
<i>Bismuth-210</i>	<i>5.0 days</i>	<i>130,000</i>	<i>β</i>	<i>-</i>	<i>0.39</i>	<i>-</i>
<i>Polonium-210</i>	<i>140 days</i>	<i>4,500</i>	<i>α</i>	<i>5.3</i>	<i><0.001</i>	<i><0.001</i>
Manganese-54	310 days	7,700	EC	-	0.0042	0.84
Molybdenum-93	3,500 yr	1.1	EC	-	0.0055	0.011
<i>Niobium-93m</i>	<i>14 yr</i>	<i>280</i>	<i>IT</i>	<i>-</i>	<i>0.028</i>	<i>0.0019</i>
Neptunium-237	2.1 million yr	0.00071	α	4.8	0.070	0.035
<i>Protactinium-233</i>	<i>27 days</i>	<i>21,000</i>	<i>β</i>	<i>-</i>	<i>0.20</i>	<i>0.20</i>
Nickel-59	75,000 yr	0.082	EC	-	0.0046	0.0024
Nickel-63	96 yr	60	β	-	0.17	-
Niobium-94	20,000 yr	0.19	β	-	0.17	1.6
Plutonium-238	88 yr	17	α	5.5	0.011	0.0018
Plutonium-239	24,000 yr	0.063	α	5.1	0.0067	<0.001
Plutonium-240	6,500 yr	0.23	α	5.2	0.011	0.0017
Plutonium-241	14 yr	100	β	<0.001	0.0052	<0.001
Plutonium-242	380,000 yr	0.0040	α	4.9	0.0087	0.0014
Promethium-147	2.6 yr	940	β	-	0.062	<0.001
<i>Samarium-147</i>	<i>110 billion yr</i>	<i>0.000000023</i>	<i>α</i>	<i>2.2</i>	<i>-</i>	<i>-</i>
Protactinium-231	33,000 yr	0.048	α	5.0	0.065	0.048
Radium-226	1600 yr	1.0	α	4.8	0.0036	0.0067
<i>Radon-222</i>	<i>3.8 days</i>	<i>160,000</i>	<i>α</i>	<i>5.5</i>	<i><0.001</i>	<i><0.001</i>
<i>Polonium-218</i>	<i>3.1 min</i>	<i>290 million</i>	<i>α</i>	<i>6.0</i>	<i><0.001</i>	<i><0.001</i>
<i>Lead-214</i>	<i>27 min</i>	<i>33 million</i>	<i>β</i>	<i>-</i>	<i>0.29</i>	<i>0.25</i>
<i>Bismuth-214</i>	<i>20 min</i>	<i>45 million</i>	<i>β</i>	<i>-</i>	<i>0.66</i>	<i>1.5</i>
<i>Polonium-214</i>	<i>0.00016 s</i>	<i>330 trillion</i>	<i>α</i>	<i>7.7</i>	<i><0.001</i>	<i><0.001</i>

TABLE B-8 (Cont.)

Radionuclide	Half-Life	Specific Activity (Ci/g)	Decay Mode	Radiation Energy per Decay (MeV)		
				Alpha (α)	Beta (β)	Gamma (γ)
Radium-228	5.8 yr	280	β	-	0.017	<0.001
<i>Actinium-228</i>	<i>6.1 h</i>	<i>2.3 million</i>	<i>β</i>	-	<i>0.48</i>	<i>0.97</i>
<i>Thorium-228</i>	<i>1.9 yr</i>	<i>830</i>	<i>α</i>	<i>5.4</i>	<i>0.021</i>	<i>0.0033</i>
Samarium-151	90 yr	27	β	-	0.020	<0.001
Strontium-90	29 yr	140	β	-	0.20	-
<i>Yttrium-90</i>	<i>64 h</i>	<i>550,000</i>	<i>β</i>	-	<i>0.94</i>	<i><0.001</i>
Technetium-99	210,000 yr	0.017	β	-	0.10	-
Thorium-229	7,300 yr	0.22	α	4.9	0.12	0.096
<i>Radium-225</i>	<i>15 days</i>	<i>40,000</i>	<i>β</i>	-	<i>0.11</i>	<i>0.014</i>
<i>Actinium-225</i>	<i>10 days</i>	<i>59,000</i>	<i>α</i>	<i>5.8</i>	<i>0.022</i>	<i>0.018</i>
<i>Francium-221</i>	<i>4.8 min</i>	<i>180 million</i>	<i>α</i>	<i>6.3</i>	<i>0.010</i>	<i>0.031</i>
<i>Astatine-217</i>	<i>0.032 s</i>	<i>1.6 trillion</i>	<i>α</i>	<i>7.1</i>	<i><0.001</i>	<i><0.001</i>
<i>Bismuth-213</i>	<i>46 min</i>	<i>20 million</i>	<i>α, β</i>	<i>0.13</i>	<i>0.44</i>	<i>0.13</i>
<i>Polonium-213 (98%)</i>	<i>0.000042 s</i>	<i>13,000 trillion</i>	<i>α</i>	<i>8.4</i>	-	-
<i>Thallium-209 (2%)</i>	<i>2.2 min</i>	<i>410 million</i>	<i>β</i>	-	<i>0.69</i>	<i>2.0</i>
<i>Lead-209</i>	<i>3.3 h</i>	<i>4.7 million</i>	<i>β</i>	-	<i>0.20</i>	-
Thorium-230	77,000 yr	0.020	α	4.7	0.015	0.0016
Thorium-232	14 billion yr	0.0000011	α	4.0	0.012	0.0013
Uranium-232	72 h	22	α	5.3	0.017	0.0022
Uranium-233	160,000 yr	0.0098	α	4.8	0.0061	0.0013
Uranium-234	240,000 yr	0.0063	α	4.8	0.013	0.0017
Uranium-235	700 million yr	0.0000022	α	4.4	0.049	0.16
<i>Thorium-231</i>	<i>26 h</i>	<i>540,000</i>	<i>β</i>	-	<i>0.17</i>	<i>0.026</i>
Uranium-236	23 million yr	0.000065	α	4.5	0.011	0.0016
Uranium-238	4.5 billion yr	0.00000034	α	4.2	0.010	0.0014
<i>Thorium-234</i>	<i>24 days</i>	<i>23,000</i>	<i>β</i>	-	<i>0.060</i>	<i>0.0093</i>
<i>Protactinium-234m</i>	<i>1.2 min</i>	<i>690 million</i>	<i>β</i>	-	<i>0.82</i>	<i>0.012</i>

- ^a This table provides a summary of the key radioactive properties of the major radionuclides addressed in this EIS. Many of these radionuclides have short-lived decay products, which will accompany them in the wastes or be present in the future as a result of ingrowth. These associated radionuclides are indicated in italics following the parent radionuclide. A hyphen means the entry is not applicable. EC = electron capture, IT = isomeric transition, Ci = curie, g = gram, and MeV = million electron volts. Values are given to two significant figures and were obtained from Appendix G of Federal Guidance Report Number 13 issued by the U.S. Environmental Protection Agency (EPA 1999) and Publication 38 of the International Commission on Radiological Protection (ICRP 1983).
- ^b Some radionuclides, such as actinium-227 and bismuth-213, decay by more than one mode. Where this occurs and the resultant decay products are also radioactive, the relative percentages of the decay products are indicated in the table.
- ^c An "m" following the isotopic number, such as barium-137m, indicates that this radionuclide is metastable and reaches a more stable energy configuration by isomeric transition, generally accompanied with one or more gamma rays.

1 the half-lives and radiation energies of the alpha and beta particles and photons (gamma rays and
2 x-rays) emitted by these radionuclides. Also indicated are the short-lived radionuclides that
3 accompany these 44 radionuclides.

4
5 The information in Tables B-4 through B-7 is useful in assessing the long-term impacts
6 associated with disposing of these wastes at the various sites evaluated in this EIS. The impacts
7 associated with waste handling and transportation were developed by using radionuclide profiles
8 specific to the various waste streams. As noted previously, the activities given here represent
9 information from available sources, and they were decay-corrected to provide a common basis
10 for the EIS analysis.

11 12 13 **B.3 PHYSICAL CHARACTERISTICS OF THE WASTES**

14
15 Following is a description of the physical characteristics of the three waste types
16 (i.e., activated metals, sealed sources, and Other Waste).

17 18 19 **B.3.1 Activated Metals**

20
21 The activated metal waste consists of steel, stainless-steel, and a number of specialty
22 alloys used in nuclear reactors. Portions of the reactor assembly and other components near the
23 nuclear fuel are activated by high fluxes of neutrons during reactor operations for long periods of
24 time, and high concentrations of some radionuclides are produced. Many of these radionuclides
25 have very short half-lives and decay rapidly, while others have longer half-lives and remain
26 radioactive for an extended period of time. Most of the activated metal waste will be generated in
27 the future from the decommissioning of commercial nuclear power reactors.

28
29 Only a very small fraction of the metallic waste generated from decommissioning
30 commercial nuclear power plants will be GTCC LLRW. Most of the waste will be Class A, B, or
31 C LLRW that can be disposed of at existing commercial radioactive waste disposal sites. For
32 purposes of analysis in the EIS, all of the GTCC LLRW activated metal waste is considered to be
33 remote-handled (RH) waste on the basis of the expected high concentrations of gamma-emitting
34 radionuclides in this material. This waste will need a significant amount of shielding to reduce
35 the levels of radiation to acceptable levels and/or will have to be handled remotely. RH waste is
36 defined to be radioactive waste with contact dose rates greater than 200 millirem per hour
37 (mrem/h). The physical form of this waste is solid metal, which is both physically and
38 chemically inert.

39 40 41 **B.3.2 Sealed Sources**

42
43 Sealed sources typically consist of concentrated radioactive material encapsulated in
44 relatively small containers made of titanium, stainless-steel, or other metals. These sources are
45 commonly used to sterilize medical products, detect flaws and failures in pipelines and metal
46 welds, determine the moisture content in soil and other materials, and diagnose and treat illnesses

1 such as cancer. Only a small fraction of the sealed sources are GTCC LLRW, depending upon
2 the quantity (curies) and half-life of the specific radionuclide present in the source. Most sealed
3 sources are Class A, B, or C LLRW and can be disposed of at existing commercial LLRW
4 disposal facilities, subject to facility waste acceptance criteria and state/compact requirements.
5 The sealed sources that are GTCC LLRW are those that represent a long-term hazard to human
6 health and the environment and exceed the radionuclide concentrations for classification as
7 Class C LLRW given in Title 10, Section 61.55, of the *Code of Federal Regulations*
8 (10 CFR 61.55).

9
10 Essentially all of the sealed sources being addressed in this EIS are in Group 1. There are
11 two categories of sealed sources considered in this EIS: small sealed sources and large Cs-137
12 irradiators. For purposes of analysis, it is assumed that the small GTCC LLRW sealed sources
13 will be packaged in 208-L (55-gal) drums by radionuclide on the basis of packaging factor limits
14 developed by the DOE Global Threat Reduction Initiative/Off-Site Source Recovery Project
15 (GTRI/OSRP) at Los Alamos National Laboratory (LANL). About 8,700 drums are estimated to
16 be required to dispose of these packaged sealed sources.

17
18 In addition to these small sealed sources, there are 1,435 large Cs-137 irradiators in the
19 waste inventory, each with an assumed volume of 0.71 m³ (25 ft³). These irradiators cannot be
20 packaged in 208-L (55-gal) drums and are assumed to be disposed of individually in their
21 original shielded devices. In these irradiators, the Cs-137 source is contained within a very robust
22 shielded device, which would be expected to retain its integrity for many years following
23 disposal.

24
25 Sealed sources can encompass several physical forms, including ceramic oxides, salts, or
26 metals. Cesium chloride salt was generally used in older Cs-137 sources, and newer small
27 sources typically have the radionuclide bonded in a ceramic. Of these two forms, cesium chloride
28 salt is much more water soluble. For this EIS, all of the Cs-137 sources are assumed to be present
29 as cesium chloride salt. For the rest of the sealed sources, the radionuclides are assumed to be in
30 the form of oxides. These oxide sources are likely to be in the form of pellets (Sandia 2008).
31 While there are some sealed sources currently in storage, most of this waste will be generated in
32 the future.

33
34 Sealed sources generally have relatively low dose rates when packaged for disposal. As
35 noted in Sandia (2008), all of the packaged sealed sources are expected to be contact-handled
36 (CH) waste, with the exception of two americium-241/beryllium sources. For purposes of
37 analysis in this EIS, CH waste is waste for which the contact dose rates on the surface of the
38 package are less than 200 mrem/h. If RH sealed-source wastes are generated, appropriate
39 precautions will be taken to protect workers during waste handling and disposal operations.

40 41 42 **B.3.3 Other Waste**

43
44 Other Waste consists of a wide variety of materials, including contaminated equipment,
45 debris, scrap metal, glove boxes, filters, resins, soil, solidified sludges, and other materials. This
46 type of waste includes those GTCC LLRW and GTCC-like wastes that do not fall into one of the

1 other two types (activated metals or sealed sources). Other Waste can come in a number of
2 physical forms, and a range of radionuclides may be present. About 58% of the Other Waste is
3 RH waste, and 42% is CH waste.

4
5 Much of the waste in this category is associated with the West Valley Site.
6 Decontamination and decommissioning activities at the West Valley Site would generate both
7 GTCC LLRW and GTCC-like wastes, with the possible exhumation of the NDA and SDA
8 generating all of the GTCC LLRW at this site. It is expected that most of the GTCC-like Other
9 Waste associated with the West Valley Site would meet the DOE definition of TRU waste. This
10 waste might have originated from non-defense activities and therefore might not be authorized
11 for disposal at WIPP under the WIPP LWA. In addition to the Other Waste associated with the
12 West Valley Site, this waste type includes GTCC LLRW from two commercial Mo-99
13 production projects and GTCC-like waste from a planned DOE Pu-238 production project.

14
15 It is assumed for purposes of analysis in this EIS that the radionuclides in Other Waste
16 can leach out somewhat readily when exposed to water. Therefore, it is assumed that the Other
17 Waste would be stabilized with grout or another matrix prior to being shipped to the disposal
18 facilities considered in this EIS, as appropriate.

19 20 21 **B.4 ASSUMED WASTE GENERATION TIMES**

22
23 The waste generation times assumed for purposes of analysis in the EIS are shown in
24 Figure 3.4.2-1. As shown in this figure, much of the waste is assumed to be generated and
25 received at the alternative disposal facilities before 2035.

26
27 The GTCC waste disposal facility is assumed to be available to receive wastes in 2019,
28 and at that time, the GTCC LLRW and GTCC-like wastes in storage would begin to be
29 transported to the disposal facility. The actual start date for operations is uncertain at this time
30 and dependent upon, among other things, the alternative or alternatives selected, additional
31 NEPA analysis as required, characterization studies, and other actions necessary to initiate and
32 complete construction and operation of a GTCC disposal facility. For purposes of analysis in the
33 Draft EIS, DOE assumed a start date of disposal operations in 2019. However, given these
34 uncertainties, the actual start date could vary. As shown in Table B-1, the current volume of
35 stored GTCC LLRW and GTCC-like waste is about 1,100 m³ (39,000 ft³), and this volume is
36 expected to increase somewhat over the next nine years. While very little additional activated
37 metal from decommissioning commercial nuclear reactors would be generated before 2019, the
38 volumes of sealed sources and Other Waste would increase as sealed sources would continue to
39 become disused and a number of ongoing projects that would generate GTCC-like waste would
40 be completed.

41
42 A number of assumptions were made in developing the assumed generation and waste
43 receipt rates. For the Group 1 wastes, future inventory estimates are projected to 2035 for Other
44 Waste, 2062 for activated metals, and 2083 for sealed sources. The time period used for activated
45 metal waste accounts for the decommissioning of all currently NRC-licensed commercial nuclear
46 power plants, which will produce most of the radionuclide activity for Group 1 wastes. Many

1 nuclear utilities are currently seeking and being granted extensions to their operating licenses
2 from NRC. These extensions are generally for about 20 years. Assuming that all commercial
3 nuclear power reactors receive 20-year license extensions, the last currently operating nuclear
4 power plant will cease operation in 2056. It is assumed that a 6-year cooling period occurs before
5 decommissioning operations commence and these wastes become available for disposal. When
6 one year is allowed for disposal, all such waste will be disposed of by 2062 (Sandia 2008).

7
8 The time period for Group 1 Other Waste reflects a reasonable amount of time for
9 addressing the indicated wastes. Many of these wastes are associated with the West Valley Site,
10 and activities that could generate Group 1 wastes at this site are expected to be completed before
11 2035. The waste volumes and activities for the Other Waste generated by other sources are
12 comparatively small and well defined. The time period for Group 1 sealed sources is consistent
13 with the assumption used to address the future decommissioning of Group 2 commercial nuclear
14 power reactors.

15
16 All of the wastes in Group 2 will be generated in the future. Some of these facilities may
17 or may not be constructed and operated as currently envisioned, so these projections have a high
18 degree of uncertainty associated with them. This situation contrasts with that of the Group 1
19 wastes, some of which are already in storage and the rest of which are expected to be generated
20 from currently operating facilities.

21
22 The same approach as that used for the Group 1 activated metal wastes from commercial
23 nuclear reactors was used for comparable Group 2 wastes from proposed new reactors. Although
24 the schedules for new commercial reactors are subject to change, it is projected that activated
25 metal wastes from decommissioning these reactors would be generated to 2083. A total of
26 33 new reactors was assumed to estimate the volumes and radionuclide activities for these
27 wastes, consistent with information provided by the NRC (NRC 2009). As was the case for the
28 Group 1 activated metal wastes, it is assumed that the new reactors would have a 60-year
29 operational life and that a 6-year cooling period would occur before decommissioning operations
30 would commence and these wastes would become available for disposal.

31
32 All other GTCC LLRW and GTCC-like wastes in Group 2 are expected to be disposed of
33 shortly after generation. Most of the Group 2 GTCC LLRW is associated with the assumed
34 exhumation of the NDA and SDA at the West Valley Site. For purposes of analysis in the EIS, it
35 is assumed that a decision to exhume these wastes would be made within 10 years of the *Record*
36 *of Decision: Final Environmental Impact Statement for Decommissioning and/or Long-Term*
37 *Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service*
38 *Center* (DOE 2010b) and that these wastes would be exhumed from 2020 to 2035. This is a
39 conservative approach, because if the wastes were exhumed later, additional radioactive decay
40 would occur prior to generation of this GTCC waste. As noted previously, it is assumed that the
41 interim on-site storage of wastes from the two planned commercial Mo-99 production projects
42 and the planned DOE Pu-238 production project would allow for decay of the short-lived
43 radionuclides in these wastes.

1 **B.5 PACKAGING ASSUMPTIONS**

2
3 Packaging and shipment configurations vary among Alternatives 2, 3, 4, and 5.
4 Section B.5.1 provides the assumptions used for the land disposal alternatives (3, 4, and 5). The
5 assumptions for disposal at WIPP (Alternative 2) are discussed in Section B.5.2.
6

7 8 **B.5.1 Land Disposal**

9
10 For the purpose of this EIS, GTCC LLRW and GTCC-like waste are assumed to be
11 transported by truck and rail to a disposal facility in Type B shipping packages. There are more
12 truck casks readily available for shipping CH waste than for shipping RH waste, especially RH
13 waste with external radiation dose rates on the order of 1,000 rem/h at the container surface.
14 Rates this high are characteristic of the activated metal waste discussed in Section B.3.1. On the
15 other hand, a number of rail casks can accommodate waste containers and payloads that are
16 larger than those handled by truck casks, and the rail casks also have sufficient shielding for
17 waste with high external radiation dose rates. Table B-9 provides examples of shipping packages
18 that could be used for the transport of GTCC LLRW and GTCC-like waste, some of which are
19 discussed further in Sections B.5.1.1 and B.5.1.2. Note that not all GTCC LLRW or GTCC-like
20 waste would necessarily require shipment in Type B packaging as discussed in Section C.9.4.2.
21 Because the levels of radioactivity of the CH waste (including the sealed sources) in their
22 Type A containers (i.e., 208-L [55-gal] drums and SWBs) are assumed to be near the upper
23 limits specified in 10 CFR Part 71, with multiple drums or SWBs per shipment, Type B shipping
24 packaging is assumed for this analysis. However, at the time of actual shipment, all GTCC
25 LLRW and GTCC-like waste would be packaged in compliance with applicable radioactive
26 material transportation safety regulations, and Type B packaging might not be required,
27 depending on the characteristics of the waste to be transported.
28

29 30 **B.5.1.1 Contact-Handled Waste**

31
32 A common container for the storage and disposal of CH and RH GTCC LLRW and
33 GTCC-like waste is the 208-L (55-gal) drum (referred to as drum(s) in the remainder of this
34 appendix). In addition, some stored and projected CH wastes may be packaged for disposal in
35 standard waste boxes (SWBs). This EIS assumes that the disposal of CH waste, with the
36 exception of Cs-137 irradiators, will be in drums and SWBs. The Transuranic Package
37 Transporter-II (TRUPACT-II) Type B package (DOE 2005) is an example of what can be used
38 to transport the CH waste for disposal. This package is in widespread use for similar types of
39 waste and can be used for both truck and rail transport. Two common shipping configurations of
40 waste used with the TRUPACT-II are two stacked 7-drum packs (seven 208-L [55-gal] drums in
41 a close-packed hexagonal unit) or two stacked SWBs.
42

43 For the purposes of this EIS, the external volume occupied by a drum is assumed to be
44 0.267 m^3 (9.43 ft^3), which assumes a right circular cylinder with an outside diameter of 0.610 m
45 (2.0 ft) and a length of 0.914 m (3.0 ft). This external volume is in the upper range of 0.226 to
46 0.283 m^3 (8 to 10 ft^3) (DOE 2006a) that is expected for these types of drums at an LLRW

TABLE B-9 Representative Sample of Type B Shipping Packages with the Potential for Transporting GTCC LLRW and GTCC-Like Waste^a

Package	Internal Diameter in m (in.)	Internal Length in m (in.)	Maximum Payload in kg (lb)	Maximum Gross Weight in kg (lb)	Waste Type		Transport Mode	
					CH	RH ^b	Truck ^c	Rail
TRUPACT-II	1.85 (73)	1.91 (75)	3,300 (7,265)	8,700 (19,250)	X		X	
HalfPACT	1.85 (73)	1.14 (45)	3,400 (7,600)	8,200 (18,100)	X		X	
CNS 10-160B	1.73 (68)	1.96 (77)	6,600 (14,500)	32,700 (72,000)		X	X	
RH 72-B	0.79 (31)	3.30 (130)	3,600 (8,000)	15,200 (33,500)		X	X	
CNS 3-55 ^d	0.91 (36)	2.82 (111)	4,200 (9,220)	31,800 (70,000)		X	X	
3-60B ^e	0.89 (35)	2.82 (111)	4,300 (9,500)	36,300 (80,000)		X	X	
TN-RAM	0.89 (35)	2.82 (111)	4,300 (9,500)	36,300 (80,000)		X	X	
NAC STC	1.80 (71)	4.19 (165)	8,500 (18,700) ^f	118,000 (260,000)		X		X
NAC UMS	1.73 (68)	4.90 (193)	9,100 (20,000) ^f	113,000 (250,000)		X		X
125-B	1.30 (51)	4.90 (193)	20,000 (44,000)	82,300 (181,500)		X		X
TS 125	1.70 (67)	4.90 (193)	38,000 (85,000)	129,000 (285,000)		X		X

^a The packages' internal dimensions and weight limits were taken from NRC (2006).

^b Casks designed to handle RH waste may also transport CH waste.

^c Truck casks may also be used for rail transport.

^d The certificate of compliance expired in October 2008 and will not be renewed.

^e Proposed design intended for replacement of the CNS 3-55 cask (Carlson et al. 2006; NRC 2007).

^f Listed payload weight is that specified for the transport of GTCC waste.

1

2

3 disposal site but is not considered to be overly conservative. The internal volume of a 208-L
4 (55-gal) drum is 0.208 m³ (7.34 ft³). The outside dimensions of an SWB are 1.80 m (71 in.) in
5 length, 1.37 m (54 in.) in width, and 0.94 m (37 in.) in height (DOE 2004). The approximate
6 internal and external volumes of an SWB are 1.88 m³ (66.4 ft³) and 2.08 m³ (73.4 ft³),
7 respectively. SWBs are rounded on the ends for use as shipping containers within TRUPACT-II
8 shipping casks, with two SWBs to a cask in a stacked configuration.

9

10 While other shipping configurations (e.g., 321- and 378-L [85- and 100-gal] drums, as
11 well as 10-drum overpacks) might be possible with the TRUPACT-II or other casks, their use is

1 not considered in this EIS, but the use of other types of containers could be accommodated in the
2 current disposal facility designs discussed in Appendix D. Also, GTCC LLRW and GTCC-like
3 CH waste may be found in storage in containers larger than SWBs at some sites, but there are
4 currently no viable casks available for transport. Packing arrangements in the CH disposal units
5 could be modified accordingly in the future if such packages became available (e.g., the
6 TRUPACT-III [DOE 2007]).

9 **B.5.1.2 Remote-Handled Waste**

10
11 A number of Type B casks are available for the transport of RH waste. Selection of the
12 proper cask will depend on the external dose rate and the use of the appropriate shipping
13 container or canister for a given cask. Except for activated metal waste (which has a high
14 external dose rate similar to spent nuclear fuel), the majority of the RH wastes being considered
15 for disposal can be packaged in drums and shipped in truck casks, such as the RH 72-B
16 (DOE 2006b) and 10-160B (NRC 2005), or in a rail cask (such as the Nuclear Assurance Corp.
17 [NAC] STC). This EIS assumes that all RH waste, except for activated metal waste, is packaged
18 for disposal in drums. If shipped in the RH 72-B cask, three drums can be packaged in an RH
19 canister (DOE 1995) that is designed for use with this cask. The RH canister has a length of
20 3.07 m (121 in.), a diameter of 0.66 m (26 in.), a wall that is 0.64-cm (0.25-in.) thick, and an
21 internal volume of 0.89 m³ (31.4 ft³). As an alternative, RH waste can be loaded directly into the
22 canister for disposal (DOE 2006c). The proposed land disposal facility designs in Appendix D
23 can accommodate both drums and RH canisters.

24
25 Activated metal is assumed to be packaged in unshielded right circular stainless-steel
26 canisters (activated metal canisters ([AMCs]). To facilitate potential shipment by truck as well as
27 rail and to provide flexibility in the facility design as discussed in Appendix D, the size and
28 weight of these canisters were selected to be compatible with existing containers and weight
29 limitations of truck casks. AMCs are assumed to have an external length of 1.22 m (48 in.), an
30 outside diameter of 0.66 m (26 in.), an external volume of 0.418 m³ (14.8 ft³), and an internal
31 volume of 0.370 m³ (13.1 ft³), with a wall thickness of 1.27 cm (0.5 in.) and an end plate
32 thickness of 2.54 cm (1 in.). The external diameter of 0.66 m (26 in.) was chosen to match that of
33 the RH canister (DOE 1995) and remain close to the 0.61-m (24-in.) diameter of drums used for
34 RH waste disposal. A loaded AMC is estimated to weigh approximately 2,600 kg (5,800 lb).
35 This weight was based on a fill fraction of 75% (Sandia 2007). Additional discussion on the size
36 of the AMCs in relation to RH disposal is presented in Appendix D.

37
38 Most Type B casks would need to be recertified to transport activated metals. A recent
39 investigation of appropriate truck and rail casks for the transport of activated metals showed that
40 few options are available, primarily because of the cargo's high external radiation dose rates
41 (Carlson et al. 2006). The certificate of compliance for the heavily shielded CNS 3-55 truck cask
42 is no longer valid (it expired in October 2008). However, Energy Solutions may be in the process
43 of supplying an equivalent replacement, the 3-60B cask (NRC 2007). The TN-RAM is also a
44 candidate truck cask, but only one cask is in existence (Carlson et al. 2006). On the other hand,
45 the TN-RAM and/or the CNS 3-55 design could be used as the basis for another certificate of

1 compliance submittal. Both the 3-60B and TN-RAM designs have a payload capacity of
2 4,300 kg (9,500 lb) and internal dimensions that could support a longer AMC.

3
4 The present length of the AMC was selected to keep it compatible with the RH 72-B and
5 10-160B packages. For containers with lower dose rates, an AMC could be shipped with spacers
6 in the RH 72-B, which has a 3,600-kg (8,000-lb) payload. The 10-160B is certified to transport
7 activated metal and has a 6,580-kg (14,500-lb) payload. However, additional shielding would be
8 needed for any AMCs with radiation dose rates on the order of 1,000 rem/h at contact. The
9 payload limit includes any additional shielding and bracing that would be needed, which would
10 likely require recertification of the package.

11 12 13 **B.5.2 Waste Isolation Pilot Plant**

14
15 The assumptions about the packaging used to dispose of CH waste are the same for
16 disposal at WIPP and for the land disposal options. However, it is assumed that RH waste would
17 be packaged in one of the two shielded containers discussed below, so it could be handled as CH
18 waste in order to optimize disposal space at WIPP (Sandia 2007, 2008). Both truck and rail
19 transport modes are considered for shipment of GTCC LLRW and GTCC-like waste to WIPP.

20
21 For activated metal and RH waste with higher external dose rates, packaging in canisters
22 with a diameter of 0.71 m (28 in.), height of 1.4 m (55 in.), and inner cavity dimensions of
23 0.47 m (18.4 in.) in diameter and 1.15 m (45.4 in.) in length is assumed. The canister is fitted
24 with a 9.71-cm (3.825-in.) lead shield to reduce radiation rates at the surface to less than
25 200 mrem/h (Sandia 2007). The canister is based on an older AMC design and should not be
26 confused with the AMCs used in this EIS as described in Section B.5.1.2; it is referred to as a
27 half-shielded activated metal canister (h-SAMC) in this EIS. A loaded canister is estimated to
28 weigh 4,190 kg (9,220 lb). For truck transport, only one h-SAMC is assumed per shipment; there
29 is one h-SAMC per truck Type B package. Three h-SAMCs are assumed per rail Type B
30 package.

31
32 RH waste with lower external dose rates is assumed to be packaged in lead-shielded
33 containers currently undergoing certification for use at WIPP (DOE undated). These containers
34 are roughly the size of 208-L (55-gal) drums with a 2.54-cm (1-in.) lead liner designed to hold a
35 113-L (30-gal) drum of RH waste. One HalfPACT type B package can transport one three-pack
36 (DOE undated).

37 38 39 **B.6 SITE INVENTORIES AND SHIPMENTS**

40
41 The number of shipments from a generator site to a disposal facility depends on the type
42 of waste, the amount of waste, the packaging used, and the transport mode. Sections B.6.1 and
43 B.6.2 summarize this information for disposal at land disposal sites and WIPP, respectively.
44 Table B-10 summarizes the shipment loading assumptions used for the alternatives considered.

TABLE B-10 Number of Waste Containers per Shipment

Waste Container	Number of Containers per Vehicle	Comments
Truck shipments		
AMC	1	One AMC per Type B shipping package
h-SAMC	1	One h-SAMC per Type B shipping package
CH drum	42	Two 7-drum packs per TRUPACT-II, three TRUPACT-IIs per truck
SWB	6	Two SWBs per TRUPACT-II, three TRUPACT-IIs per truck
Cs-137 irradiator	6	Two irradiators per TRUPACT-II, three TRUPACT-IIs per truck
RH drum	3	Three drums per one RH canister in an RH 72-B
Lead-shielded container	9	Three containers per HalfPACT, three HalfPACTs per truck
Rail shipments		
AMC	4	The weight of the number of AMCs is limited by the Type B shipping package
h-SAMC	3	The weight of the number of h-SAMCs is limited by the Type B shipping package
CH drum	84	Two 7-drum packs per TRUPACT-II, six TRUPACT-IIs per railcar
SWB	12	Two SWBs per TRUPACT-II, six TRUPACT-IIs per railcar
Cs-137 irradiator	12	Two SWBs per TRUPACT-II, six TRUPACT-IIs per railcar
RH drum	6	Three drums per RH canister, two RH canisters/RH 72-Bs per railcar
Lead-shielded container	18	Three containers per HalfPACT, six HalfPACTs per railcar

1

2

3 B.6.1 Land Disposal

4

5 It is assumed that approximately 12,600 truck shipments or 5,000 rail shipments of all
6 GTCC LLRW and GTCC-like waste considered in Groups 1 and 2 would be needed if the
7 land disposal methods were used. For the purposes of this EIS, Table B-11 summarizes waste
8 volumes generated, disposal containers, and number of shipments estimated.

9

10

11 B.6.2 Deep Geologic Disposal at WIPP

12

13 It is assumed that approximately 33,700 truck shipments or 11,800 rail shipments would
14 be needed to dispose of all Group 1 and 2 GTCC LLRW and GTCC-like waste at WIPP, as
15 summarized in Table B-12. The number of shipments is more than double the number estimated
16 for the land disposal sites because of the use of the lead-shielded containers to transport the RH
17 waste. The h-SAMC and lead-shielded containers have less internal volume than the AMCs and
18 208-L (55-gal) drums, respectively.

19

20

TABLE B-11 Estimated Number of Radioactive Material Shipments for Disposal of GTCC LLRW and GTCC-Like Waste at Potential Land Disposal Sites^a

Shipment Site	Waste Type	Volume (m ³)	Container Type	No. of Containers	No. of Truck Shipments	No. of Railcar Shipments ^b
Group 1						
GTCC LLRW						
Activated metals						
Past/present commercial reactors ^c	RH	882.4	AMC	2,452	2,452	660
Sealed sources ^d						
Small	CH	1,810.0	55-gal drum	8,702	209	105
Cs-137 irradiators	CH	1,018.9	Self-contained	1,435	240	120
Other Waste						
CH	CH	42.1	55-gal drum	203	5	3
RH	RH	33.6	55-gal drum	162	54	27
GTCC-like waste						
Activated metals						
RH	RH	12.8	AMC	38	38	11
Sealed sources ^d						
Small	CH	0.8	55-gal drum	4	1	1
Other Waste						
CH drum	CH	33.9	55-gal drum	173	5	3
CH SWB	CH	708.8	SWB	381	64	32
RH	RH	716.3	55-gal drum	3,462	1,155	579
Group 1 total		5,259.5		17,012	4,223	1,541

TABLE B-11 (Cont.)

Shipment Site	Waste Type	Volume (m ³)	Container Type	No. of Containers	No. of Truck Shipments	No. of Railcar Shipments ^b
Group 2						
GTCC LLRW						
Activated metals						
New BWRs	RH	72.6	AMC	202	202	54
New PWRs	RH	303.4	AMC	833	833	227
Additional commercial waste	RH	735.3	AMC	1,990	1,990	498
Other Waste						
CH	CH	1,551.0	SWB	829	139	70
RH	RH	2,361.8	55-gal drum	11,365	3,789	1,896
GTCC-like waste						
Other Waste						
CH	CH	488.3	SWB	261	44	22
RH	RH	874.4	55-gal drum	4,207	1,403	702
Group 2 total		6,386.8		19,687	8,400	3,469
Total Groups 1 and 2		11,646.2		36,699	12,623	5,010

^a AMC = activated metal canister, BWR = boiling water reactor, CH = contact-handled, PWR = pressurized water reactor, RH = remote-handled, SWB = standard waste box.

^b Rail shipments are assumed to consist of one railcar as part of a general freight train.

^c Sum of shipments from the individual commercial reactor site locations. Approximate reactor locations are listed in Table 3.4-1 in Chapter 3.

^d For purposes of this EIS, commercial and DOE sealed sources are assumed to be shipped from the population-weighted center of the United States. These sources are distributed throughout the country and are projected waste.

TABLE B-12 Estimated Number of Radioactive Material Shipments for Disposal of GTCC LLRW and GTCC-Like Waste at WIPP^a

Shipment Site	Waste Type	Volume (m ³)	Container Type	No. of Containers	No. of Truck Shipments	No. of Railcar Shipments ^b
Group 1						
GTCC LLRW						
Activated metals						
Past/present commercial reactors ^c	RH	882.4	h-SAMC	12,595	12,595	4,237
Sealed sources ^d						
Small	CH	1,810.0	55-gal drum	8,702	209	105
Cs-137 irradiators	CH	1,018.9	Self-contained	1,435	240	120
Other Waste						
CH	CH	42.1	55-gal drum	203	5	3
RH	RH	33.6	h-SAMC	172	172	58
GTCC-like						
Activated metals						
RH	RH	12.8	h-SAMC	70	70	24
Sealed sources ^d						
Small	CH	0.8	55-gal drum	4	1	1
Other Waste						
CH drum	CH	33.9	55-gal drum	173	5	3
CH SWB	CH	708.8	SWB	381	64	32
RH	RH	716.3	h-SAMC	3,654	3,654	1,221
Group 1 total		5,259.5		27,389	17,015	5,804

TABLE B-12 (Cont.)

Shipment Site	Waste Type	Volume (m ³)	Container Type	No. of Containers	No. of Truck Shipments	No. of Railcar Shipments ^b
Group 2						
GTCC LLRW						
Activated metals						
New BWRs	RH	72.6	h-SAMC	956	956	320
New PWRs	RH	303.4	h-SAMC	4,789	4,789	1,607
Additional commercial waste	RH	735.3	h-SAMC	3,736	3,736	1,246
Other Waste						
CH	CH	1,551.0	SWB	829	139	70
RH container	RH	2,298.9	Shielded container	20,348	2,262	1,131
RH h-SAMC	RH	62.9	h-SAMC	323	323	109
GTCC-like waste						
Other Waste						
CH	CH	488.3	SWB	261	44	22
RH	RH	874.4	h-SAMC	4,441	4,441	1,481
Group 2 total		6,386.8		35,683	16,690	5,986
Total Groups 1 and 2		11,646.2		63,072	33,705	11,790

^a BWR = boiling water reactor, CH = contact-handled, h-SAMC = half-shielded activated metal canister, PWR = pressurized water reactor, RH = remote-handled, SWB = standard waste box.

^b Rail shipments are assumed to consist of one railcar as part of a general freight train.

^c Sum of shipments from the individual commercial reactor site locations. Approximate reactor locations are listed in Table 3.4-1 in Chapter 3.

^d For purposes of this EIS, commercial and DOE sealed sources are assumed to be shipped from the population-weighted center of the United States. These sources are distributed throughout the country and are projected waste.

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APPENDIX C:**IMPACT ASSESSMENT METHODOLOGIES**

This appendix summarizes the methodologies used in evaluating the various environmental resource areas discussed in this environmental impact statement (EIS). The environmental resource areas evaluated are as follows:

- Climate, air quality, and noise;
- Geology and soils;
- Water resources;
- Human health (including accidents and intentional destructive acts);
- Ecological resources;
- Socioeconomics;
- Environmental justice;
- Land use;
- Transportation (including accidents);
- Cultural resources; and
- Waste management.

In addition to the above resource areas, DOE has evaluated cumulative impacts that could result from implementation of the proposed GTCC action at each of the sites evaluated in combination with past, present, and planned activities (including federal and nonfederal activities) at or in the vicinity of each of the sites.

C.1 AIR QUALITY AND NOISE**C.1.1 Air Quality**

Potential air quality impacts under each alternative were evaluated by estimating potential air pollutant emissions from the activities associated with facility construction and operations. Potential air emission sources were obtained from Appendix D. Air emissions of criteria pollutants, volatile organic compounds (VOCs), and carbon dioxide (CO₂, a primary greenhouse gas) that would result from the activities associated with construction (e.g., engine exhaust and fugitive dust emissions from heavy equipment and vehicles) and operations (e.g., boiler and emergency generator stack emissions) were estimated by using emission factors available in the standard reference (EPA 2004) and by using activity-level data obtained from Appendix D. Information previously developed for other similar projects was also obtained and used to the extent possible. The significance of project-related emissions to overall air quality was determined by comparing the estimated project-related emissions with the sitewide/countywide emissions or statewide/worldwide emissions of CO₂.

1 **C.1.2 Noise**

2
3 Potential noise impacts under each alternative were assessed by estimating the noise
4 levels from noise-emitting sources associated with facility construction and operations, then
5 performing noise propagation modeling. First, all potential noise-emitting sources were
6 identified, as described in Appendix D. Examples of noise-emitting sources include heavy
7 equipment used in earth-moving activities during construction, process equipment, emergency
8 generators used during operations, and both the on-site and off-site vehicles used throughout the
9 project. Sound power or sound pressure levels of individual noise sources were obtained from
10 the literature (e.g., Hanson et al. 2006; Menge et al. 1998; Wood and Barnes 2006). Potential
11 noise impacts at the nearest sensitive receptors (e.g., residences) were estimated by using a
12 simple noise propagation formula (e.g., considering geometric spreading of sound energy and
13 ground effects only) (Hanson et al. 2006). Estimated potential noise levels were assessed by
14 comparing them to the U.S. Environmental Protection Agency (EPA) noise guideline
15 (EPA 1974), which is more stringent than the state or local guidelines. In addition, a
16 groundborne vibration impact analysis was performed in the same way as was the noise impact
17 analysis. Common groundborne vibration sources include construction and operational activities
18 (e.g., use of heavy equipment). The distances at which vibration levels are below the threshold of
19 perception for humans and interference with vibration-sensitive activities were estimated
20 (Hanson et al. 2006).

21

22

23 **C.2 GEOLOGY AND SOILS**

24

25 The main elements considered when assessing impacts on geologic and soil resources
26 were the location and extent of land disturbed during construction and operations. Activities that
27 could result in land disturbance include excavating for the trench and vault facilities, drilling for
28 boreholes, and staging of equipment in designated areas. Geologic and soil conditions within
29 each of the greater-than-Class C (GTCC) reference locations and at the Waste Isolation Pilot
30 Plant (WIPP) are described in the affected environment section. Surveys in the vicinity of the
31 candidate sites, including soil surveys, topographic surveys, and geologic and seismic hazard
32 maps, were reviewed as an initial step in the assessment. Well log data from on-site (or near-site)
33 wells and boreholes were also reviewed.

34

35 The impact analysis for geologic resources evaluated effects on critical geologic
36 attributes, including access to mineral or energy resources, destruction of unique geologic
37 features, and mass movement induced by construction. The impact analysis also evaluated
38 regional geologic conditions, such as earthquake potential. The impact analysis for soil resources
39 evaluated effects on specific soil attributes, including the potential for soil erosion and
40 compaction by construction activities.

41

42 The determination of the relative magnitude of an impact for each evaluated site was
43 based on an analysis of both the context of the action and the intensity of the impact on a
44 particular resource.

45

46

1 C.3 WATER RESOURCES

2
3 Water resources that could be affected by the GTCC waste disposal facility include
4 rivers, streams, and groundwater. Hydrologic conditions (including hydrologic parameters, such
5 as flow volumes [surface water] and hydraulic conductivity [groundwater]) in the vicinity of
6 each site evaluated in this GTCC EIS and are described in the affected environment sections.
7

8 Impacts on surface water were evaluated in terms of runoff and water quality. Changes in
9 runoff were assessed by comparing runoff conditions with and without the GTCC waste disposal
10 facility. The potential for impacts on surface water quality was assessed on the basis of the site's
11 location relative to rivers and streams, local runoff rates, and groundwater discharge.
12

13 The impact analysis for groundwater resources evaluated effects on underlying aquifers
14 in terms of changes in groundwater depth, direction of groundwater flow, groundwater velocity,
15 groundwater quality, and recharge rates. Impacts on groundwater depth and direction of flow
16 were assessed by comparing existing water use with water demand under the proposed action.
17 For the land disposal alternatives (borehole, trench, and vault), the RESRAD-OFFSITE
18 (Yu et al. 2007) model was used to estimate the concentrations and migration rates of
19 contaminants from source areas to groundwater (i.e., changes in groundwater quality over time).
20 Changes in recharge rates were assessed by estimating the impermeable area that would result
21 from GTCC waste disposal facility construction and operations and comparing it to the recharge
22 area currently available at each of the sites evaluated (see Appendix E).
23
24

25 C.4 HUMAN HEALTH RISK

26
27 This section describes the approach used for assessing the human health impacts from
28 disposal of GTCC low-level radioactive waste (LLRW) and GTCC-like waste under normal and
29 accident conditions. For normal operations (Section C.4.1), potential impacts are evaluated for
30 the short term (during construction and disposal operations) and long term (post-closure of the
31 facility). Facility accidents are considered in Section C.4.2.
32
33

34 C.4.1 Operations

35
36 The GTCC wastes would arrive at the disposal facility prepackaged in accordance with
37 appropriate packaging and transportation regulations, and it is expected that the containers would
38 retain their integrity throughout the disposal operations. Leakage of the waste containers is not
39 expected to occur under routine operations; hence, airborne emissions or wastewater discharges
40 are likewise not expected. As a result, human health impacts during the operational phase would
41 be limited to external radiation exposure, which could occur without direct contact with the
42 waste. The release of contaminants from the waste material could occur after the closure of the
43 disposal facility, as a result of the degradation of the waste containers in the environment over
44 time. Only after the release of the contaminants could human health risks result from direct
45 contact with the contaminants as a result of inhalation and ingestion through potentially available
46 pathways and subsequent transport in the environment.
47

C.4.1.1 Receptors and Exposure Pathways

Human health impacts are estimated for three categories of receptors in this EIS: involved workers, noninvolved workers, and the off-site general public. Both involved workers and noninvolved workers would be employed by the waste disposal facility. Involved workers are those workers who conduct waste disposal activities, such as loading and unloading the waste containers and placing them into the disposal cells. Noninvolved workers work at the disposal facility but do not perform hands-on activities. For example, they would be employees who work in the administration building or outside the immediate area of the disposal facility but within the boundary of the disposal facility footprint. The general public consists of residents who live outside the boundary of the disposal facility but within 80 km (50 mi) of the facility boundary.

As noted previously, the release of waste material through airborne emissions or wastewater discharges is not expected during the operation of the disposal facility except as a result of accidents, which are discussed in Section C.4.2. Potential impacts are thus estimated only for the involved workers who, because of their close proximity to the waste material, could incur radiation doses through external exposure. Radiation exposures of the noninvolved workers and the off-site general public would be low because they would be farther away from the waste materials. More details are provided in Sections 5.3.4.1.1 and 5.3.4.1.2.

After the closure of the land disposal facility (i.e., borehole, trench, or vault), exposures could occur from waste material released by airborne emissions (should the cover system fail) and from leaching of radionuclides to the groundwater (which is used for drinking and household activities). Such releases could occur over a long time period, usually following closure of the disposal facility. The potential radiation doses and latent cancer fatality (LCF) risks from the airborne pathway would be low; the pathway of most concern is leaching to groundwater (see Section 5.3.4.3). To assess the potential impact associated with using contaminated groundwater in the future, a well located 100 m (330 ft) from the edge of the disposal facility was assumed to be installed by a hypothetical member of the general public. The potential dose from using the contaminated water was analyzed to provide an indication of the post-closure impact associated with waste disposal. Post-closure analysis for Alternative 2 (disposal at WIPP) is discussed in Chapter 4 (Section 4.3.4.3).

Another scenario that could be used to assess the potential impacts from the closure of a waste disposal facility involves a hypothetical intruder who has no knowledge of the waste disposal history and establishes a residence above the waste disposal area after the institutional control period. While digging soil to build the house, the intruder could exhume radioactive material and place it around the house for fill. This exposure scenario is considered to be very unlikely because there would be an engineered barrier (reinforced concrete slab) and a thick layer of cover material placed above the waste material for Alternatives 3 to 5. This scenario is not relevant for Alternative 2 (disposal at WIPP, a geologic repository). The potential exposure of such an individual would be limited and result from the slow release mechanism of gas diffusion. The radionuclides of concern include carbon-14 (C-14), hydrogen-3 (H-3), and radon isotopes and their progeny. It is assumed that the C-14 and H-3 in the waste material would be converted to CO₂ and tritiated water vapor (HTO) in the environment prior to their diffusion process in soil. Radon gas would be generated in the disposal area through radiological decay of

1 radon precursors (radium-226 and radium-228). It is assumed that because the intruder would
2 live above the waste disposal area, he or she would incur radiation exposure by inhaling the
3 gaseous radionuclides (including radon isotopes and their progeny) that would be released as the
4 waste containers gradually degraded. The intruder scenario was not assessed quantitatively in the
5 EIS because of its low probability of occurrence. Disposal procedures would be conducted in a
6 manner to make this scenario implausible.

9 **C.4.1.2 Radiation Dose and Health Effects**

10
11 The primary human health impact of concern would be radiation exposure that would
12 occur as a result of the radionuclides contained in the waste material. All radiological exposures
13 are presented in terms of committed dose and associated health effects. The calculated dose is the
14 total effective dose equivalent (TEDE), which is the sum of the effective dose equivalent (EDE)
15 from exposure to external radiation and the 50-year committed effective dose equivalent (CEDE)
16 from exposures to internal radiation. For this EIS, the radiation doses were calculated by using
17 the dose conversion factors (DCFs) for adults developed by the International Commission on
18 Radiological Protection (ICRP) as given in ICRP 72 (ICRP 1996). (See Section 5.2.4 for more
19 discussion on these DCFs). The results are generally given in terms of rem or mrem (0.001 rem)
20 for individuals and in terms of person-rem for collective populations.

21
22 The primary adverse health effect from the potential radiation doses resulting from
23 disposal operations would be the potential for the induction of LCFs. The health risk conversion
24 factor (expected LCFs per dose) used to convert radiation doses to LCFs (i.e., 0.0006 per rem or
25 person-rem) is a value identified by the Interagency Steering Committee on Radiation Standards
26 (ISCORS) as a reasonable factor to use in the calculation of potential LCFs associated with
27 radiation doses as given in DOE guidance and recommendations (DOE 2003, 2004). Adverse
28 health effects for individuals are presented in terms of the probability of developing an excess
29 LCF, whereas adverse health effects for collective populations are presented as the number of
30 excess LCFs among the population.

33 **C.4.1.3 Sources of Data and Application of Software**

34
35 The external exposures incurred by the involved workers for the three land disposal
36 alternatives are estimated on the basis of information on worker activities, the estimated number
37 of workers required to implement each alternative, and an average estimated annual dose of
38 0.2 rem per full-time equivalent (FTE) employee. This value is higher than but generally
39 consistent with doses incurred by workers performing comparable activities at DOE sites (see
40 Section 5.3.4.1.1) and those associated with storage of activated metal wastes at commercial
41 nuclear reactors (see Section 3.5.1.1). Actual worker dose information was used for waste
42 disposal activities at WIPP. This approach was used because there is considerable uncertainty
43 about the procedures workers would use to dispose of these wastes. The exact approach workers
44 would use to dispose of these wastes would be determined after the disposal site and detailed
45 facility design had been approved. This approach for addressing involved worker impacts is
46 considered reasonable for this EIS and is described in more detail in Section 5.3.4.1.1.

1 The radiological impacts from inhaling gaseous radionuclides are estimated by using the
2 RESRAD-OFFSITE computer code (Yu et al. 2007). The inhalation rate of the individual is
3 assumed to be 20 m³/d, with an exposure duration of 24 hours per day for 365 days per year. The
4 outdoor air concentrations are used for these calculations, and the time spent indoors, where
5 concentrations would be less than they are outdoors, is not accounted for. Site-specific wind
6 speed and contamination source data are used in these calculations; the data are based on
7 information contained in the post-closure performance analysis report for the waste disposal
8 facility (Argonne 2010). This approach ensures consistency with the assumptions used for the
9 groundwater impact analysis.

10
11 The assessment of the potential impacts from groundwater contamination for the land
12 disposal alternatives was conducted by using the same computer code (RESRAD-OFFSITE), as
13 summarized in the post-closure performance analysis report (Argonne 2010). The maximum
14 radiation doses associated with using the contaminated groundwater as the source of drinking
15 water are analyzed for a resident farmer scenario for time frames of 10,000 years and
16 100,000 years. The ingestion rate of drinking water for the groundwater receptor is assumed to
17 be 730 L/yr (190 gal/yr), which is the ingestion rate for adults recommended by the EPA
18 (EPA 1997). See Appendix E for more details on this evaluation.

19
20 The nonradiological impacts on workers are calculated as the number of lost workdays
21 that could occur from occupational accidents and illnesses. Data from the National Safety
22 Council are used to develop these estimates, as described in Section 5.3.4.2.2.

23 24 25 **C.4.2 Facility Accidents**

26
27 The methodology for analyzing the range of potential accidents that could result in a
28 release of radioactive material to the environment and that could occur at the land disposal
29 facilities is discussed in this section. The accident analysis considers potential events involving
30 the different GTCC LLRW and GTCC-like waste types considered in the EIS. Accidents could
31 be initiated during facility operations, such as those that result from equipment or operator
32 failure, or they could be caused by external events, including natural phenomena (earthquake,
33 flood, wind, or tornado). Reasonably foreseeable accidents were screened to identify the
34 accidents that would have the greatest consequences on workers and the public. These
35 “bounding” accidents provide an envelope for the consequences of the other potential accidents
36 that would have less impact on workers and the public.

37
38 Because the disposal options involve similar operations and the same waste packages, the
39 accidents evaluated are applicable to all three land disposal options. Because of the differences in
40 the local weather patterns and the location of the potential receptors, the radiological impacts for
41 Alternatives 3 to 5 are site-dependent and are discussed in Chapters 6 through 11 for the Hanford
42 Site, Idaho National Laboratory (INL), Los Alamos National Laboratory (LANL), Nevada
43 National Security Site (NNSS), Savannah River Site (SRS), and the Waste Isolation Pilot Plant
44 (WIPP) Vicinity, respectively.

1 The output from the disposal facility accident analyses consists of (1) identification of the
2 accidents potentially important with regard to human health risk for each waste type,
3 (2) assessment of the frequencies of these accidents, (3) evaluation of the source terms resulting
4 from these accidents, and (4) identification of the human health impacts associated with the
5 release and atmospheric dispersion of the source term.

6 7 8 **C.4.2.1 Accidents Evaluated** 9

10 An accident is an event or series of unexpected or undesirable events leading to a loss of
11 waste containment or shielding that could result in radiological exposure to workers or members
12 of the general public. The accidents considered fall under two broad categories (operational
13 events and natural phenomena) that had been previously evaluated for similar types of waste and
14 packaging (DOE 1997a, 2006, 2007). Table C-1 summarizes the accident scenarios analyzed.
15 Table C-2 provides more details for each potential accident considered.
16

17
18 **C.4.2.1.1 Operational Events.** It is not expected that any waste would be repackaged at
19 the disposal facility; therefore, the only way an operational event could release radioactive
20 material to the environment would be if a disposal container ruptured during handling or
21 temporary storage operations. Handling operations would include (1) transfer of the disposal
22 containers from their Type B shipping packages as received at the Waste Handling Building
23 (WHB) to temporary storage, (2) transfer from temporary storage to an on-site transport cask
24 (if waste is remote-handled [RH]) or to a vehicle, and (3) transfer from the transport vehicle into
25 the disposal unit. All such operations are expected to involve the use of forklifts and/or cranes.
26

27 Physical damage to waste containers could result from low-speed vehicle collisions,
28 being dropped, or being crushed by falling objects. Only minor releases would be likely should
29 such accidents happen. High-speed impacts are not anticipated at the disposal facility because
30 of the operational procedures that are followed (e.g., the on-site maximum speed limits are low,
31 waste disposal operations are separated from worker vehicular transport, and access to disposal
32 operations is limited).
33

34 Accidents involving contact-handled (CH) waste containers (208-L [55-gal] drums and
35 standard waste boxes [SWBs]) are expected to result in higher impacts because these Type A
36 containers, although fairly robust, are not as sturdy as the cesium irradiators and the RH canisters
37 or activated metal canisters (AMCs) and their shielding casks. As a consequence, the CH waste
38 containers would be more prone to release a portion of their contents. CH drum and SWB
39 radionuclide inventories that had the highest impacts were used in this facility accident analysis
40 for Accidents 1–9, 11, and 12. Accident 10 was also evaluated to provide that perspective should
41 an RH canister fail during an accident. A preliminary screening analysis, in which equivalent
42 release fractions were assumed both for GTCC Other Waste - CH and for GTCC Other
43 Waste - RH released from their containers, showed greater impacts for the CH waste. In addition,
44 if an AMC somehow became breached, the airborne radioactive contamination from material
45 such as activated metal waste would be minimal compared to that from Other Waste, because of
46 the relatively immobile nature of the contamination. Before sealed sources are packaged in

TABLE C-1 Accidents Evaluated for the Land Disposal Facilities

Accident Number	Accident Scenario	Accident Description	Frequency Range			
			>10 ⁻² /yr	10 ⁻⁴ to 10 ⁻² /yr	10 ⁻⁶ to 10 ⁻⁴ /yr	<10 ⁻⁶ /yr
1	Single drum drops, lid failure in Waste Handling Building	A single CH drum is damaged by a forklift and spills its contents onto the ground inside the Waste Handling Building.		X		
2	Single SWB drops, lid failure in Waste Handling Building	A single CH SWB is damaged by a forklift and spills its contents onto the ground inside the Waste Handling Building.		X		
3	Three drums drop, puncture, lid failure in Waste Handling Building	Three CH drums are damaged by a forklift and spill their contents onto the ground inside the Waste Handling Building.		X		
4	Two SWBs drop, puncture, lid failure in Waste Handling Building	Two CH SWBs are damaged by a forklift and spill their contents onto the ground inside the Waste Handling Building.		X		
5	Single drum drops, lid failure outside	A single CH drum is damaged by a forklift and spills its contents outside.		X		
6	Single SWB drops, lid failure outside	A single CH SWB is damaged by a forklift and spills its contents outside.		X		
7	Three drums drop, puncture, lid failure outside	Three CH drums are damaged by a forklift and spill their contents outside.		X		
8	Two SWBs drop, puncture, lid failure outside	Two CH SWBs are damaged by a forklift and spill their contents outside.		X		

TABLE C-1 (Cont.)

Accident Number	Accident Scenario	Accident Description	Frequency Range			
			>10 ⁻² /yr	10 ⁻⁴ to 10 ⁻² /yr	10 ⁻⁶ to 10 ⁻⁴ /yr	<10 ⁻⁶ /yr
9	Fire inside the Waste Handling Building, one SWB assumed to be affected	A fire within the Waste Handling Building affects the contents of a single CH SWB.			X	
10	Single RH waste canister breach	A single RH waste canister is breached during a fall in the Waste Handling Building.			X	
11	Earthquake affects 18 pallets, each with four CH drums	The Waste Handling Building is damaged during a design basis earthquake, and the structure and confinement systems fail.			X	
12	Tornado, missile hits one SWB, contents released	A major tornado and associated tornado missiles result in failure of the Waste Handling Building structure and its confinement systems.			X	
13	Flood	The facility would be sited in a location that would preclude severe flooding.				X

C-9

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TABLE C-2 Hypothetical Facility Accident Descriptions

Accident Number	Accident Scenario Description
1	A package (either a 7-drum pack or 4-drum pallet of CH transuranic [TRU] waste) is dropped from a forklift or crane while being handled in the Waste Handling Building. Because the waste containers are Type A packages, per U.S. Nuclear Regulatory Commission (NRC) requirements, they are designed to withstand a 1-m (3.3-ft) drop onto an unyielding surface without damage. However, because the vertical lift can exceed this design rating, it is assumed that the container drop and subsequent crushing cause the lid of a single container to be knocked off. No inner plastic liner is assumed to be present. A fraction of the respirable-sized particulates in the drum are assumed to be suspended inside the drum during the fall and to be released when a lid fails. Spilled contents are released, and the respirable particles are resuspended from this material. Facility high-efficiency particulate air (HEPA) filtration is considered for releases to the atmosphere.
2	Same as Accident 1, except that a single, direct-loaded SWB with CH waste is involved in a drop from a forklift or crane.
3	An error made by the Waste Handling Building forklift operator causes a forklift to strike and puncture two drums. An additional drum is knocked off, and the lid fails. Because the waste containers are Type A packages, per NRC requirements, they are designed to withstand a 1-m (3.3-ft) drop onto an unyielding surface without damage. However, because the vertical lift can exceed this design rating, it is assumed that the container drop and subsequent crushing cause the lid of a single container to be knocked off. No inner plastic liner is assumed to be present. A fraction of the respirable-sized particulates in the drum are assumed to be suspended inside the drum during the fall. A fraction of these are released when the lid fails, or the contents may be released and the respirable particles may be resuspended from this material. Facility HEPA filtration is considered for releases to the atmosphere.
4	An error made by the Waste Handling Building forklift operator causes a forklift to strike and puncture a single, direct-loaded SWB. An additional SWB is knocked off, and the lid fails. Because the waste containers are Type A packages, per NRC requirements, they are designed to withstand a 1-m (3.3-ft) drop onto an unyielding surface without damage. However, because the vertical lift can exceed this design rating, it is assumed that the container drop and subsequent crushing cause the lid of a single container to be knocked off. No inner plastic liner is assumed to be present. A fraction of the respirable-sized particulates in the SWB are assumed to be suspended inside the SWB during the fall. A fraction of these are released when the lid fails, or the contents may be released and the respirable particles may be resuspended from this material. Facility HEPA filtration is considered for releases to the atmosphere.
5	Same as Accident 1, except that it occurs outdoors during disposal operations.
6	Same as Accident 2, except that it occurs outdoors during disposal operations.
7	Same as Accident 3, except that it occurs outdoors during disposal operations.
8	Same as Accident 4, except that it occurs outdoors during disposal operations.
9	A fire in the WHB is caused by the malfunction or overheating of electrical equipment. This fire subsequently ignites nearby combustibles and is assumed to involve one SWB with CH waste.

TABLE C-2 (Cont.)

Accident Number	Accident Scenario Description
10	During the unloading of an RH shipping cask or the loading of an on-site transfer cask, the crane, grapples, or lift fixtures fail, and an RH canister is dropped, resulting in the canister being crushed or punctured.
11	The Waste Handling Building is assumed to be damaged during a design basis earthquake, and the structure and confinement systems fail. The roof is assumed to collapse onto 18 4-drum pallets of CH waste that are in the storage area awaiting final internment. Although four 4-drum pallets are assumed for disposal in trenches, the same number of drums could be involved as 7-drum packs for disposal in 40-m (130-ft) boreholes or above-grade vaults. In either case, the number of drums involved (72) is less than two full truck shipments of CH waste (84 drums).
12	A major design basis tornado is assumed to damage the Waste Handling Building to the extent that a wind-driven missile is able to hit a single SWB containing CH waste. Missiles might be produced from nearby trees, poles, cranes, parts of the facility structure, or various pieces of equipment or material (e.g., pallets).
13	The facility would be sited in a location that would preclude severe flooding.

1

2

3 drums for disposal, they are relatively immune to collisions and physical impacts because it is
4 assumed that sealed sources are already encased in their own sealed cases or shields; thus,
5 releases from sealed sources are expected to be less than those from the Other Waste - CH.

6

7 Fire from internal or external causes is another potential reason for radioactive
8 contamination. Internal causes would be minimized by properly treating the waste before it was
9 packaged and received at the facility. External causes, which are primarily linked to vehicle or
10 equipment fires, would be minimized through proper maintenance and use. Accident 9 considers
11 the impacts from a short-term fire in the WHB.

12

13

14 **C.4.2.1.2 Natural Hazards.** Potential releases of radioactive material could also occur
15 as a result of natural hazards. Such releases are anticipated only before emplacement (i.e., while
16 the waste is at the WHB). However, it is assumed that the disposal facility would be sited in an
17 area that is not prone to flooding, and depending on the area of the country in which it would be
18 situated, the facility would be built to meet local standards for earthquakes. Other natural hazards
19 (such as tornadoes) in certain areas of the country could cause releases. Accidents 11 and 12 look
20 at potential scenarios involving earthquakes and tornadoes, respectively.

21

22

23 A flood is not considered to be a credible hazard because it is assumed that the facility
24 would be sited to preclude severe flooding. It is assumed that the location and design of the
25 disposal facility would bring the frequency below 1×10^{-6} /yr. For example, the U.S. Nuclear
26 Regulatory Commission's (NRC's) regulations in Title 10, Section 61.50 of the *Code of Federal
Regulations* (10 CFR 61.50) require, in part, that waste disposal shall not take place in a

1 100-year floodplain. U.S. Department of Energy (DOE) guidance (DOE M 435.1-1) also
2 indicates that floodplains should be avoided.

3

4 High winds and tornadoes could cause extensive damage, including collapse of a
5 structure. For this accident analysis, it is assumed that the WHB could be damaged if a major
6 tornado, with associated tornado debris missiles, would sweep through the area. Missiles could
7 be produced from nearby trees, poles, cranes, parts of the facility structure, or various pieces of
8 equipment or material (e.g., pallets). The radiological dose would be much lower for a tornado
9 than a high wind because the tornado's higher wind would disperse releases more widely, but
10 credit is not taken in the dispersion analysis for this effect. It is assumed that a missile driven by
11 the wind from a tornado would hit and break an SWB, causing it to release some of its
12 radioactive contents.

13

14 The major earthquake assumed would be severe enough to cause the WHB roof to
15 collapse. The earthquake analysis assumes that 18 4-drum pallets of CH waste in the storage area
16 awaiting final internment would be affected. While it is assumed that 4-drum pallets would be
17 disposed of in trenches, the same number of drums could be involved as 7-drum packs for
18 disposal in 40-m (130-ft) boreholes or above-grade vaults. In either case, the number of drums
19 involved (72) is less than two full truck shipments of CH waste (84 drums).

20

21

22 **C.4.2.1.3 Accident Frequency.** The annual frequency of occurrence for waste handling
23 accidents is the product of the number of drums received per year, number of operations per
24 drum, and probability that a mishandling accident would damage a drum so it would release
25 radioactive material to the surrounding environment. Table C-3 summarizes the development of
26 the accident frequencies.

27

28 Seismic design guidelines for DOE facilities are based on facility usage categories. For
29 each category, an earthquake hazard level is specified by using site-specific seismic hazard data.
30 This process ensures that facilities are designed on a uniform basis to address the effects of
31 seismic events, regardless of their locations (DOE 1997b). A beyond-design-basis earthquake,
32 regardless of accident frequency, must be assumed to defeat all building confinement functions.
33 Buildings are typically constructed to withstand earthquakes. Therefore, the frequency of the
34 beyond-design-basis earthquake scenario is assumed to be equal at all of the disposal sites
35 considered. A similar process applies to the hardening of facilities to the potential impacts from
36 high winds and tornados.

37

38

39 **C.4.2.1.4 Source Terms.** In analyzing the potential consequences of postulated facility
40 accidents, the source term, which is the amount of radioactive material released, is evaluated.
41 The source term is the product of five factors (DOE 1994):

42

43

44

45

$$Q = \text{MAR} * \text{DR} * \text{ARF} * \text{RF} * \text{LPF}$$

TABLE C-3 Determination of Frequencies of Occurrence of Hypothetical Facility Accidents

Accident Number	Accident Scenario	Number of Containers per Year ^a	Number of Operations per Container	Frequency per Operation	Accident Frequency ^b (1/yr)
1	Single drum drops, lid failure in Waste Handling Building	330	2	1.1E-05 ^c	7.3E-03
2	Single SWB drops, lid failure in Waste Handling Building	83	2	1.1E-05	1.8E-03
3	Three drums drop, puncture, lid failure in Waste Handling Building	330	2	0.25 × 1.1E-05	1.8E-03
4	Two SWBs drop, puncture, lid failure in Waste Handling Building	83	2	0.25 × 1.1E-05	4.6E-04
5	Single drum drops, lid failure outside	330	2	1.1E-05	7.3E-03
6	Single SWB drops, lid failure outside	83	2	1.1E-05	1.8E-03
7	Three drums drop, puncture, lid failure outside	330	2	0.25 × 1.1E-05	1.8E-03
8	Two SWBs drop, puncture, lid failure outside	83	2	0.25 × 1.1E-05	4.6E-04
9	Fire inside the Waste Handling Building, one SWB assumed to be affected ^d	NA ^e	NA	NA	1.0E-05
10	Single RH waste canister breach	1,150	NA	NA	1.0E-05
11	Earthquake affects 18 pallets, each with four CH drums ^f	NA	NA	NA	1.0E-05
12	Tornado, missile hits one SWB, contents released ^f	NA	NA	NA	1.0E-05
13	Flood	NA	NA	NA	< 1e-6

^a Based on postulated receipt rates, with the majority of the waste being disposed of by 2035.

^b Calculated as the product of the number of containers times the number of handling events per container times the accident frequency per handling event.

^c Drop frequency of 1.1×10^{-5} per operation taken from page 6.13-7-5 of Dubrin et al. (1997).

^d Annual frequency of 1×10^{-5} per year taken from page G-69 of DOE (1997b).

^e NA = not applicable, since the number of affected containers is defined in the accident scenario.

^f Natural phenomena frequency of 1×10^{-5} per year assuming disposal facilities would be constructed as DOE Hazard Category 2 facilities, as per pages G-6 and G-10 of DOE (1997b).

1 where:

2

3

Q = source term (Ci);

4

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MAR = material at risk, the maximum amount and type of material present that
may be acted upon by the potentially dispersive energy source (Ci);

6

7

8

DR = damage ratio, the fraction of the MAR actually affected by the accident
condition;

9

10

11

ARF = airborne release fraction, the fraction of radioactive material actually
affected by the accident condition that is suspended in air;

12

13

14

RF = respirable fraction, the fraction of the airborne radioactive particles that
are in the respirable size range (i.e., less than 10 μm); and

15

16

17

LPF = leak path factor, the cumulative fraction of airborne material that escapes
to the atmosphere from the postulated accident.

18

19

20

Table C-4 summarizes the values used in the EIS facility accident analysis.

21

22

The source term should represent a reasonable maximum for a given waste stream. A
screening analysis identified the CH waste stream that is the most hazardous to human health.
For CH waste assumed to be packaged in 208-L (55-gal) drums, waste from INL is expected to
pose the highest risk. For CH waste packaged in SWBs, DOE waste from the West Valley Site is
expected to pose the highest risk. For RH packaged in 208-L (55-gal) drums, DOE waste from
the West Valley Site is expected to pose the highest risk. Note that three RH drums are contained
within the RH canister evaluated in Accident 10.

23

24

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30

Because of the uncertainties involved in waste type characterization at the present time,
container activity inventories were averaged by taking the total activity for a given waste type
from a specific generator and dividing that by the number of containers necessary to hold the
waste (discussed further in Appendix B). This information was developed from the waste
inventory database established for this EIS. Table C-5 lists the estimated inventories for a CH
drum (Accidents 1, 3, 5, 7, and 11), CH SWB (Accidents 2, 4, 6, 8, 9, and 12), and RH drum
(Accident 10) as used in this analysis. The actual respirable amount (Ci) released to the
environment, the source term, is obtained by multiplying the value in the "Release Factor"
column in Table C-4 by the activity from the appropriate container (Table C-4) for a given
accident.

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Values for the damage ratio, airborne release fraction, and respirable fraction as given in
Table C-4 were identified through a review of similar past analyses (DOE 1997b, 2006) and
current recommendations (DOE 2007). A leak path factor of 0.001 represents containment by the
WHB and assumes continuous operation of the building's heating, ventilation, and air-
conditioning (HVAC) system, with high-efficiency particulate air (HEPA) filters removing

TABLE C-4 Estimated Release Fractions for Hypothetical Facility Accidents^a

Accident Number	Container Type	Number of Containers	DR	ARF ^b	RF ^b	LPF ^c	Release Factor ^d
1	CH drum	1	0.25 ^e	0.001	0.1	0.001	2.5E-08
2	CH SWB	1	0.25	0.001	0.1	0.001	2.5E-08
3	CH drum	3	$(2 \times 0.1 + 1 \times 0.25)/3^f$	0.001	0.1	0.001	4.5E-08
4	CH SWB	2	$(1 \times 0.1 + 1 \times 0.25)/2^g$	0.001	0.1	0.001	3.5E-08
5	CH drum	1	0.25	0.001	0.1	1	0.000025
6	CH SWB	1	0.25	0.001	0.1	1	0.000025
7	CH drum	3	$(2 \times 0.1 + 1 \times 0.25)/3$	0.001	0.1	1	0.000045
8	CH SWB	2	$(1 \times 0.1 + 1 \times 0.25)/2$	0.001	0.1	1	0.000035
9	CH SWB	1	1	0.0005 ^h	1	1	0.0005
10	RH canister	1	0.01 ^e	0.001	0.1	0.001	1E-09
11	CH drum	72	0.1 ⁱ	0.001	0.1	1	0.00072
12	CH SWB	1	1	0.001 ^j	0.1 ^j	1	0.0001
13	Sited to preclude severe flooding, no release assumed						

^a DR = damage ratio, ARF = airborne release fraction, RF = respirable fraction, LPF = leakpath factor; CH = contact-handled, SWB = standard waste box, RH = remote-handled.

^b For direct loaded containers (DOE 2006).

^c The values for LPF are explained on page C-17.

^d The release factor is the product of the number of containers \times DR \times ARF \times RF \times LPF. Multiplication of this factor by the appropriate container inventory in Table C-5 provides the source term for each accident.

^e Source: DOE (1997b).

^f Damage ratio of 0.1 for each punctured drum and 0.25 for dropped drum with lid failure (DOE 1997b).

^g Damage ratio of 0.1 for the punctured SWB and 0.25 for the dropped SWB with lid failure (DOE 1997b).

^h Based conservatively on packaged cellulosic or plastic materials (DOE 2007).

ⁱ Assumed to behave similarly to a postulated collapse of the Waste Handling Building at WIPP (DOE 2006).

^j Release fractions associated with tornado missiles are assumed to resemble the fractions associated with mechanical spills (DOE 2007).

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TABLE C-5 Waste Container Inventories (Ci) for Use in the Facility Accident Analysis^a

Element	Container Type		
	CH Drum	CH SWB	RH Drum
Ac-227	1.0E-08	1.0E-04	4.6E-06
Am-241	7.5E+00	9.1E+00	1.2E+00
Am-242m	6.3E-10	–	–
Am-243	2.9E-08	9.9E-02	1.7E-02
Bi-212		5.9E-03	4.7E-04
C-14	8.4E-09	3.8E-02	1.8E-02
Cd-113m	2.0E-07	–	–
Ce-144	5.9E-12	5.9E-04	4.7E-05
Cm-242		3.3E-03	2.7E-04
Cm-243	9.7E-10	2.3E-04	9.6E-04
Cm-244	9.5E-07	5.7E-03	2.1E-02
Cm-245	1.3E-11	–	5.4E-02
Cm-246	1.2E-13	–	8.6E-03
Co-57	2.3E-13	–	–
Co-60	2.5E-05	7.5E-07	4.9E-02
Cs-134	4.9E-08	3.2E-05	4.2E-06
Cs-135	4.0E-08	–	–
Cs-137	2.3E-03	1.3E-01	5.6E+01
Eu-152	2.0E-05	–	–
Eu-154	5.4E-06	6.8E-04	2.7E-03
Eu-155	1.9E-06	–	1.2E-04
Fe-55	2.2E-06	3.0E-02	3.6E-03
H-3	1.0E-06	5.6E-04	2.6E-03
I-129	3.1E-07	9.5E-08	4.3E-04
K-40	–	2.2E-03	8.1E-05
Mn-54	9.7E-15	2.8E-05	2.3E-06
Ni-59	–	2.2E-04	–
Nb-94	3.3E-07	–	1.6E-05
Ni-59	1.7E-06	–	2.5E-02
Ni-63	1.6E-04	–	1.5E+00
Np-237	6.4E-03	1.4E-04	3.4E-04
Pa-231	6.8E-08	–	–
Pb-210	2.3E-08	–	–
Pb-212	–	4.1E-03	3.3E-04
Pd-107	7.5E-10	–	–
Pm-146	7.0E-10	–	–
Pm-147	–	–	8.9E-04
Pu-236	7.0E-11	1.6E-04	1.2E-05
Pu-238	5.3E-01	3.5E+00	2.8E-01
Pu-239	7.0E-03	2.6E+00	5.3E-01
Pu-240	5.6E-05	2.0E+00	3.6E-01
Pu-241	2.7E-02	4.7E+01	5.0E+00
Pu-242	1.4E-08	1.3E-02	1.1E-03
Ra-226	1.6E-07	1.2E-02	4.6E-04
Ra-228	–	9.2E-04	5.7E-05

TABLE C-5 (Cont.)

Element	Container Type		
	CH Drum	CH SWB	RH Drum
Ru-106	6.1E-11	2.9E-04	2.4E-05
Sb-125	3.6E-07	–	–
Se-79	2.0E-08	–	–
Sm-147	3.2E-14	–	–
Sm-151	1.8E-05	–	–
Sn-121m	2.8E-09	–	–
Sn-126	1.9E-12	–	–
Sr-90	2.1E-03	1.4E-01	1.2E+01
Tc-99	5.5E-07	9.1E-04	2.7E-02
Th-228	2.3E-10	1.3E-02	1.0E-03
Th-229	2.6E-07	6.4E-03	2.5E-04
Th-230	2.8E-05	1.2E-03	4.7E-05
Th-232	5.2E-09	8.1E-04	3.3E-05
U-232	7.0E-07	6.8E-02	3.0E-03
U-233	2.5E-07	2.7E-02	1.8E-03
U-234	1.5E-05	1.3E-01	4.9E-03
U-235	8.9E-04	5.3E-05	5.3E-05
U-236	5.0E-08	1.5E-04	1.3E-04
U-238	5.7E-08	2.6E-04	3.0E-04
Zr-93	1.0E-07	–	–

^a CH = contact-handled, RH = remote-handled, SWB = standard waste box. A dash means not applicable, since this radionuclide was not identified as being present for the waste packaged in this type of container.

1

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3 99.9% of the airborne particulates. A leak path factor of 1 represents an accident that occurs
4 outdoors or an accident whose conditions have negated the WHB containment.

5

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C.4.2.2 Human Health Impacts

8

9

10 The consequences to the collective off-site general public and individuals receiving the
11 highest impacts are estimated by using an air dispersion model to predict the downwind air
12 concentrations following a release. A number of factors are considered, including the amount of
13 the material released (as discussed in Section C.4.2.1), location of the release, and
14 meteorological conditions. The air concentrations are used to estimate the radiation doses and the
15 potential LCFs associated with these doses. The consequences are estimated on the basis of the
16 assumption that the wind is blowing in the direction that would yield the greatest impacts. For
17 accidents involving releases of radioactive material, the consequences are expressed in the same
way as are the consequences from routine operations (i.e., as radiation doses and LCFs for the

1 exposed population and individual receiving the highest dose for all important exposure
2 pathways).

3
4
5 **C.4.2.2.1 General Public.** The general public consists of the population living within
6 80 km (50 mi) of the GTCC reference location. The radiation exposure estimates include
7 potential doses from inhalation, groundshine, cloudshine, and ingestion of contaminated crops
8 for 1 year following a hypothetical accidental release of radioactive material, as discussed above.

9
10 The GENII computer code (Napier et al. 1988) was used to assess the radiological
11 impacts to the collective off-site population (members of the public) for each accident
12 considered. The off-site population distributions used for the accident analysis were determined
13 by using the latest geographic information (2007 population estimates) available for the land
14 disposal reference locations (ESRI 2008). Future population projections were not used because
15 they are considered too speculative for the time frame covered in the EIS.

16
17 The meteorological data used in GENII are joint frequencies of wind speed, wind
18 direction, and atmospheric stability class. The joint-frequency weather data for the Hanford Site
19 (Duncan 2007), LANL (Fuehne 2008), NNSS (DOE 2002a), SRS (NRC 2005), and the WIPP
20 Vicinity (DOE 1997b) were obtained from published reports. Weather data for INL were based
21 on the weather file data (for Idaho Falls, Idaho) originally provided with CAP88-PC (Clean Air
22 Act Assessment Package 1988-Personal Computer) (EPA 1992).

23
24 A ground-level release (1-m [3.3-ft] release height) is assumed for all accidents. To
25 provide a conservative estimate for the impacts, the sector with the highest exposure (highest
26 population dose, which is dependent on the number and location of people as well as the
27 weather conditions) was selected, but 50% meteorology (weather conditions that produce
28 impacts that are not exceeded 50% of the time) is used so as not to be overly conservative. For
29 the 1-year exposure period, the length of time of external exposure to contaminated soil is
30 0.5 year (NRC 1977b), and no credit is given for shielding for inhalation exposure and external
31 exposure to the passing airborne plume. The highest potential ingestion doses, from the autumn
32 period, are incorporated in the reported exposures.

33
34 The radiological impacts on the general public for Alternatives 3 to 5 are discussed in
35 Chapters 6 through 11 for the Hanford Site, INL, LANL, NNSS, SRS, and the WIPP Vicinity,
36 respectively.

37
38
39 **C.4.2.2.2 Highest-Exposed Individuals.** The risk to involved workers would be very
40 sensitive to the specific circumstances of the accident and depend on how rapidly the accident
41 developed, the exact location and response of the workers, the direction and amount of the
42 release, the physical and thermal forces causing or caused by the accident, meteorological
43 conditions, and the characteristics of the building if the accident occurred indoors. Impacts on
44 involved workers under accident conditions would likely be dominated by physical forces from
45 the accident itself, so the radiological impacts (radiation doses and LCFs) on such workers would
46 not be meaningful and are not quantified in the EIS. However, it is recognized that injuries and

1 fatalities among involved workers would be possible as a result of the radiological and physical
2 forces if an accident did occur.

3
4 Accident impacts to the individual receiving the highest potential dose were determined
5 by using the GENII code. The same release height and meteorological conditions as those used
6 for the population accident impacts were used for this analysis. The accident analysis evaluated
7 the potential exposure of a hypothetical individual located 100 m (330 ft) downwind of an
8 accident (radiation doses and LCFs). The exposure estimates are reported for the sector (wind
9 direction) with the highest impacts that include potential doses from inhalation, groundshine, and
10 cloudshine for 2 hours following a hypothetical accidental release of radioactive material. The
11 2-hour exposure accounts for plume passage and potential delays in relocation, if necessary. No
12 mitigative actions are assumed. The individual receiving the highest dose is expected to be a
13 noninvolved worker at the disposal facility. The radiological impacts for Alternatives 3 to 5 are
14 discussed in Chapters 6 through 11 for the Hanford Site, INL, LANL, NNSS, SRS, and the
15 WIPP Vicinity, respectively.

18 **C.5 ECOLOGICAL RESOURCES**

19
20 Impacts on ecological resources consider the effects of facility construction, operations,
21 and post-closure on terrestrial, wetland, aquatic, and special-status species and their habitats at
22 and in the vicinity of each GTCC reference location or disposal facility site. Special attention
23 was paid to resources protected by regulations (e.g., federally listed species, migratory birds,
24 bald and golden eagles, and wetlands). Section 5.3.5 presents a discussion of the methodology
25 used to determine the potential impacts of the GTCC disposal options on ecological resources.
26 Direct and indirect impacts on ecological resources are evaluated on the basis of the:

- 27
- 28 • Nature and quality of habitats within and adjacent to the construction
29 footprint,
- 30
- 31 • Potential magnitude of changes to habitat quality and quantity,
- 32
- 33 • Temporal characteristics of when impacts could occur,
- 34
- 35 • Expected duration of impacts,
- 36
- 37 • Sensitivity of biological resources that could be affected by changes in habitat
38 quality or quantity,
- 39
- 40 • Rarity and importance of affected resources, and
- 41
- 42 • Regulatory requirements (wetlands, threatened and endangered species,
43 migratory birds).
- 44
- 45

1 Factors considered in evaluating impacts from the GTCC disposal facility include:

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- Habitat loss, modification, and fragmentation;
- Barriers to movement;
- Changes in hydrology and water quality;
- Erosion and sedimentation;
- Air quality and fugitive dust;
- Introduction of invasive species;
- Exposure to contaminants (including radionuclides);
- Mortality and injury; and
- Noise and disturbance.

21 A quantitative assessment of the impacts on the large number of species found at each
22 alternative site was not practical. The approach used for this EIS consisted of gathering land use
23 and land cover data to identify areas of potential habitat and how it would be affected. Thus,
24 impacts on plants and wildlife primarily addressed the effects of facility construction on habitat
25 loss and fragmentation. The potential impacts on wetlands were based on the direct impacts that
26 could result from construction (e.g., filling) or indirect impacts (e.g., changes in water quality,
27 hydrologic regime, or soil compaction and runoff). Impacts on threatened and endangered
28 species were investigated by using a species-specific approach. Consultations with regulatory
29 agencies (e.g., U.S. Fish and Wildlife Service [USFWS] and state fish and game departments)
30 were undertaken to assist with the identification of threatened, endangered, and other special-
31 status species to be considered at each site (see Appendix F for consultation letters).

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An overview of the potential impacts that could occur on ecological resources regardless
of the GTCC reference location or method is presented in Section 5.3.5. The implementation of
mitigation measures to minimize the impacts described in Section 5.3.5 would help to limit the
potential impacts on ecological resources.

39 **C.6 SOCIOECONOMICS**

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The analysis of socioeconomic impacts from the construction of additional rooms and
waste disposal operations at WIPP and the construction and waste disposal operations at the land
disposal facilities assesses impacts in a region of influence (ROI) at each of the sites evaluated in
this EIS. The ROI includes the counties in which the majority (up to 90%) of employees reside at
each of the sites. The ROI includes county governments, city governments, and school districts.
Within the ROI at each site, there are also various jurisdictions that could be affected by GTCC

1 waste disposal facility construction and operations. The assessment of the impacts from GTCC
2 waste disposal facilities covers impacts on employment, income, population, housing,
3 community services, and traffic.
4
5

6 **C.6.1 Impacts on Regional Employment and Income**

7

8 The assessment of impacts from a GTCC waste disposal facility on regional employment
9 and income is based on the use of regional economic multipliers in association with project
10 expenditure data for the construction and operational phases. Multipliers capture the indirect
11 (off-site) effects of on-site activities associated with the construction and operational activities or
12 events. Expenditure data associated with the construction and operations of a GTCC waste
13 disposal facility are derived from numerous sources. These sources provide the relevant data on
14 construction and operating costs for labor and materials, in various general cost categories.
15

16 Cost data for each cost category are then mapped into the relevant North American
17 Industry Classification System (NAICS) codes for use with multipliers from an IMPLAN model
18 specified for each state (MIG, Inc. 2008). IMPLAN input-output economic accounts show the
19 flow of commodities to industries from producers and institutional consumers. The accounts also
20 show consumption activities by workers, owners of capital, and imports from outside the region.
21 The IMPLAN model contains 528 sectors representing industries in agriculture, mining,
22 construction, manufacturing, the wholesale and retail trade, utilities, finance, insurance and real
23 estate, and consumer and business services. The model also includes information for each sector
24 on employee compensation; proprietary and property income; personal consumption
25 expenditures; federal, state, and local expenditures; inventory and capital formation; and imports
26 and exports.
27

28 Impacts on employment are described in terms of the total number of jobs created in the
29 region in the peak year of construction and in the first year of operations. The relative impact of
30 the increase in employment in the ROI is calculated by comparing total GTCC waste facility
31 construction employment over the period in which construction occurs with baseline ROI
32 employment forecasts over the same period. Impacts are expressed in terms of the percentage
33 point difference in the average annual employment growth rate with and without GTCC project
34 construction. Forecasts are based on data provided by the U.S. Department of Commerce.
35
36

37 **C.6.2 Impacts on Population**

38

39 An important consideration in the assessment of the impacts from a GTCC waste disposal
40 facility is the number of workers, families, and children who would migrate into the ROI, either
41 temporarily or permanently, to construct and operate the facility. The capacity of regional labor
42 markets to supply workers in the occupations required for facility construction and operations in
43 sufficient numbers is closely related to the occupational profile of the ROI and occupational
44 unemployment rates. To estimate the in-migration that would occur to satisfy direct labor
45 requirements, the analysis develops estimates of the available labor in each direct labor category
46 based on ROI unemployment rates applied to each occupational category. In-migration

1 associated with indirect labor requirements are derived from estimates of the available labor
2 supply in the ROI economy as a whole that is able to satisfy the demand for labor by industry
3 sectors in which GTCC waste disposal facility spending initially occurs. The national average
4 household size is used to calculate the number of additional family members who would
5 accompany direct and indirect in-migrating workers.

6
7 Impacts on population are described in terms of the total number of in-migrants arriving
8 in the region in the peak year of construction and in the first year of operations. The relative
9 impact of the increase in population in the ROI is calculated by comparing total GTCC waste
10 disposal facility construction in-migration over the period in which construction occurs with
11 baseline ROI population forecasts over the same period. Impacts are expressed in terms of the
12 percentage point difference in the average annual population growth rate with and without
13 project construction. Forecasts are based on data provided by the U.S. Bureau of the Census.

14 15 16 **C.6.3 Impacts on Housing**

17
18 The in-migration of workers during construction and operations has the potential to
19 substantially affect the housing market in the ROI. The analysis considers these impacts by
20 estimating the increase in demand for rental housing units in the peak year of construction and
21 for owner-occupied housing in the first year of operations, resulting from the in-migration of
22 both direct and indirect workers into the ROI. The impacts on housing are described in terms of
23 the number of rental units required in the peak year of construction and the number of owner-
24 occupied units required in the first year of operations. The relative impact on the existing
25 housing in the ROI is estimated by calculating the impact of GTCC-related housing demand on
26 the forecasted number of vacant rental housing units in the peak year of construction and the
27 forecasted number of vacant owner-occupied units in the first year of operations. Forecasts are
28 based on data provided by the U.S. Bureau of the Census.

29 30 31 **C.6.4 Impacts on Community Services**

32
33 In-migration associated with the construction and operations of a GTCC facility could
34 translate into increased demand for educational services and public services (police, fire
35 protection, health services, etc.) in the ROI. Estimates of the total number of in-migrating
36 workers and their families are used to calculate the impact of GTCC waste disposal facility
37 construction and operations for the ROI counties in which the majority of new workers would
38 locate. Impacts of the facility on county, city, and school district revenues and expenditures are
39 calculated by using baseline data provided in the relevant jurisdictions' annual comprehensive
40 financial reports forecasted for the peak year of construction and first year of operations, based
41 on per-capita revenues and expenditures for each jurisdiction. Population forecasts are based on
42 data provided by the U.S. Bureau of the Census.

43
44 Impacts of GTCC waste disposal facility in-migration on community service employment
45 are also calculated for the ROI counties in which the majority of new workers would locate. By
46 using estimates of the number of in-migrating workers and families, the analysis calculates the

1 number of new sworn police officers, firefighters, and general government employees required to
2 maintain the existing levels of service for each community service. Calculations are based on the
3 existing number of employees per 1,000 population for each community service. The analysis of
4 the impact on educational employment estimates the number of teachers in each school district
5 who would be required to maintain the existing teacher-student ratios across all student age
6 groups. Information on existing employment and levels of service is collected from the
7 individual jurisdictions providing each service.

10 **C.6.5 Impacts on Traffic**

12 Impacts on traffic in the ROI are described in terms of the impact of the increase in traffic
13 caused by the GTCC waste disposal facility on the major road segments used to commute to and
14 from the site by existing site employees. The analysis allocates trips made by construction
15 workers to individual road segments on the basis of the residential distribution of existing site
16 workers. The impact on the existing annual average number of daily trips is then calculated, and
17 the impact on the level of service provided by each individual segment is estimated. Traffic
18 information is collected from state and county transportation departments.

21 **C.7 ENVIRONMENTAL JUSTICE**

23 Executive Order 12898 (February 16, 1994) formally requires federal agencies to
24 incorporate environmental justice as part of their missions. Specifically, it directs them to
25 address, as appropriate, any disproportionately high and adverse human health or environmental
26 effects of their actions, programs, or policies on minority and low-income populations.

28 The analysis of the impacts of a GTCC waste disposal (i.e., construction of additional
29 rooms and waste operations at WIPP, and construction and operation of a new borehole, trench,
30 or vault disposal facility at the GTCC reference location evaluated) on environmental justice
31 issues follows Council on Environmental Quality (CEQ) guidelines described in *Environmental*
32 *Justice Guidance under the National Environmental Policy Act* (CEQ 1997). The analysis
33 method (1) describes the geographic distribution of low-income and minority populations in the
34 affected area; (2) assesses whether the impacts of construction and operations would be high and
35 adverse; and (3) if impacts are high and adverse, determines whether these impacts would
36 disproportionately affect minority and low-income populations.

38 Construction and operations associated with GTCC waste disposal could affect
39 environmental justice if any adverse health and environmental impacts resulting from either
40 phase of development were significantly high and if these impacts disproportionately affected
41 minority and low-income populations. If an analysis that accounted for any unique exposure
42 pathways (such as subsistence fish, vegetation or wildlife consumption, or well-water
43 consumption) determined that health and environmental impacts would not be significant, there
44 could be no high and adverse impacts on minority and low-income populations. If impacts were
45 found to be significant, disproportionality would be determined by comparing the proximity of
46 high and adverse impacts to the location of low-income and minority populations. Information

1 needed to conduct the analysis would be collected and developed to support future evaluations
2 that would be included in follow-on documents for the selected alternative(s).

3
4 The analysis of environmental justice issues considers impacts in an 80-km (50-mi)
5 buffer around the site in order to include any potential adverse human health or socioeconomic
6 impacts related to the GTCC waste disposal (i.e., construction of additional rooms and waste
7 disposal operations at WIPP, and construction and operation of a new borehole, trench, or vault
8 disposal facility). Accidental radiological releases, for example, could affect minority and low-
9 income population groups located some distance from the site, depending on the size and nature
10 of potential releases and on the meteorological conditions. Any accidental release to the
11 environment could also affect fish and other natural resources that might be used for subsistence
12 by low-income and minority population groups some distance from the site, the extent of which
13 also would depend on the size and nature of any potential release at the site.

14
15 The description of the geographic distribution of minority and low-income groups is
16 based on demographic data from the 2000 Census (U.S. Bureau of the Census 2008). Definitions
17 of minority and low-income population groups are as follows:

- 18
19 • *Minority.* Persons are included in the minority category if they identify
20 themselves as belonging to any of the following racial groups: (1) Hispanic,
21 (2) Black (not of Hispanic origin) or African American, (3) American Indian
22 or Alaska Native, (4) Asian, or (5) Native Hawaiian or other Pacific Islander.

23
24 Beginning with the 2000 Census, where appropriate, the census form allows
25 individuals to designate multiple population group categories to reflect their
26 ethnic or racial origin. In addition, persons who classify themselves as being
27 of multiple racial origins may choose up to six racial groups. The term
28 minority includes all persons, including those classifying themselves in
29 multiple racial categories, except those who classify themselves as “White”
30 (U.S. Bureau of the Census 2008).

31
32 The CEQ guidance proposes that minority populations should be identified in
33 locations where either (1) the minority population of the affected area exceeds
34 50% or (2) the minority population percentage of the affected area is
35 meaningfully greater than the minority population percentage in the general
36 population or other appropriate unit of geographic analysis.

37
38 The EIS applies both criteria in using the Census Bureau data for census block
39 groups, in that consideration is given to the minority population that is both
40 more than 50% and 20 percentage points higher in the relevant location than it
41 is in the state (the reference geographic unit).

- 42
43 • *Low-income.* These are individuals who fall below the poverty line. The
44 poverty line takes into account the family size and the age of individuals in the
45 family. In 1999, for example, the poverty line for a family of five with three
46 children below the age of 18 was \$19,882. For any given family below the

1 poverty line, all family members are considered as being below the poverty
2 line for the purposes of analysis in this EIS.

3 4 5 **C.8 LAND USE**

6
7 Land use impacts are identified changes in land use categories and alternative or
8 conflicting uses caused by a proposed action. Potential impacts on land use were evaluated for
9 each alternative site by examining the characteristics and size of the land required for GTCC
10 waste disposal and the compatibility of current land use designations with the GTCC waste
11 disposal facility. The analyses considered potential land use impacts that could be incurred
12 during the construction, operations, and post-closure phases of the project at each alternative site.
13 An impact on land use would occur if the facility would change land use in the area in which the
14 facility was located (i.e., the facility would not conform to existing DOE land use plans and
15 policies) or in surrounding areas. Therefore, the GTCC waste disposal facility was considered to
16 have a potential impact on land use only if it would:

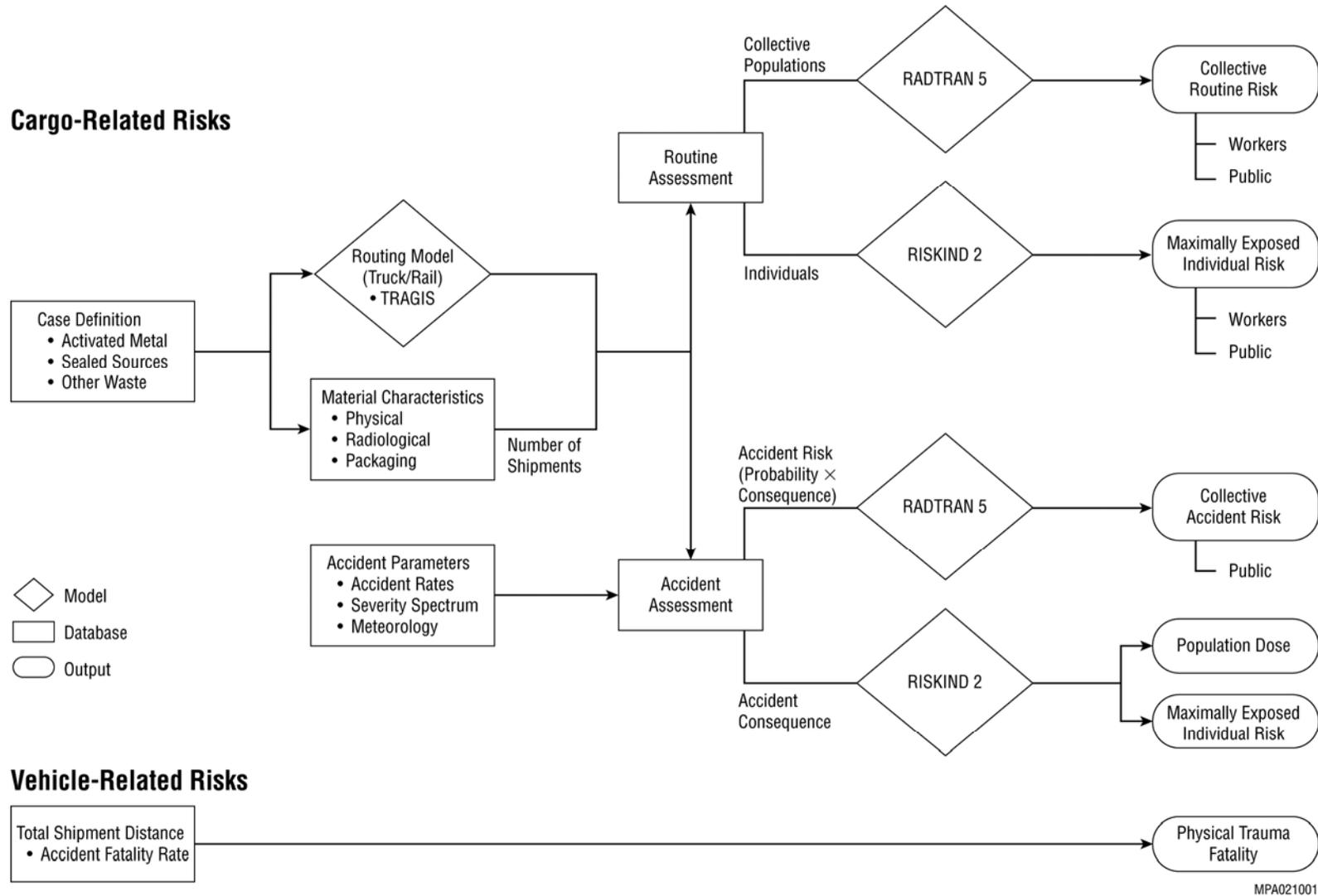
- 17
18 • Conflict with existing land use plans;
19
20 • Conflict with existing recreational, educational, scientific, or other uses of the
21 area;
22
23 • Conflict with existing conservation goals for the area; or
24
25 • Require a conversion from existing commercial land use of the area
26 (e.g., timber harvest, mineral extraction, livestock grazing).
27
28

29 **C.9 TRANSPORTATION RISK ANALYSIS**

30
31 This section provides the methodology and key input parameters used for the
32 transportation risk analysis performed in support of the GTCC EIS. The methodology follows the
33 common approach identified in DOE (2002b). The analysis evaluated the transportation of the
34 waste from its assumed or known location of generation or storage to each of the proposed
35 disposal facility locations. Transportation impacts were estimated for shipment by both truck and
36 rail modes for the three GTCC LLRW and GTCC-like waste types.
37
38

39 **C.9.1 Overview**

40
41 The transportation risk assessment considered human health risks both from routine
42 (normal, incident-free) transport of radiological materials and from potential accidents. In both
43 cases, risks associated with the nature of the cargo itself (“cargo-related” impacts) were
44 considered. Risks related to the transportation vehicle regardless of type of cargo (“vehicle-
45 related” impacts) were considered for potential accidents. Transportation of hazardous chemicals
46 was not part of this analysis because no hazardous chemicals have been identified as being part
47 of the waste disposal operations. Figure C-1 depicts the overall approach.



1
2

FIGURE C-1 Technical Approach for the Transportation Risk Assessment

C.9.1.1 Routine Transportation Risk

The radiological risk associated with routine transportation would be cargo-related and result from the potential exposure of people to low levels of external radiation near a loaded shipment. No direct physical exposure to radioactive material would occur during routine transport because these materials would be in packages designed and maintained to ensure that their contents were contained and shielded during normal transport. Any leakage or unintended release would be considered under accident risks.

C.9.1.2 Accident Transportation Risk

The cargo-related radiological risk from transportation-related accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people through multiple exposure pathways (e.g., exposure to contaminated soil, inhalation, or the ingestion of contaminated food).

Vehicle-related accident risks refer to the potential for transportation-related accidents that would result in fatalities caused by physical trauma unrelated to the cargo.

C.9.2 Routine Risk Assessment Methodology

The RADTRAN 5 computer code (Neuhauser and Kanipe 2003; Weiner et al. 2006) was used in the routine and accident cargo-related risk assessments to estimate the radiological impacts on collective populations. RADTRAN 5 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by truck, rail, air, ship, or barge. The code has been used extensively for transportation risk assessments since it was originally issued in the late 1970s as RADTRAN (RADTRAN 1) and has been reviewed and updated periodically. RADTRAN 1 was originally developed to facilitate the calculations presented in NUREG-0170 (NRC 1977a).

C.9.2.1 Collective Population Risk

The radiological risk associated with routine transportation would result from the potential exposure of people to low-level external radiation in the vicinity of loaded shipments. Even under routine transportation, some radiological exposure could occur. Because the radiological consequences (dose) would occur as a direct result of normal operations, the probability of routine consequences is taken to be 1 in the RADTRAN 5 code. Therefore, the dose risk is equivalent to the estimated dose.

For routine transportation, the RADTRAN 5 computer code considers major groups of potentially exposed persons. The RADTRAN 5 calculations of risk for routine highway and rail transportation include exposures of the following population groups:

- 1 • *Persons along the route (off-link population)*. Collective doses were
2 calculated for all persons living or working within 0.8 km (0.5 mi) of each
3 side of a transportation route. The total number of persons within the 1.6-km
4 (1-mi) corridor was calculated separately for each route considered in the
5 assessment.
6
- 7 • *Persons sharing the route (on-link population)*. Collective doses were
8 calculated for persons in all vehicles sharing the transportation route. This
9 group includes persons traveling in the same or opposite directions as the
10 shipment, as well as persons in vehicles passing the shipment.
11
- 12 • *Persons at stops*. Collective doses were calculated for people who might be
13 exposed while a shipment was stopped en route. For truck transportation,
14 these stops would include those for refueling, food, and rest. For rail
15 transportation, it was assumed that stops would occur for purposes of
16 classification.
17
- 18 • *Crew members*. Collective doses were calculated for truck transportation crew
19 members involved in the actual shipment of material. Workers involved in
20 loading or unloading were not considered. The doses calculated for the first
21 three population groups were added together to yield the collective dose to the
22 public. The dose calculated for the fourth group represents the collective dose
23 to workers.
24

25 The RADTRAN 5 calculations for routine dose generically compute the dose rate as a
26 function of distance from a point or line source (Neuhauser and Kanipe 2003). Associated with
27 the calculation of routine doses for each exposed population group are parameters such as the
28 radiation field strength, source-receptor distance, duration of exposure, vehicular speed, stopping
29 time, traffic density, and route characteristics (such as population density). The RADTRAN
30 manual contains derivations of the equations used and descriptions of these parameters
31 (Neuhauser and Kanipe 2003).
32
33

34 **C.9.2.2 Highest-Exposed Individual Risk** 35

36 In addition to assessing the routine collective population risk, the risks to individuals
37 receiving the highest impacts were estimated for a number of hypothetical exposure scenarios by
38 using the RISKIND model (Yuan et al. 1995; Biwer et al. 1997). Receptors included
39 transportation crew members, departure inspectors, and members of the public exposed during
40 traffic delays, while working at a service station, or while living near a facility, as summarized in
41 Table C-6.
42

43 RISKIND was used to calculate the dose to each individual considered for an exposure
44 scenario defined by an exposure distance, duration, and frequency specific to that receptor. The
45 distances and durations of exposure were similar to those given in previous transportation risk

TABLE C-6 Individual Exposure Scenarios

Receptor	Exposure Event	Source
Workers		
Inspector (truck and rail)	1 m for 1 hour	DOE 2008
Railyard crew member	10 m for 2 hours	DOE 1997a, 2008
Public		
Resident near route	18 m (rail), 30 m (truck)	DOE 2008 (rail), DOE 1997a (truck)
Person in traffic jam	1.2 m for 1 hour	DOE 2008
Person at service station	16 m for 49 minutes	DOE 2008
Resident near railyard	200 m for 20 hours	DOE 1997a

1

2

3 assessments (DOE 1990, 1995, 1996, 1997a, 1999). The scenarios were not meant to be
4 exhaustive but were selected to provide a range of potential exposure situations.

5

6 The RISKIND external dose model considers direct external exposure and exposure from
7 radiation scattered from the ground and air. RISKIND was used to calculate the dose as a
8 function of distance from a shipment on the basis of the dimensions of the shipment (millirem
9 per hour for stationary exposures and millirem per event for moving shipments). The code
10 approximates the shipment as a cylindrical volume source, and the calculated dose includes
11 contributions from secondary radiation scattering from buildup (scattering by the material
12 contents), cloudshine (scattering by the air), and groundshine (scattering by the ground). As a
13 conservative measure, credit for potential shielding between the shipment and the receptor was
14 not considered.

15

16

17 **C.9.3 Accident Assessment Methodology**

18

19 The radiological transportation accident risk assessment used the RADTRAN 5 code for
20 estimating collective population risks and the RISKIND code for estimating individual and
21 population consequences. The collective accident risk for each type of shipment was determined
22 in a manner similar to that described for routine collective population risks.

23

24

25 **C.9.3.1 Radiological Accident Risk Assessment**

26

27 The risk analysis for potential accidents differs fundamentally from the risk analysis for
28 routine transportation because occurrences of accidents are statistical in nature. The accident risk
29 assessment is treated probabilistically in RADTRAN 5 for radiological risk. Accident risk is
30 defined as the product of the accident consequence (dose or exposure) and the probability of the
31 accident occurring. In this respect, RADTRAN 5 estimates the collective accident risk to
32 populations by considering a spectrum of transportation-related accidents. The spectrum of
33 accidents was designed to encompass a range of possible accidents, including low-probability

1 accidents that have high consequences and high-probability accidents that have low
2 consequences (such as “fender benders”). For radiological risk, the results for collective accident
3 risk can be directly compared with the results for routine collective risk because the latter results
4 implicitly incorporate a probability of occurrence of 1 if the shipment takes place.

5

6 The RADTRAN 5 calculation of collective accident risk uses models that quantify the
7 range of potential accident severities and the responses of transported packages to accidents. The
8 spectrum of accident severity is divided into several categories, each of which is assigned a
9 conditional probability of occurrence (i.e., the probability that if an accident does occur, it will
10 be of a particular severity). Release fractions, defined as the fraction of the material in a package
11 that could be released in an accident, are assigned to each accident severity category on the basis
12 of the physical and chemical form of the material. The model takes into account the mode of
13 transportation and the type of packaging by selecting the appropriate accident probabilities and
14 release fractions, respectively. The accident rates, the definitions of accident severity categories,
15 and the release fractions used in this analysis are discussed further in Section C.9.4.4.

16

17 For accidents involving the release of radioactive material, RADTRAN 5 assumes that
18 the material is dispersed in the environment according to standard Gaussian diffusion models.
19 For the risk assessment, default data for atmospheric dispersion were used, representing an
20 instantaneous ground-level release and a small-diameter source cloud (Neuhauser and
21 Kanipe 2003). The calculation of the collective population dose following the release and
22 dispersal of radioactive material includes the following exposure pathways:

23

- 24 • External exposure to the passing radioactive cloud,
- 25
- 26 • External exposure to contaminated ground,
- 27
- 28 • Internal exposure from inhalation of airborne contaminants, and
- 29
- 30 • Internal exposure from the ingestion of contaminated food.

31

32 For the ingestion pathway, state-average food transfer factors, which relate the amount of
33 radioactive material ingested to the amount deposited on the ground, were calculated in
34 accordance with the methods described by NRC Regulatory Guide 1.109 (NRC 1977b) and were
35 used as input to the RADTRAN code. Doses of radiation from the ingestion or inhalation of
36 radionuclides were calculated by applying standard dose conversion factors (DCFs) (EPA 1999;
37 ICRP 1996).

38

39

40 **C.9.3.2 Vehicle-Related Accident Risk Assessment**

41

42 The vehicle-related accident risk refers to the potential for transportation accidents that
43 could result directly in fatalities not related to the nature of the cargo in the shipment. This risk
44 represents fatalities from physical trauma. State-average rates for transportation fatalities are
45 used in the assessment, as discussed in Section C.9.4.1.3. Vehicle-related accident risks were
46 calculated by multiplying the total distance traveled by the rates for transportation fatalities. In

1 all cases, the vehicle-related accident risks were calculated on the basis of distances for round-
2 trip shipment, since the presence or absence of cargo would not be a factor in accident frequency.

3 4 5 **C.9.3.3 Accident Consequence Assessment**

6
7 The RISKIND code is used to provide a scenario-specific assessment of radiological
8 consequences from severe transportation-related accidents for each waste type. The RADTRAN
9 accident risk assessment considers the entire range of accident severities and their related
10 probabilities, whereas the RISKIND accident consequence assessment focuses on accidents that
11 result in the largest releases of radioactive material to the environment.

12
13 For each waste type, accident consequences are presented for a shipment of waste that
14 represents the highest potential radiological risk if an accident was to occur. This “maximum
15 reasonably foreseeable accident” is identified for each waste type by screening the site-specific
16 radiological waste characteristics (that is, activity concentrations) developed for this EIS, taking
17 into account the physical forms of waste and the relative hazards of individual radionuclides. For
18 most waste shipments, the consequences of severe accidents would be less than those presented
19 for the maximum reasonably foreseeable case. The accident consequence assessment is intended
20 to provide an estimate of the maximum potential impacts posed by a severe transportation-
21 related accident involving a particular waste type.

22
23 The severe accidents considered in the consequence assessment are characterized by
24 extreme mechanical and thermal forces. In all cases, these accidents result in a release of
25 radioactive material to the environment. The accidents correspond to those within the highest
26 accident severity category, as described previously. These accidents represent low-probability,
27 high-consequence events. Therefore, accidents of this severity are expected to be extremely rare.
28 However, the overall probability that such an accident could occur depends on the potential
29 accident rates for this severity category and the shipping distance for each case.

30
31 For each waste type, RISKIND is used to calculate the accident consequences for local
32 populations and for the highest-exposed individual. The population dose includes the population
33 within 80 km (50 mi) of the accident site. The exposure pathways considered are similar to those
34 discussed previously for the accident risk assessment. Although remedial activities after the
35 accident (for example, evacuation or ground cleanup) would reduce the consequences, these
36 activities are not considered in the consequence assessment.

37
38 Because predicting the exact location of a severe transportation-related accident is
39 impossible when estimating population impacts, separate accident consequences are calculated
40 for accidents occurring in three population density zones: rural, suburban, and urban. Moreover,
41 to address the effects of the atmospheric conditions existing at the time of an accident, two
42 atmospheric conditions are considered: neutral and stable.

43
44 The highest-exposed individual for severe transportation accidents would be located at
45 the point that would have the highest concentration of hazardous material that would be
46 accessible to the general public. This location is assumed to be 30 m (100 ft) or farther from the

1 release point at the location of highest air concentration. Only the shipment accident that would
2 result in the highest contaminant concentration is evaluated for individual exposures.

5 **C.9.4 Input Parameters and Assumptions**

7 The principal input parameters and assumptions used in the transportation risk
8 assessment are discussed in this section. DOE has broad authority under the Atomic Energy Act
9 to regulate all aspects of activities involving radioactive materials that are undertaken by DOE or
10 on its behalf, including the transportation of radioactive materials. DOE exercises this authority
11 to regulate certain DOE shipments, such as shipments undertaken by governmental employees or
12 shipments involving special circumstances. In most cases that do not involve national security,
13 DOE utilizes commercial carriers that undertake shipments of DOE material under the same
14 terms and conditions as those of commercial shipments. These shipments are subject to
15 regulation by the U.S. Department of Transportation (DOT) and other entities, as appropriate. As
16 a matter of policy, all DOE shipments are undertaken in accordance with the requirements and
17 standards that apply to comparable commercial shipments, except where there is a determination
18 that national security or another critical interest requires different action. In implementing this
19 policy, DOE cooperates with federal, state, local, and tribal entities and utilizes existing expertise
20 and resources to the extent practicable. In all cases, DOE will achieve a level of protection that
21 meets or exceeds the level of protection associated with comparable commercial shipments.

23 DOT and the NRC have the primary responsibility for federal regulations governing
24 commercial radioactive material transportation. The Hazardous Materials Transportation Act of
25 1975, as amended (49 *United States Code* [U.S.C.] 5105, et seq.), requires DOT to establish
26 regulations for the safe transportation of hazardous materials in commerce (including radioactive
27 materials). Title 49 of the *Code of Federal Regulations* (CFR) contains DOT standards and
28 requirements for the packaging, transporting, and handling of radioactive materials for all modes
29 of transportation. DOT's Hazardous Materials Regulations, or HMRs, on the transportation of
30 hazardous and radioactive materials can be found in 49 CFR Parts 171 through 180. In addition,
31 the requirements for motor carrier transportation can be found in 49 CFR Parts 350 through 399,
32 and the requirements for transportation by rail can be found in 49 CFR Parts 200 through 268.
33 The NRC sets additional design and performance standards for packages that carry materials
34 with higher levels of radioactivity. The NRC regulations pertaining to transportation of
35 radioactive materials are found in 10 CFR Part 71. These regulations include detailed
36 requirements for certification testing of packaging designs. This certification testing involves a
37 variety of conditions, such as heating, free dropping onto an unyielding surface, immersing in
38 water, dropping the package onto a vertical steel bar, and checking gas tightness.

41 **C.9.4.1 Route Characteristics**

43 The transportation route selected for a shipment determines the total population of
44 potentially exposed individuals and the expected frequency of transportation-related accidents.
45 For truck and rail transportation, the route characteristics most important for a risk assessment

1 include the total shipping distance between each origin site and destination site and the
2 population density along the route.
3
4

5 **C.9.4.1.1 Route Selection.** The DOT routing regulations concerning radioactive
6 materials on public highways are prescribed in 49 CFR 397.101 (Requirements for Motor
7 Carriers and Drivers). The objectives of the regulations are to reduce the impacts from
8 transporting radioactive materials, establish consistent and uniform requirements for route
9 selection, and identify the role of state and local governments in routing radioactive materials.
10 The regulations attempt to reduce potential hazards by prescribing that populous areas be
11 avoided and that travel times be minimized. In addition, the regulations require the carrier of
12 radioactive materials to ensure (1) that the vehicle is operated on routes that minimize
13 radiological risks and (2) that accident rates, transit times, population density and activity, time
14 of day, and day of week are considered in determining risk. The final determination of the route
15 is left to the discretion of the carrier unless the shipment contains a “highway route controlled
16 quantity” (HRCQ) of radioactive material, as defined in 49 CFR 173.403 (Definitions). Many
17 potential shipments evaluated for this EIS, such as shipments of activated metal from
18 commercial reactors, fall under this category.
19

20 A vehicle transporting an HRCQ of radioactive materials is required to use the interstate
21 highway system except when moving from the point of origin to the interstate or from the
22 interstate to a destination point, when making a necessary repair or rest stop, or when emergency
23 conditions make continued use of the interstate unsafe or impossible. Carriers are required to use
24 interstate circumferential or bypass routes, if available, to avoid populous areas. Any state or
25 Native American tribe may designate other “preferred highways” to replace or supplement the
26 interstate system. Under its authority to regulate interstate transportation safety, DOT can
27 prohibit state and local bans and restrictions as “undue restraint of interstate commerce.” State or
28 local bans can be preempted if inconsistent with the HRCQ regulations.
29

30 DOT has no railroad routing regulations specific to the transportation of radioactive
31 materials. Routes are generally fixed by the location of rail lines, and urban areas cannot be
32 readily bypassed.
33

34 For this analysis, representative shipment routes were identified by using the
35 Transportation Routing Analysis Information System (TRAGIS) (Version 1.5.4) routing model
36 (Johnson and Michelhaugh 2003) for truck and rail shipments. The routes were selected to be
37 reasonable and consistent with routing regulations and general practice, but they are
38 representative routes only because the actual routes will be chosen in the future. At the time of
39 shipment, the route would be selected on the bases of current road or railroad track conditions,
40 including repairs and traffic congestion.
41

42 The highway data network in TRAGIS is a computerized road atlas that includes a
43 complete description of the interstate highway system and of all U.S. highways. In addition, most
44 principal state highways and many local and community highways are identified. The code is
45 periodically updated to reflect current road conditions and has been compared with reported

1 mileages and observations of commercial trucking firms. The TRAGIS highway database
2 version used was Highway Data Network 4.0.

3
4 Truck routes are calculated within the model by minimizing the total impedance between
5 origin and destination. The impedance is basically defined as a function of distance and driving
6 time along a particular segment of highway. The HRCQ option in the model was used to select
7 routes for all shipments. The population densities along a route are derived from 2000 Census
8 data.

9
10 The rail network used in TRAGIS consists of numerous subnetworks and represents
11 various competing rail companies in the United States. The network was originally based on data
12 from the Federal Railroad Administration and reflected the U.S. railroad system in 1974. The
13 database has been expanded and modified over the past three decades. The code is updated
14 periodically to reflect current track conditions and has been compared with reported mileages
15 and observations of commercial rail firms. A 1:100,000-scale rail network is now incorporated
16 into TRAGIS. The TRAGIS rail database version used was Railroad Data Network 3.2.

17
18 Rail routes are calculated by using a “shortest-route” algorithm that finds the path of
19 minimum impedance within an individual subnetwork. A separate method is used to find paths
20 along the subnetworks. The routes chosen for this study were selected by using the standard
21 assumptions in the model, which simulate the process of selection that railroads would use to
22 direct shipments of radioactive waste. The population densities along a route are derived from
23 2000 Census data.

24
25
26 **C.9.4.1.2 Population Density.** Three population density zones — rural, suburban, and
27 urban — were used for the population risk assessment. The fractions of travel and average
28 population density in each zone were determined with the TRAGIS routing model. Rural,
29 suburban, and urban areas are characterized according to the following breakdown: Rural
30 population densities range from 0 to 54 persons/km² (0 to 139 persons/mi²); suburban densities
31 range from 55 to 1,284 persons/km² (140 to 3,326 persons/mi²); and urban densities cover all
32 population densities greater than 1,284 persons/km² (3,326 persons/mi²). Use of these three
33 population density zones is based on an aggregation of the 11 population density zones provided
34 in the TRAGIS model output. For calculation purposes, information about population density
35 was generated at the state level and used as RADTRAN input for all routes.

36
37
38 **C.9.4.1.3 Accident and Fatality Rates.** For calculating accident risks, vehicle accident
39 involvement and fatality rates were taken from data provided in Saricks and Tompkins (1999).
40 For each transport mode, accident rates are generically defined as the number of accident
41 involvements (or fatalities) in a given year per unit of travel by that mode in the same year.
42 Therefore, the rate is a fractional value: The accident-involvement count is the numerator, and
43 vehicular activity (total traveled distance) is the denominator. Accident rates are derived from
44 multiple-year averages that automatically account for such factors as heavy traffic and adverse
45 weather conditions. For assessment purposes, the total number of expected accidents or fatalities
46 is calculated by multiplying the total shipping distance for a specific case by the appropriate
47 accident or fatality rate.

1 For truck transportation, the rates presented in Saricks and Tompkins (1999) are
2 specifically for heavy combination trucks involved in interstate commerce. Heavy combination
3 trucks are rigs composed of a separable tractor unit containing the engine and one to three freight
4 trailers connected to each other and the tractor. Heavy combination trucks are typically used for
5 shipping radioactive wastes. Truck accident rates are computed for each state on the basis of
6 statistics for 1994 to 1996 compiled by the DOT Office of Motor Carriers. Saricks and Tompkins
7 (1999) present accident involvement and fatality counts, estimated kilometers of travel by state,
8 and the corresponding average accident involvement and fatality rates for the three years
9 investigated. Fatalities (including of crew members) are deaths that are attributable to the
10 accident and that occurred within 30 days of the accident.

11
12 The truck accident assessment presented in this EIS uses state-specific accident and
13 fatality rates for travel on interstate highways. The total accident risk for a case depends on
14 the total distance traveled in various states and does not rely on national average accident
15 statistics. For comparative purposes, the national average truck accident rate on interstate
16 highways presented in Saricks and Tompkins (1999) is 3.15×10^{-7} accidents/truck-km
17 (5.07×10^{-7} accidents/mi). Likewise, the national average truck fatality rate was reported as
18 8.9×10^{-9} fatalities/truck-km (1.4×10^{-8} fatalities/mi).

19
20 Rail accidents rates are computed and presented in a manner similar to truck accident
21 rates in Saricks and Tompkins (1999). However, for rail transport, the unit of haulage is the
22 railcar. State-specific rail accident involvements and fatality rates are based on statistics for 1994
23 to 1996 compiled by the Federal Railroad Administration. Rail accidents include both mainline
24 accidents and those occurring in rail yards.

25
26 The rail accident assessment presented in this EIS uses accident and fatality rates for
27 travel on mainline (Class 1 and 2) railroads. The total accident risk for a case depends on the
28 total distance traveled in various states and does not rely on national average accident statistics.
29 For comparative purposes, the national rail accident rate on mainline railroads presented in
30 Saricks and Tompkins (1999) is 2.74×10^{-7} accidents/railcar-km (4.41×10^{-7} accidents/mi).
31 Likewise, the national average rail fatality rate was reported as 7.82×10^{-8} fatalities/railcar-km
32 (1.26×10^{-7} fatalities/km).

33
34 Note that the accident rates used in this assessment were computed by considering all
35 interstate shipments, regardless of the cargo. Saricks and Kvitek (1994) points out that shippers
36 and carriers of radioactive material generally have a higher-than-average awareness of
37 transportation risk and prepare cargoes and drivers for such shipments accordingly. This
38 preparation should have the twofold effect of reducing component and equipment failure and
39 mitigating the contribution of human error to accident causation. However, these mitigating
40 effects are not considered in the accident assessment.

41 42 43 **C.9.4.2 Packaging** 44

45 The packaging used for shipping radioactive materials must be designed, constructed, and
46 maintained to ensure that it will contain and shield the contents during normal transportation. For

1 more highly radioactive material, the packaging must contain and shield the contents in severe
2 accidents. The type of packaging used is determined by the radioactive hazard associated with
3 the packaged material. The basic types of packaging required by the applicable regulations are
4 designated as Type A, Type B, or industrial packaging (generally for low-specific-activity
5 material). All shipments evaluated in this analysis are assumed to use Type B packaging for
6 transportation.

7
8 The 208-L (55-gal) drums and SWBs that are assumed to contain the CH waste (as
9 discussed in Appendix B, Section B.4) are Type A packaging. This type of packaging must
10 withstand the conditions of normal transportation without the loss or dispersal of the radioactive
11 contents, as specified in 49 CFR 173.413 (Additional Design Requirements for Type A
12 Packages). “Normal” transportation refers to all transportation conditions except those resulting
13 from accidents or sabotage. Approval of Type A packaging is obtained by demonstrating that the
14 packaging can withstand specified testing conditions intended to simulate normal transportation.
15 Type A packaging usually does not require special handling, packaging, or transportation
16 equipment. Because the levels of radioactivity in many of these Type A containers containing
17 CH GTCC LLRW or GTCC-like waste would be near the upper limits specified in 10 CFR
18 Part 71, with multiple drums or SWBs per shipment, the use of Type B packaging is assumed for
19 CH waste shipments. At the time of actual shipment, all GTCC LLRW and GTCC-like waste
20 would be packaged in compliance with radioactive material transportation safety regulations, and
21 Type B packaging might not be required, depending on the characteristics of the waste to be
22 transported.

23
24 In addition to meeting all the Type A standards, Type B packaging must also provide a
25 high degree of assurance that the package integrity will be maintained even during severe
26 accidents, with essentially no loss of the radioactive contents or serious impairment of the
27 shielding capability. Type B packaging is required for shipping large quantities of radioactive
28 material and must satisfy stringent testing criteria (as specified in 10 CFR Part 71). The testing
29 criteria were developed to simulate conditions of severe hypothetical accidents, including
30 impact, puncture, fire, and immersion in water. The most widely recognized Type B packaging is
31 the massive casks used to transport highly radioactive spent nuclear fuel (SNF) from nuclear
32 power stations. Large-capacity cranes and mechanical lifting equipment are usually necessary for
33 handling Type B packaging. Many Type B packages are transported on trailers specifically
34 designed for that purpose.

35
36 The CH waste considered in this EIS, while it is placed in Type A packaging, is assumed
37 to be transported in Type B containers referred to as the Transuranic Package Transporter-II
38 (TRUPACT-II). TRUPACT-IIs are being used for the shipment of similar types of waste to
39 WIPP. One TRUPACT-II can accommodate either 14 208-L (55-gal) drums (two stacked
40 7-drum packs [hexagonal arrays with one in the middle]) or two stacked SWBs. For the purposes
41 of this EIS, four cesium irradiators are assumed to be shipped in one TRUPACT-II.

42
43 A discussion of the RH waste packaging assumed for this EIS is provided in
44 Section B.4.1.2 in Appendix B. Section B.5 in Appendix B summarizes the shipment
45 configurations and number of shipments used in the transportation analysis.

C.9.4.3 Accident Characteristics

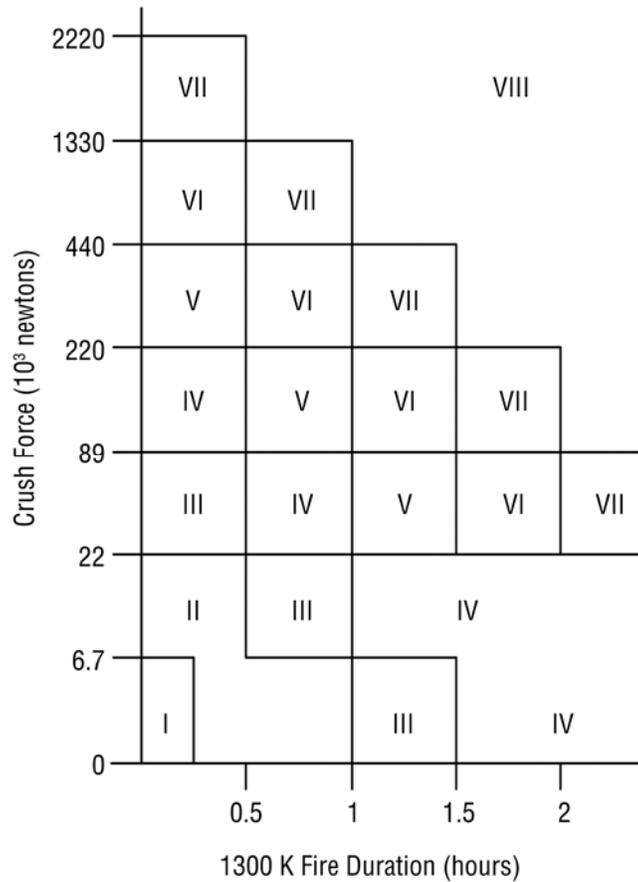
The assessment of transportation accident risk takes into account the fraction of material in a package that would be released or spilled to the environment during an accident, commonly referred to as the release fraction. The release fraction is a function of the severity of the accident and the material packaging. For instance, a low-impact accident, such as a fender-bender, is not expected to cause any release of material. Conversely, a very severe accident is expected to release nearly all of the material in the shipment into the environment. The method used to characterize accident severities and the corresponding release fractions for estimating radioactive risks are described below.

C.9.4.3.1 Accident Severity Categories. A method to characterize the potential severity of transportation-related accidents is described in NUREG-0170 (NRC 1977a). The NRC method divides the spectrum of transportation accident severities into eight categories. Other studies have divided the same accident spectrum into six categories (Wilmot 1981), 20 categories (Fischer et al. 1987), or more (Sprung et al. 2000); however, these latter studies focused primarily on accidents involving shipments of SNF. In this analysis, the NUREG-0170 scheme is used for all shipments.

The NUREG-0170 scheme for accident classification is shown in Figures C-2 and C-3 for truck and rail transportation, respectively. Severity is described as a function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package might be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, any sequence of events that results in an accident in which a package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range. The scheme for accident severity is designed to take into account all credible transportation-related accidents, including those accidents with a low probability but high consequences and those with a high probability but low consequences.

Each severity category represents a set of accident scenarios defined by a combination of mechanical and thermal forces. A conditional probability of occurrence (i.e., the probability that if an accident occurs, it is of a particular severity) is assigned to each category. The fractional occurrences for accidents by accident severity category and population density zone are shown in Table C-7 and are used for estimating the radioactive risks.

Category I accidents are the least severe but the most frequent. Category VIII accidents are very severe but very infrequent. To determine the expected frequency of an accident of a given severity, the conditional probability in the category is multiplied by the baseline accident rate. Each population density zone has a distinct distribution of accident severities related to differences in average vehicular velocity, traffic density, location (rural, suburban, or urban), and other factors.



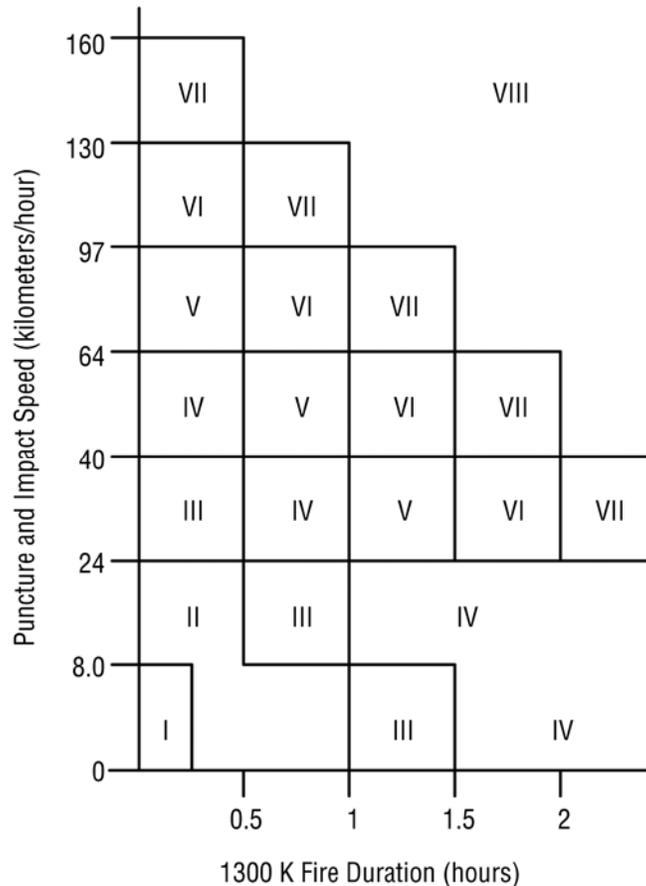
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**FIGURE C-2 Scheme for NUREG-0170
Classification by Accident Severity Category for
Truck Accidents (Source: NRC 1977a)**

C.9.4.3.2 Package Release Fractions. In NUREG-0170, radiological and chemical consequences are calculated by assigning package release fractions to each accident severity category. The release fraction is defined as the fraction of the material in a package that could be released from the package as the result of an accident of a given severity. Release fractions take into account all the mechanisms necessary to release material from a damaged package into the environment. Release fractions vary according to the type of package and the physical form of the material.

Representative release fractions for accidents involving activated metal shipments were taken from NUREG-0170 (NRC 1977b). The recommendations in NUREG-0170 are based on best engineering judgments and have been shown to provide conservative estimates of material releases following accidents. Release fractions for accidents of each severity category are given in Table C-8. As shown in that table, the amount of material released from the package ranges from zero for minor accidents to 100% for the most severe accidents. Important for the purposes of risk assessment are the fraction of the released material that can be entrained in an aerosol



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**FIGURE C-3 Scheme for NUREG-0170
Classification by Accident Severity Category for
Rail Accidents (Source: NRC 1977a)**

(part of an airborne contaminant plume) and the fraction of the aerosolized material that is also respirable (of a size that can be inhaled into the lungs). These fractions depend on the physical form of the material. Most solid materials are difficult to release in particulate form and are therefore relatively nondispersible. Conversely, liquid or gaseous materials are relatively easy to release if the container is breached in an accident.

The aerosolized fraction and the respirable fraction were taken to be 1×10^{-6} and 0.05, respectively, for the activated metal that is expected to behave as immobile material (Neuhauser and Kanipe 1992). The release fractions used for the CH and other RH waste shipments with the TRUPACT-II and RH-72B Type B packages, respectively, are also provided in Table C-8.

TABLE C-7 Fractional Occurrences for Truck and Rail Accidents by Severity Category and Population Density Zone

Accident Severity Category	Fractional Occurrence	Fractional Occurrence by Population Density Zone		
		Rural	Suburban	Urban
Truck				
I	5.5E-01	1.0E-01	1.0E-01	8.0E-01
II	3.6E-01	1.0E-01	1.0E-01	8.0E-01
III	7.0E-02	3.0E-01	4.0E-01	3.0E-01
IV	1.6E-02	3.0E-01	4.0E-01	3.0E-01
V	2.8E-03	5.0E-01	3.0E-01	2.0E-01
VI	1.1E-3	7.0E-01	2.0E-01	1.0E-01
VII	8.5E-05	8.0E-01	1.0E-01	1.0E-01
VIII	1.5E-05	9.0E-01	5.0E-02	5.0E-02
Rail				
I	5.0E-01	1.0E-01	1.0E-01	8.0E-01
II	3.0E-01	1.0E-01	1.0E-01	8.0E-01
III	1.8E-01	3.0E-01	4.0E-01	3.0E-01
IV	1.8E-02	3.0E-01	4.0E-01	3.0E-01
V	1.8E-03	5.0E-01	3.0E-01	2.0E-01
VI	1.3E-04	7.0E-01	2.0E-01	1.0E-01
VII	6.0E-05	8.0E-01	1.0E-01	1.0E-01
VIII	1.0E-05	9.0E-01	5.0E-02	5.0E-02

Source: NRC (1977a)

1
2
3 **C.9.4.3.3 Atmospheric Conditions during Accidents.** Hazardous material released to
4 the atmosphere is transported by the wind. The amount of dispersion, or dilution, of the
5 contaminant material in the air depends on the meteorological conditions at the time of the
6 accident. Because predicting the specific location of an off-site transportation-related accident
7 and the exact meteorological conditions at the time of an accident is impossible, generic
8 atmospheric conditions were selected for the accident risk assessment. National average weather
9 conditions (Weiner et al. 2006) were used in the analysis.

10 11 12 **C.9.4.4 Radiological Risk Assessment Input Parameters and Assumptions**

13
14 The dose (and, correspondingly, the risk) to populations during routine transportation of
15 radioactive materials is directly proportional to the assumed external dose rate from the
16 shipment. The actual dose rate from the shipment is a complex function of the composition and
17 configuration of shielding and containment materials used in the packaging, the geometry of the
18 loaded shipment, and the characteristics of the radioactive material itself.

TABLE C-8 Estimated Release Fractions for Type B Packages under Various Accident Severity Categories

Accident Severity Category	Release Fraction ^a	TRUPACT-II ^b		RH-72B ^c	
		Truck	Rail	Truck	Rail
I	0	0	0	0	0
II	0	0	0	0	0
III	0.01	8×10^{-9}	2×10^{-8}	6×10^{-9}	2×10^{-8}
IV	0.1	2×10^{-7}	7×10^{-7}	2×10^{-7}	7×10^{-7}
V	1	8×10^{-5}	8×10^{-5}	1×10^{-4}	1×10^{-4}
VI	1	2×10^{-4}	2×10^{-4}	1×10^{-4}	1×10^{-4}
VII	1	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}
VIII	1	2×10^{-4}	2×10^{-4}	2×10^{-4}	2×10^{-4}

- ^a Source: NRC (1977b), used for all activated metal shipments. Aerosolized and respirable fractions for activated waste in Type B packages for all accident severity categories are assumed to equal 1×10^{-6} and 0.05, respectively.
- ^b Source: DOE (1997b), used for CH waste shipments. Both aerosolized and respirable fractions are assumed to equal 1.0.
- ^c Source: DOE (1990), used for RH waste shipments. Both aerosolized and respirable fractions are assumed to equal 1.0.

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Table C-9 lists the external dose rates developed for this transportation analysis. The dose rates are presented in terms of the transport index, which is the dose rate at 1 m (3.3 ft) from the lateral sides of the transport vehicle. These values are well below the regulatory limit established in 49 CFR 173.441 (Radiation Level Limitations) and 10 CFR 71.47 (External Radiation Standards for All Packages) to protect the public. The regulatory limit is set at is 0.1 mSv/h (10 mrem/h) at 2 m (6 ft) from the outer lateral sides of the transport vehicle. This dose rate corresponds to approximately 14 mrem/h at 1 m (3 ft) from the shipment. Previous estimates of external dose rates at 1 m from CH and RH wastes similar to GTCC LLRW and GTCC-like waste have ranged up to 3.3 mrem/h for CH waste and up to 9.2 mrem/h for RH waste (DOE 1997b). By using a DOE-complex-wide average radionuclide profile of similar waste, a more recent transport index estimate of 0.5 mrem/h for CH waste truck shipments and 2.5 mrem/h for RH waste truck shipments was calculated (Sandia 2008). Because of the high activities associated with the GTCC LLRW and GTCC-like waste, especially for the activated metals, these estimates could be lower than the actual values for some specific shipments in the future, but they represent a more realistic overall average external dose rate than the use of an excessive bounding estimate, and they are consistent across alternatives. Once an alternative is selected for disposal of specific waste, further analysis may be required to optimize waste packaging and shipment configurations to minimize impacts on the basis of the characteristics of the actual waste to be transported.

TABLE C-9 External Dose Rates, Package Sizes, and Distances Used in RADTRAN

Shipment	Dose Rate at 1 m (3.3 ft) from Source (mrem/h)	Package Size (m)	Crew Distance (m)	Crew View (m)
Activated metal and RH waste				
Truck	2.5 ^a	3.6 ^b	3.2	0.66
Rail	5.0	7.2 ^c	NA ^d	NA
CH waste				
Truck	0.5	7.4 ^e	10	1.85
Rail	1.0	14.8 ^f	NA	NA

^a Source: Sandia (2008).

^b One RH-72B package.

^c Two RH-72B packages.

^d NA = not applicable.

^e Three TRUPACT-II packages.

^f Six TRUPACT-II packages.

In addition to the specific parameters discussed previously, values for a number of general parameters must be specified within the RADTRAN code to calculate radiological risks. Standard values were used in most cases. These general parameters define basic characteristics of the shipment and traffic and are specific to the mode of transportation. The user's manual for the RADTRAN code (Neuhauser and Kanipe 2003; Weiner et al. 2006) contains derivations and descriptions of these parameters. The general RADTRAN input parameters used in the radiological transportation risk assessment are summarized in Table C-10.

C.9.5 Uncertainties and Conservatism in Estimated Impacts

The sequence of analyses performed to generate estimates of risk from transporting radioactive waste is as follows: (1) determine the waste inventory and characteristics at each site, (2) estimate the shipment requirements, (3) determine the route characteristics, (4) calculate the radiation doses to exposed individuals (including estimating environmental transport and uptake of radionuclides), and (5) estimate health effects. Uncertainties are associated with each step. Uncertainties exist in the (1) way that the physical systems being analyzed are represented by the computational models; (2) data required to apply the models (because of measurement errors, sampling errors, natural variability, or unknown factors caused simply because the actions being analyzed will occur in the future; and (3) calculations themselves (e.g., the approximation algorithms used in the computer programs).

TABLE C-10 General RADTRAN Input Parameters^a

Parameter	Truck	Rail
Number of crew members	2	5
Average vehicular speed (km/h) ^b		
Rural	88.49	64.37
Suburban	40.25	40.25
Urban	24.16	24.16
Stop time (h/km)	0.0015	0.033
Number of people exposed while stopped	25	Route-specific suburban population average density
Distance for exposure while stopped (m)	20	10 to 400
Number of people per vehicle sharing route	2	3
Population density (persons/km ²) ^c	Route specific	Route specific
One-way traffic count (vehicles/h) ^d		
Rural	530	1
Suburban	760	1
Urban	2,400	5
Fraction of farmland ^e	Route specific	Route specific

^a Accident conditional probabilities are listed by severity category in Table C-7. Accident release fractions are given in Table C-8. External dose rates are given in Table C-9.

^b Fraction of rural and suburban travel on freeways is assumed to be 1. Thus, the rural speed is used for both urban and suburban zones in RADTRAN for truck transport.

^c Route-specific population densities are from the TRAGIS route outputs.

^d Source: DOE (2002b).

^e State-specific fraction of farmland was taken from Table 8, pp. 291–299, in USDA (2004).

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In principle, one could estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each subsequent set of calculations. Thus, one could propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result. However, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions that would be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure — through uniform and judicious selection of scenarios, models, and input parameters — that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this objective is accomplished by uniformly applying input parameters and assumptions to all alternatives for each waste type. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

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In the following sections, areas of uncertainty are discussed for each assessment step enumerated previously, with the exception of health effects. Special emphasis is placed on

1 identifying whether the uncertainties affect relative or absolute measures of risk. Where
2 practical, the parameters that most significantly affect the risk assessment results are identified,
3 and quantitative estimates of uncertainty are provided.

6 **C.9.5.1 Uncertainties in the Waste Inventory and Characterization**

7
8 The site-specific waste inventories and the physical and radiological waste characteristics
9 are important input parameters for the transportation risk assessment. The potential amount of
10 transportation required for any alternative is determined primarily by the projected waste
11 inventory at each site and assumptions about shipment configurations (packaging and shipment
12 capacities). The physical and radiological characteristics of the waste are important in
13 determining the amount of waste that would be released during an accident and the subsequent
14 doses to exposed individuals through multiple environmental exposure pathways.

15
16 In general, the uncertainties in the data specific to the site and waste type could affect the
17 relative and absolute measures of transportation risk, and they are difficult to quantify. For
18 example, there is a large amount of uncertainty associated with the amount of GTCC activated
19 metal waste that would come from commercial reactors, in terms of reactor availability (when a
20 given reactor would shut down) and in terms of the time decommissioning would actually occur
21 (e.g., if there were years between shutdown and decommissioning, it is possible that little or
22 no activated metal waste would be classified as GTCC waste). Precisely defining the impact of
23 these uncertainties on the transportation risk is difficult, given the large number of sites.

24
25 The uncertainties in the waste characterization data are reflected to some degree in the
26 transportation risk results. If the waste inventories are consistently overestimated (or
27 underestimated), the resulting transportation risk estimates are also overestimated (or
28 underestimated) by roughly the same factor. In terms of relative risk comparisons, such
29 uncertainties have little effect, since the majority of the waste would require shipment under all
30 disposal alternatives (i.e., none of the sites being considered for disposal are also large generators
31 of GTCC LLRW or GTCC-like waste).

34 **C.9.5.2 Uncertainties in Defining the Shipment Configurations**

35
36 As stated previously, the amount of transportation required for each disposal alternative
37 is partly based on assumptions about the packaging and shipment configurations for each waste
38 type. Representative shipment configurations have been defined for each waste type on the basis
39 of either historical or potential future shipment capacities. (For example, all truck shipments of
40 activated metal could be made in RH-72B or similar Type B packages because of the
41 hypothetical design used for the activated metal canisters). In reality, the actual shipment
42 capacities might differ from the predicted capacities, so the projected number of shipments and
43 consequently the total transportation risk would change. (For example, some GTCC activated
44 metal is already stored in large transportation, storage, and disposal canisters that are suitable
45 only for rail transport). However, although the predicted transportation risks would increase or

1 decrease accordingly (decrease in this case), the relative differences in risks among alternatives
2 would generally remain unchanged.

3 4 5 **C.9.5.3 Uncertainties in Determining the Route**

6
7 Representative routes between all origin sites and destination sites considered for the
8 disposal alternatives have been determined. The routes chosen were consistent with current
9 guidelines, regulations, and practices but may not be the actual routes that will be used in the
10 future. In reality, the actual routes may differ from the representative ones in terms of the lengths
11 of the routes and total populations along them. Moreover, because the assessment considers
12 wastes generated over the next 50 to 70 years, the highway and rail infrastructures and the
13 demographics along the routes could also change over time. Although these effects are not
14 accounted for in the transportation assessment, it is anticipated that any changes would not
15 significantly affect the comparisons of risk among the disposal alternatives considered in
16 the EIS.

17 18 19 **C.9.5.4 Uncertainties in Calculating Radiation Doses**

20
21 The models used to calculate radiation doses from transportation activities introduce
22 additional uncertainty into the risk assessment process. Estimating the accuracy, or absolute
23 uncertainty, of the risk assessment results is generally difficult. The accuracy of the calculated
24 results is closely related to the limitations of the computational models and to the uncertainties in
25 each of the input parameters that the model requires. The single greatest limitation facing users
26 of RADTRAN, RISKIND, or any computer code of this type is the scarcity of data for certain
27 input parameters.

28
29 Uncertainties associated with the computational models are minimized by using state-of-
30 the-art computer codes that have been extensively reviewed. However, because numerous
31 uncertainties are recognized but are difficult to quantify, assumptions are made at each step of
32 the risk assessment process. These assumptions are intended to produce conservative results (that
33 is, overestimate the calculated dose and radiological risk). Because parameters and assumptions
34 are applied equally to all disposal alternatives for a waste type, this model bias is not expected to
35 affect the meaningfulness of the risk comparisons; however, the results may not represent risks
36 in an absolute sense.

37
38 Incident-free transportation risks are the dominant component of the total transportation
39 risk for both truck and rail modes. The most important parameter in calculating incident-free
40 doses is the shipment external dose rate (i.e., incident-free doses are directly proportional to the
41 shipment external dose rate). For calculation purposes, average dose rates were applied to each
42 waste type because information is not available to predict shipment dose rates accurately on a
43 site-by-site and waste-stream basis. In practice, the external dose rates will vary not only from
44 one site to another and one waste type to another but also from one shipment to another for a
45 given site; the rates are expected to range near the levels assumed for this assessment.

C.9.5.5 Uncertainties in Comparing Truck and Rail Transportation Modes

The transportation risk assessment results presented in this EIS indicate that rail transportation would pose a lower overall risk to workers and the public than would truck transportation of the same quantity of waste. However, it is important to recognize that although rail shipments were found to result in no expected fatalities, the risks from transportation operations for both modes are, in general, small. Moreover, comparisons between truck and rail shipment risks need to consider the uncertainties inherent in the risk assessment process. As discussed above, in most cases, the calculational uncertainties are difficult to quantify and may, in fact, not be the same for truck transport as they are for rail transport. Some important issues that should be considered while comparing truck and rail shipment risks are discussed below.

In this EIS, transportation risks are estimated for the shipment of all waste by 100% truck or by 100% rail mode for each disposal alternative and waste type. The intent of this approach is to bound the transportation impacts for any possible mix of truck and rail shipments, recognizing that both modes would likely take place in the future. Therefore, all facilities were assumed to have rail access. However, a number of the generator sites and some disposal sites do not have direct rail access. For those sites lacking direct rail access, the risks associated with shipping waste by truck to a rail siding are not considered in detail; however, preliminary evaluations indicate that these activities generally contribute only a small amount to the overall transportation risk (DOE 1997a).

Although subject to calculational uncertainties, a number of factors that contribute to the assessment results indicate that rail shipments have lower impacts than truck shipments for the same alternative. These factors include the following:

- Rail shipments are larger than truck shipments; thus, fewer total rail shipments are needed. Consequently, impacts from rail shipment tend to be lower because overall transportation impacts tend to be proportional to shipment mileage.
- On a per-shipment basis, rail shipments have lower radiological impacts than do truck shipments. The radiological impacts from rail shipments tend to be lower because fewer members of the public are exposed during rail transport (primarily because there are fewer people at railroad stops and because fewer people share the routes). In addition, rail crew members tend to be much farther from the radioactive material packages than are truckers. However, the differences in radiological risk between the two transport modes for all disposal alternatives lie within the uncertainty of the estimates on the number and location of exposed persons.

Although rail impacts were found to be less than truck impacts, a number of considerations were not specifically addressed in the representative assessment conducted for the purposes of the EIS. First, rail shipments may require additional handling and preparation, especially for sites lacking rail access, and this handling would contribute to the overall rail shipment risk. Second, to be cost effective, rail shipments generally require a large inventory of

1 waste. Rail may thus not be a cost-effective option at smaller generating sites. Finally, rail
2 operations in general are not as flexible and responsive to individual site needs and capabilities
3 as are truck operations.

6 C.10 CULTURAL RESOURCES

8 Cultural resources are the physical remains of past human activity or natural features that
9 have significant historical or cultural meaning. These resources include archaeological sites,
10 historic structures, cultural landscapes, and traditional cultural properties.

12 The analysis of impacts on cultural resources relied on similar types of information for
13 each site and alternative. The area potentially affected was determined for each site and included
14 the areas needed for both construction and operations. To the extent possible, these areas
15 included some buffer to allow for any minor changes during implementation. Information on the
16 presence of cultural resources within the area that might be affected was compiled. This task
17 relied on cultural and historical background data that provided an overarching context for the
18 types of cultural resources that could be present in each region. Previous cultural resource studies
19 were reviewed to determine if specific resources exist within the area potentially affected. A
20 records search was done to determine if any of the cultural resources that are present are eligible
21 for listing on the *National Register of Historic Places* (NRHP).

23 DOE initiated consultation and communication activities on the GTCC EIS with
24 14 participating American Indian tribal governments that have cultural or historical ties to the
25 DOE sites being analyzed in this EIS. The consultation activities are being conducted in
26 accordance with President Obama's Memorandum on Tribal Consultation (dated
27 November 5, 2009); Executive Order 13175 (dated November 6, 2000) entitled "Consultation
28 and Coordination with American Indian Tribal Governments"; Executive Memorandum (dated
29 September 23, 2004) entitled "Government-to-Government Relationship with Tribal
30 Governments" (White House 2004); and DOE Order 144.1, "American Indian Tribal
31 Government Interaction and Policy" (dated January 2009). The consultation activities include
32 technical briefings, the development of the written tribal narrative included in this EIS related to
33 the specific site affiliated with the tribe, and/or discussions with elected tribal officials, based on
34 individual tribal preferences and mutually agreed-upon protocols.

36 Once the baseline for the types of cultural resources present was established, the
37 assessment considered the activities that would be required for the proposed action and their
38 potential for affecting cultural resources. Of greatest concern were activities that would require
39 ground disturbance because these activities would have the greatest impact on cultural resources.
40 If archeological surveys had not been completed for the project area, the analysis assumed that
41 the distribution of resources was the same as the distribution known for the surrounding region.
42 Once the potential for impacts from each alternative was determined, the effects of each
43 alternative were compared. Tribal perspectives, comments, and concerns identified during the
44 consultation process will be considered by DOE in the decision-making process for selecting and
45 implementing (a) disposal alternatives(s) for GTCC waste.

1 C.11 WASTE MANAGEMENT

2
3 Potential impacts on waste management programs at the various sites considered in this
4 EIS were evaluated. Wastes that could be generated from the construction of the land disposal
5 options evaluated in this EIS include small quantities of hazardous solids, nonhazardous solids
6 (concrete and steel spoilage, excavated materials), hazardous liquids, and nonhazardous (sanitary
7 waste) liquids. Wastes that could be generated from the operation of the land disposal methods
8 include small quantities of solid LLRW, such as spent HEPA filters, and nonhazardous solid
9 waste (including recyclable wastes). Some liquid LLRW would also be generated from truck
10 washdown water. A compilation of the waste volumes that could be generated from the
11 construction and operations of the land disposal facilities is presented in Appendix D and in
12 Table 5.3.11-1. For the assessment of waste management impacts in this EIS, annualized
13 construction waste data were derived from the information presented in Appendix D. An initial
14 construction period of 3.4 years was assumed in the derivation.

15
16 At all the sites evaluated for the land disposal options, the waste management programs
17 for the waste categories generated were reviewed to determine potential impacts from the
18 additional waste that could be generated. All the waste categories are routinely handled at all the
19 DOE sites evaluated. Waste generated at the WIPP Vicinity could be sent off-site for disposal;
20 commercial disposal options are available for the waste categories that would be generated.

21
22 Disposal operations would generate types of waste similar to those currently generated
23 (i.e., liquid nonhazardous, solid nonhazardous, and hazardous waste); it is expected that existing
24 handling procedures and capacities would accommodate the additional waste.

25 26 27 C.12 CUMULATIVE IMPACTS

28
29 Cumulative effects or impacts result from the incremental impact of the action
30 alternatives when added to other past, present, and reasonably foreseeable future actions,
31 regardless of what government agency or private entity undertakes such actions. Cumulative
32 effects may result from impacts that are minor individually but that, when viewed collectively
33 over space and time, can produce significant impacts. The approach used for cumulative impacts
34 analysis in this EIS was based on the principles outlined in CEQ (1997) and on the guidance
35 developed by the EPA in EPA (1999) for independent reviewers of EISs.

36
37 The cumulative impact analysis for this EIS was not meant to be a review of all potential
38 environmental impacts at and near a site, nor was it meant to be a sitewide impact analysis. For
39 this EIS, past and present impacts at a given site are generally addressed in the affected
40 environment discussion for each resource area. Reasonably foreseeable future actions at a given
41 site were gleaned primarily from a review of various National Environmental Policy Act (NEPA)
42 documents available for the site. In addition, the latest EIS (draft or final, as appropriate)
43 available for the site was reviewed to identify total cumulative impact values reported for the site
44 (with the reasonably foreseeable future actions considered). The potential impacts from this EIS
45 were then compared to those reported values in order to gain perspective on the potential
46 contribution from the GTCC EIS alternatives to overall cumulative impacts at the sites.

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APPENDIX D:**CONCEPTUAL DISPOSAL FACILITY DESIGNS**

This appendix presents information on the conceptual facility designs and layouts, modes of transportation, waste packaging, facility resource requirements, and facility emissions associated with the three land disposal methods that the U.S. Department of Energy (DOE) is considering for disposal of greater-than-Class C (GTCC) low-level radioactive waste (LLRW) and GTCC-like waste: (1) borehole disposal, (2) trench disposal, and (3) vault disposal. Each conceptual facility is designed to provide the disposal capacity needed for the entire inventory described in Appendix B. In addition, this appendix provides supporting information for estimating incremental air emissions from waste to be disposed of at the Waste Isolation Pilot Plant (WIPP).

D.1 SCOPE

Two enhanced near-surface methods for disposing of GTCC LLRW and GTCC-like waste were evaluated: a trench and an above-grade vault. One intermediate-depth method — the borehole disposal method — was also evaluated. The level of detail of the proposed designs that is presented in this appendix is sufficient for use in this environmental impact statement (EIS). Further studies, including a site-specific safety analysis report, would be necessary to support further decision-making with regard to implementing any of the three methods.

The disposal facility designs are sized to accommodate the disposal of approximately 12,000 m³ (420,000 ft³) of GTCC LLRW and GTCC-like wastes that are expected to be generated through the year 2083. Information on the waste types and their radionuclide activities, volumes, and packaging is provided in Appendix B. The disposal facilities are designed as stand-alone operations. Depending on the final location of such a facility, certain components, such as buildings, equipment, or personnel, could be shared with or obtained from existing facilities, thus lowering anticipated costs.

Section D.2 presents a summary of the assumed disposal packages. Section D.3 provides descriptions of the three land disposal methods considered. Conceptual designs of the proposed facilities are presented in Section D.4. Section D.5 discusses the number of and the cost associated with the personnel required for the construction of and operations at each facility. Estimates of the resource materials and utilities needed to construct and operate the facility are provided in Section D.6. Estimated construction and operation emissions and wastes are discussed in Section D.7, and data on emissions from material deliveries and worker vehicles are provided in Section D.8. Section D.9 provides additional estimates of air emissions related to the expansion and operation of the WIPP facility to accommodate the GTCC LLRW and GTCC-like waste considered in this EIS.

The number of construction workers required at any one time during site preparation and facility construction will vary because of the temporary nature of the work and because certain

1 tasks can be accomplished concurrently while others must occur consecutively. A minimum
2 number of workers are necessary to operate the facility, and that number depends on the waste
3 receipt rate, as discussed further in Section D.5.2. Thus, the estimated resources and emissions
4 from facility operations presented in Sections D.6, D.7, and D.8 are based on the personnel
5 estimates given in Section D.5.2.

8 **D.2 TRANSPORTATION AND PACKAGING**

10 This section provides information on the assumptions about waste transportation and
11 packaging for the borehole, trench, and vault disposal alternatives. Information on the
12 transportation and packaging assumptions for the deep geologic disposal alternative (WIPP) is
13 found in Appendix B. It is assumed that GTCC LLRW and GTCC-like waste would be shipped
14 to the disposal facility in their final disposal containers. Thus, the disposal facilities would be
15 designed to most efficiently accommodate the types of containers that would most likely be used
16 to transport and dispose of this waste. It is assumed that GTCC LLRW and GTCC-like waste
17 would be transported by truck and rail to the disposal facility in Type B shipping packages, as
18 discussed in Section 5. The waste to be disposed of would include sealed sources, contact-
19 handled (CH) Other Waste (Other Waste - CH), remote-handled (RH) Other Waste (Other
20 Waste - RH), and activated metals, as discussed in Appendix B.

23 **D.2.1 Contact-Handled Waste**

25 A common container for the storage of CH and RH GTCC LLRW and GTCC-like waste
26 is the 208-L (55-gal) drum (referred to as drum(s) in the remainder of this appendix). In addition,
27 it is assumed that some stored and projected CH wastes would be packaged for disposal in
28 standard waste boxes (SWBs). As discussed in Appendix B, this EIS explicitly assumes that the
29 disposal of CH waste, except for cesium (Cs) irradiator sources, would be in drums and SWBs.
30 The Cs irradiators are self-contained and would be disposed of in their original shielded
31 container. The size of these irradiators is assumed to be 150 × 65 × 67 cm (59 × 26 × 27 in.)
32 (Sandia 2008a).

34 Although the use of other shipping and disposal configurations (e.g., 320-L and 380-L
35 [85-gal and 100-gal] drums) might be possible, their use is not explicitly considered; however,
36 the use of other container types could be accommodated in the current disposal facility designs.
37 Also, GTCC LLRW and GTCC-like CH waste might be found in storage in containers larger
38 than SWBs at some sites, but there are currently no viable casks available for transport. Stacking
39 arrangements in the CH disposal cells could be modified accordingly in the future if such
40 packages became available.

43 **D.2.2 Remote-Handled Waste**

45 It is assumed that all RH waste, except for the activated metal waste types, would be
46 packaged for disposal in drums. As discussed in Appendix B, three drums could be packaged in
47 an RH canister (DOE 1995) that is designed for use with the RH-72B shipping cask. As an

1 alternative, RH waste could be loaded directly into the canister for disposal (DOE 2006). The
2 proposed facility designs can accommodate both drums and RH canisters, as discussed further in
3 Sections D.3.1.2.2, D.3.2.2.2, and D.3.3.2.2.

4
5 It is assumed that activated metals would be packaged in right circular stainless-steel
6 canisters (activated metal canisters [AMCs]). To facilitate potential shipment by truck as well as
7 rail and to provide flexibility in the facility design, the size and weight of these canisters were
8 selected to be compatible with existing containers and weight limitations of truck casks.
9 Additional discussion on the size of the AMCs is presented in Section B.4.1.2.

10 11 12 **D.3 LAND DISPOSAL METHODS**

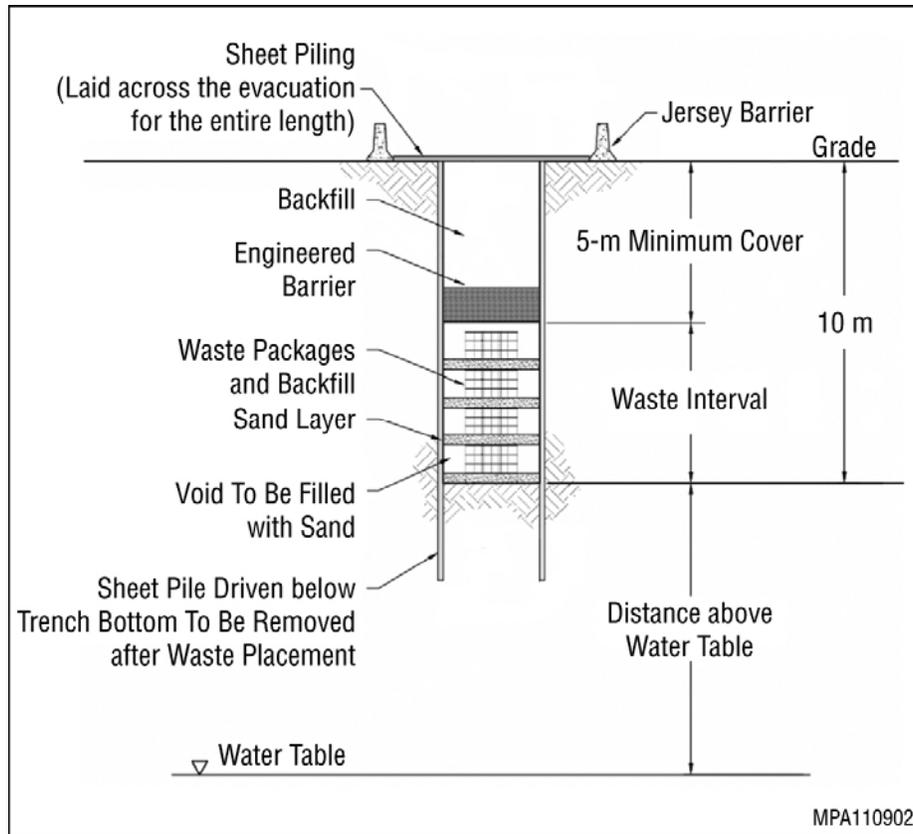
13 14 15 **D.3.1 Trench Disposal**

16 17 18 **D.3.1.1 Conceptual Trench Design**

19
20 The basic design for the trench disposal facility utilizes trenches that are 3-m (10-ft)
21 wide, 11-m (36-ft) deep, and 100-m (330-ft) long. The trench width and depth were selected to
22 optimize disposal capacity per trench within the limits of excavation equipment that is readily
23 available and shoring equipment that is commercially available. The conceptual drawing of a
24 cross section of the basic trench design (Figure D-1) illustrates the trench design features and
25 dimensions. In addition, the conceptual design for a trench facility is deeper and narrower than it
26 is for conventional near-surface LLRW disposal facilities in order to minimize the potential for
27 inadvertent human intrusion during the post-closure period.

28
29 The side walls of the trench would be vertically constructed. A well-compacted material
30 would be placed on top of the native material in the floor of the trench. A layer of sand or gravel
31 (0.3 m [1 ft]) would be placed on top of the compacted material to improve stability. The nature
32 of the compacted material would be selected to be compatible with the surrounding geologic
33 material. The trench sidewalls would be constructed with temporary metal shoring. The metal
34 shoring would be removed when the trench was closed.

35
36 The waste packages would be placed into the trench about 5 to 10 m (15 to 30 ft) bgs, and
37 a fine-grained cohesionless fill (sand) would be used to backfill around the waste containers to
38 fill voids. After the trench was filled with the waste containers and backfilled, a reinforced
39 concrete layer would be placed over the waste packages to help mitigate any future inadvertent
40 intrusion. Use of 6-in. (15-cm) on-center steel reinforcement (rebar), in two perpendicular layers,
41 would strengthen the concrete. In addition to adding strength to the concrete layer, the spacing of
42 the rebar would provide protection against inadvertent drilling straight down into the trenches.
43 For this reason, the concrete would have two sets of perpendicular steel reinforcement, one near
44 the top face and the other near the bottom face of the barrier. With a spacing of 6 in. (15 cm),
45 most drill bits would not pass into the trench without encountering the steel reinforcement first
46 (discouraging further penetration), if they had not initially been stopped by the concrete itself.

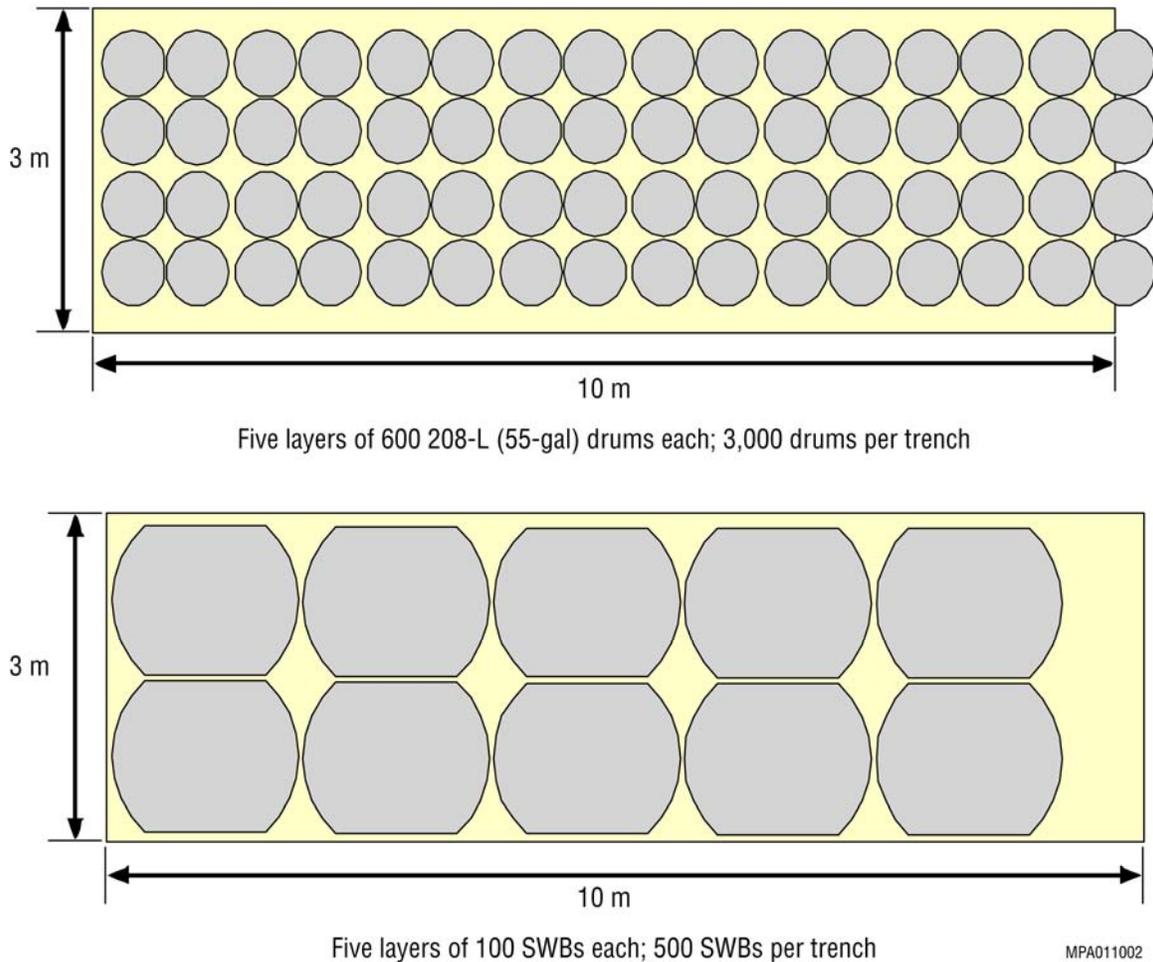


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2 **FIGURE D-1 Cross Section of a Conceptual Trench Disposal Unit**

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5 It is anticipated that clean fill from construction would be used to backfill the trench
6 above the concrete layer. Each trench could be capped with a cover system consisting of a
7 geotextile membrane overlain by gravel, sand, and topsoil layers (similar to that shown for the
8 vault design final cover system depicted later in Figure D-8). In the case of the trench, the top of
9 the cover system would be flush with or slightly elevated above the surrounding ground surface,
10 depending on the final design.

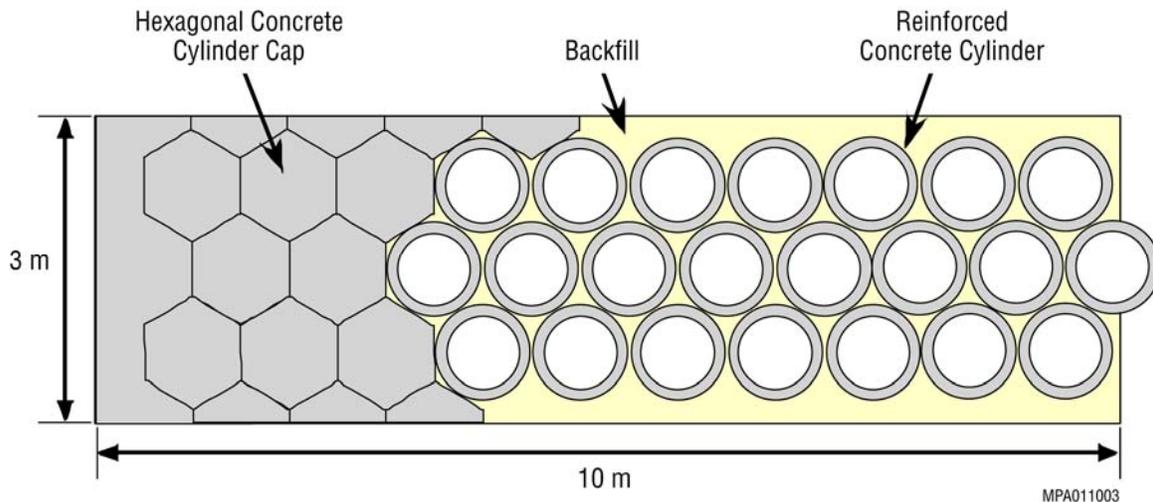
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13 **D.3.1.2 Disposal Package Configurations**

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16 **D.3.1.2.1 Contact-Handled Waste.** The assumed packing arrangement for 208-L
17 (55-gal) drums and SWBs in a 10-m (33-ft) section of trench is shown in Figure D-2. Up to five
18 layers of drums or SWBs could be accommodated with approximately 0.3 m (1 ft) of fill above
19 and below each layer, for a total of 3,000 drums or 500 SWBs per trench. For the larger cesium
20 sources, it is assumed that there would be 560 units per layer (four across the trench width) and
21 three layers, for a total of 1,680 cesium sources per trench. During disposal operations for CH
22 waste, one end of a trench would have a ramp to the surface for entry by a forklift carrying CH
23 waste packages (a pallet of four drums, four cesium sources, or one SWB) for emplacement.
24



1
2 **FIGURE D-2 Top View of a 10-m (33-ft) Section of a Trench Packed with Contact-Handled**
3 **Waste**
4
5

6 **D.3.1.2.2 Remote-Handled Waste.** Additional features are needed in the trenches where
7 RH waste would be buried to provide shielding for the workers once the waste was in place. The
8 RH waste packages (AMCs, drums, and RH canisters) would be disposed of in vertical
9 reinforced concrete cylinders with concrete shield plugs (1.2-m [4-ft] thick) on the top of each
10 cylinder. This design is similar to that proposed for activated metal disposal (Harvego 2007). A
11 mating flange would enable coupling of the bottom-loading transfer cask to a given cylinder for
12 transfer of the waste package into the disposal unit. The transfer cask would be moved off an
13 on-site transport truck into position by an overhead crane. Figure D-3 shows a top view of a
14 10-m (33-ft) section of an RH waste disposal trench. Each cylinder would be capable of holding
15 up to three AMCs, four individual 208-L (55-gal) drums, or one RH canister. With 302 cylinders
16 per trench, as many as 906 AMCs, 1,208 drums, or 302 RH canisters could be emplaced in one
17 trench.
18
19



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2 **FIGURE D-3 Top View of a 10-m (33-ft) Section of a Trench for Disposal of**
3 **Remote-Handled Waste**

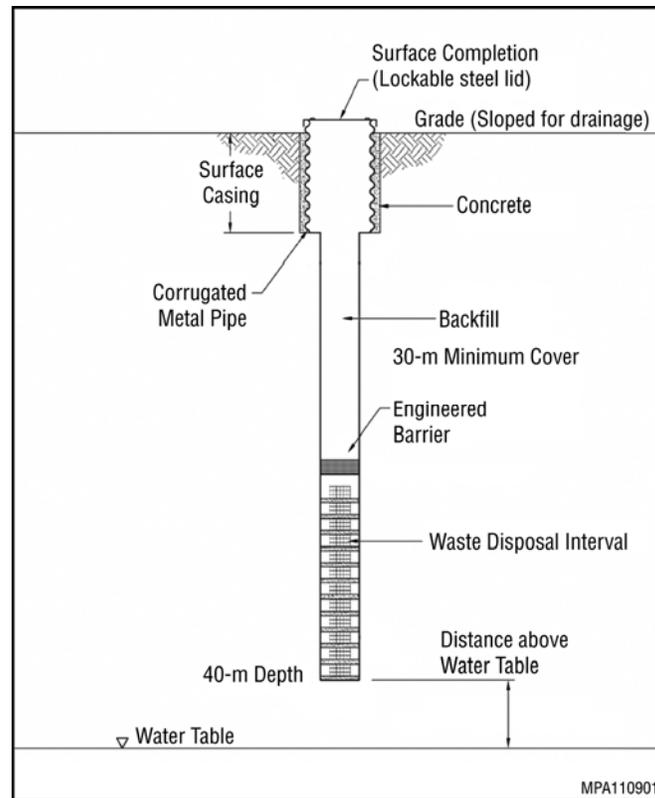
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6 **D.3.2 Borehole Disposal**

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9 **D.3.2.1 Conceptual Borehole Design**

10
11 Borehole disposal would entail the emplacement of waste in boreholes at depths below
12 30 m (100 ft) but above 300 m (1,000 ft). Boreholes can vary widely in diameter (from 0.3 to
13 3.7 m [1 to 12 ft]), and the proximity of one borehole to another can vary depending on the
14 design of the facility. The technology for drilling larger-diameter boreholes is simple and widely
15 available. The current conceptual design employs boreholes that are 2.4 m (8 ft) in diameter and
16 40-m (130-ft) deep in unconsolidated to semiconsolidated soils, as shown in Figure D-4, with
17 GTCC waste emplacement assumed to be about 30 to 40 m (100 to 130 ft) bgs.

18
19 A bucket auger would be used to drill the large-diameter borehole (see Figure D-5), and a
20 smooth steel casing would be advanced to the depth of the borehole during the drilling and
21 construction of the borehole. The casing would provide stability to the borehole walls and ensure
22 that waste packages would not snag and plug the borehole as they were lowered and would not
23 sit in an upright position when they reached the bottom. The upper 30 m (100 ft) of smooth steel
24 casing would be removed upon closure of the borehole. In some cases where consolidated
25 materials might be encountered, a more robust drilling technology would be required. A casing
26 would also be used in this latter case as an aid in placing waste packages.

27
28 The waste packages would be placed into the borehole, and a fine-grained cohesionless
29 fill (sand) would be used to backfill around the waste containers to fill voids. After the borehole
30 was filled with the waste containers and backfill, a reinforced concrete layer would be placed
31 over the waste packages to help mitigate any future inadvertent intrusion. Use of 6-in. (15-cm)
32 on-center steel reinforcement (rebar), in two perpendicular layers, would strengthen the concrete.
33 In addition to adding strength to the concrete layer, the spacing of the rebar would provide



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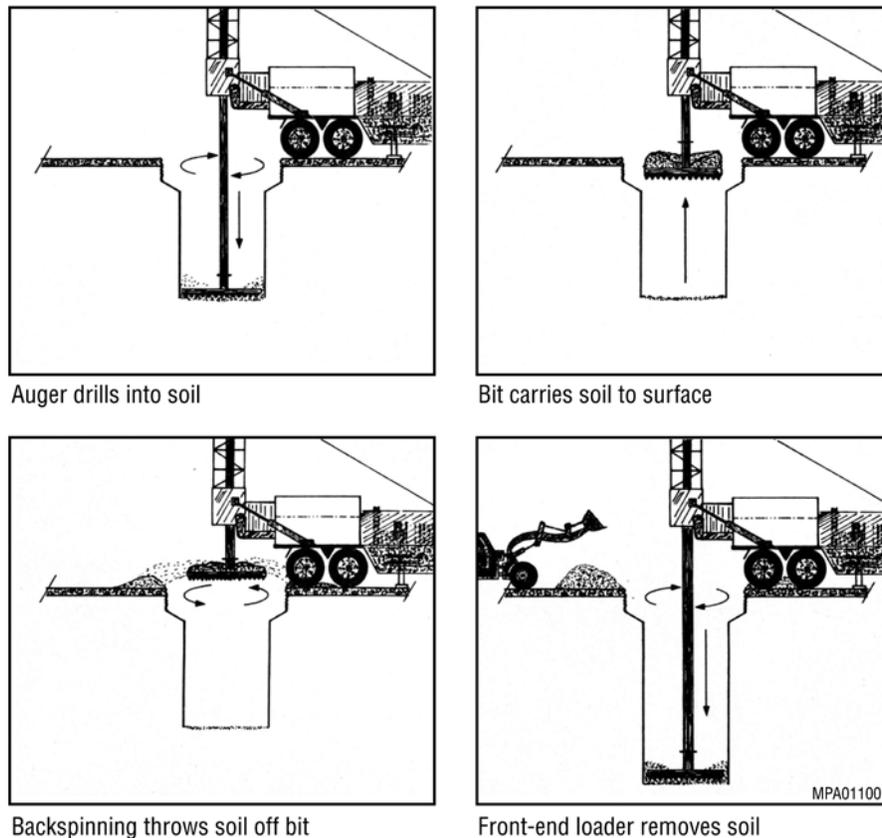
FIGURE D-4 Cross Section of a Conceptual 40-m (130-ft) Borehole

protection against inadvertent drilling straight down into a borehole. For this reason, the concrete would have two sets of perpendicular steel reinforcement, one near the top face and the other near the bottom face of the barrier. With a spacing of 6 in. (15 cm), most drill bits would not pass into the borehole without encountering the steel reinforcement first (discouraging further penetration), if they had not initially been stopped by the concrete itself.

It is anticipated that clean fill from the construction of the facility would be used to backfill the borehole above the concrete layer. Each borehole could be capped with a cover system consisting of a geotextile membrane overlain by gravel, sand, and topsoil layers, similar to that discussed for trench disposal in Section D.3.1.1 and shown for the vault design final cover system depicted later in Figure D-8. In the case of the borehole, the top of the cover system would be flush with or slightly elevated above the surrounding ground surface, depending on the final design.

D.3.2.2 Disposal Package Configurations

D.3.2.2.1 Contact-Handled Waste. CH waste would be taken off the on-site transport vehicle and lowered by crane into a borehole for emplacement. For a borehole, assumed packing



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2 **FIGURE D-5 Process Schematic for Drilling a Large-Diameter**
3 **Borehole by Using a Bucket Auger (Source: Sandia 2007b)**
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6 arrangements for CH waste are eight intervals (levels) of 208-L (55-gal) drum 7-packs
7 (56 drums), five intervals of cesium-source 4-packs (20 cesium sources), or eight intervals of
8 one SWB (eight SWBs). Approximately 0.3 m (1 ft) of fill would be used between intervals.
9 Single-interval packing arrangements are shown in Figure D-6.

10
11
12 **D.3.2.2.2 Remote-Handled Waste.** For RH waste, three intervals of two 3-packs of
13 RH canisters or six intervals of two 3-packs of AMCs are assumed. Thus, 18 RH canisters or
14 36 AMCs could be emplaced in a borehole. Boreholes for disposal of RH waste would have a
15 shielded cover once the RH waste was emplaced, prior to being full and backfilled. On-site
16 transport of RH waste would occur in shielded bottom-loading transfer casks (e.g., smaller
17 versions of the type used at independent spent fuel storage installations for the movement of
18 spent nuclear fuel [SNF]) that would mate with ports on a borehole cover. Once the transfer cask
19 was mated to the borehole cover, the RH waste would be lowered into place.
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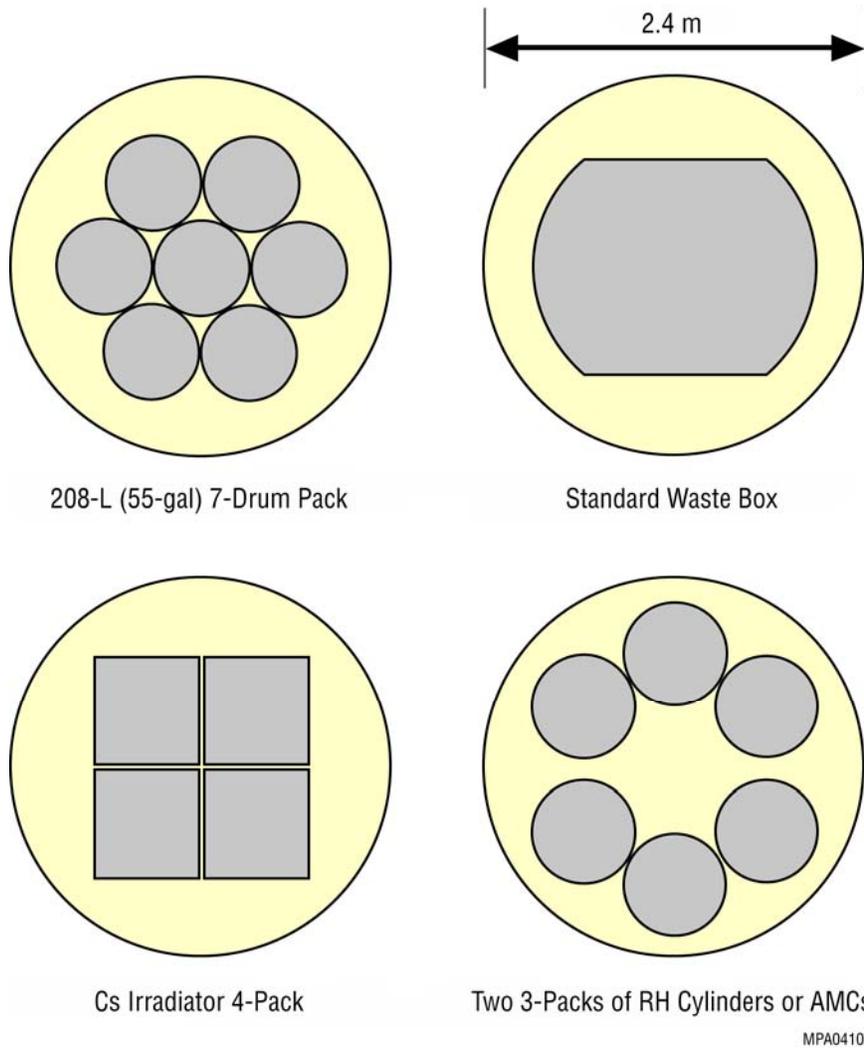


FIGURE D-6 Top View of Single-Interval Packing Arrangements in 2.4-m-Diameter (8-ft-Diameter) Boreholes for Different Container Types

D.3.3 Vault Disposal

D.3.3.1 Conceptual Vault Design

The conceptual design for the vault disposal of GTCC LLRW is a reinforced concrete vault constructed near grade level, with the footings and floors of the vault situated in a slight excavation just below grade. The design is a modification of one disposal concept proposed by Henry (1993) for GTCC LLRW and is similar to a belowground (Denson et al. 1987) vault LLRW disposal method previously investigated by the U.S. Army Corps of Engineers. A similar below-grade concrete vault structure is currently in use for disposal of higher-activity LLRW at the Savannah River Site (SRS) (MMES et al. 1994).

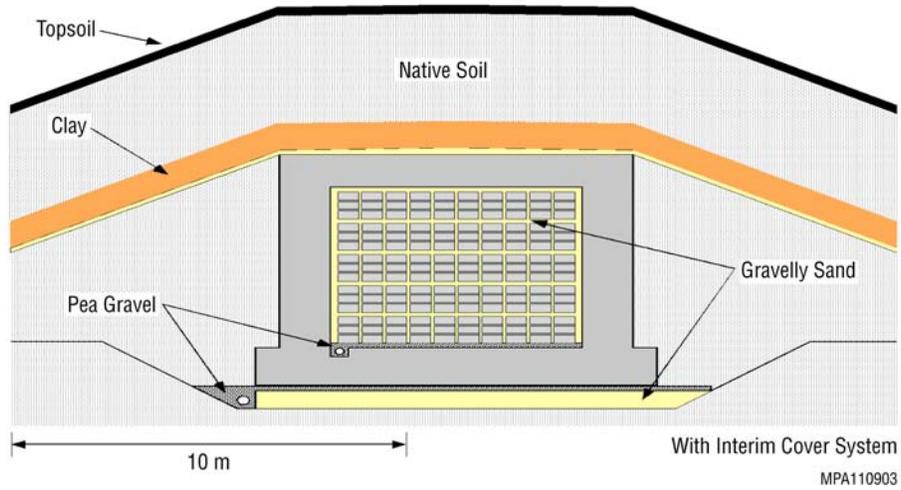
1 **D.3.3.1.1 Vault System.** Each vault would be 11-m (35-ft) wide, 94-m (310-ft) long, and
2 7.9-m (26-ft) tall, with 11 disposal cells situated in a linear array. Interior cell dimensions would
3 be 8.2-m (27-ft) wide, 7.5-m (25-ft) long, and 5.5-m (18-ft) high, with an internal volume of
4 340 m³ (12,000 ft³) per cell. Double interior walls with an expansion joint would be included
5 after every second cell. GTCC waste disposal placement is assumed to be about 4.3 to 5.5 m
6 (14 to 18 ft) above ground surface. Figure D-7 shows a schematic cross section of a vault cell.
7

8 The exterior walls and roof would be composed of 1.1-m (3.8-ft)-thick reinforced
9 concrete. In addition to adding strength and durability to the vault, the thick concrete would
10 attenuate the radiation emanating from the RH waste component of the material destined for
11 disposal. The most hazardous of the wastes in this respect would be the activated metals from
12 reactor decommissioning; their external radiation rates, primarily from cobalt-60 (Co-60), could
13 be a few thousand roentgens per hour at the waste package surface (Sandia 2007a). With an
14 attenuation of Co-60 gamma rays of one-half for about every 6.2 cm (2.4 in.) of concrete
15 (Shleien 1992), a reduction in radiation (by a factor of more than 260,000) to near background
16 levels is expected.
17

18 Use of 6-in. (15-cm) on-center steel reinforcement (rebar), in two perpendicular layers,
19 would strengthen the concrete in the floor, walls, and vault cap (ceiling). In addition to adding
20 strength to the vault construction, the spacing of the rebar would provide protection against
21 inadvertent drilling into the disposal cells. For this reason, the vault cap would have two sets of
22 perpendicular steel reinforcement, one near the exterior face and the other near the interior face
23 of the cap. With a spacing of 6 in. (15 cm), most drill bits would not pass into the vault without
24 encountering the steel reinforcement first (discouraging further penetration), if they had not
25 initially been stopped by the concrete itself. Steel reinforcement in the walls was included
26 because of the increased prevalence of using directional drilling at deeper depths for utility work,
27 which can expose the walls as well as the top of the vault to drilling.
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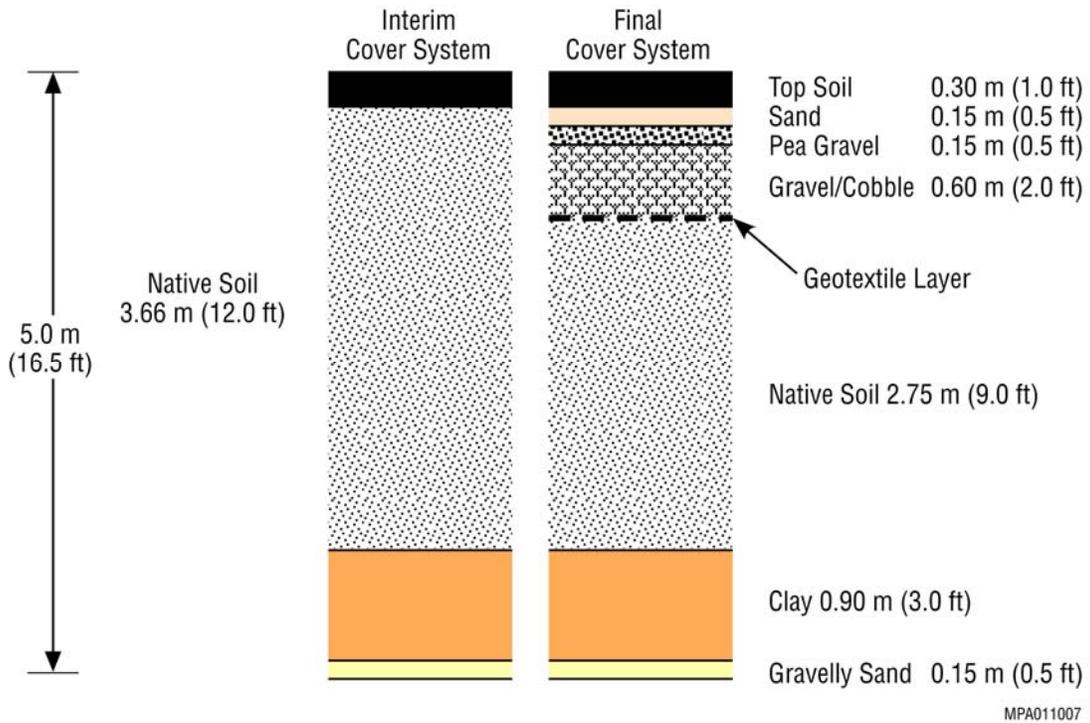
30 **D.3.3.1.2 Engineered Cover Systems.** An engineered cover would be used to aid in the
31 isolation of the waste from the environment over the long term. In addition to the protection
32 afforded by the vault and its internal backfill, the thickness of the cover would assure that
33 external exposure rates remained at background levels. The design would direct surface water
34 away from the waste and help deter intrusion by humans, plants, and animals. Minimum and
35 maximum slope requirements would be incorporated to ensure adequate drainage and to reduce
36 erosion/maintain slope stability, respectively.
37

38 Two engineered cover systems are included in the design for the vaults, as shown in
39 Figure D-8. The first would be put in place after a vault was filled with waste and permanently
40 closed, or it could be implemented incrementally as the vault was filled (the interim cover with a
41 rise-to-run of 1:3 from the vault edge to ground level). The second cover system would partially
42 replace the interim cover prior to closure of the disposal facility (the final cover with a rise-to-
43 run of 1:5 from the vault edge to ground level). A graded slope of 3% would be used over the
44 combined cover of all of the vaults. Both covers would have a minimum depth of 5.0 m (17 ft)
45 over any portion of a vault, with a 15-cm (0.5-ft) layer of gravelly sand over a vault followed by
46 a layer of clay 0.9-m (3-ft) thick, as shown in Figure D-8. The next layer in the interim cover
47 would consist of 3.7 m (12.0 ft) of native soil followed by 0.3 m (1 ft) of topsoil. In the final



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FIGURE D-7 Cross Section of a Conceptual Above-Grade Vault Design (drawn to scale)



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FIGURE D-8 Conceptual Cover Systems for a Vault Disposal Facility (Source: Modified from Henry 1993)

1 cover, the next layer over the clay layer would have 2.8 m (9.0 ft) of native soil, followed by a
2 geotextile layer, 0.6 m (2 ft) of gravel, 15 cm (0.5 ft) of pea gravel, 15 cm (0.5 ft) of sand, and
3 0.3 m (1 ft) of topsoil (Henry 1993). If needed, rock armor could also be incorporated into the
4 final cover to further protect against erosion.

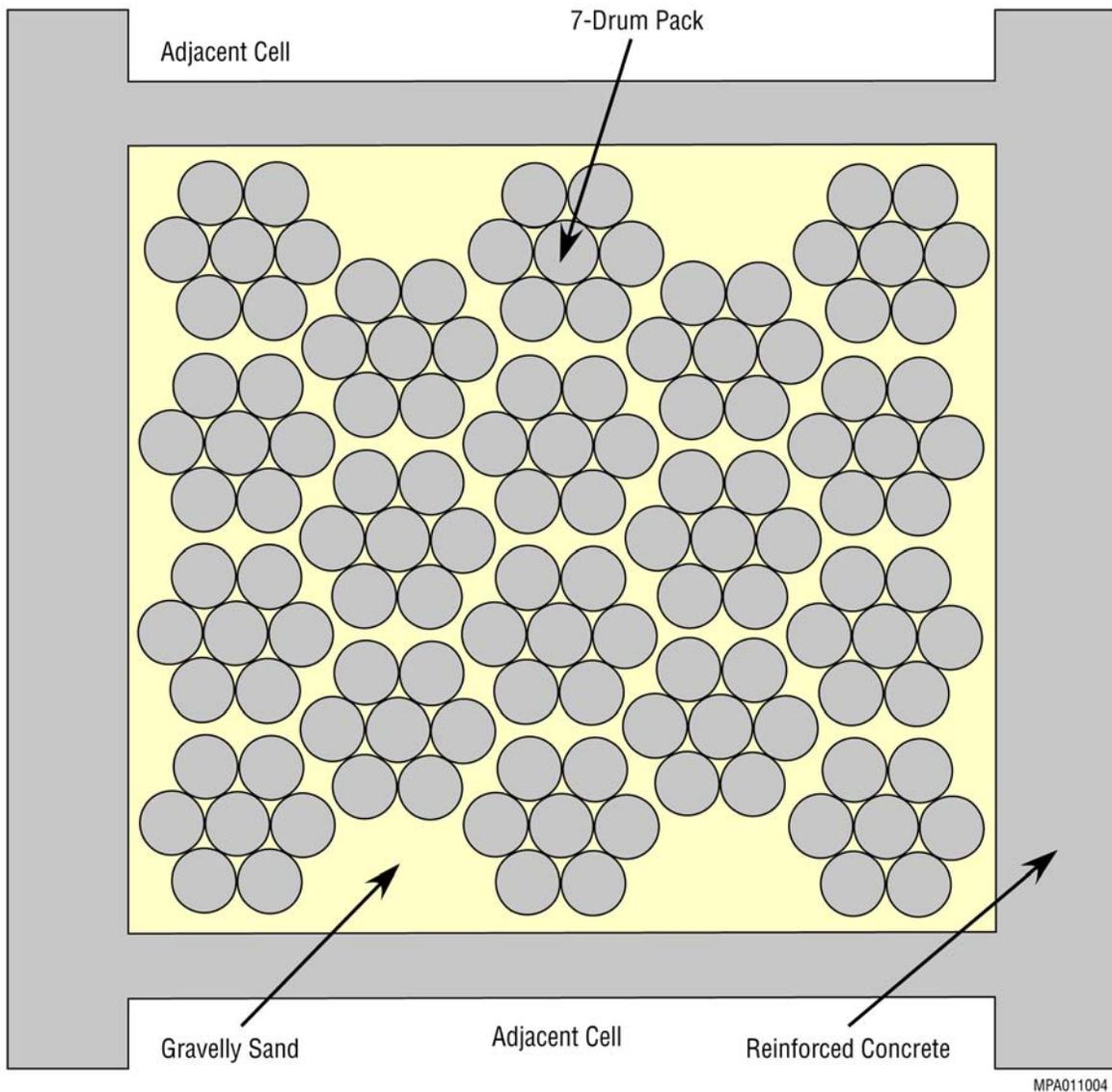
7 **D.3.3.2 Disposal Package Configurations**

10 **D.3.3.2.1 Contact-Handled Waste.** The packing arrangement of CH 208-L (55-gal)
11 drums in a cell assumes placement of 7-drum packs as received at the facility in a Transuranic
12 Package Transporter-II (TRUPACT-II) Type B transportation package. Figure D-9 shows the
13 arrangement for the CH drums, with 18 7-packs used per layer. With five layers, 630 drums
14 could be accommodated in each cell. For SWBs, 20 could be arranged in one layer
15 (see Figure D-10), with five layers for 100 SWBs in one vault cell. In addition, it is estimated
16 that about 300 cesium irradiators (three layers of 10 × 10) would fit in one cell. A layer of fill
17 would be used between layers of disposal containers to minimize void spaces. SWBs, 7-drum
18 packs, and 4-packs of irradiators would be taken off an on-site transport truck and loaded into the
19 vault cell by an overhead crane.

22 **D.3.3.2.2 Remote-Handled Waste.** Vault cells for disposal of RH waste would be
23 similar in design to the trench approach as discussed in Section D.3.1.2.2. RH AMCs, 208-L
24 (55-gal) drums, or canisters would be loaded from a bottom-loading transfer cask into vertical
25 reinforced concrete cylinders with thick concrete shield plugs within each cell. Figure D-11
26 provides a view from the top of a vault cell. The cylinder loading would be the same as that for
27 the trench approach — three AMCs, four 208-L (55-gal) drums, or one RH canister per cylinder.
28 With 72 cylinders per cell, 216 AMCs, 288 drums, or 72 RH canisters could be emplaced in each
29 vault cell.

32 **D.4 CONCEPTUAL FACILITY LAYOUTS**

34 For all methods, an outside fence would maintain a minimum 30-m (100-ft) buffer
35 around the site, with a larger buffer where the stormwater retention pond and site support
36 facilities could be located. A guard house would restrict access to the site. An administration
37 building would provide the base for site operations, with waiting areas, offices, record storage,
38 and personnel support facilities (e.g., meeting rooms, locker rooms). A receipt and storage (waste
39 handling) building would provide space for inspecting newly received waste for disposal,
40 offloading the waste, and temporarily storing the waste before its emplacement in the disposal
41 units. Vehicles, equipment, and supplies necessary to site operations would be maintained,
42 repaired, and stored in a maintenance and storage building. A laboratory building would provide
43 space for analysis of sample monitoring swipes taken from the exterior of waste packages and
44 equipment. A utilities building would house a boiler and refrigeration system, as well as pump
45 equipment for maintaining proper water levels for an on-site water tank to support potable and
46 sanitary water systems, fire protection systems, and dust suppression. A washdown pad would
47 provide an area for cleaning vehicles and equipment.



1

2 **FIGURE D-9 Top View of a Single-Layer Packing Arrangement of Contact-Handled Waste**
 3 **in 208-L (55-gal) 7-Drum Packs in Vault Cells**

4

5

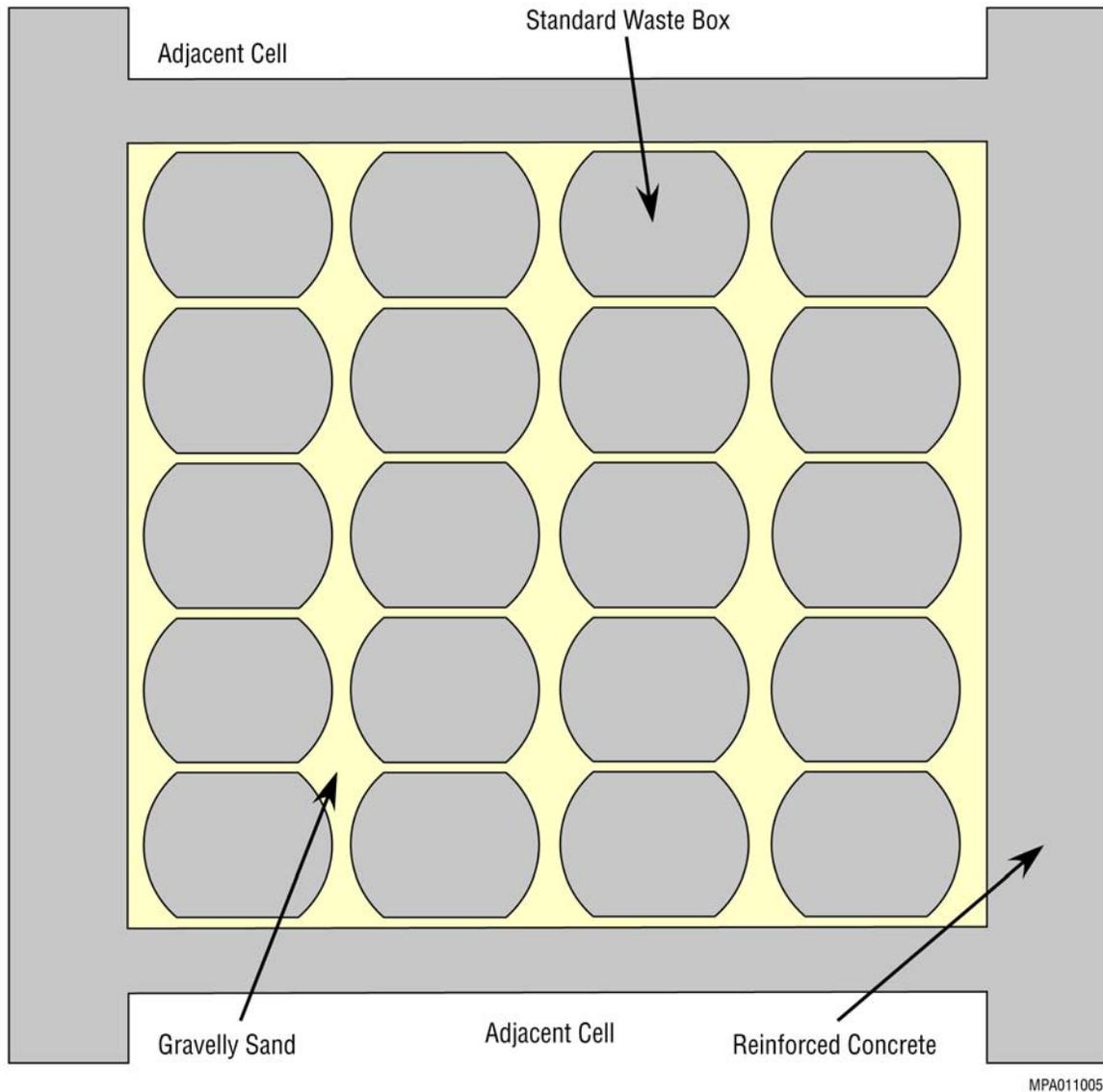
6 **D.4.1 Trench Disposal**

7

8 Figure D-12 shows the layout of a conceptual enhanced near-surface trench waste
 9 disposal facility. It is estimated that approximately 29 trenches would be required for the
 10 disposal of the 12,000 m³ (420,000 ft³) of waste currently under consideration. Trenches would
 11 be spaced 30 m (100 ft) apart within a facility footprint of about 50 ac (20 ha) with dimensions
 12 of 550 × 330 m (1,800 × 1,100 ft) at the fence line.

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2 **FIGURE D-10 Top View of a Single-Layer Packing Arrangement of Contact-Handled**
 3 **Waste in Standard Waste Boxes in Vault Cells**

4

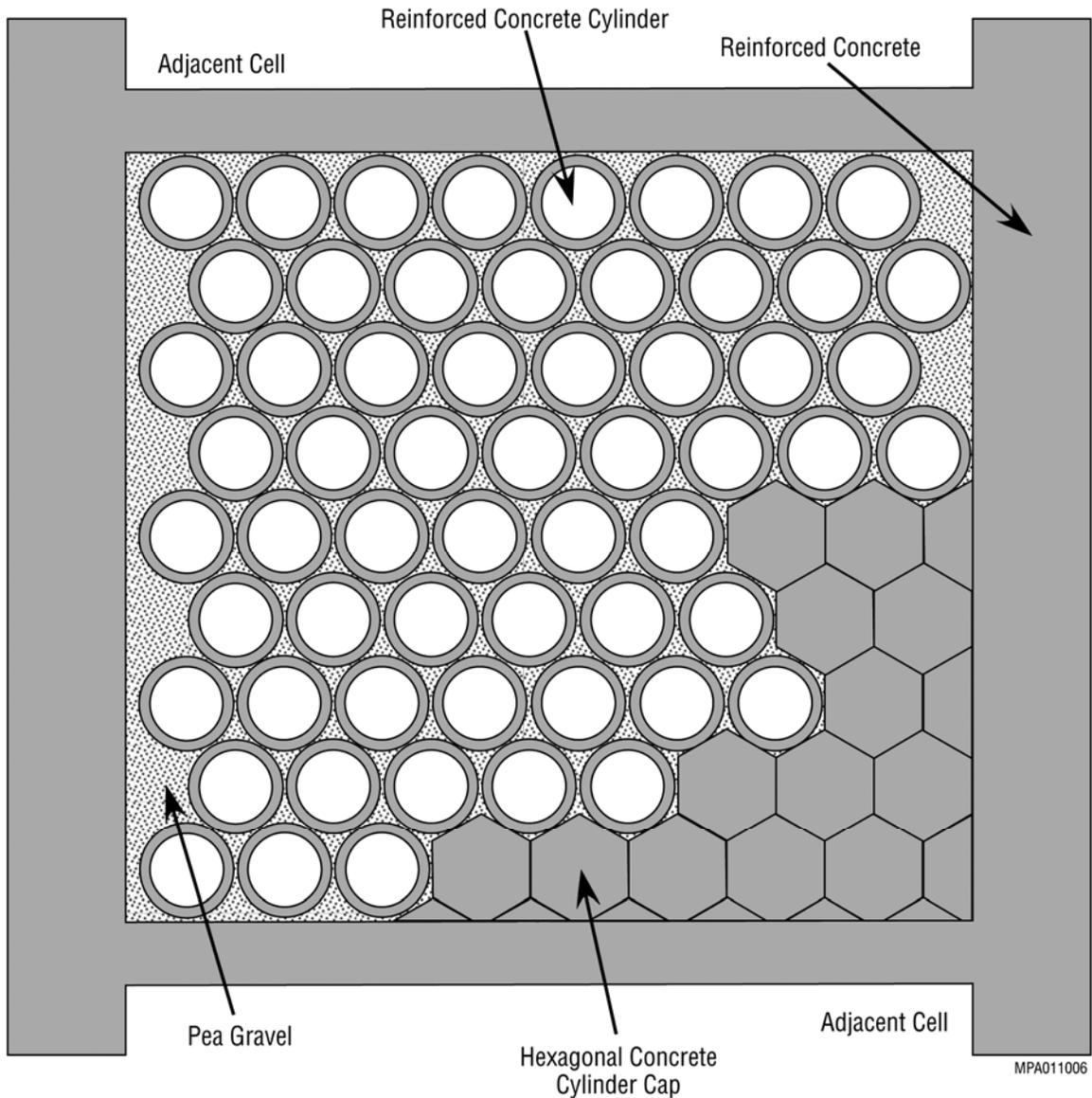
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6 **D.4.2 Borehole Disposal**

7

8 Figure D-13 shows the layout of a conceptual intermediate-depth borehole waste disposal
 9 facility that covers about 110 acres (44 ha). It is estimated that approximately 930 40-m (130-ft)
 10 boreholes would be required for the disposal of the 12,000 m³ (420,000 ft³) of waste currently
 11 under consideration. Boreholes would be spaced 10 m (33 ft) apart on-center with a 30-m (98-ft)
 12 space between rows. The facility footprint dimensions would be about 510 × 870 m
 13 (1,700 × 2,800 ft) at the fence line.

14



1

2 **FIGURE D-11 Top View of a Vault Cell for Disposal of Remote-Handled Waste**

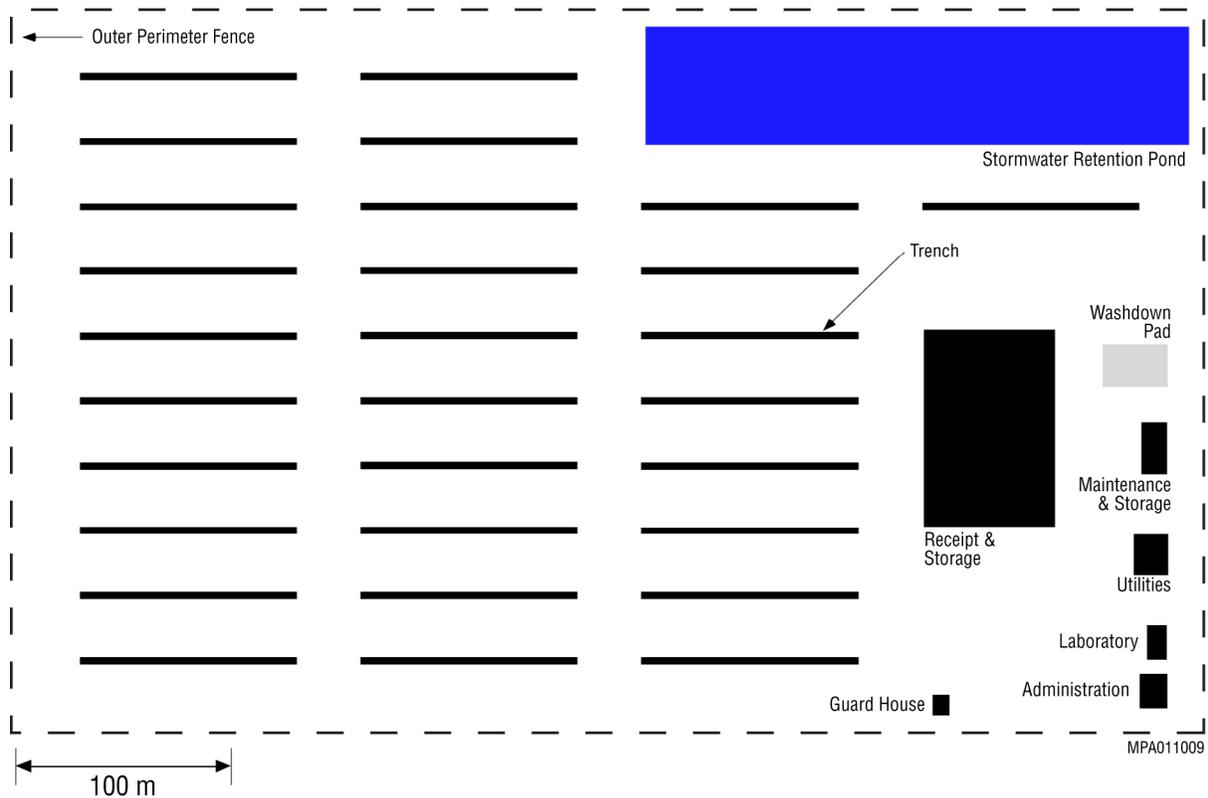
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5 **D.4.3 Vault Disposal**

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7 The conceptual above-grade vault system design incorporates 12 vaults with a total land
 8 use requirement of about 60 ac (25 ha) within the outer perimeter fence, as shown by the layout
 9 of a conceptual facility presented in Figure D-14. Approximately 40 ac (16 ha) would be
 10 required for the 12 disposal vaults and their final cover system. The vaults would be spaced to
 11 (1) provide adequate room for the interim cover systems (2.1 ac or 0.8 ha each) to be emplaced
 12 as each vault was completely filled, (2) protect site workers, and (3) isolate the waste before
 13 decommissioning and emplacement of the final cover system prior to facility closure. The
 14 facility footprint dimensions would be about 420 × 610 m (1,400 × 2,000 ft) at the fence line.



1

2 **FIGURE D-12 Layout of a Conceptual Trench Disposal Facility**

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Ditches would separate the vaults with their interim cover systems to minimize standing water and provide site drainage. The conceptual design incorporates a retention pond that is 180 × 110 × 0.30 m (580 × 350 × 1 ft) to manage stormwater runoff. The proposed size of the pond might need to be modified on the basis of site-specific conditions, including precipitation.

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12 **D.5 STAFFING AND COST ESTIMATES**

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15 **D.5.1 Construction**

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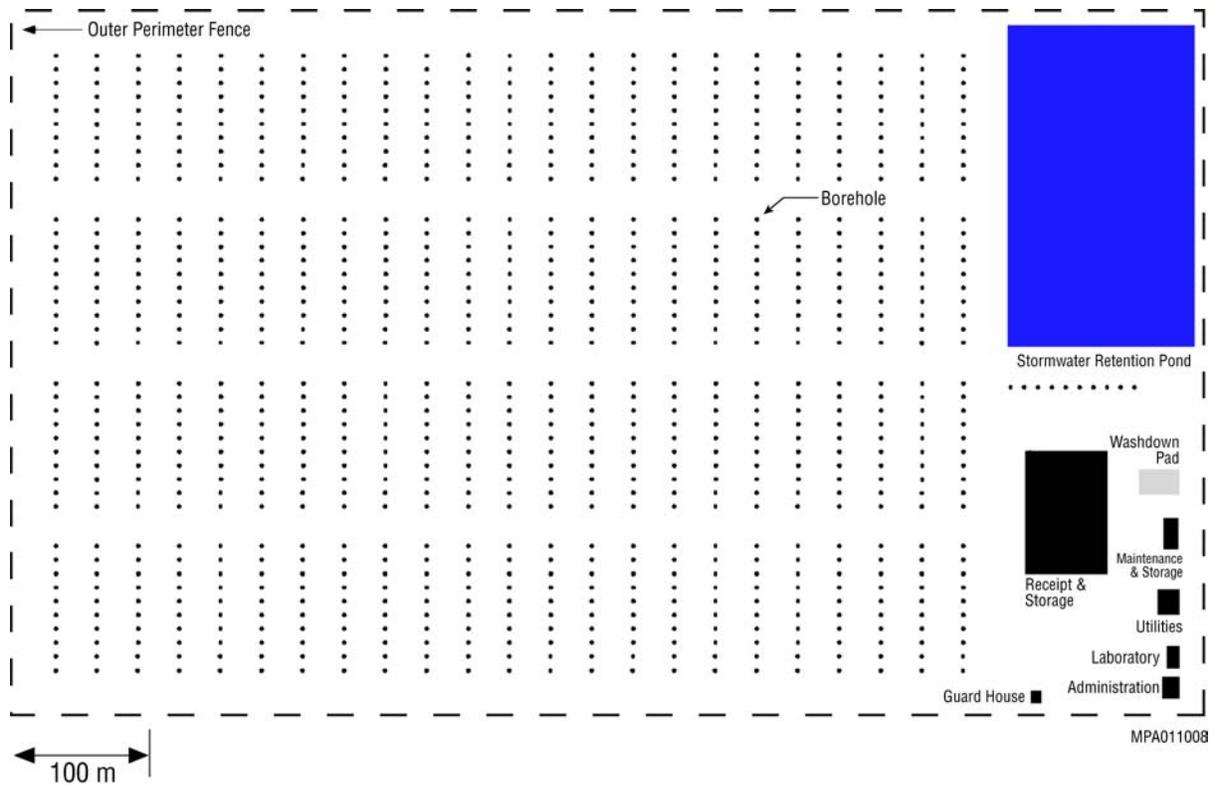
The construction labor force could be organized into five groups:

17

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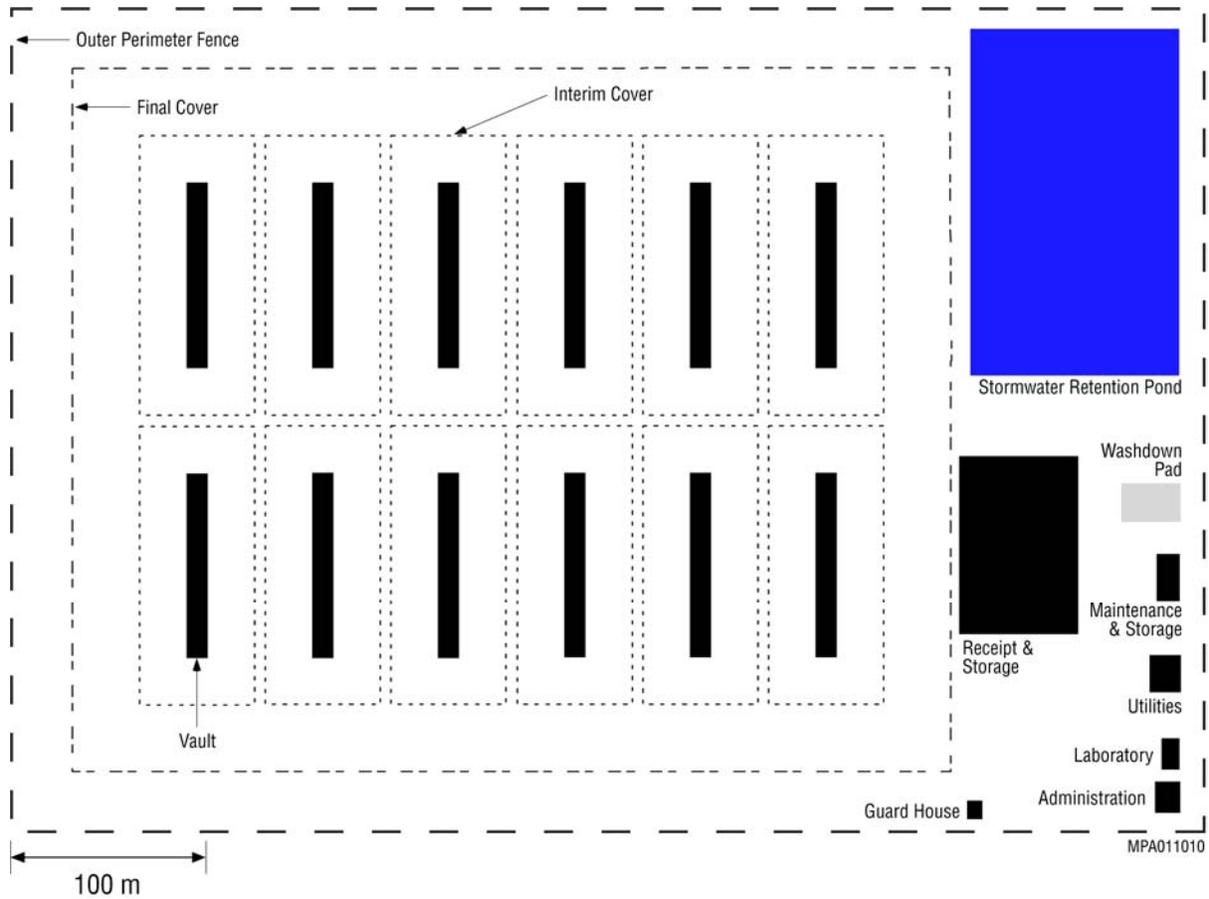
1. *Management, engineering, design, permitting (Home Office)*. This group includes management, planning, engineering, and permitting personnel. Permitting includes licensing activities and National Environmental Policy Act (NEPA) documentation. This group is typically located at the contractors' home or regional office rather than in the field.

24



1
2 **FIGURE D-13 Layout of a Conceptual Borehole Disposal Facility**

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5 2. *Management and supervision at the construction site (Field Office).* This
6 group represents overall field management and supervision during actual
7 construction and excavation. Personnel would be stationed in trailers initially.
8 They would relocate to finished buildings (e.g., administration building) upon
9 their completion. This group would remain at one relatively constant level for
10 initial construction of the disposal facility and the initial disposal units. Other
11 levels would be used for intermittent construction of the other disposal units
12 and installation of the final cover system.
- 13
- 14 3. *Site preparation.* This group includes the surveyors, operating engineers, truck
15 drivers, and laborers who would provide the initial construction entrance,
16 temporary (gravel) roads, stormwater management, initial grubbing,
17 installation of utility services, and associated activities. The level of effort for
18 this group would be greatest during site preparation leading up to construction
19 of the first disposal unit.
- 20
- 21 4. *Construction.* This group includes those who would be involved in building
22 the trenches, boreholes, or vaults and constructing the support buildings.
- 23



1

2 **FIGURE D-14 Layout of a Conceptual Vault Disposal Facility**

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- 5. *Checkout and startup.* This group includes those involved in readiness assessments, final licensing and permitting activities, and training and certification of the operating staff.

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Summaries of labor and cost estimates are provided in Tables D-1 through D-4 for construction of the disposal facility. All cost estimates are based on R.S. Means construction data (R.S. Means 2004, 2006).

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D.5.2 Operations

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D.5.2.1 Staffing-Level Methodology

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To assure that trained personnel would be available at a stand-alone facility, the estimates presented here assume that a disposal facility would remain open on a continuous basis; that is, the facility would not open periodically to receive a short shipping campaign and then close again until a sufficient amount of waste required disposal. This continuous operation would

22

TABLE D-1 Estimated Person-Hours and Direct Costs Associated with the Construction of the Conceptual Disposal Facilities

Activity	Person-Hours	Material Cost (\$)	Labor Cost (\$)	S/C ^a Cost (\$)	Total Cost (\$)
Trench					
Geotechnical investigation	256	16,700	11,600	0	28,300
Shoring placement	1,790	264,000	80,400	0	345,000
Drilling deflector	1,070,000	9,400,000	33,100,000	0	42,500,000
Site prep	44,500	1,020,000	1,210,000	3,360,000	5,600,000
Earthwork grading	1,470	88,800	58,600	0	147,000
RH trenches	155,000	7,680,000	5,730,000	0	13,400,000
Trench closure	20,600	869,000	586,000	0	1,460,000
Support facilities	75,400	4,260,000	2,210,000	1,040,000	7,500,000
Total direct costs	1,370,000	23,600,000	43,000,000	4,400,000	71,000,000
Borehole					
Geotechnical investigation	256	16,700	11,600	0	28,300
Borehole	168,000	103,000,000	13,500,000	0	116,000,000
Drilling deflector	92,000	33,100,000	2,100,000	0	35,200,000
Site prep	81,500	1,620,000	2,220,000	1,320,000	5,170,000
Earthwork grading	3,650	220,000	146,000	0	366,000
Support facilities	88,700	5,120,000	2,530,000	1,090,000	8,740,000
Total direct costs	434,000	143,000,000	20,500,000	2,410,000	166,000,000
Vault					
Vault site preparation	69,800	13,700,000	1,910,000	1,660,000	17,300,000
Vault construction	3,570,000	60,800,000	180,000,000	800,000	241,000,000
Vault cap	307,000	12,700,000	8,650,000	0	21,400,000
Support facilities	114,000	4,870,000	3,330,000	1,480,000	9,690,000
Total direct costs	4,060,000	92,100,000	194,000,000	3,950,000	290,000,000

^a S/C = subcontract.

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TABLE D-2 Estimated Total Construction Full-Time Equivalents

Construction Phase	Staff (FTE-yr)		
	Trench	Borehole	Vault
Direct construction	686	217	2,029
Indirect construction (20% of above)	137	43	406
Total construction	824	260	2,434

3

TABLE D-3 Project Management Labor Staffing

Project Management Labor	Staff (FTE-yr)		
	Trench	Borehole	Vault
Program manager	1.5	0.5	5.6
Project manager	7.2	2.3	21.1
Program QA/QC manager	0.5	0.1	1.2
Construction manager	43.3	13.7	127.6
Project QA inspector	15.1	4.8	44.6
Health and safety officer	43.3	13.7	127.6
Administrative assistant	22.7	7.2	67.0
Accounting clerk	3.8	1.2	11.1

1
2**TABLE D-4 Total Estimated Construction Costs**

Cost Summary	Cost (\$)		
	Trench	Borehole	Vault
Subcontractor costs	71,000,000	166,000,000	290,000,000
Engineering and design fees	2,840,000	6,630,000	11,600,000
Other direct costs (ODC)	533,000	1,240,000	2,170,000
Subtotal ODC, design, and subcontracts	74,400,000	174,000,000	303,000,000
Markup (15%)	11,200,000	26,000,000	45,500,000
Project management labor costs	1,120,000	2,600,000	4,550,000
Estimated construction costs	86,700,000	202,000,000	354,000,000
Professional services contingency	989,000	2,310,000	4,040,000
Total cost ^a	88,000,000	210,000,000	360,000,000

^a Total cost is rounded off to two significant figures.

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ensure that the same trained personnel would be available to operate the facility and that institutional knowledge would not be lost. In addition, a minimum number of personnel would be necessary for proper operation of the facility, but that number would not scale linearly as the receipt rate increased. Thus, single-value cost estimates or full-time equivalent (FTE) values per shipment or unit volume of waste received are not used.

Coupled with the assumptions on waste receipt rates at the facility, the assumption that the disposal facility would operate on a continuous basis provides for conservative estimates of staffing levels and associated impacts. As discussed below, the number of staff members required to operate the facility is based on potential waste receipt rates in the years following the

1 opening of the facility, which is the time when the majority of the waste would be emplaced. The
 2 remaining years of operation would likely require lower staffing levels. Depending on the actual
 3 schedules of when the waste could be delivered, the facility could operate on an interim-type
 4 basis. In such a case, a pool of trained workers would need to be available when required.

5
 6 The number of personnel and their functions were estimated on the basis of the
 7 functions of the facility, waste volume receipt rates at the facility, and on-site movements of
 8 waste packages for final disposal. Details of the time-motion information (unit operations)
 9 used to determine the average number of workers required for operations are presented in
 10 Argonne (2010). The time period through 2035 was used to estimate the size of the workforce
 11 because the majority of the waste under consideration (approximately 75%) would be available
 12 for disposal by that time. The annual average receipt rate between 2019 and 2035 is estimated to
 13 be 570 truck shipments. As a conservative measure, this receipt rate was used to estimate
 14 impacts from operations for the entire period a disposal facility would be open, from 2019 to
 15 2083.

16 17 18 **D.5.2.2 Operational Data**

19
 20 Table D-5 provides information on the number and function of personnel required to
 21 operate the facility. Annual costs for labor, consumables, and equipment are provided in
 22 Tables D-6 through D-8 for trench, borehole, and vault disposal, respectively. More detailed
 23 supporting information on operating equipment costs can be found in Argonne (2010).
 24
 25

**TABLE D-5 Detailed Worker Breakdown for
 Disposal Facility Operations^a**

Labor Category	Number of FTEs		
	Trench	Borehole	Vault
Officials and managers	1	1	1
Professionals	1.1	0.6	1.1
Technicians	8	5	8
Security	11	11	11
Craft workers (maintenance)	2	3	2
Office and clerical	6	6	6
Line supervisors	4	4	4
Operators	15	8	18
Total personnel	48	38	51

^a Values are rounded to appropriate significant figure.

TABLE D-6 Annual Operating and Maintenance Costs for a Conceptual Trench Disposal Facility

Description	Quantity	Unit	Unit Cost (\$)	Total Cost (\$)
Consumables				
Diesel fuel	210,000	gal/yr	2.49	522,900
Electricity	1,160	MWh/yr	89.00	103,240
Water	1,100,000	gal/yr	0.002	2,498
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				763,038
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Forklift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pickup trucks	5	Each	1,100.00	5,500
Miscellaneous tools	1	Year	8,805.87	8,806
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				87,756
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	1.1	FTE	130,000.00	142,544
Technicians	7.7	FTE	100,000.00	774,351
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.4	FTE	100,000.00	237,500
Office and clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,014
Operators	15.2	FTE	100,000.00	1,523,673
Indirect costs (at 12%)				574,163
Total labor cost				5,358,856
Contingency				
Summary	Subtotal (\$)	(%)	(\$)	Total (\$)
Consumables	763,038	40	305,215	1,068,254
Equipment	87,756	30	26,327	114,083
Labor	5,358,856	25	1,339,714	6,698,570
Total	6,209,651		1,671,256	7,880,907 ^a

^a Value rounded to \$8 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a trench disposal facility is assumed to be about \$160 million.

TABLE D-7 Annual Operating and Maintenance Costs for a Conceptual Borehole Disposal Facility

Description	Quantity	Unit	Unit Cost (\$)	Total Cost (\$)
Consumables				
Diesel fuel	80,000	gal/yr	2.49	199,200
Electricity	970	MWh/yr	89.00	86,330
Water	410,000	gal/yr	0.002	931
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				420,861
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Fork lift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pick up trucks	4	Each	1,100.00	4,400
Miscellaneous tools	1	Year	5,133.60	5,134
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				82,984
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	0.6	FTE	130,000.00	78,419
Technicians	5.5	FTE	100,000.00	545,135
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.7	FTE	100,000.00	265,000
Office and clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,078
Operators	7.6	FTE	100,000.00	761,721
Indirect costs (at 12%)				450,836
Total labor cost				4,207,799
Contingency				
Summary	Subtotal (\$)	(%)	(\$)	Total (\$)
Consumables	420,861	40	168,344	589,206
Equipment	82,984	30	24,895	107,879
Labor	4,207,799	25	1,051,950	5,259,748
Total	4,711,644		1,245,189	5,956,833 ^a

^a Value rounded to \$6 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a borehole disposal facility is assumed to be about \$120 million.

TABLE D-8 Annual Operating and Maintenance Costs for a Conceptual Above-Grade Vault Facility

Description	Quantity	Unit	Unit Cost (\$)	Total Cost (\$)
Consumables				
Diesel fuel	210,000	gal/yr	2.49	522,900
Electricity	1,150	MWh/yr	89.00	102,350
Water	1,090,000	gal/yr	0.002	2,476
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				762,126
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Fork lift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pick up trucks	6	Each	1,100.00	6,600
Miscellaneous tools	1	Year	10,009.12	10,009
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				90,059
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	1.1	FTE	130,000.00	141,606
Technicians	7.7	FTE	100,000.00	770,803
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.3	FTE	100,000.00	225,000
Office and Clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,015
Operators	17.8	FTE	100,000.00	1,776,823
Indirect costs (at 12%)				602,503
Total labor cost				5,623,360

<u>Contingency</u>				
Summary	Subtotal (\$)	(%)	(\$)	Total (\$)
Consumables	762,126	40	304,850	1,006,976
Equipment	90,059	30	27,018	117,077
Labor	5,623,360	25	1,405,840	7,029,201
Total	6,475,545		1,737,708	8,213,253 ^a

^a Value rounded to \$8 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a vault disposal facility is assumed to be about \$160 million.

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1 **D.6 RESOURCE ESTIMATES**

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3 Resources needed for the construction and operations of a GTCC waste disposal facility
4 can be divided into two classes: materials and utilities. Materials are the substances used to
5 construct the disposal trenches, boreholes, or vaults and support buildings, such as sand, clay,
6 gravel, and concrete. This category also includes the excavated materials. Utilities include
7 electricity, natural gas or propane, water, and diesel fuel. Materials would be consumed primarily
8 during construction activities. Utilities would be consumed during both construction and
9 operations.

10

11

12 **D.6.1 Construction**

13

14 Table D-9 summarizes materials and resources consumed during construction of a GTCC
15 waste disposal facility. The large amount of soil required for vault disposal is necessary for the
16 final 5-m (16-ft) cover depth. More detailed supporting information on resources required for
17 construction can be found in Argonne (2010).

18

19

20 **D.6.2 Operations**

21

22 Operational activities would include receiving the packages of waste, inspecting them,
23 possibly storing them temporarily, possibly reconfiguring them for disposal (e.g., bundling RH
24 canisters into 3-packs for borehole disposal), transporting the waste containers to the disposal
25 cells, and emplacing them. To some extent, construction activities and operational activities
26 would be concurrent. For example, one or more trenches, boreholes, or vaults would be being
27 filled while others were being constructed. Once all the GTCC LLRW and GTCC-like waste had
28 been emplaced and the facility had undergone closure, a period of institutional control would
29 follow. An institutional control program would include physical control of access to the site, an
30 environmental monitoring program, periodic surveillance, and custodial care. The use of utilities
31 would be much greater during the operational period than the institutional control period, so
32 utility use during the institutional control period is not considered here.

33

34

35 **D.6.2.1 Materials**

36

37 The only major consumable materials used during operations would be pallets for
38 potential bundling operations, sand for backfill, and chemicals used to treat the water used
39 on-site, as shown in Table D-10.

40

41

42 **D.6.2.2 Utilities**

43

44 The utilities required for operations are summarized in Table D-11 and D-12. Water and
45 sewage usage are based on the staffing requirements discussed in Section D.5.2.1. Gas, oil, and
46 electricity would be consumed primarily to keep the facility buildings operational, with minor

TABLE D-9 Estimates of the Materials and Resources Consumed during Construction of the Conceptual Disposal Facilities

Construction Materials and Resources	Total Consumption		
	Trench	Borehole	Vault
Utilities			
Water (gal) ^a	5,300,000	2,800,000	17,100,000
Electricity (MWh) ^{b,c}	34,200	10,800	101,000
Solids^c			
Concrete (yd ³)	25,600	18,600	88,200
Steel (tons)	2,000	1,400	7,960
Gravel (yd ³)	36,100	25,300	156,400
Sand (yd ³)	3,600	27,900	198,300
Clay (yd ³)	12,900	5,180	56,000
Soil (off-site) (yd ³)	– ^d	–	254,000
Liquids			
Diesel fuel (gal) ^b	750,000	2,030,000	3,380,000
Oil and grease (gal)	18,000	48,000	86,000
Gases			
Industrial gases (propane) (gal) ^b	5,400	4,300	13,600

^a Water requirement estimates are based on DOE (1997), in which each FTE requires 20 gal/d, and cementation requires 26.1 lb of water per 100 lb of cement.

^b Scaling methodology is based on LLNL (1997).

^c Peak demand is 1.71, 0.54, or 5.05 MWh for the trench, borehole, and vault disposal facilities, respectively.

^d Dash means not applicable.

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3 amounts of electricity required to operate the overhead cranes during unloading. More
4 information on utility demand can be found in Argonne (2010).

5

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7 **D.7 FACILITY EMISSIONS AND WASTES**

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9

10 **D.7.1 Construction**

11

12 Wastes generated during construction of the disposal facility would be typical of large
13 construction projects. Wastes would consist primarily of construction debris, including concrete
14 fragments, and sanitary wastes generated by the labor force. Emissions would result primarily
15 from the use of fuels in constructing the facility, removing construction debris, and disturbing the

TABLE D-10 Materials Consumed Annually during Operations^a

Material and Chemical ^b	Quantity (lb/yr)		
	Trench	Borehole	Vault
Sand	2.59E+05	5.20E+04	9.80E+03
Standard pallet (trench = 48-in. × 48-in. × 7.5-in. tall, borehole = steel pallet)	140	5.84E+05	–
Hydrochloric acid (37% HCl)	277	103	275
Sodium hydroxide (50% NaOH)	227	85	225
Sodium hypochlorite	107	40	106
Copolymers	150	56	149
Phosphates	17	6	17
Phosphonates	16	6	15

^a See Kemmer (1988) for water treatment.

^b The chemicals are used to treat the raw water used during waste operations.

^c Dash means not applicable.

TABLE D-11 Average-Day Utility Consumption during Disposal Operations

Utility ^a	Average-Day Consumption		
	Trench	Borehole	Vault
Potable water (USG/d)	1,300	1,000	1,300
Raw water (USG/d) ^b	4,600	1,700	4,500
Sanitary sewer (USG/d)	1,300	1,000	1,300
Natural gas (Mcf/d)	47	47	47
Diesel fuel (USG/d)	900	300	900
Electricity (MWh) ^c	4.8	4.0	4.8

^a USG/d = U.S. gallons per day, Mcf = million cubic feet.

^b Includes potable water and water used in truck washdown. Estimate assumes that on average, 605 gal are used to wash down the truck that transports the GTCC waste. The estimate is based on Table 6-1 in EPA (2001).

^c Peak-day demand is 0.5, 0.5, and 0.5 MWh for the trench, borehole, and vault disposal facilities, respectively.

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TABLE D-12 Annual Utility Consumption during Disposal Operations

Utility ^a	Annual Consumption ^b		
	Trench	Borehole	Vault
Potable water (USG/yr)	310,000	240,000	310,000
Raw water (USG/yr) ^{b,c}	1,100,000	410,000	1,090,000
Sanitary sewer (USG/yr)	310,000	240,000	320,000
Natural gas (Mcf/yr)	11,200	11,200	11,200
Diesel fuel (USG/yr)	210,000	80,000	210,000
Electricity (MWh)	1,160	970	1,150

^a USG/yr = U.S. gallons per year, Mcf = million cubic feet.

^b Based on 240 operations-days per year.

^c Includes potable water and water used in truck washdown. Estimate assumes that, on average, 605 gal (2,300 L) are used to wash down the truck that transports the GTCC waste. The estimate is based on Table 6-1 in EPA (2001).

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3 land (fugitive dust). The amount of concrete waste was estimated on the basis of the assumption
 4 that 0.65% of the concrete usage would be spoilage. The other solid wastes, which would include
 5 construction debris and rock cuttings, were taken to be eight times the volume of the concrete
 6 spoilage. Steel waste was taken to be 0.5% of the steel requirements. These solid nonhazardous
 7 wastes would be disposed of in a municipal solid waste landfill. The amount of sanitary waste
 8 was estimated on the basis of the total construction workforce. Liquid (sanitary) nonhazardous
 9 wastes would be treated in a portable system or hauled off-site for treatment and disposal.
 10 Table D-13 summarizes the amount of waste that would be generated during construction.

11

12 Estimates of criteria pollutant emissions generated during construction were based on the
 13 estimated amounts of fuel used by the trucks, cranes, and other heavy equipment during
 14 construction. Standard U.S. Environmental Protection Agency (EPA) emission factors from the
 15 WebFire database (<http://cfpub.epa.gov/oarweb/index.cfm?action=fire.main>) were used in these
 16 calculations. Emissions were calculated from the total quantity of diesel fuel consumed. Dust
 17 was estimated from the amount of disturbed land area and the length of time that the disturbed
 18 area would be under construction. National Ambient Air Quality Standards (NAAQS) for criteria
 19 air pollutants are given in Table D-14. Estimates of construction emissions are given in
 20 Table D-15 for the disposal facilities. The initial construction period was assumed to be 3.4 years
 21 (824 days for site preparation and construction of support facilities at 240 working days per
 22 year). Although disposal unit construction might span more than 60 years because it is assumed
 23 that the disposal units would be constructed as the waste became available for disposal, a total of
 24 20 years of actual time for construction operations was assumed, which corresponds to the period
 25 when most of the GTCC waste is expected to be received for disposal. Emissions of the
 26 following criteria air pollutants were estimated: sulfur oxides (SO_x) as sulfur dioxide (SO₂),
 27 nitrogen oxides (NO_x) as nitrogen dioxide (NO₂), carbon monoxide (CO), particulate matter with

TABLE D-13 Total Wastes Generated during Construction

Waste Generation by Category	Trench	Borehole	Vault
Hazardous solids (yd ³)	57	18	168
Hazardous liquids (gal)	23,000	7,300	68,000
Nonhazardous solids (yd ³) ^a	62,000	300,000	5,200
Nonhazardous liquids (gal) ^b	4,800,000	1,500,000	14,000,000

^a Includes concrete and other excavated materials. Excavated materials (if clean) could be used as backfill during operations and would reduce the volume that could be considered as waste.

^b Includes sanitary and other nonhazardous liquids.

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TABLE D-14 National Ambient Air Quality Standards (NAAQS) for Criteria Air Pollutants

Criteria Air Pollutant	Averaging Time	Primary Standard
CO	1 hour	40 mg/m ³
	8 hours	10 mg/m ³
Hydrocarbons	3 hours	160 µg/m ³
NO _x (as NO ₂)	Annual	100 µg/m ³
SO _x (as SO ₂)	24-hours ^a	365 µg/m ³
	Annual	80 µg/m ³
PM ₁₀	24 hours	150 µg/m ³
PM _{2.5}	24 hours	35 µg/m ³
	Annual	15 µg/m ³

^a Not to be exceeded more than once a year.

Source: 40 CFR Part 50.0 et seq.

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TABLE D-15 Estimated Air Emissions during Construction^a

Criteria Pollutant ^b	Total Emissions (tons)			Peak-Year Emissions (tons/yr)		
	Trench	Borehole	Vault	Trench	Borehole	Vault
VOCs ^b	13	31	62	0.9	2.7	3.6
NO _x	110	270	540	8.1	26	31
SO ₂	12	32	53	0.9	3.0	3.2
CO	39	110	190	3.3	11	11
PM ₁₀ ^c	25	60	65	5.0	13	8.6
PM _{2.5} ^d	12	30	44	1.5	4.1	3.6
CO ₂	8,400	29,000	38,000	670	2,200	2,300

^a Excludes delivery and commuter vehicles.

^b VOCs = volatile organic compounds.

^c Assumes construction emission factor for fugitive dust PM₁₀ of 0.22 tons/acre-month (average conditions) (URBEMIS2007 2007).

^d Assumes 21% of fugitive dust PM₁₀ is PM_{2.5} and that 89% of combustion PM₁₀ is PM_{2.5} (www.aqmd.gov/CEQA/handbook/PM2_5/handout1.doc).

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3 a diameter of less than or equal to 10 micrometers (PM₁₀), and particulate matter with a diameter
4 of less than or equal to 2.5 micrometers (PM_{2.5}). The construction equipment fuel use, emission
5 factors, and other supporting information can be found in Argonne (2010).

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8 **D.7.2 Operations**

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10 Data on annual facility wastes are provided in Table D-16. Data on emissions from fixed
11 facility sources and from mobile sources are provided in Tables D-17 and D-18, respectively. A
12 fixed facility source would be the process steam boiler used for space and water heating and
13 periodic testing of backup diesel generators for electrical power. Mobile emission sources would
14 include tractor trailers, end-loaders, cranes, and forklifts.

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17 **D.8 TRANSPORTATION**

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20 **D.8.1 Construction**

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22 Local transportation of workers and materials could lead to significant amounts of vehicle
23 emissions that could affect the local air quality. Large volumes of materials, especially sand and
24 backfill, would be required for the construction of the GTCC waste disposal facility.

25 Approximately 9,200, 36,600, or 74,200 truck shipments for trench, borehole, or vault disposal,

26

TABLE D-16 Annual Wastes during Operations

Waste Category	Treatability Category	Average Annual Generation Rate		
		Trench	Borehole	Vault
Radioactive waste				
Liquid LLRW (water from truck washdown ^a) (gal)	Liquid LLRW	790,000	170,000	780,000
Solid LLRW (including HEPA filters ^b) (yd ³)	Combustible and noncombustible solid LLRW	16	10	16
Nonradioactive waste				
Liquid nonhazardous (sanitary) wastes (gal)	NA ^c	310,100	240,000	320,000
Solid nonhazardous wastes ^d (yd ³)	NA	120	95	120

^a The water used to wash down the truck after it delivered the GTCC waste to the disposal facility could be contaminated (but that is not likely). This analysis conservatively assumes that the washdown water would be considered liquid LLRW until determined otherwise.

^b HEPA = high-efficiency particulate air.

^c NA = not applicable.

^d Solid nonhazardous wastes include domestic trash and office waste.

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TABLE D-17 Estimated Annual Emissions of Criteria Pollutants from Fixed Facility Emission Sources

Criteria Pollutant	Mission-Critical Equipment Emissions (tons/yr)			Process Steam Boiler Emissions (tons/yr)		
	Trench	Borehole	Vault	Trench	Borehole	Vault
SO ₂	3.57E-02	3.57E-02	3.57E-02	3.4E-03	3.4E-03	3.4E-03
NO _x	5.44E-01	5.44E-01	5.44E-01	2.8E-01	2.8E-01	2.8E-01
CO	1.17E-01	1.17E-01	1.17E-01	4.7E-01	4.7E-01	4.7E-01
PM ₁₀	1.26E-02	1.26E-02	1.26E-02	4.3E-02	4.3E-02	4.3E-02
PM _{2.5}	1.26E-02	1.26E-02	1.26E-02	4.3E-02	4.3E-02	4.3E-02
CO ₂	2.03E+01	2.03E+01	2.03E+01	6.7E+02	6.7E+02	6.7E+02

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TABLE D-18 Estimated Annual Emissions of Criteria Pollutants from Mobile Sources^a

Criteria Pollutant	Mobile Equipment Emissions (tons/yr)		
	Trench	Borehole	Vault
SO ₂	3.23E+00	1.20E+00	3.27E+00
NO _x	2.58E+01	9.06E+00	2.59E+01
CO	1.25E+01	4.63E+00	1.26E+01
PM ₁₀	2.38E+00	8.46E-01	2.39E+00
PM _{2.5}	2.12E+00	7.53E-01	2.12E+00
CO ₂	2.34E+03	8.73E+02	2.37E+03

^a Mobile emission sources include forklifts and mobile cranes.

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respectively, would be required, as summarized in Table D-19. Estimated emissions from these shipments are provided in Table D-20. The emission factors used in the calculations are given in Table D-21. Additional vehicles required for worker intrasite transportation would also result in some emissions during construction, as shown in Table D-20, which also provides estimates for emissions as a result of worker commuter trips.

10 D.8.2 Operations

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Estimated emissions for local transportation of disposal site workers (i.e., daily commutes) are provided in Table D-22.

16 D.9 WASTE ISOLATION PILOT PLANT

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The primary source of information for estimating the impacts of disposing of the GTCC LLRW and the GTCC-like waste at the Waste Isolation Pilot Plan (WIPP) (Alternative 2) is Sandia (2008b). The following text provides supplemental information for estimating the incremental air emissions during construction of the additional underground rooms required to emplace the waste and during disposal operations.

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25 D.9.1 Construction

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Emissions from construction of the underground rooms would result from underground haul trucks taking the mined salt to the waste hoist and surface haul trucks taking the mined salt from the waste hoist to the Salt Storage Area. The miner itself is powered by electricity and thus

TABLE D-19 Rough Order-of-Magnitude Estimate of the Number of Truck Shipments of Construction Materials^a

Resource	Truck Capacity	Total Consumption			No. of Truck Shipments		
		Trench	Borehole	Vault	Trench	Borehole	Vault
Portland cement (yd ³) ^b	10	2,816	2,046	9,702	282	205	971
Gravel (yd ³) ^b	10	46,596	32,926	192,562	4,660	3,293	19,257
Sand (yd ³) ^b	10	10,256	32,736	221,232	1,026	3,274	22,124
Clay (yd ³)	10	12,900	5,180	56,000	1,290	518	5,600
Steel (tons) ^c	21	2,000	1,400	7,960	96	67	380
Asphalt paving (tons) ^d	20	600	900	700	30	45	35
Backfill (yd ³) ^e	10	–	–	254,000	–	–	25,400
Diesel fuel (gal) ^f	9,000	7.5E+05	2.0E+06	3.4E+06	84	226	376
Excavated materials	10	62,000	294,400	–	6,200	29,440	–
Total (rounded up)					13,700	37,100	74,200

- ^a Calculation neglects truck deliveries of process equipment and related items (which should be low in comparison with other shipments). A dash means not applicable.
- ^b Assumes that concrete is composed of 11% Portland cement, 41% gravel, and 26% sand and is shipped to the site in a standard 10-yd³ (7.6-m³) end-dump truck.
- ^c Assumes that the net payload for steel transport to site is 42,000 lb (19,000 kg).
- ^d Assumes hot mix asphalt is loaded into the 20-ton-capacity tri-axle trucks for transport to the paving site.
- ^e Assumes that shipment uses standard 10-yd³ (7.6-m³) end-dump trucks.
- ^f Assumes that shipment uses a U.S. Department of Transportation (DOT) 406/MC-306 atmospheric-pressure tank truck with a 9,000-gal (34,000-L) capacity.

TABLE D-20 Estimated Annual Emissions from Construction Vehicles^a

Criteria Pollutant	Delivery Vehicle Emissions (tons) ^b			Support Vehicle Emissions (tons) ^c			Worker Commuter Vehicle Emissions (tons) ^d		
	Trench	Borehole	Vault	Trench	Borehole	Vault	Trench	Borehole	Vault
SO _x	1.09E-04	2.96E-04	5.92E-04	1.66E-04	5.35E-05	4.87E-04	2.62E-03	8.26E-04	7.73E-03
NO _x	6.85E-03	1.86E-02	3.71E-02	1.04E-02	3.36E-03	3.06E-02	6.15E-02	1.94E-02	1.82E-01
CO	2.62E-02	7.09E-02	1.42E-01	3.99E-02	1.28E-02	1.17E-01	1.63E+00	5.16E-01	4.82E+00
PM ₁₀	1.43E-03	3.88E-03	7.77E-03	2.19E-03	7.02E-04	6.40E-03	1.26E-02	3.99E-03	3.74E-02
PM _{2.5}	7.63E-04	2.07E-03	4.13E-03	1.16E-03	3.74E-04	3.41E-03	6.10E-03	1.93E-03	1.80E-02
VOCs	4.28E-03	1.16E-02	2.32E-02	6.52E-03	2.10E-03	1.91E-02	7.85E-02	2.48E-02	2.32E-01
CO ₂	1.59E+01	4.29E+01	8.59E+01	2.42E+01	7.77E+00	7.08E+01	1.66E+02	5.23E+01	4.89E+02

^a Assumes a construction period of 20 years.

^b Estimates of 13,700, 37,100, and 74,200 auto one-way trips to the construction site are based on the total number of deliveries for trench, borehole, or vault construction, respectively. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distances.

^c Assumes one support vehicle per 30 construction workers (824, 260, or 2,434 FTEs assumed for trench, borehole, or vault construction, respectively), as taken from LLNL (1997) and NRC (1994). Assumes that 10 mi (16 km) are travelled per day per vehicle, as taken from Table 4.5 on page 4-15 of NRC (1994).

^d Estimates of 9,885, 3,123, and 29,212 auto one-way trips to the construction site are based on the total construction personpower for trench, borehole, or vault facility construction, respectively. Assumes 240 workdays per year. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distance.

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TABLE D-21 Criteria Pollutant Vehicle Emission Factors

Criteria Pollutant	Emission Factor (g/mi) ^a		
	Delivery Vehicle	Support Vehicle	Commuter Vehicle
SO _x	0.00225	0.00225	0.006
NO _x	0.141	0.141	0.141
CO	0.539	0.539	3.745
PM ₁₀	0.0295	0.0295	0.029
PM _{2.5}	0.0157	0.0157	0.014
VOCs	0.0880	0.0880	0.18
CO ₂	326	326	380

^a Emission factors were determined by using Argonne GREET 2.8a Version (version date: August 30, 2007) available at http://www.transportation.anl.gov/software/GREET/greet_2-8a_beta.html.

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TABLE D-22 Estimated Annual Emissions from Commuter Vehicles

Criteria Pollutant	Commuter Vehicle Emissions (tons/yr) ^a		
	Trench	Borehole	Vault
SO _x	3.1E-03	2.4E-03	3.2E-03
NO _x	7.2E-02	5.7E-02	7.5E-02
CO	1.9E+00	1.5E+00	2.0E+00
PM ₁₀	1.5E-02	1.2E-02	1.5E-02
PM _{2.5}	7.1E-03	5.6E-03	7.5E-03
VOCs	9.2E-02	7.2E-02	9.6E-02
CO ₂	1.9E+02	1.5E+02	2.0E+02

^a Estimates of 11,548, 9,117, and 12,116 one-way auto trips to the disposal facility are based on the total operational personpower for trench, borehole, or vault facility construction, respectively. Assumes 240 workdays per year. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distance.

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1 would not produce any direct emissions. The assumed
 2 construction period for the additional 26 rooms is 20 years.
 3 The estimated annual emissions, based on 23,700 tons of
 4 salt mined per room (Sandia 2008b), are shown in
 5 Table D-23 for the criteria pollutants. Estimates are based
 6 on the fuel consumption of the haul trucks given in
 7 Table D-24 and the vehicle emission factors provided in
 8 Table D-25.

11 D.9.2 Operations

13 The estimated emissions from operations at WIPP to
 14 dispose of the GTCC LLRW and GTCC-like waste would
 15 result from the equipment that moves disposal packages
 16 underground. For CH waste, a waste transporter moves the
 17 package from the waste hoist to a disposal room, where a
 18 20-ton forklift subsequently moves the waste to its
 19 emplacement location. For RH waste, it is assumed that a
 20 41-ton forklift would move the disposal package from the
 21 hoist to its emplacement location (Sandia 2008b).
 22 Table D-26 summarizes the effort involved on an annual
 23 basis.

25 From Table D-26, the average annual hours of operation for each piece of equipment
 26 were estimated: 539, 941, and 1,432 hours, respectively, for the 20-ton forklift, the waste
 27 transporter, and the 41-ton forklift. The annual average emissions were then estimated by using
 28 the emission factors given in Table D-27, as shown in Table D-28.

TABLE D-24 Annual Diesel Fuel Use for Construction of the Additional Disposal Rooms at WIPP

Type of Haul Truck	Diesel Fuel Use per Room (gal) ^a	Duration per Room (h) ^a	No. of Rooms per Year ^b	Duration per Year (h)	Diesel Fuel Use per Year (gal)
185-hp underground	11,440	1,082.2	1.3	1,407	14,872
Surface	3,160	105.3	1.3	137	4,108

^a Source: Sandia (2008).

^b Assumes 20-year period to construct the 26 additional rooms required for GTCC LLRW and GTCC-like waste.

TABLE D-23 Air Emissions during Construction at WIPP

Criteria Pollutant	Total Emissions (tons)	Annual Emissions (tons/yr)
VOCs	2.9	0.14
NO _x	28.7	1.4
SO ₂	4.7	0.23
CO	19.4	0.97
PM ₁₀ ^b	36.5	1.8
PM _{2.5} ^c	28.1	1.4
CO ₂	3,734	186.7

^a Calculated by using EPA methodology for coal mining (<http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf>).

^b Assumes 89% of combustion PM₁₀ is PM_{2.5} (www.aqmd.gov/CEQA/handbook/PM2_5/handout1.doc).

TABLE D-25 Construction Equipment Fuel Consumption and Emission Factors

Type of Haul Truck	Consumables (gal/h)		Emission Factor (lb/1,000 gal)					
	Diesel	Oil and	VOCs	NO _x	SO ₂	CO	PM ₁₀ ^a	CO ₂
	Fuel	Grease						
185-hp underground	10.6	0.2	17.1	171.7	31.2	123.5	16.8	22,600.0
Surface	30.0	0.2	0.2	2.3	0.0	0.8	0.1	272.3

^a These emission factors are for combustion-derived PM₁₀ emissions and do not include the fugitive dust component.

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TABLE D-26 Annual Equipment Usage for Disposal of Waste at WIPP

Equipment	Horsepower Rating ^a	Time per Disposal Package (min) ^a	Estimated Diesel Usage (gal) ^a	Average No. of Disposal Packages/yr ^b	Average Diesel Usage (gal/yr)
20-ton forklift (diesel)	94	10	0.9	3,230	2,910
Waste transporter (diesel)	138	20	2.6	2,820	7,340
41-ton forklift (diesel) – RH	231	60	13.2	1,430	18,900
Total					29,200

^a Source: Sandia (2008b).

^b Average estimated for operations is based on the assumption that the majority of the waste disposed of annually at WIPP is composed of GTCC LLRW and GTCC-like waste.

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TABLE D-27 Equipment Emission Factors

Criteria Air Pollutant	Emission Factor (lb/horsepower per hour)		
	20-ton Forklift	41-ton Forklift	Waste Transporter
SO ₂	1.87E-03	1.87E-03	1.87E-03
NO _x	1.15E-02	9.92E-03	9.92E-03
CO	2.20E-03	2.20E-03	2.20E-03
PM ₁₀	1.59E-03	8.82E-04	8.82E-04
PM _{2.5}	1.41E-03	7.85E-04	7.85E-04
VOCs	8.82E-04	8.82E-04	8.82E-04
CO ₂	1.15E+00	1.15E+00	1.15E+00

Source: www.aqmd.gov/CEQA/documents/2005/nonaqmd/chevron/appB.xls.

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TABLE D-28 Estimated Average Annual Emissions of Criteria Pollutants from GTCC LLRW and GTCC-Like Waste Emplacement at WIPP

Criteria Air Pollutant	Annual Average Emissions (tons/yr)
SO ₂	4.8E-01
NO _x	2.6E+00
CO	5.6E-01
PM ₁₀	2.4E-01
PM _{2.5}	2.2E-01
VOCs	2.3E-01
CO ₂	2.9E+02

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37

APPENDIX E:**EVALUATION OF LONG-TERM HUMAN HEALTH IMPACTS FOR THE NO ACTION ALTERNATIVE AND THE LAND DISPOSAL ALTERNATIVES**

This appendix presents the approach used to evaluate the long-term impacts on human health that could result from the No Action Alternative in Chapter 3 and the land disposal alternatives (via the borehole, trench, or vault disposal methods) in Chapters 6 through 12 considered in the Greater-Than-Class C (GTCC) Environmental Impact Statement (EIS). The approach used to evaluate long-term impacts on human health from use of the Waste Isolation Pilot Plant (WIPP) deep geologic repository is presented in Chapter 4. The RESRAD-OFFSITE computer code (Yu et al. 2007), with site-specific parameters to the extent that this information was available, was used to perform the analyses for the three land disposal methods at the six federal and four generic commercial sites. This computer code was also used to evaluate the long-term human health impacts for the No Action Alternative. The information given in this appendix summarizes the approach and results described in Argonne (2010). A number of simplifying assumptions are made for the purposes of the comparative analysis in this EIS, especially in terms of the long-term performance of engineered materials assumed for the borehole, trench, and vault disposal facilities. It is expected that detailed, site-specific assessments that would include more specific calculations on the physical and chemical performance of different engineered materials would be made before implementation of any alternative.

For the No Action Alternative, it is assumed that the long-term human health impacts would be limited to members of the general public who might be exposed to GTCC wastes stored in facilities located within the four NRC regions. For the land disposal alternatives, it is assumed that the long-term human health impacts would be limited to members of the general public who might be exposed to radioactive contaminants released from the waste packages after the engineering barriers (including the cover) and waste containers failed. Direct intrusion into the waste disposal units is considered to be a very unlikely event and is not addressed in this appendix; this issue is addressed in Section 5.5. A number of markers and barriers would be placed on, in, and near the closed disposal facility to prevent intrusion into the buried wastes. The impacts from direct intrusion into the disposal facility are therefore addressed qualitatively in the EIS.

There are three release mechanisms considered in RESRAD-OFFSITE that can lead to contamination at off-site locations: airborne releases, surface runoff, and leaching (see Section E.1). However, only two of these mechanisms are considered significant and applicable to storage or disposal of GTCC wastes in the long term: (1) airborne releases and (2) leaching of radioactive contaminants from the waste containers or packages, with transport to groundwater and migration to an accessible location, such as a groundwater well. These two mechanisms are addressed in this EIS to determine the impacts on off-site members of the general public following closure of the storage or disposal facility. Surface runoff is not considered to be a viable pathway, given the depth of the disposal facility cover and use of good engineering practices during closure of the disposal facility, which would include measures to minimize erosion by surface water.

1 Airborne releases could include gases (e.g., radon, carbon dioxide [CO₂], and water
2 vapor containing tritium [H-3]) and particulates if the disposal facility cover was completely lost
3 through erosion. Particulate radionuclide emissions are not expected to be significant, because it
4 is very unlikely that the thick disposal facility cover would be completely lost through erosion. In
5 addition, any material removed from the facility surface cover by erosion or weathering could be
6 replaced to some extent by nearby soil similarly removed. Potential radiation doses to individuals
7 from gaseous releases are expected to be small because the gases would have to diffuse through
8 the thick covers placed on top of the waste disposal units.

9
10 Standard engineering practices and measures would be taken in designing and
11 constructing the disposal facility to ensure long-term stability and to minimize the likelihood of
12 contaminant migration from the wastes to the surrounding environment. The facility would be
13 sited in a location consistent with applicable requirements, which would include the
14 consideration of geologic characteristics, to minimize events that could compromise the
15 containment characteristics of the disposal facilities in the long term. It is expected that the use
16 of engineering controls in concert with the natural features of the selected site would ensure the
17 long-term viability of this facility.

18
19 The groundwater pathway is generally the pathway of most concern with regard to
20 addressing the post-closure impacts on the general public from a disposal facility for GTCC
21 LLRW and GTCC-like wastes, and this pathway is the focus of this appendix. Releases to
22 surface water would only occur once the entire engineered cover over the disposed wastes had
23 eroded away. Because of the thick cover layer and the use of very robust engineering techniques
24 to construct it, it was assumed for the analyses in the EIS that the buried GTCC wastes would
25 always be overlain by some cover material through 10,000 years, eliminating surface water
26 runoff as a potential exposure mechanism for the action alternatives.

27
28 Even if releases to surface water were to occur, it is not expected that these releases
29 would be significant or result in higher peak annual doses or latent cancer fatality (LCF) risks
30 than would releases to groundwater. The disposal facility and waste containers are assumed to
31 maintain their integrity for at least 500 years, and this factor would allow many of the shorter-
32 lived radionuclides to decay to innocuous levels prior to any releases to the environment. In
33 addition, it is expected that releases to surface water would be much more diluted in the
34 environment (such as in a river or lake) before being ingested by the hypothetical receptor than
35 would comparable releases to groundwater (in which case the hypothetical receptor would
36 extract water for use from a well). Because of this smaller amount of dilution, the groundwater
37 pathway would likely be much more significant than the surface water pathway.

38
39 Since the travel time to a hypothetical receptor would likely be shorter for any releases to
40 surface water than for releases to groundwater, the time at which the peak annual dose and LCF
41 risk would occur could be sooner for the surface water pathway than the groundwater pathway.
42 However, this is not expected to have a significant impact on the peak annual dose or LCF risk,
43 because the radionuclides that would cause most of the dose have very long half-lives. That is,
44 the additional time to reach a hypothetical receptor through groundwater would not result in any
45 appreciable additional reduction in the radionuclide concentrations causing most of the impacts

1 due to radioactive decay. For these reasons, the groundwater pathway is considered to be the
2 most significant pathway in the long term in this EIS.

3
4 An analysis similar to that done for the land disposal alternatives was done for the No
5 Action Alternative (see Chapter 3). Under this alternative, no credit is taken for maintenance of
6 the stored GTCC wastes beyond 100 years. That is, it is assumed for analysis purposes in this
7 EIS that after 100 years, water could contact the radioactive contaminants in the waste packages
8 and leach radionuclides from the wastes, and that these radionuclides could then move toward
9 the underlying groundwater system. While airborne releases from degraded containers could
10 occur, it is expected that the dispersion of any released radionuclides by the wind would greatly
11 decrease the air concentrations. In addition, it is expected that surface runoff would not be a
12 major concern with regard to this alternative in the long term, because the storage sites would
13 probably have berms or other engineered features to minimize water runoff from the site.

14
15 The highest doses associated with the No Action Alternative would therefore probably be
16 those associated with the migration of radionuclides to groundwater that would subsequently be
17 used by members of the general public. Focusing on the groundwater pathway for this alternative
18 also allows for a more direct comparison of the long-term impacts from the No Action
19 Alternative with the post-closure impacts given for the action alternatives.

20 21 22 **E.1 RESRAD-OFFSITE COMPUTER CODE**

23
24 The RESRAD-OFFSITE computer code (Yu et al. 2007) is an extension of the original
25 RESRAD code (Yu et al. 2001) developed by Argonne National Laboratory for the
26 U.S. Department of Energy (DOE). The original (on-site) RESRAD code was developed to
27 address exposure pathways relevant to an individual exposed to residual radioactive soil
28 contamination. This focus allowed for the development of soil cleanup criteria for various
29 exposure scenarios, and RESRAD was largely used to develop cleanup criteria for radioactively
30 contaminated soil in support of DOE remedial action projects.

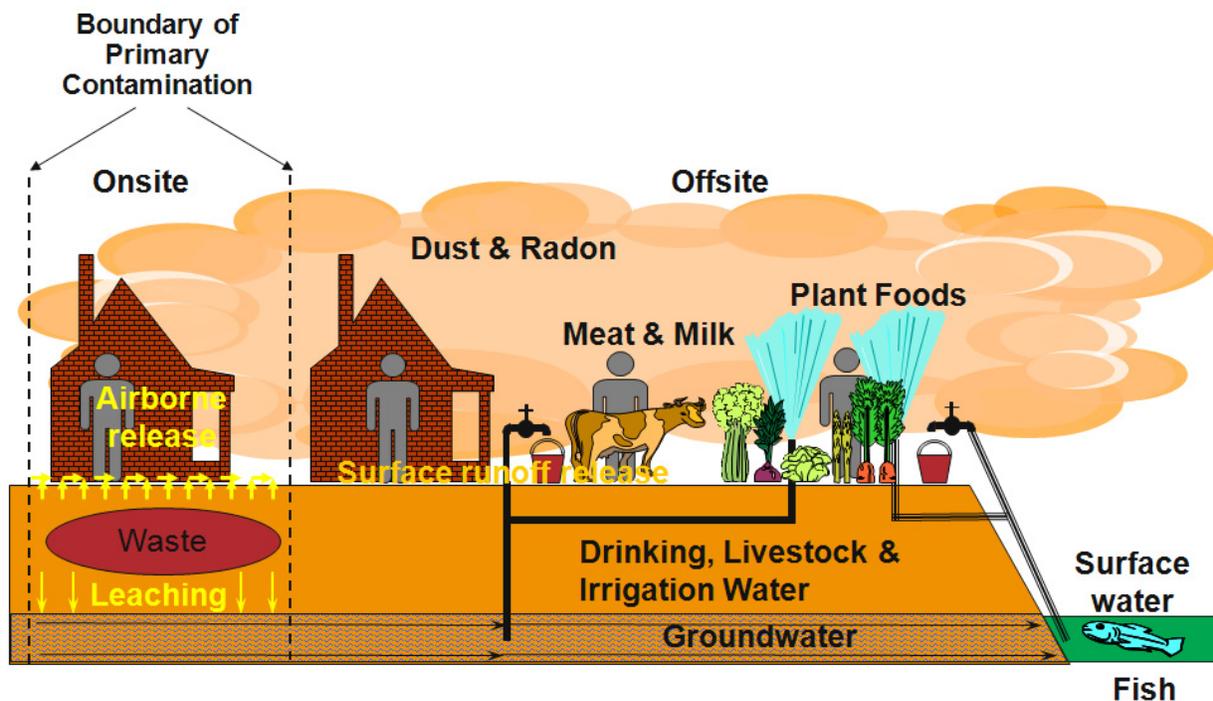
31
32 This code was expanded in RESRAD-OFFSITE to address the radiological consequences
33 to a receptor located either on-site or outside the area of primary contamination. The expanded
34 code can be used to calculate the radiological dose and excess lifetime cancer risk to various
35 receptors by using dose coefficients and radionuclide slope factors from the U.S. Environmental
36 Protection Agency (EPA) and International Commission on Radiological Protection (ICRP).
37 Although this code, too, was developed largely to address soil cleanup guidelines corresponding
38 to a specified dose limit, it has a number of features that make it a good choice for use in the
39 analyses done for this EIS.

40
41 The following discussion on the use of RESRAD-OFFSITE focuses on the use of this
42 code for the action alternatives. The same general approach that was used for the action
43 alternatives was used for the No Action Alternative. The simulation approach for the action
44 alternatives is described in Section E.2, and the approach used for the No Action Alternative is
45 described in Section E.3.

1 The RESRAD-OFFSITE computer code allows for the initial radiological contamination
 2 to be in environmental settings ranging from those involving surficial contamination to situations
 3 in which a clean cover layer overlies a zone of radioactive contamination. This latter situation
 4 simulates the closed land disposal facilities for GTCC wastes addressed in this EIS, in which
 5 there is an overlying soil cover over the disposed-of wastes (the zone of radioactive
 6 contamination). The RESRAD-OFFSITE computer code can incorporate the presence of up to
 7 five partially saturated layers below the contaminated zone, a feature that is advantageous for
 8 delineating the various sites addressed in this EIS. The RESRAD-OFFSITE code is more flexible
 9 than the original RESRAD code in that it has the capability to not only model the radiation
 10 exposure of an individual who spends time directly above the primary zone of radioactive
 11 contamination (on-site) but also one who spends time away from the primary contamination
 12 (off-site), which is the application that is most useful for this EIS.

13

14 As noted previously, there are three types of releases that can lead to contamination at
 15 off-site locations (Figure E-1) that are addressed by RESRAD-OFFSITE: airborne releases,
 16 surface runoff, and leaching. Airborne releases can lead to the off-site releases of either
 17 particulates or gases (such as radon). Particulate releases are limited to sites having surficial soil
 18 contamination, while gases can be released from buried materials following their upward
 19 movement from the radioactive contamination source through any overlying cover materials. For
 20 this EIS, particulate releases are expected to be very unlikely given the thick covers overlying the
 21 disposed-of wastes. In addition, any such releases would be greatly diluted in the atmosphere,
 22 such that potential doses to members of the general public would be very low. The only
 23 radionuclides that would be subject to airborne releases are gases, because the surface soil cover
 24



25

26 **FIGURE E-1 Environmental Release Mechanisms and Exposure Pathways Considered**
 27 **in RESRAD-OFFSITE**

28

1 is assumed to remain sufficiently intact so as to not expose the buried wastes to the atmosphere.
2 That is, it is assumed in the EIS analyses that the soil cover is not completely removed with
3 regard to all of the sites and disposal methods.
4

5 The second release mechanism (surface runoff) is also considered to not be relevant to
6 the analysis conducted for this EIS. This mechanism addresses the loss of surficial contamination
7 by precipitation that flows along the slope of the ground surface to the surrounding area. In the
8 RESRAD-OFFSITE code, any radioactively contaminated material removed by surface runoff is
9 modeled as a release to a nearby surface water body. This exposure pathway is not relevant to
10 this assessment because it is assumed that the disposed-of wastes would always be overlain by
11 some clean soil cover.
12

13 The third release mechanism considered by RESRAD-OFFSITE is the leaching of
14 radionuclides by precipitation that percolates through the contaminated waste zone. This is the
15 pathway of most concern in the post-closure assessment of potential human health impacts. For
16 this EIS, it is assumed that once contamination reaches the groundwater, it is removed by a
17 hypothetical individual using a well. Radionuclides in groundwater can also be discharged to a
18 surface water body, but this would result in much lower concentrations of radionuclides due to
19 dilution. For conservatism, groundwater was assumed to be the sole source of potable water for
20 the hypothetical individual for assessing the post-closure impacts.
21

22 Since RESRAD-OFFSITE does not contain features to simulate the movement of
23 percolating water over the various layers of an engineered cover or the degradation of waste
24 containers over time, simplifying assumptions were made in this analysis. For example, the
25 engineered barriers and waste containers were assumed to begin to degrade and fail 500 years
26 after closure of the disposal facility. This is a conservative assumption that was used because
27 RESRAD-OFFSITE does not have the capability to calculate a container failure distribution.
28 This adds conservatism to the results presented in this EIS.
29

30 However, RESRAD-OFFSITE does have features that allow a reasonable estimate to be
31 made of the release of radioactive contaminants from the GTCC wastes. Specifically, the code
32 uses a rate-controlled release to model the quantity of contaminants that can be removed by
33 leaching from the wastes as water flows down through the primary zone of contamination. The
34 release rate can be specified to vary as a function of time and is used by RESRAD-OFFSITE to
35 simulate the entry of radionuclides into the percolating water with subsequent transport in the
36 unsaturated zone(s) and groundwater aquifer. This is a very useful feature of this code for use in
37 the EIS analyses, because it allows the source term (GTCC waste) to have any physical or
38 chemical form. What needs to be specified is the release rate of the radionuclides from the
39 source.
40

41 The RESRAD-OFFSITE groundwater transport model simulates the convection and
42 dispersion of radionuclides in the liquid phase during transport in soils. Some sites have very
43 uniform settings, and parameters can be selected to represent soil properties on the basis of the
44 measurements taken in site soils. Other sites have much more complicated geological settings,
45 and they can include fracture flow. In these cases, it is important to select the parameter values
46 that best represent flow conditions in the local environment so that these conditions can be

1 adequately modeled with the RESRAD-OFFSITE computer code. For example, in the analyses
2 for disposal of GTCC LLRW and GTCC-like waste at Idaho National Laboratory (INL), a
3 distribution coefficient (K_d) value of zero was specified for all radionuclides for the thick-flow
4 basalt layers. This selection was made to simulate the fracture flow condition in which water
5 flows through the basalt layers quickly, leaving little contact time for dissolved radionuclides to
6 be adsorbed to the solid phase.

7

8 In evaluating the movement of radionuclides through the environment, the RESRAD-
9 OFFSITE computer code addresses radioactive decay and ingrowth of progeny radionuclide(s).
10 This capability is one of the major reasons RESRAD-OFFSITE was selected for use in this EIS.
11 Many of the radionuclides in the GTCC wastes (in particular, the actinide elements) are present
12 in long decay chains, and it is necessary to accurately account for the decay and ingrowth of all
13 radionuclides that could affect a potential receptor in the long-term future. The RESRAD code
14 has been used in a number of situations addressing radionuclide decay and ingrowth during
15 groundwater transport, and it has been shown to provide good estimates of this effect.

16

17 In addition to simply accounting for decay and ingrowth of radioactive progeny as the
18 primary radionuclides move through the environment, RESRAD-OFFSITE uses radionuclide-
19 specific retardation factors to address the effects of sorption and desorption on the transport
20 speed through soil. This feature allows the code to simulate the different rates at which
21 radionuclides in the same decay chain move in the environment. Numerical methods are
22 employed in RESRAD-OFFSITE to evaluate the analytical solutions to the differential equations
23 that characterize the behavior of radionuclides being transported in the unsaturated and saturated
24 zones. To increase the precision of the calculation results in this EIS, the saturated zone was
25 further divided to smaller sublayers.

26

27 While other computer models have features that could be used to support this analysis,
28 use of these codes would not significantly improve the results presented in the EIS. The results
29 of most interest were the estimated peak annual dose and peak annual LCF risk in the first
30 10,000 years. If the peak annual impacts did not occur within 10,000 years, the analysis was
31 extended out to 100,000 years. The radionuclides that would cause most of the dose have long
32 half-lives (C-14, Tc-99, I-129, and isotopes of uranium and plutonium), and the peak annual
33 dose, in many cases, would occur in the distant future. Because of this, it was not necessary to
34 know in great detail the exact mechanisms by which the radionuclides from the site would be
35 released in order to perform this comparative assessment.

36

37 A number of the computer codes considered for this analysis require detailed information
38 on the engineering design and the specific materials used to construct the facility, which are
39 generally lacking at this point in the process. Also, although these codes might improve the
40 estimates for the first few hundred years, or even a thousand years, they provide no information
41 to address the conditions of the engineered barriers and waste containers and their performances
42 over the very long time frame necessary for this EIS. After radionuclides would be released from
43 the disposal unit, they would travel through the various layers of soils underneath the disposal
44 facility to reach the groundwater table and then travel in the groundwater aquifer to arrive at the
45 receptor location. The time that the radionuclides would spend traveling in soils could be
46 thousands of years or even longer, and the potential radioactive ingrowth and decay and the

1 different transport speeds between parent and progeny radionuclides could significantly affect
2 the groundwater concentrations.

3
4 The RESRAD-OFFSITE code has the ability to simulate the transport of radionuclides in
5 the vadose zone and saturated zone, and this capability has been demonstrated in the past.
6 Although the code does not have the ability to estimate distributed container failure over time, it
7 has provisions that allow users to bypass the release rate calculations and accept the input release
8 rates of radionuclides as a function of time.

9
10 There are other computer codes with functions similar to those of RESRAD-OFFSITE.
11 Some neglect the ingrowth of progeny nuclides during transport; some consider ingrowth by
12 assuming progeny nuclides are transported at the same speed as are parent nuclides. Others
13 consider both ingrowth of progeny and different transport speeds of parents and progeny but
14 employ numerical analysis methods that would take very long (unrealistic) computation times for
15 simulations that are run over 10,000 or 100,000 years. The precision of results from a numerical
16 analysis can be greatly affected when the analysis is extended to such a long period of time as
17 that required by this EIS.

18
19 Given the complexity of the facility design, the various physical and chemical
20 compositions of waste, the complexity of the actual geologic nature and hydrogeologic nature of
21 the candidate sites, and the unknown behavior of the engineered barriers and waste containers
22 over a very long period of time, estimates of the peak annual radiation doses and LCF risks to
23 human health are very difficult to predict over the time periods considered in the EIS.
24 Assumptions were made to simplify the impact analysis, and these were applied in a uniform
25 manner across the different sites. This allows a comparison to be made of the relative merits of
26 the various disposal alternatives and sites considered in the EIS. These results would not be
27 significantly affected if other computer codes were utilized in the analysis.

28
29 RESRAD-OFFSITE also accounts for the accumulation of radionuclides at off-site
30 locations through dust deposition and water irrigation. Water irrigation can lead to the
31 accumulation of radionuclides in soil, which is significant for the hypothetical off-site receptor
32 considered in the EIS (i.e., a resident farmer).

33
34 The RESRAD-OFFSITE methodology has been used in two model validation studies: the
35 Biospheric Model Validation Study II (BIOMOV II) program and the Environmental Modeling
36 for Radiation Safety (EMRAS) program (BIOMOV II 1996; IAEA 1996). Both programs were
37 organized by the International Atomic Energy Agency (IAEA). Currently, the EMRAS Naturally
38 Occurring Radioactive Material Working Group is using RESRAD-OFFSITE for a model
39 comparison study with area source scenarios. This level of validation supports the use of this
40 code in performing the comparative evaluation in this EIS.

41 42 43 **E.2 SIMULATION APPROACH FOR THE LAND DISPOSAL ALTERNATIVES**

44
45 Potential long-term impacts on human health that could result from the disposal of GTCC
46 LLRW and GTCC-like wastes were analyzed in this EIS by using the RESRAD-OFFSITE

1 computer code, as summarized above. Additional details on this computer code are presented in
2 its user manual, which can be reviewed for more information (Yu et al. 2001). This section
3 discusses the exposure scenario and source term assumptions used for the analyses.
4
5

6 **E.2.1 Exposure Scenario and Pathways**

7

8 The assessment of long-term impacts on human health from the closed disposal facility
9 requires the identification of an appropriate exposure scenario. Proper site selection and proper
10 design, closure, and post-closure monitoring and maintenance of the facility would reduce the
11 likelihood, to the extent possible, that anyone would actually be exposed to the radioactive
12 contaminants in the wastes. A hypothetical resident farmer exposure scenario was selected for
13 performing a comparative analysis in this EIS as a conservative approach. This scenario is
14 unlikely to occur at the federal sites evaluated in this EIS, since current land use designations for
15 the reference locations do not include residential use. The results presented here should not be
16 used for regulatory compliance purposes in the future, and they should not be compared with
17 site-specific performance assessments that have been conducted for existing waste disposal
18 facilities. Such assessments are based on site-specific exposure scenarios and conditions.
19 However, the assessment in this EIS does provide useful information to guide the decision-
20 making process for identifying the most appropriate method to manage these GTCC wastes.
21

22 For the analysis of long-term impacts on human health after closure of the disposal
23 facility, a hypothetical resident farmer is assumed to move near the site and reside in a house
24 located 100 m (330 ft) from the edge of the disposal facility boundary. This location was selected
25 because it is consistent with the minimum buffer zone distance surrounding a DOE LLRW
26 disposal site identified in DOE Manual 435.1-1 (DOE 1999). This DOE *Radioactive Waste*
27 *Management Manual* notes that a larger or smaller buffer zone for a DOE LLRW disposal
28 facility may be used if adequate justification is provided. No additional distance beyond this
29 minimum buffer zone of 100 m (330 ft) from the edge of the disposal facility is assumed in this
30 analysis. This assumption is conservative since the federal sites considered in this EIS are very
31 large, and a significant buffer zone of greater than 100 m (330 ft) would likely be employed for
32 this disposal facility. An evaluation of the reduction in the potential radiation dose to this
33 hypothetical receptor at greater distances is given in Section E.6.
34

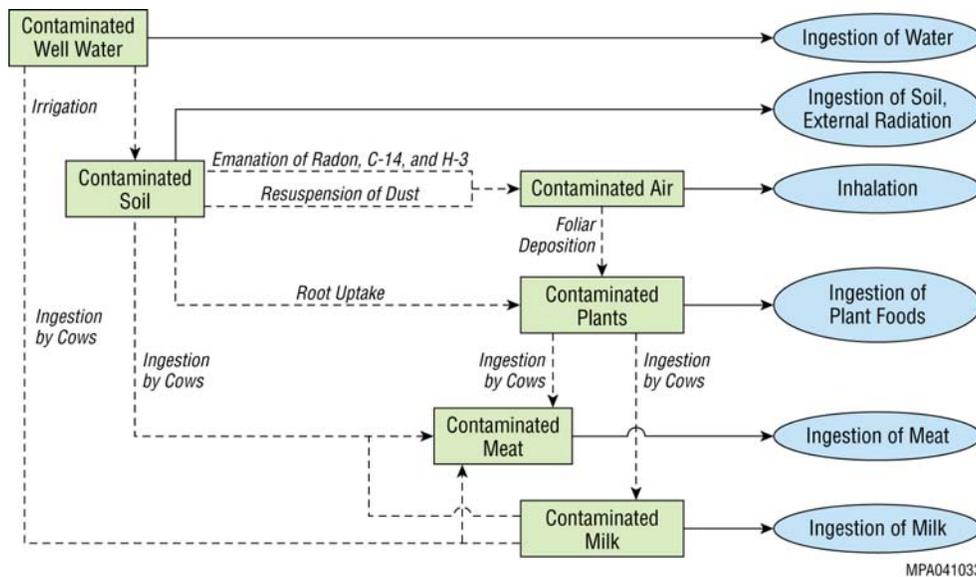
35 For this analysis, a hypothetical individual is assumed to move to this location and
36 develop a farm. This resident farmer is then assumed to develop a groundwater well as the sole
37 source of water (for drinking, household use, irrigation, and feeding livestock) and to obtain
38 much of his/her food (fruits, vegetables, meat, and milk) from the farm. A hypothetical resident
39 farmer was selected for this evaluation because this scenario would involve the most intensive
40 use of the land, and this receptor would thus incur the highest dose of any potential receptor in
41 the future. As mentioned previously, the assumption of a resident farmer presents a potentially
42 conservative bias against sites where such a scenario is less likely. However, the use of the same
43 exposure scenario at all sites provides a common basis for comparison of the results for the sites
44 considered in this EIS. DOE will consider the result of the hypothetical resident farmer scenario
45 and other factors in developing the preferred alternative as discussed in Section 2.9.
46

1 The hypothetical resident farmer could be exposed to airborne contaminants, including
 2 particulates, radon gas and its short-lived decay products, and gaseous radionuclides such as
 3 C-14 (in the form of CO₂) and H-3 (in the form of water vapor). These gases could diffuse out of
 4 the waste containers and move through the disposal facility cover and then be transported by the
 5 wind to the off-site location where the farmer resides. As noted previously, airborne particulates
 6 are not expected to be generated, given the presence of the engineered cover over the GTCC
 7 wastes. This individual could also incur a radiation dose through the use of groundwater
 8 contaminated as the result of leaching of radionuclides in the waste containers and their transport
 9 to the underlying groundwater table.

10
 11 Secondary soil contamination at off-site locations would be possible if contaminated
 12 groundwater was used for irrigation and if this practice was continued for an extended period of
 13 time. Potential exposure pathways related to the use of contaminated groundwater include
 14 (1) external irradiation; (2) inhalation of dust particulates from irrigated fields, radon gas (and its
 15 short-lived decay products), H-3, and C-14; and (3) ingestion of water, soil, plant foods, meat,
 16 and milk. Plant foods (fruits and vegetables) could become contaminated through foliar
 17 deposition as well as root uptake. Meat and milk could become contaminated if livestock
 18 ingested contaminated water (obtained from the well) and fodder contaminated by use of this
 19 groundwater. Figure E-2 illustrates the exposure pathways associated with use of contaminated
 20 groundwater.

21
 22
 23 **E.2.2 Assumptions Related to Leaching from the Wastes**

24
 25 It is assumed that the only way the hypothetical receptor would be exposed to radiation in
 26 the future would be if the radionuclides were released from the waste containers and disposal
 27
 28



29
 30 **FIGURE E-2 Exposure Pathways Associated with the Use of Contaminated**
 31 **Groundwater**
 32

1 facility. The most likely mechanism for this to occur would be contact with infiltrating water.
2 Precipitation could infiltrate into the disposal area and contact the waste containers. It is assumed
3 that no releases would occur while the waste containers and engineering barriers (including the
4 cover) remained intact. However, it is expected that over time, the waste packages and
5 engineering barriers would lose their integrity. When this condition occurred, water could
6 contact the waste materials within the packages and move downward to the groundwater table.
7 Although water could also enter the contaminated waste zone as a result of the rising
8 groundwater, this scenario is not considered likely because the disposal facility would be sited in
9 accordance with NRC regulations that should preclude this from occurring.

10
11 Data on the performance of waste packages and engineering barriers over an extended
12 time period are limited. Even when data are available, using the data to predict the release rates
13 of radionuclides over a very long time period can be difficult to defend. The potential impacts on
14 groundwater are evaluated over a very long time period in this EIS (10,000 years and longer to
15 obtain peak annual doses and LCF risks). Determining how and when the waste packages and
16 engineering barriers would begin to degrade and how this degradation would progress over time
17 is one of the more challenging and site- and design-specific aspects of the analysis. Thus, for a
18 comparative analysis such as this, simplifying assumptions are made regarding the performance
19 of engineering barriers and waste packages.

20
21 The radiation doses presented in the post-closure assessment in this EIS are intended to
22 be used for comparing the performance of each land disposal method at each site evaluated. The
23 results indicate that the use of robust engineering designs and redundant measures in the disposal
24 facility could delay the potential release of radionuclides and could reduce the release to very
25 low levels, thereby minimizing the potential groundwater contamination and associated human
26 health impacts in the future.

27
28 For purposes of analysis in this EIS, it is assumed that the engineered barriers would
29 begin to degrade and fail 500 years after the closure of the disposal facility. This assumption is
30 considered to be conservative (i.e., yield greater impacts) since the integrity of the engineered
31 barriers is expected to last longer than 500 years. It is assumed that the radionuclides in the
32 disposed-of wastes (listed in Appendix B) would not be available for leaching until the
33 engineering barriers started to degrade. Many of the radionuclides in the GTCC LLRW and
34 GTCC-like wastes have very long half-lives, so this 500-year time period would not result in an
35 appreciable reduction in the total hazard associated with these wastes as a result of radioactive
36 decay. This assumption is more conservative for some sites than others where conditions are
37 more favorable to the long-term performance of waste packages.

38
39 In performing these evaluations, the protection provided by a number of engineering
40 measures included in the conceptual facility designs, such as a cover designed to minimize water
41 infiltration, was considered in the analyses. It is assumed that these engineering measures would
42 completely eliminate water infiltration into the waste units for the first 500 years. It is assumed
43 that after that time, the integrity of these engineering measures would begin to degrade and fail,
44 reducing their effectiveness in keeping percolating water out of the waste disposal units. A study
45 at the Savannah River Site (SRS) indicated that after 10,000 years, the closure cap at the F-Area
46 would still shed about 80% of the cumulative precipitation falling on it, with a higher degree of

1 effectiveness occurring before 10,000 years (Phifer et al. 2007). The cover effectiveness would
2 continue to decrease very slowly after 10,000 years. This information was used to estimate the
3 amount of water that could infiltrate into the disposed-of wastes as described in the following
4 text. The assumed effectiveness of a cover system can be a critical factor for distinguishing
5 between facility performance at a humid site and at an arid site.

6
7 It is assumed that the water infiltration rate into the top of waste disposal facility would
8 be zero for the first 500 years following closure, and then it would be 20% of the natural rate.
9 This approach is meant to account for the reduction in the integrity of the cover and other
10 engineering barriers as they begin to degrade and fail. This value was used for all future times
11 extending to 10,000 years and longer (to obtain peak annual doses). This reduced water
12 infiltration rate (from the natural rate for the area) is limited to the waste disposal area; at the
13 perimeter of the waste disposal facility, the natural background infiltration rate is used in the EIS
14 analyses.

15
16 This is a simplified approach to address the reduction in cover effectiveness over time.
17 The amount of water infiltrating into the disposal facility would increase as the cover
18 effectiveness decreased. It is difficult to model the gradual degradation of the engineered cover;
19 hence, the long-term average effectiveness was simulated in the calculations. A sensitivity
20 analysis was conducted to examine the potential change in off-site doses by using varied values
21 to simulate varying degrees of effectiveness that would yield different water infiltration rates.
22 The results of this sensitivity analysis are given in Section E.6.

23
24 This approach of using a reduced water infiltration rate only for the waste disposal area is
25 assumed to be conservative, because with a higher water infiltration rate outside the waste
26 disposal area, the transport time needed for radionuclides to reach the underlying groundwater
27 table after they have been released from the waste disposal area would be shortened. This
28 approach provides less time for radioactive decay to occur during transport, which results in
29 higher groundwater concentrations being estimated at the receptor location.

30 31 32 **E.2.3 Assumptions Related to Radionuclide Release Rates**

33
34 As described in Appendix B, the GTCC LLRW and GTCC-like wastes encompass three
35 waste types for purposes of analysis in this EIS: activated metals, sealed sources, and Other
36 Waste. For activated metal wastes, the release of radionuclides was correlated with the corrosion
37 of metals. The radionuclide release fraction for activated metals was taken to be $1.19 \times 10^{-5}/\text{yr}$ in
38 this analysis. This value is assumed to be reasonable for stainless-steel waste forms for the
39 purpose of this comparative analysis on the basis of rates observed in corrosion experiments on
40 stainless-steel coupons conducted at INL (INL 2006; Adler Flitton et al. 2004). However, if the
41 environmental conditions surrounding a specific waste were not controlled and were more
42 conducive to causing corrosion, or if the metal making up a specific waste was more conducive
43 to corrosion, the release fractions could be higher than those used here.

44
45 The release rates of radionuclides in sealed sources were simulated on the basis of the
46 assumption that radionuclides would partition between water and the sealed source matrix when

1 coming in contact with water. It is assumed that the partitioning factor of each radionuclide has
2 the same value as the K_d associated with the surface soil at the various sites. Because there
3 would be backfill soil surrounding the waste containers in the disposal units, radionuclides
4 released from the sealed sources would have to travel through the surrounding soils before
5 leaving the disposal area. By using the soil K_d values to calculate the radionuclide release rates,
6 the binding of radionuclides to the sealed source matrix is assumed to be the same as that in the
7 surrounding soil. This approach is conservative, because it tends to overestimate the release rates
8 of radionuclides from sealed sources.

9
10 While activated metals and sealed sources are structurally sound and generally resistant
11 to leaching with water, many of the wastes in the Other Waste type are not. For this analysis, it is
12 assumed that the Other Waste would be solidified (e.g., with grout or another similar material)
13 before being placed in the disposal units. This assumption is reasonable and consistent with
14 current disposal practices for such wastes, which include a wide variety of materials that could
15 compact or quickly degrade without such measures. Use of such a stabilizing agent is not
16 assumed for activated metal and sealed source wastes.

17
18 The solidification provided by mixing the Other Waste with a stabilizing agent would
19 also reduce the leaching of radionuclides. However, the reduction in leaching might not last over
20 a long period of time, when the nature of the stabilizing agent would change in the environment
21 or the integrity of the stabilizing agent would deteriorate. In this analysis, the effectiveness of
22 solidification in terms of leaching reduction is assumed to last for 500 years following facility
23 closure; after that, the retention of radionuclides by the stabilizing agent is assumed to be the
24 same as that of the surrounding backfill soils. Hence, the release rates of radionuclides from the
25 Other Waste were simulated with soil K_d values after the effective period of the stabilizing
26 agent. The release rates of radionuclides were simulated with the K_d values for a cementitious
27 system during the effective period, assuming cement would be used as the stabilizing agent.

28
29 Cement that contains slag has been shown to reduce the leaching of nickel, technetium,
30 and uranium more effectively than cement that does not contain slag. The presence of slag results
31 in an environment that is more reducing and not oxidizing, as opposed to cement alone. Since
32 technetium and uranium are major radionuclides of concern with respect to the GTCC LLRW
33 and GTCC-like wastes, it is assumed that slag-containing cement would be used to solidify the
34 Other Waste for purposes of analysis in this EIS. Although the cementitious material could
35 eventually convert to an oxidized form over long periods of time, this effect would be offset by
36 the corrosion of the metal drums in the disposal environment, which would consume oxygen and
37 lead to chemically reducing conditions.

38
39 Information on the K_d values in cementitious systems is given in Table E-1 for a number
40 of elements from different sources. (All tables appear before the references at the end of this
41 appendix.) Only one set of values was given in Krupka et al. (2004), which was taken to
42 represent a non-slag-containing cementitious system. Kaplan is a co-author of this 2004 report,
43 as well as the author of a separate study published in 2006 (Kaplan 2006). It is assumed that the
44 second report contains additional information that was not available when the first report was
45 published in 2004. Therefore, when selecting the K_d values for cementitious systems, only data
46 from the second report were used for comparison with data from the other sources.

47

1 The last two columns of Table E-1 provide the selected K_d values for oxidizing and
2 reducing cement. These values are generally the lowest (or most conservative in that they allow
3 for the most potential leaching into the groundwater) of the reported values, unless multiple
4 sources provided the same higher value. In addition to the reported values, chemical similarity
5 was also considered in determining the values to use in this analysis. The use of the smallest K_d
6 values would result in more conservative (higher) dose estimates.

7
8 The K_d values for reducing cement are used in this analysis to estimate the release rates
9 of radionuclides when water infiltrates into the waste disposal units while the effectiveness of the
10 stabilizing agent still holds. As indicated in Table E-1, the selected values for oxidizing and
11 reducing cement are the same except for nickel, technetium, and uranium. Note that these values
12 are based on specific assumptions regarding the type of cement used and would need to be
13 reconsidered on the basis of the actual cements that could be used in a specific situation.
14 Maintaining local reducing conditions can be an important consideration in designing the final
15 system for specific wastes containing significant amounts of nickel, technetium, and uranium
16 isotopes.

17
18 For the analyses in this EIS, the grout is assumed to retain its effectiveness for 500 years
19 following facility closure. After this time period, the leachability of the Other Waste would
20 increase as the grout degraded, which would result in higher off-site doses. The amount of the
21 increase would depend on the rate at which the grout failed. While it is difficult to model the
22 gradual degradation of the grout system, a sensitivity analysis was conducted to examine the
23 potential change in off-site doses that would result from a different effective period for the grout
24 stabilization system. The results of this sensitivity analysis are given in Section E.6.

25 26 27 **E.3 SIMULATION APPROACH FOR THE NO ACTION ALTERNATIVE**

28
29 An analysis of the long-term human health impacts associated with the No Action
30 Alternative (in which the wastes are stored indefinitely) was conducted to provide information
31 for comparison of the post-closure human health impacts associated with the action alternatives.
32 As noted previously, the pathway of most concern in the long term is expected to be radionuclide
33 migration to groundwater underlying the storage facilities. The analysis of the No Action
34 Alternative was also done by using the RESRAD-OFFSITE computer code.

35
36 Under the No Action Alternative, it is assumed that a generic site located within each of
37 the four NRC regions would be the storage location for all of the GTCC LLRW and DOE
38 GTCC-like wastes within that region. It is assumed that the activated metals and Other Waste
39 would remain within the NRC region in which the facility that generated the wastes was located,
40 and the sealed sources would be divided among the four NRC regions in proportion to the
41 number of NRC-licensed facilities within each region. That is, the potential long-term impacts
42 from the groundwater pathway were analyzed for four different sites with different waste
43 inventories (Table E-2). The characteristics of the generic storage site within each region are
44 assumed to be the same as those of the generic commercial site within the same region for the
45 action alternatives.

1 It is assumed that the GTCC LLRW and GTCC-like wastes would be placed on the
2 ground surface without any protective covers. They would be stacked randomly and would take
3 up more space than they would in the disposal cells for the action alternatives. Monitoring and
4 surveillance of the waste containers are assumed to last for 100 years but would be discontinued
5 after that period. The waste packages are assumed to be left unattended in this manner for the
6 indefinite future (10,000 years and beyond).

7
8 This analysis of the No Action Alternative was performed to provide a baseline against
9 which the action alternatives could be compared. This alternative is not a viable long-term
10 management option for the GTCC wastes, and at some point in the future, a decision would have
11 to be made to dispose of these wastes.

12 13 14 **E.3.1 Exposure Scenario and Pathways**

15
16 The exposure scenario and pathways considered for the No Action Alternative are the
17 same as those considered for the action alternatives described above. That is, a hypothetical
18 resident farmer is assumed to inhabit a site located 100 m (330 ft) from the edge of the storage
19 facility and to obtain water for use at the farm from a groundwater well. The storage area is
20 assumed to cover an area of 90,000 m² (970,000 ft²); that is, 300 × 300 m (1,000 × 1,000 ft).

21 22 23 **E.3.2 Assumptions Related to Leaching from the Wastes**

24
25 The potential long-term human health impacts (peak annual doses and LCF risks) for the
26 No Action Alternative were calculated for each waste type separately. Because there would be
27 no protection against weathering of the waste containers after the monitoring and surveillance
28 period ended (at 100 years), it is assumed that the containers would breach and fail at this time.
29 This would allow precipitation water to enter the containers and contact the waste materials. The
30 precipitation rates assumed for the generic storage sites are 1.07, 1.34, 0.82, and 0.27 m/yr for
31 Regions I, II, III, and IV, respectively (Poe 1998; Toblin 1999). The other assumptions related to
32 leaching of contaminants from the waste packages are generally the same as those given for the
33 action alternatives.

34 35 36 **E.3.3 Assumptions Related to Radionuclide Release Rates**

37
38 The release rates of radionuclides contained in activated metal waste were calculated with
39 an assumed release fraction of 1.19×10^{-5} /yr, which was the same as that assumed for the action
40 alternatives. This release fraction reflects the corrosion rate of metal and was obtained from
41 actual measurements conducted at INL ((INL 2006). For the sealed source and Other Waste
42 types, the release rates of radionuclides were calculated by assuming the partitioning of
43 radionuclides between the waste matrix and the precipitation water would be the same as the
44 partitioning of radionuclides between soil particles and water. This assumption was made
45 because the wastes would not be solidified, and the use of soil K_d s for calculating radionuclide
46 release rates is consistent with the approach used for evaluating the action alternatives.

1 After radionuclides were released from the waste containers, they would accumulate in
2 the surface soil underneath the containers. This contamination could be released from the storage
3 site by runoff water or be carried to deeper soils by infiltration water. The fraction of released
4 radionuclides removed by runoff water would depend on the amount of runoff water, the slope of
5 the ground surface, the adsorption of radionuclides to the surface soil, and engineered site
6 features such as berms. Unlike the design of a disposal facility that would incorporate
7 engineering measures to facilitate surface water runoff away from the disposal area to prevent
8 water from infiltrating to deeper soils, a preferred feature for a storage area would be the
9 capability to reduce surface water runoff to reduce the spread of contamination to the
10 surrounding area.

11
12 For this analysis of the No Action Alternative, it is assumed that all released
13 radionuclides accumulating in the surface soil would be carried by infiltration water to deeper
14 soils. The infiltration rate of water is assumed to be the same as that for the generic commercial
15 disposal facility located in the same region. As shown in Table E-19, the water infiltration rates
16 for the generic disposal facilities in Regions I, II, III, and IV are 0.074, 0.18, 0.05, and
17 0.001 m/yr, respectively. These values are listed as precipitation rates in the table. Because the
18 irrigation rates, runoff coefficients, and evapotranspiration coefficients are all zero, the
19 infiltration rates would be equivalent to the precipitation rates.

20 21 22 **E.4 INPUT PARAMETERS FOR RESRAD-OFFSITE EVALUATIONS**

23
24 As described previously, the RESRAD-OFFSITE computer code (Yu et al. 2007) was
25 used to calculate the potential impacts on a hypothetical resident farmer located 100 m (330 ft)
26 from the edge of the disposal facility. Two potential release mechanisms (associated with
27 airborne emissions and leaching to groundwater) were considered in the assessment for the
28 action alternatives. For the potential radiation doses resulting from airborne releases coming
29 directly from the disposal area, a Gaussian plume dispersion model (which is incorporated into
30 the RESRAD-OFFSITE code along with the default wind speed and stability class frequency
31 data from the weather station that is nearest the site) was used in this evaluation. The doses from
32 this release mechanism were largely from gaseous emissions (principally radon gas and its short-
33 lived decay products). The results of these analyses are provided in the appropriate sections of
34 the EIS and are not repeated in this appendix.

35
36 For the groundwater pathway, site-specific input parameters were used to simulate the
37 movement of contaminants from the wastes contained in the disposal unit to the hypothetical
38 resident farmer located 100 m (330 ft) from the edge of the disposal facility in the downgradient
39 direction. These parameters were obtained from published information given in performance
40 assessments, risk assessments, and environmental modeling studies for the various sites. The
41 input parameters relevant to the groundwater pathway are provided in Tables E-3 through E-14
42 for the six federal sites. Two tables are provided for each of the six sites. The first table provides
43 the values for all of the input parameters except the K_d values; the K_d values for each of the
44 radionuclides addressed for each site are given in the second table.

1 For example, Table E-3 provides the values used for the RESRAD-OFFSITE parameters
2 for the evaluation at INL except for the K_d values, which are provided in Table E-4. The same is
3 done for the Hanford Site (Tables E-5 and E-6), Los Alamos National Laboratory (LANL,
4 Tables E-7 and E-8), Nevada National Security Site (NNSS, Tables E-9 and E-10), SRS
5 (Tables E-11 and E-12), and the WIPP Vicinity (Tables E-13 and E-14). Additional details on
6 these values (including the selection rationale and sources used in determining these values) are
7 also provided in the tables.

8
9 The input parameters most significant in an evaluation of the groundwater migration
10 pathway are given in a comparative manner for these six sites in Tables E-16 through E-18, in
11 order that differences in site characteristics can be more easily compared. These parameters
12 include the water infiltration rates (Table E-15), characteristics of the unsaturated and saturated
13 zones (Tables E-16 and E-17), and K_d values (Table E-18).

14
15 Data for the generic commercial sites located in the four regions were obtained from the
16 same sources (NRC 1981; Poe 1998; Toblin 1999). These values are shown in Tables E-19 and
17 E-20 for comparison. Table E-19 provides the values for all input parameters except the K_d
18 values, and Table E-20 provides the K_d values. These same values were also used for the No
19 Action Alternative.

20
21 The calculated concentrations of the various radionuclides in groundwater were used to
22 calculate the radiation dose to the hypothetical resident farmer for the relevant exposure
23 pathways. This individual is assumed to be an adult who spends 75% of his/her time at the site in
24 the vicinity of his/her house (50% indoors and 25% outdoors) and 25% of his/her time away
25 from the area. The farmer is assumed to cultivate an agricultural field encompassing 1,000 m²
26 (0.25 ac) for growing fruits and vegetables and a grazing area of 10,000 m² (2.5 ac) for raising
27 livestock. It is assumed that the yields of fruits, vegetables, meat, and milk would be sufficient to
28 provide 50% of the needs of the farmer and his family. The remainder of the food would be
29 obtained from sources removed from the farm and be free of any radioactive contamination.
30 These assumptions are taken directly from the RESRAD-OFFSITE code for the default
31 residential farmer scenario.

32
33 It is assumed that the farmer would drill a well close to his/her house to supply the
34 potable water needs for drinking, household activities, watering livestock, and irrigating the farm
35 fields. The farmer would draw approximately 2,500 m³ (660,000 gal) of water from the well
36 each year. For the fruit and vegetable fields, an irrigation rate of 0.1 m/yr (0.33 ft/yr) of water
37 applied to the field is used for SRS and the two generic sites located in Regions I and II; a higher
38 value of 0.2 m/yr (0.66 ft/yr) is used for the other federal sites and the two generic sites located
39 in Regions III and IV. Because SRS and the generic sites located in Regions I and II have higher
40 precipitation rates, less irrigation water would be needed to sustain the growth of crops and
41 vegetables. An irrigation rate of 0.1 m/yr (0.33 ft/yr) is used for the livestock grazing field for all
42 sites. Although irrigation water may not actually be needed at all of these sites (or lesser amounts
43 than those indicated here), this assumption has the effect of increasing the cumulative amount of
44 contamination in the agricultural field that could end up in the resident farmer's food supply.

45

1 It is assumed that the resident farmer would ingest 730 L (200 gal) of water; 14 kg (31 lb)
2 of leafy vegetables; 160 kg (350 lb) of fruit, grain, and nonleafy vegetables; 63 kg (140 lb) of
3 meat; and 92 L (24 gal) of milk every year. While working in the fields, the farmer would ingest
4 36.5 g (0.080 lb) of soil every year (or an average of 0.1 g per day for each day of the year). The
5 inhalation rate of the farmer was taken to be 8,400 m³/yr (297,000 ft³/yr). Except for the water
6 ingestion rate, which is about the 90th percentile value for the general public (EPA 2000), these
7 values for the consumption and exposure parameters are the same as the RESRAD-OFFSITE
8 default values.

9
10 As noted previously, this assessment is meant to provide a comparative evaluation of the
11 relative merits of each of the disposal sites. While the assumption used (that there would be a
12 complete loss of institutional memory and that residential use of the area in the immediate
13 vicinity of a GTCC waste disposal facility would occur) provides a uniform basis for evaluating
14 potential impacts, its use does not imply that such a situation is expected to occur. Use of
15 standardized assumptions and input parameters (as was done in this analysis) should help to
16 ensure that the best alternative site is selected for disposal of GTCC LLRW and GTCC-like
17 wastes.

18
19 While the health effects addressed in this EIS are limited to LCF risks, additional health
20 effects beyond cancer can occur in individuals exposed to radiation, including cardiovascular
21 disease and hereditary effects. However, these additional health effects are not quantified in this
22 EIS. The risk of cardiovascular disease has been shown to increase in persons exposed to high
23 therapeutic doses and also in atomic bomb survivors exposed to more modest doses (NAS 2006).
24 However, there is no direct evidence of increased risk of noncancer diseases at low doses, such
25 as the doses that could potentially occur to members of the general public under the alternatives
26 evaluated in this EIS.

27
28 Also, the risk of hereditary effects from radiation exposure is generally attributable to
29 gamma irradiation of the reproductive organs. In contrast, most of the dose to the hypothetical
30 resident farmer in the long term would be a result of long-lived radionuclides having alpha and
31 beta radiation. As noted in NAS (2006), the risk of heritable disease is sufficiently small that it
32 has not been detected in humans, even in thoroughly studied irradiated populations, such as those
33 of Hiroshima and Nagasaki. The risk of cancer fatality was determined to be a reasonable means
34 of comparing alternatives in the EIS.

35
36 The assessment of potential human health impacts resulting from groundwater
37 contamination was conducted for a time period of 10,000 years following facility closure. If the
38 maximum impacts (peak annual doses and LCF risks) were not observed in this time period, the
39 assessment time was extended to 100,000 years, which is the maximum time limit for the
40 RESRAD-OFFSITE code. The results of this assessment are provided in Section E.5. A detailed
41 discussion of this evaluation is provided in Argonne (2010).

1 E.5 RESULTS

2
3 The results of the RESRAD-OFFSITE simulations are summarized in Table E-21 for the
4 No Action Alternative. This table presents the estimated peak annual doses when the storage of
5 each individual waste type in each NRC region is considered. As indicated by the results, storage
6 of the GTCC LLRW and GTCC-like wastes in Region I would result in very high radiation
7 exposure to a hypothetical farmer residing 100 m (330 ft) from the edge of the storage facility.
8 The peak annual dose could reach 270,000 mrem/yr for the GTCC-like Other Waste - RH in this
9 region. The peak annual dose for Region II during the first 10,000 years would be much lower,
10 with a maximum value of about 850 mrem/yr for GTCC LLRW Other Waste - RH. However,
11 after 10,000 years, the peak annual dose would increase and could reach as high as
12 16,000 mrem/yr for GTCC LLRW sealed sources.

13
14 A similar tendency was found in the estimated annual doses for Region III. The lowest
15 impacts would occur in Region IV. Within 100,000 years, the estimated peak annual dose would
16 be less than 10 mrem/yr. While the estimated results can largely be explained on the basis of
17 precipitation and infiltration rates as well as the depth to the groundwater table assumed for the
18 storage site at each region, they are also in part due to the different waste inventories assumed to
19 be stored in the different regions.

20
21 The results for the action alternatives are summarized in Tables E-22 through E-25.
22 Table E-22 presents the estimated peak annual doses to the hypothetical resident farmer from
23 each individual waste type in the Group 1 stored inventory, and Table E-23 presents the results
24 from each individual waste type in the Group 1 projected inventory. These results are based on
25 the dose conversion factors for an adult in ICRP 72 (ICRP 1996), as discussed in Appendix C.
26 The peak annual doses from each individual waste type in the entire Group 1 waste inventory are
27 given in Table E-24. Table E-25 gives the peak annual doses for the Group 2 inventory (all of
28 which is projected waste). These two groups of wastes are defined in Section 1.4.1 of the EIS.
29 The dose calculations were performed over two time periods — 10,000 years and 100,000 years
30 — following closure of the disposal facility.

31
32 The results are provided separately for GTCC LLRW and GTCC-like wastes and address
33 the three separate waste types (activated metals, sealed sources, and Other Waste). The estimated
34 peak annual doses are associated with the disposal of each type of waste material, respectively;
35 therefore, they may occur at different times in the future. The results are provided in this format
36 to allow for an evaluation of the post-closure human health impacts associated with disposing of
37 certain types of wastes at specific locations with specific disposal approaches. For example, it is
38 possible to compare the peak annual projected doses for the stored activated metal GTCC LLRW
39 that could result from using the three disposal methods at the different alternate sites by looking
40 at the appropriate column in Table E-22. As noted previously, these results are intended to be
41 viewed in a comparative manner given the uncertainties associated with this analysis.

42
43 The results given in these four tables differ from those given in the site-specific chapters
44 of the EIS. The values given in this appendix are the peak annual doses associated with the
45 disposal of each individual waste type in the Group 1 stored inventory (Table E-22), Group 1
46

1 projected inventory (Table E-23), Group 1 total inventory (Table E-24), and Group 2 total
2 inventory (Table E-25). The values given in the main body of the EIS represent the peak annual
3 doses to the hypothetical resident farmer at the time of peak annual dose for the entire GTCC
4 waste inventory. Because of the different radionuclide mixes and activities contained in the
5 different waste types, the maximum doses that could result from each waste type individually
6 generally occur at different times than the peak annual dose from the entire inventory. The
7 results given in the main body of the EIS could be used to support the decision-making process
8 when disposal of the entire inventory at a single separate location is considered, while those in
9 this appendix would support decision-making for the disposal of individual waste types.

10
11 The peak annual doses range from zero (meaning that the radioactive contaminants from
12 that particular waste type do not reach the off-site receptor) up to 2,200 mrem/yr for vault
13 disposal of Group 1 GTCC-like Other Waste at INL in 10,000 years. All annual doses calculated
14 as being less than 0.001 mrem/yr are reported as being “<0.001 mrem/yr,” since these doses are
15 much too low to be measured or detected. The highest doses calculated for the federal sites are
16 those from disposing of wastes at INL. For the INL site, the high doses are due to the low K_d
17 values for several radionuclides, particularly for iodine-129 (I-129) and uranium isotopes (a
18 value of 0 cm³/g was used for I-129, and for uranium isotopes, a value of 0 cm³/g was used for
19 part of the basalt layers and a value of 0.66 cm³/g was use for the saturated zone in this analysis).
20 A low K_d indicates that the radionuclide has a high potential for partitioning to the liquid phase
21 while moving through soil.

22
23 The highest dose for the generic commercial facilities located in the four regions ranges
24 from zero up to 10,000 mrem/yr in 10,000 years. On the basis of the results of the RESRAD-
25 OFFSITE modeling, it is estimated that there would be no groundwater dose within 10,000 years
26 for a generic commercial facility located in Region IV because the radioactive contamination
27 would not reach the groundwater table in 10,000 years as a result of the arid conditions at this
28 location. The highest dose estimated is for a commercial facility located in Region I because of
29 the higher water infiltration rate there, in combination with a shallow depth to groundwater table
30 and low K_d values for C-14 and I-129 (a value of 0 cm³/g was used in the analysis).

31
32 The sites with the lowest estimated annual doses are those located in the arid regions of
33 the country. The analyses indicate that the radionuclides are not expected to reach groundwater
34 for any waste type and disposal method at NNSS in 100,000 years, and generally lower doses are
35 projected to occur at the other sites located in the Western United States (except for INL). No
36 radionuclides are expected to reach groundwater at the WIPP Vicinity in 10,000 years, and the
37 maximum annual doses in 100,000 years at this site are low.

38
39 The arid sites result in lower doses because of lower water infiltration rates there (due to
40 lower precipitation) and the longer distance to the groundwater table. Of these two factors, the
41 water infiltration rate appears to be more significant than the depth to the groundwater table. The
42 time period of this analysis is very long (longer than 10,000 years), and many of the
43 radionuclides have very long half-lives. Radionuclides released from the disposed-of wastes
44 would eventually reach the groundwater table within this time period, even if the depth to the
45 groundwater table was increased. Reducing the water infiltration rate would not only reduce the

1 radionuclide release rate but would also increase the transport time to reach the hypothetical
2 exposure location.

5 **E.6 SENSITIVITY ANALYSIS**

7 The peak annual doses and LCF risks to a hypothetical resident farmer located 100 m
8 (330 ft) downgradient of the edge of a disposal facility from using contaminated groundwater are
9 presented in Section E.5. The following assumptions were used in the EIS to perform this
10 evaluation:

- 12 1. The engineering barriers incorporated in the disposal facility would keep
13 percolating water out of the waste units for 500 years following closure of the
14 disposal facility.
- 16 2. After 500 years, the integrity of the barriers and waste containers would begin
17 to degrade, allowing for water infiltration into the top of the disposal units at
18 20% of the natural infiltration rate for the area.
- 20 3. The water infiltration rate around and beneath the disposal facility would
21 remain at 100% of the natural rate for the area at all times.
- 23 4. Once water would begin to affect the disposed-of wastes, radionuclides would
24 be leached out at a rate that would depend on the waste type.
- 26 5. A stabilizing agent (grout) would be used to solidify the Other Waste type,
27 and this grout would maintain its effectiveness for 500 years.
- 29 6. After 500 years, the effectiveness of the grout would be compromised,
30 allowing for more leaching to occur.
- 32 7. The activated metal and sealed source wastes would be disposed of without
33 the use of any additional stabilizing material.

35 These assumptions were applied across various alternate sites so that the peak annual doses and
36 LCF risks for the different sites could be compared on a uniform basis.

38 The parameters used in these analyses were generally selected to provide conservative
39 estimates (i.e., to overestimate the peak annual doses and LCF risks that would likely occur in
40 the future should one of these alternatives be implemented). Uncertainties are inherent with these
41 types of analyses, especially given the long periods analyzed in this EIS (10,000 years and longer
42 to obtain peak annual doses and LCF risks). To evaluate the uncertainties associated with key
43 assumptions used for the analysis of the long-term human health impacts, a sensitivity analysis
44 was performed to provide information on the effects that key assumptions have on the results. In
45 this sensitivity analysis, the RESRAD-OFFSITE calculations were repeated while the value of
46 only one parameter was varied and the values of the other parameters were kept at their base

1 values. This approach excluded the influence of the other parameters and provides results that
2 can be analyzed to determine which assumptions have the most impact on these estimates.

3
4 Two sites were considered in this sensitivity analysis: SRS and WIPP Vicinity. The first
5 site is representative of sites in the Eastern United States (a humid site), and the second site is
6 representative of sites in the Western United States (an arid site). The analysis was limited to
7 trench disposal of the GTCC-like stored Group 1 Other Waste - CH, and it was conducted for a
8 time period of 10,000 years. It is assumed that this waste would be stabilized with grout, and this
9 waste type has a radionuclide mix that is representative of many of the GTCC wastes. The results
10 of the sensitivity analysis for this waste type and disposal method at these two sites can be used
11 to infer conclusions about different waste streams disposed of at other alternate sites by using the
12 three land disposal methods. This analysis also gives some indication of the level of
13 conservatism in the results, which is useful information for the decision-making process.

14
15 Three parameters were addressed in this sensitivity analysis: (1) the water infiltration rate
16 through the disposal facility cover after 500 years following closure of the facility, (2) the
17 effectiveness of the stabilizing agent (grout) used for Other Waste, and (3) the distance to the
18 assumed hypothetical receptor. These three parameters address issues related to disposal facility
19 design, waste form stability, and site selection.

20
21 To address the influence of the water infiltration rate on the estimated radiation doses to
22 the hypothetical future farmer, two additional infiltration rates (corresponding to 50% and 100%
23 of the natural infiltration rate for the area) were considered along with the base value of 20%.

24
25 The effective period for the stabilizing agent (grout) used for Other Waste is assumed to
26 be 500 years in this EIS. This assumption is considered to be reasonable, but it is likely that the
27 grout could be effective for a longer period of time. To address the significance of this time
28 period assumed for grout, two additional effective periods were addressed for both the SRS and
29 WIPP Vicinity: 2,000 years and 5,000 years.

30
31 The exposure distance to the resident farmer is assumed to be 100 m (330 ft) from the
32 edge of the disposal facility. This distance was based on the minimum buffer zone identified for
33 DOE LLRW disposal facilities. This distance would likely be much longer, especially for the
34 federal sites considered in this EIS. To address the significance of the distance to a future
35 hypothetical receptor (which may have a bearing on-site selection and development of a buffer
36 zone), this distance was increased to 300 m (980 ft) and 500 m (1,600 ft).

37
38 In addition to the Base Case, two additional values were considered for each of the three
39 parameters at the two sites as discussed above. A total of 10 additional cases were constructed
40 and analyzed by using RESRAD-OFFSITE at SRS and WIPP Vicinity. Table E-26 lists the
41 different cases and the parameter values assumed for those cases.

42
43 Tables E-27 and E-28 provide the peak annual doses and the times at which they would
44 occur for the Base Case and the 10 sensitivity analysis cases analyzed for the WIPP Vicinity and
45 SRS, respectively. A time period of 10,000 years was used to perform these analyses with the
46 RESRAD-OFFSITE computer code. Note that the results given here for the Base Case differ

1 from those given in the site-specific chapters in the main body of the EIS. The peak annual doses
2 in this appendix for the Base Case are the peak values when disposal of only the Group 1 stored
3 GTCC-like Other Waste - CH is considered, whereas the values in the main body of the EIS are
4 the peak annual doses when disposal of the entire inventory of GTCC wastes is considered.

5

6 For the WIPP Vicinity, groundwater contamination would not occur within 10,000 years
7 for any of the three water infiltration rates used in this analysis (20%, 50%, or 100% of the
8 natural background rate for this area) after failure of the engineering barriers (including the
9 cover) and waste containers. A higher rate than is naturally present at that site is needed for
10 groundwater contamination to occur. A higher infiltration rate to the disposal units would result
11 in higher release rates of radionuclides, yielding higher peak doses. However, the transport time
12 required for radionuclides to move to the groundwater table after leaving the disposal units
13 would be the same, regardless of the water infiltration rate to the disposal units. The times would
14 be the same because in the analysis, it is assumed that the water infiltration rate to areas outside
15 the waste disposal units would be equivalent to the natural background rate. (This assumption
16 was selected to provide more conservative estimates of the potential doses.) Since groundwater
17 contamination would not occur within 10,000 years in the Base Case, the contamination would
18 not be observed in Cases I or II either.

19

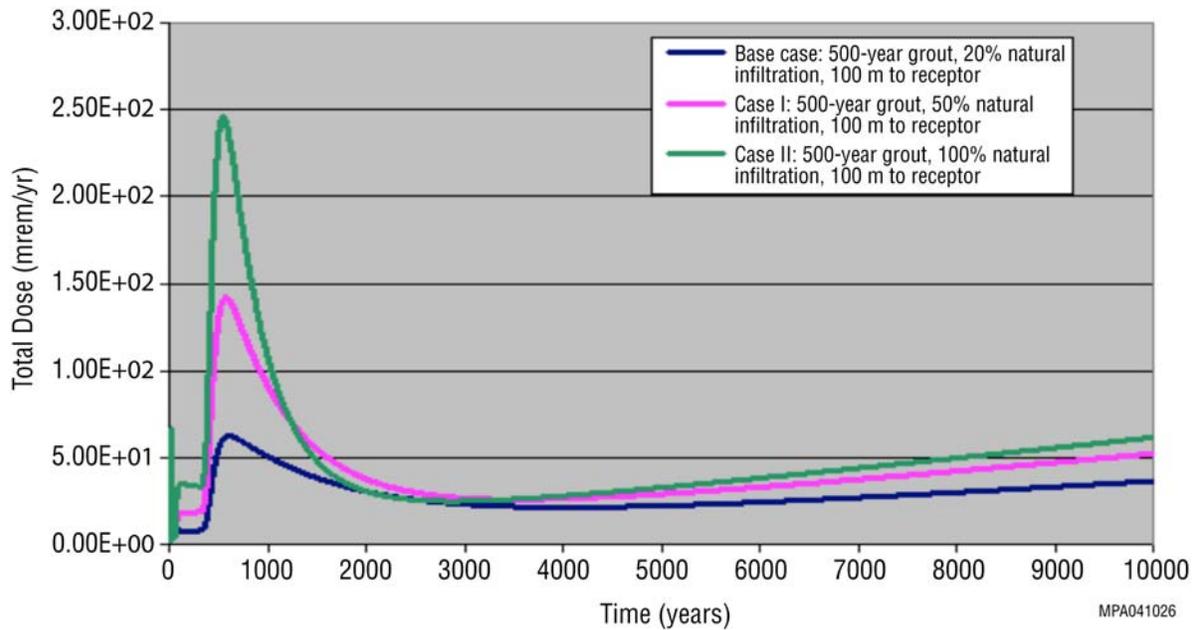
20 For Cases III to VIII, the effectiveness of grouting was extended from 500 years to either
21 2,000 years or 5,000 years, which would reduce the leaching of radionuclides for a longer time
22 when compared with the time for the Base Case. Consequently, at the WIPP Vicinity, no
23 groundwater contamination was observed within 10,000 years for these cases. Increasing the
24 exposure distance of the receptor from 100 m (330 ft) to 300 m (980 ft) in Case IX and to 500 m
25 (1,600 ft) in Case X would postpone the onset of radiation exposure. In addition, because of the
26 extra dilution by clean water coming down from the ground surface, the potential radiation dose
27 would also be lower than that in the Base Case. The maximum dose of 0 mrem/yr within
28 10,000 years as calculated for Cases IX and X at the WIPP Vicinity is consistent with this
29 expectation.

30

31 The results for the Base Case and Cases I and II as calculated for SRS (Table E-28)
32 demonstrate the influence of the water infiltration rate on the GTCC wastes in the disposal unit.
33 The results provide information on the influence that the performance of the disposal facility
34 cover has on long-term radiation doses through the groundwater pathway. The peak annual dose
35 would increase as the water infiltration rate increased, because when more water would enter the
36 waste packages, more radionuclides would be leached and released from the disposal area. The
37 increase in the peak annual dose would be roughly proportional to the increase in the water
38 infiltration rate. Similar conclusions can be drawn about the results for Cases III, IV, and V or
39 the results for Cases VI, VII, and VIII. Figure E-3 compares the radiation doses as a function of
40 time among the Base Case, Case I, and Case II. Figure E-4 compares the radiation doses among
41 Cases III, IV, and V. Figure E-5 compares the radiation doses among Cases VI, VII, and VIII.

42

43 In Figure E-3, for all the three cases (Base Case, Case I, and Case II), the sharp peak
44 close to time 0 is caused by C-14, which was assumed to be highly soluble in water (a K_d value

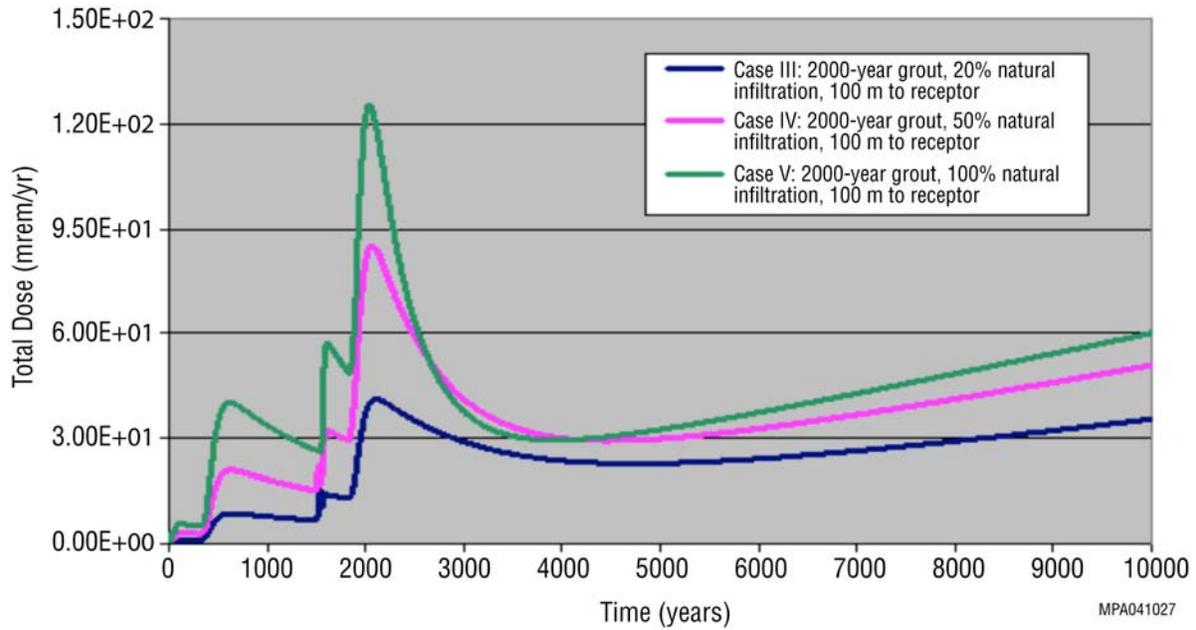


1

2 **FIGURE E-3 Comparison of Annual Doses for the Base Case and Cases I and II for Trench**
 3 **Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS**

4

5



6

7 **FIGURE E-4 Comparison of Annual Doses for Cases III, IV, and V for Trench Disposal of**
 8 **Stored Group 1 GTCC-Like Other Waste - CH at SRS**

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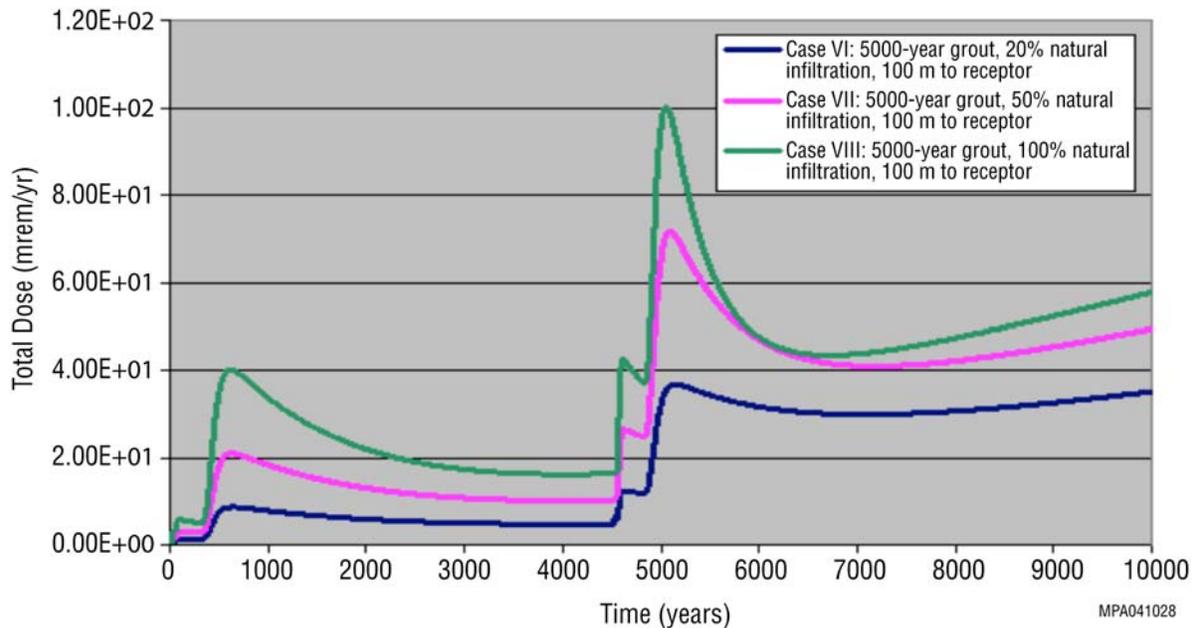
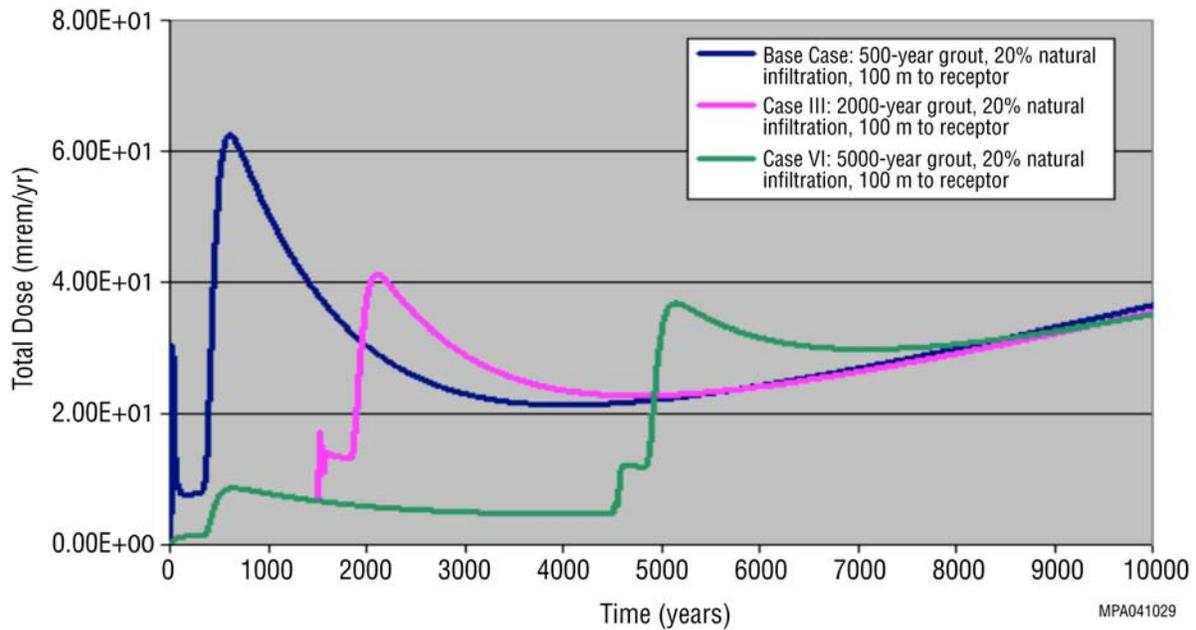


FIGURE E-5 Comparison of Annual Doses for Cases VI, VII, and VIII for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

of $0 \text{ cm}^3/\text{g}$ was used in the analyses). After C-14, Np-237 and then Ra-226 would reach the groundwater table. The radiation dose between 100 and 350 years is mainly contributed by Np-237. After 350 years, Ra-226 plays a dominant role in determining the radiation dose. Because of more adsorption to the soil particles during transport to the receptor location, the peaks created by Np-237 and Ra-226 are not as sharp as the peak created by C-14. In addition to the initial inventory in the Group 1 GTCC-like stored Other Waste - CH, Np-237 could be generated by the decay of Am-241, while Ra-226 could be generated by the decay of U-234 and Th-230. The ingrowth of Np-237 and Ra-226 explains the gradual rise of the radiation dose, which continues all the way to 10,000 years after the peak at around 500–600 years. Note that for the RESRAD-OFFSITE analyses, time 0 corresponds to the onset of leaching of radionuclides, which is assumed to occur 500 years after the closure of the disposal facility when the integrity of the barrier materials and waste containers begins to degrade. Therefore, if the reported time is 600 years, it means 1,100 years after the closure of the disposal facility.

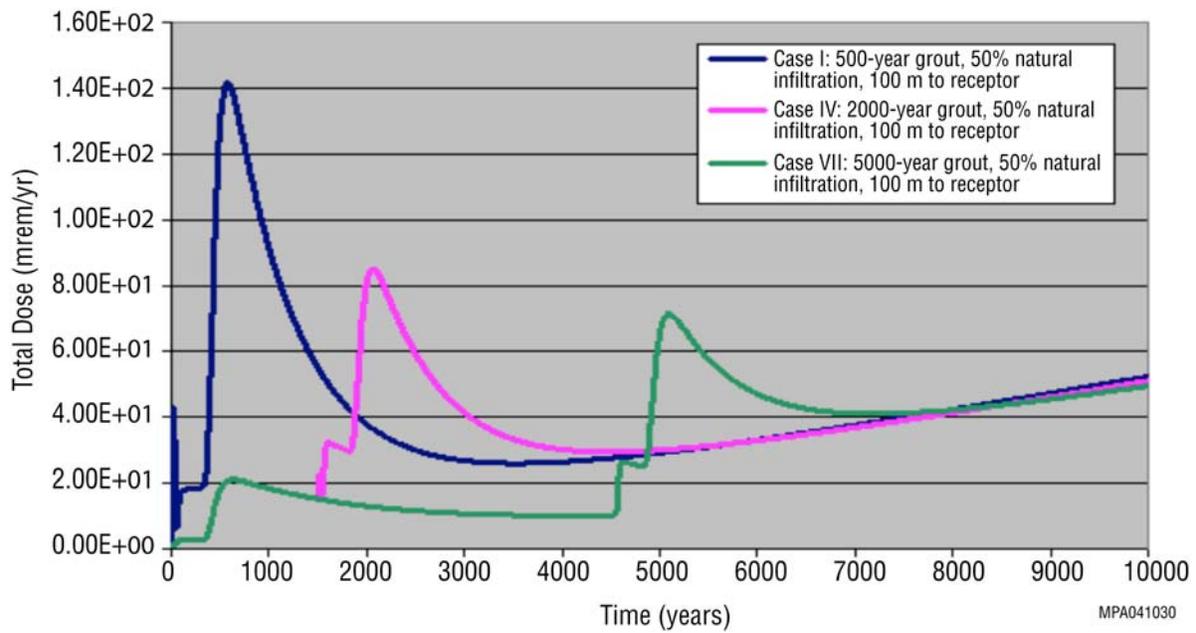
The influence of the effectiveness of the stabilizing agent (grout) on the potential radiation doses is demonstrated by comparing the results of the Base Case and Cases III and VI (see Figure E-6). During the effective period, the release rates of radionuclides from the waste disposal area would be reduced, thereby reducing the radiation dose associated with groundwater contamination for the corresponding period. The retention of more radionuclides in the waste containers would allow for more radioactive decay to occur before the release. Hence, the peak annual dose after the effective period would be lower than when there was no waste stabilizing or when the effective period of the stabilizing agent was shorter. The longer the effective period, the more evident the delay and reduction of the peak dose (compare the dose results for Cases I, IV, and VII in Figure E-7 or the results for Cases II, V, and VIII in Figure E-8).



1

FIGURE E-6 Comparison of Annual Doses for the Base Case and Cases III and VI for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

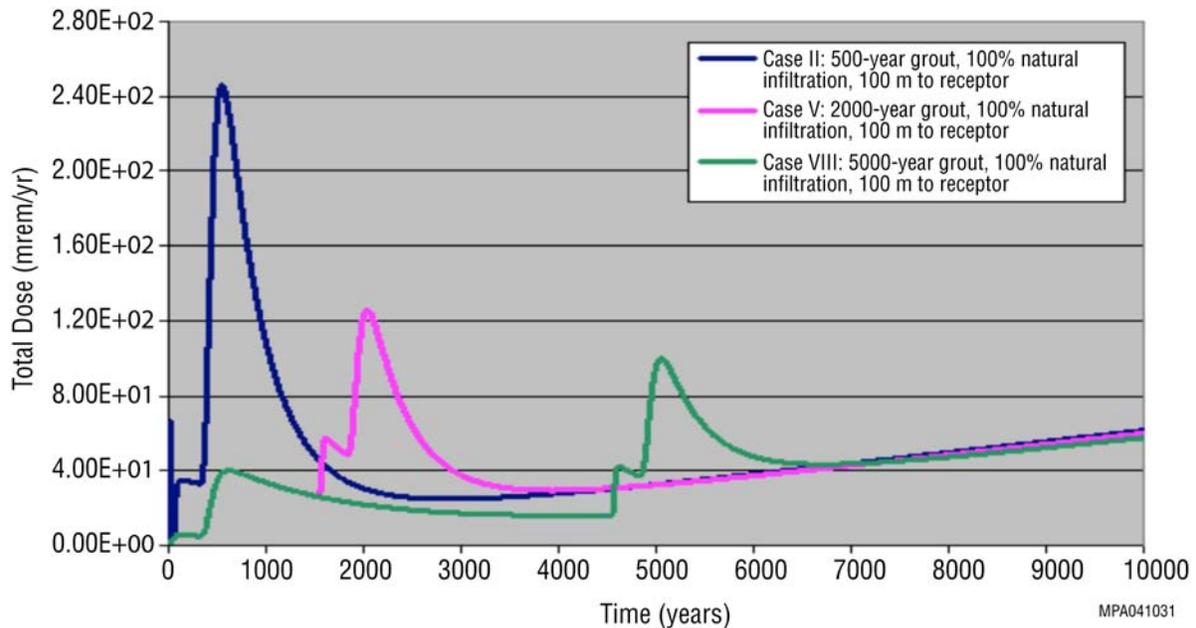
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FIGURE E-7 Comparison of Annual Doses for Cases I, IV, and VII for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

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2 **FIGURE E-8 Comparison of Annual Doses for Cases II, V, and VIII for Trench Disposal of**
 3 **Stored Group 1 GTCC-Like Other Waste - CH at SRS**

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6 For Case III in Figure E-6 (the first part of the curve overlaps with the curve for
 7 Case VI), the dose results were obtained by assuming the effectiveness of grouting would last for
 8 2,000 years (i.e., the grouting would be effective for 1,500 years after water started to infiltrate
 9 into the waste containers). The grouting would reduce the releases of radionuclides and allow for
 10 more radioactive decay to take place in the containers. By the time the grout was no longer
 11 effective, the partitioning of radionuclides to the water phase would increase simultaneously,
 12 resulting in a sudden increase of the release rates, and the corresponding increase in radiation
 13 dose would be observed at a later time depending on the travel time required for the
 14 radionuclides to reach the receptor location. Because the grouting would have more influence on
 15 Np-237 than on Ra-226 (K_d s used for Np-237 and Ra-226 were 300 and 100 cm^3/g , respectively,
 16 in the analyses), the radiation dose within the effective period (the first 1,500 years in the
 17 RESRAD-OFFSITE analyses) would be largely contributed by Ra-226. After the effective
 18 period, the release rates of both Np-237 and Ra-226 would increase. However, because Np-237
 19 (with a K_d of 0.6 cm^3/g) would travel faster than Ra-226 (with a K_d of 5 cm^3/g) in the soil
 20 column and groundwater aquifer, its influence on the radiation dose would be observed earlier
 21 (the first peak after 1,500 years in the dose profile) than that from Ra-226 (the second peak after
 22 1,500 years in the dose profile). The grouting would also reduce the release rate of C-14 (a K_d of
 23 10 cm^3/g was assumed for the grouting system); therefore, a sharp peak before 1,500 years
 24 would no longer be observed. The sharp peak (close to 1,500 years in the dose profiles) would
 25 occur after the effective period of the grout; however, the radioactivity of C-14 would have
 26 decayed some by then, so the sharp peak would become less obvious.

27

28

29

For Case VI in Figure E-6, the dose results were obtained by assuming that the
 effectiveness of grouting would last for 5,000 years. The dose profiles are similar to that for

1 Case III and can be explained by the same reasons provided in the previous paragraph, except
 2 that more decay and ingrowth of radioactivity would occur in the waste containers prior to the
 3 loss of grout effectiveness. The increased radioactive decay explains why magnitudes of the
 4 peaks after 4,500 years for Case VI are smaller than magnitudes of the peaks after 1,500 years
 5 for Case III. The increased ingrowth of progeny radionuclides explains why the difference in the
 6 maximum dose between Cases III and VI is less than the difference in the maximum dose
 7 between the Base Case and Case III.

8

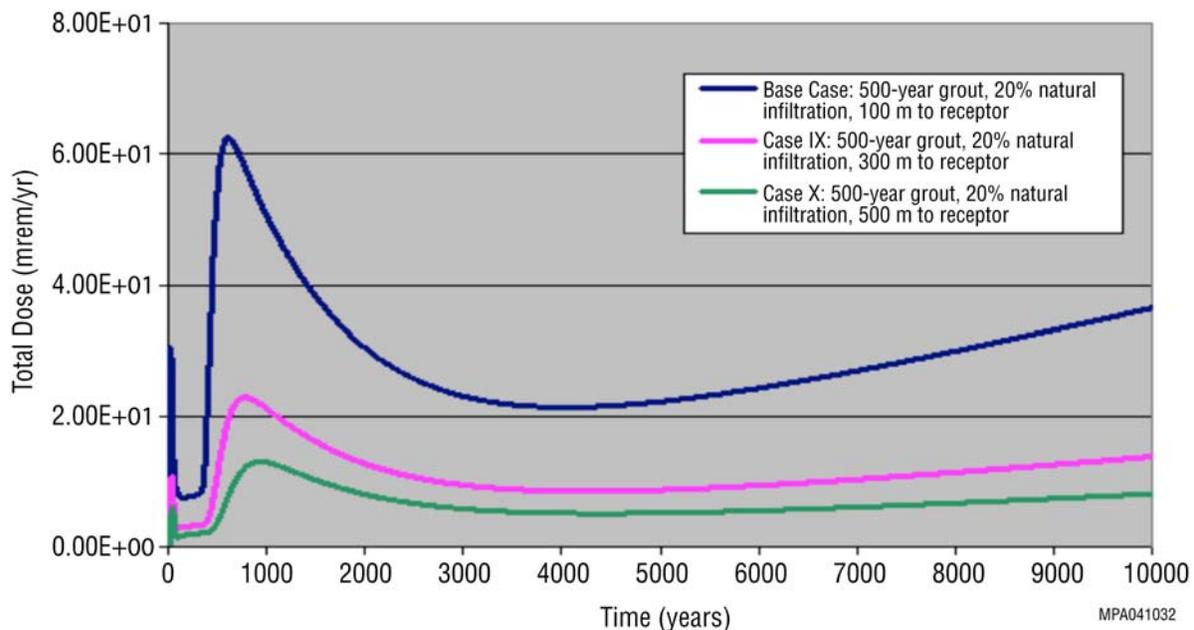
9 The radiation dose incurred by the hypothetical resident farmer considered for post-
 10 closure impact analyses would decrease with increasing exposure distance, as demonstrated by
 11 the results for the Base Case and Cases IX and X (see also Figure E-9). As mentioned before,
 12 this result would occur because additional dilution of radionuclide concentrations in groundwater
 13 would result from the additional transport distance toward the location of the off-site well. As the
 14 distance would increase from 100 m (330 ft) to 500 m (1,600 ft), the maximum annual radiation
 15 dose would decrease by more than 70%.

16

17 Although the sensitivity analysis was not conducted with the entire inventory of GTCC
 18 LLRW and DOE GTCC-like waste, the results in this appendix provide a good indication of the
 19 dose reduction that would occur with the entire inventory under more favorable conditions than
 20 those assumed for the Base Case (i.e., a lower water infiltration rate with better engineering of
 21 the cover, a longer effective time for the stabilizing agent [grout], and a longer distance to a
 22 hypothetical receptor). It is expected that with more robust designs of engineering barriers and
 23 waste containment procedures, the actual human health impacts would be much lower than those
 24 presented in this EIS.

25

26



27

28 **FIGURE E-9 Comparison of Annual Doses for the Base Case and Cases IX and X for Trench**
 29 **Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS**

TABLE E-1 Distribution Coefficients (cm³/g) for Cementitious Systems (moderately aged concrete)^a

Element	PNNL-13037 Rev. 2 (Krupka et al. 2004)	WSRC-TR-2006-0004 Rev. 0 (Kaplan 2006)		SRNL-RPA-2007- 00006 (Kaplan 2007)		Mattigod et al. 2002 ^b		Mattigod et al. 2002	Selected Value	
		Oxidizing	Reducing	Oxidizing	Reducing	Oxidizing	Reducing	Haddam Neck Samples	Oxidizing	Reducing
Ac	5,000	5,000	5,000	– ^c	–	–	–	–	1,000	1,000
Am	5,000	5,000	5,000	–	–	1,000–5,000	1,000–5,000	>230 – >1,750	1,000	1,000
C	10	10	10	–	–	100	100	–	10	10
Cm	5,000	5,000	5,000	–	–	1,000	1,000	–	1,000	1,000
Co	100	1,000	1,000	–	–	100	100	3,400–32,500, 180–380	100	100
Cs	30	4	4	–	–	20	20	14,800–26,800, 34–240	4	4
Fe	–	–	–	5,000	1,000	100	100	7–18	12	12
Gd	–	5,000	5,000	–	–	–	–	–	1,000	1,000
H	0	0	0	–	–	0	0	–	0	0
I	8	20	20	–	–	–	–	–	20	20
Mn	–	–	–	100	100	–	–	–	100	100
Mo	–	–	–	0.1	0.1	–	–	–	0.1	0.1
Nb	40	1,000	1,000	–	–	1,000	1,000	–	1,000	1,000
Ni	100	1,000	1,000	–	–	100	100	10-61	10	100
Np	2,000	2,000	2,000	–	–	2,000–5,000	5,000	>300 – >510	300	300
Pa	2,000	2,000	2,000	–	–	–	–	–	2,000	2,000
Pb	5,000	500	500	–	–	–	–	–	500	500
Po	–	500	500	–	–	–	–	–	500	500
Pu	5,000	5,000	5,000	–	–	5,000	5,000	>1,300 – >5,600	5,000	5,000
Ra	100	100	100	–	–	–	–	–	100	100
Sm	–	5,000	5,000	–	–	–	–	–	1,000	1,000
Sr	–	1	1	–	–	1–3	1–3	10–11	1	1
Tc	0	0	5,000	–	–	0-1	1,000	6–21	0	1,000
Th	5,000	5,000	5,000	–	–	5,000	5,000	–	5,000	5,000
U	1,000	1,000	5,000	–	–	–	–	–	1,000	5,000

^a Sources for the K_d values for cementitious systems are Krupka et al. (2004), Kaplan (2006, 2007), and Mattigod et al. (2002).

^b Values obtained from Table 5 of Mattigod et al. (2002) for Environment II, which considers moderately aged cement that may last from 100–10,000 years to 1,000–100,000 years. The original sources cited by Mattigod et al. (2002) for the K_d values are Krupka and Serne (1998) and Bradbury and Van Loon (1998).

^c A dash means no information was available.

TABLE E-2 Inventories of the GTCC LLRW and GTCC-Like Waste in the Four NRC Regions for the No Action Alternative^a

Waste Volume (m ³)									
NRC Region	GTCC LLRW				GTCC-Like Waste				
	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	All Waste Types
I	960	520	1,600	2,000	0	0	930	1,300	7,300
II	420	740	0	390	2.9	0	270	270	2,100
III	220	420	0	0	0	0	0	0	640
IV	390	1200	42	33	9.9	0.83	31	19	1,700

Waste Activity (Ci)									
NRC Region	GTCC LLRW				GTCC-Like Waste				
	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	All Waste Types
I	3.3E+07	3.7E+05	2.4E+04	3.1E+04	0.0	0.0	3.3E+04	4.9E+05	3.4E+07
II	5.2E+07	5.3E+05	0.0	9.8E+04	2.3E+05	0.0	2.4E+02	4.2E+04	5.3E+07
III	2.4E+07	3.0E+05	0.0	0.0	0.0	0.0	0.0	0.0	2.4E+07
IV	4.7E+07	8.2E+05	1.1E+01	9.5E+04	5.2+03	7.7E+01	1.3E+03	2.0E+02	4.8E+07

^a All values are given to two significant figures.

TABLE E-3 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for INL

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.4	Site-specific data.	WRCC 2007
Precipitation (m/yr)	0.22	Site-specific data.	WRCC 2007
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.52	To obtain an infiltration rate of 4 cm/yr, which is close to the value used for the base-case scenario (4.1 cm/yr) in the performance assessment (PA) for the Tank Farm facility.	DOE 2003
Runoff coefficient	0.6212		
Rainfall and runoff	160	To obtain an erosion rate of 1E-5 m/yr for the cover and contamination zone (i.e., would yield more conservative results).	Yu et al. 2007 (applies to the sum of all four parameters at left)
Slope-length-steepness factor	10		
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the contaminated zone would not be eroded away (i.e., would yield more conservative results).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste types, based on GTCC inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain an erosion rate of 1E-5 m/yr.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain an erosion rate of 1E-5 m/yr.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	9.14	Alluvium (surficial sediment, a coarse-grain unit consisting of predominantly sand and gravel). Based on Well USGS-51 strata information.	DOE 2003, p. 2-46
Density (g/cm ³)	1.643	Density for sandy clay/clay.	Yu et al. 2000, Table 3.1-1
Total porosity	0.5		DOE 2003

1

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Effective porosity	0.5	Set to the same value as total porosity.	DOE 2003
Field capacity	0.1	Coarse grain retains less water.	
Hydraulic conductivity (m/yr)	29,200	Corresponds to 80 m/d used in the PA for the Tank Farm facility.	DOE 2003, p. 3-42
b-parameter	4.339	This b-parameter value, along with the hydraulic conductivity and infiltration rate, gives a moisture content of 0.16.	
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all the sites.	
Unsaturated Zone 2		Thick-flow basalt units.	
Thickness (m)	94.64	Sum of thicknesses of thick-flow basalt layers. According to Well USGS-51 strata profile, thick-flow basalt constitutes roughly 90% of the total thickness of all basalt layers above the groundwater table.	
Density (g/cm ³)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for the basalt unit.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Field capacity	0.001	Set to a value less than moisture content.	
Hydraulic conductivity (m/yr)	3,650	Corresponds to 10 m/d.	DOE 2003, p. 3-43
b-parameter	0.76	Selected to give a moisture content of 0.004, which is provided in INL's comments on RESRAD-OFFSITE input parameters.	Wilcox 2008
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 3		Upper interbed sequence with a low permeability.	
Thickness (m)	7.47	Sum of thicknesses of upper interbeds.	
Density (g/cm ³)	1.46	Value for silt loam.	NUREG/CR-6697 (Yu et al. 2000)
Total porosity	0.57	Porosity used for the C-D interbed in the Radioactive Waste Management Complex (RWMC) PA.	DOE 2006a
Effective porosity	0.57	Set to the same as total porosity.	DOE 2006a
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	1.29	Corresponds to 0.0035 m/d, the geometric mean of 0.005 m/d and 0.0025 m/d assumed for the C-CD and D-DE2 interbeds in the Tank Farm facility PA.	DOE 2003

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
b-parameter	3.6	Calculated mean for silt loam soil. Distribution is log normal (1.28, 0.334). The b-parameter, along with the assumed infiltration rate and hydraulic conductivity, results in a moisture content of 0.414.	NUREG/CR-6697 (Yu et al. 2000)
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 4			
Thickness (m)	15.88	Lower sedimentary interbeds. The difference between total thickness of the interbeds (estimated to be about 23.35 m according to the Well USGS-51 profile) and the thickness of the upper interbeds, 7.47 m.	
Density (g/cm ³)	1.643	Set to the value for alluvium sediment since they were assumed to have similar hydraulic characteristics in the Tank Farm facility PA.	DOE 2003
Total porosity	0.5		
Effective porosity	0.5	Set to the same as total porosity.	RESRAD-OFFSITE default
Field capacity	0.3		
Hydraulic conductivity (m/yr)	29,200	Set to the same value as for alluvium.	DOE 2003
b-parameter	10.4	Value for silty clay. This b-parameter value, along with the infiltration rate and hydraulic conductivity, results in a moisture content of 0.286.	
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 5			
Thickness (m)	15.39	Thin-flow basalt units. Sum of thicknesses of thin-flow basalt layers. According to Well USGS-51 strata profile, thin flows basalt constitutes roughly 10% of the total thickness of all basalt layers above the groundwater table.	
Density (g/cm ³)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for the basalt unit.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Field capacity	0.001	Set to a value less than moisture content.	
Hydraulic conductivity (m/yr)	365,000	Corresponds to 1,000 m/d.	DOE 2003, p. 3-43
b-parameter	1.67	Selected to give a moisture content of 0.004, which is provided in INL's comments on RESRAD-OFFSITE input parameters.	Wilcox 2008

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Saturated zone hydrology			
Thickness (m)	495	Site-specific average (76–914 m).	Anderson and Lewis 1989
Density of saturated zone (g/cm ³)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for basalt.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Hydraulic conductivity (m/yr)	1,979	Corresponds to 5.42 m/d (the geometric mean of the range from 3.0E-3 to 9.8E+3 m/d, reported as the effective hydraulic conductivity of the basalt and interbedded sediments that compose the Snake River Plain Aquifer at and near INL).	DOE 2003
Hydraulic gradient to well	0.00075	Average for the site (0.00019 to 0.0028), close to the average slope of the water table (4 ft/mi) reported in the Tank Farm facility PA.	McCarthy and McElroy 1995; Anderson and Lewis 1989; DOE 2003
Depth of aquifer contributing to well (m), below the water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of distance traveled	Assumption used for all sites, which is commonly used for groundwater transport modeling.	
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

TABLE E-4 Soil/Water Distribution Coefficients (K_d values)^a for Different Radionuclides for INL

Element	K_d Value (cm^3/g)						Value Selection Rationale ^b	Source
	Unsaturated Zone 1 (alluvium, surficial sediment)	Unsaturated Zone 2 (thick flow basalt units)	Unsaturated Zone 3 (upper interbed sequence with a low permeability)	Unsaturated Zone 4 (lower sedimentary interbeds)	Unsaturated Zone 5 (thin flow basalt units)	Saturated Zone		
Ac	225	0	225	225	0	9	Based on comments from INL, the same K_d value was used for alluvium and interbeds. The basalt K_d was set to 0, and the K_d for the saturated zone was set to 1/25 that of alluvium and interbeds.	DOE 2007
Am	225	0	225	225	0	9	Same as for Ac.	DOE 2007
C	0.4	0	0.4	0.4	0	0.016	Same as for Ac.	DOE 2007
Cm	4,000	0	4,000	4,000	0	160	Same as for Ac.	DOE 2007
Co	10	0	10	10	0	0.40	Same as for Ac.	Jenkins 2001
Cs	500	0	500	500	0	20	Same as for Ac.	Jenkins 2001
Fe	220	0	220	220	0	8.8	Same as for Ac.	Jenkins 2001
Gd	240	0	240	240	0	9.6	Same as for Ac.	Jenkins 2001
H	0	0	0	0	0	0	Same as for Ac.	DOE 2007
I	0	0	0	0	0	0	Same as for Ac.	DOE 2007
Mn	50	0	50	50	0	2	Same as for Ac.	Jenkins 2001
Mo	10	0	10	10	0	0.4	Same as for Ac.	DOE 2007
Nb	500	0	500	500	0	20	Same as for Ac.	DOE 2007
Ni	100	0	100	100	0	4	Same as for Ac.	Jenkins 2001
Np	23	0	23	23	0	0.92	Same as for Ac.	DOE 2007
Pa	8	0	8	8	0	0.32	Same as for Ac.	DOE 2007
Pb	270	0	270	270	0	10.80	Same as for Ac.	DOE 2007
Po	150	0	150	150	0	6	Same as for Ac.	Jenkins 2001
Pu	2,500	0	2,500	2,500	0	100	Same as for Ac.	DOE 2007

TABLE E-4 (Cont.)

Element	K _d Value (cm ³ /g)					Saturated Zone	Value Selection Rationale ^b	Source
	Unsaturated Zone 1 (alluvium, surficial sediment)	Unsaturated Zone 2 (thick flow basalt units)	Unsaturated Zone 3 (upper interbed sequence with a low permeability)	Unsaturated Zone 4 (lower sedimentary interbeds)	Unsaturated Zone 5 (thin flow basalt units)			
Ra	575	0	575	575	0	23	Same as for Ac.	DOE 2007
Sm	2,500	0	2,500	2,500	0	100	Same as for Ac.	DOE 2007
Sr	12	0	12	12	0	0.48	Same as for Ac.	Jenkins 2001
Tc	0	0	0	0	0	0	Same as for Ac.	DOE 2007
Th	500	0	500	500	0	20	Same as for Ac.	DOE 2007
U	15.4	0	15.4	15.4	0	0.616	Same as for Ac.	DOE 2007

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

^b For INL's review comments on the RESRAD-OFFSITE input parameters, see Wilcox (2008).

TABLE E-5 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for Hanford

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.4	Site-specific data at Hanford Meteorology Station (HMS), 50 m above ground.	DOE 2004
Precipitation (m/yr)	0.17	Site-specific data (54.39 in./yr), based on HMS measurements. Consistent with values reported by the Western Regional Climate Center (1948–2005).	DOE 2004, p. 4.16
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.97878	In DOE 2005, the infiltration rate suggested for the post-design life for the sitewide surface barrier is 3.5 mm/yr; the post-design life for the Integrated Disposal Facility (IDF) surface barrier is 0.9 mm/yr. However, for the IDF surface barrier, a sensitivity analysis needs to be conducted for an infiltration rate of 5.0 mm/yr as well. Considering the recharge rate at the 200 E Area, which ranges from 1.5 to 4 mm/yr with shrub covering, and to be consistent with the other sites that use a natural infiltration rate for the GTCC analysis, an infiltration rate of 3.5 mm/yr was chosen for the groundwater analysis. To obtain an infiltration rate of 0.0035 m/yr (3.5 mm/yr), the evapotranspiration coefficient was calculated to be 0.97878.	DOE 2005
Runoff coefficient	0.03	Runoff is about 3% of the total precipitation; most of the remaining precipitation is lost through evapotranspiration.	Duncan et al. 2007
Rainfall and runoff	160	To obtain the desired erosion rates for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the desired erosion rate.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.35	To obtain the desired erosion rate.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	58	Fine sand plus coarse sand-dominated layers in the Hanford Formation. They were considered together because of their similar geological and hydrogeological properties. Average value calculated with the stratigraphic columns data for 200 E area.	Last et al. 2006
Density (g/cm ³)	1.65	For fine sand and coarse sand layers in Hanford Formation.	Last et al. 2006
Total porosity	0.37	Set to the same as effective porosity.	Last et al. 2006
Effective porosity	0.37	For fine sand and coarse sand layers in Hanford Formation.	Last et al. 2006
Field capacity	0.03	Residual moisture content.	Last et al. 2006
Hydraulic conductivity (m/yr)	710	Corresponding to 2.25E-3 cm/s. Selected based on the information presented in Last et al. 2006 for fine and coarse sands in Hanford Formation.	
b-parameter	4.05	Value for sand soil.	Yu et al. 2001
Longitudinal dispersivity (m)	0	No dispersion.	Assumption used for all sites

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 2			
		Gravel-dominated layers in the Hanford Formation plus Ringold Unit E. They were considered together because of their similar geological and hydrogeological properties.	
Thickness (m)	30	Average value calculated with the stratigraphic columns data for 200 E area.	Data presented in Last et al. 2006, Appendix A.
Density (g/cm ³)	1.93	For gravel-dominated layers in Hanford Formation and Ringold Unit E.	Last et al. 2006
Total porosity	0.27	Value for Hanford and Ringold gravel.	DOE 2009
Effective porosity	0.27	Set to the same as total porosity.	DOE 2009
Field capacity	0.024	Residual moisture content.	Last et al. 2006
Hydraulic conductivity (m/yr)	148	Corresponding to 4.68E-4 cm/s. Selected on the basis of information presented in Last et al. 2006 for gravel-dominated layers in Hanford Formation and Ringold Unit E.	Last et al. 2006
b-parameter	7.12	Value for sandy clay loam soil.	Yu et al. 2001, Table E-2
Longitudinal dispersivity (m)	0	No dispersion.	Assumption used for all sites.
Saturated zone hydrology			
		Consider the combination of the Hanford Formation and Ringold Unit E.	
Thickness (m)	45	Entire aquifer is 45 to 71.7 m thick. Use the lower value.	Horton 2007
Density of saturated zone (g/cm ³)	1.98	Calculated on the basis of a soil particle density of 2.65 g/cm ³ and a total porosity of 0.25.	
Total porosity	0.25	Used for unconfined aquifer.	Page O-91, DOE 2009
Effective porosity	0.25	Set to the same as total porosity.	Page O-91, DOE 2009
Hydraulic conductivity (m/yr)	12,775	Slug tests at five monitoring wells in the IDF location (Reidel 2004) indicate a high-permeability condition, ranging from >25 to >45 m/d. These estimates for the hydraulic conductivity beneath the IDF site are consistent with the unconfined aquifer flow through the gravel-dominated facies of the lower Hanford Formation. Use the average of 35 m/day, which converts to 12,775 m/yr.	Reidel 2004
Hydraulic gradient to well	0.00124	Geometric mean of the range from 0.00073 to 0.00209.	Horton 2007
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Longitudinal dispersivity (m)	10% of distance traveled	Assumptions used for all sites. Common practices for groundwater transport modeling.	
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of horizontal lateral dispersivity	Assumptions used for all sites.	

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TABLE E-6 Soil/Water Distribution Coefficients (K_d values)^a for Different Radionuclides for Hanford

Source	K_d Value (cm ³ /g)			Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone				
Ac	300	30	300	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Krupka et al. 2004, Table 5.6	Use 10% of the value for sand-dominated soil, an approach used in the groundwater data package.	Thorne et al. 2006
Am	1,900	190	1,900	To be consistent with values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
C	4	0.4	4	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Cm	300	30	300	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Table 5.6, Krupka et al. 2004	Same as above.	Thorne et al. 2006
Co	2,000	200	2,000	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Table 5.6, Krupka et al. 2004	Same as above.	Thorne et al. 2006
Cs	80	8	80	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Fe	220	22	220	Generic value for sand soil.	Site-specific value preferred. Sheppard and Thibault 1990; Yu et al. 2000	Same as above.	Thorne et al. 2006

TABLE E-6 (Cont.)

Source	K _d Value (cm ³ /g)			Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone				
Gd	825	82.5	825	Generic value for soil.	Yu et al. 2000	Same as above.	Thorne et al. 2006
H	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
I	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Mn	50	5	50	To be consistent with the values used DOE 2009.	Sheppard and Thibault 1990, Yu et al. 2000	Same as above.	Thorne et al. 2006
Mo	10	1	10	To be consistent with the values used DOE 2009.	Sheppard and Thibault (1990); Yu et al. 2000	Same as above.	Thorne et al. 2006
Nb	300	30	300	Best K _d value for far field in sand sequence with natural recharge (no impact from wastes).	Krupka et al. 2004, Table 5.6	Same as above.	Thorne et al. 2006
Ni	400	40	400	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
Np	2.5	0.25	2.5	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Pa	2.5	0.25	2.5	Set to the same values as Np.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Pb	80	8	80	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006

TABLE E-6 (Cont.)

Source	K _d Value (cm ³ /g)			Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone				
Po	150	15	150	Generic value for sand soil.	Sheppard and Thibault 1990; Yu et al. 2000	Same as above.	Thorne et al. 2006
Pu	150	15	150	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Ra	10	1	10	Same as Sr.	DOE 2005	Same as above.	Thorne et al. 2006
Sm	300	30	300	Same as Ac.	Krupka et al. 2004, Table 5.6	Same as above.	Thorne et al. 2006
Sr	10	1	10	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Tc	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Th	3,200	320	3,200	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
U	0.6	0.06	0.6	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and the site-specific soil K_d values and cementitious system K_d values for Other Waste.

TABLE E-7 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for LANL

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	2.65	Geometric mean of the distribution log normal (2.65, 1.35).	Distribution information from Henckel 2008. The distribution function is based on wind speed data collected at the meteorological tower at TA-54 from January 1992 through April 2005 (http://weather.lanl.gov)
Precipitation (m/yr)	0.356	Site-specific data.	Bowen 1990
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.9	To obtain an infiltration rate of 5 mm/yr, which was determined for use in the analysis on the basis of the histogram shown on p. 23 of Stauffer et al. 2005.	Stauffer et al. 2005
Runoff coefficient	0.8596		
Rainfall and runoff	160	To obtain the erosion rates used as the input values for the cover and contamination zone.	Yu et al. 2007 (applies to the sum of all four parameters at left)
Slope-length-steepness factor	10		
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste streams, on the basis of preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain the erosion rate used for the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the cover material would not be eroded away completely within the time frame considered.	Yu et al. 2007
Dry bulk density (g/cm ³)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain the erosion rate used for the input value.	Yu et al. 2007

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TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 1			
Thickness (m)	13	Tshirege Member Unit 2. Determined on the basis of as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm ³)	1.4	Value for Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
Total porosity	0.41	Value for Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
Effective porosity	0.41	Set to the same value as total porosity.	
Field capacity	0.02	Set to a smaller value than 0.024, the moisture content for a saturation of 0.06.	
Hydraulic conductivity (m/yr)	61.81	Corresponds to a permeability of 2.0E-13 m ² for the Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
b-parameter	0.175	Selected to give a saturation of 0.06, an approximated value based on the range of site data for Unit 2 presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 2			
Thickness (m)	26	Tshirege Units 1v, 1g, and Cerro Toledo interval. Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm ³)	1.2	Average value for Tshirege Member Unit 5.	Stauffer et al. 2005, Table 4
Total porosity	0.47	Average value for Tshirege Units 1f, 1g, and Cerro Toledo interval.	Stauffer et al. 2005, Table 4
Effective porosity	0.47	Set to the same value as total porosity.	
Field capacity	0.02	Set to a smaller value than 0.094, the moisture content for a saturation of 0.2.	
Hydraulic conductivity (m/yr)	46.36	Corresponds to a permeability of 1.5E-13 m ² , the average for Tshirege Member Units 1v, 1g, and Cerro Toledo interval.	Stauffer et al. 2005, Table 4
b-parameter	1.339	Selected to give a saturation of 0.2, an approximated value based on the range of site data for Unit 2 presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	

TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 3			
Thickness (m)	16	Otowi Member above Guaje Pumice. Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm ³)	1.2	Value for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
Total porosity	0.44	Value for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
Effective porosity	0.44	Set to the same value as total porosity.	
Field capacity	0.04	Set to a smaller value than 0.12; the moisture content corresponds to a saturation of 0.27.	
Hydraulic conductivity (m/yr)	71.08	Corresponds to a permeability of 2.3E-13 m ² for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
b-parameter	2.152	Selected to give a saturation of 0.27, an approximated value based on a range of site data in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 4			
Thickness (m)	3	Otowi Member Guaje Pumice. Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm ³)	0.8	Value for Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
Total porosity	0.67	Value for Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
Effective porosity	0.67	Set to the same value as total porosity.	
Field capacity	0.00001	Set to a small value so that it is not used to reset the saturation ratio calculated.	
Hydraulic conductivity (m/yr)	46.36	Corresponds to a permeability of 1.5E-13 m ² for the Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
b-parameter	1.891	Selected to give a saturation of 0.26, an approximated value based on a range of site data presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 5			
Thickness (m)	211	Cerros del Rio basalts vadose zone. Determined on the basis of as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm ³)	2.7	Value for the basalts.	Stauffer et al. 2005, Table 4

TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Total porosity	0.001	Value for basalts vadose zone.	Stauffer et al. 2005, Table 4
Effective porosity	0.001	Set to the same value as total porosity.	
Field capacity	0.00001	Set to a small value so that it is not used to reset the saturation ratio calculated.	
Hydraulic conductivity (m/yr)	309.05	Corresponds to a permeability of $1.0\text{E-}12\text{ m}^2$ for the basalts vadose zone.	Stauffer et al. 2005, Table 4
b-parameter	2.713	Selected to give a saturation of 0.27, an approximated value based on the range of site data presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Saturated zone hydrology		Cerro del Rio basalts saturated zone.	
Thickness (m)	37.5	Used for groundwater modeling.	Stauffer et al. 2005
Density of saturated zone (g/cm^3)	2.7	Value for the basalts.	Stauffer et al. 2005, Table 4
Total porosity	0.05	Value for basalts saturated zone.	Stauffer et al. 2005, Table 4
Effective porosity	0.05	Set to the same value as total porosity.	
Hydraulic conductivity (m/yr)	309.05	Corresponds to a permeability of $1.0\text{E-}12\text{ m}^2$ for the basalts vadose zone.	Stauffer et al. 2005, Table 4
Hydraulic gradient to well	0.013		Stauffer et al. 2005, Section 3.1.4.3
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of distance traveled	Assumption applied to all sites considered. A common practice used in groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption applied to all sites considered.	

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TABLE E-8 Soil/Water Distribution Coefficients (K_d values)^a for Different Radionuclides for LANL

Element	K_d Value (cm^3/g)		Value Selection Rationale	Source
	Unsaturated Zone	Saturated Zone		
Ac	130	130	Value suggested by French of LANL for use in RESRAD-OFFSITE modeling to develop a GTCC waste disposal facility.	French 2008; Wolsberg 1980
Am	2,400	2,400	Most likely value based on the distribution, T (2.0E+02, 2.4E+3, 2.7E+04).	French 2008; Longmire et al. 1996
C	0	0	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Cm	50	50	For devitrified volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Co	0.45	0.45	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Cs	7.5	7.5	Mean of distribution, U(1.0E+0, 1.5E+01, 7.5E+0).	French 2008; Bechtel/SAIC 2004
Fe	209	209	Value for generic soil.	Yu et al. 2000
Gd	50	50	Value for generic soil.	Krier et al. 1997
H	0	0	Assumed no adsorption.	Krier et al. 1997
I	0	0	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997
Mn	158	158	Value for generic soil.	Yu et al. 2000
Mo	4	4	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Nb	100	100	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Ni	50	50	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Np	2.2	2.2	Most likely value based on the distribution, T(1.7E-01, 2.2E+0, 3.1E+0).	French 2008; Longmire et al. 1996
Pa	5,500	5,500	Mean of the distribution, TN(5.5E+03, 1.5E+03, 1.0E+03, 1.0E+04).	French 2008; Bechtel/SAIC 2004
Pb	25	25	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Po	10	10	Value for generic soil.	Yu et al. 2000
Pu	4.10	4.10	Geometric mean for volcanic tuff (4.1-110).	Birdsell et al. 1999, Krier et al. 1997
Ra	500	500	Mean of the distribution, U(1.0E+2, 1.0E+03, 5.0E+02).	French 2008; Bechtel/SAIC 2004
Sm	50	50	Set to the same value as Gd.	Krier et al. 1997; Baes et al. 1984
Sr	40	40	Mean of the distribution, U(1.0E+0, 7.0E+01, 4.0E+01).	French 2008; Bechtel/SAIC 2004
Tc	0	0	Assumed no adsorption.	Birdsell et al. 1999; Krier et al. 1997; French 2008; Longmire et al. 1996
Th	5,000	5,000	Mean of the distribution, U(1.0E+3, 1.0E+04, 5.0E+03).	French 2008; Bechtel/SAIC 2004
U	2.4	2.4	Most likely value based on the distribution, T(1.4E+0, 2.4E+0, 3.5E+0).	French 2008; Longmire et al. 1996

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

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TABLE E-9 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for NNSS

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	2.6	Site-specific data.	Bechtel Nevada 2006
Precipitation (m/yr)	0.13	Site-specific data.	National Security Technologies, LLC 2008
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.99	Selected to give an infiltration rate of 0.00003 m/yr, which is the site-specific hydraulic conductivity for the vadose zone.	Shott et al. 1998
Runoff coefficient	0.977		
Rainfall and runoff	160	To obtain the erosion rates used as the input values for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the erosion rate used as the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the cover material would not be eroded away completely within the time frame considered. Would yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm ³)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.35	To obtain the erosion rate used as the input value.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	246	Average of the range from 235.3 to 256.6 m.	Bechtel Nevada 2001, 2002

TABLE E-9 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Density (g/cm ³)	1.65	Site-specific data.	Shott et al. 1998
Total porosity	0.36	Site-specific data.	Shott et al. 1998
Effective porosity	0.36	Site-specific data.	Shott et al. 1998
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	0.00003	Site-specific data.	Shott et al. 1998
b-parameter	5.3		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	0	No dispersivity was assumed for the unsaturated zone.	Assumption used for all sites.
Saturated zone hydrology			
Thickness (m)	220	Average value from well monitoring data.	Reynolds Electrical & Engineering Company, Inc. 1994
Density of saturated zone (g/cm ³)	1.6	Site-specific data.	Shott et al. 1998
Total porosity	0.36	Site-specific data.	Shott et al. 1998
Effective porosity	0.36	Site-specific data.	Shott et al. 1998
Hydraulic conductivity (m/yr)	439	Site-specific data.	Shott et al. 1998
Hydraulic gradient to well	9.70E-05	Site-specific data.	National Security Technologies, LLC 2008
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

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TABLE E-10 Soil/Water Distribution Coefficients for Different Radionuclides for NNSS^a

Element	<u>K_d Value (cm³/g)</u>		Value Selection Rationale	Source
	Unsaturated Zone	Saturated Zone		
Ac	7,000	7,000	Mean value of the distribution used in the Area 5 Radioactive Waste Management Site (RWMS) performance assessment (PA) model.	Bechtel Nevada 2006
Am	7,000	7,000	Same as Ac.	Bechtel Nevada 2006
C	0	0	Same as Ac.	Bechtel Nevada 2006
Cm	4,000	4,000	Suggested value for sandy soil.	Yu et al. 2000
Co	60	60	Suggested value for sandy soil.	Yu et al. 2000
Cs	280	280	Suggested value for sandy soil.	Yu et al. 2000
Fe	209	209	Suggested value for generic soil.	Yu et al. 2000
Gd	825	825	Suggested value for generic soil.	Yu et al. 2000
H	0	0	Value used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
I	0	0	Value used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Mn	50	50	Suggested value for sandy soil.	Yu et al. 2000
Mo	10	10	Suggested value for sandy soil.	Yu et al. 2000
Nb	7,000	7,000	Mean value of the distribution used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Ni	100	100	Same as Nb.	Bechtel Nevada 2006
Np	5	5	Same as Nb.	Bechtel Nevada 2006
Pa	5	5	Same as Nb.	Bechtel Nevada 2006
Pb	300	300	Same as Nb.	Bechtel Nevada 2006
Po	300	300	Set to the same value as Pb.	Bechtel Nevada 2006
Pu	7.5	7.5	Same as Nb.	Bechtel Nevada 2006
Ra	185	185	Same as Nb.	Bechtel Nevada 2006
Sm	245	245	Set to the same value as Eu used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Sr	420	420	Same as Nb.	Bechtel Nevada 2006
Tc	0	0	Same as Nb.	Bechtel Nevada 2006
Th	7,000	7,000	Same as Nb.	Bechtel Nevada 2006
U	0.8	0.8	Same as Nb.	Bechtel Nevada 2006

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

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TABLE E-11 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for SRS

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3	Site-specific data.	SRCC 2007a
Precipitation (m/yr)	1.2	Site-specific data.	SRCC 2007b; Cook et al. 2004
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.598	On the basis of both coefficients, an infiltration rate of 0.376 m/yr (14.8 in./yr) was derived. The Flach et al. 2005 estimate for trenches covered with a 4-ft operational soil cover and topsoil is 14.8 in./yr. The Young and Pohlmann 2003 study shows an infiltration rate ranging from 9 to 16 in./yr with a median value of 14.8 in./yr, or 1/3 of the yearly rainfall of approximately 48 in. The above information is cited in WSRC 2008, Part C, pp. 68 and 69.	WSRC 2008 (applies to both parameters at left)
Runoff coefficient	0.221		
Rainfall and runoff	160		
Slope-length-steepness factor	10	To obtain the desired erosion rates for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.01E-05	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain the desired erosion rate.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default

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TABLE E-11 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm ³)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain the desired erosion rate.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	6.1	According to Part B, Figure 1-6, of WSRC 2008, the thickness of the upper vadose zone can be calculated as the sum of the thicknesses of the soil fill (4 ft), upper waste zone (2.5 ft), and lower waste zone (13.5 ft). The total is 20 ft, (i.e., 6.1 m).	WSRC 2008, Figure 1-6
Density (g/cm ³)	1.65	Calculated with a soil particle density of 2.70 g/cm ³ and an effective porosity of 0.39.	WSRC 2008, Part B, Table 1-14
Total porosity	0.39		WSRC 2008, Part B, Table 1-14, p. 1-55
Effective porosity	0.39	Set to the same value as total porosity.	
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	2.7	For upper vadose zone.	WSRC 2008, Part B, Table 1-14, Appendix G, Table G-2
b-parameter	6.62	Mean of distribution, log normal (LN) (1.89, 0.260) for sandy clay soil.	Yu et al. 2000
Longitudinal dispersivity (m)	0		WSRC 2008, p. 2-43
Unsaturated Zone 2			
Thickness (m)	16.9	The water table in the E-Area and Z-Area is approximately 20 to 25 m below the ground surface.	Kaplan 2006
Density (g/cm ³)	1.62	Calculated with a soil particle density of 2.66 g/cm ³ and an effective porosity of 0.39.	WSRC 2008, Table 1-14
Total porosity	0.39	Used for PORFLOW transport analysis for lower vadose zone.	WSRC 2008, p. 2043
Effective porosity	0.39	For lower vadose zone.	WSRC 2008, Table 1-14
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	29	For lower vadose zone.	WSRC 2008, Tables 1-14, G-2
b-parameter	4.1	Mean of distribution, LN (1.41, 0.275), for sandy clay loam.	Yu et al. 2000
Longitudinal dispersivity (m)	0		WSRC 2008, p. 2-43

TABLE E-11 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Saturated zone hydrology			
Thickness (m)	27.85	Mean of the range of site-specific data (15.5–40.2 m), including thicknesses from the upper and lower aquifer zones and the tan clay confining zone.	For E Area, Cook et al. 2004
Density of saturated zone (g/cm ³)	1.39	Considering the distribution of local clayey sediments throughout the sandy aquifer.	WSRC 2008, p. 1-67
Total porosity	0.38	For sandy material associated with aquifers.	WSRC 2008, p. 1-57
Effective porosity	0.25	Considering the distribution of local clayey sediments throughout the sandy aquifer.	WSRC 2008, p. 1-67
Hydraulic conductivity (m/yr)	1,265	Geometric mean of the values for Upper Three Runs aquifer and Lower Three Runs aquifers.	WSRC 2008, p. 1-57 and Table G-1
Hydraulic gradient to well	0.0079	Geometric mean of the site-specific range for Aquifer Unit IIB, 0.0035–0.018.	MMES et al.1994
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	1% of distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	0.1% of distance traveled	Assumption used for all sites.	

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TABLE E-12 Soil/Water Distribution Coefficients for Different Radionuclides for SRS^a

Element	K _d Value (cm ³ /g)			Value Selection Rationale	Source
	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone		
Ac	8,500	1,100	1,100	Clay/sand material best estimated K _d . Clay material K _d for unsaturated Zone 1. Sand material K _d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; Kaplan 2006
Am	8,500	1,100	1,100	Same as above.	Same as above
C	0	0	0	Same as above.	Same as above
Cm	8,500	1,100	1,100	Same as above.	Same as above
Co	30	7	7	Best value for clayey/sandy sediment.	Kaplan 2006, Table 10
Cs	250	50	50	Best value for sandy/clayey sediment.	Kaplan 2006, Table 10
Fe	400	200	200	Best value for clayey/sandy soil.	Kaplan 2007
Gd	8,500	1,100	1,100	Best value for clayey/sandy sediment.	Kaplan 2006, Table 10
H	0	0	0	Clay/sand material best estimated K _d . Clay material K _d for unsaturated Zone 1. Sand material K _d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
I	0.6	0	0	Same as above.	Same as above
Mn	200	15	15	Best value for clayey/sandy soil.	Kaplan 2007
Mo	120	6	6	Best value for clayey/sandy soil.	Kaplan 2007
Nb	0	0	0	Same as above.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
Ni	30	7	7	Same as above.	Same as above
Np	35	0.6	0.6	Same as above.	Same as above
Pa	35	0.6	0.6	Same as above.	Same as above
Pb	5,000	2,000	2,000	Same as above.	Same as above
Po	5,000	2,000	2,000	Best value for clayey/sandy soil.	Kaplan 2006
Pu	5,900	270	270	Clay/sand material best estimated K _d . Clay material K _d for unsaturated Zone 1. Sand material K _d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
Ra	17	5	5	Same as above.	Same as above
Sr	17	5	5	Same as above.	Same as above
Sm	8,500	1,100	1,100	Same as above.	Same as above
Tc	0.2	0.1	0.1	Same as above.	Same as above
Th	2,000	900	900	Same as above.	Best value for sandy soil, Kaplan 2006
U	300	200	200	Same as above.	Same as above

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

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TABLE E-13 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for WIPP Vicinity

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.71	Site-specific data, low end of the most prevalent range.	DOE 2006b
Precipitation (m/yr)	0.3048	Site-specific data (about 12 in.).	DOE 2006b
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.9934	To obtain an infiltration rate of 0.002 m/yr, which is indicated in the source suggested by WIPP staff for reference.	Campbell et al. 1996
Runoff coefficient	0.0125	Because of the flat ground surface, the annual runoff is typically 0.1 to 0.2 in. The average value of 0.15 in. converts to a runoff coefficient of 0.0125.	For annual runoff — DOE 2006b
Rainfall and runoff	160	To obtain the erosion rates used as input values for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05		Yu et al. 2007
Dry bulk density (g/cm ³)	1.8	Estimated average for different waste streams, based on GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the erosion rate used as the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05		Yu et al. 2007
Dry bulk density (g/cm ³)	1.5	To obtain the erosion rate used as the input value.	RESRAD-OFFSITE default
Soil erodibility factor	0.35		Yu et al. 2007

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TABLE E-13 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 1			
		The perched aquifer located in the Dewey Lake Formation was selected as the groundwater of concern in the modeling. Among the subsurface and deep groundwater aquifers, it has the best water quality and was classified as a U.S. Environmental Protection Agency (EPA) Class II aquifer. The depth to the groundwater table (153 m) specified in Table 4.4-1 of Sandia 2007 (Task 3.4 report) also corresponds to this aquifer in Dewey Lake Formation.	
Thickness (m)	153	Comparable to the groundwater level measurement data.	DOE 2006b; Sandia 2007
Density (g/cm ³)	1.47	Average of sandy and silty soils. According to the description in DOE 2006b, the Dewey Lake Redbeds Formation consists of alternating thin beds of siltstone and fine-grained sandstone.	Yu et al. 2000
Total porosity	0.445	Average of silty and sandy soil.	Distribution information for silt and sand soils from Yu et al. 2000
Effective porosity	0.404	Average of silty and sandy soil.	Distribution information for silt and sand soils from Yu et al. 2000
Field capacity	0.1	Used a smaller value because the moisture content is expected to be low because of the small infiltration rate.	
Hydraulic conductivity (m/yr)	107.31	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 803.5 m/yr. Geometric mean for silty soil was calculated as 14.33 m/yr.	Distribution information for silt and sand soils from Yu et al. 2000
b-parameter	1.76	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 0.975. Geometric mean for silty soil was calculated as 3.1899.	Distribution information for sand and silt soils from Yu et al. 2000
Longitudinal dispersivity (m)	0	No dispersivity was assumed for the unsaturated zone.	Assumption used for all sites.

TABLE E-13 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Saturated zone hydrology			
Thickness (m)	5.1	Saturated thickness for the natural water table identified in middle Dewey Lake.	DOE 2006b
Density of saturated zone (g/cm ³)	1.47	Average of sandy and silty soils.	Distribution information for silt and sand soils from Yu et al. 2000
Total porosity	0.445	Average of silt and sand soil.	Distribution information for silt and sand soils from Yu et al. 2000
Effective porosity	0.404	Average of silt and sand soil.	Distribution information for silt and sand soils from Yu et al. 2000
Hydraulic conductivity (m/yr)	107.31	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 803.5 m/yr. Geometric mean for silty soil was calculated as 14.33 m/yr.	Distribution information for silt and sand soils from Yu et al. 2000
Hydraulic gradient to well	0.017	The gradient in Dewey Lake is 20–40 ft/mi in the east. It is up to 150 ft/mi to the west. Average is 90 ft/mi.	Powers et al. 1978
Depth of aquifer contributing to well (m), below water table	5.1	Set to the depth of aquifer.	Yu et al. 2007
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

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TABLE E-14 Soil/Water Distribution Coefficients for Different Radionuclides for WIPP Vicinity^a

Element	K_d Value (cm^3/g)		Value Selection Rationale ^b	Source
	Unsaturated Zone	Saturated Zone		
Ac	450	450	Value for sandy soil	Sheppard and Thibault 1990
Am	1,445	1,445	Value for generic soil	Yu et al. 2000
C	5	5	Value for sandy soil	Sheppard and Thibault 1990
Cm	4,000	4,000	Value for sandy soil	Sheppard and Thibault 1990
Co	60	60	Value for sandy soil	Sheppard and Thibault 1990
Cs	280	280	Value for sandy soil	Sheppard and Thibault 1990
Fe	209	209	Value for generic soil	Yu et al. 2000
Gd	825	825	Value for generic soil	Yu et al. 2000
H	0.06	0.06	Value for generic soil	Yu et al. 2000
I	1	1	Value for sandy soil	Sheppard and Thibault 1990
Mn	50	50	Value for sandy soil	Sheppard and Thibault 1990
Mo	10	10	Value for sandy soil	Sheppard and Thibault 1990
Nb	160	160	Value for sandy soil	Sheppard and Thibault 1990
Ni	400	400	Value for sandy soil	Sheppard and Thibault 1990
Np	5	5	Value for sandy soil	Sheppard and Thibault 1990
Pa	380	380	Value for generic soil	Yu et al. 2000
Pb	270	270	Value for sandy soil	Sheppard and Thibault 1990
Po	150	150	Value for sandy soil	Sheppard and Thibault 1990
Pu	550	550	Value for sandy soil	Sheppard and Thibault 1990
Ra	500	500	Value for sandy soil	Sheppard and Thibault 1990
Sr	15	15	Value for sandy soil	Sheppard and Thibault 1990
Sm	245	245	Value of sandy soil	Sheppard and Thibault 1990
Tc	0.1	0.1	Value for sandy soil	Sheppard and Thibault 1990
Th	3,200	3,200	Value for sandy soil	Sheppard and Thibault 1990
U	35	35	Value for sandy soil	Sheppard and Thibault 1990

^a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

^b The K_d value selected was the smaller one of either the value for sandy soil given in Sheppard and Thibault (1990) or the value for generic soil recommended in NUREG/CR-6697 (Yu et al. 2000).

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TABLE E-15 Water Infiltration Rates Used in the RESRAD-OFFSITE Analyses for the Six DOE Sites^a

Parameter	Evaluated Sites					
	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Precipitation rate (m/yr)	0.17	0.22	0.36	0.13	1.2	0.3
Irrigation rate ^b (m/yr)	0	0	0	0	0	0
Infiltration rate used in the analyses (m/yr)	0.0035	0.05	0.005	0.00003	0.376	0.002

^a Values were obtained from site reports.

^b No agricultural activity over the disposal areas was assumed for this analysis

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TABLE E-16 Unsaturated Zone Characteristics Used as Input Parameters in the RESRAD-OFFSITE Analyses for the Six DOE Sites^a

Parameter	Disposal Site Considered					
	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Unsaturated Zone 1						
Thickness (m)	58	9.14	13	246	6.1	153
Density (g/cm ³)	1.65	1.64	1.4	1.65	1.65	1.47
Total porosity	0.37	0.5	0.41	0.36	0.39	0.445
Effective porosity	0.37	0.5	0.41	0.36	0.39	0.404
Field capacity	0.03	0.1	0.02	0.3	0.3	0.1
Hydraulic conductivity (m/yr)	710	29,200	61.81	0.00003	2.7	107.31
Soil b-parameter	4.05	4.34	0.175	5.3	6.62	1.76
Unsaturated Zone 2						
Thickness (m)	30	94.6	26	– ^b	16.9	–
Density (g/cm ³)	1.93	2.0	1.2	–	1.62	–
Total porosity	0.27	0.05	0.47	–	0.39	–
Effective porosity	0.27	0.05	0.47	–	0.39	–
Field capacity	0.024	0.001	0.02	–	0.3	–
Hydraulic conductivity (m/yr)	148	3650	46.36	–	29	–
Soil b-parameter	7.12	0.76	1.339	–	4.1	–
Unsaturated Zone 3						
Thickness (m)	–	7.47	16	–	–	–
Density (g/cm ³)	–	1.46	1.2	–	–	–
Total porosity	–	0.57	0.44	–	–	–
Effective porosity	–	0.57	0.44	–	–	–
Field capacity	–	0.3	0.04	–	–	–
Hydraulic conductivity (m/yr)	–	1.29	71.08	–	–	–
Soil b-parameter	–	3.6	2.152	–	–	–
Unsaturated Zone 4						
Thickness (m)	–	15.88	3	–	–	–
Density (g/cm ³)	–	1.64	0.8	–	–	–
Total porosity	–	0.5	0.67	–	–	–
Effective porosity	–	0.5	0.67	–	–	–
Field capacity	–	0.3	0.00001	–	–	–
Hydraulic conductivity (m/yr)	–	29,200	46.36	–	–	–
Soil b-parameter	–	10.4	1.891	–	–	–
Unsaturated Zone 5						
Thickness (m)	–	15.39	211	–	–	–
Density (g/cm ³)	–	2.0	2.7	–	–	–
Total porosity	–	0.05	0.001	–	–	–
Effective porosity	–	0.05	0.001	–	–	–
Field capacity	–	0.001	0.00001	–	–	–
Hydraulic conductivity (m/yr)	–	365,000	309.05	–	–	–
Soil b-parameter	–	1.67	2.71	–	–	–

^a The values given here were used in the RESRAD-OFFSITE evaluations for post-closure performance of the vault method. A smaller value for thickness (of the effective unsaturated zone) was used as the input value for evaluating post-closure performance of the trench and borehole methods to simulate placement of the waste in the unsaturated zone for these two methods.

^b A dash means not applicable.

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TABLE E-17 Saturated Zone Characteristics Used as Input Parameters in the RESRAD-OFFSITE Analyses for the Six DOE Sites^a

Parameter	Site Included for Evaluation					
	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Thickness (m)	45	495	37.5	220	27.85	5.1
Density of saturated zone (g/cm ³)	1.98	2.0	2.7	1.6	1.39	1.47
Total porosity	0.25	0.05	0.05	0.36	0.38	0.445
Effective porosity	0.25	0.05	0.05	0.36	0.25	0.404
Hydraulic conductivity (m/yr)	12,775	1,979	309.1	439	1,265	107.31
Hydraulic gradient to well	0.00124	0.00075	0.013	0.000097	0.0079	0.017
Depth of aquifer contributing to well (m)	10	10	10	10	10	5.1

^a Parameter values were obtained from site reports when available.

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TABLE E-18 Soil/Water Distribution Coefficient (K_d) Values (cm^3/g) Used in RESRAD-OFFSITE Analyses for the Six DOE Sites^a

Element ^b	Soil Layer ^c	Site					
		Hanford	INL	LANL ^d	NNSS	SRS	WIPP Vicinity
Ac	UZ	300, 30	225, 0, 225, 225, 0	130	7,000	8,500; 1,100	450
	SZ	300	9	130	7,000	1,100	450
Am	UZ	1,900; 190	225, 0, 225, 225, 0	2,400	7,000	8,500; 1,100	1,445
	SZ	1,900	9	2,400	7,000	1,100	1,445
C	UZ	4, 0.4	0.4, 0, 0.4, 0.4, 0	0	0	0, 0	5
	SZ	4	0.016	0	0	0	5
Cm	UZ	300, 30	4,000; 0; 4,000; 4,000; 0	50	4,000	8,500; 1,100	4,000
	SZ	300	160	50	4,000	1,100	4,000
Co	UZ	2,000; 200	10, 0, 10, 10, 0	0.45	60	30, 7	60
	SZ	2,000	0.4	0.45	60	7	60
Cs	UZ	80, 8	500, 0, 500, 500, 0	7.5	280	250, 50	280
	SZ	80	20	7.5	280	50	280
Fe	UZ	220, 22	220, 0, 220, 220, 0	209	209	400, 200	209
	SZ	220	8.8	209	209	200	209
Gd	UZ	825, 82.5	240, 0, 240, 240, 0	50	825	8,500; 1,100	825
	SZ	825	9.6	50	825	1,100	825

TABLE E-18 (Cont.)

Element ^b	Soil Layer ^c	Site					
		Hanford	INL	LANL ^d	NNSS	SRS	WIPP Vicinity
H	UZ	0, 0	0, 0, 0, 0, 0	0	0	0, 0	0.06
	SZ	0	0	0	0	0	0.06
I	UZ	0, 0	0, 0, 0, 0, 0	0	0	0.6, 0	1
	SZ	0	0	0	0	0	1
Mn	UZ	50, 5	50, 0, 50, 50, 0	158	50	200, 15	50
	SZ	50	2	158	50	15	50
Mo	UZ	10, 1	10, 0, 10, 10, 0	4	10	120, 6	10
	SZ	10	0.4	4	10	6	10
Nb	UZ	300, 30	500, 0, 500, 500, 0	100	7,000	0, 0	160
	SZ	300	20	100	7,000	0	160
Ni	UZ	400, 40	100, 0, 100, 100, 0	50	100	30, 7	400
	SZ	400	4	50	100	7	400
Np	UZ	2.5, 0.25	23, 0, 23, 23, 0	2.2	5	35, 0.60	5
	SZ	2.5	0.92	2.2	5	0.6	5
Pa	UZ	2.5, 0.25	8, 0, 8, 8, 0	5,500	5	35, 0.6	380
	SZ	2.5	0.32	5,500	5	0.6	380
Pb	UZ	80, 8	270, 0, 270, 270, 0	25	300	5,000; 2,000	270
	SZ	80	10.8	25	300	2,000	270
Po	UZ	150, 15	150, 0, 150, 150, 0	10	300	5,000; 2,000	150
	SZ	150	6	10	300	2,000	150

TABLE E-18 (Cont.)

Element ^b	Soil Layer ^c	Site					
		Hanford	INL	LANL ^d	NNSS	SRS	WIPP Vicinity
Pu	UZ	150, 15	2,500; 0; 2,500; 2,500; 0	4.1	7.5	5,900; 270	550
	SZ	150	100	4.1	7.5	270	550
Ra	UZ	10, 1	575, 0, 575, 575, 0	500	185	17, 5	500
	SZ	10	23	500	185	5	500
Sm	UZ	300, 30	2,500; 0; 2,500; 2,500; 0	50	245	8,500; 1,100	245
	SZ	300	100	50	245	1,100	245
Sr	UZ	10, 1	12, 0, 12, 12, 0	40	420	17, 5	15
	SZ	10	0.48	40	420	5	15
Tc	UZ	0, 0	0, 0, 0, 0, 0	0	0	0.2, 0.1	0.1
	SZ	0	0	0	0	0.1	0.1
Th	UZ	3,200; 320	500, 0, 500, 500, 0	5,000	7,000	2,000; 900	3,200
	SZ	3,200	20	5,000	7,000	900	3,200
U	UZ	0.6, 0.06	15.4, 0, 15.4, 15.4, 0	2.4	0.8	300, 200	35
	SZ	0.6	0.616	2.4	0.8	200	35

^a K_d values were obtained from site reports and other site sources, as identified in Tables E-3, E-5, E-7, E-9, E-11, and E-13.

^b The K_d values for different isotopes of the same element were assumed to be the same in the analysis.

^c For purposes of this analysis, the transport of radionuclides leached from the disposal area was assumed to occur in vadose zones and the saturated zone at all potential disposal sites. The physical properties of these zones are site dependent. Abbreviations for vadose zones (which are unsaturated) and the saturated zone are UZ and SZ, respectively.

^d For the LANL site, all the vadose zones were assumed to have the same K_d value.

TABLE E-19 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for Generic Commercial Sites in the Four Regions

Parameter Name	Region I	Region II	Region III	Region IV
Site properties				
Precipitation (m/yr) ^a	0.074	0.18	0.05	0.001
Primary contamination area properties ^b				
Irrigation (m/yr)	0	0	0	0
Evapotranspiration coefficient	0	0	0	0
Runoff coefficient ^c	0	0	0	0
Rainfall and runoff ^c	160	160	160	160
Slope-length-steepness factor	0.4	0.4	0.4	0.4
Cover and management factor	0.03	0.03	0.03	0.03
Support practice factor	1	1	1	1
Contaminated zone ^b				
Total porosity	0.4	0.4	0.4	0.4
Erosion rate (m/yr)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Dry bulk density (g/cm ³)	1.8	1.8	1.8	1.8
Soil erodibility factor	0.42	0.42	0.42	0.42
Field capacity	0.3	0.3	0.3	0.3
b-parameter	5.3	5.3	5.3	5.3
Hydraulic conductivity (m/yr)	10	10	10	10
Cover layer ^b				
Total porosity	0.4	0.4	0.4	0.4
Erosion rate (m/yr)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Dry bulk density (g/cm ³)	1.5	1.5	1.5	1.5
Soil erodibility factor	0.35	0.35	0.35	0.35
Unsaturated zone 1 ^d				
Thickness (m)	3.353	13.41	2.16	54.86
Density (g/cm ³)	1.6	1.5	1.5	1.6
Total porosity	0.38	0.42	0.44	0.41
Effective porosity	0.38	0.42	0.44	0.41
Field capacity	0.093	0.15	0.23	0.12
Hydraulic conductivity (m/yr)	1981	201	518	1798
b parameter ^b	5.3	5.3	5.3	5.3
Longitudinal dispersivity (m) ^b	0	0	0	0
Saturated zone hydrology ^d				
Thickness (m)	13.72	15.24	11.28	64
Density of saturated zone (g/cm ³)	1.6	1.8	1.6	1.7
Total porosity	0.38	0.4	0.38	0.3
Effective porosity	0.22	0.23	0.22	0.17
Hydraulic conductivity (m/yr) ^e	103.6	18.9	21.03	91
Hydraulic gradient to well ^e	1	1	1	1
Depth of aquifer contributing to well (m), below water table	10	10	10	10
Longitudinal dispersivity (m)	10% of distance traveled			

TABLE E-19 (Cont.)

Parameter Name	Region I	Region II	Region III	Region IV
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity			
Disperse vertically (yes/no)	Yes	Yes	Yes	Yes
Vertical lateral dispersivity (m)	10% of horizontal lateral dispersivity			

- ^a The input value for the precipitation rate was set to match the infiltration rate used in NUREG-0782, Vol. 4 (NRC 1981). In order to obtain the same infiltration rate to the vadose zone as that used in NUREG-0782, the irrigation rate, evapotranspiration rate, and runoff coefficient were all set to 0.
- ^b Input parameters for the primary contamination area, contaminated zone, and cover layers were kept the same as those used for the DOE alternate sites, unless specifically noted.
- ^c The evapotranspiration rate and runoff coefficient were set to zero in order to obtain the desired water infiltration rate. See also note footnote a.
- ^d Input parameters for the unsaturated and saturated zones were obtained from Toblin (1998, 1999), and Poe (1998), unless specifically noted.
- ^e To obtain the same Darcy's velocity as used in Toblin (1999), the hydraulic conductivity was set to the Darcy velocity value, while the hydraulic gradient was set to 0.

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TABLE E-20 Soil/Water Distribution Coefficients (cm³/g) for Different Radionuclides^a for Commercial Facilities in the Four Regions

Element	Region I		Region II		Region III		Region IV	
	Unsaturated Zone	Saturated Zone						
Ac	228	228	538	228	538	228	228	228
Am	82	82	200	82	200	82	82	82
C	0	0	0	0	0	0	0	0
Cm	82	82	200	82	200	82	82	82
Co	2	2	9	2	9	2	2	2
Cs	51	51	249	51	249	51	51	51
Fe ^b	209	209	209	209	209	209	209	209
Gd ^b	50	50	50	50	50	50	50	50
H	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0
Mn ^b	50	50	50	50	50	50	50	50
Mo ^b	4	4	4	4	4	4	4	4
Nb	50	50	100	50	100	50	50	50
Ni	12	12	59	12	59	12	12	12
Np	3	3	3	3	3	3	3	3
Pa	0	0	50	0	50	0	0	0
Pb	234	234	597	234	597	234	234	234
Po ^c	234	234	597	234	597	234	234	234
Pu	10	10	100	10	100	10	10	10
Ra	24	24	100	24	100	24	24	24
Sm	228	228	538	228	538	228	228	228
Sr	24	24	100	24	100	24	24	24
Tc	3	3	3	3	3	3	3	3
Th	100	100	100	100	100	100	100	100
U	0	0	50	0	50	0	0	0

^a K_d values were obtained from Toblin (1999) unless specifically noted.

^b Selected K_d values for Fe, Gd, Mn, Mo, respectively, were the smallest values among those used for the six federal sites.

^c The value of the K_d for Po was set to be same as the value of the K_d for Pb.

TABLE E-21 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater for the No Action Alternative^{a,b}

NRC Region	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
		GTCC LLRW				GTCC-Like Waste			
		Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
I	10,000	130	73,000	3,800	26,000	–	–	97,000	270,000
	100,000	130	73,000	3,800	26,000	–	–	97,000	270,000
II	10,000	10	210	–	850	0.14	–	0.14	0
	100,000	170	16,000	–	3,200	0.14	–	180	14,000
III	10,000	6.2	120	–	–	–	–	–	–
	100,000	190	13,000	–	–	–	–	–	–
IV	10,000	0	0	0	0	0	0	0	0
	100,000	0	9.3	0	0.023	0	0	0.89	9.8

^a CH = contact-handled, GTCC = greater-than-Class C, RH = remote-handled, Region I–IV = a generic storage site located within each of the four NRC regions.

^b These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the storage facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in Chapter 3 of the EIS.

TABLE E-22 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Stored Group 1 Inventory^{a,b}

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	0.26	– ^b	0	0.044	0	0	0.012	40
		100,000	0.26	–	< 0.001	0.36	0	< 0.001	20	40
	Trench	10,000	0.33	–	0	0.042	0	0	0.014	39
		100,000	0.33	–	< 0.001	0.35	0	< 0.001	24	39
	Borehole	10,000	0.17	–	0	0.013	0	0	< 0.0042	0.11
		100,000	0.17	–	0	0.11	< 0.001	< 0.001	7.5	0.63
INL	Vault	10,000	7.7	–	0	2.3	0.86	0	5.5	2,200
		100,000	7.7	–	0.0029	2.3	0.86	0	70	2,200
	Trench	10,000	8.9	–	0	2.0	0.99	0	6.4	1,900
		100,000	8.9	–	0	2.0	0.99	0	78	1,900
	Borehole	10,000	6.2	–	0	0.79	0.68	0	48	750
		100,000	6.2	–	0	0.79	0.68	0	53	750
LANL	Vault	10,000	60	–	0	0.22	0.45	0	1.8	230
		100,000	60	–	0	0.22	0.45	0	1.8	230
	Trench	10,000	5.2	–	0	0.21	0.55	0	2.2	210
		100,000	5.2	–	0	0.21	0.55	0	2.2	210
	Borehole	10,000	3.0	–	0	0.065	0.33	0	0.74	67
		100,000	3.0	–	0	0.065	0.33	0	0.74	67
NNSS	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0

TABLE E-22 (Cont.)

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS ^c	Vault	10,000	2.9	–	0.0051	1.3	0.21	< 0.001	40	1,000
		100,000	2.9	–	0.0051	1.3	0.21	< 0.001	120	1,000
	Trench	10,000	4.0	–	0.0059	1.4	0.27	< 0.001	62	1,100
		100,000	8.0	–	0.0059	1.4	0.27	< 0.001	130	1,100
WIPP Vicinity	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.16	0	0	0.039	36
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.12	0	0	0.039	28
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.068	0	0	0.022	16
Region I ^c	Vault	10,000	14	–	0	24	0.027	0.0075	700	3,200
		100,000	14	–	0	24	0.027	0.0075	700	3,200
Region II ^c	Vault	10,000	0.98	–	0.013	0.056	0.13	0	18	940
		100,000	16	–	0.013	5.4	0.13	0	130	940
	Trench	10,000	1.7	–	0	0.25	0.16	0	20	950
		100,000	62	–	0	18	0.16	0	590	2,100
Region III ^c	Vault	10,000	1.1	–	0	0.077	0.16	0	6.3	410
		100,000	32	–	0	3.7	0.16	0	90	410
Region IV	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	0.0041	–	0	0.11	0	0	5.8	5.7
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	0.0072	–	0	0.10	0	0	7.1	5.4
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	0.028	–	0	0.034	0.0039	0	2.3	1.7

Footnotes appear on next page.

TABLE E-22 (Cont.)

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- ^a CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I–IV = a generic commercial site located within each of the four major regions of the country.
 - ^b These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.
 - ^c The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

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TABLE E-23 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Projected Group 1 Inventory^{a,b}

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (in mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	4.0	0	– ^b	0.0013	0	0	0.0045	0.12
		100,000	4.0	21	–	0.011	0	0.0012	5.6	480
	Trench	10,000	5.0	0	–	0.0013	0	0	0.0055	0.12
		100,000	5.0	25	–	0.011	0	0.0015	6.9	460
	Borehole	10,000	2.6	0	–	< 0.001	0	0	0.0016	0.036
		100,000	2.6	11	–	0.0033	< 0.001	< 0.001	2.1	140
INL	Vault	10,000	120	0.028	–	0.069	2.1	0	1.6	6.4
		100,000	120	150	–	0.069	2.1	0.0058	19	1,700
	Trench	10,000	140	0	–	0	2.5	0	1.8	5.7
		100,000	140	170	–	0	2.5	0	22	1,500
	Borehole	10,000	93	32	–	0.024	1.7	0	8.4	580
		100,000	93	74	–	0.024	1.7	0	8.6	580
LANL	Vault	10,000	64	0	–	0	1.1	0	0.52	0.62
		100,000	64	0	–	0	1.1	0	0.52	0.62
	Trench	10,000	78	0	–	0	1.4	0	0.63	0.58
		100,000	78	0	–	0	1.4	0	0.63	0.58
	Borehole	10,000	46	0	–	0	0.81	0	0.21	0.18
		100,000	46	0	–	0	0.81	0	0.21	0.18
NNSS	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0

TABLE E-23 (Cont.)

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS ^c	Vault	10,000	45	150	–	0.039	0.53	< 0.001	10	3.6
		100,000	45	150	–	0.039	0.53	< 0.001	33	400
	Trench	10,000	60	170	–	0.043	0.66	< 0.001	16	3.9
		100,000	120	330	–	0.043	0.66	0.073	38	430
WIPP Vicinity	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0047	0	0	0.014	0.44
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0037	0	0	0.014	0.34
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0021	0	0	< 0.001	0.19
Region I ^c	Vault	10,000	220	5,300	–	0.73	0.067	10	200	9,700
		100,000	220	5,300	–	0.73	0.067	10	200	9,700
Region II ^c	Vault	10,000	15	220	–	0.0059	0.33	0	3.2	0.55
		100,000	250	1,400	–	0.16	0.33	0.049	37	330
	Trench	10,000	26	250	–	0	0.39	0	4.7	320
		100,000	940	5,400	–	0.54	0.39	4.6	170	430
Region III ^c	Vault	10,000	18	95	–	0	0.40	0	1.4	0.2
		100,000	490	940	–	0.11	0.40	0.19	26	170
Region IV	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	0.062	5.7	–	0.0032	0	0	1.6	130
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	0.11	6.9	–	0.0031	0.0013	0	1.9	130
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	0.45	2.3	–	< 0.001	< 0.001	0	0.64	44

Footnotes appear on next page.

TABLE E-23 (Cont.)

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- ^a CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I-IV = a generic commercial site located within each of the four major regions of the country.
 - ^b These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.
 - ^c The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

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TABLE E-24 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Total Group 1 Inventory^{a,b}

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	4.2	0	0	0.045	0	0	0.016	41
		100,000	4.2	21	< 0.001	0.38	0	0.0012	26	490
	Trench	10,000	5.3	0	0	0.043	0	0	0.02	39
		100,000	5.3	25	< 0.001	0.36	0	0.0015	31	480
	Borehole	10,000	2.8	0	0	0.013	0	0	0.0058	0.14
		100,000	2.8	11	0	0.11	< 0.001	< 0.001	9.6	140
INL	Vault	10,000	130	0.028	0	2.3	3.0	0	7.1	2,200
		100,000	130	150	0.0029	2.3	3.0	0.0058	89	2,200
	Trench	10,000	150	0	0	2.0	3.4	0	8.2	1,900
		100,000	150	170	0	2.0	3.4	0	100	1,900
	Borehole	10,000	99	32	0	0.81	2.4	0	56	750
		100,000	99	74	0	0.81	2.4	0	61	750
LANL	Vault	10,000	120	0	0	0.22	1.6	0	2.3	230
		100,000	120	0	0	0.22	1.6	0	2.3	230
	Trench	10,000	84	0	0	0.21	1.9	0	2.8	210
		100,000	84	0	0	0.21	1.9	0	2.8	210
	Borehole	10,000	49	0	0	0.065	1.1	0	0.95	67
		100,000	49	0	0	0.065	1.1	0	0.95	67
NNSS	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0

TABLE E-24 (Cont.)

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS ^c	Vault	10,000	48	150	0.0051	1.3	0.74	< 0.001	50	1,000
		100,000	48	150	0.0051	1.3	0.74	< 0.001	150	1,000
	Trench	10,000	64	170	0.0059	1.4	0.93	< 0.001	79	1,100
		100,000	130	330	0.0059	1.4	0.93	0.073	170	1,100
WIPP Vicinity	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.16	0	0	0.054	36
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.13	0	0	0.053	28
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.070	0	0	0.030	16
Region I ^c	Vault	10,000	230	5,300	0	25	0.093	10	900	10,000
		100,000	230	5,300	0	25	0.093	10	900	10,000
Region II ^c	Vault	10,000	16	220	0.013	0.060	0.46	0	19	940
		100,000	260	1,400	0.013	5.5	0.46	0.049	170	940
	Trench	10,000	27	250	0	0.25	0.55	0	22	950
		100,000	1,000	5,400	0	18	0.55	4.6	760	2,600
Region III ^c	Vault	10,000	19	95	0	0.077	0.55	0	6.8	410
		100,000	520	940	0	3.8	0.55	0.19	120	580
Region IV	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	0.066	5.7	0	0.11	0	0	7.3	140
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	0.12	6.9	0	0.11	0.0013	0	9	130
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	0.48	2.3	0	0.035	0.013	0	3	45

Footnotes appear on next page.

TABLE E-24 (Cont.)

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- ^a CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I– IV = a generic commercial site located within each of the four major regions of the country.
 - ^b These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.
 - ^c The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

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TABLE E-25 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Total Group 2 Inventory^{a,b}

Site	Method	Time Period of Analysis (yr)	Peak Annual Dose (rem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
			Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	2.0	0	0.025	1.6	– ^b	–	0.0062	0.23
		100,000	2.0	0	3.7	9.4	–	–	11	22
	Trench	10,000	2.5	0	0.031	1.5	–	–	0.0076	0.22
		100,000	2.5	0	4.5	8.9	–	–	14	21
	Borehole	10,000	1.3	0	0.0091	0.47	–	–	0.0023	0.066
		100,000	1.3	0	1.4	2.8	–	–	4.2	6.5
INL	Vault	10,000	57	0	2.4	100	–	–	3.1	12
		100,000	57	0	13	100	–	–	38	76
	Trench	10,000	65	0	2.9	100	–	–	3.6	11
		100,000	65	0	14	100	–	–	43	69
	Borehole	10,000	45	0	5.6	50	–	–	17	26
		100,000	45	0	5.9	50	–	–	18	30
LANL	Vault	10,000	30	0	0.87	40	–	–	1.0	3.1
		100,000	30	0	0.87	40	–	–	1.0	3.1
	Trench	10,000	37	0	1.0	38	–	–	1.2	2.9
		100,000	37	0	1.0	38	–	–	1.2	2.9
	Borehole	10,000	22	0	0.35	13	–	–	0.42	0.96
		100,000	22	0	0.35	13	–	–	0.42	0.96
NNSS	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0

TABLE E-25 (Cont.)

		Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years								
		Time Period of Analysis (yr)	GTCC LLRW				GTCC-Like Waste			
Site	Method		Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS ^c	Vault	10,000	21	0	10	390	–	–	20	50
		100,000	21	0	26	390	–	–	66	110
	Trench	10,000	28	0	13	460	–	–	32	59
		100,000	62	0	27	460	–	–	76	59
WIPP Vicinity	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	20	0	0.017	3.6	–	–	0.022	0.67
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	20	0	0.016	2.8	–	–	0.022	0.52
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	19	0	0.0091	1.6	–	–	0.012	0.29
Region I ^c	Vault	10,000	110	0	71	490	–	–	410	820
		100,000	110	0	71	490	–	–	410	820
Region II ^c	Vault	10,000	7.1	0	5.4	210	–	–	6.3	39
		100,000	120	0	10	210	–	–	76	150
	Trench	10,000	12	0	6.6	210	–	–	9.5	35
		100,000	480	0	43	330	–	–	340	530
Region III ^c	Vault	10,000	7.8	0	2.1	83	–	–	2.5	15
		100,000	240	0	7.1	74	–	–	56	110
Region IV	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	0.11	0	1.0	8.4	–	–	3.1	6.2
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	0.14	0	1.2	6.9	–	–	3.9	5.8
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	0.26	0	0.41	1.5	–	–	1.3	2.0

Footnotes appear on next page.

TABLE E-25 (Cont.)

- ^a CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I–IV = a generic commercial site located within each of the four major regions of the country.
- ^b These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.
- ^c The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

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TABLE E-26 Sensitivity Analysis Cases Addressed in the EIS

Parameter	Base Case	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
Effective period of grout (yr)	500	500	500	2,000	2,000	2,000	5,000	5,000	5,000	500	500
Percentage of natural infiltration rate into the waste units after 500 years (%)	20	50	100	20	50	100	20	50	100	20	20
Distance to the hypothetical receptor (m)	100	100	100	100	100	100	100	100	100	300	500

TABLE E-27 Peak Annual Doses within 10,000 Years and the Occurrence Times at the WIPP Vicinity for the Different Sensitivity Analysis Cases^a

Result	Base Case	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
Peak annual dose (mrem/yr)	0	0	0	0	0	0	0	0	0	0	0
Time (yr)	0	0	0	0	0	0	0	0	0	0	0

^a The sensitivity analysis considered the disposal of stored Group 1 GTCC-like Other Waste - CH by using the trench method.

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TABLE E-28 Peak Annual Doses within 10,000 Years and the Occurrence Times at SRS for the Different Sensitivity Analysis Cases^a

Result	Base	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
	Case										
Peak annual dose (mrem/yr)	62	140	250	41	85	130	37	72	100	23	13
Time (yr)	610	580	550	2,100	2,100	2,000	5,100	5,100	5,100	780	940

^a The sensitivity analysis considered the disposal of stored Group 1 GTCC-like Other Waste - CH by using the trench method. All values are given to two significant figures. The times for the peak annual doses represent the time after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility).

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APPENDIX F:

**CONSULTATION CORRESPONDENCE FOR THE DRAFT ENVIRONMENTAL
IMPACT STATEMENT FOR THE DISPOSAL OF GREATER-THAN-CLASS C
(GTCC) LOW-LEVEL RADIOACTIVE WASTE AND GTCC-LIKE WASTE**

Table F-1 lists the consultation correspondence related to the GTCC reference locations evaluated in this EIS. (Note that in the letters, the Nevada National Security Site was still referred to as the Nevada Test Site or NTS, and this was not changed.) Copies of the correspondence follow this table. Background information on the project, which was included as an attachment to each letter from A.M. Edelman of the U.S. Department of Energy, Office of Disposal Operations, is provided at the end of this appendix, after the letters.

TABLE F-1 Consultation Correspondence

Page	Source	Recipient	Date of Letter
F-3	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Wenatchee, Wash. (J. Gonzales)	December 10, 2009
F-4	U.S. Fish and Wildlife Service, Wenatchee, Wash. (K.S. Berg)	U.S. Department of Energy (A.M. Edelman)	January 27, 2010
F-8	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Boise, Id. (J. Foss)	December 10, 2009
F-9	U.S. Fish and Wildlife Service, Chubbock, Id. (D. Miller)	U.S. Department of Energy (A.M. Edelman)	January 4, 2010
F-10	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Albuquerque, N.M. (W. Murphy)	December 10, 2009
F-11	U.S. Fish and Wildlife Service, Albuquerque, N.M. (W. Murphy)	U.S. Department of Energy (A.M. Edelman)	February 2, 2010
F-13	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Reno, Nev. (R. Williams)	December 10, 2009
F-14	U.S. Fish and Wildlife Service, Reno, Nev. (R.D. Williams)	U.S. Department of Energy (A.M. Edelman)	January 21, 2010
F-19	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Charleston, S.C. (M. Tobin)	December 10, 2009
F-20	U.S. Fish and Wildlife Service, Charleston, S.C. (D.L. Lynch)	U.S. Department of Energy (A.M. Edelman)	January 6, 2010
F-23	U.S. Department of Energy (A.M. Edelman)	Washington State Department of Fish and Wildlife Service, Yakima, Wash. (J. Tayer)	January 19, 2010

TABLE F-1 (Cont.)

Page	Source	Recipient	Date of Letter
F-25	U.S. Department of Energy (A.M. Edelman)	Idaho Department of Fish and Game, Idaho Falls, Id. (S. Schmidt)	January 19, 2010
F-27	U.S. Department of Energy (A.M. Edelman)	Ecological Services, Albuquerque, N.M. (W. Murphy)	January 19, 2010
F-29	U.S. Department of Energy (A.M. Edelman)	Nevada Natural Heritage Program, Carson City, Nev. (J.E. Newmark)	January 19, 2010
F-31	Nevada Natural Heritage Program, Carson City, Nev. (E.S. Miskow)	U.S. Department of Energy (A.M. Edelman)	February 10, 2010
F-35	U.S. Department of Energy (A.M. Edelman)	South Carolina Department of Natural Resources, Columbia, S.C. (J. Holling)	January 19, 2010
F-37	South Carolina Department of Natural Resources, Columbia, S.C. (J. Holling)	U.S. Department of Energy (A.M. Edelman)	January 27, 2010
F-40	U.S. Department of Energy (A.M. Edelman)	Los Alamos Site Office (J. Griego)	January 19, 2010
F-41	U.S. Department of Energy (A.M. Edelman)	Department of Archeology and Historic Preservation, Olympia, Wash. (A. Brooks)	January 19, 2010
F-43	U.S. Department of Energy (A.M. Edelman)	State Historic Preservation Office, Boise, Id. (K. Reid)	January 19, 2010
F-45	U.S. Department of Energy (A.M. Edelman)	State of New Mexico Department of Cultural Affairs, Santa Fe, N.M. (J. Biella)	January 19, 2010
F-47	U.S. Department of Energy (A.M. Edelman)	Nevada State Historic Preservation Office, Carson City, Nev. (R. James)	January 19, 2010
F-49	Nevada State Historic Preservation Office, Carson City, Nev. (A.M. Baldrice)	U.S. Department of Energy (A.M. Edelman)	February 26, 2010
F-50	U.S. Department of Energy (A.M. Edelman)	Department of Archives and History, Columbia, S.C. (E. Emerson)	January 19, 2010

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Department of Energy
Washington, DC 20585

December 10, 2009

Ms. Jessica Gonzales
Assistant Project Leader
Wenatchee Field Office
U.S. Fish and Wildlife Service
215 Melody Lane, Suite 119
Wenatchee, Washington 98801

Dear Ms. Gonzalez:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location immediately south of the Integrated Disposal Facility site in the 200 East Area in the central portion of the Hanford Site, Benton County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential Hanford GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

A handwritten signature in cursive script that reads "Arnold M. Edelman".

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Woody Russell, ORP



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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington Fish and Wildlife Office
 Central Washington Field Office
 215 Melody Lane, Suite 119
 Wenatchee, WA 98801



January 27, 2010

In Reply Refer To:
 USFWS Reference: 13260-2010-SL-0019

Arnold M. Edelman
 EIS Document Manager, Office of Disposal Operations
 Department of Energy
 1000 Independence Ave., SW
 Washington, DC 20585

Dear Mr. Edelman:

We have received your request for information on endangered and threatened species and their critical habitats that may be present near your potential disposal location of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC LLRW) in Benton County, Washington. For your convenience, updated countywide species and habitat listings are now available on our website at <http://www.fws.gov/easternwashington>. To view the listings in your area of concern, select "county species lists" within the ESA programs page, and then select the county of interest. The lists available on our website are compliant with Section 7(c) of the Endangered Species Act of 1973, as amended (Act), and are the most current available listings of endangered, threatened and proposed species and critical habitats in a given area. For optional consideration, the lists also contain updated species of concern and candidate species. Please be aware that the U.S. Fish and Wildlife Service is in the process of proposing bull trout critical habitat.

Species of anadromous fish that have been listed under the Act by the National Marine Fisheries Service (NMFS) may also occur in your project area. Please contact NMFS in Ellensburg, Washington, at (509) 962-8911 to request information on listed species within NMFS's jurisdiction.

If you would like information concerning state listed species or species of concern, you may contact the Washington Department of Fish and Wildlife, at (360) 902-2543, for fish and wildlife species; or the Washington Department of Natural Resources, at (360) 902-1667, for plant species.

When you submit a request for Section 7 consultation, we request that you include your downloaded species list and the date it was downloaded, as an attachment. If applicable,



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Arnold M. Edelman

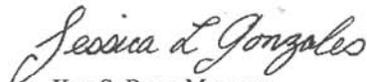
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please also include the USFWS reference number on your consultation request. This will document your compliance with 50 CFR 402.12 (c).

Should your project plans change significantly, or if the project is delayed more than 90 days, you should update your species lists through our website and through the above listed agencies.

Thank you for your efforts to protect our nation's species and their habitats. If you have any questions concerning the above information, please contact Jeff Krupka at (509) 665-3508, extension 18, or via e-mail at Jeff_Krupka@fws.gov.

Sincerely,



Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc: Joe Bartoszek, Mid-Columbia River NWR Complex, USFWS, Burbank, WA

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Arnold M. Edelman

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Enclosure A

**LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES,
CRITICAL HABITAT, CANDIDATE SPECIES, AND SPECIES OF CONCERN
THAT MAY OCCUR IN THE COUNTIES OF EASTERN WASHINGTON
AS LISTED BY THE U.S. FISH AND WILDLIFE SERVICE**

January 27, 2010

FWS Reference: 13260-2010-SL-0019

COMMENTS

Major concerns that should be addressed in your biological assessment of project impacts to listed threatened, endangered, or proposed animal species are:

1. Level of use of the project area by listed species.
2. Effect of the project on listed species' primary food stocks and foraging areas in all areas influenced by the project.
3. Impacts from project construction and implementation (e.g. increased noise levels, increased human activity and/or access, loss or degradation of habitat) which may result in disturbance to listed species and/or their avoidance of the project area.

Major concerns that should be addressed for listed or proposed plant species are:

1. Distribution of taxon in project vicinity.
2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.
3. Changes in hydrology where taxon is found.

Candidate species are those species for which the U.S. Fish and Wildlife Service has sufficient information to propose for listing as threatened or endangered under the Act. Species of concern (some of which are former Category 1 and Category 2 candidates) are those species whose conservation standing is of concern to the Service, but for which status information is still needed. Conservation measures for species of concern and candidate species are voluntary but recommended. Protection provided to these species now may preclude possible listing in the future.

For information regarding species listed by NOAA Fisheries, please visit the following website <http://www.nwr.noaa.gov/l salmon/salmesa/index.hhn> or call (509) 962-8911 in Ellensburg, Washington.

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Arnold M. Edelman

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BENTON COUNTY

Updated 4/15/2008

Listed*Endangered*Pygmy rabbit (*Brachylagus idahoensis*) – Columbia Basin distinct population segment*Threatened*Bull trout (*Salvelinus confluentus*) – Columbia River distinct population segment
Spiranthes diluvialis (Ute ladies'-tresses), plant**Candidate**Yellow-billed cuckoo (*Coccyzus americanus*)
Eriogonum codium (Umtanum desert buckwheat), plant**Species of Concern***Animals*Bald eagle (*Haliaeetus leucocephalus*) (delisted, monitor status)
Burrowing owl (*Athene cunicularia*)
California floater (*Anodonta californiensis*), mussel
Columbia clubtail (*Gomphus lynnae*), dragonfly
Ferruginous hawk (*Buteo regalis*)
Giant Columbia spire snail (*Fluminicola columbiana*)
Loggerhead shrike (*Lanius ludovicianus*)
Long-eared myotis (*Myotis evotis*)
Margined sculpin (*Cottus marginatus*)
Pacific lamprey (*Lampetra tridentata*)
Pallid Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)
Redband trout (*Oncorhynchus mykiss*)
River lamprey (*Lampetra ayresi*)
Sagebrush lizard (*Sceloporus graciosus*)
Townsend's ground squirrel (*Spermophilus townsendii*)
Western brook lamprey (*Lampetra richardsoni*)*Vascular Plants**Astragalus columbianus* (Columbia milk-vetch)
Cryptantha leucophaea (Gray cryptantha)
Haplopappus liatriformis (Palouse goldenweed)
Lomatium tuberosum (Hoover's desert-parsley)
Mimulus jungermannioides (Liverwort monkey-flower)
Rorippa columbiae (Persistent sepal yellowcress)1
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Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Jeffery Foss, Field Supervisor
U.S. Fish and Wildlife Service
Idaho Fish and Wildlife Office
1387 South Vinnell Way, Suite 368
Boise, Idaho 83709-1657

Dear Mr. Foss:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential INL GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

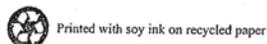
Sincerely,

A handwritten signature in black ink that reads "Arnold M Edelman".

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Richard Kauffman, ID



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United States Department of the Interior
FISH AND WILDLIFE SERVICE

Eastern Idaho Field Office
4425 Burley Dr., Suite A
Chubbuck, Idaho 83202
Telephone (208) 237-6975
<http://IdahoES.fws.gov>



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations
Department of Energy
Washington, DC 20585

JAN 04 2010

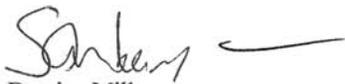
Subject: Proposed Disposal of Greater-Than-Class-C Low-Level-Radioactive
Waste at the INL in Southeast Idaho. SL #10-0116

Dear Mr. Edelman:

The U.S. Fish and Wildlife Service (Service) is writing in response to your request for information about the potential impacts to endangered, threatened, proposed, and/or candidate species from the proposed disposal of greater-than-C low-level-radioactive waste at the INL in Southeast Idaho. The Service has not identified any issues that indicate that consultation under section 7 of the Endangered Species Act of 1973, as amended, is needed for this project. This finding is based on our understanding of the nature of the project, local conditions, and/or current information indicating that no listed species are present. If you determine otherwise or require further assistance, please contact Sandi Arena of this office at (208)237-6975 ext 102.

Thank you for your interest in endangered species conservation.

Sincerely,


Damien Miller
Supervisor, Eastern Idaho Field Office

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Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Wally Murphy, Field Supervisor
U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113

Dear Mr. Murphy:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the three proposed GTCC LLRW disposal locations in your State: 1. Los Alamos National Laboratory within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County; 2. the Waste Isolation Pilot Plant (WIPP) in Eddy County; and 3. Sections 27 and 35 in and around WIPP.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

A handwritten signature in cursive script that reads "Arnold M. Edelman".

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: George Rael, LASO
Nancy Werdel, DOE AL
Susan McCauslin, CBSO



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FEB-02-2010 09:27AM

FROM-US.FISH AND WILDLIFE

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T-237 P.001/004 F-406



United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Mexico Ecological Services Field Office:

2105 Osuna NE

Albuquerque, New Mexico 87113

Phone: (505) 346-2525 Fax: (505) 346-2542

FEB -2 2010

Thank you for your recent request for information on threatened or endangered species or important wildlife habitats that may occur in your project area. The New Mexico Ecological Services Field Office has posted lists of the endangered, threatened, proposed, candidate and species of concern occurring in all New Mexico Counties on the Internet. Please refer to the following web page for species information in the county where your project occurs: http://www.fws.gov/southwest/es/NewMexico/SBC_intro.cfm. If you do not have access to the Internet or have difficulty obtaining a list, please contact our office and we will mail or fax you a list as soon as possible.

After opening the web page, find New Mexico Listed and Sensitive Species Lists on the main page and click on the county of interest. Your project area may not necessarily include all or any of these species. This information should assist you in determining which species may or may not occur within your project area.

Under the Endangered Species Act of 1973, as amended (Act), it is the responsibility of the Federal action agency or its designated representative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with us further. Similarly, it is their responsibility to determine if a proposed action has no effect to endangered, threatened, or proposed species, or designated critical habitat. On December 16, 2008, we published a final rule concerning clarifications to section 7 consultations under the Act (73 FR 76272). One of the clarifications is that section 7 consultation is not required in those instances when the direct and indirect effects of an action pose no effect to listed species or critical habitat. As a result, we do not provide concurrence with project proponent's "no effect" determinations.

If your action area has suitable habitat for any of these species, we recommend that species-specific surveys be conducted during the flowering season for plants and at the appropriate time for wildlife to evaluate any possible project-related impacts. Please keep in mind that the scope of federally listed species compliance also includes any interrelated or interdependent project activities (e.g., equipment staging areas, offsite borrow material areas, or utility relocations) and any indirect or cumulative effects.

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Candidates and species of concern have no legal protection under the Act and are included on the web site for planning purposes only. We monitor the status of these species. If significant declines are detected, these species could potentially be listed as endangered or threatened. Therefore, actions that may contribute to their decline should be avoided. We recommend that candidates and species of concern be included in your surveys.

Also on the web site, we have included additional wildlife-related information that should be considered if your project is a specific type. These include communication towers, power line safety for raptors, road and highway improvements and/or construction, spring developments and livestock watering facilities, wastewater facilities, and trenching operations.

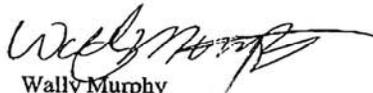
Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. We recommend you contact the U.S. Army Corps of Engineers for permitting requirements under section 404 of the Clean Water Act if your proposed action could impact floodplains or wetlands. These habitats should be conserved through avoidance, or mitigated to ensure no net loss of wetlands function and value.

The Migratory Bird Treaty Act (MBTA) prohibits the taking of migratory birds, nests, and eggs, except as permitted by the U.S. Fish and Wildlife Service. To minimize the likelihood of adverse impacts to all birds protected under the MBTA, we recommend construction activities occur outside the general migratory bird nesting season of March through August, or that areas proposed for construction during the nesting season be surveyed, and when occupied, avoided until nesting is complete.

We suggest you contact the New Mexico Department of Game and Fish, and the New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division for information regarding fish, wildlife, and plants of State concern.

Thank you for your concern for endangered and threatened species and New Mexico's wildlife habitats. We appreciate your efforts to identify and avoid impacts to listed and sensitive species in your project area.

Sincerely,



Wally Murphy
Field Supervisor

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Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Robert Williams, State Supervisor
U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
1340 Financial Boulevard, Suite 234
Reno, Nevada 89502-7147

Dear Mr. Williams:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential NTS GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

A handwritten signature in black ink that reads "Arnold M. Edelman".

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Linda Cohn, NSO



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United States Department of the Interior



FISH AND WILDLIFE SERVICE

Nevada Fish and Wildlife Office
 4701 North Torrey Pines Drive
 Las Vegas, Nevada 89130
 Ph: (702) 515-5230 ~ Fax: (702) 515-5231

January 21, 2010
 File No. 84320-2010-SL-0133

Mr. Arnold Edelman
 Office of Disposal Operations
 U.S. Department of Energy
 Cloverleaf Building (EM-43)
 1000 Independence Avenue, SW
 Washington, DC. 20585

Dear Mr. Edelman:

Subject: Request for Information on Federally Listed and Proposed Threatened or Endangered Species or Designated Critical Habitats that May Occur Near the Proposed Low-level Radioactive Waste Disposal Project Area on the Nevada Test Site in Nye County, Nevada

This responds to your letter dated December 10, 2009, requesting information on federally listed and proposed threatened or endangered species or designated critical habitat that may occur near the proposed project area on the Nevada Test Site in Nye County, Nevada. We have determined that there is no critical habitat in/near the action area, but that the following federally listed species may occur in/near the action area:

- Desert tortoise (*Gopherus agassizii*) (Mojave population), threatened

This response fulfills the requirement of the Fish and Wildlife Service (Service) to provide information on potential presence of federally listed species pursuant to section 7(c) of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*), for projects that are authorized, funded, or carried out by a Federal agency.

To minimize the potential effects to this species from the implementation of this proposed action, we recommend the Department of Energy (DOE) propose minimization measures in accordance with the terms of the *Incidental Take Statement* in our Final Programmatic Biological Opinion for Implementation of Actions Proposed on the Nevada Test Site, Nye County, Nevada dated February 12, 2009 (Service File No. 84320-2008-F-0416).



Mr. Arnold M. Edelman

File No. 84320-2010-SL-0133

As a reminder, pursuant to the Act if the action agency determines that the proposed action may affect listed species or designated critical habitat the action agency would request that the proposed action be appended under the programmatic consultation and provide project-specific information that: (1) describes each proposed action and the specific areas to be affected; (2) identifies the species and critical habitat that may be affected; (3) describes the manner in which the proposed action may affect listed species; (4) describes the anticipated effects; (5) specifies, if appropriate, that the *anticipated effects from the proposed project are consistent with those anticipated in the programmatic biological opinion*; (6) describes proposed measures to minimize potential effects of the action; (7) describes any additional effects, if any, not considered in the programmatic consultation. The project information and effects analysis should be accompanied by a cover letter that specifies that the action agency has determined the proposed project is consistent with the programmatic biological opinion.

The Nevada Fish and Wildlife Office no longer provides species-of-concern lists. Most of these species for which we have concern are on the at-risk or watch-list species lists for Nevada maintained by the State of Nevada's Natural Heritage Program (Heritage). Instead of maintaining our own list, we have adopted Heritage's lists and partnered with them to provide distribution data and information on the conservation needs for sensitive species to agencies or project proponents. The mission of Heritage is to continually evaluate the conservation priorities of native plants, animals, and their habitats, particularly those most vulnerable to extinction or those that are in serious decline. Consideration of these sensitive species and exploring management alternatives early in the planning process can provide long-term conservation benefits and avoid future conflicts.

For a comprehensive list of at-risk or watch-list species that may occur in the project area, you can obtain a data request form from <http://heritage.nv.gov/forms.htm> or by contacting the Administrator of Heritage at 901 South Stewart Street, Suite 5002, Carson City, Nevada, 89701, 775-684-2900. Please indicate on the form that your request is being obtained as part of your coordination with the Service under the Act. During your project analysis, if you obtain new information or data for any Nevada sensitive species, we request that you provide the information to Heritage at the above address.

We are concerned that the project may impact the Gila monster (*Heloderma suspectum cinctum*), a species listed as sensitive under the Heritage Program and as a protected species under Nevada State law. The banded Gila monster resides primarily in the Mojave desert scrub and salt desert scrub ecosystems in southern Nevada, southeastern California, southwestern Utah, and western Arizona. The Gila monster is one of only two venomous lizard species in the world. Gila monsters are difficult to locate as they spend the majority of the year in underground burrows; however, illegal collection, construction of roads, and loss of habitat continue to threaten this sensitive. Given that the Gila monster may occur within the project area, we encourage you to minimize project impacts to any existing populations and suitable habitat for this species.

Mr. Arnold M. Edelman

File No. 84320-2010-SL-0133

Furthermore, certain species of fish and wildlife are protected by the State of Nevada (see <http://www.leg.state.nv.us/NAC/NAC-503.html>). You must first obtain the appropriate license, permit, or written authorization from the Nevada Department of Wildlife to take or possess any parts of protected wildlife species. Please visit <http://www.ndow.org> or contact Supervisory Biologist - Habitat, Nevada Department of Wildlife at 4747 Vegas Drive, Las Vegas, Nevada 89108, 702-486-5127.

The Service also has conservation responsibilities and management authority for migratory birds under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 U.S.C. 703 *et seq.*). Under the MBTA, nests (nests with eggs or young) of migratory birds may not be harmed, nor may migratory birds be killed. Such destruction may be in violation of the MBTA. Therefore, we recommend land clearing, or other surface disturbance associated with the proposed project, be conducted outside the avian breeding season to avoid potential destruction of bird nests or young, or birds that breed in the area. If this is not feasible, we recommend a qualified biologist survey the area prior to land clearing. If nests are located, or if other evidence of nesting (*i.e.*, mated pairs, territorial defense, carrying nesting material, transporting food) is observed, a protective buffer (the size depending on the habitat requirements of the species) should be delineated and the entire area avoided to prevent destruction or disturbance to nests until they are no longer active.

In particular, we are concerned about the State-protected western burrowing owl (*Athene cunicularia hypugea*) and potential project impacts to this species from your project. The reduction of habitat in southern Nevada is a major threat to this species. Therefore, we recommend that the project avoid disturbing burrows that are used by burrowing owls. If this is not possible, we ask that the project incorporate the recommendations in our pamphlet, "Protecting Burrowing Owls at Construction Sites in Nevada's Mojave Desert Region" (Enclosure).

Please reference File No. 84320-2010-SL-0133 in future correspondence concerning this species list. If you have questions regarding this correspondence or require additional information, please contact Brian A. Novosak in the Nevada Fish and Wildlife Office in Las Vegas at 702-515-5230.

Sincerely,



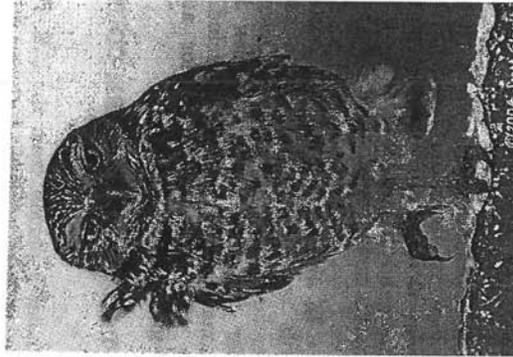
for Robert D. Williams
State Supervisor

Enclosure

U. S. Fish and Wildlife Service

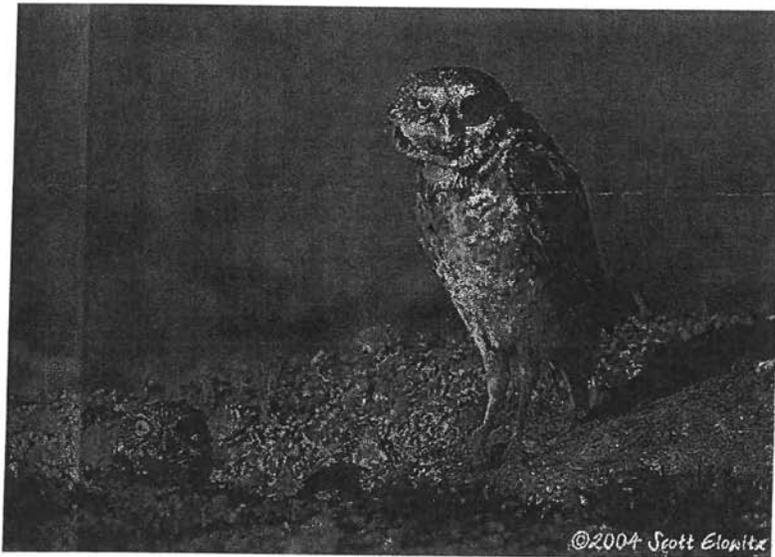
Nevada Fish and Wildlife Office
*Conserving the Biological Diversity of Great Basin, Eastern Sierra
& Mojave Desert*

**PROTECTING BURROWING OWLS
AT CONSTRUCTION SITES
IN NEVADA'S MOJAVE DESERT REGION**
(June 2007)



Burrowing owl numbers are declining despite protection under the Migratory Bird Treaty Act. Killing or possessing these birds or destruction of their eggs or nest is prohibited.

Be part of the solution: help these owls!



U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
4701 N. Torrey Pines Drive
Las Vegas, NV 89130
Phone: 702-515-5230
Fax: 702-515-5231

<http://www.fws.gov/nevada>

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Though burrowing owls are capable of digging their own burrows, they often will use burrows of other animals for shelter and nesting. They will even adopt pipes or culverts 6" to 8" in diameter.

Tips for Protecting Burrowing Owls, Their Eggs and Young at Construction Sites:

Even though burrowing owls are often active during the day, always check burrows, cracks, and crevices for owls before beginning construction. Use of a fiber-optic scope or remote mini-camera to look into a burrow can help determine the presence of owls or nests. Ensure owls and eggs are not present in burrows when grading begins, to avoid burying them.

In southern Nevada, owls breed from about mid-March through August. If a burrow has an active nest, the site must be avoided until the chicks have fledged. To ensure that birds will not abandon the nest, a buffer of at least a 250-foot radius should be placed around the burrow, within which no construction should occur. It takes a minimum of 74 days from when eggs are laid until chicks are able to fly (fledge). After the young have fledged, check the nest burrow for any owlets before resuming construction.

The following owl behaviors may help determine breeding or the presence of an active nest:

- A pair of owls is initially observed at a site, then only one owl is observed. This may indicate that the pair has chosen a nest burrow, and the female has gone down into the burrow to lay and incubate eggs. Once incubation begins the female rarely leaves the burrow.
- An owl is frequently observed carrying food to the burrow. The male provides food for the female while she is incubating eggs. The best time of day to observe owls is dawn and dusk, but they may be active throughout the day. The male will most likely leave the food in front of the burrow and the female will come to the entrance to take

the food. This is probably the best indication that the owls have an active nest.

- Only one owl has been seen for a period of time; then, two owls are observed. This may indicate that either the nest has failed, or the eggs have hatched, and the female has emerged from the burrow to assist the male in hunting for food to feed the chicks. The chicks will appear at the burrow entrance when they are about 10 days old.

If you are unsure of breeding status, seek the assistance of a professional biologist or other knowledgeable person. Should breeding behavior be observed, presence of an active nest should be assumed and the area avoided until the chicks have fledged or the nest is no longer occupied.

IMPORTANT! In the Mojave Desert portions of Clark, southern Lincoln and Nye counties, owls may use desert tortoise burrows for nesting and shelter. Desert tortoises are protected under the Endangered Species Act. Killing, harming, or harassing desert tortoises, including destruction of their nests with eggs, without prior authorization is prohibited by Federal law.*

*** IF YOUR PROJECT IS IN CLARK COUNTY, PLEASE READ ON:**

Clark County holds a permit from the U.S. Fish & Wildlife Service authorizing "take" of desert tortoises during the course of otherwise legal activities on non-federal lands. In Clark County only, discouraging burrowing owls from breeding in the construction site on private property is allowed by collapsing tortoise burrow's during the owl's non-breeding season (September through February). This may help avoid construction delays. Prior to collapsing a burrow, always check for owls or other protected wildlife occupying the burrow for the winter. Call the Nevada Department of Wildlife at 702-486-5127 if a Gila monster is found as this is a State protected species.

Thank you for your assistance in protecting migratory birds and Nevada's endangered and threatened species!



Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Melvin Tobin, Field Supervisor
U.S. Fish and Wildlife Service
Charleston Ecological Services Field Office
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407-7558

Dear Mr. Tobin:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential SRS GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosure

cc: Drew Grainger, SR



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United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407



January 6, 2010

Mr. Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations
Department of Energy
Washington, DC 20585

Re: Radioactive Waste Disposal, Savannah River Site, Aiken County, SC
FWS Log No. 42410-2010-SL-0118

Dear Mr. Edelman:

The U.S. Fish and Wildlife Service (Service) has received your request for information regarding threatened and endangered species in the vicinity of the proposed low level radioactive waste disposal site at the Savannah River Site in Aiken County, SC. The Department of Energy (DOE) is developing an Environmental Impact Statement (EIS) to consider alternative disposal sites for low level radioactive waste. The Savannah River Station is one of the sites under consideration. Information requested by the DOE is pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended.

Please find attached a list of T&E species that are known to or may occur in Aiken County. This list includes species of state and federal concern. Reconnaissance efforts for the project must include a search for the federally listed T&E species. We also recommend the DOE include all state listed species in its biological/ecological review. Please contact the S.C. Department of Natural Resources for further information on these species and their habitat requirements.

The Service appreciates the opportunity to provide comments and reserves the right to provide additional comments throughout the development of this project. If you have any questions concerning the submitted comments please contact the Service's project manager Mr. Mark Caldwell at (843) 727-4707 ext. 215.

Sincerely,

[Handwritten signature of Diane L. Lynch]

Diane L. Lynch
Acting Field Supervisor

DLL/MAC



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**South Carolina Distribution Records of
Endangered, Threatened, Candidate and Species of Concern
March 2009**

E	Federally endangered
T	Federally threatened
P	Proposed in the Federal Register
CH	Critical Habitat
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	The U.S. Fish and Wildlife Service or the National Marine Fisheries Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
S/A	Federally protected due to similarity of appearance to a listed species
SC	Federal Species of concern. These species are rare or limited in distribution but are not currently legally protected under the Endangered Species Act.
*	Contact the National Marine Fisheries Service for more information on this species

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated continually and may be different from the following.

AIKEN COUNTY

Bald eagle	<i>Haliaeetus leucocephalus</i>	BGEPA	Known
Wood stork	<i>Mycteria americana</i>	E	Known
Red-cockaded woodpecker	<i>Picoides borealis</i>	E	Known
Shortnose sturgeon	<i>Acipenser brevirostrum</i> *	E	Known
Relict trillium	<i>Trillium reliquum</i>	E	Known
Piedmont bishop-weed	<i>Ptilimnium nodosum</i>	E	Known
Smooth coneflower	<i>Echinacea laevigata</i>	E	Known
Southern Dusky Salamander	<i>Desmognathus auriculatus</i>	SC	Possible
Gopher frog	<i>Rana capito</i>	SC	Known
Small-flowered buckeye	<i>Aesculus parviflora</i>	SC	Known
Sandhills milk-vetch	<i>Astragalus michauxii</i>	SC	Known
Elliott's croton	<i>Croton elliotii</i>	SC	Known
Dwarf burhead	<i>Echinodorus parvulus</i>	SC	Known
Shoals spider-lily	<i>Hymenocallis coronaria</i>	SC	Known
White-wicky	<i>Kalmia cuneata</i>	SC	Known
Bog spicebush	<i>Lindera subcoriacea</i>	SC	Known
Boykin's lobelia	<i>Lobelia boykinii</i>	SC	Known
Carolina bogmint	<i>Macbridea caroliniana</i>	SC	Known
Awnead-meadowbeauty	<i>Rhexia aristosa</i>	SC	Known
Pickering's morning-glory	<i>Stylisma pickeringii</i> var. <i>pickeringii</i>	SC	Known

AIKEN COUNTY (cont)

Reclined meadow-rue	Thalictrum subrotundum	SC	Known
Bachman's sparrow	Aimophila aestivalis	SC	Possible
Henslow's sparrow	Ammodramus henslowii	SC	Known
American kestrel	Falco sparverius	SC	Possible
Loggerhead shrike	Lanius ludovicianus	SC	Possible
Painted bunting	Passerina ciris ciris	SC	Possible
Redhorse, Robust	Moxostoma robustum	SC	Known
Arogos skipper	Atrytone arogos arogos	SC	Known
Rafinesque's big-eared bat	Corynorhinus rafinesquii	SC	Known
Gopher tortoise	Gopherus polyphemus	SC	Known
Southern hognose snake	Heterodon simus	SC	Known
Pine or Gopher snake	Pituophis melanoleucus melanoleucus	SC	Known

**Department of Energy**

Washington, DC 20585

JAN 19 2010

Mr. Jeff Tayer
Regional Program Director
Washington State Department of Fish and Wildlife
1701 South 24th Avenue
Yakima, Washington 98902

Dear Mr. Tayer:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of state listed and proposed threatened and endangered species and state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location immediately south of the Integrated Disposal Facility site in the 200 East Area in the central portion of the Hanford Site, Benton County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

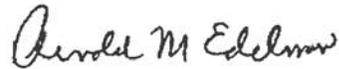


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Woody Russell, ORP



Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Steve Schmidt
Idaho Department of Fish and Game
4279 Commerce Circle
Idaho Falls, Idaho 83401

Dear Mr. Schmidt:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

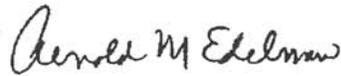


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Jack Depperschmidt, IDSO



Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Wally Murphy, Field Office Supervisor
Ecological Services
2105 Osuna Road, NE
Albuquerque, New Mexico 87113

Dear Mr. Murphy:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of state listed and proposed threatened and endangered species and any State sensitive species that may occur on or in the vicinity of the three proposed GTCC LLRW disposal locations in your State: 1. Los Alamos National Laboratory within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County; and 2. the Waste Isolation Pilot Plant (WIPP) in Eddy County; and 3. Sections 27 and 35 in and around WIPP.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.



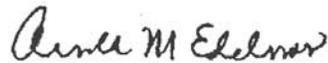
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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: George Rael, LASO
Nancy Werdel, DOE AL
Susan McCauslin, CBFO



Department of Energy

Washington, DC 20585

JAN 19 2010

Ms. Jennifer E. Newmark, Administrator
 Nevada Natural Heritage Program
 Richard H. Bryan Building
 901 South Stewart Street, Suite 5002
 Carson City, Nevada 89701-5245,

Dear Ms. Newmark:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published, anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

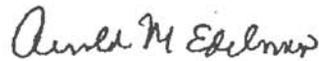


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Linda Cohn, NSO
Lori Plummer, NSO

ALLEN BIAGGI
Director

Department of Conservation
and Natural Resources

JENNIFER E. NEWMARK
Administrator

JIM GIBBONS
Governor



Nevada Natural Heritage Program
Richard H. Bryan Building
901 S. Stewart Street, Suite 5002
Carson City, Nevada 89701-5245
U.S.A.

tel: (775) 684-2900
fax: (775) 684-2909



STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
Nevada Natural Heritage Program
<http://heritage.nv.gov>

10 February 2010

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Ave., SW
Washington, DC 20585

RE: Data request received 25 January 2010

Dear Mr. Edelman:

We are pleased to provide the information you requested on endangered, threatened, candidate, and/or at risk plant and animal taxa recorded within or near the Proposed Greater-Than-Class-C Low Level Radioactive Waste disposal project area on the Nevada Test Site. We searched our database and maps for the following, a three kilometer radius around the location provided in your request including:

Township 12S	Range 54E	Sections All
Township 12S	Range 55E	Sections All
Township 13S	Range 53E	Sections All
Township 13S	Range 54E	Sections All
Township 13S	Range 55E	Sections All

The enclosed printout lists the taxa recorded within the given area. Please be aware that habitat may also be available for: the Clokey pincushion, *Coryphantha vivipara* var. *rosea*, a Taxon determined to be Vulnerable by the Nevada Natural Heritage Program as well as a protected cactus under NRS 527.060-120); the Clarke phacelia, *Phacelia filiae*, a Nevada Bureau of Land Management (BLM) Sensitive Species; the western small-footed myotis, *Myotis ciliolabrum*, a Nevada BLM Sensitive Species; and the pallid bat, *Antrozous pallidus*, a Nevada BLM Sensitive Species. We do not have complete data on various raptors that may also occur in the area; for more information contact Chet VanDellen, Nevada Division of Wildlife at (775) 688-1565. Note that all cacti, yuccas, and Christmas trees are protected by Nevada state law (NRS 527.060-.120), including taxa not tracked by this office.

Please note that our data are dependent on the research and observations of many individuals and organizations, and in most cases are not the result of comprehensive or site-specific field surveys. Natural Heritage reports should never be regarded as

(NSPO 8-08)



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DOE GTCC NTS
10 February 2010

page 2 of 2

final statements on the taxa or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments.

Thank you for checking with our program. Please contact us for additional information or further assistance.

Sincerely,



Eric S. Miskow
Biologist/Data Manager

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At Risk Taxa Recorded Near the GTCC Reference Location on the NTS Project Area
 Compiled by the Nevada Natural Heritage Program for the U.S. Department of Energy
 10 February 2010

Scientific name	Common name	Usfws	Bim	Usfs	State	Srank	Grank	UTM E	UTM N	Prec	Last observed
Plants											
<i>Arctomecon merriamii</i>	white bearpoppy		N	S		S3	G3	597410.49	4064718.51	G	1971-06-04
<i>Astragalus funereus</i>	black woollypod		N:C	S		S2	G2	596692.17	4086468.33	S	1979-05-10
<i>Astragalus funereus</i>	black woollypod		N:C	S		S2	G2	593788.82	4084956.51	S	1992-05-04
<i>Astragalus funereus</i>	black woollypod		N:C	S		S2	G2	593421.31	4084613.41	S	1992-05-05
<i>Camissonia megalantha</i>	Cane Spring suncup		N			S3	G3Q	594939.94	4081610.01	M	1978-09-26
<i>Camissonia megalantha</i>	Cane Spring suncup		N			S3	G3Q	593595.51	4086772.70	M	1992-08-17
<i>Camissonia megalantha</i>	Cane Spring suncup		N			S3	G3Q	594251.35	4083420.67	S	1992-08-04
<i>Camissonia megalantha</i>	Cane Spring suncup		N			S3	G3Q	593834.18	4085326.80	S	1992-08-04
<i>Cymopterus ripleyi</i> var. <i>saniculoides</i>	sanicle biscuitroot		N:C			S3	G3G4T3Q	590467.43	4073764.28	G	1965-05-19
<i>Cymopterus ripleyi</i> var. <i>saniculoides</i>	sanicle biscuitroot		N:C			S3	G3G4T3Q	589218.92	4088821.27	G	1965-05-20
<i>Cymopterus ripleyi</i> var. <i>saniculoides</i>	sanicle biscuitroot		N:C			S3	G3G4T3Q	595068.38	4070085.31	G	1941-05-13
<i>Phacelia beatleyae</i>	Beatley scorpionflower		N			S3	G3	595818.80	4087105.60	M	1976-06-21
<i>Phacelia beatleyae</i>	Beatley scorpionflower		N			S3	G3	594839.83	4083920.27	S	1992-06-11
<i>Phacelia beatleyae</i>	Beatley scorpionflower		N			S3	G3	597347.06	4083301.44	M	1979-05-10
<i>Phacelia beatleyae</i>	Beatley scorpionflower		N			S3	G3	596294.14	4086648.76	S	1977-PRE
<i>Phacelia beatleyae</i>	Beatley scorpionflower		N			S3	G3	597773.31	4089285.29	M	1979-05-10
Reptiles											
<i>Gopherus agassizii</i>	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	599229.05	4079008.49	M	1994-PRE
<i>Gopherus agassizii</i>	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	599850.80	4076673.52	M	1994-PRE
<i>Gopherus agassizii</i>	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	587377.81	4072961.68	M	1994-PRE
<i>Gopherus agassizii</i>	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	593997.43	4081753.65	S	1993-05-05
<i>Gopherus agassizii</i>	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	587532.46	4079619.89	M	1994-PRE
Mammals											
<i>Notiosorex crawfordi</i>	Crawford's desert shrew					S3	G5	595367.85	4067684.80	G	1961-10-11

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U.S. Fish and Wildlife Service (USFWS) Categories for Listing under the Endangered Species Act:

LT Listed Threatened - likely to be classified as Endangered in the foreseeable future if present trends continue

Bureau of Land Management (BLM) Species Classification:

S Nevada Special Status Species - USFWS listed, proposed or candidate for listing, or protected by Nevada state law
 N Nevada Special Status Species - designated Sensitive by State Office
 C California Special Status Species (see definition S and N)

United States Forest Service (USFS) Species Classification:

S Region 4 (Humboldt-Toiyabe NP) sensitive species
 T Region 4 and/or Region 5 Threatened species

Nevada State Protected (State) Species Classification:

Fauna: YES Species protected under NRS 501.

Precision (Pre) of Mapped Occurrence:

Precision, or radius of uncertainty around latitude/longitude coordinates:

S Seconds: within a three-second radius
 M Minutes: within a one-minute radius, approximately 2 km or 1.5 miles
 G General: within about 8 km or 5 miles, or to map quadrangle or place name

Nevada Natural Heritage Program Global (Grank) and State (Srank) Ranks for Threats and/or Vulnerability:

G Global rank indicator, based on worldwide distribution at the species level
 T Global trinomial rank indicator, based on worldwide distribution at the infraspecific level
 S State rank indicator, based on distribution within Nevada at the lowest taxonomic level

1 Critically imperiled and especially vulnerable to extinction or extirpation due to extreme rarity, imminent threats, or other factors
 2 Imperiled due to rarity or other demonstrable factors
 3 Vulnerable to decline because rare and local throughout its range, or with very restricted range
 4 Long-term concern, though now apparently secure; usually rare in parts of its range, especially at its periphery
 5 Demonstrably secure, widespread, and abundant

A Accidental within Nevada
 B Breeding status within Nevada (excludes resident taxa)
 H Historical; could be rediscovered
 N Non-breeding status within Nevada (excludes resident taxa)
 Q Taxonomic status uncertain
 U Unrankable
 Z Enduring occurrences cannot be defined (usually given to migrant or accidental birds)
 ? Assigned rank uncertain



Department of Energy
Washington, DC 20585

JAN 19 2010

Ms. Julie Holling
Department of Natural Resources
Wildlife and Freshwater Fisheries Division
P.O. Box 167
Columbia, South Carolina 29202-0167

Dear Ms. Holling:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

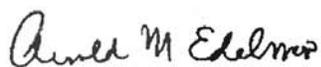


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Drew Grainger, SR



South Carolina Department of Natural Resources

DNR

John E. Frampton
Director
Ken Rentiers
Deputy Director for
**Land, Water and Conservation
Division**

January 27, 2010

Mr. Arnold M. Edelman, EIS Document Manager
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

RE: Threatened and Endangered Species and GTCC LLRW waste disposal at
Savannah River Site, South Carolina

Dear Mr. Johnson,

Because our database does not represent a comprehensive biological inventory of the state, I can only verify the known occurrences in the vicinity of your project. There may be occurrences of species in the vicinity of your project area that have not been reported to us. Fieldwork remains the responsibility of the investigator.

Since this is a preliminary report and only a rough idea given for the location, I have reviewed our database a little more broadly than usual. There are no known occurrences or any federally or state listed threatened or endangered within the expected drainage of the project area. However, there are a number of rare plant records for the drainage area, including: *Carex folliculata* (Long Sedge, G4G5, S1), *Ilex amelanchier* (Sarvis Holly, G4, S3), *Lindera subcoriacea* (Bog Spicebush, G2G3, S3), *Nestronia umbellula* (Nestronia, G4, S3), *Nolina georgiana* (Georgia Bear-grass, G3G5, S3), *Platanthera lacera* (Green-fringe Orchis, G5, S2), and *Rhododendron flammeum* (Piedmont azalea, G3, S3). Although these species do not have any legal protection, we ask that you consider protecting them during your work. As further indication of other species that may occur in the project area, I have also enclosed the list of rare, threatened, and endangered species and communities that occur within roughly 5 miles of the project site.

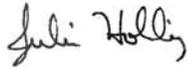
Rembert C. Dennis Building • 1000 Assembly Street • PO Box 167 • Columbia, SC 29202 • Telephone: 803-734-9100 • Fax: 803-734-9200
EQUAL OPPORTUNITY AGENCY www.dnr.sc.gov PRINTED ON RECYCLED PAPER

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As a professional courtesy, we ask that you acknowledge S.C. Heritage Trust as a source of information whenever you use this data in reports.

If you need additional assistance, please contact me by phone at 803-734-3917 or by e-mail at HollingJ@dnr.sc.gov.

Sincerely,



Julie Holling, Data Manager
SC Department of Natural Resources
Heritage Trust Program

Encl.

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Rare, Threatened, and Endangered Species and Communities Known to Occur within 5 miles of SRS GTCC LLRW Disposal Site
January 26, 2010

Scientific Name	Common Name	USES Designation	State Protection	Global Rank	State Rank
<u>Vertebrate Animals</u>					
<i>Condylura cristata</i>	Star-nosed Mole			G5	S3?
<i>Corynorhinus rafinesquii</i>	Rafinesque's Big-eared Bat		SE-Endangered	G3G4	S2?
<i>Egretta caerulea</i>	Little Blue Heron			G5	SNRB,SNRN
<i>Heterodon simus</i>	Southern Hognose Snake			G2	SNR
<i>Neotoma floridana</i>	Eastern Woodrat			G5	S3S4
<i>Pituophis melanoleucus</i>	Pine or Gopher Snake			G4	S3S4
<i>Rana capito</i>	Gopher Frog		SE-Endangered	G3	S1
<u>Vascular Plants</u>					
<i>Allium cuthbertii</i>	Striped Garlic			G4	S2
<i>Baptisia lanceolata</i>	Lance-leaf Wild-indigo			G4	S3
<i>Carex folliculata</i>	Long Sedge			G4G5	S1
<i>Coreopsis rosea</i>	Rose Coreopsis			G3	S2
<i>Croton elliotii</i>	Elliott's Croton			G2G3	S2S3
<i>Echinacea laevigata</i>	Smooth Coneflower	LE: Listed endangered		G2G3	S3
<i>Echinodorus tenellus</i>	Dwarf Burhead			G5?	S2
<i>Eleocharis robbinsii</i>	Robbins Spikerush			G4G5	S2
<i>Ilex amelanchar</i>	Sarvis Holly			G4	S3
<i>Lindera subcordata</i>	Bog Spicebush			G2G3	S3
<i>Ludwigia spathulata</i>	Spatulate Seedbox			G2G3	S3
<i>Nestronia umbellula</i>	Nestronia			G4	S3
<i>Nolina georgiana</i>	Georgia Beargrass			G3G5	S3
<i>Paronychia americana</i>	American Nailwort			G3G4	SNR
<i>Platanthera lacera</i>	Green-fringe Orchis			G5	S2
<i>Rhododendron flammeum</i>	Piedmont Azalea			G3	S3
<i>Sagittaria isoetiformis</i>	Slender Arrow-head			G4?	S3
<i>Utricularia floridana</i>	Florida Bladderwort			G3G5	S2
<i>Utricularia olivacea</i>	Piedmont Bladderwort			G4	S2
<u>Communities</u>					
<i>Fagus grandifolia</i> - (Liquidambar styraciflua) / <i>Oxydendrum arboreum</i> / <i>Kalmia latifolia</i> forest	Piedmont/coastal Plain Beech - Mountain Laurel Slope Forest			G3?	SNR



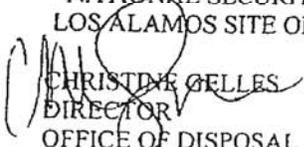
Department of Energy
Washington, DC 20585

JAN 19 2010

MEMORANDUM FOR JUAN GRIEGO

ASSISTANT MANAGER FOR
NATIONAL SECURITY MISSION
LOS ALAMOS SITE OFFICE

FROM:


CHRISTINE GELLES
DIRECTOR
OFFICE OF DISPOSAL OPERATIONS

SUBJECT:

Cultural and Paleontological Resources Consultation for
the *Disposal of Greater-Than-Class C (GTCC) Low
Level Radioactive Waste and GTCC-Like Waste
Environmental Impact Statement (DOE/EIS-0375D)*

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action and potential impacts to cultural resources. We request that you provide us with any information regarding cultural resources that may be affected by the location of the proposed GTCC LLRW disposal locations within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County.

I have attached a brief background of the project, including information on the potential GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact Arnie Edelman at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Attachment

cc: Vicki Loucks, LASO



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Department of Energy
Washington, DC 20585

JAN 19 2010

Dr. Allyson Brooks
State Historic Preservation Officer
Department of Archeology and Historic Preservation
Washington Department of Community, Trade and Economic Development
P.O. Box 48343
Olympia, Washington 98504-8343

Dear Dr. Brooks:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing information regarding cultural and paleontological resources in the 200-West Area. This information will be presented in the Draft EIS chapter on Hanford.

Should the EIS Record of Decision, expected to be issued in 2011, select a site near the Hanford Site Central Waste Complex for disposal of GTCC waste, a formal Cultural Resources Review would be conducted in accordance with Section 106 of the National Historic Preservation Act, and Advisory Council on Historic Preservation regulations for Protection of Historic Properties (36 CFR Part 800).

In support of the preparation of this EIS, DOE is soliciting any specific concerns you may have regarding cultural resources that may be affected by the proposed project.



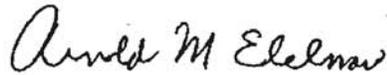
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I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Woody Russell, ORP
A. Rodriguez, DOE-RL
R. Corey, DOE-RL



Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Ken Reid, Deputy SHPO
State Historic Preservation Office
210 Main Street (The Assay Office)
Boise, Idaho 83702

Dear Mr. Reid:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

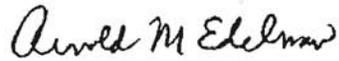


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Jack Depperschmidt, IDSO



Department of Energy

Washington, DC 20585

JAN 19 2010

Ms. Jan Biella
 State of New Mexico Department of Cultural Affairs
 Bataan Memorial Building
 407 Galisteo Street
 Suite 236
 Santa Fe, New Mexico 87501

Dear Ms. Biella:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing the proposed action and their potential impacts. We therefore request that you provide us with any information regarding cultural and paleontological resources that may be affected by the location of the proposed GTCC LLRW disposal locations in your State, the Waste Isolation Pilot Plant (WIPP) in Eddy County; and Sections 27 and 35 in and around WIPP. Please note that we are working with our DOE offices on development of the EIS and that Consultation with the State, if needed for LANL, will occur through the Los Alamos Site Office.

I have enclosed a brief background of the project, including information on the potential New Mexico GTCC locations, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.



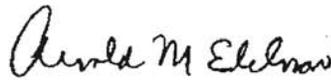
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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Susan McCauslin, CBFO
Vicki Loucks, LASO
Elizabeth Withers, DOE-AL



Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Ronald James
Historic Preservation Office
100 North Stewart Street
Capitol Complex
Carson City, Nevada 89701-4285

Dear Mr. James:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

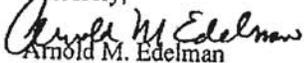


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

If you have any questions, please contact me at (301) 903-5145.

Sincerely,

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Linda Cohn, NSO

From: Alice Baldrice [mailto:ABaldrice@nevadaculture.org]
Sent: Wednesday, March 24, 2010 5:39 PM
To: Edelman, Arnold
Subject: RE: your request for information

Dear Mr. Edelman:

I checked the Nevada Cultural Resources Information System (NVCRIS), the State's electronic database for archaeological resources. A handful of very small lithic scatters are located within the alternative project area but none of them are eligible for inclusion in the National Register of Historic Places.

Historic properties resulting from nuclear testing activities have been recorded at Frenchman Flat that are associated with the Cold War. At the present time, the effect of a project on such historic properties is unknown.

If you have any questions let me know.

Alice M. Baldrice
State Historic Preservation Office
100 N. Stewart St.
Carson City, NV 89701
Telephone: 775-684-3444
FAX: 775-684-3442
abaldrice@nevadaculture.org



Department of Energy

Washington, DC 20585

JAN 19 2010

Mr. Eric Emerson
 Department of Archives and History
 8301 Parklane Road
 Columbia, South Carolina 29223-4905.

Dear Mr. Emerson:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPA) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPA) of 1985. The LLRWPA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPA, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is currently in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, which should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

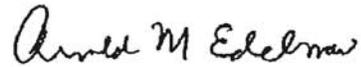


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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,



Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Drew Grainger, SRSO

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PROJECT BACKGROUND INFORMATION

This is a copy of the information attached as an enclosure to the letter sent out by
A.M. Edelman of DOE.

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Enclosure

Project Background Information

The following provides a brief background of the project and an overview of the alternative disposal sites.

The Department of Energy (DOE) published its Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) for disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW) in the Federal Register (Vol. 72, No.140) on July 23, 2007. (A copy of the NOI is attached).¹ DOE proposes to construct and operate a new facility or facilities, or use an existing facility or facilities, for the disposal of GTCC LLRW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Institutional controls, including monitoring, would be employed for a period of time determined during the implementation phase. A combination of disposal methods and locations may be appropriate, depending on the characteristics of the waste and other factors.

The Waste Isolation Pilot Plant (WIPP) in Eddy County, New Mexico is evaluated for deep geologic disposal. Land disposal methods (i.e., boreholes, trench and above-grade vault methods) are evaluated at seven federally owned sites: (1) Hanford Site in Benton County, Washington; (2) Idaho National Laboratory (INL) in Butte County, Idaho; (3) Los Alamos National Laboratory (LANL) in Los Alamos County, New Mexico; (4) Nevada Test Site (NTS) in Nye County, Nevada; (5) Oak Ridge Reservation (ORR) in Roane and Anderson Counties, Tennessee; (6) Savannah River Site (SRS) in Aiken County, South Carolina; and (7) WIPP Vicinity in Eddy County, New Mexico. The WIPP Vicinity location is situated just outside the boundary of the WIPP facility. A map of these sites being considered for waste disposal is provided in Figure 1.

The DOE sites evaluated for the land disposal methods were chosen on the basis of mission compatibility (i.e., only DOE sites that currently have radioactive waste disposal as part of their ongoing mission were considered). Since these sites are currently being used for disposal of LLRW, it is expected that they may contain areas within them that are suitable for disposal of similar but generally higher-activity LLRW (i.e., the GTCC LLRW and GTCC-like waste inventory that will be discussed in the EIS). These DOE sites would also have supporting infrastructure already in place that might be useful for future potential GTCC waste disposal activities. The WIPP Vicinity was chosen because of its proximity to ongoing waste disposal operations at WIPP and the potential to use its supporting infrastructure.

Aside from mission compatibility, site factors that were considered in identifying an acceptable area for developing a GTCC LLRW disposal facility were as follows: have sufficient depth to avoid groundwater; not to be located within the 100-year floodplain or in or near wetlands; be consistent with current land use plans; have low probability for erosion, mass wasting, faulting, folding, and seismic activity; and have site data available for modeling or evaluation purposes.

¹ The proposed Yucca Mountain repository mentioned in the NOI is no longer being considered for a disposal site for GTCC LLRW.

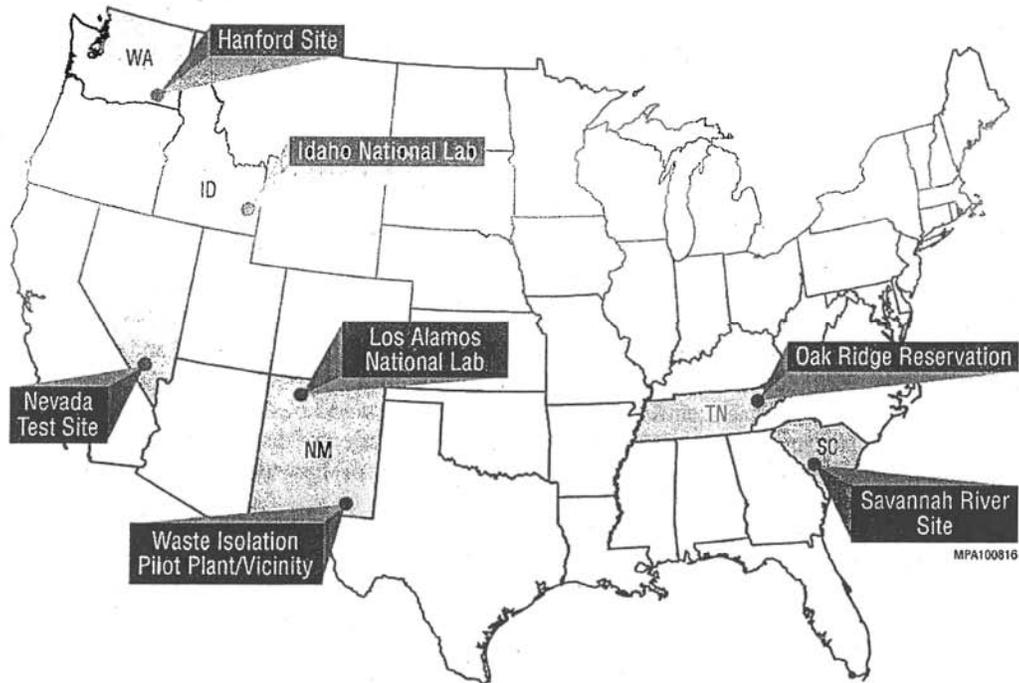


FIGURE 1 Map of Sites Being Considered for Disposal of GTCC LLRW and GTCC-Like Waste

WIPP

WIPP is a DOE facility that is the world's first underground repository permitted by the U.S. Environmental Protection Agency (EPA) and the state of New Mexico to safely and permanently dispose of defense-related TRU radioactive waste associated with the research and production of nuclear weapons. WIPP is located 26 mi east of Carlsbad, New Mexico, in the Chihuahuan Desert in the southeast corner of the state (Figure 2). Project facilities include disposal rooms that are mined 2,150 ft under the ground in a salt formation (the Salado Formation) that is 2,000-ft thick and has been stable for more than 200 million years. The WIPP facility sits in the approximate center of a 16-mi² area that was withdrawn from public domain and transferred to DOE (Figure 3). The facility footprint itself encompasses 35 fenced acres of surface space and about 7.5 mi of underground excavations in the Salado Formation.

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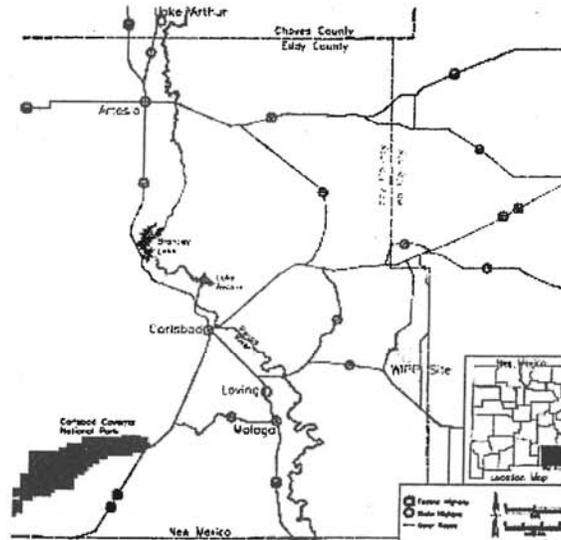


FIGURE 2 General Location of WIPP in Eddy County, New Mexico

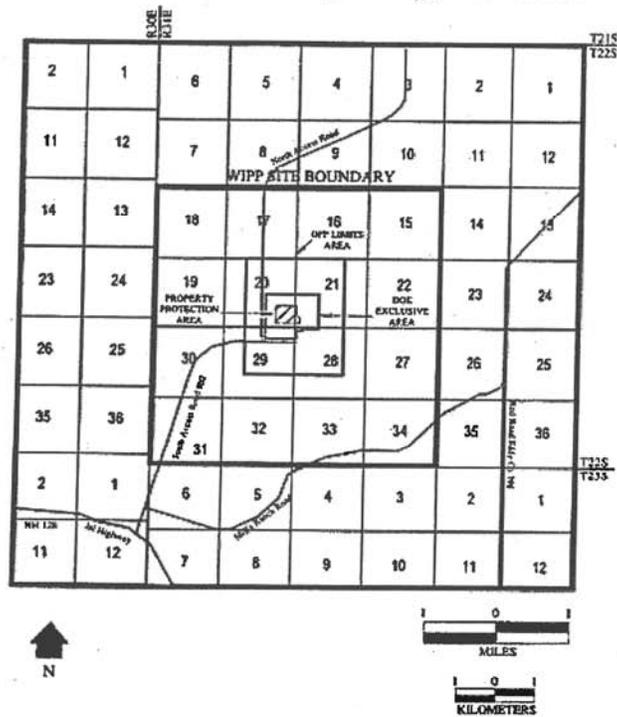


FIGURE 3 Land Withdrawal Area Boundary at WIPP

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Hanford Site

The Hanford Site is located in south-central Washington State on 586 mi² of land between the Cascade Range and the Rocky Mountains (Figure 4). The Columbia River flows through the northern portion of the site and forms part of its eastern boundary. Hanford has been operated by DOE and its predecessors (the Manhattan Engineer District, U.S. Atomic Energy Commission [AEC], and U.S. Energy Research and Development Administration) since it was created in 1943. Its primary mission was to produce nuclear materials in support of national defense, research, and biomedical programs. Operations associated with those programs used facilities for the fabrication of nuclear reactor fuel, reactors for nuclear materials production, chemical separation plants, nuclear material processing facilities, research laboratories, and waste management facilities. Current activities include research, environmental restoration, and waste management. The U.S. Fish and Wildlife Service (Service) and DOE co-manage the 195,000-acre Hanford Reach National Monument, which was established by Presidential proclamation in 2000.

The GTCC reference location is immediately south of the Integrated Disposal Facility (IDF) site in the 200 East Area in the central portion of the Hanford Site (Figure 4). The 200 East and West Areas are located on a plateau about 7 and 5 miles, respectively, south of the Columbia River. Historically, these areas have been dedicated to fuel reprocessing and to waste management and disposal activities.

Current waste management activities at the Hanford Site include the treatment and disposal of LLRW on site, the processing and certification of TRU waste pending its disposal at WIPP, and the storage of high-level radioactive waste on site pending its disposal in a geologic repository. The main areas where waste management activities occur are the 200 West Area and the 200 East Area, which are south of the Columbia River. These 200 Areas cover about 6 mi². Activities at the 200 Areas include the operation of lined trenches for the disposal of LLRW and mixed LLRW and the operation of the Environmental Restoration Disposal Facility for the disposal of LLRW generated by environmental restoration activities that are being conducted at Hanford Site to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). U.S. Ecology, Inc., operates a commercial LLRW disposal facility on a 40-ha (100-ac) site leased by the State of Washington near the 200 East Area. The facility is licensed by the NRC and the State of Washington.

INL

INL is located in southeastern Idaho on 890 mi² of relatively undisturbed DOE land in the upper Snake River Plain (Figure 5). Basalt flows cover most of the plain, producing a rolling topography. INL is bordered by mountain ranges on the north and by volcanic buttes and open plain on the south. Lands immediately adjacent to the INL site consist of open rangeland, foothills, and agricultural fields. About 60 percent of the site is open to livestock grazing. Key facilities at INL consist of clusters of buildings and structures that are typically less than a few square miles each, separated from each other by miles of gently rolling sagebrush-covered semi-arid desert. The GTCC reference location is southwest of the Reactor Technology Complex

(RTC) in the south central portion of INL (Figure 5). The RTC is dedicated to research supporting DOE missions, including nuclear technology research.

Current waste management activities at INL include the treatment and storage of mixed LLRW (waste containing hazardous constituents in addition to radionuclides) on site, the treatment and disposal of LLRW on site, the storage of TRU waste on site, and the storage of high-level radioactive waste and Spent Nuclear Fuel (SNF) on site pending the disposal of these last two materials in a geologic repository. These wastes originate from DOE activities and from the on-site Naval Reactors Program. LLRW from INL site operations is disposed of at the Subsurface Disposal Area at the Radioactive Waste Management Complex (RWMC). TRU waste is also stored and treated at the RWMC to prepare it for disposal at WIPP.

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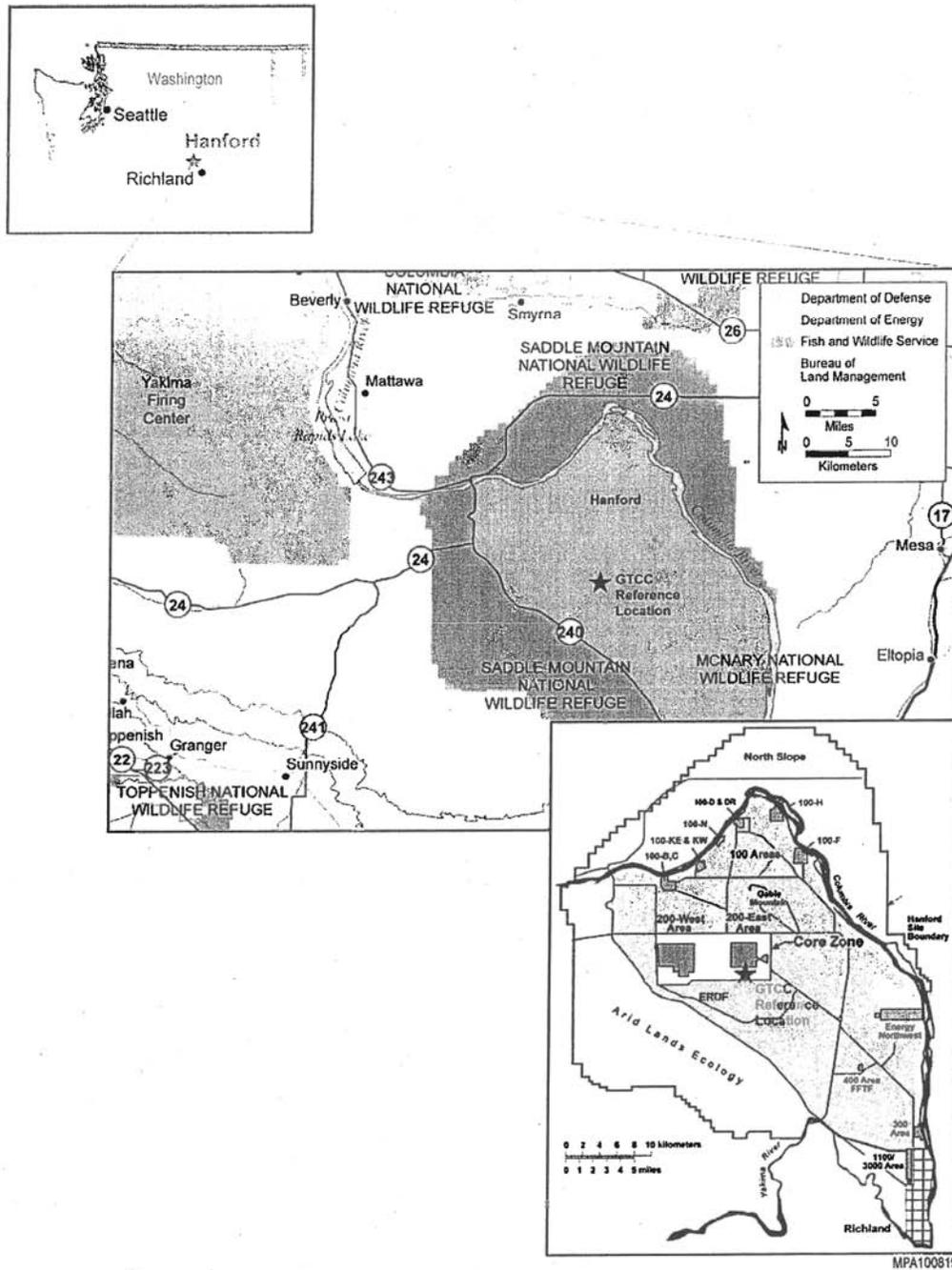


FIGURE 4 GTCC Reference Location at the Hanford Site

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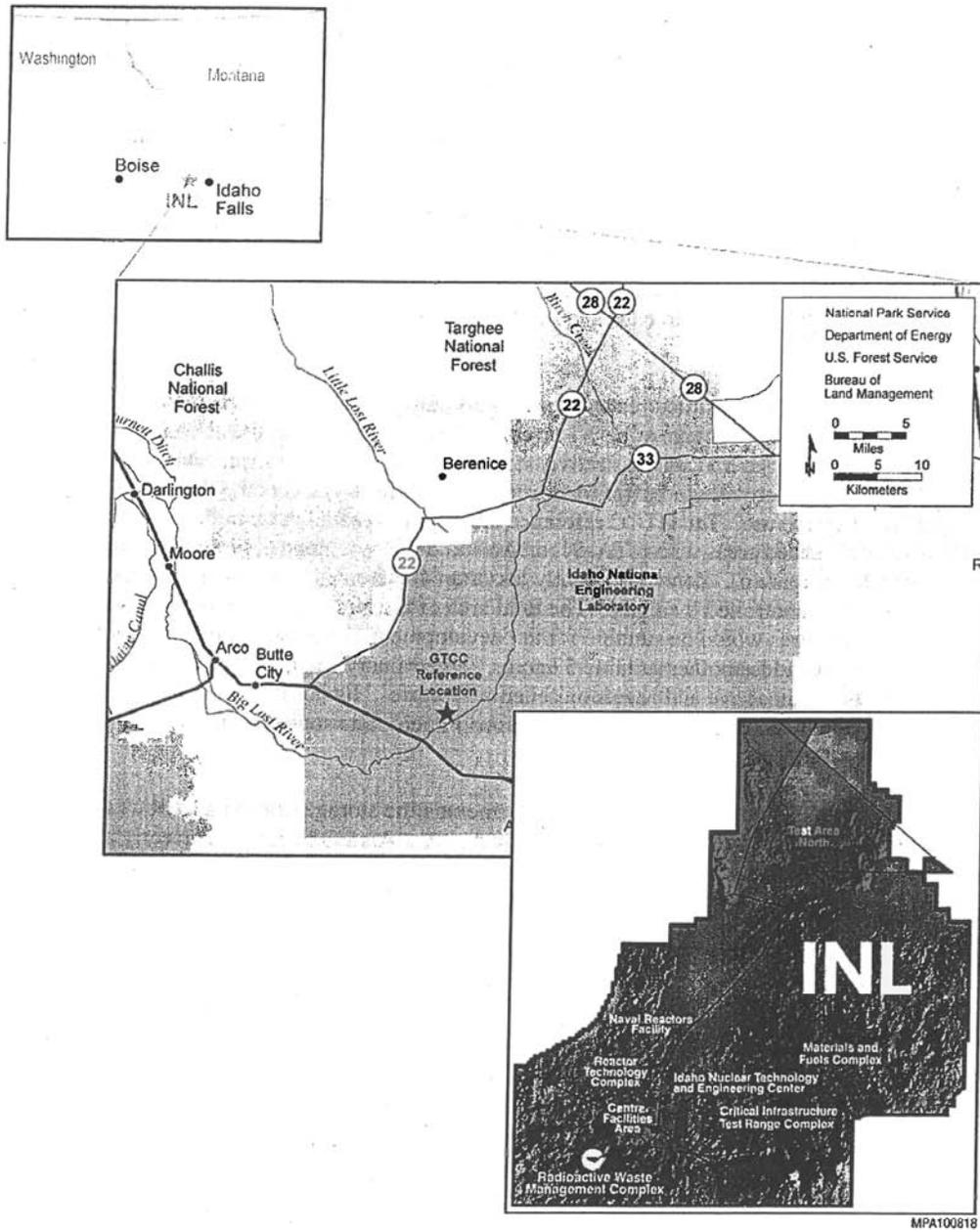


FIGURE 5 GTCC Reference Location at INL

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LANL

LANL is located in northern New Mexico, within Los Alamos County, on 40 mi² or 25,600 acres of land owned by the U.S. Government. The laboratory is administered by DOE and the National Nuclear Security Administration (NNSA) (Figure 6). The site is situated on the eastern flank of the Jemez Mountains along an area known as the Pajarito Plateau. The terrain in the LANL area consists of mesa tops and canyon bottoms that trend in a west-to-east direction, with the canyons intersecting the Rio Grande River to the east of LANL. Laboratory operations are conducted in numerous facilities located in 48 designated technical areas (TAs) and at other leased properties located nearby. The laboratory's core mission has been to maintain the effectiveness of the nation's nuclear deterrent. As one of the world's leading research institutions, it is also involved in hydrogen fuel cell development, supercomputing, and applied environmental research.

There are more than 2,000 structures on the site, providing about 8.6 million ft² of covered space. About half of the square footage at LANL is considered laboratory or production space; the remaining area is considered administrative, storage, service, or other space. Most of the site is undeveloped, which provides a buffer for security and safety and offers the possibility of expansion for future use. The GTCC reference location is situated in two undeveloped and relatively undisturbed areas within TA-54, on Mesita del Buey: Zone 6, North Site, and North Site Expanded (Figure 6). Zone 6 is slightly less than 40 acres in area. It is not fenced, but access by road is controlled by a gate. The total area of the North Site is about 63 acres, of which about 50 acres would be suitable for the development of disposal cells. The North Site Expanded section adds another suitable 57 acres. The primary function of TA-54 is the management of radioactive and hazardous chemical wastes. Its northern border coincides with the boundary between LANL and the San Ildefonso Pueblo; its southeastern boundary borders the town of White Rock.

Current waste management activities at LANL include the storage of mixed LLRW, the disposal of LLRW on site, and the storage of TRU waste on site. Area G at TA-54 currently accepts on-site LLRW for disposal, and in special cases, off-site waste has also been accepted from other DOE sites for disposal. Engineered shafts are actively used to dispose of remote handled LLRW.

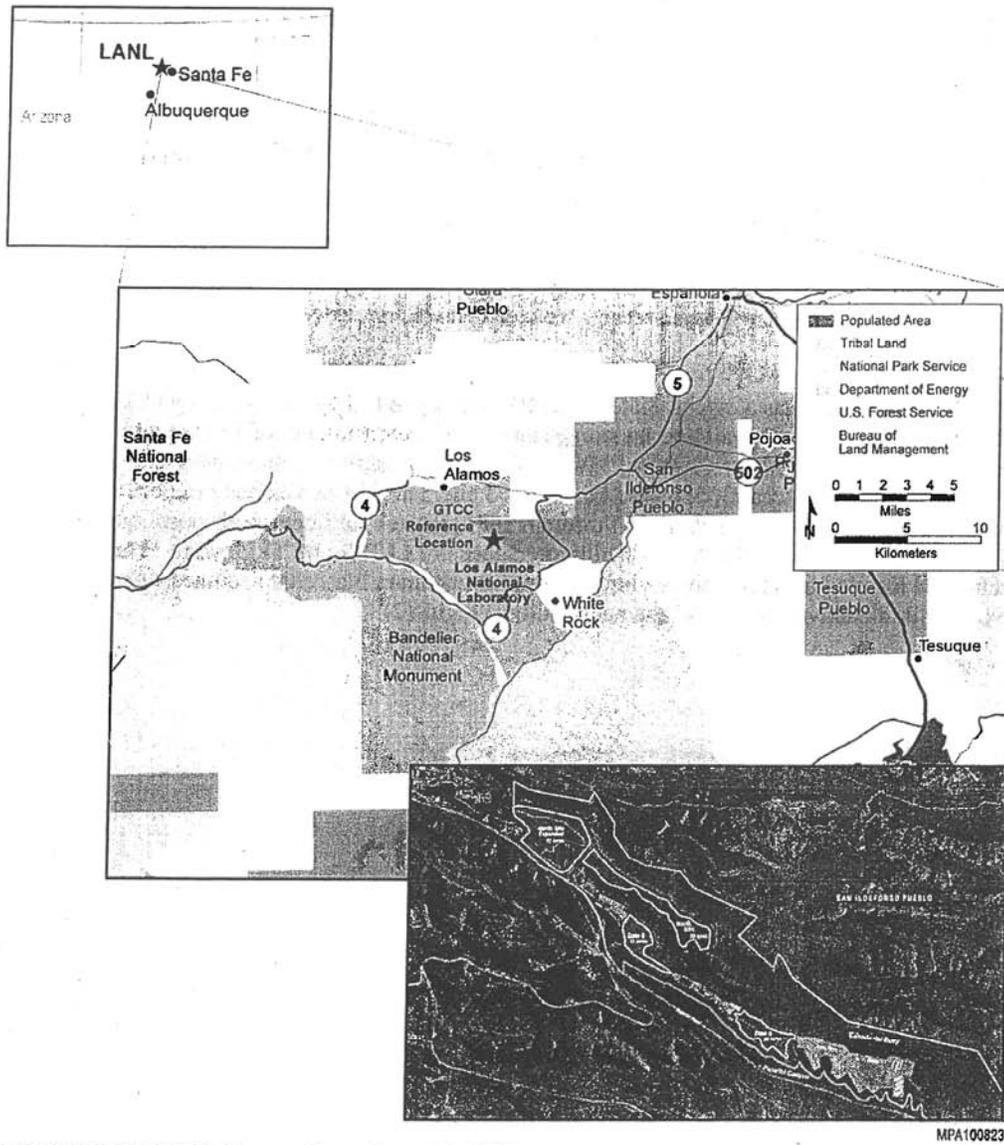


FIGURE 6 GTCC Reference Location at LANL

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NTS

NTS is located about 65 miles northwest of Las Vegas in southern Nevada on 1,350 mi² of land managed by DOE (Figure 7). Its terrain is characterized by high relief, with elevations ranging from about 3,000 ft at Frenchman Flat in the southeastern portion of the site to about 7,400 ft on Rainier Mesa. Historically, the primary mission of NTS was to conduct nuclear weapons tests. The tests have altered the natural topography of NTS, creating craters in Yucca Flat and Frenchman Flat basins and on the Pahute and Rainier Mesas. Since the moratorium on nuclear testing that began in October 1992, the mission of NTS has changed to one of maintaining readiness to conduct nuclear tests in the future. The site also supports DOE's waste management program, as well as other national-security related research and development and testing programs.

NTS presently serves as a disposal site for LLRW and mixed LLRW generated by DOE defense-related facilities. It is also an interim storage site for a limited amount of TRU mixed wastes pending transfer to WIPP for disposal. Waste management activities are conducted in four primary NTS areas: Areas 3, 5, 6, and 11. Areas 3 and 5 are the two existing radioactive waste management sites at NTS. From 1984 through 1989, greater confinement disposal (at depths of 70 to 120 ft) was used at the Area 5 facility to dispose of LLRW and TRU waste. The GTCC reference location at NTS in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility (Figure 7).

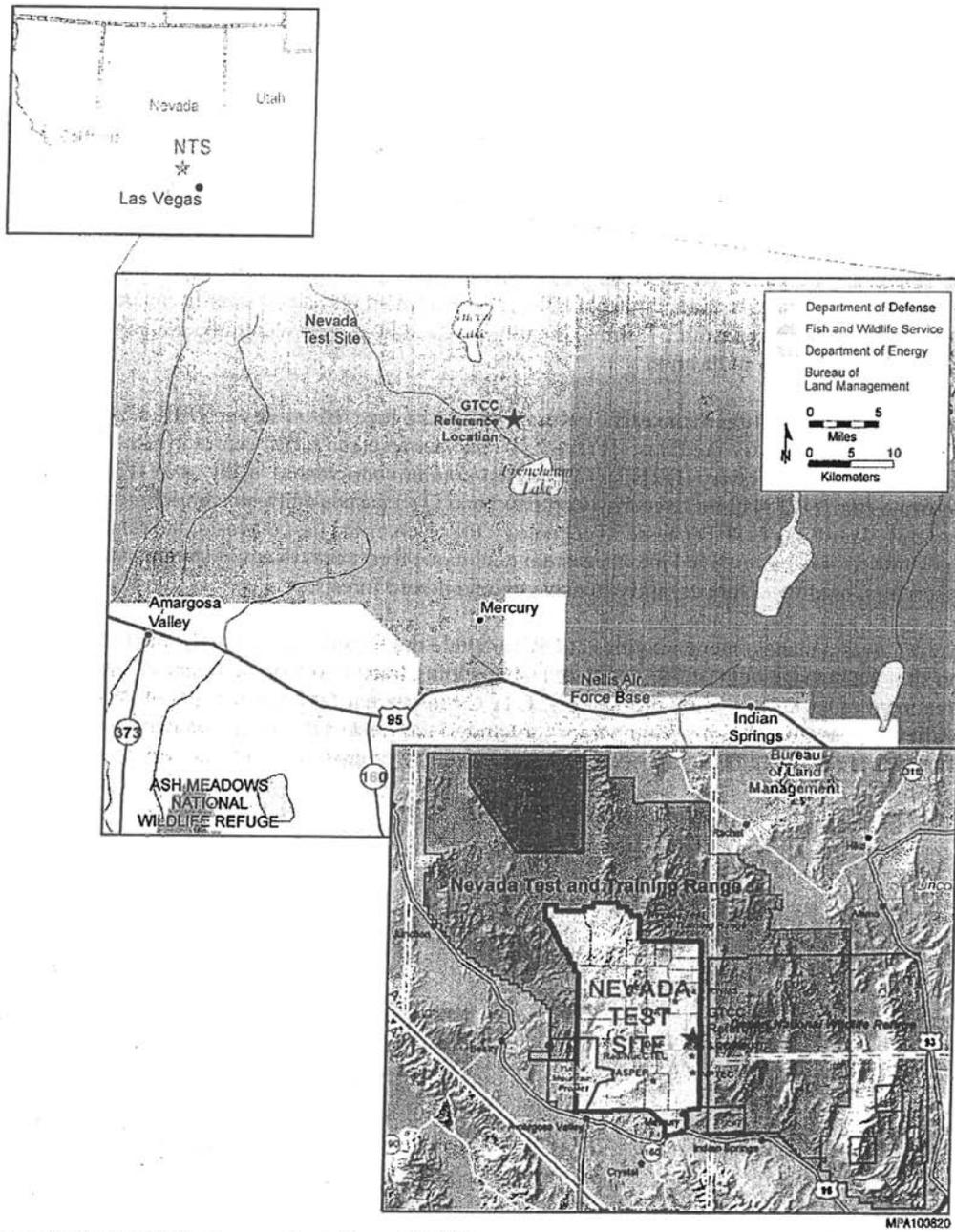


FIGURE 7 GTCC Reference Location at NTS

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ORR

ORR is located in eastern Tennessee, in Roane and Anderson Counties, on 34,241 acres of mostly contiguous land owned by DOE (Figure 8). The terrain is characterized by a series of parallel valleys and ridges with a northeast-southwest trend caused by the differential weathering of interstratified formations exposed at the surface. The topographic relief between valley floors and ridge crests is generally about 300 to 350 ft. The majority of ORR lies within the corporate limits of the city of Oak Ridge. The residential section of Oak Ridge forms ORR's northern and eastern boundaries; the Tennessee Valley Authority's Melton Hill and Watts Bar Reservoirs on the Clinch and Tennessee Rivers form the southern and western boundaries. Except for the city of Oak Ridge, the land within 5 miles of ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, boating, water skiing, and swimming are popular recreational activities in the area.

Following its acquisition in the early 1940s, much of the land that makes up ORR served as a buffer for three primary facilities: (1) the X-10 nuclear research facility currently known as Oak Ridge National Laboratory (ORNL); (2) the first uranium enrichment facility or Y-12, currently known as the Y-12 National Security Complex; and (3) a gaseous diffusion enrichment facility currently known as East Tennessee Technology Park. Over the past 60 years, the relatively undisturbed area has evolved into an eastern deciduous forest ecosystem of streams and reservoirs, hardwood forests, and extensive upland mixed forests.

Current waste management activities at ORR include the treatment and storage of mixed LLRW on site, the management of TRU waste on site pending transfer off site for disposal, and the treatment of hazardous waste on site. The GTCC reference location is in Western Bear Creek Valley, just south of White Wing Scrap Yard and to the west of the Y-12 Complex (Figure 8). The area is relatively flat and bisected by a creek running perpendicular to the valley's trend.

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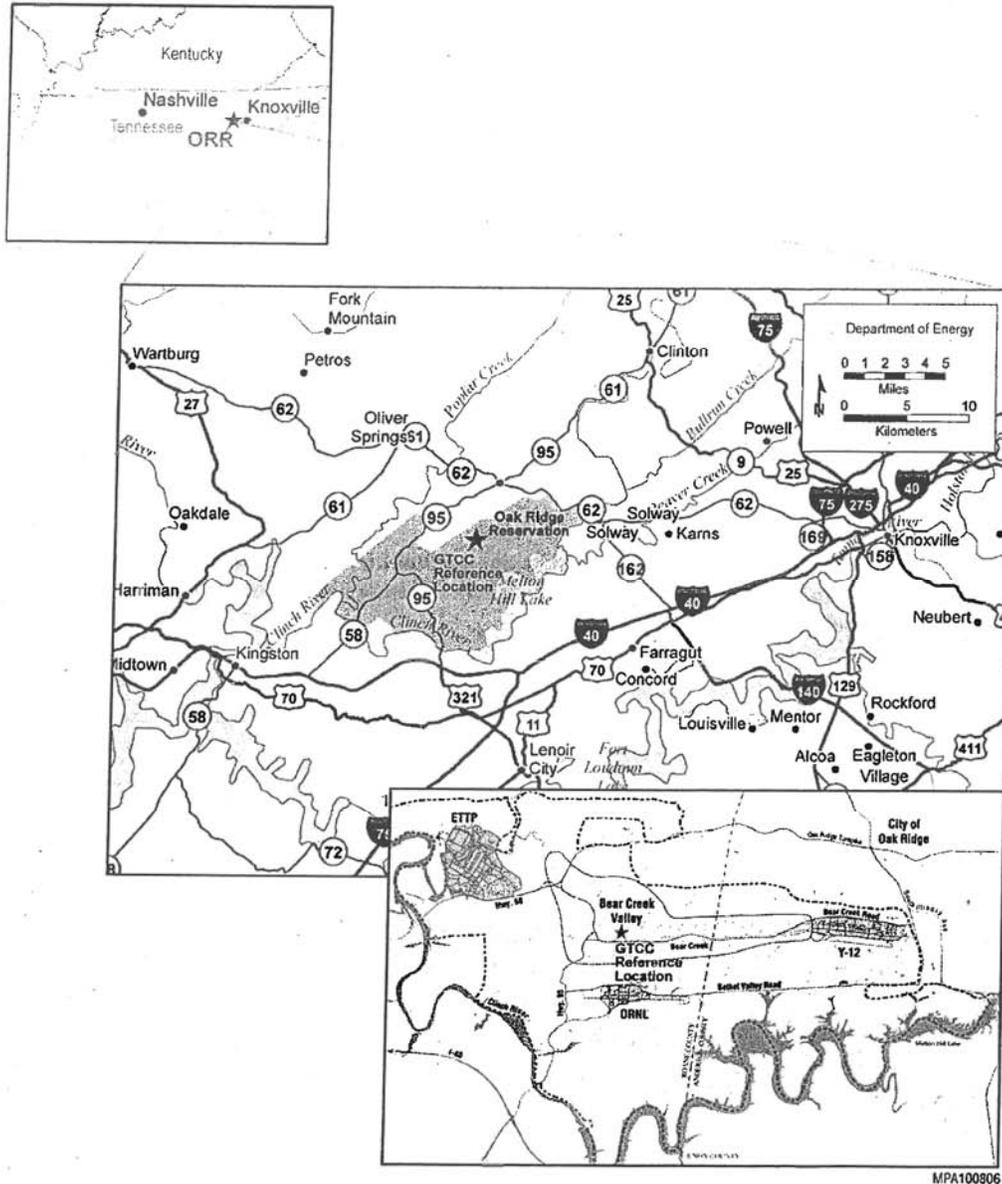


FIGURE 8 GTCC Reference Location at ORR

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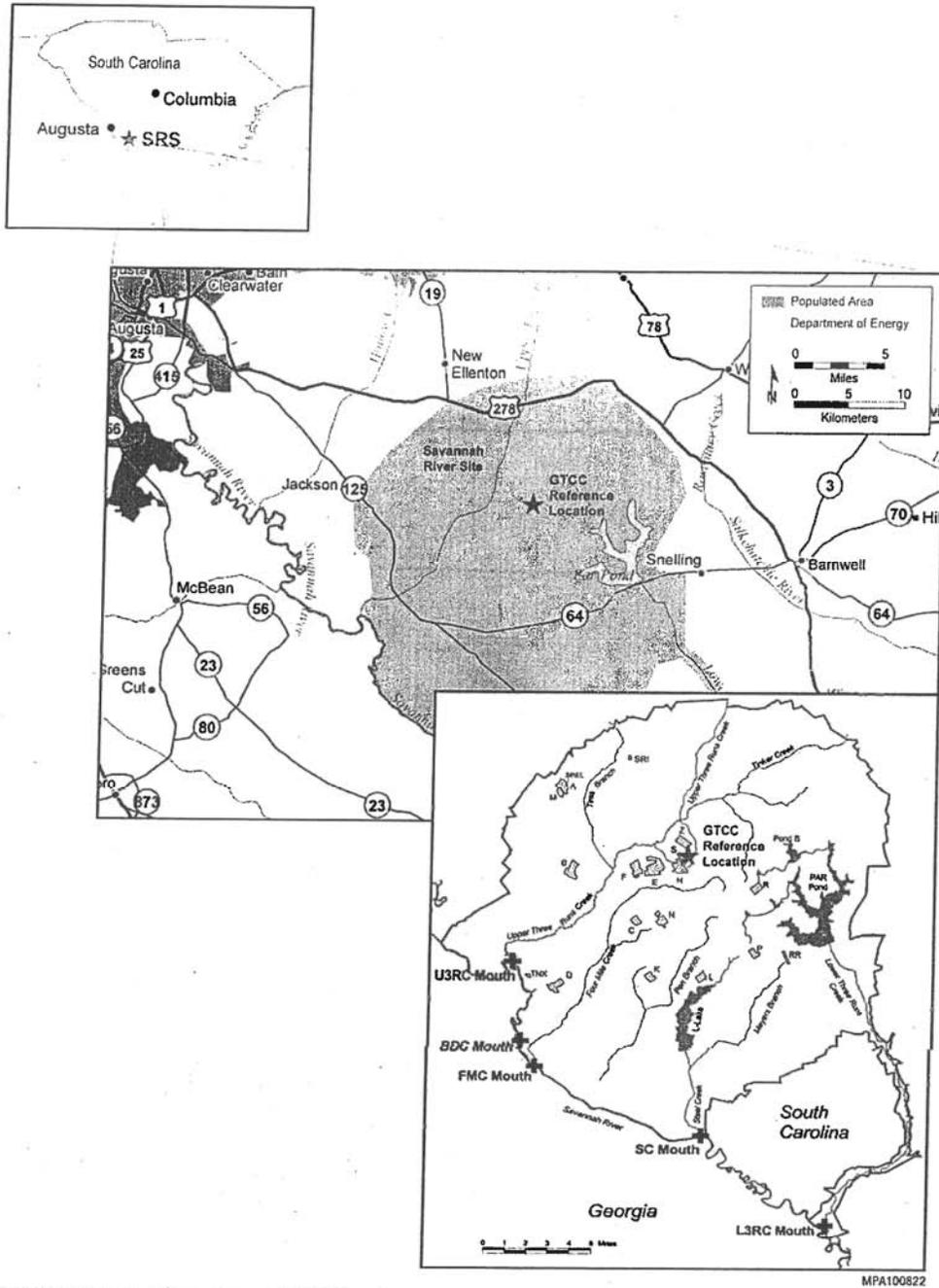
SRS

SRS is located on 310 mi² of DOE land along the Savannah River, about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia, in southwestern South Carolina (Figure 9). Until the early 1990s, SRS primary mission was the production of special radioactive isotopes to support national defense programs. Currently, the site's mission emphasizes waste management, environmental restoration, and decontamination and decommissioning of facilities that are no longer needed for its traditional defense activities.

Current waste management activities at SRS include shipping hazardous waste, mixed LLRW, and TRU waste off site for treatment and disposal. High-level radioactive waste is stored on site pending disposal in a geologic repository. LLRW is treated and disposed of on site as well as at other DOE or commercial facilities. In addition, mixed LLRW may be treated and stored on site before being shipped off site. Other on-site activities include the treatment of LLRW prior to disposal and the preparation of TRU waste for shipment to WIPP for disposal. On-site disposal facilities at SRS include engineered trenches and vaults for the permanent disposal of solid LLRW.

The GTCC reference location is on an upland ridge overlooking Tinker Creek, to the northeast of Area Z in the north-central portion of SRS (Figure 9). The area is not currently being used for waste management.

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GTCC Reference Location at SRS

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WIPP Vicinity

The WIPP Vicinity reference locations are within Section 27, within the WIPP Land Withdrawal Boundary (LWB) and Section 35, outside of and immediately adjacent to the south eastern boundary of the WIPP LWB. WIPP is located in Eddy County in southeastern New Mexico, about 30 miles east of the city of Carlsbad (Figure 10). The land is a relatively flat area. It is primarily used for grazing, potash mining, and oil and gas exploration. There are currently no waste management activities being conducted within either of these locations.

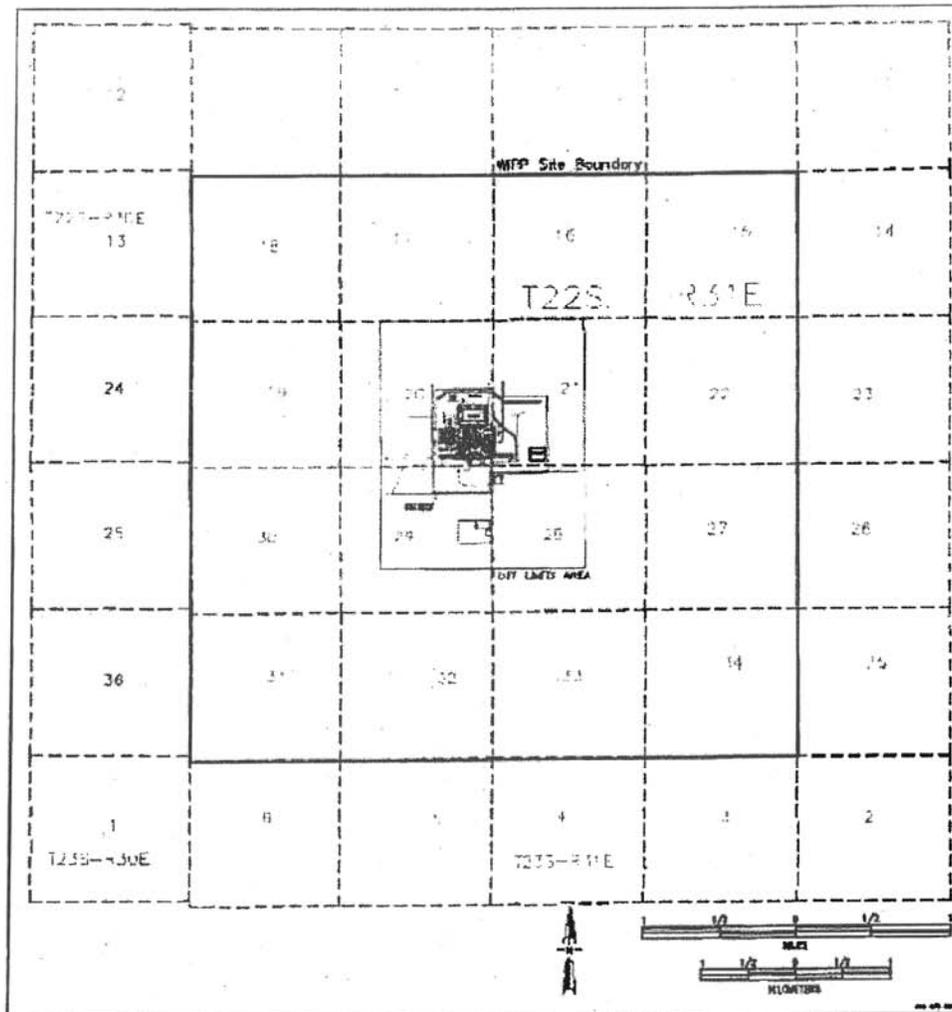


FIGURE 10 GTCC Reference Locations (Section 27 and 35) at the WIPP Vicinity

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Attachment

**Federal Register /Vol. 72, No. 140 /Monday,
DEPARTMENT OF ENERGY
Notice of Intent To Prepare an
Environmental Impact Statement for
the Disposal of Greater-Than-Class-C
Low-Level Radioactive Waste**

AGENCY: Department of Energy.

ACTION: Notice of Intent To Prepare an Environmental Impact Statement.

SUMMARY: The Department of Energy (DOE) announces its intent to prepare an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) for the disposal of Greater-Than-Class-C low-level radioactive waste (GTCC LLW). GTCC LLW is defined by the Nuclear Regulatory Commission (NRC) in 10 CFR 72.3 as "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in [10 CFR 61.55]." GTCC LLW is generated by NRC or Agreement State-licensed activities (hereafter referred to as NRC-licensed activities). DOE proposes to evaluate alternatives for GTCC LLW disposal: in a geologic repository; in intermediate depth boreholes; and in enhanced near surface facilities. Candidate locations for these disposal facilities would be: the Idaho National Laboratory (INL) in Idaho; the Los Alamos National Laboratory (LANL) and Waste Isolation Pilot Plant (WIPP) in New Mexico; the Nevada Test Site (NTS) and the proposed Yucca Mountain repository in Nevada; the Savannah River Site (SRS) in South Carolina; the Oak Ridge Reservation (ORR) in Tennessee; and the Hanford Site (Hanford) in Washington. DOE will also evaluate disposal at generic commercial facilities in arid and humid locations.

In addition, DOE proposes to include DOE LLW and transuranic waste having characteristics similar to GTCC LLW and which may not have an identified path to disposal (hereafter referred to as GTCC-like waste) in the scope of this EIS. DOE's GTCC-like waste is owned or generated by DOE. The use of the term "GTCC-like" does not have the intent or effect of creating a new classification of radioactive waste.

DOE invites public comment on the scope of this EIS during a 60-day public scoping period. During this period, DOE will hold public scoping meetings to

provide the public with an opportunity to comment on the scope of the EIS and to learn more about the proposed action from DOE officials.

DOE issued an Advance Notice of Intent (ANOI), 70 FR 24775 (May 11, 2005), inviting the public to provide preliminary comments on the potential scope of the EIS. This Notice of Intent (NOI) includes a summary of the public comments received on the ANOI.

DATES: The public scoping period starts with the date of publication of this NOI in the *Federal Register* and will continue until September 21, 2007. DOE will consider all comments received or postmarked by September 21, 2007 in defining the scope of this EIS.

Comments received or postmarked after that date will be considered to the extent practicable.

Public scoping meetings will be held to provide the public with an opportunity to present comments on the scope of the EIS and to learn more about the proposed action from DOE officials. The locations, dates, and times for the public scoping meetings are listed in the "Public Scoping" section under **SUPPLEMENTARY INFORMATION**.

ADDRESSES: Written comments on the scope of the GTCC LLW EIS or requests to speak at one of the public scoping meetings should be sent to: James L. Joyce, Document Manager, Office of Regulatory Compliance (EM-10), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585-0119.

Telephone: (301) 903-2151. Fax: 301-903-4303. E-mail: gtcceis@anl.gov.

Written comments on the scope of the GTCC LLW EIS and requests to speak at one of the public scoping meetings can also be submitted through the Web site at <http://www.gtcceis.anl.gov>.

FOR FURTHER INFORMATION CONTACT: To request further information about the EIS, the public scoping meetings, or to be placed on the EIS distribution list, use any of the methods (fax, telephone, e-mail, or Web site) listed under **ADDRESSES** above. For general information concerning the DOE NEPA process, contact: Carol Borgstrom, Director, Office of NEPA Policy and Compliance (GC-20), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585-0119.

Telephone: 202-586-4600, or leave a message at 1-800-472-2756.

Fax: 202-586-7031.

This NOI will be available on the internet at <http://www.eh.doe.gov/nepa>. Additional information on the GTCC LLW EIS can be found at <http://www.gtcceis.anl.gov>.

SUPPLEMENTARY INFORMATION:

Background

GTCC LLW is defined by NRC in 10 CFR 72.3 as "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in 10 CFR 61.55." In 10 CFR 61.55, the NRC defines classes of LLW as A, B and C by the concentration of specific short- and long-lived radionuclides, with Class C LLW having the highest radionuclide concentration limits. Consistent with NRC's and DOE's authorities under the Atomic Energy Act of 1954 (as amended), the NRC LLW radioactive waste classification system does not apply to radioactive wastes generated or owned by DOE and disposed of at DOE facilities. However, DOE owns and generates LLW and transuranic radioactive waste with characteristics similar to GTCC LLW and that may not have a path to disposal. For the purposes of this EIS, DOE is referring to this DOE waste as GTCC-like waste (the use of the term "GTCC-like" does not have the intent or effect of creating a new classification of radioactive waste). DOE proposes to evaluate alternatives for the disposal of both GTCC LLW and DOE GTCC-like waste in this EIS.

Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPA) assigns the responsibility for the disposal of GTCC LLW to the Federal Government. The LLRWPA specifies that the GTCC LLW covered under Section 3(b)(1)(D) is to be disposed of in a facility licensed and determined to be adequate by the NRC. DOE is the federal agency responsible for the disposal of GTCC LLW. This responsibility was described in a 1987 report to Congress, *Recommendations for Management of Greater-Than-Class-C Low-Level Waste* (DOE/NE-0077), U.S. Department of Energy, February 1987. The report can be obtained by contacting the Document Manager listed under ADDRESSES above or from the Web site at <http://www.gtcceis.anl.gov>. The September 11, 2001, attacks and subsequent threats have heightened

concerns that terrorists could gain possession of radiological sealed sources, including GTCC LLW sealed sources, and use them for malevolent purposes. Since 2003, the Government Accountability Office (GAO) has issued three reports on matters related to the security of uncontrolled sealed sources, including the Department's progress in developing a GTCC LLW disposal facility. In addition, the Energy Policy Act of 2005 contains several provisions (e.g., sections 631, 651, and 957) directed at improving the control of sealed sources, including disposal availability.

Because of its technical expertise in radiation protection, the U.S. Environmental Protection Agency (EPA) will participate as a cooperating agency in the preparation of this EIS. NRC will be a commenting agency.

Energy Policy Act of 2005 Reporting Requirements

Section 631 of the Energy Policy Act of 2005 requires the Secretary of Energy to: provide Congress with notification of the DOE office with responsibility for completing activities needed to provide for safe disposal of GTCC LLW; submit a report to Congress containing an estimate of the cost and schedule to complete an EIS and record of decision (ROD) for a permanent disposal facility for GTCC LLW; and prior to making a final decision on the disposal alternative or alternatives to be implemented, submit to Congress a report that describes all alternatives considered in the EIS. In meeting these requirements thus far, DOE has named the Office of Environmental Management as the lead organization having responsibility to develop GTCC LLW disposal capability and has submitted a report to Congress dated July 2006 on the estimated cost and proposed schedule to complete the EIS. *Types and Estimated Quantities of GTCC LLW and DOE GTCC-like Waste* GTCC LLW may generally be categorized into the following three types: sealed sources, activated metals, and other miscellaneous waste (e.g., contaminated equipment). Sealed sources are typically small, high-activity radioactive materials encapsulated in closed metal containers. They are used for a variety of purposes including irradiating food and medical products for sterilization, detecting flaws and failures in pipelines and metal welds,

calculating moisture content in soil and other materials, and assisting in the diagnosis and treatment of illnesses. Activated metal wastes are primarily generated in nuclear reactors during facility modifications and decommissioning. There are 104 operating commercial reactors in the United States and an additional 18 that have been closed or decommissioned. The activated metals consist of internal nuclear components that have become radioactive from neutron absorption. These components include portions of the reactor vessel and other stainless steel components near the fuel assemblies.

Other miscellaneous waste includes all GTCC LLW that is not activated metals or sealed sources. This waste includes contaminated equipment, debris, trash, scrap metal and decontamination and decommissioning waste from miscellaneous industrial activities, such as the manufacture of sealed sources and laboratory research. DOE GTCC-like waste includes some sealed sources owned or generated by DOE activities; activated metals including reflector materials from research reactors as well as other miscellaneous waste owned by DOE or generated by DOE activities that has characteristics similar to GTCC LLW and may not have a path to disposal. Most of the DOE GTCC-like waste consists of transuranic waste² (a DOE waste category) that may have originated from non-defense activities and therefore may not be authorized for disposal at WIPP under the Waste Isolation Pilot Plant Land Withdrawal Act of 1992 and has no other currently identified path to disposal. DOE estimates a total inventory (existing and projected to be generated) of approximately 2,600 cubic meters of GTCC LLW and approximately 3,000 cubic meters of GTCC-like waste. A small percentage of this waste is mixed waste (i.e., radioactive waste that contains a hazardous component subject

to the Resource Conservation and Recovery Act). Table 1 shows estimated quantities of GTCC LLW and GTCC-like waste that DOE proposes to analyze and is based on the report entitled *Greater-Than-Class C Low-Level Radioactive Waste Inventory Estimates*, (DOE, July 2007). This report updates the 1993 inventory estimates contained in the report entitled *Greater-Than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclides, Activities, and Other Characteristics*, DOE/LLW-114, Revision 1 (Sept. 1994), which served as the basis for inventories in the ANOI. Copies of both reports are available by contacting the Document Manager listed under ADDRESSES above or at <http://www.gtccis.anl.gov>.

² Transuranic waste is radioactive waste containing more than 100 nanocuries of alphaemitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) High-level waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of EPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

TABLE 1.—INVENTORY SUMMARY OF ESTIMATED QUANTITIES OF GTCC LLW AND DOE GTCC-LIKE WASTE*

Waste type	In storage	Projected	Total stored and projected			
			Volume in cubic meters (m ³)	Activity ^b MCI	Volume m ³	Activity ^b MCI
GTCC LLW:						
Activated metal	58	3.5	810	110	870	110
Sealed sources	8 ^(c)	0 ^(c)	1,700	2.4	1,700	2.4
Other ^d	76	0.0076	1.0	0.00023	77	0.0078
Total GTCC LLW	130	3.5	2,500	110	2,800	110
DOE GTCC-like waste:						
Activated metal	5.0	0.11	20	0.82	34	0.93
Sealed sources	8.7	0.013	25	0.030	34	0.043
Other ^d	860	11	2,000	19	2,900	30
Total DOE GTCC-like waste	870	11	2,100	20	3,000	31
Total GTCC and GTCC-like waste	1,000	15	4,600	130	5,600	140

*Values have been rounded to two significant figures.
^bRadioactivity values are in millions of curies (MCI).
^cThere are sealed sources currently possessed by NRC licensees that may become GTCC LLW when no longer needed by the licensee. The estimated volume and activity of those sources are included in the projected inventory, notwithstanding the lack of information on the current status of the sources (e.g., in use, waste, etc.).
^dOther GTCC LLW and DOE GTCC-like waste includes contaminated equipment, debris, trash, scrap metal and decontamination and decommissioning waste.

Purpose and Need for Action

As shown in Table 1, NRC and Agreement State licensees have generated and continue to generate GTCC LLW for which there is no permitted disposal facility. DOE is responsible for the safe and secure disposal of GTCC LLW covered under Section 3(b)(1)(D) of the LLRWPA, including determining how and where to dispose of these wastes. In addition, DOE owns or generates certain LLW and transuranic wastes with characteristics similar to GTCC LLW that also may not have an identified path to disposal.

Proposed Action

DOE proposes to construct and operate a new facility or facilities, or use an existing facility, for the disposal of GTCC LLW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Based on the EIS analysis, DOE expects to make a decision on the method(s) and location(s) for disposing of GTCC LLW and DOE GTCC-like waste. A combination of disposal methods and locations may be appropriate based on the characteristics of the waste and other factors.

Alternatives Proposed for Evaluation

The GTCC EIS will evaluate the range of reasonable alternatives for the disposal of GTCC LLW and GTCC-like waste, together with a no action alternative. The NRC regulations at 10

CFR 61.55(a)(2)(iv) define GTCC LLW as that waste which would require disposal in a geologic repository as defined in 10 CFR Part 60 or 63, unless proposals for an alternative method of disposal are approved by NRC under 10 CFR 61.55(a)(2)(iv). Although NRC regulations state that GTCC LLW is generally not acceptable for near surface-disposal, the NRC recognizes in 10 CFR 61.7(b)(5) that "there may be some instances where waste with concentrations greater than permitted for Class C waste would be acceptable for near-surface disposal with special processing or design." Therefore, the disposal methods DOE proposes to evaluate in the EIS include deep geologic repository disposal, intermediate depth borehole disposal, and enhanced near-surface disposal. For deep geologic disposal, DOE intends to analyze disposal at Yucca Mountain in Nevada, a proposed geologic repository to be licensed under 10 CFR Part 63. DOE will also evaluate deep geologic repository disposal at WIPP in New Mexico. Identification of the proposed Yucca Mountain repository for analysis in the EIS is based on the 10 CFR 61.55 regulations, which identify disposal in a geologic repository licensed under 10 CFR Part 60 or 63 as an acceptable method for the disposal of GTCC LLW. Identification of WIPP is based on its characteristics as

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a geologic repository, although not subject to NRC licensing as a geologic repository under 10 CFR Parts 60 or 63. DOE does not plan to evaluate an additional deep geologic repository facility because siting of another deep geologic repository facility for GTCC LLW and GTCC-like waste is impractical due to the cost, time, and the relatively small volume of GTCC LLW and GTCC-like waste. DOE also intends to evaluate disposal of GTCC LLW and GTCC-like waste in a new intermediate depth borehole facility and enhanced-near surface facility at existing DOE sites and generic commercial locations. The DOE sites considered for analysis include INL in Idaho, LANL in New Mexico, WIPP vicinity (either within the WIPP Land Withdrawal perimeter that is under the jurisdiction of DOE, or on government property in the vicinity of WIPP), NTS in Nevada, SRS in South Carolina, ORR in Tennessee, and Hanford in Washington. Identification of these sites for potential analysis is based on mission compatibility (these DOE sites currently have waste disposal operations as part of their mission) and physical characteristics of the sites such as hydrogeology and topography. In addition, DOE intends to evaluate a generic enhanced near surface and intermediate depth borehole commercial disposal facility under both arid and humid conditions in the EIS. In a Request for Information in the *FedBizOpps* on July 1, 2005, DOE solicited technical capability statements from commercial vendors that may be interested in constructing and operating a GTCC waste disposal facility. Although several commercial vendors expressed an interest, no vendors have provided specific information on disposal locations and methods for analysis in the EIS. Including a generic commercial facility in the EIS would allow DOE to make a programmatic determination regarding disposal of GTCC LLW and GTCC-like waste in such a facility. Should one or more commercial facilities be identified at a later time, DOE would conduct further NEPA review, as appropriate. DOE intends to evaluate each of the GTCC waste types (*i.e.*, sealed sources, activated metals, and other waste) individually and in combination for each of the disposal alternatives, taking into account the characteristics of the

waste types and other considerations (e.g., waste volumes, physical and radiological characteristics, and generation rates). For example, GTCC LLW containing transuranic radionuclides with longer half-lives may require greater isolation or other special measures to protect against potential inadvertent human intrusion, whereas GTCC LLW containing radionuclides with shorter half-lives may require less extensive measures. DOE will also consider volumes and time periods when wastes would be generated and require disposal.

In the GTCC LLW EIS, DOE will describe the statutory and regulatory requirements for each disposal alternative and whether legislation or regulatory modifications may be needed to implement the alternative under consideration. In summary, DOE proposes to evaluate the alternatives listed below:

Alternative 1: No Action—under this alternative, current and future GTCC LLW and GTCC-like waste would be stored at designated locations consistent with ongoing practices, such as storage of GTCC LLW activated metals at nuclear utilities;

Alternative 2: Disposal in a Geologic Repository at WIPP—under this alternative, DOE would dispose of GTCC LLW and GTCC-like waste at WIPP;

Alternative 3: Disposal in a Geologic Repository at Yucca Mountain—under this alternative, DOE would dispose of GTCC LLW and GTCC-like waste at the proposed Yucca Mountain Repository;

Alternative 4: Disposal at a New Enhanced Near-Surface Facility—under this alternative, DOE would dispose of GTCC LLW or GTCC-like waste at a new enhanced near-surface facility at INL, LANL, WIPP vicinity, NTS, SRS, ORR, and Hanford, or a commercial facility should such a facility be identified in the future;

Alternative 5: Disposal at a New Intermediate Depth Borehole Facility—under this alternative, DOE would dispose of GTCC LLW or GTCC-like waste at a new intermediate depth borehole facility at INL, LANL, WIPP vicinity, NTS, SRS, ORR and Hanford, or a commercial facility should such a facility be identified in the future.

Identification of Environmental Issues
DOE proposes to evaluate disposal

technologies at various DOE and generic commercial locations for the construction, operation, and closure of a facility or facilities for the disposal of GTCC LLW and GTCC-like waste. DOE proposes to address the issues listed below in the process of considering the potential impacts of the proposed disposal alternatives.

- Potential impacts on air, noise, surface water and groundwater.
- Potential impacts from the shipment of GTCC LLW and GTCC-like waste to the disposal site(s).
- Potential impacts from postulated accidents.
- Potential impacts on human health, including impacts to involved and noninvolved site workers and members of the public.
- Potential impacts to historical and cultural artifacts or sites of historical and cultural significance.
- Potential disproportionately high and adverse effects on low income and minority populations (environmental justice).
- Potential Native American concerns.
- Short-term and long-term land use impacts.
- Long-term site suitability, including erosion and seismicity.
- Potential impacts to endangered species.
- Intentional destructive acts.
- Compliance with applicable federal, state, and local requirements.
- Irretrievable and irreversible commitment of resources.
- Cumulative impacts from past, present and reasonably foreseeable actions.

This list is not intended to be inclusive, and we invite interested parties to suggest other issues to be considered, including aspects of the waste inventories presented in Table I.

Summary of Public Comments on the Advance Notice of Intent

In 2005, DOE issued an ANOI, 70 Fed. Reg. 24775 (May 11, 2005), inviting the public to provide preliminary comments on the potential scope of the EIS. DOE received comments on the ANOI from: the states of Nevada, Oregon and Washington; the Sacramento Municipal Utility District; the New England Coalition; the Sierra Club; the Nuclear Energy Institute; and the Savannah River Site Citizens Advisory Board. The

major scoping issues identified in the comments are summarized below, along with DOE's response.

EIS General Scope: Commenters questioned the need for the EIS, assuming that GTCC LLW would be disposed of in the proposed Yucca Mountain repository for spent nuclear fuel and high-level waste. Some commenters favored the inclusion of DOE's GTCC-like waste along with GTCC LLW generated from NRC-licensed activities in the EIS, while other commenters recommended restricting the scope of the EIS to GTCC LLW analyzed in the Yucca Mountain EIS (DOE/EIS-0250, February 2002) or to waste generated from NRC-licensed activities. Still other commenters questioned the basis for projecting the GTCC LLW volume to 2035 and 2055. *Response:* GTCC waste is LLW, not high-level waste or spent nuclear fuel; nevertheless, DOE has identified the proposed Yucca Mountain repository as one of the sites to be analyzed in the EIS for GTCC LLW as a disposal alternative, as well as other appropriate sites, in accordance with 10 CFR Part 61. Under the LLRWPAA, DOE is responsible for disposing of this waste, and because such disposal would be a major federal action, DOE is required by the Council on Environmental Quality regulations that implement NEPA to complete an EIS analyzing the range of reasonable alternatives for this action. The Energy Policy Act of 2005 also requires DOE to take actions related to the preparation of an EIS for GTCC LLW. DOE plans to include its GTCC-like waste that may have no path to disposal, as well as waste generated from NRC or Agreement State licensed activities, and to identify where economies of scale may be achieved in using the same disposal methods and locations. DOE has identified the estimated GTCC LLW and GTCC-like waste volumes based on the best available data. DOE has changed the projections to 2035 and 2062 to include the 20-year license renewal that commercial reactors may receive plus an additional 6-year "cooling period" before commencing reactor decommissioning activities. Thus GTCC LLW and GTCC-like waste estimates are projected through 2035, except for GTCC LLW activated metals estimates, which are projected through 2062, based on anticipated nuclear reactor

decommissioning schedules.

Waste Disposal Alternatives:

Commenters stated that DOE should identify its criteria for including sites considered in the EIS as potential disposal locations and criteria for selecting the technologies and disposal methods to be evaluated.

Response: DOE has identified its basis for the disposal locations and disposal methods proposed for analysis in the EIS under "Alternatives Proposed for Evaluation" in this Notice.

Waste Inventories: Commenters stated that the inventory data provided in the ANOI should be updated.

Response: DOE has updated the inventory data as shown in Table 1. DOE will incorporate other appropriate inventory data that may become available during preparation of the EIS.

Resource Areas Proposed for Analysis: Commenters suggested a number of subjects that DOE should include in the EIS impact analyses.

Response: DOE's list of subjects proposed for evaluation in the EIS under "Identification of Environmental Issues" in this NOI responds to those comments.

Concentration Averaging:

Commenters raised questions about DOE's potential use of "concentration averaging" in which, for example, the activity of one component is averaged over the volume or mass of waste to identify applicable waste classification standards.

Response: For the purposes of analysis in the EIS, DOE would use guidance in the *Branch Technical Position on Concentration Averaging and Encapsulation*, U.S. Nuclear Regulatory Commission, Washington DC, January 1995, to determine when LLW is greater than Class C as defined at according to 10 CFR Part 61.

Regulatory Requirements: A number of commenters discussed the need to address compliance with regulatory and other legal requirements in the EIS.

Response: The EIS would describe applicable regulatory and other legal requirements and consider the extent to which the alternatives analyzed meet those requirements.

Public Scoping

Interested parties are invited to participate in the public scoping process to provide their comments on the proposed disposal alternatives for

analysis in the EIS and the environmental issues to be analyzed.

The scoping process is intended to involve all interested agencies (federal, state, county, and local), public interest groups, Native American tribes, businesses, and members of the public. Public scoping meetings will be held at the following locations and times:

Carlsbad, New Mexico: Pecos River Village Conference Center, Carousel House, 711 Muscatel Avenue, Carlsbad, New Mexico, Monday, August 13, 2007, 6 p.m.–9 p.m.

Los Alamos, New Mexico: Hilltop House Best Western, La Vista Room, 400 Trinity Drive, Los Alamos, New Mexico, Tuesday, August 14, 2007, 6 p.m.–9 p.m.

Oak Ridge, Tennessee: DOE Oak Ridge Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee, Wednesday, August 22, 6 p.m.–9 p.m.

North Augusta, South Carolina: North Augusta Community Center, 495 Brookside Avenue, North Augusta, South Carolina, Thursday, August 23, 6 p.m.–9 p.m.

Troutdale, Oregon: Comfort Inn & Suites-Columbia Gorge West, 477 NW Phoenix Drive, Troutdale, Oregon, Monday, August 27, 2007, 6 p.m.–9 p.m.

Pasco, Washington: Red Lion Hotel, Gold Room, 2525 N 20th Avenue, Pasco, Washington, Tuesday, August 28, 2007, 6 p.m.–9 p.m.

Idaho Falls, Idaho: Red Lion Hotel On The Falls, Yellowstone/Teton Rooms, 475 River Parkway, Idaho Falls, Idaho, Thursday, August 30, 2007, 6 p.m.–9 p.m.

Las Vegas, Nevada: Atomic Testing Museum, 755 E. Flamingo Road (Just East of Paradise Road), Las Vegas, Nevada, Tuesday, September 4, 2007, 6 p.m.–9 p.m.

Washington DC: Hotel Washington, Washington Room, 15th and Pennsylvania Avenue, NW., Washington, DC, Monday, September 10, 1 p.m.–5 p.m.

During the first hour of each scoping meeting, DOE officials will be available for informal discussions with attendees. During the formal part of the meeting, the public will have the opportunity to provide comments orally or in writing. The presiding officer will establish procedures to ensure that everyone who wishes to speak has a chance to do so. Both oral and written comments will be considered and given equal weight.

Issued in Washington, DC on July 17, 2007.

James A. Rispoli,
*Assistant Secretary for Environmental
Management.*

[FR Doc. E7-14139 Filed 7-20-07; 8:45 am]
BILLING CODE 6450-01-P

**DEPARTMENT OF ENERGY
Office of Civilian Radioactive Waste
Management; Safe Routine
Transportation and Emergency
Response Training; Technical
Assistance and Funding**

AGENCY: Department of Energy.

ACTION: Notice of revised proposed

policy and request for comments.

SUMMARY: The Department of Energy (DOE) is publishing this notice of revised proposed policy to set forth its revised plans for implementing Section 180(c) of the Nuclear Waste Policy Act of 1982 (the NWPA). Under Section 180(c) of the NWPA, DOE shall provide technical and financial assistance for training of local public safety officials to States and Indian Tribes through whose jurisdictions the DOE plans to transport spent nuclear fuel or high-level

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APPENDIX G:
TRIBAL NARRATIVES

Consolidated Group of Tribes and Organizations Tribal Narrative for the Nevada Test Site ^a	G-3
Nez Perce Tribe Narrative for EIS, Department of Energy, Hanford Site	G-43
Pueblo Views on Environmental Resource Areas, Los Alamos Meeting of Pueblo EIS Writers	G-79
Umatilla Input from NEPA Analysis for Confederated Tribes of the Umatilla Indian Reservation (CTUIR) at Hanford.....	G-93
Wanapum Overview and Perspectives Developed during Tribal Narrative Workshop, Hanford, WA.....	G-137

^a In the tribal narratives, the Nevada National Security Site was still referred to as the Nevada Test Site or NTS, and this was not changed.

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1 **American Indian Writers Committee**
2 **of the**
3 **Consolidated Group of Tribes and Organizations**

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5 **Tribal Narrative for the Nevada Test Site**
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11 May 11-15, 2009
12

13
14
15 American Indian Writers Committee
16 Richard Arnold
17 Jerry Charles
18 Betty Cornelius
19 Maurice Frank-Churchill
20 Danelle Gutierrez
21 Gerald Kane
22 Lalovi Miller
23

24
25 Facilitated By
26 Richard W. Stoffle, University of Arizona
27

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29
30 Document Approved by
31 Consolidated Group of Tribes and Organizations
32 Meeting August 31 – September 2, 2009
33 Mercury, Nevada
34

35 Date Submitted to DOE/EM Division
36
37 September 2009

Tribal Views on Nevada Test Site: Affected Environment and Consequences

1.0 Affected Environment

1.1 Climate

CGTO knows that the climate of the region has changed over the thousands of years that the Indian people have lived in this region (See Indian Appendix for more). The NTS has only occupied this area since the early 1940s. It is important to recognize that major climatic changes have taken place since the end of the Pleistocene and shorter term climate changes such as the wet period in the 1980s and 1990s contrast with the current 10-year drought. It is important for the GTCC EIS to assess the impacts of short term and long term climatic changes because the DOE expects to safely manage these GTCC wastes for up to 10K years during which similar climate changes can be expected.

The current climate description in the GTCC EIS is specific to the present decade-long period of extended drought (a similar one occurred between 1896 and 1906) so this type of drought and the wet period between 1980s and 1990s may be a factor in siting the GTCC facility. An analysis of long term impacts based on current conditions will neither be representative of climate conditions viewed over much longer periods nor applicable to a short climate shift to much wetter conditions.

1.2 Groundwater

The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lake beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member added, to Indian people "water is life. Our water has healing powers" (NRC 2009a). So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

1.3 Ecology

The CGTO knows that this site (in Area 5) is an ancient playa, surrounded by mountain ranges (See Indian Appendix for more). The runoff from these ranges serves to maintain the healthy desert floor. Animals frequent this area, there are numerous animals' trails, and these play a significant part in the history of the locality and of the Indian lifestyles. Our ancestors knew that the Creator always provided for them and this site is one of their favorite places to hunt and trap rabbits. We have special leaders that organized large rabbit hunts. Many people participated so this place would be occupied at times by all kinds of our people. Rabbits provided good eating,

1 bones for tool-making, warm blankets, and even games. Indian people refrained from eating
2 coyote, wolves, and birds but these contribute to our stories which tell us how to behave and why
3 we are here. We have many stories and songs that include animals and birds who have human-
4 like antics. From these antics Indian people learn the life lessons to build character to become
5 better persons. So animals and the places where they live contribute to our history and culture.
6

7 This culturally central place was used by and important to Indian people from our agricultural
8 and horticultural communities located to the north – near Reese River Valley and Duckwater, to
9 the south – near Ash Meadows, to the southeast – near Indian Springs and Corn Creek, to the
10 east – near the Pahranaagat-Muddy River, and west – near the Oasis Valley. It was also used by
11 people from our agricultural and horticultural communities to the far west in Owens Valley, to
12 the far south near Cottonwood Island and Palo Verde Valley on the Colorado River, to the far
13 southwest at Twenty Nine Palms, to the far east along the Virgin River, Santa Clara River, and
14 Kanab Creeks, to the far north along the Humbolt River and Ruby Valley.
15

16 *Plants*

17 The CGTO knows based on previous DOE-sponsored ethnobotany studies that there are at least
18 364 Indian use plants on the NTS (see Appendix G). Indian people visiting the proposed location
19 of the GTCC facility identified the following traditional use plants: (1) Indian Tea, (2) White
20 Sage or Winter Fat, (3) Indian Rice Grass, (4) Creosote, (5) Wolfberries, (6) Four O'clock, (7)
21 Spiny Hop Sage, (8) Joshua Tree, (9) Daises, (10) Desert Trumpet, (11) Cholla, (12) Globe
22 Mallow, (13) Fuzzy Sage, (14) Tortoise Food plant, (15) Sacred Datura, (16) Wheat Grass, and
23 (17) Lichen. Other plants were present but not identified due to the late season and the dry
24 condition of the plants.
25

26 Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony –
27 both social and healing. The characteristics of the plants at the proposed GTCC area are smaller
28 and thinner than in other desert areas where it is wetter. Indian people from elsewhere traveled to
29 this area to gather specific plants because they have stronger characteristics when they grow in
30 dry places. The sage is used for spiritual ceremonies, smudging, and medicine. The Indian rice
31 grass and wheat grass are used for breads and puddings. Joshua trees and Yucca plants are
32 important for hair dye, basketry, foot ware, and rope. Datura is used for hallucinogenic effects
33 during which alternative places can be visited by medicine men. Datura also goes itself to
34 disturbed areas and heals them. The globe mallow had traditional medicine uses, but in recent
35 times is also used for curing European contagious diseases.
36

37 *Animals/Insects*

38 The CGTO knows based on previous DOE-sponsored ethnofauna studies that there are at least
39 170 Indian use animals on the NTS (see Appendix G). Indian people visiting the proposed
40 location of the GTCC facility identified the following traditional use animals: (1) Jack Rabbits,
41 (2) Whiptail Lizards, (3) Antelope, (4) Tortoise, (5) Kangaroo Rats, (6) Horned Toad, (7) Rock
42 Wrens, (8) Ravens, (9) Grasshoppers, and (10) Stink Bugs. Other animals (such as snakes, bats,
43 and owls) were perceived to be present but not observed because they primarily emerge at night.
44

45 All animals and insects were and are culturally important and the relationships between them, the
46 Earth, and Indian people are represented by the respectful roles they play in the stories of our life

1 then and now. The GRCC valley is where a spiritual journey occurred. It involved Wolf (*Tavats*
2 in Southern Paiute, *Bia esha* in Western Shoshone, *Wi gi no ki* in Owens Valley Paiute) and
3 Coyote (*Sinav* in Southern Paiute, *Duhvo esha* in Western Shoshone, *Esha* in Owens Valley
4 Paiute) and is considered a Creation Story. Only parts of this can be presented here. When Wolf
5 and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious.
6 Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and
7 tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a
8 beautiful Rainbow (*Paro wa tsu wu nutuvi* in Southern Paiute, *Oh ah podo* in Western Shoshone,
9 *Paduguna* in Owens Valley Paiute). When Coyote saw this special privilege he cried to the
10 Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put
11 Coyote as a fine white mist at the bottom of the Rainbow's arch. This story and the spiritual
12 trails discussed in the full version are connected to the Spring Mountains and the large sacred
13 cave in the Pintwater Mountains as well as to lands now called the Nevada Test Site. This area is
14 the home place of Wolf who is still present and watches over the area and us.

15

16 *Minerals*

17 The CGTO knows based on previous DOE-sponsored cultural studies that there are many
18 minerals on the NTS (no complete list available). Indian people visiting the proposed GTCC site
19 identified the following traditional use minerals: (1) Obsidian, (2) chalcedony, (3) Yellow Chert
20 or Jasper, (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other minerals
21 were perceived to be present but not observed because of the limited time and search area.

22

23 All minerals are culturally important and have significant roles in many aspects of Indian life.
24 For example, the Chalcedony on the proposed GTCC site would have made an attractive offering
25 which would be acquired here by a ceremonial traveler and then left at the vision quest or
26 medicine site located to the north on top of a volcano like Scrugham Peak. Returning ceremonial
27 travelers would also bring offerings back to where they had acquired offerings, thus the Yellow
28 Chert or Jasper (observed on the GTCC site) which outcrops about 70 miles to the north would
29 be gathered there and returned to the Chalcedony site as an offering.

30

31 *Playas*

32 The CGTO knows, based on cultural studies funded by the DOE on the NTS and playa-specific
33 studies funded by Nellis Air Force Test and Training Range (Henderson 2008), that playas
34 occupy a special place in Indian culture. Playas are often viewed as empty and meaningless
35 places by western scientists, but to Indian people playas have a role and often contain special
36 resources that occur no where else. The following text was prepared by the Indian people who
37 visited the proposed GTCC site.

38

39 Is a playa a wasteland? According to Indian elders playas were used in traveling or moving to
40 places where work, hunting, pine cutting or gathering of other important foods and medicine
41 could be done. One elder remembers crossing over dry lake beds and traveling around but near
42 the edges and they discussed how provisions were left there and at nearby springs by previous
43 travelers at camping spots. Indian people left caches in playa areas for people who crossed
44 valleys when water and food was scarce. Frenchmen Playa is such a place. Indian people took
45 advantage of traveling through this playa as mountains completely surround this area. The
46 CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake

1 near Barstow, California. The Mohave River flows into this dry lake and most of the year it
2 looks dry but it actually flows underground. Building berms on dry lake beds to offset water and
3 runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member
4 added, to Indian people "water is life. Our water has healing powers" (NRC 2009a). So why
5 build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian
6 people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in
7 the immediate region and has special meanings. There should be a more descriptive study to
8 fully understand the impacts. More time is needed, also for Indians to revisit this site. Although
9 some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not.
10 Further ethnographic studies are needed.

11

12 **1.4 Environmental Justice**

13

14 DOE has recognized the need to address environmental justice concerns of the CGTO based on
15 disproportionately high and adverse impacts to their member tribes from DOE NTS activities. In
16 1996, the CGTO expressed concerns relating to environmental justice that included (1) damage
17 to Holy Lands, (2) negative health impacts, and (3) lack of access to traditional places that
18 contributes to breakdowns in cultural transmission. In the 2002 NTS SA, NNSA/NSO concluded
19 that with the selection of the Preferred Alternative, the CGTO would be impacted at a
20 disproportionately high and adverse level consequently creating an environmental justice issue.
21 Since 2002, NNSA/NSO has supported a few ethnographic studies involving the CGTO and
22 culturally important places including in 2004, when NNSA/NSO arranged for tribal
23 representatives to conduct evening ceremonies at Water Bottle Canyon. While the opportunity
24 for the evening ceremony was a significant accommodation, disproportionately high and adverse
25 impacts from DOE NTS activities continue to affect American Indians. The three environmental
26 justice issues noted by the CGTO need to be addressed.

27

28 **1.5 Radiation**

29

30 The CGTO knows that radiation can be and is viewed from both a western science and a Native
31 American perspective (See Indian Appendix for more). These alternative and competing
32 perspectives are key for understanding the cultural foundations of American Indian responses to
33 the mining, processing, use, transportation, and disposal of radioactive materials. At some level
34 of analysis from an Indian perspective, all radioactive waste is basically the same problem to
35 Indian people. Subtle differences in classification from a western science perspective of
36 radioactive waste only mask and do not significantly modify the basic cultural problems of
37 radioactive waste for Indian people and their traditional lands.

38

39 The Angry Rock is a concept used by Indian people, involved in DOE funded radioactive waste
40 transportation and disposal studies, to quickly summarize the complex cultural problems
41 associated with what happened to this known mineral when it was improperly taken and used by
42 non-Indians. The notion of an Angry Rock is premised on the belief that all of the earth is alive,
43 sentient, speaks Indian, and has agency. When the elements of the earth are approached with
44 respect and asked for the permission before being used they share their power with humans. The
45 reverse occurs when they are taken without permission – they become angry withhold their
46 power and often using it against humans. Thus uranium is an Angry Rock. Uranium has been

1 known and carefully used by spiritual specialists and medicine persons for thousands of years
2 (Lindsay et al. 1968). The following American Indian elder quote from a DOE funded report
3 (Austin 1998) begins to explain this perspective:

4 *We are the only ones who can talk to these things. If we do not make sure that we talk to those*
5 *things, then they are going to give us more bad harm, because it is already happening*
6 *throughout the country. Those are the reasons why the Indian people say ... like uranium, for*
7 *one, uranium was here since the beginning of this Earth, when it was here we knew uranium at*
8 *one time. And still it is used, but then they got a hold of it and made something else out of it.*
9 *Now it is a man made thing, and today it accumulates waste from nuclear power plants, it*
10 *accumulates more, it has its own life. Radiation has said to us at one time "If you use me make*
11 *sure you tell me before you use me why you are going to use me and what for. " And we never*
12 *said anything to that uranium at all, and we put something else in there with it, which shouldn't*
13 *belong with it. It gives it more power to eliminate the life, of all living things on this planet of*
14 *ours. Those are the reasons, why the Indian people always say, and I know because I have been*
15 *there. The rocks have a voice...*

16 Although from a Western science perspective radiation can be isolated and contained by
17 conventional techniques, the Angry Rock has the power to move and cannot be contained by
18 barriers. Indian people who have dealt with the Angry Rock for thousands of years note that
19 there are traditional ways to deal with uranium, the natural rock, if used by trained Indian
20 specialists, but these may or may not work with the Angry Rock of modern radiation waste.

21 *Songs ... we are the ones who should be talking to those things. Radiation is going to take all of*
22 *our lives; it is continuously moving over the land. The land don't want it, nobody wants it. And*
23 *today, we are doing a bad thing by using radiation on each other. Radiation is something that*
24 *should not be used to kill animal life...*

25
26 Another elder noted:

27
28 *And can it be contained? As it's transformed it can be, I think it can be contained physically but*
29 *not spiritually, and again I think spiritually as it's been altered because it's in that energy field*
30 *because it's been altered. The spirit, that's where it can do its harm in an altered form. It doesn't*
31 *do any good to anybody. And there you're just in the wrong place in the wrong time, it does*
32 *influence plants and animals, minerals and air, the spirit of any area it passes through. The*
33 *reason somebody is sick. I don't think it's necessary to talk about how each one of these is*
34 *influenced, it just is.*

35
36 Another elder noted:

37
38 *As far as the transportation of waste there's a lot of unknowns and we don't know what the*
39 *consequences are. We know there are many sicknesses that come out from people that have*
40 *been contaminated by nuclear waste and as far as Indian people go, we show respect to the*
41 *land, show respect to other people, for the animals, the plants, the rocks. The power of the rock*
42 *– Just looking at Chemehuevi Mountain, it's a very spiritual mountain from this perspective*
43 *right here. When I look out towards the mountains and I don't just see a mountain, I see a place*

1 of power, I see a place where I can go and meditate and speak with the Creator directly and
2 ask for prayers and blessings for people directly. Just like anything else, you have to give
3 prayers all the time because the creator is here to watch and protect over us. I feel that we
4 wouldn't have come this far if he wasn't here to watch over us and we are here to pray and we
5 are here to protect the other resources.

6

7 Another elder said:

8 I can envision the animals standing back once it goes through for the first time and they
9 recognize that there's a danger that they would move away because of fear. That they would no
10 longer be there and that there's something bad coming down the road and they disperse and
11 move away into different corridors. Kind of like a dust storm, they disperse and move further and
12 further away. I see it from the animals' standpoint, they're a lot smarter than us and they've been
13 doing this for longer than us and their senses are more keen and I think the animals would get
14 back and it would create dead zones throughout the country. Through these corridors or
15 transportation routes of course at the site there will be those that are curious who want to go
16 see.

17

18 Another elder said:

19 I don't know what you would do with this rock if it's angry and this is its way of rebelling, getting
20 back. I think as a Native American I would backstep and ask for forgiveness. Sometimes
21 forgiving is not very easy because there's sacrifices we have to make and there's consequences ...
22 I don't think it can be done as a group, it's an individual thing and each one of us has to go back
23 and ... ask for forgiveness for what has taken place. It's not just only that I think it's going to be
24 more complicated than going out into the mountains and saying, "hey, I'm sorry, I won't do this,
25 I won't do that and I won't bother you anymore. There's a lot of other things that need to be
26 forgiven. The rock is the most precious and it's the largest and it's the one that needs to be
27 forgiven the most. There's a lot of small forgiveness that have to be given before the large rock. I
28 think it's a stepping stone... the rocks are angry, yes, they're striking out saying "don't do this to
29 me, don't touch me, don't let this happen. " In a sense you look at it from a spirituality
30 standpoint, it's the spirits of Mother Earth telling us don't mess with Mother Earth. It remains a
31 matter of debate as to whether traditional means of placating powerful rock-based forces can be
32 used to control or placate radioactive waste. Western scientists have created a problem for
33 Indian people that, despite being very critical to their future, is not easily resolved.

34

35 **1.6 Cultural Resources**

36

37 The CGTO knows that American Indian cultural resources include all physical, artifactual, and
38 spiritual aspects of the NTS. The CGTO has established that formal studies of these aspects of
39 the land should be conducted to identify, assess, mitigate, and manage these resources. These
40 resources should be studied with members of the CGTO recommended for the study. Such
41 studies are termed: (1) Ethnoarchaeology, (2) Ethnobotany, (3) Ethnozoology, (4) Storied Rocks,
42 (5) Traditional Cultural Properties, (6) Ethnogeography, and (7) Cultural Landscapes (see
43 Appendix G).

44

45 The CGTO knows that many of these cultural resources are directly present on the GTCC
46 proposed site, in the Indian Defined Area of Potential Effect, and immediate region surrounding

1 the GTCC site. The Indian people who visited the GTCC site note that their time on site was
2 insufficient to fully identify, analyze, and evaluate resource that may be present. They
3 recommend one or more of the kinds of resource studies identified above be conducted. Based on
4 their site visit they do know that the area contains important cultural resources including plants,
5 animals, minerals, trails, and portions of cultural landscapes (see Indian Appendix of this EIS).

6 7 Cultural Artifacts and Features

8
9 The CGTO knows based on previous DOE-sponsored cultural studies that there are many
10 cultural artifacts and features on the NTS (American Indian Transportation Committee, Stoffle,
11 and Toupal 1998; American Indian Transportation Committee, et al. 1999; American Indian
12 Writers Subgroup, CGTO 1996; Arnold et al. 1997; Arnold et al. 1998; Arnold et al. 1999; Austin
13 1998; Stoffle et al. 2001a; Stoffle et al. 2001b; Stoffle, Evans, Harshbarger 1989; Stoffle, Evans,
14 Halmo 1988; Stoffle et al. 1989; Stofle, Halmo, and Dufort 1994; Stoffle, Olmsted, and Evans
15 1988; Stoffle, Zedeño, and Carroll 2000; United States Department of Energy (USDOE) 1996;
16 USDOE, National Nuclear Security Administration 2002; USDOE, National Nuclear Security
17 Administration 2008; Henderson 2008). Indian people visiting the proposed GTCC site identified
18 the following traditional cultural artifacts and features: (1) Chert Flakes, (2) Rock Alignments,
19 (3) Boulder Grinding Indentation or metate (*Mata* in Owens Valley, *Doso* in Western Shoshone,
20 *Mada* in Southern Paiute), (4) Hand Grinding Stone or mano (*Paha* or *Tusu* in Owens Valley,
21 *Botoh* in Western Shoshone, *Mohum* in Southern Paiute), (5) Volcanoes, (6) Trails, and (7)
22 Chalcedony, and (8) Yellow Jasper.

23
24 Artifacts are the evident signs of our ancestors on this land. They are proof that we were here for
25 thousands of years. We were told by our elders never to move artifacts or take them from their
26 place. This is their home because they were left there for us to see and understand the past. We
27 never remove them because they still belong to the ancestors who put them there for us and still
28 watch over them today. Artifacts come from parts of the living earth and are still alive with a
29 right to remain where they were placed. Whether or not there is evidence of being modified, the
30 volcanoes, stones, rocks and trails that we incorporated into our lives are artifacts. These were
31 visited for ceremony, chosen and moved as offerings, and traveled on our journeys and thus were
32 a part of our life, are artifacts of our ancestors that we respect, and are there for future
33 generations.

34 35 **1.7 Visual Resources**

36 Views are important cultural resources that contribute to the location and performance of
37 American Indian ceremonialism. Views combine with other cultural resources to produce special
38 places where power is sought for medicine and other types of ceremonies. Views can be of any
39 landscape, but more central views are experienced from high places, which are often the
40 tops of mountains and the edges of mesas. Indian views tend to be panoramic and are
41 special when they contain highly diverse topography. The viewscape panorama is further
42 enhanced by the presence of volcanic cones and lava flows. Views are tied with songscapes
43 and storyscapes, especially when the vantage point has a panorama composed of multiple
44 locations from either song or story. Key to the Indian experience of views is isolation.
45 Successful performance of ceremonies (whether by individuals or groups) is often
46 commemorated by the building of rock cairns and by storied rocks and paintings. The CGTO

1 tribes recognize the cultural significance of viewsapes and have identified a number of these on
2 the NTS. The Timber Mountain Caldera contains a number of significant points with different
3 panoramas, including Scrugham Peak-Buckboard Mesa and the Shoshone Mountain massif.
4

5 **1.8 Waste Management**

6

7 The CGTO requests an analysis of the hydrological and ecological impacts of the existing water
8 diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE
9 recognizes that this is a very flood prone area, with major flooding episodes occurring about
10 every 23 years. Indian people visiting this site observed that even though the current dike has
11 been built recently and thus not experienced a 23-year flood, it has diverted and consolidated
12 sufficient runoff that a small arroyo has been established. The Indian people visiting this site
13 believe that the existing dike has unnaturally stressed down-slope plants and animals who now
14 do not receive normal sheet runoff. The Indian people visiting the site believe that by
15 concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet
16 runoff because the consolidated runoff moves more quickly and only flows in the new and
17 developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC
18 facility to be established east of the current RWMC then the dike would necessarily have to be
19 extended causing an even greater runoff shadow and an even greater developing arroyo. The
20 desert tortoise in the area will have to move out of this larger runoff shadow and may be
21 concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will
22 expose them to higher levels of radioactivity. The Indian people visiting the site believe that
23 these current and potential impacts should be analyzed, monitored by Indian people, and reported
24 back to the CGTO at the next annual meeting.
25

26 **1.9 Site Description**

27

28 The CGTO knows that the southern bajada (alluvial fan) of French Peak and associated hills to
29 the east combine to periodically cause massive runoffs which flow rapidly towards Frenchman
30 Playa making it a seasonal shallow lake. Frenchman Playa has a 140 square-mile watershed that
31 could impact the GTCC site as it potentially does the current RWMS (Raytheon Services 1993).
32 Especially considered in these Indian comments are runoffs from the north of the proposed
33 GTCC storage area. This watershed involves 13.6 square miles and directly impacts the current
34 RWMS. This runoff from this area is normally sheetflow, but every 23 years or so a major flood
35 occurs. This threat has resulted in the RWMS building a large diversion dike and trench to
36 protect the current Radioactive Waste Management Complex. The Raytheon study indicates that
37 the southwest corner of the RWMS is located in the 100-year flood hazard zone, but the entire
38 northern alluvial fan brings runoff directly into the immediate area.
39
40

41 **1.10 Climate and Air Quality**

42

43 One performance objective in selecting a preferred site is to protect individuals and communities
44 who might occupy the disposal site after active and passive controls are no longer present. These
45 individuals are to be protected from exposure to GTCC radiation while they engage in normal
46 activities such as agriculture, dwelling construction, food acquisition, and ceremony. The CGTO

1 believes that a wetter climate will raise the water table up to or over the GTCC waste site.
2 Nearby wetland plants and animals would absorb radiation and then expose local people.
3 Drinking water from these wetlands will also result in exposure. Indian people visiting the site
4 believe their descendants will live near and use these wetlands as their ancestors did thousands of
5 years ago.

6
7 The climatic effects of both wet and dry periods should be analyzed and incorporated in the
8 GTCC site assessment.

9

10

11

12 **2.0 Environmental Consequences**

13

14 **2.1 Radiation**

15 Indian people have raised in past radioactive waste disposal and transportation studies a range of
16 questions regarding how to protect themselves and their natural resources from exposure to what
17 they call the Angry Rock (See Indian Appendix for more). The analysis of GTCC waste should
18 address directly these potential impacts and suggest ways to either avoid or mitigate them. The
19 potential impacts to Indian people and their life are significant including potentially blocking the
20 path to the afterlife (Stoffle and Arnold 2003).

21

22 **2.2 Cultural Resources**

23

24 The CGTO knows that there are physical, spiritual, and archaeological elements associated with
25 the entire Frenchman Flat valley. Impacts to any of these elements are considered important and
26 need to be considered during GTCC siting considerations. There are direct impacts to Indian
27 cultural resources that have been observed by the Indian people who visited the current RWMS.
28 Especially obvious is the construction of a water diversion dike and subsequent arroyo cutting
29 and dewatering of areas down slope of the dike. Surface disturbance will remove medicine and
30 food plants, impact animal habitat and concentrate certain species of animals. The Chalcedony
31 deposits and chert offerings will be totally removed thus causing a disconnect between the Indian
32 ancestors who used these and contemporary and future generations of Indian people. This is an
33 act of disrespect.

34

35 **2.3 Waste Management**

36

37 The CGTO requests an analysis of the hydrological and ecological impacts of the existing water
38 diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE
39 recognizes that this is a very flood prone area, with major flooding episodes occurring about
40 every 23 years. Indian people visiting this site observed that even though the current dike has
41 been built recently and thus not experienced a 23-year flood, it has diverted and consolidated
42 sufficient runoff that a small arroyo has been established. The Indian people visiting this site
43 believe that the existing dike has unnaturally stressed down-slope plants and animals who now
44 do not receive normal sheet runoff. The Indian people visiting the site believe that by
45 concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet

1 runoff because the consolidated runoff moves more quickly and only flows in the new and
2 developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC
3 facility to be established east of the current RWMS then the dike would necessarily have to be
4 extended causing an even greater runoff shadow and an even greater developing arroyo. The
5 desert tortoise in the area will have to move out of this larger runoff shadow and may be
6 concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will
7 expose them to higher levels of radioactivity. The Indian people visiting the site believe that
8 these current and potential impacts should be analyzed, monitored by Indian people, and reported
9 back to the CGTO at the next annual meeting.

11 **2.4 Cumulative Impacts from the GTCC Action at NTS**

13 According to the CGTO tribes, increased land disturbances associated with all forms of activities
14 and development on the NTS could result in a decrease in access to these areas for American
15 Indians. Limiting access could reduce the traditional use of the NTS and other areas and affect
16 their sacred nature. Increased development at the NTS could increase the potential for greater
17 disturbance and vandalism of American Indian cultural resources. The CGTO tribes believe (See
18 Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the
19 State of Nevada 1996: Appendix G) that cumulative impacts in the following areas may occur:

- 21 • *Holy land violations.* Further destruction of traditional cultural sites, making the water
22 disappear, general treatment of the land without proper respect.
- 24 • *Cultural survival.* Decreased ability and access to perform ceremonies.
- 26 • *Environmental restoration.* Revegetation of restored lands with native species.
- 28 • *Empowerment process.* Over the past 17 years of regular consultation between the
29 NNSA/NV and the CGTO tribes, there has been a growing co-management role for the
30 tribes. Their recommendations have been heard and, for the most part, responded to by
31 the NNSA/NV. Indian access to places on the NTS has increased, after an early period of
32 access loss. Unfortunately, each new program that is added to the NTS decreases the
33 amount of space that is available for the practice of Indian religions, ceremonies, and
34 cultural persistence. However, having no programs also can have an impact. For example,
35 even though the mesas are now accessible to Indians for ceremonies, the roads are not
36 maintained because there are no projects on the mesas. This makes access to the
37 ceremonially important areas difficult.
- 39 • *Radiation risks.* These risks began with nuclear testing. Today, the CGTO tribes perceive
40 that the radioactive risks continue in known and unknown ways underground.

42 There are still ongoing risks to Indian people from storage and disposal of waste and these will
43 continue. Finally, transportation of radioactive materials is continuing and increasing. It is not
44 clear to the CGTO tribes that, after two American Indian studies of radioactive waste
45 transportation, there has been a meaningful consideration of their concerns. It is not clear to what
46 extent further radioactive waste disposal at the proposed GTCC facility will do to increase

1 radiation risks to the physical and spiritual dimensions of Frenchman Playa area but some
2 assessment is possible by Indian religious leaders.

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Appendix A: Native American Responses to The GTCC Proposal on the NTS

This Greater Than Class C EIS study was funded by the Waste Management Office of the DOE and NNSA/NSO. Text was provided by the American Indian Subgroup who represents the seventeen tribes and Indian organizations that are in consultation with the NNSA/NSO regarding the Nevada Test Site (NTS) and related locations. The consulting Indian tribes and organizations are known as the Consolidated Group of Tribes and Organizations (CGTO), within which there are numerous subgroups who act in different roles such as the American Indian Writers Subgroup (AIWS). The recognized role of the AIWS and other CGTO subcommittees is to follow closely specific issues and report to the CGTO. The CGTO members then report back to their respective tribal governments or Indian organization governing boards. It is important to note that official responses to issues only come from tribal governments and governing boards.

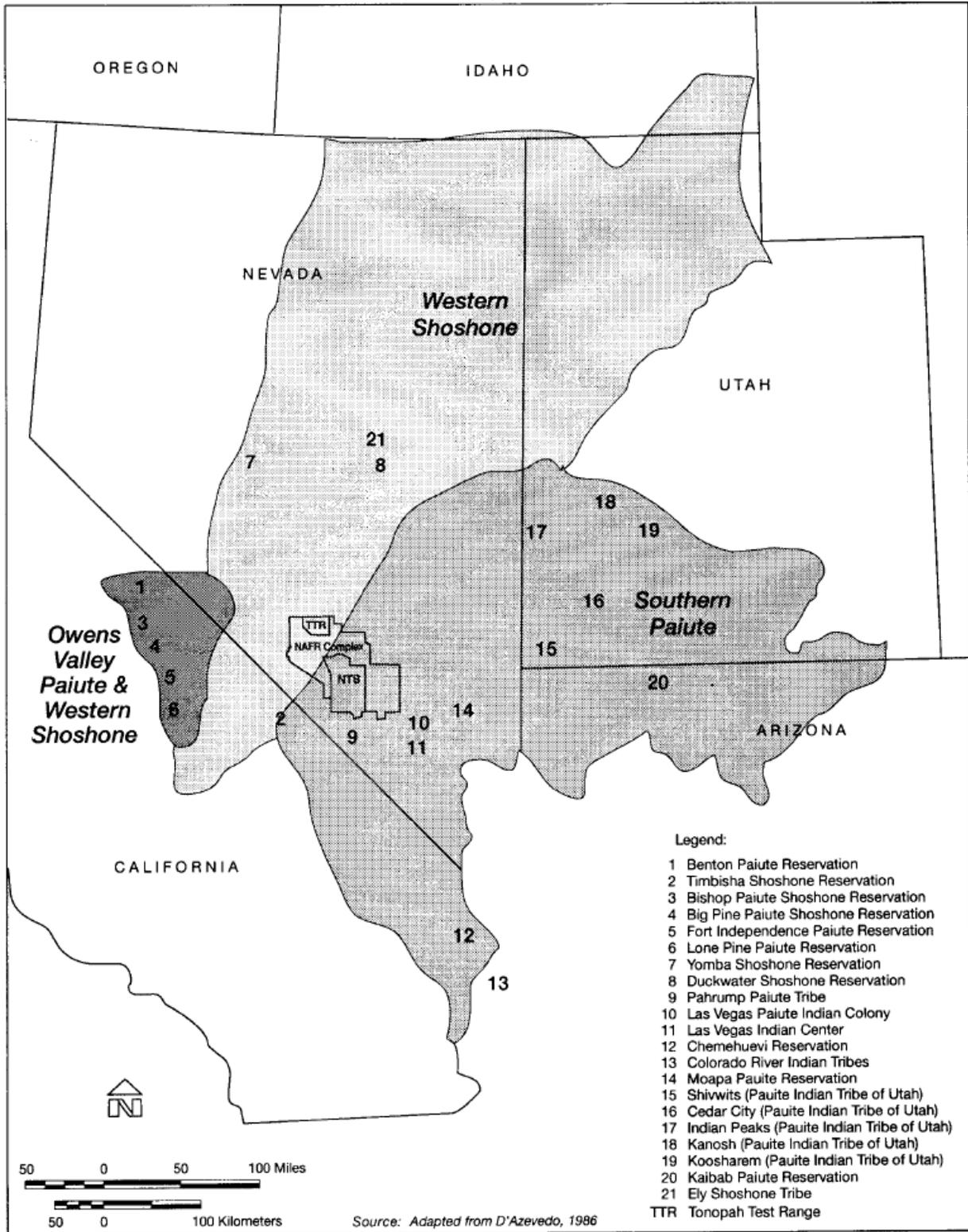
The role of the AIWS is to review all manuscripts that involve Indian people on the NTS and to review fieldwork proposals. The AIWS is composed of a coordinator, three officially appointed members, and three alternates who were selected by the subgroup members. The members of this subcommittee are (1) Southern Paiutes – Betty Cornelius and Lalovi Miller, (2) Western Shoshones – Maurice Frank-Churchill and Jerry Charles, and (3) Owens Valley Paiutes – Gerald Kane and Danelle Gutierrez. Richard Arnold is the appointed AIWS coordinator.

AIWS Responses

The AIWS believes that the Native American responses for the current GTCC EIS should be presented together with some responses also repeated in relevant sections of the main body of the EIS. Their responses, however, are directed at different sections of this EIS and vary in terms of structure and purpose. The current American Indian text builds upon already established ideas presented in Appendix G (American Indian Writers Subgroup, CGTO 1996), the *2002 Nevada Test Site Supplement Analysis* (United States Department of Energy, National Nuclear Security Administration 2002) and the *2008 Draft Nevada Test Site Supplement Analysis* (United States Department of Energy, National Nuclear Security Administration 2008). This writing procedure reflects the ongoing interest of the CGTO in the activities and potential environmental impacts of NNSA/NSO, and emphasizes the continuity of issues established in the previous documents and again in this SA.

The following text is provided as an appendix of this GTCC EIS. This integrated essay represents the responses of the consulting tribes who have participated for almost 23 years in the NNSA/NSO American Indian Program and who refer to themselves in this consultation as the CGTO. Some portions of the following text are repeated in other sections of this report. The full analysis and text are held together in this section so that the consulting tribes and organizations who will review this document will have a holistic view of the American Indian responses. This report reflects the assessments of the AIWS, but it was technically finalized by the Bureau of Applied Research in Anthropology (BARA) team at the University of Arizona.

1 LAND USE (DaMiDovia "Our Land", Ia-voovTuvipum "Our Land")
2



3
4 **Figure A-1 American Indian Region of Influence for NTS GTCC EIS**

1 The CGTO maintains that members of the consulting tribes have Creation based rights to protect,
2 use, and access lands (Divia, 1 Tuvip, 2) of the NTS and immediate area. These rights were
3 established at Creation and persist forever. During the past decade representatives of the
4 consulting tribes have visited portions of the NTS and have identified places, Puha Paths, and
5 cultural landscapes of traditional and contemporary cultural significance. The managers of the
6 NTS have responded to CGTO requests that portions of these identified areas be set aside for
7 traditional and contemporary ceremonial use. Because this is a public document the exact
8 locations of these areas will not be revealed, however they do include a burial cave, a Native
9 American Graves Protection and Repatriation Act (NAGPRA) reburial area, and a local Puha
10 Path and ceremonial landscape near a large water tank (Stoffle, Evans, and Harshbarger 1989;
11 Stoffle et al. 2001a; Stoffle et al. 2001b; Stoffle, Zedeño, and Halmo 2001; Stoffle et al. 2006).
12 These actions by the agency are in keeping with the persistent recommendations of the CGTO
13 that portions of their holy lands be placed under co-stewardship arrangements. In order to fulfill
14 the holy land use expectations, the members of the consulting tribes of the CGTO recommend
15 continuing to identify special places, Puha Paths, and landscapes and setting aside these places
16 for unique co-stewardship and ceremonial access. For example, currently studies have begun and
17 portions are completed regarding the identification of places, Puha Paths and cultural landscapes
18 in the Timber Mountain Caldera (Stoffle et al. 1994a; Stoffle, Halmo, and Dufort 1994; Stoffle et
19 al. 2001a; Stoffle et al. 2001b; Stoffle, Zedeño, and Halmo 2001; Stoffle et al. 2006). These
20 studies are planned to continue and when completed will add a Native American cultural
21 sensitivity component which will contribute to the currently recognized importance of this
22 National Natural Landmark and Area of Critical Environmental concern.

23

24

25 **Climate**

26

27 CGTO knows that the climate of the region has changed over the thousands of years that the
28 Indian people have lived in this region. The NTS has only occupied this area since the early
29 1940s. It is important to recognize that major climatic changes have taken place since the end of
30 the Pleistocene and shorter term climate changes such as the wet period in the 1980s and 1990s
31 contrast with the current 10-year meteorological drought. It is important for the GTCC EIS to
32 assess the impacts of short term and long term climatic changes because the DOE expects to
33 safely manage these GTCC wastes for up to 10K years during which similar climate changes can
34 be expected.

35

36 The current climate description in the GTCC EIS is specific to the present decade-long period of
37 extended drought (a similar one occurred between 1896 and 1906), so this type of drought and
38 the wet period between 1980s and 1990s may be factors in siting the GTCC facility. An analysis
39 of long term impacts based on current conditions will neither be representative of climate
40 conditions viewed over much longer periods nor applicable to short climate shift to much wetter
41 conditions.

42

43 The CGTO maintains that during the last decade the NTS and surrounding region has
44 experienced a meteorological drought. Current meteorological analysis suggests that this is a 10-
45 year duration type drought and even could be the beginning of a longer drought episode. The
46 region has not experienced a drought with these characteristics since a decade spanning the

1 beginning of the 20th century. Therefore, this meteorological episode can be termed a 100-year
 2 drought. The early 20th century drought becomes an analog against which to discuss the
 3 environmental implications of the current episode (see Figure A-4).

4

5 **The 100-Year Drought (Uh-na-hp dumime sogobe basa-type “A long time our Mother**
 6 **Earth has been dry”, Minga- na-vas-so-quip “very dry land”)**

7

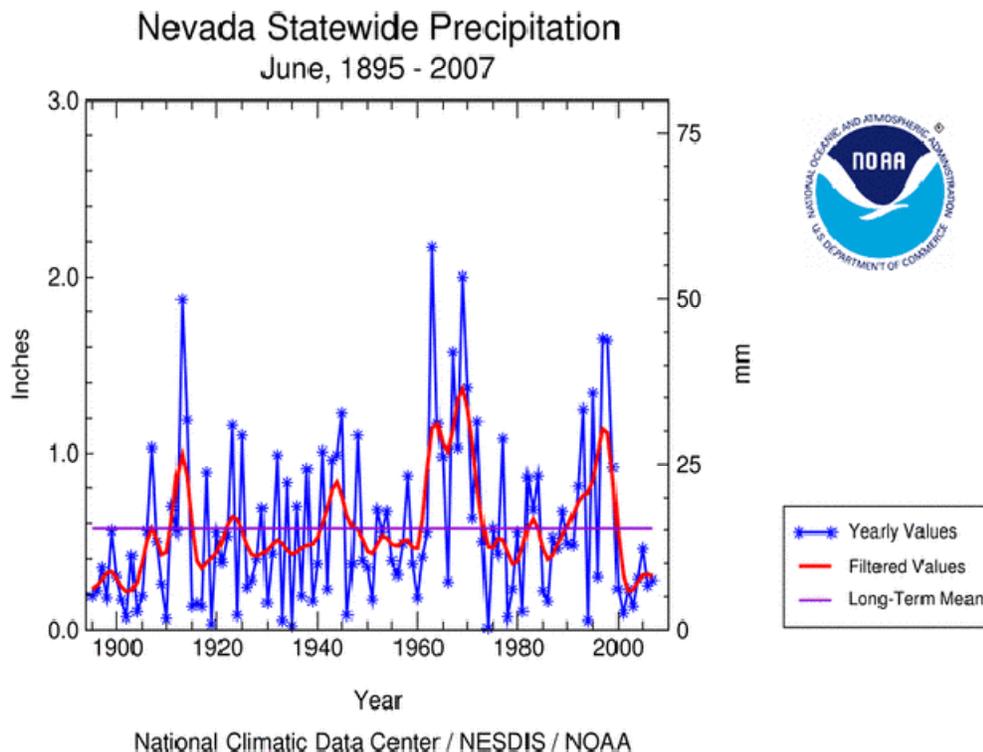
8 Nevada is “much below normal” to date in 2007. As of June 2007, the Palmer Z Index, which
 9 measures short term drought on a monthly scale, indicated that central Nevada, including the
 10 NTS, was in a “severe drought” condition. Data from the National Climatic Data Center shows
 11 that Nevada was ranked the driest state in the U.S. for the period of August 2006 to June 2007.
 12 This period reflects the drought trend in Nevada that has characterized the past decade (Figures
 13 A-1, A-2) (<http://www.ncdc.noaa.gov/oa/climate/research/2007/jun/st026dv00pcp200706.html>).

14

15 On a broad scale, the two previous decades (1980s and 1990s) were unusually wet with
 16 short periods of extensive droughts. The 1930s and 1950s showed the opposite trend with
 17 prolonged periods of extensive droughts and few wet periods
 18 <http://www.ncdc.noaa.gov/oa/climate/research/2007/jun/us-drought.html>.

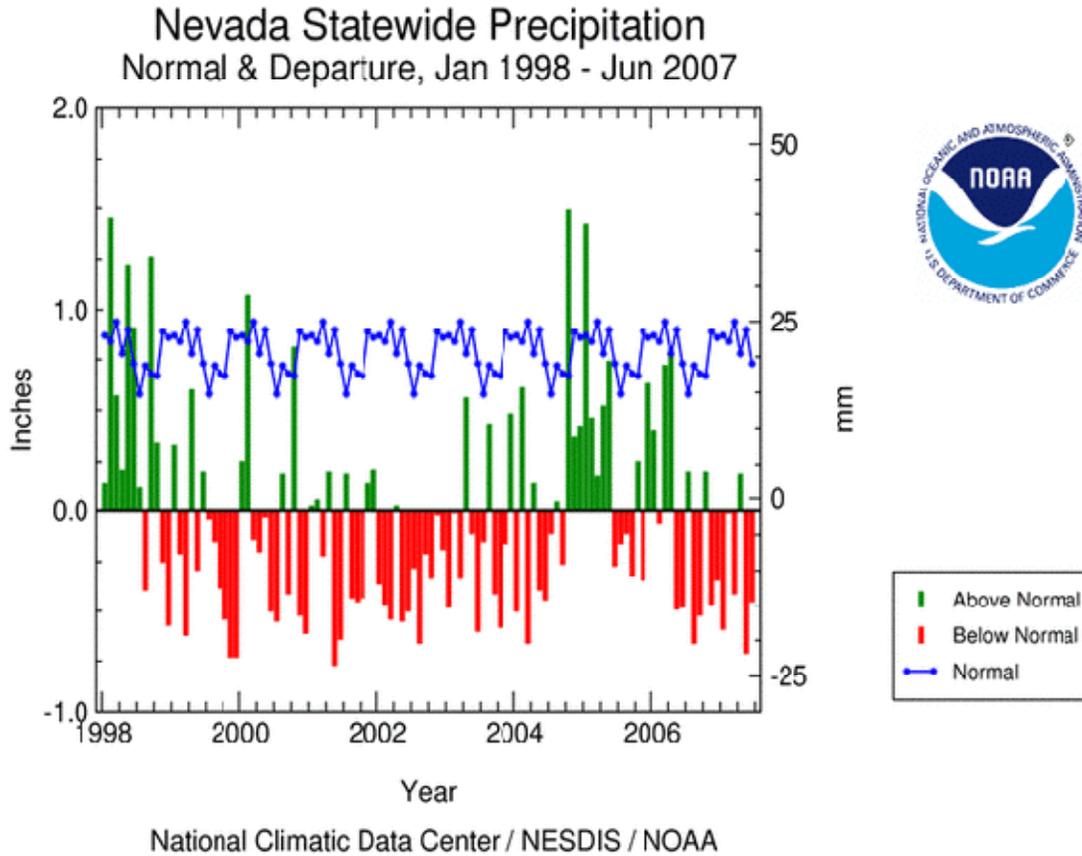
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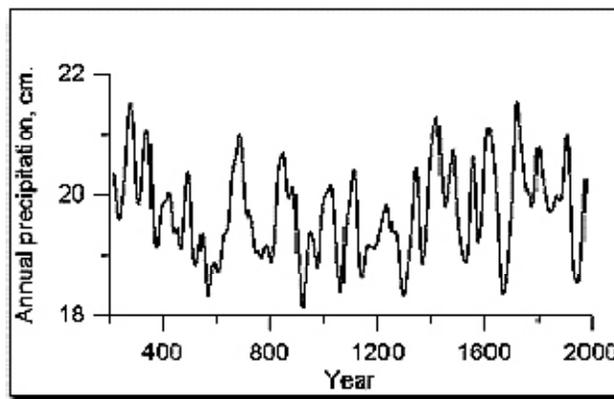
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22 **Figure A-2 One hundred and twelve years of Nevada precipitation averages**



1
2 **Figure A-3 Fluxuations in Nevada statewide precipitation since 1998**

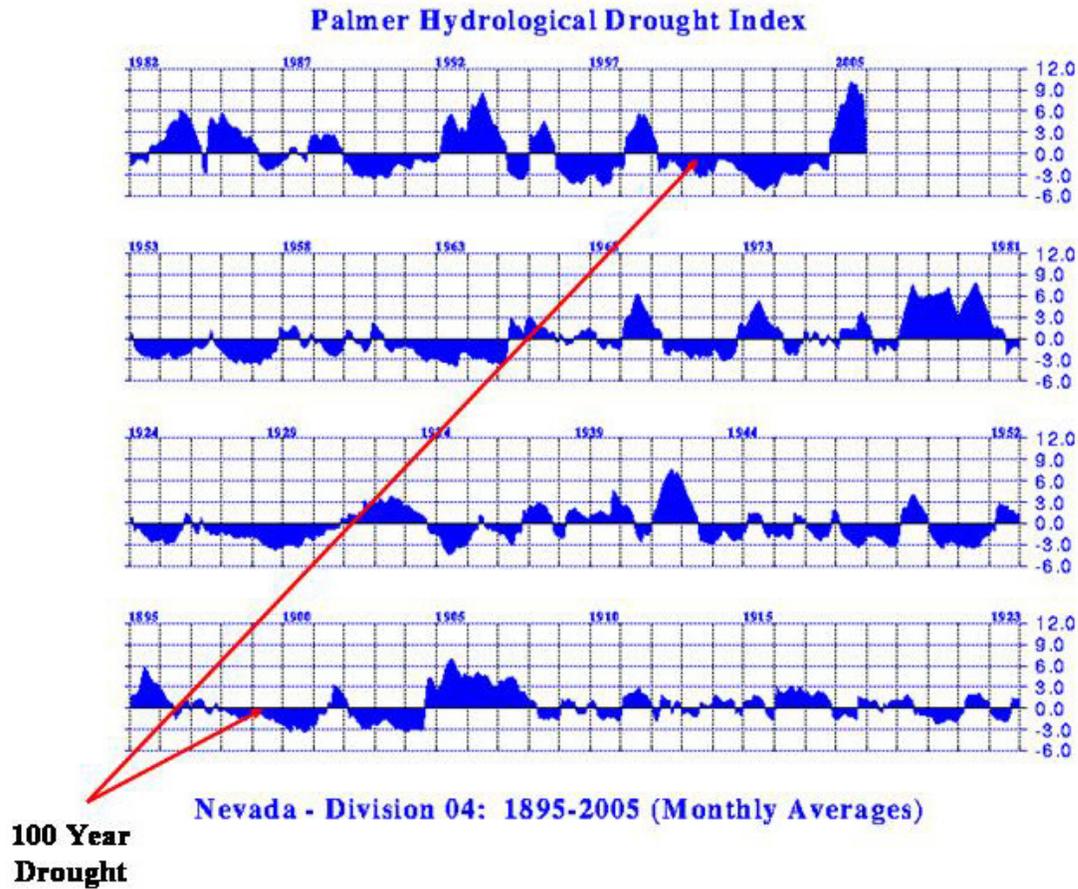
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4 Hughes and Graumlich (1996) reconstructed 7979 years of annual precipitation from bristlecone
5 pine in the White Mountains of eastern California to document the occurrence of eight multi-
6 decadal droughts, with the two most recent centered on 924 AD and 1299 AD (Figure A-3).
7



8
9
10 **Figure A-4 7979 Years of annual precipitation reconstructed from bristlecone pine**

11
12

1 Areas specific to the NTS and southern Nevada are in a 100-year drought cycle; Figure A-4
 2 shows that major drought conditions have occurred in multiyear waves since 1895. The current
 3 drought that is affecting the NTS and its neighboring lands has persisted since 1996 (Goodrich
 4 2007). Researchers think that the rise in greenhouse gases in the atmosphere may lead to a return
 5 of multi-decadal megadrought conditions that existed prior to 1600 AD. The most severe
 6 megadrought occurred between 900 AD and 1300 AD (Cook et al. 2004, Goodrich 2007).
 7



8
9

10 **Figure A-5 Palmer hydrological drought index from 1895-2005 in Nevada – Division 04**

11

12 The CGTO recommends that action be taken to lessen the impacts of this drought cycle through
 13 meaningful research and management applications because there is the potential for irreversible
 14 environmental degradation and biodiversity loss. This type of action is a concept found in social
 15 impact assessment and environmental studies known as the precautionary principle. This
 16 principle implies that there must be a willingness to take action in the advance of scientific proof
 17 or evidence of the need for proposed action. If there is a delay in action, it will be devastating to
 18 both society and nature (Cooney and Dickson 2005). The precautionary principle stresses that
 19 there must be ethical responsibilities towards maintaining the integrity of natural systems, and
 20 the fallibility of human understanding. The CGTO requests that traditional environmental
 21 management practices occur in order to help restore and maintain the ecology of the NTS.

22
23

1 **HYDROLOGY**

2

3 One inevitable implication of the current 100-year drought is that the surface water on the NTS
4 and immediate areas has diminished and become more sporadic. Surface water is here defined as
5 water available for shallow rooted plants during rainfall, water available during post-rain
6 ponding, runoff, and absorption, and water recharged into near-surface aquifers. The
7 modification and availability of surface water has the ability to affect all plants, animals, and
8 associated trophic levels on the NTS.

9

10 **Calling the Rain (Pahwwanipagee “calling the rain”, Oo-wap-pi “calling the rain”)**

11

12 One type of interaction was in the form of calling the rain. Rain calling is a basic aspect of
13 American Indian life and culture. Traditionally there were rain callers (rain shamans, rain
14 doctors), rain ceremonies, and helpers from the spiritual world which would help facilitate rain
15 production. Most traditional communities had a rain maker. When the special rain shaman called
16 upon the rain, he sang songs and was aided by his spirit helper, which was usually in the form of
17 a mountain sheep, to call upon the rain. The mountains had important roles in this activity. They
18 interacted with the clouds and the sky to call down the rain.

19

20 *Winter Ceremonies-Snow Making Ceremonies: Western Shoshone*

21

22 The Winter Ceremony was performed in the fall to ensure that a good winter with heavy snow
23 fall will happen. The spiritual leader (weather doctor) would call the people together and meet at
24 a special place in the mountains, sometimes near a Pine Nut gathering area. Prayers and songs
25 were done by the spiritual leader. Usually this ceremony lasted a day. If too much rain was
26 falling certain precautions would be taken, for example, the children were not allowed to shake
27 willows that would be used for weaving or to kill frogs as this would bring more rain.

28 *Hummingbirds*

29 were not killed for many reasons, but if they were killed, there would be flooding and lightning
30 storms, with lightning killing the person who killed the hummingbird.

31

32 *Stinkbug (Bee-voos, Wu-who-koo-wechuts)*

33

34 Even today, individual traditional native people can bring rain. This is done by turning a
35 stinkbug on his back. The rain will come provided the stinkbug allows a person to tickle his belly
36 with a small stick. As the person prays for rain, he tells the stinkbug why he is asking for rain.

37

38 *Snow Fleas*

39

40 Snow Fleas represent a special category of Native American environmental knowledge because
41 they are almost invisible and live at the highest elevations on mountains. According to Indian
42 beliefs during the late fall when it is cold there is a snow ceremony. A part of this ceremony
43 involves calling on the snow fleas. The snow fleas are the ones that make the snow wet and
44 absorb into the mountain. Without the snow fleas, the snow is dry and evaporates quickly.
45 Without ceremonies and the water making fleas, there is less water for the mountains and the
46 valleys below. The snow ceremony is conducted in relationship with ceremony of the seeds

1 where young girls dance with seeds in winnowing trays and a spiritual person sings songs to
2 bring whirlwinds which envelope the dancers and scatter the seeds as a gesture of fertilizing the
3 earth. Thus, water is brought to the fertile and dispersed seeds.

5 **Ecology Indian Comments**

7 The CGTO knows that this site is an ancient playa, surrounded by mountain ranges. The runoff
8 from these ranges serves to maintain the healthy desert floor. Animals frequent this area, there
9 are numerous animals' trails, and these play a significant part in the history of the locality and of
10 the Indian lifestyles. Our ancestors knew that the Creator always provided for them and this site
11 is one of their favorite places to hunt and trap rabbits. We have special leaders that organized
12 large rabbit hunts. Many people participated so this place would be occupied at times by all
13 kinds of our people. Rabbits provided good eating, bones for tool-making, warm blankets, and
14 even games. Indian people refrained from eating coyote, wolves, and birds but these contribute
15 to our stories which tell us how to behave and why we are here. We have many stories and songs
16 that include animals and birds who have human-like antics. From these antics Indian people
17 learn the life lessons to build character to become better persons. So animals and the places
18 where they live contribute to our history and culture.

20 This culturally central place was used by and important to Indian people from our agricultural
21 and horticultural communities located to the north – near Reese River Valley and Duckwater, to
22 the south – near Ash Meadows, to the southeast – near Indian Springs and Corn Creek, to the
23 east – near the Pahranaagat-Muddy River, and west – near the Oasis Valley. It was also used by
24 people from our agricultural and horticultural communities to the far west in Owens Valley, to
25 the far south near Cottonwood Island and Palo Verde Valley on the Colorado River, to the far
26 southwest at Twenty Nine Palms, to the far east along the Virgin River, Santa Clara River, and
27 Kanab Creeks, to the far north along the Humbolt River and Ruby Valley.

29 *Plants*

31 The CGTO knows based on previous DOE-sponsored ethnobotany studies that there are at least
32 364 Indian use plants on the NTS (see Appendix G). Indian people visiting the proposed location
33 of the GTCC facility identified the following traditional use plants: (1) Indian Tea, (2) White
34 Sage or Winter Fat, (3) Indian Rice Grass, (4) Creosote, (5) Wolfberries, (6) Four O'clock, (7)
35 Spiny Hop Sage, (8) Joshua Tree, (9) Daises, (10) Desert Trumpet, (11) Cholla, (12) Globe
36 Mallow, (13) Fuzzy Sage, (14) Tortoise Food Plant, (15) Sacred Datura, (16) Wheat Grass, and
37 (17) Lichen. Other plants were present but not identified due to the late season and the dry
38 condition of the plants.

40 Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony –
41 both social and healing. The characteristics of the plants at the proposed GTCC area are smaller
42 and thinner than in other desert areas where it is wetter. Indian people from elsewhere traveled to
43 this area to gather specific plants because they have stronger characteristics when they grow in
44 dry places. The sage is used for spiritual ceremonies, smudging, and medicine. The Indian rice
45 grass and wheat grass are used for breads and puddings. Joshua tree is important for hair dye,
46 basketry, foot ware, and rope. Datura is used for hallucinogenic effects during which alternative

1 places can be visited by medicine men. Datura also goes itself to disturbed areas and heals them.
2 The globe mallow had traditional medicine uses, but in recent times is also used for curing
3 European contagious diseases.

4

5 *Animals/Insects*

6

7 The CGTO knows based on previous DOE-sponsored ethnofauna studies that there are at least
8 170 Indian use animal on the NTS (see Appendix G). Indian people visiting the proposed
9 location of the GTCC facility identified the following traditional use animals: (1) Jack Rabbits,
10 (2) Whiptail Lizards, (3) Antelope, (4) Tortoise, (5) Kangaroo Rats, (6) Horned Toad, (7) Rock
11 Wrens, (8) Ravens, (9) Grasshoppers, and (10) Stink Bugs. Other animals (such as snakes, bats,
12 and owls) were perceived to be present but not observed because they primarily emerge at night.

13

14 All animals and insects were and are culturally important and the relationships between them, the
15 Earth, and Indian people are represented by the respectful roles they play in the stories of our life
16 then and now. The GRCC valley is where a spiritual journey occurred. It involved Wolf (*Tavats*
17 in Southern Paiute, *Bia esha* in Western Shoshone, *Wi gi no ki* in Owens Valley Paiute) and
18 Coyote (*Sinav* in Southern Paiute, *Duhvo esha* in Western Shoshone, *Esha* in Owens Valley
19 Paiute) and is considered a Creation Story. Only parts of this can be presented here. When Wolf
20 and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious.
21 Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and
22 tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a
23 beautiful Rainbow (*Paro wa tsu wu nutuvi* in Southern Paiute, *Oh ah podo* in Western Shoshone,
24 *Paduguna* in Owens Valley Paiute). When Coyote saw this special privilege he cried to the
25 Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put
26 Coyote as a fine white mist at the bottom of the Rainbow's arch. This story and the spiritual
27 trails discussed in the full version are connected to the Spring Mountains and the large sacred
28 cave in the Pintwater Mountains as well as to lands now called the Nevada Test Site. This area is
29 the home place of Wolf who is still present and watches over the area and us.

30

31 *Minerals*

32

33 The CGTO knows based on previous DOE-sponsored cultural studies that there are many
34 minerals on the NTS (no complete list available). Indian people visiting the proposed GTCC site
35 identified the following traditional use minerals: (1) Obsidian, (2) Chalcedony, (3) Yellow Chert
36 or Jasper, (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other minerals
37 were perceived to be present but not observed because of the limited time and search area.

38

39 All minerals are culturally important and have significant roles in many aspects of Indian life.
40 For example, the Chalcedony on the proposed GTCC site would have made an attractive offering
41 which would be acquired here by a ceremonial traveler and then left at the vision quest or
42 medicine site located to the north on top of a volcano like Scrugham Peak. Returning ceremonial
43 travelers would also bring offerings back to where they had acquired offering, thus the Yellow
44 Chert or Jasper (observed on the GTCC site) which outcrops about 70 miles to the north would
45 be gathered there and returned to the Chalcedony site as an offering.

46

1 *Playas*

2

3 The CGTO knows, based on cultural studies funded by the DOE on the NTS and playa-specific
4 studies funded by Nellis Air Force Test and Training Range (Henderson 2008), that playas
5 occupy a special place in Indian culture. Playas are often viewed as empty and meaningless
6 places by Western scientists, but to Indian people playas have a role and often contain special
7 resources that occur nowhere else. The following text was prepared by the Indian people who
8 visited the proposed GTCC site.

9

10 Is a playa a wasteland? According to Indian elders playas were used in traveling or moving to
11 places where work, hunting, pine cutting or gathering of other important foods and medicine
12 could be done. One elder remembers crossing over dry lake beds and traveling around but near
13 the edges and they discussed how provisions were left there and at nearby springs (See NRC
14 2009b for additional information about the cultural importance of springs) by previous travelers
15 at camping spots. Indian people left caches in playa areas for people who crossed valleys when
16 water and food was scarce. Frenchmen playa is such a place. Indian people took advantage of
17 traveling through this playa as mountains completely surround this area. The CGTO knows that
18 most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow,
19 California. The Mohave River flows into this dry lake and most of the year it looks dry but it
20 actually flows underground. Building berms on dry lakes beds to offset water and runoff doesn't
21 sound like a good idea to the Indian way of thinking. So why build a GTCC site on and use this
22 playa when the odds of radiation seem feasible? The Indian people who visited this site
23 recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has
24 special meanings. There should be a more descriptive study to fully understand the impacts.
25 More time is needed, also for Indians to revisit this site. Although some people continue to view
26 Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are
27 needed.

28

29 **BIOLOGICAL RESOURCES (Dá Me Na-Nu-Wu-Tsi “Our Relations All of Mother**
30 **Earth”)**

31

32 It is nearly impossible to observe and monitor the changes on cultural resources on the NTS
33 study lands. Some changes occur quickly and certain changes happen slowly. For an example, an
34 earthquake could cause serve damage instantly and the onslaught of impending drought and
35 famine can become a great heavy burden on mankind and his environment.

36

37 The current 100-year drought has increasingly stressed all of the plants and animals on the NTS.
38 Because this is a unique, albeit, perhaps a cyclical event, its environmental impacts are
39 unprecedented in the history of the operation and management of the lands of the NTS. It is
40 expected that the 100-year drought has modified the abundance and distribution of all animals
41 and plants. The quality, quantity, and distribution of indigenous plants necessary to sustain a
42 healthy environment to maintain a productive animal habitat is clearly affected.

43

44 Because Native Americans view the NTS lands as holy lands there is deep concern for it. Certain
45 springs have dried up, which makes animals travel into other districts, makes food foraging
46 difficult, and dries up the land (See NRC 2009b for additional information about the cultural

1 importance of springs). The remaining stressed animals and plants have lower fecundity and
2 nutritional value in the food chain. The CGTO recognizes the nation-wide need to identify and
3 protect threatened and endangered plants and animals.

4
5 The members of the consulting tribes who have lived on these lands since Creation value all
6 plants and animals, yet some of these occupy a more culturally central position in their lives. The
7 main characteristic of a healthy landscape is healthy plants, animals, and visual beauty. The role
8 of land managers is to help care for the land and its ecosystems. Therefore, the CGTO applauds
9 the efforts being designed to minimize the severe impacts of the ongoing drought. Conservation
10 and preservation should become high priority. In order to convey the Native American meaning
11 of these plants, a series of studies were conducted and the findings were negotiated into a set of
12 criteria for assessing the cultural importance of each plant and of places where plant
13 communities exist. The CGTO provided these cultural guidelines so that NEPA analysis and
14 other agency decisions could be assessed from a Native American perspective.

15
16 Because of these stresses, the animals and plants of the NTS require management interventions
17 unforeseen during the 1996 *NTS EIS*. American Indian people have faced such drought episodes
18 in the past and have the capacity to suggest and carry out adaptive responses. Adaptive responses
19 to extreme climatic fluctuations involve both physical and spiritual interventions designed to
20 restore balance and well-being to the area. All tribes involved in the CGTO recognize a range of
21 these interventions, which have been successful in the past. The following are a series of cases
22 that demonstrate how Native American people have interacted with the land and natural elements
23 to help all aspects of life.

24 25 **What is Out There?**

26
27 The CGTO has identified as fundamental in their cultural concern a list of 364 plants and 170
28 animals which were traditionally used and are currently culturally central. Concerns exist that
29 this larger list has been reduced to an official list of 107 plants and 26 animals (see American
30 Indian Writers Subgroup, CGTO 1996: Table G-1, G-2, pp G-14 – G-17, G-18). The CGTO
31 argues that the full list should be used to assess impacts because both plants and animals appear
32 and disappear on the NTS at various seasons and during various climatic episodes. Thus the
33 working list of potentially impacted plants and animals needs to be expanded to the full list of
34 Indian plants and animals. These species have been identified as indicators of the health of NTS
35 ecosystems.

36
37 Native Americans have always been concerned that the native species of vegetation on the NTS
38 may be in danger of being lost. To native people, plants provided most of the food resources as
39 well as the raw materials for medicines, tools, shelter, and even ceremonial objects. Take the
40 tobacco, considered highly sacred, the tobacco plant was carefully cultivated to ensure its
41 posterity. Religious leaders and traditionalists would guard the location for their own use. The
42 plant used properly would bloom and blossom for the user, because it was being utilized
43 appropriately. Other sacred plants were the sage, sweet-grass and cedar. These are considered
44 as gifts from the earth and are to be applied in traditional ceremonies and not for so-called
45 “recreational” purposes. There is much evidence that regaining and reclaiming Indian plant

1 knowledge could benefit humans in many ways. The CGTO would like the land managers of the
2 NTS to implement measures with the goal of restoring lands with native species.
3 Ecosystem health includes the people with whom the natural environment developed,
4 specifically, the member tribes of the CGTO. By involving the CGTO in the design,
5 implementation, and analysis of the biological surveys, NNSA/NSO can obtain more
6 comprehensive reports of ecosystem health and potential impacts, as well as further facilitate
7 government-to-government consultation with the CGTO.

8

9 **Environmental Justice**

10

11 The CGTO would like to have their DOE approved definition of Environmental Justice added to
12 the current Environmental Justice description.

13

14 DOE has recognized the need to address environmental justice concerns of the CGTO based on
15 disproportionately high and adverse impacts to their member tribes from DOE NTS activities. In
16 1996, the CGTO expressed concerns relating to environmental justice that included 1) damage to
17 Holy Lands, 2) negative health impacts, and 3) lack of access to traditional places that
18 contributes to breakdowns in cultural transmission. In the 2002 NTS SA, NNSA/NSO concluded
19 that with the selection of the Preferred Alternative, the CGTO would be impacted at a
20 disproportionately high and adverse level consequently creating an environmental justice issue.
21 Since 2002, NNSA/NSO has supported a few ethnographic studies involving the CGTO and
22 culturally important places including in 2004, when NNSA/NSO arranged for tribal
23 representatives to conduct evening ceremonies at Water Bottle Canyon. While the opportunity
24 for the evening ceremony was a significant accommodation, disproportionately high and adverse
25 impacts from DOE NTS activities continue to affect American Indians. The three environmental
26 justice issues noted by the CGTO need to be addressed.

27

28 The CGTO is the voice for acclaiming the responsibility of maintaining stewardship with the
29 land for all Native American Indian Tribes. The bonding is a privilege to be faceted above all
30 else and must be carried and held by enabling principles. The CGTO believes this right was
31 given to them at Creation and must be followed. Otherwise, the networking of the other spirit
32 world will be severed. The CGTO knows there are places on the NTS landscape that needs
33 traditional ceremonies and blessings to offset the tensions of severe land disturbances done to it.
34 An example is Shoshone Mountain. Shoshone Mountain is large and long. Roads are limited to
35 its crest making it inaccessible for religious and traditional people to go there to conduct
36 ceremonies. The CGTO recommends that special privileges be allowed for ceremonial journeys
37 to take place and to provide funding for transporting traditional leaders to inaccessible places
38 such as Shoshone Mountain by helicopter to perform ceremonies.

39

40 *Environmental Justice and the Ruby Valley Treaty of 1863*

41

42 The CGTO supports the efforts of the Western Shoshone to have the Ruby Valley Treaty of
43 1863 be fully recognized as originally intended. Previously, DOE/ NNSA has relied on the
44 Supreme Court Decision of U.S. v. Dann as a means of abrogating their trust responsibilities.
45 The focus of this case dealt with trespass violations associated with grazing cattle on government
46 land. In the opinion of the Western Shoshone people, this treaty of peace and friendship is still in

1 full force and affect. Subsequent, to this court decision, the Western Shoshone Nation brought
2 the matter before the United Nations and the Organization of Human Rights in Geneva,
3 Switzerland. On January 9, 2003, the Inter-American Commission on Human Rights rendered its
4 final decision in the case of Western Shoshone land rights in favor of Mary and Carrie Dann.
5 This international body found the actions of the U.S. Government to be in violation of Western
6 Shoshone rights with regard to property, due process, and equality under the law.

7
8 In 2004, the United States attempted to bring closure to the Western Shoshone claims by offering
9 compensation. This highly controversial action has not affected nor diminished the aboriginal
10 claims of the Western Shoshone to the land. It is maintained in previous EIS documents that the
11 United States has failed to uphold its trust responsibility and negotiate further with the Western
12 Shoshone Nation. No nation to nation discussions as promulgated under federal law have
13 occurred. In this regard, the Western Shoshone Nation should receive equal treatment as afforded
14 to other countries.

15
16 In March 2005, the Western Shoshone Nation filed a lawsuit against the DOE for the siting of a
17 High-Level Nuclear Waste and Spent Nuclear Fuel Underground Geologic Repository at Yucca
18 Mountain. It is the position of the Western Shoshone that such action being proposed by the
19 DOE violates the terms and conditions of the Ruby Valley Treaty of 1863. At this current time,
20 all activities at Yucca Mountain have been suspended as ordered by President Obama. Despite
21 this freeze, the CGTO recommends that the DOE abide by the treaty as originally intended.

22 23 **Transportation**

24
25 The transportation of low level radioactive waste (LLRW) was a major issue originally
26 addressed in Appendix G of the 1996 EIS. The AIWS addressed serious flaws in the then draft
27 transportation study by noting that neither the CGTO nor the tribes were consulted formally. The
28 tribes were only informed of the matter through a series of public meetings, which the AIWS
29 viewed as a violation of federal legislation requiring government to government consultation.
30 The AIWS also detected limited and faulty assessments of new railroads and other activities on
31 cultural and Native American resources. The study documents revealed missing or misnamed
32 Indian tribes and reservations therefore, the AIWS recommended a systematic comprehensive
33 study of American Indian transportation issues to complete the general study that incorporated
34 concerns of “stakeholders.”

35
36 *Native Americans Respond to the Transportation of Low Level Radioactive Waste to the Nevada*
37 *Test Site (Austin 1998)*

38
39 On July 25, 1996, the DOE/NV sent a letter announcing a comprehensive Native
40 American LLRW study and requested tribal participation. The five members of the AIWS who
41 recommended the study participated in a planning team and formed the core of the American
42 Indian Transportation Committee (AITC). The planning team began by meeting with DOE/NV
43 officials to determine which proposed transportation routes were under consideration. A study
44 proposal was developed and three criteria were determined that needed to be met by each tribe
45 invited to participate in the study. The criteria were aboriginal and/or historic cultural affiliation

1 to the lands along any of the three proposed routes, location near any of the three proposed routes
2 in the vicinity of Nevada, and frequent use of the proposed routes by tribal members.

3
4 In addition to the regular CGTO members, the AITC planning team identified six
5 additional Western Shoshone tribes, bands, communities, and organizations, as well as Mohave,
6 Hopi, Navajo, and Goshute peoples all of whom met the criteria for participation in the study. A
7 total of 29 tribes, subgroups, bands, communities, and organizations were potentially affected by
8 the transportation of LLRW.

9
10 This study addressed perceived risks by American Indians that derive from the
11 transportation of LLRW. It focused on three truck haul routes as these pass through in a four-state
12 area that generally reflects the administrative responsibility of the DOE/NV. The study involved a
13 series of unique methods including both quantitative and qualitative data collection. The study
14 documented that radiation is perceived as an Angry Rock by many Indian people. It exists and acts
15 according to epistemological guidelines that do not reflect those perceived as existing in Western
16 science. This is an extremely important finding because American Indian responses to radioactivity
17 reflect its spiritual as well as its physical dimensions (Austin 1998).

18
19 **U.S. DOE Nevada Operations Office, Intermodal Transportation of LLRW to the Nevada**
20 **Test Site, Summary of Meeting with Native Americans, November 18 to 20, 1998, Tonopah,**
21 **NV (American Indian Transportation Committee 1998)**

22
23 While the initial Native American LLRW study was being completed, the DOE decided to
24 conduct an Environmental Assessment of the Intermodal Transportation of Low Level Radioactive
25 Waste (IM EA). Intermodal refers to the use of both railroad and trucks to haul LLRW from its
26 producers to the NTS. The intermodal study introduced the concept of an entrepot (a trans-
27 shipment facility) where LLRW would be taken from railroads, perhaps stored for a period of time,
28 and then reshipped via truck to the NTS. The DOE asked the members of the AITC to take the
29 findings from the Austin report and any pertinent previous studies and apply them directly to the
30 IM EA. This task was accomplished at a meeting held in Tonopah, Nevada and resulted in a report
31 entitled *U.S. DOE Nevada Operations Office, Intermodal Transportation of LLRW to the Nevada*
32 *Test Site, Summary of Meeting with Native Americans, November 18 to 20, 1998, Tonopah NV*
33 *(American Indian Transportation Committee 1998).*

34
35 **American Indian Transportation Committee Field Assessment of Cultural Sites Regarding**
36 **the U.S. Department of Energy Pre-approval Draft Environmental Assessment of Intermodal**
37 **Transportation of Low-Level Radioactive Waste to the Nevada Test Site (American Indian**
38 **Transportation Committee 1999)**

39
40 The AITC concluded that the Austin study (1) was not designed to assess specific locations
41 along its study-area highways, (2) the IM EA was considering some highway routes that had not
42 been considered in the Austin study, and (3) the IM EA raised the issue of potential LLRW
43 impacts along railroad routes. The AITC thus recommended to the DOE/NV that they support the
44 AITC to conduct on-site studies along the new highway routes. This request was resulted in a
45 formal research proposal submitted to the DOE on December 22, 1998. The proposal was funded
46 on January 4, 1999. The AITC went into the field on January 11, 1999 and worked continuously

1 until January 21, 1999. The direct field observations of the AITC during this period of study were
2 the foundation for their summary of findings.

3
4 The study was guided by a series of agreed to methods for collecting data. Given the great
5 distances and the time needed to assess each place visited along the proposed routes, it was agreed
6 by the AITC that two kinds of site evaluations would be conducted. The first is a complete site
7 evaluation and the second was called a mini-site evaluation. Each had his/her own forms and each
8 AITC member filled out one or the other form at each site that was identified along the proposed
9 routes. At the end of three days of site visits, the AITC spent one day writing the results of their
10 evaluations. These site descriptions and evaluations were fully discussed by the AITC; therefore,
11 the text provided in this summary of findings has been agreed to by the entire AITC.

12
13 A total of 25 sites were evaluated by the AITC. The sites were dispersed across an
14 extensive area within the previously established region of influence, from Moapa and Caliente,
15 Nevada in the east, to Barstow, California in the west. This vast stretch of land contained a large
16 variety of culturally significant Indian places. Cultural resources and cultural landscape features
17 were identified and evaluated; these included mountains, valleys, springs, trails, a variety of plants
18 and animals, archaeological remains, storied rocks, rivers, and urban communities considered
19 important to Numic and Yuman speaking peoples.

20
21 Comments and concerns made for the places visited and the associated resources, as well as
22 Indian socioeconomics and environmental justice were edited and integrated into the existing pre-
23 approval draft IM EA text sections. Also recommendations pertaining to further Native American
24 input and assessments as part of the EA process were made to the DOE (Arnold et al. 1999).

25
26 *Confronting the Angry Rock: American Indians' Situated Risks from Radioactivity* (Stoffle and
27 Arnold 2003)

28
29 This article synthesized the key findings from the previous transportation studies by
30 discussing Numic-speaking peoples' epistemological views towards radioactive materials and how
31 it could impact places and resources on traditional lands. The article framed the discussion in terms
32 of perceived risks from the transportation of radioactive waste. As mentioned earlier, Numic-
33 speaking people view radioactive material as an angry rock and they have possessed this
34 knowledge and have used this rock for thousands of years. The angry rock is a powerful spiritual
35 being that is a threat that cannot be controlled nor contained through conventional means. It has the
36 power to pollute places, food, and medicines thus they cannot be used afterwards by Indian people.
37 The angry rock also has the ability to cause serious spiritual impacts. The transportation of the
38 angry rock along the highways poses threats to areas like Animal Creation places (the Red Tail
39 Hawk Origin Site), access to spiritual beings (Potato Woman), human souls that have not been
40 sung to the afterlife (Hiko Massacre Site), and ceremonial areas (Black Canyon, Pahrnagat
41 Valley).

42
43 The findings presented in this article demonstrate that American Indian risk perceptions are
44 real and need to be understood as calculated risks. Also the shared cognitions of risk among people
45 who share a common culture raise questions of alternative epistemologies which are not normally
46 addressed in risk assessments. The article concluded with thoughts on the "logical step" towards

1 addressing risk. There is a need to afford special protection for Indian people and their connected
2 environment and allow the reestablishment of this relationship (Stoffle and Arnold 2003). The
3 AIWS addresses this issue directly in the Biological Resources and Environmental Justice sections
4 of this essay.

5
6 *The Angry Rock*

7
8 The CGTO knows that radiation can be and is viewed from both a western science and a Native
9 American perspective. These alternative and competing perspectives are key for understanding
10 the cultural foundations of American Indian responses to the mining, processing, use,
11 transportation, and disposal of radioactive materials. At some level of analysis from an Indian
12 perspective, all radioactive waste is basically the same problem to Indian people. Subtle
13 differences in classification from a Western science perspective of radioactive waste only mask
14 and do not significantly modify the basic cultural problems of radioactive waste for Indian
15 people and their traditional lands.

16
17 The Angry Rock is a concept used by Indian people, involved in DOE funded radioactive waste
18 transportation and disposal studies, to quickly summarize the complex cultural problems
19 associated with what happened to this known mineral when it was improperly taken and used by
20 non-Indians. The notion of an Angry Rock is premised on the belief that all of the earth is alive,
21 sentient, speaks Indian, and has agency. When the elements of the earth are approached with
22 respect and asked for the permission before being used they share their power with humans. The
23 reverse occurs when they are taken without permission – they become angry withhold their
24 power and often using it against humans. Thus, uranium is an Angry Rock. Uranium has been
25 known and carefully used by spiritual specialists and medicine persons for thousands of years
26 (Lindsay et al. 1968). The following American Indian elder quote from a DOE funded report
27 (Austin 1998) begins to explain this perspective:

28
29 *We are the only ones who can talk to these things. If we do not make sure that we talk to those*
30 *things, then they are going to give us more bad harm, because it is already happening*
31 *throughout the country. Those are the reasons why the Indian people say ... like uranium for one,*
32 *uranium was here since the beginning of this Earth, when it was here we knew uranium at one*
33 *time. And still it is used, but then they got a hold of it and made something else out of it. Now it*
34 *is a man made thing, and today it accumulates waste from nuclear power plants, it accumulates*
35 *more, it has its own life. Radiation has said to us at one time "If you use me make sure you tell*
36 *me before you use me why you are going to use me and what for. " And we never said anything*
37 *to that uranium at all, and we put something else in there with it, which shouldn't belong with it.*
38 *It gives it more power to eliminate the life, of all living things on this planet of ours. Those are*
39 *the reasons, why the Indian people always say, and I know because I have been there. The rocks*
40 *have a voice...*

41
42 Although from a Western science perspective radiation can be isolated and contained by
43 conventional techniques, the Angry Rock has the power to move and cannot be contained by
44 barriers. Indian people who have dealt with the Angry Rock for thousands of years note that
45 there are traditional ways to deal with the uranium the natural rock if used by trained Indian
46 specialists, but these may or may not work with the Angry Rock of modern radiation waste.

1

2 Another elder noted:

3

4 *Songs ... we are the ones who should be talking to those things. Radiation is going to take all of*
5 *our lives, it is continuously moving over the land. The land don't want it, nobody wants it. And*
6 *today, we are doing a bad thing by using radiation on each other. Radiation is something that*
7 *should not be used to kill animal life...*

8

9 Another elder noted:

10

11 *And can it be contained? As it's transformed it can be, I think it can be contained physically but*
12 *not spiritually, and again I think spiritually as it's been altered because it's in that energy field*
13 *because it's been altered. The spirit, that's where it can do its harm in an altered form. It doesn't*
14 *do any good to anybody. And there you're just in the wrong place in the wrong time, it does*
15 *influence plants and animals, minerals and air, the spirit of any area it passes through. The*
16 *reason somebody is sick. I don't think it's necessary to talk about how each one of these is*
17 *influenced, it just is.*

18

19 Another elder noted:

20

21 *As far as the transportation of waste there's a lot of unknowns and we don't know what the*
22 *consequences are. We know there are many sicknesses that come out from people that have been*
23 *contaminated by nuclear waste and as far as Indian people go, we show respect to the land,*
24 *show respect to other people, for the animals, the plants, the rocks. The power of the rock – Just*
25 *looking at Chemehuevi Mountain, it's a very spiritual mountain from this perspective right here.*
26 *When I look out towards the mountains and I don't just see a mountain, I see a place of power, I*
27 *see a place where I can go and meditate and speak with the Creator directly and ask for prayers*
28 *and blessings for people directly. Just like anything else, you have to give prayers all the time*
29 *because the creator is here to watch and protect over us. I feel that we wouldn't have come this*
30 *far if he wasn't here to watch over us and we are here to pray and we are here to protect the*
31 *other resources.*

32

33 Another elder said:

34

35 *I can envision the animals standing back once it goes through for the first time and they*
36 *recognize that there's a danger that they would move away because of fear. That they would no*
37 *longer be there and that there's something bad coming down the road and they disperse and*
38 *move away into different corridors. Kind of like a dust storm, they disperse and move further and*
39 *further away. I see it from the animals' standpoint, they're a lot smarter than us and they've been*
40 *doing this for longer than us and their senses are more keen and I think the animals would get*
41 *back and it would create dead zones throughout the country. Through these corridors or*
42 *transportation routes of course at the site there will be those that are curious who want to go see.*

43

44 Another elder said:

45

46 *I don't know what you would do with this rock if it's angry and this is its way of rebelling, getting*

1 *back. I think as a Native American I would backstep and ask for forgiveness. Sometimes*
2 *forgiving is not very easy because there's sacrifices we have to make and there's consequences ...*
3 *I don't think it can be done as a group, it's an individual thing and each one of us has to go*
4 *back and ... ask for forgiveness for what has taken place. It's not just only that I think it's going*
5 *to be more complicated than going out into the mountains and saying, "hey, I'm sorry, I won't do*
6 *this, I won't do that and I won't bother you anymore. There's a lot of other things that need to be*
7 *forgiven. The rock is the most precious and it's the largest and it's the one that needs to be*
8 *forgiven the most. There's a lot of small forgiveness that have to be given before the large rock. I*
9 *think it's a stepping stone...*
10 *... the rocks are angry, yes, they're striking out saying "don't do this to me, don't touch me, don't*
11 *let this happen. " In a sense you look at it from a spirituality standpoint, it's the spirits of Mother*
12 *Earth telling us don't mess with Mother Earth.*

13
14 It remains a matter of debate as to whether traditional means of placating powerful rock-based
15 forces can be used to control or placate radioactive waste. Western scientists have created a
16 problem for Indian people that, despite being very critical to their future, is not easily resolved.

17 **Cultural Resources**

18
19
20 The CGTO affirms a commitment to assisting the archaeology program by providing CGTO
21 appointed tribal monitors. These monitors are provided approved guidance and training by the
22 CGTO as well as extensive project orientation by the professional archaeologists. Monitors are
23 trained so they know certain appropriate cultural responses to materials identified during
24 archaeological survey, but they recognize that certain kinds of cultural resources require spiritual
25 specialists who are then called in to evaluate and respond to newly identified cultural resources.
26 In cases where NAGPRA relevant resources are identified then the CGTO is contacted and will
27 set into motion NAGPRA inadvertent discovery protocols (NAGPRA 1990; Stoffle, Halmo, and
28 Dufort 1994; Stoffle, Zedeño, and Carroll 2000). At the end of the monitoring experience, each
29 monitor provides his or her own personal notes and experiences for a summary report that is
30 prepared and submitted to the CGTO.

31
32 The CGTO knows the distribution and density of known archaeology sites has not significantly
33 changed since the 1996 NTS EIS. They know the largest number of recorded cultural resources
34 is in the northwest part of the NTS, on and around Jackass Flats, Yucca Mountain and Shoshone
35 Mountain. The reason for this is because numerous activities were conducted on those portions
36 of the NTS within the last 10 years, less attention has been directed to these regions and adverse
37 impacts has been minimized. While this lapse is occurring, NTS decision-makers may consider
38 conducting new projects and investigations. The CGTO recommends that prior to land
39 disturbances of projects a timely American Indian Assessment be completed.

40 41 **Types of American Indian Resources**

42
43 The CGTO knows, based upon its collective knowledge of Indian culture and past American
44 Indian studies, that American Indian people view cultural resources as being integrated. Thus
45 certain systematic studies of a variety of American Indian cultural resources must be conducted
46 before the cultural significance of a place, area, or region can be fully assessed. Although some

1 of these studies have been conducted, in other areas studies have not begun. A number of studies
2 are currently planned. Indian people can fully assess the cultural significance of a place and its
3 associated natural and cultural resources when all studies have been completed and our
4 governments and tribal organizations have reviewed the recorded thoughts of our elders and have
5 officially supported these conclusions. American Indian studies focus on one topic at a time so
6 that tribes and organizations can send experts in the subject being assessed. The following is a
7 list of studies for a complete American Indian assessment:

- 8
- 9 • Ethnoarchaeology – the interpretation of the physical artifacts produced by our Indian
10 ancestors.
- 11
- 12 • Ethnobotany – the identification and interpretation of the plants used by Indian people.
- 13
- 14 • Ethnozoology – the identification and interpretation of the animals used by Indian people.
- 15
- 16 • Storied Rocks – the identification and interpretation of traditional Indian paintings and
17 rock peckings.
- 18
- 19 • Traditional Cultural Properties – the identification and interpretation of places of central
20 cultural importance to a people, called Traditional Cultural Properties; often Indian
21 people refer to these as “power places.” Native American Indian properties and
22 interpretations shall be determined by Native American spiritual person when:
 - 23 ○ Cleansing (removing negatives)
 - 24 ○ Purifications/preparations (repatriations and related issues).
- 25
- 26 • Ethnogeography – the identification and interpretation of soils, rocks, water, and air.
- 27
- 28 • Cultural Landscapes – the identification and interpretation of special units that are
29 culturally and geographically unique areas for American Indian people.
- 30

31 When all of these subjects have been studied, then it will be possible for American Indian people
32 to assess three critical issues: (1) What is the natural condition of this portion of our traditional
33 lands? (2) What has changed due to DOE activities? And (3) What impacts will proposed
34 alternatives have on either furthering existing changes in the natural environment or restoring our
35 traditional lands to their natural condition? Indian people believe that the natural state of their
36 traditional lands was what existed before 1492, when Indian people were fully responsible for
37 the continued use and management of these lands. The NTS and nearby lands were central to the
38 Western Shoshone, Owens Valley Paiute, and Southern Paiute people. The lands were central in
39 the lives of these people and so were mutually shared for religious ceremony, resource use, and
40 social events (Stoffle et al. 1990a and b). When Europeans encroached on these lands, the
41 numbers of Indian people, their relations with one another, and the condition of their traditional
42 lands began to change. European diseases killed many Indian people; European animals replaced
43 Indian animals and disrupted fields of natural plants; Europeans were guided to and then
44 assumed control over Indian minerals; and Europeans took Indian agricultural areas. Despite the
45 pollution and destruction of some cultural resources and the physical separation from the NTS

1 and neighboring lands, Indian people continue to value and recognize the central role of these
2 lands in their continued survival.

3
4 Recognizing this continuity in traditional ties between the NTS and Indian people, the DOE in
5 1985 began long-term research involving the inventory and evaluation of American Indian
6 cultural resources in the area. This research was designed to comply with the American Indian
7 Religious Freedom Act (AIRFA), which specifically reaffirms the First Amendment of the U.S.
8 Constitution rights of American Indian people to have access to lands and resources essential in
9 the conduct of their traditional religion. These rights are exercised not only in tribal lands, but
10 also beyond the boundaries of a reservation (AIRFA 1978; Stoffle et al. 1994; Stoffle, Halmo,
11 and Dufort 1994). To reinforce their cultural affiliation rights to prevent the loss of ancestral ties
12 to the NTS, 17 tribes and organizations have aligned themselves to form the CGTO. This group
13 is formed by officially appointed representatives who are responsible for representing their
14 respective tribal concerns and perspectives. The CGTO has established a long standing
15 relationship with the DOE. The primary focus of the group has been the protection of cultural
16 resources.

17
18 The DOE and the CGTO have participated in cultural resource management, including the Yucca
19 Mountain Project (Stoffle 1987; Stoffle, Evans, and Halmo 1988; Stoffle, Olmsted, and Evans
20 1988; Stoffle, Evans, and Harsbarger 1989; Stoffle et al. 1989; Stoffle, Halmo, and Olmsted
21 1990; Stoffle et al. 1990a; Stoffle et al. 1990b; Stoffle and Evans 1988; Stoffle and Evans 1990;
22 Stoffle and Evans 1992), the Underground Weapons Testing Project (Stoffle et al. 1994), the
23 Rock Art Study (Zedeño et al. 1999), the Water Bottle Canyon Interpretation and Traditional
24 Cultural Property Study (Arnold et al. 1998; Stoffle, Van Vlack, and Arnold 2005) and the
25 Timber Mountain Caldera Study (Stoffle et al. 2006). These studies are used in this GTCC EIS,
26 along with the collective knowledge of the CGTO, as the basis of the comments in the 1996 NTS
27 EIS, 2002 NTS SA, and the current SA. The cultural resource management projects sponsored
28 by the DOE have been extremely useful for expanding the inventory of American Indian cultural
29 resources beyond the identification of archaeological remains and historic properties.

30 31 **Visual Resources**

32 Views are important cultural resources that contribute to the location and performance of
33 American Indian ceremonialism. Views combine with other cultural resources to produce special
34 places where power is sought for medicine and other types of ceremonies. Views can be of any
35 landscape, but more central viewscapes are experienced from high places, which are often the
36 tops of mountains and the edges of mesas. Indian viewscapes tend to be panoramic and are
37 special when they contain highly diverse topography. The viewscape panorama is further
38 enhanced by the presence of volcanic cones and lava flows. Viewscapes are tied with songscapes
39 and storyscapes, especially when the vantage point has a panorama composed of multiple
40 locations from either song or story. Key to the Indian experience of viewscapes is isolation.
41 Successful performance of ceremonies (whether by individuals or groups) is often
42 commemorated by the building of rock cairns and by storied rocks and paintings. The CGTO
43 tribes recognize the cultural significance of viewscapes and have identified a number of these on
44 the NTS. The Timber Mountain Caldera contains a number of significant points with different
45 panoramas, including Scrugham Peak-Buckboard Mesa and the Shoshone Mountain massif.

46

1

2 Waste Management

3

4 The CGTO requests an analysis of the hydrological and ecological impacts of the existing water
5 diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE
6 recognizes that this is a very flood prone area, with major flooding episodes occurring about
7 every 23 years. Indian people visiting this site observed that even though the current dike has
8 been built recently and thus not experienced a 23-year flood, it has diverted and consolidated
9 sufficient runoff that a small arroyo has been established. The Indian people visiting this site
10 believe that the existing dike has unnaturally stressed down-slope plants and animals who now
11 do not receive normal sheet runoff. The Indian people visiting the site believe that by
12 concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet
13 runoff because the consolidated runoff moves more quickly and only flows in the new and
14 developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC
15 facility to be established east of the current RWMC then the dike would necessarily have to be
16 extended causing an even greater runoff shadow and an even greater developing arroyo. The
17 desert tortoise in the area will have to move out of this larger runoff shadow and may be
18 concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will
19 expose them to higher levels of radioactivity. The Indian people visiting the site believe that
20 these current and potential impacts should be analyzed, monitored by Indian people, and reported
21 back to the CGTO at the next annual meeting.

22

23 NTS Waste Management in Perspective

24

25 After 11 years of formal transportation studies the CGTO continues to have reservations in
26 regards to the storage of low-level and other hazardous wastes at the NTS and the transportation
27 of low-level waste to the NTS for storage. The CGTO still maintains that what was suggested 11
28 years ago still exists and affects cultural resources. Disposal diminishes the potential for
29 visitation by members of the CGTO representatives and other Indian people.

30

31 The CGTO still believes that the waste should be disposed of in a culturally appropriate manner
32 and that the transportation of low-level radioactive waste poses risks to the people and the
33 environment. Previous reports on this issue document the extent and depth of our concerns for
34 these issues (American Indian Transportation Committee 1998; Arnold et al.1997; Austin 1998;
35 Stoffle and Arnold 2003). Waste disposal activity on the NTS is still ongoing in regards to non-
36 Nevada low-level radioactive waste. The NTS presently uses the Disposal Crater Complex,
37 which is expected to close by 2010. Although the NTS has future low-level radioactive waste
38 disposal pits on standby, there is a possibility that additional craters would need to be developed.
39 Disposal of the following materials is performed at the NTS: Nevada-generated low-level
40 radioactive waste, mixed low-level radioactive waste, greater confinement disposal waste,
41 asbestiform low level radioactive waste, Nevada-generated mixed waste and transuranic waste,
42 mixed transuranic waste. These materials are stored on-site until shipped elsewhere. The CGTO
43 remains on record as opposed to this type of practice as it potentially will limit cultural activities
44 involving the Indian tribes.

45

46

1 Cumulative Impacts

2

3 Cumulative Impacts are key to the various Indian peoples connected to the NTS and specifically
4 the proposed GTCC waste facility in Frenchman Flats. These issues have been discussed for
5 more than 13 years with the DOE (See American Indian Writers Subgroup, CGTO 1996) but it
6 remains unclear the extent that the process of negative impacts to Indian people and culture has
7 been mitigated by DOE actions. Still some progress has occurred through appropriate
8 consultation with the CGTO and their subsequent involvement in the identification and
9 management of cultural resources (see earlier discussion of what Indian people define as cultural
10 resources).

11

12 According to the CGTO tribes, increased land disturbances associated with all forms of activities
13 and development on the NTS could result in a decrease in access to these areas for American
14 Indians. Limiting access could reduce the traditional use of the NTS and other areas and affect
15 their sacred nature. Increased development at the NTS could increase the potential for greater
16 disturbance and vandalism of American Indian cultural resources. The CGTO tribes believe (See
17 Appendix G – AIWS 1996) that cumulative impacts in the following areas may occur:

18

19 • *Holy land violations.* Further destruction of traditional cultural sites, making the water
20 disappear, general treatment of the land without proper respect.

21

22 • *Cultural survival.* Decreased ability and access to perform ceremonies.

23

24 • *Environmental restoration.* Revegetation of restored lands with native species.

25

26 • *Empowerment process.*

27

28 • *Radiation risks.* These risks began with nuclear testing. Today, the CGTO tribes perceive
29 that the radioactive risks continue in known and unknown ways underground.

30

31 Over the past 17 years of regular consultation between the NNSA/NV and the CGTO tribes,
32 there has been a growing co-management role for the tribes. Their recommendations have been
33 heard and, for the most part, responded to by the NNSA/NV. Indian access to places on the NTS
34 has increased, after an early period of access loss. Unfortunately, each new program that is added
35 to the NTS decreases the amount of space that is available for the practice of Indian religions,
36 ceremonies, and cultural persistence. However, having no programs also can have an impact. For
37 example, even though the mesas are now accessible to Indians for ceremonies, the roads are not
38 maintained because there are no projects on the mesas. This makes access to the ceremonially
39 important areas difficult.

40

41 There are still ongoing risks to Indian people from storage and disposal of waste and these will
42 continue. Finally, transportation of radioactive materials is continuing and increasing. It is not
43 clear to the CGTO tribes that, after two American Indian studies of radioactive waste
44 transportation, there has been a meaningful consideration of their concerns. It is not clear to what
45 extent further radioactive waste disposal at the proposed GTCC facility will do to increase

- 1 radiation risks to the physical and spiritual dimensions of Frenchman Playa area but some
- 2 assessment is possible by Indian religious leaders.
- 3

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GTCC Waste Repository

Nez Perce Tribe Narrative for EIS

Department of Energy, Hanford Site

2009

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4
5

1 INTRODUCTION

2 **Nez Perce History and Perspective**

3 **Preparing for the Nez Perce**

4 Tribal memory can still recall the origins of the Nimiipuu or Nez Perce. The oral traditions bind the Nez
5 Perce to the landscape. They also explain how to perceive and value the landscape and its many
6 resources. The oral traditions described hereafter are formative in the Nez Perce relationship with the land
7 and its resources. The first story describes how the animal people stepped forth in council to offer
8 assistance and guidance to the new people to help them survive. It is one of the earliest oral traditions
9 explaining the arrival of the Nimiipuu. The synopsis of this oral tradition is as follows:

10 *At one time only the animal people lived on the land and all of them spoke the same*
11 *language. Each animal could communicate with the others. A council was called and the*
12 *animal people began to gather around. It was announced that the land would change*
13 *with the arrival of a new creature that walked on two legs and this new creature will*
14 *need help to survive. It would need to learn what to eat and how to keep warm. The*
15 *animal people were asked to make an offering to help this creature survive. A great*
16 *commotion arose as the animal people engaged in discussion about what was going to be*
17 *offered. First among them was Nacox the Salmon. It said that it would give its entire body*
18 *as food to help the new people survive. It said that it would travel to far away places and*
19 *give gifts to the people upon its return. Nacox said that its sacrifice must be remembered*
20 *by allowing it to die in the place in which it was born.*

21 *All were impressed by the generosity of the Salmon and followed its example by making*
22 *an offering of food. One group of animals was discussing how they were going to look.*
23 *They were trying to settle their size, color of fur and horns as well as which direction*
24 *their horns or antlers were going to face. At last they stepped forth and declared that they*
25 *give their bodies to be foods for the new people just as salmon had proclaimed, adding*
26 *that their skins could be made into clothing for the new people to keep warm. They also*
27 *announced that their bones, horns and antlers could be made into tools to process hides*
28 *into clothing and shelter. The were recognized with names and they are Bison, Moose,*
29 *Elk, Mountain Sheep, Mountain Goat, Antelope and various kinds of deer. The birds were*
30 *next and they went through the same process and were recognized as the various birds.*
31 *Some of them are Prairie Chicken, Raven, Crow, Meadowlark, Owl, Hawk, Eagle,*
32 *Condor and the many other types of birds found in Nez Perce Country. In a similar*
33 *manner, the rest of the animal people stepped forth and proclaimed their gifts in front of*
34 *the council; stating how they would assist the new people in their efforts to survive.*

35 *There was one animal that was late to the council and when it asked what was going on,*
36 *everything had to be retold. It was announced that there would be a new creature to walk*
37 *the land and that each animal was making an offering to help the creature to live. Each*
38 *gift was described again and upon hearing the news, the late one wanted to be like*
39 *Grizzly Bear. It was asked to display how it would be a convincing Grizzly. It promptly*
40 *showed its small teeth, slightly growled and passed its little claws through the air. All the*

1 *animal people laughed because, although this late one was furry, it was nowhere near as*
2 *fierce as Grizzly Bear. So then the late one said it wanted to be like Eagle and it backed*
3 *up and ran toward the center of the council and jumped into the air landing only a short*
4 *distance away. All the people laughed again because it failed to capture the grace of an*
5 *eagle in the air. Then it wanted to be a salmon so it was sent to the river to demonstrate*
6 *its agility in the water. It promptly dived in the water and slowly paddled around in the*
7 *fashion of a dog and all the animal people laughed as it crawled from the river and shook*
8 *the water from its fur. All the positions were taken so a special task was given to this*
9 *creature. It would be the one to create the new two-legged creatures and its name would*
10 *be 'Iceyeye or Coyote. 'Iceyeye was cautioned that all the qualities he possessed would*
11 *be carried on by the creatures he went on to create: 'Iceyeye was known to be good,*
12 *helpful, very intelligent, curious to a fault and, at times, fool hardy. He was also very*
13 *forgetful. Some of the animal people chose to remain in the area in which the council*
14 *occurred; pulling their robes up over their shoulders and heads. They became stone in*
15 *order to serve as a reminder of the great council that occurred wherein the animal*
16 *people gave tremendous gifts for the survival of the coming new people.*



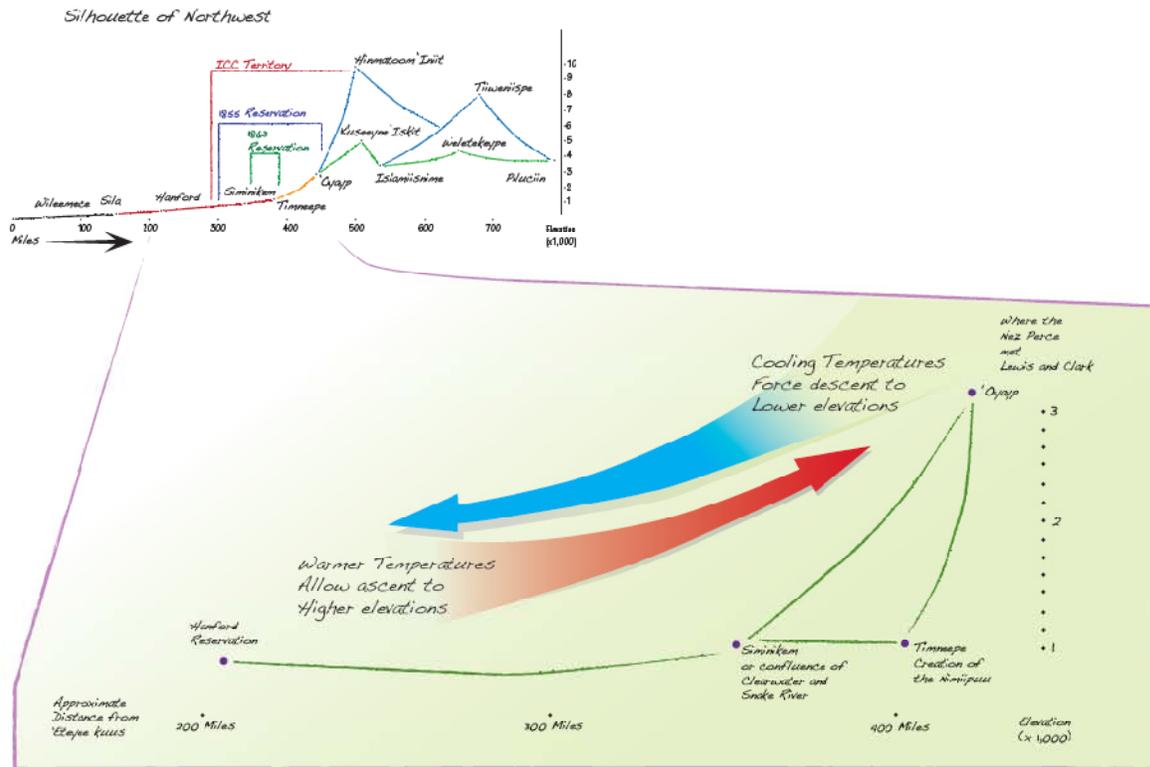
17
18 The place of the council can still be seen in the Nez Perce homeland along the valley of the Clearwater
19 River in North Central Idaho (Landeem and Pinkham 1999 p.4-8).

20

1 'Iceyeye went on to numerous adventures; frequently proclaiming his preparations for
 2 the new people. 'Iceyeye turned many animal people to stone to serve as a reminder of
 3 both proper and improper conduct. He carved rivers into the ground, turned giants into
 4 mountains and turned some animal people into constellations in the night sky so the new
 5 people could travel to far away places.

6 **Seasonal Round**

7 The seasonal round is best described as a *return to a specific area* for the purpose of gathering resources:
 8 food, medicinal or otherwise. The seasonal round advanced in area and elevation simultaneously. It is not
 9 the act of following resources wherever they occur but rather a return to an area to gather resources based
 10 on prior knowledge or experience. It is also marked by the availability as warming seasonal temperatures
 11 foster development of the resource. Examples are the return to root digging areas as spring or summer
 12 temperatures have warmed plants to the point of opening the opportunity to harvest, or a return to a
 13 hunting area in the fall before temperatures drop to low. The map below shows how the Hanford area fits
 14 into the area used by the Nez Perce over time.



15
 16 **Diagram 1**

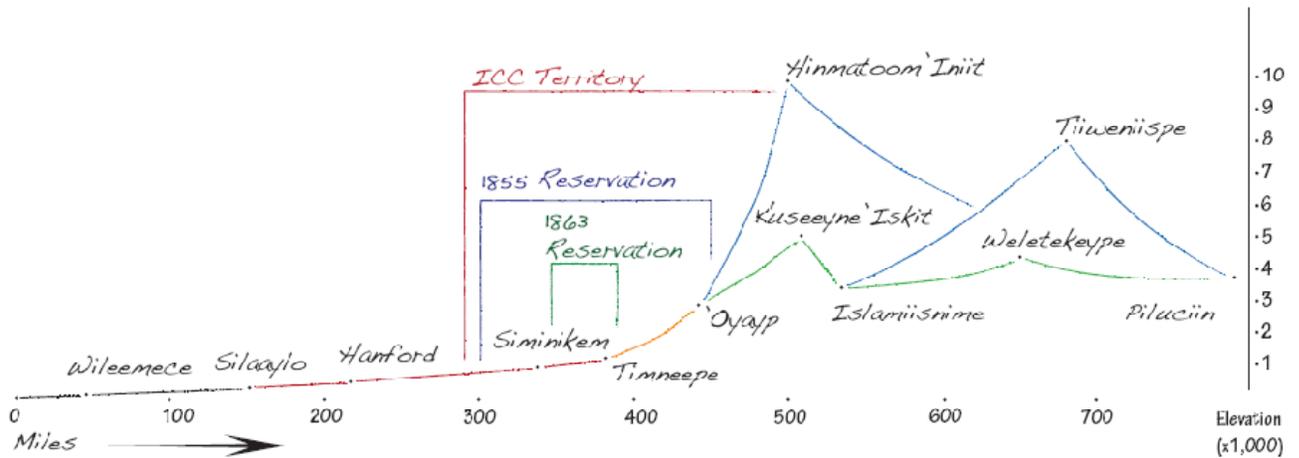
17
 18 The time for gathering resources is marked by lunar changes. Since there were more foods than there
 19 were moons during the year some resource gathering times were simultaneous. The diagram below shows
 20 how the seasons for gathering various foods correspond to the commonly used twelve-month calendar and

1 four seasons. The Nez Perce changed elevations depending on the warming weather and this is shown
 2 through another diagram showing the names of the gathering seasons and the elevations.

3 It also covered an elevation from sea level up to ten thousand feet. The map titled “Silhouette of the
 4 Northwest” shows the elevation difference in the usual and accustomed areas used by the Nez Perce. The
 5 beginning of the seasonal round is marked with a Ke’uyit or first foods ceremony in the spring. Ke’uyit
 6 translates to “first bite” and is an annual ritual of prayer immersed in song for the first foods of the year.
 7 Traditional foods are laid out on the floor in the order in which they are gathered throughout the year
 8 beginning with Salmon. This annual ritual is an expression of gratitude to the foods for their return and
 9 for those gathered during the seasonal round. Other tribes have more than one feast such as a root feast
 10 and a huckleberry feast but the Nez Perce only have one and it is held toward the latter part of the spring.

11
 12
 13

Silhouette of Northwest

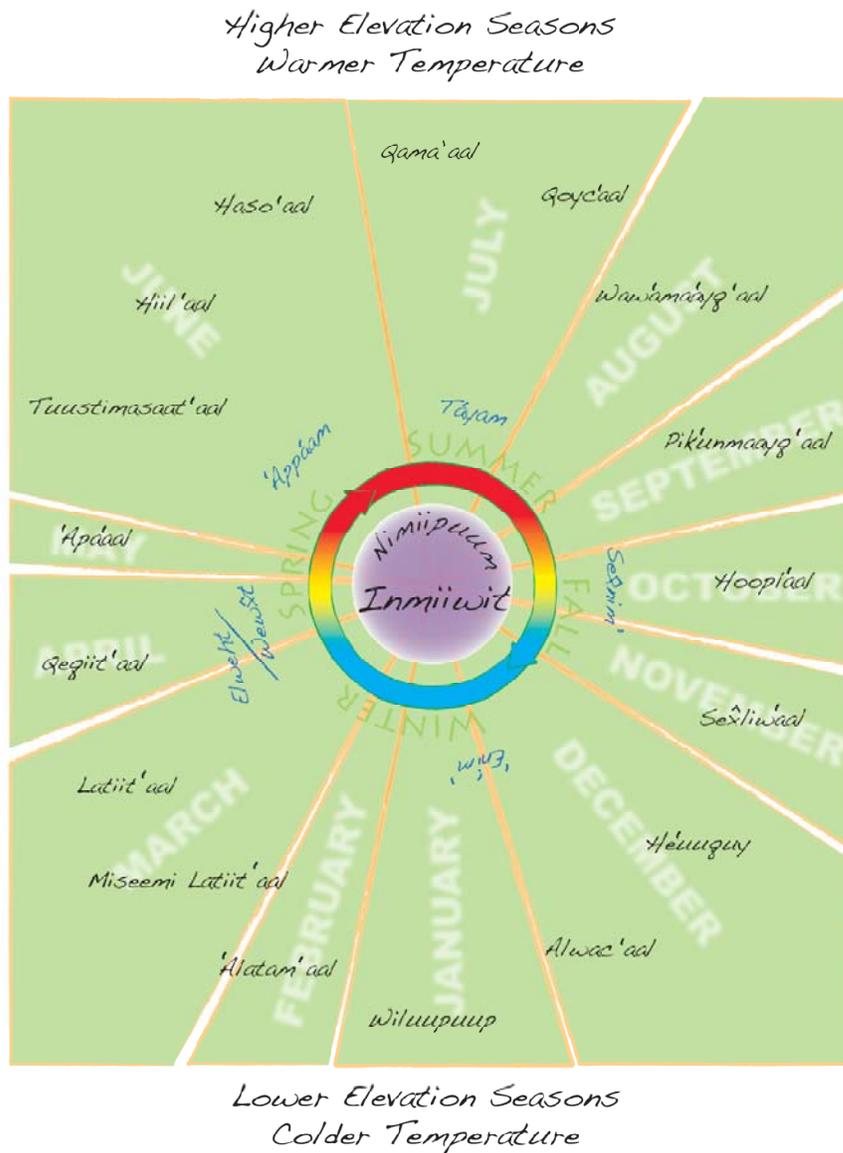


14
 15 *Diagram 2*

16
 17 **Gathering Times**

18 Examples of resource gathering times is shown in diagram 3:
 19 Wiluupup: Time when cold air travels. Often corresponds to the month of January.
 20 ‘Alatam’aal: Time between winter and spring or the time for fires (often corresponds to the month of
 21 February) ‘Ala=fire

-
- 1 Miseemi latiit'al: Time of false blossoms roughly corresponding to early March. Miseemi=to lie or speak
2 falsely, Latii=to bloom or blossom.
- 3 Latiit'al or Latiit'aal: Time when flowers bloom. Roughly corresponds to the month of March. Latii=to
4 bloom or blossom.
- 5 Qeqiit'aal or qaqiit'aal: Time of gathering qeqiit roots. Roughly corresponds to April.
- 6 'Apa'aal: Time for digging roots and making them into small cakes called 'Apa. Roughly corresponds to
7 the month of May or June.
- 8 Tustimasaatal: Ascend to higher mountain areas. Roughly corresponds to the month of June.
9 Tusti=higher/above
- 10 'Il'aal: The time of the first run of Salmon. Roughly corresponds to the month of June.
- 11 Haso'al': The time to gather eels or Pacific Lamprey. Roughly corresponds to the month of June.
12 Heesu=eel.
- 13 Qama'aal: Time for digging and roasting qem'es bulbs. Often corresponds to the month of July.
14 Qem'es=camas bulbs.
- 15 Q'oyxc'aal: Time of gathering Blueback Salmon. Often around the month of July. Q'oyxc=Blueback
16 Salmon
- 17



1

2 *Diagram 3*

3

4

5 Waw'ama'aq'aal: Season when salmon swim to the headwaters of streams (often corresponds to August)

6 Waaw'am=headwaters

7 Pik'unma'ayq'al or pik'onma'ayq'aal: Time when Chinook Salmon return to the main river and steelhead
8 begin their ascent. Roughly corresponds to September. Piik'un=river

9 Hoopl'al: Time when Tamarack needles begin to fall. Huup=to fall (as Pine needles do). Roughly
10 corresponds to October.

- 1 Sexliw'aal: Autumn or the time roughly corresponding to November.
- 2 He'uquy: Time of calf elk or foaling roughly corresponding to December.
- 3 'Alwac'aal: Time of Bison Yearling roughly corresponding to December. 'Alawa=bison yearling.

4

5 **Oral History**

6 Oral histories impart basic beliefs, taught moral values, and explained the creation of the world,
7 the origin of rituals and customs, the location of food, and the meaning of natural phenomena.
8 The oral tradition provides accounts and descriptions of the region's flora, fauna, and geology.
9 Fish and other animals are characters in many of these stories. Coyote, is the main character in
10 many of the stories because he exhibits all the good and bad of traits of human beings. Although
11 some of the characters and themes may differ slightly, many of these same stories are held in
12 common by Columbia Basin tribes.

13

14 **Tribal Values**

15 Tribal values lie imbedded within the rich cultural context of oral tradition and are conveyed to
16 the next generation by the depth of the Nez Perce language. The numerous landmarks that
17 season the precious landscape are reminders to the events, stories, and cultural practices of our
18 people. How to properly perceive life and land are among the core tenets of which the stories
19 speak. The values are what must endure and they can only be properly conveyed by the oral
20 traditions and language. Overall the values are intent on protection, preservation and
21 perpetuation of resources for the sake of survival. The Nez Perce still maintain those same
22 values for our children just as they were for those that carry them today. The most appropriate
23 way to convey the values of the Nez Perce is to discuss some of the cultural practices still
24 conducted on our landscape. They reflect a complex tradition of high regard for the land by
25 utilizing the resources, but not using so much that the resource cannot propagate to preserve their
26 continued existence.

27 Land was managed by cultural practices so that resources would not be jeopardized by the
28 actions of one generation. The Nez Perce Tribe utilized resource areas with several other tribes
29 that carried similar resource values. The Nez Perce value the landscape for the rich resources it
30 offers our children for their survival. The landscape is full of powerful reminders that were
31 placed in their respective areas in the form of rock features associated with oral traditions
32 relating the exploits of the animal people. The Nez Perce elders recall hunting and fishing areas
33 taught to them when they were young. These are the same places they learned about in the same
34 way from their elder kinsmen. The women dig roots and harvest berries in the same places that

1 they learned about from their grandmothers. Each place utilized for the resources was
2 maintained with balance to sustain children and future generations.

3 Each plant had a window of harvest in which it could be gathered. The window of harvest was
4 always honored because gathering at another time would either affect its strength or viability.
5 When women were gathering *qem'es* bulbs, they would evaluate the field to ensure that others
6 had not already gathered past the threshold of the resource's stability. If the field looked as
7 though others had already been there and the resource needed to be left so it could continue on,
8 then they would simply go to another place. When a place was found which could be used for
9 harvest, the digging would begin with prayer songs and it was common for many of the women
10 to sing as they continued to dig. When the work was finished for the day it was closed with a
11 prayer song just as it had began. They were cautious about the way in which they gathered the
12 roots as well. Arguing and fighting didn't occur while gathering foods, even among the young,
13 because they were strictly forbidden. Root diggers were reminded by the elderly to be prayerful
14 and concentrate on good thoughts as they conducted their work avoiding negative feelings that
15 might be carried by the foods to those that would consume them. Peelings from the roots always
16 were to be returned to the original grounds from which they came or buried in the earth. They are
17 never to be simply thrown in the garbage. There are traditional stories that communicate values
18 that regardless of where the oral tradition originated, it applies during times that native tribes are
19 on site and practicing usual and accustomed rights. These are teachings tied to the landscape and
20 the land ethic that is our culture.

21 Fishing and hunting were conducted in the same way. Young boys were raised with the guidance
22 of elder kinsmen. A group of hunters or fishermen would depart for areas that were, on occasion,
23 previously scouted for the presence of fish and/or game. Young hunters and fishermen would
24 observe the actions of those that were responsible for imparting knowledge of how to conduct
25 oneself appropriately as game was stalked or fish were caught. Expectations were similar to
26 those of the young women; concentrate on good thoughts and feelings, prohibited acts included
27 fighting and arguing. Excessive pride and boasting were frowned upon by elder kinfolk since the
28 hunt was to be conducted with the utmost humility. Hunters and fisherman learned to avoid
29 catching the largest fish or killing the largest animal they could find because it preserved the
30 gene pool that replaced that size animal. Upon return, the hunters were not questioned as to the
31 number each hunter killed and it was never announced because it was deemed as a group
32 activity. One exception was when a young hunter killed an animal for the first time or caught his
33 first fish. At this time the family recognized the young hunter or fisherman as a provider with a
34 ceremonial feast. The elder fisherman and hunters sat around the meat which was to be boiled,
35 baked or prepared in some traditional fashion as stories were told conveying more teachings and
36 proper conduct. As the elder hunters and fishermen consumed the meat the newly recognized
37 hunter or fisherman was not allowed to partake of even a morsel of the meal. Everyone else was
38 to eat before the hunter or fisherman could consume a meal. This reinforced their role as a
39 provider rather than someone that merely killed game or caught fish for recreational purposes.

1 Young hunters were taught proper shot placement, as it was crucial to the hunting experience.
2 Young hunters were taught to shoot an animal so that it would be killed as quickly and limit the
3 animal's suffering as much as possible. Shooting an animal or catching a fish was only part of
4 the overall commitment to the animal's sacrifice. It had to be cleaned and taken care of with the
5 same regard as the roots and berries. The utmost gratitude and respect was offered to the
6 animal's spirit for imparting a tremendous gift of life to the people.

7 Spiritual or religious aspects of natural resources are the heart of Indian culture. There is a
8 connection to the daily activities of a traditional lifestyle communicated through the oral
9 traditions that tell how to take care of the land. Even landmarks have oral traditions associated
10 with them. These landmarks are tangible cultural reminders.

11 *Value of uncontaminated resources-* For natural resources to be uncontaminated as part of
12 Niimiipuu physical and spiritual well-being, then land and waters and air from which they come
13 should be uncontaminated otherwise the risk to human health increases the potential for illness
14 and other ailments.

15 For tribal use of natural resources to be fully utilized, the example of manufacturing and using a
16 *wistiitam'o* or sweat lodge is presented. One purpose of a sweat lodge is for purification. It is for
17 cleansing and a time for meditation, spiritual reflection, healing, sharing oral history and
18 teaching. The *wistiitam'o* is often a place where the Nez Perce return to have spiritual well-
19 being restored after family losses. It is a place of contemplation and an opportunity to relieve
20 stress and anxiety built up from the day's activities. It is a place for centering your soul through
21 prayer and meditation. It is also a place where many socialize with family and friends and learn
22 what is happening in the community.

23 For these reasons, it is imperative that the materials used in making a sweat lodge come from the
24 natural environment. The structure is to be made of willows gathered from the immediate
25 vicinity of where the sweat lodge will stand. The covering is to be of animal hides, or other
26 natural materials. The water for the bathing after sweating is to be from a natural spring or
27 stream. Herbs are collected in their proper season with prayers and gratitude offered for their
28 service.

29 Sitting in a sweat bath is a rigorous activity. While outwardly relaxed, your inner organs are as
30 active as though you were exercising. The skin is the largest organ of the body and through the
31 pores it plays a major role in the detoxifying process along with the lungs, kidneys, bowels, liver
32 and the lymphatic and immune systems. Capillaries dilate permitting increased flow of blood to
33 the skin in an attempt to draw heat from the surface and disperse it inside the body. The heart is
34 accelerated to keep up with the additional demands for circulation. Impurities in the liver,
35 stomach, muscles, brain, and most other organs are flushed from the body. It is in this way that
36 purification occurs.

37

1 **Affected Environment**

2 NEPA approaches the environment with a certain defined boundary. This fragmentation of the
3 natural and human environment does not adequately describe different resource values that a
4 particular part of society may have, like a formally recognized tribe and its federally protected
5 rights. A tribal environmental ethic, which maintains a cultural and spiritual connection to the
6 natural environment and a holistic approach, is difficult to communicate in a NEPA document.
7 There needs to be a placeholder in this document to accept these important yet different values
8 that tribes bring to evaluating environmental and human impacts.

9 **The Nez Perce Tribe recommends that the draft EIS include the following analysis or issues**
10 **for the GTCC Programmatic EIS evaluation. We have summarized the issues/concerns by**
11 **EIS sections for ease of DOE's organization and inclusion. This *Tribal Narrative* is for DOE**
12 **to consider for inclusion into the EIS.**

13

14 ***Climate, Air Quality, and Noise***

15 **Climate**

16 Climate is one of the dominate issues of our time. Indian people have experience with volcanic
17 periods when it seemed our world was on fire and times when our world was much colder.
18 Distinct climatic periods have occurred during which Tribal life adapted to environmental
19 changes and our oral history reflects these climate changes and adaptations. Scientific and
20 historic knowledge validates tribal oral history for many thousands of years.

21 Columbia Plateau Tribes have stories about the world being transformed from a time considered
22 prehistoric to what is known today. The Nez Perce remember volcanoes, great floods, and
23 animals now extinct. Mammoth and bison harvest sites are found throughout the Columbia
24 Plateau. They have memories of their world being destroyed by fire and water and believe it will
25 happen again.

26 The Nez Perce know and remember about the weather and its changes because it was so
27 important to forming their lives. Oral histories indicate that the climate was much wetter and
28 supported vast forests in the region. Oral histories also recall a time when Gable Mountain or
29 *Nookshia* (Relander1986: 305), a major landscape feature on the Hanford Reservation, rose out
30 of the Missoula floods. There is a story about Indian people who fought severe winds that were
31 common a long time ago. One story tells of how a family trained their son by having him fight
32 with the ice in the river until he became strong enough to fight the wind. He then beat the very
33 strong winds of the past and now we do not have such winds.

34 Holocene (Roberts 1998) is the term used to describe the climate since the last glaciers (11,700
35 years ago), covering much of the northwestern North America. This archaeological record

36

1 confirms the prehistory that includes arctic foxes found with Marmes Rock Shelter (Browman
2 and Munsell 1969; Hicks 2004). The Palynological data would be a good source for recreating
3 climates that supported ecosystems of the past 10,000 years.

4 **Air Quality**

5 The Nez Perce believe that radioactivity is brought into the air by high winds – commonly
6 blowing 40-45 miles per hour and intermittently much stronger ([http://www.bces.wa.
7 gov/windstorms.pdf](http://www.bces.wa.gov/windstorms.pdf)). High winds over 150 mile per hour were recorded in 1972 on Rattlesnake
8 Mountain and in 1990 winds on the mountain were recorded at 90 miles per hour. Dust devils
9 can be massive in size, spin up to 60 miles per hour, and frequently occur at the site. Tornadoes
10 have been observed in Benton County which is regionally famous for receiving strong winds.

11 It gets so windy that the site managers at Environmental Restoration Disposal Facility (ERDF)
12 occasionally sends all workers home and close down the facility due to the degree of blowing
13 dust making it unsafe to work. Air quality monitoring results, including radioactive dust, should
14 be presented for ERDF, various plant operations, emission stacks, venting systems, and power
15 generation sites. Also, fugitive dust can affect Viewshed and contribute to health affects during
16 inversions.

17 **Noise**

18 Native people understand that non-natural noise can be offensive while traditional ceremonies
19 are being held. Traditional ceremonies have been held at the Hanford site in recent years. Some
20 of the cultural use of the Hanford site by Tribes is being lost. Not all ceremonial sites are known
21 to non-Indians. The noise generated by the Hanford facility may presently create noise
22 interference for ceremonies held at sites like Gable Mountain and Rattlesnake Mountain. Noise
23 generating projects, such as the GTCC proposed site, can interrupt the thoughts and focus and
24 thus the spiritual balance and harmony of the community participants of a ceremony (Greider
25 1993). The Nez Perce Tribe recommends that quiet zones and time periods should be identified
26 for known Native American ceremonial locations on and near the Hanford Reservation. The
27 general values or attributes provide solitude, quietness, darkness and wilderness-like or
28 undegraded environments. These attributes provide unquantifiable value and are fragile. These
29 types of values are also discussed in the Viewshed section.

30 **Light pollution**

31 Artificial light can be a “pollutant” when it creates measurable harm to the environment. Light
32 can affect nocturnal and diurnal animals. It can affect reproduction, migration, feeding and other
33 aspects of survival. Artificial light can also reduce the quality of experience during tribal cultural
34 and ceremonial activities.

1 **Geology and Soils**

2 **Geology**

3 **Physiography-** The Yakima Fold Belt and the Palouse Slope play potentially very significant
4 roles at Hanford both culturally and geologically. Rattlesnake and Gable Mountains are
5 examples of folded basalt structures within the Yakima Fold Belt. These geological features
6 have direct bearing on the ground water and groundwater flow direction. There are oral history
7 accounts of these basalt features above the floodwaters of Lake Missoula. Many other
8 topography features have oral history explanations such as the Mooli Mooli (flood ripples along
9 the river terrace) and the sand dunes.

10 **Site Geology and Stratigraphy -** The GTCC referenced vadose zone location is similar to
11 that of the 200 West area. A primary similarity between the GTCC location and the 200 West is
12 that the underlying sediments are the Hanford Formation and possibly the Cold Creek formation.
13 Like the 200 west area there is uncertainty about the geology and hydraulic conductivity in this
14 area.

15 The vadose zone needs to be discussed as part of the Stratigraphy Section of the GTCC EIS and
16 is probably one of the most important elements to discuss for a potential Hanford GTCC
17 repository. It should be noted that within those sediments, a major subsurface trough feature
18 exists (an eroded channel at the surface of the Ringold Formation) that can be traced in the
19 stratigraphy from Gable Gap across the eastern part of 200 East and on to the southeast. This
20 trough contains the Cold Creek sedimentary unit. Geologists are still trying to determine the
21 effects this subsurface feature in the vadose zone has on contaminant transport.

22 Clastic dikes are networks of features in the near surface wherein cracks were developed in the
23 vadose zone from sediments either upwelling from a deeper layer, or by filling in from a feature
24 open at the surface, or a combination of both. These features are thought to be related to seismic
25 activity. What affect these have directly on contaminant transport needs to be understood, and
26 thus far they have not. There is a question as to whether or not the DOE has looked for them at
27 the site. They were noted to be present in the 200 Areas during the tank farm construction.

28 Regional Seismicity –The Pacific Northwest has been historically geologically active and this
29 needs to be discussed if there is to be analysis of putting more contaminants in the ground at
30 Hanford. The 1936 earthquake and the 1973 earthquakes at Hanford need to be discussed in
31 terms of the GTCC.

32 Geologic structure of the Pacific Northwest includes a feature called the Olympic-Wallowa
33 Lineament (the OWL). Surface and depth data have identified a structural “line” within the

34

1 earth's crust that can be traced roughly from southeast of the Wallowa Mountains, under
2 Hanford, through the Cascades and under Seattle and the Sound. Such lineaments are signals of
3 crustal structure that are not yet well identified. Emerging research being reported through the
4 USGS is highlighting the importance of Seattle area faults connecting under the Cascades into
5 the Yakima Fold Belt and on along the OWL. The geologic stress on the surface of the earth in
6 the local region have a north-south compressional force direction that has caused the surface to
7 wrinkle in folds that trend approximately east-west, thus creating the Yakima Fold Belt. Fault
8 movement along these folds occurs all the time, and studies have shown these to be considered
9 active fault zones (Repasky, TR, et.al., 1998; Campbell, N.P., et.al., 1995).

10 **Soils**

11 Native Peoples understand the importance of soils and minerals. Oral history has suggested that
12 soils have a medicinal purpose for healing wounds as well as used for building structures,
13 creating mud baths, and filtering water. Material from the White bluffs was used for cleaning
14 hides, making paints, and whitewashing villages.

15 Soil characteristics: soil chemistry (ph, ion activity, micronutrients, microorganisms, lack of this
16 knowledge is a data gap such as the influence of past tank leaks on soil chemistry and
17 characteristics/properties. Sandy soils have high transmissivity. Soil integrity is important to
18 tribes since the soils support plant life, which supports many other life forms, which are all
19 important to tribes.

20 **Minerals and Energy Resources**

21 Tribal Comments: Barrow material site and waste material site: Alternatives selection will have
22 varying degrees of impact and footprint. For example, a vault alternative will need significant
23 capping material from barrow area C that has its own set of ramifications.

24 Questions to be answered: What will the energy use be for a fully functioning GTCC waste site?
25 What is the size and location of the footprint?

26 **Water Resources**

27 **Groundwater**

28 Purity of water is very important to the Nez Perce, and thus DOE should be managing for an
29 optimum condition considering Tribal cultural connection and direct use of water, rather than
30 managing for a minimum water quality threshold.

31 From the perspective of the Nez Perce Tribe, the greatest long-term threat at the Hanford site lies
32 in the contaminated groundwater. There is insufficient characterization of the vadose zone and
33 groundwater. There is a tremendous volume of radioactive and chemical contamination in the
34 groundwater. The mechanisms of flow and transport of contaminants through the soil to the

1 groundwater are still largely unknown. The volumes of contamination within the groundwater
2 and direction of flow are still only speculative. Due to lack of knowledge and limited technical
3 ability to remediate the vadose zone and groundwater puts the Columbia River at continual risk.

4 **Water Use**

5 The Columbia River is the lifeblood of the Nez Perce people. It supports the salmon and every
6 food or material that they rely on for subsistence. It is an essential human right to have clean
7 water.

8 If water is contaminated it then contaminates all living things. Tribal members that exercise a
9 traditional lifestyle would also become contaminated. A perfect example is making a sweat
10 lodge and sweating. It is a process of cleansing and purification. If water is contaminated then
11 the sweat lodge materials and process of cleansing would actually contaminate the individual.

12

13 Tribal people are well known for adopting technology if it were instituted wisely and did not
14 sacrifice or threaten the survival of the group as a whole. This approach applies to tribal use of
15 groundwater. Even though groundwater was not used except at springs, tribes would have
16 potentially used technology for developing wells and would have used groundwater if seen to be
17 an appropriate action. The existing contamination is considered an impact to tribal rights to
18 utilize this valuable resource.

19

20 The hyporheic zone in the Columbia River needs to be more fully characterized to understand
21 the location and potential of groundwater contaminants discharging to the Columbia River.

22

23 Contaminated groundwater plumes at Hanford are moving towards the Columbia River and some
24 contaminants are already recharging to the river. It is the philosophy of the Columbia River
25 Tribes that groundwater restoration and protection be paramount to DOE's management of
26 Hanford. Institutional controls, such as preventing use of groundwater, should only be a
27 temporary measure for the safety of people and animals. It will be questioned when DOE views
28 institutional controls as a viable long-term management option to allow natural attenuation. The
29 timeline of natural attenuation may not best represent a Tribal preference of a proactive
30 corrective cleanup measure(s). for contamination plumes. Cleanup should be a priority before
31 considering placement of additional waste like GTCC in the 200 area.

32

33 **Human Health**

34 Nez Perce health involves access to traditional foods and places. Both of these are located on the
35 Hanford facility and can be impacted by placement of the GTCC waste in the 200 area.

36 *Definition of Tribal health-* Native American ties to the environment are much more complex
37 and intense than is generally understood by risk assessors (Harris 1998, Oren Lyons¹). All of the
38 foods and implements gathered and manufactured by the traditional American Indian are

¹ http://www.ratical.org/many_worlds/6Nations/OLatUNin92.html;
<http://www.youtube.com/watch?v=hDF7ia23hVg>.

1 interconnected in at least one way, but more often in many ways. Therefore, if the link between a
2 person and his/her environment is severed through the introduction of contamination or physical
3 or administrative disruption, the person's health suffers, and the well being of the entire
4 community is affected.

5 To many American Indians, individual and collective well being is derived from membership in
6 a healthy community that has access to, and utilization of, ancestral lands and traditional
7 resources. This wellness stems from and is enhanced by having the opportunity and ability to live
8 within traditional community activities and values. If the links between a tribal person and his or
9 her environment were severed through contamination or DOE administrative controls, the well
10 being of the entire community is affected.

11 **Risk Assessments**

12 Risk assessments should take a public health approach to defining community and individual
13 health. Public health naturally integrates human, ecological, and cultural health into an overall
14 definition of community health and well-being. This broader approach used with risk
15 assessments is adaptable to indigenous communities that, unlike westernized communities, turn
16 to the local ecology for food, medicine, education, religion, occupation, income, and all aspects
17 of a good life (Harris, 1998, 2000; Harper and Harris, 2000).

18 "Subsistence" in the narrow sense refers to the hunting, fishing, and gathering activities that are
19 fundamental to the way of life and health of many indigenous peoples.

20 The more concrete aspects of a subsistence lifestyle are important to understanding the degree of
21 environmental contact and how subsistence is performed in contemporary times. Also,
22 traditional knowledge can be learned directly from nature. Through observation this knowledge
23 is recognized and a spiritual connection is often attained as a result. Subsistence utilizes
24 traditional and modern technologies for harvesting and preserving foods as well as for
25 distributing the produce through communal networks of sharing and bartering. The following is
26 a useful explanation of "subsistence," slightly modified from the National Park Service:

27 *"While non-native people tend to define subsistence in terms of poverty or the*
28 *minimum amount of food necessary to support life, native people equate*
29 *subsistence with their culture. It defines who they are as a people. Among many*
30 *tribes, maintaining a subsistence lifestyle has become the symbol of their survival*
31 *in the face of mounting political and economic pressures. To Native Americans*
32 *who continue to depend on natural resources, subsistence is more than eking out*
33 *a living. The subsistence lifestyle is a communal activity that is the basis of*
34 *cultural existence and survival. It unifies communities as cohesive functioning*
35 *units through collective production and distribution of the harvest. Some groups*
36 *have formalized patterns of sharing, while others do so in more informal ways.*
37 *Entire families participate, including elders, who assist with less physically*

1 *demanding tasks. Parents teach the young to hunt, fish, and farm. Food and*
2 *goods are also distributed through native cultural institutions. Nez Perce young*
3 *hunters and fisherman are required to distribute their first catch throughout the*
4 *community at a first feast (first bite) ceremony. It is a ceremony that illustrates*
5 *the young hunter is now a man and a provider for his community. Subsistence*
6 *embodies cultural values that recognize both the social obligation to share as well*
7 *as the special spiritual relationship to the land and resources.”²*

8 The following four categories of an undisturbed environment contribute to individual and
9 community health. Impacts to any of these functions can adversely affect health. Metrics
10 associated with impacts within each of these categories are presented in Harper and Harris
11 (1999).

12 **Human Health-Related Goods and Services:** This category includes the provision of water,
13 air, food, and native medicines. In a tribal subsistence situation, the land provided all the food
14 and medicine that was necessary to enjoy long and healthy lives. From a risk perspective, those
15 goods and services can also be exposure pathways.

16 **Environmental Functions and Services:** This category includes environmental functions such
17 as soil stabilization and the human services that this provides, such as erosion control or dust
18 reduction. Dust control in turn would provide a human health service related to asthma reduction.

19 Environmental functions such as nutrient production and plant cover would provide wildlife
20 services such as shelter, nesting areas, and food, which in turn might contribute to the health of a
21 species important to ecotourism. Ecological risk assessment includes narrow examination of
22 exposure pathways to biota as well as examination of impacts to the quality of ecosystems and
23 the services provided by individual biota, ecosystems, and ecology.

24 **Social and Cultural Goods, Functions, Services, and Uses:** This category includes many
25 things valued by suburban and tribal communities about Introduction particular places or
26 resources associated with intact ecosystems and landscapes. Some values are common to all
27 communities, such as the aesthetics of undeveloped area s, intrinsic existence value,
28 environmental education, and so on.

29 **Economic Goods and Services:** This category includes conventional dollar-based items such as
30 jobs, education, health care, housing, and so on. There is also a parallel non-dollar indigenous
31 economy that provides the same types of services, including employment (i.e., the functional role
32 of individuals in maintaining the functional community and ensuring its survival), shelter (house
33 sites, construction materials), education (intergenerational knowledge required to ensure
34 sustainable survival throughout time and maintain personal and community identity), commerce
35 (barter items and stability of extended trade networks), hospitality, energy (fuel), transportation

² National Park Service: http://www.cr.nps.gov/aad/cg/fa_1999/Subsist.htm

1 (land and water travel, waystops, navigational guides), recreation (scenic visitation areas), and
2 economic support for specialized roles such as religious leaders and teachers.

3 **Ecology**

4 The Nez Perce people have lived in these lands for a very long time and thus have learned about
5 the resources and their ecological interrelationships. They knew about environmental indicators
6 that foretold seasons and conditions that guided them. When Cliff Swallows first appear in the
7 spring, their arrival is an indicator that the fish are coming up the river. Doves are the fish
8 counters, telling how many fish are coming. Many natural phenomena foretell when the earth is
9 coming alive again in the spring, even if things are dormant underground. The Nez Perce has
10 traditional ecological knowledge of this environment and tribal people have ceremonies that
11 acknowledge the arrival of Spring. The winds bring information about what will happen. It
12 provides guidance about how to bring balance back to the land.

13 **Biodiversity on the National Monument**

14 The Monument encompasses a biologically diverse landscape containing an irreplaceable natural
15 and historic legacy. Limited development over approximately 70 years has allowed for the
16 Monument to become a haven for important and increasingly scarce plants and animals of
17 scientific, historic and cultural interest. It supports a broad array of newly discovered or
18 increasingly uncommon native plants and animals. Migrating salmon, birds and hundreds of
19 other native plant and animal species, some found nowhere else in the world, rely on its natural
20 ecosystems. The Monument also includes 46.5 miles of the last free-flowing, non-tidal stretch of
21 the Columbia River, known as the “Hanford Reach.”

22 **Salmon**

23 Columbia River salmon runs, once the largest in the world, have declined over 90% during the
24 last century. The 7.4 – 12.5 million average annual number of fish above Bonneville Dam have
25 dropped to 600,000. Of these, approximately 350,000 are produced in hatcheries. Many salmon
26 stocks have been removed from major portions of their historic range (Columbia Basin Fish and
27 Wildlife Authority, 2009).

28 Multiple salmon runs reach the Hanford Nuclear Reservation. These runs include Spring
29 Chinook, Fall Chinook, Sockeye, Silver and Steelhead. The runs tend to begin in April and end
30 in November.

31 Salmon runs have been decimated as a result of loss and change to habitat. The changes include
32 non-tribal commercial fisheries, agriculture interests, and especially construction of hydro-
33 projects on the Columbia River. Protection and preservation of anadromous fisheries were not a
34 priority when the 227 Columbia River dams were constructed. Some dams were constructed
35 without fish ladders and ultimately eliminated approximately half of the spawning habit available
36 in the Columbia System.

1 The Hanford Reach is approximately 51 miles long and is the only place on the upper main stem
2 of the Columbia River where Chinook salmon still spawn naturally. This reach is the last free
3 flowing section of the Columbia River above Bonneville Dam. It produces about eighty to ninety
4 percent of the fall Chinook salmon run on the Columbia River.

5 Tribal elders say that the last runs of big salmon (Chinook) that came through the Hanford Reach
6 occurred in 1905. Non-Tribal Commercial fisheries on the lower Columbia are largely
7 responsible for the loss of the large Chinook salmon.

8 The Columbia River Tribes, out of a deep commitment to the fisheries and in spite of the odds,
9 plan to restore stocks of Chinook, Coho, Sockeye, Steelhead, Chum, Sturgeon and Pacific
10 Lamprey. This effort was united in 1995 under a recovery plan called the Wy-Kan-Ush-Mi Wa-
11 Kish-Wit (Spirit of the Salmon). Member tribes are the Nez Perce Umatilla, Warm Springs and
12 Yakama.

13 The Columbia River tribes see themselves as the keepers of ancient truths and laws of nature.
14 Respect and reverence for the perfection of Creation are the foundation of their culture. Salmon
15 are part of our spiritual and cultural identity. Tribal values are transferred from generation to
16 generation with the salmon returns. Without salmon, tribes would lose the foundation of their
17 spiritual and cultural identity.

18 All tribes affected by the Hanford site are co-managers of Columbia River fisheries including
19 assisting in tagging fry and counting redds along the Hanford Reach for the purposes of
20 estimating fish returns. This information is essential in the negotiation of fish harvest between
21 the USA and Canada as well as between Indian and non-Indian fishermen.

22 In many ways, the loss of salmon mirrors the plight of native people. Elders remind us that the
23 fate of humans and salmon are linked. The circle of life has been broken with the loss of
24 traditional fishing sites and salmon runs on the Columbia River.

25 **Socioeconomics**

26 **Modern tribal economy**

27 A subsistence economy is one in which currency is limited because many goods and services are
28 produced and consumed within families or bands, and currency is based as much on obligation
29 and respect as on tangible symbols of wealth and immediate barter. It is well-recognized in
30 anthropology that indigenous cultures include networks of materials interlinked with networks of
31 obligation. Together these networks determine how materials and information flow within the
32 community and between the environment and the community. Today, there is an integrated
33 interdependence between formal (cash-based) and informal (barter and subsistence-based)

1 economic sectors that exists and must be considered when thinking of economics and
2 employment of tribal people.³

3 Indian people engage in a complex web of exchanges that often involves traditional plants,
4 minerals, and other natural resources. These exchanges are a foundation of community and
5 intertribal relationships. Thus there are natural resource issues, some of which are located on
6 Hanford, that involve direct production that permeate Indian life. Indian people, catch salmon
7 that become gifts to others living near and far. Sharing self-gathered food or self-made items is a
8 part of establishing and maintaining reciprocal relationships. People have similar relationships
9 between places and elements of nature, which are based on mutual respect for the rights of
10 animals, plants, places and people.

11 Use of the Hanford site and surrounding areas by tribes was tied primarily to the robust
12 Columbia River fishery. Past social activities of native people include gatherings for such
13 activities like marriages, trading, feasts, harvesting, fishing, and mineral collection. Tribal
14 families and bands lived along the Columbia either year round or seasonally for catching, drying
15 and smoking salmon. The reduction of salmon runs, loss of fishing sites due to dam
16 impoundments and Hanford land use restrictions have contributed to the degradation of the
17 supplies necessary for this gifting and barter system of our tribal culture.

18 The future of salmon and treaty-reserved fisheries will likely be determined during the life of the
19 GTCC waste. With the tremendous efforts to recover salmon (and other fish species) by tribes,
20 government agencies, and conservation organizations, Tribal expectations are that these species
21 will be recovered to healthy populations.

22 If aquatic species were to recover, the regional economy and tribal barter economy would likely
23 greatly increase in the Hanford area. These fish returns and the associated social and economic
24 potential should be considered within the lifecycle of a GTCC waste repository.

25 **Direct Production**

26 Direct production by tribes is part of the economy that needs to be represented, especially
27 considering the Tribe's emphasis on salmon recovery. This type of individual commerce in
28 modern economics is termed and calculated as "direct production". The increase in direct
29 production would be relational to the region's salmon recovery, yet there is no economic
30 measure (within the NEPA process) to account for this robust element of a traditional economy.

31 In a traditional sense, direct production is a term of self and community reliance on the
32 environment for existence as opposed to employment or modern economies. Direct production is
33 use of salmon and raw plant materials for foods, ceremonial, and medicinal needs and the
34 associated trading or gifting of these foods and materials. Direct production needs to be

³ <http://arcticcircle.uconn.edu/NatResources/subsistglobal.html>

1 understood, and should include elements like: use of plant foods, ceremonial plants, medicinal
2 plants, beadwork, hide work, tule mats and dried salmon.

3 An example of this economy would be the documented number of Native Americans that fished
4 at Celilo Falls; as many as 1500 fisherman assembled at the site not far from Hanford during the
5 peak fishing seasons. Trading between and among tribes include but are not limited to items like
6 dentalia shells, mountain sheep horns, bows, horses, baskets, tule mats, art, bead work, leather
7 and raw hide, and buffalo robes.

8 **Environmental Justice**

9 President Clinton signed Executive Order 12898 to address Environmental Justice issues and to
10 commit each federal department and agency to “make achieving Environmental Justice part of its
11 mission.” (Environmental Biosciences Program 2001). According to the Executive Order, no
12 single community should host disproportionate health and social burdens of society’s polluting
13 facilities. Many American Indians are concerned about the interpretation of “Environmental
14 Justice” by the U.S. Federal Government in relation to tribes. By this definition, tribes are
15 included as a minority group. However, the definition as a minority group fails to recognize
16 tribes’ sovereign nation-state status, the federal trust responsibility, or protection of treaty and
17 statutory rights of American Indians. Because of a lack of the these details, tribal governments
18 and federal agencies have not been able to develop a clear definition of Environmental Justice in
19 Indian Country, and thus it is difficult to determine appropriate actions.

20 American Indian and Alaskan Natives use and manage the environment holistically; everything
21 is viewed as living and having a spirit. Thus, many federal and state environmental laws and
22 regulations designed to protect the environment do not fully address the needs and concerns of
23 American Indian and Alaskan Natives. Land based resources are the most important assets to
24 tribes spiritually, culturally and economically.

25 **Land Use**

26 The Nez Perce Tribe recommends that DOE continue efforts to identify special places and
27 landscapes with spiritual significance. Newly identified sites would be added to those already
28 requiring American Indian ceremonial access and needing long-term stewardship.

29 Native people maintain that aboriginal and treaty rights allow for the protection, access to, and
30 use of resources. These rights were established at the origin of the Native People and persist
31 forever. There are sites or locations within the existing Hanford reservation boundary with tribal
32 significance that are presently restricted through DOE’s institutional controls and should be
33 considered for special protections or set aside for traditional and contemporary ceremonial uses.
34 Sites like the White Bluffs, Gable Mountain, Rattlesnake Mountain, Gable Butte, and the islands
35 on the river are known to have special meaning to Tribes and should be part of the discussion for
36 special access and protection. These locations should be placed in co-management with DOE,
37 FWS and the Tribes for long-term management and protection.

1 **Tribal Access**

2 In the Regulatory Section there are several federal regulations, policies, and executive orders that
3 define tribal access that override institutional controls of the CLUP or the CCP when risk levels
4 are acceptable for access. The following is a brief summary of those legal references:

5 According to the *American Indian Religious Freedom Act*, tribal members have a protected right
6 to conduct religious ceremonies at locations on public lands where they are known to have
7 occurred before. There has been an incomplete effort to research the full extent of tribal
8 ceremonial use of the Hanford site.

9 *Executive Order 13007* supports the American Religions Freedom Act by stating that Tribal
10 members have the right to access ceremonial sites. This includes agencies to maintain existing
11 trails or roads that provide access to the sites.

12 DOE managers that are considering the placement of GTCC waste at Hanford must evaluate any
13 potential impact to ceremonial access as part of their trust responsibility to Tribes.

14 There are locations that have specific protections due to culturally significant findings, burial
15 sites, artifact clusters, etc. These types of areas are further described under the Cultural
16 Resources Sections. As decommissioning and reclamation occurs across the Hanford site, any
17 culturally significant findings will continue to expand the list of sites and their locations with
18 special protections that override existing land use designation as outlined in the CLUP or other
19 documents.

20 **Comprehensive Land Use Plan (CLUP):**

21 The present DOE land use document for Hanford, called the Comprehensive Land Use Plan
22 (CLUP), has institutional controls that limit present and future use by Native Americans. DOE
23 plans to remove some institutional controls over time as the contamination footprint is reduced as
24 a result of instituting the 2015 vision along the river and also the proposed cleanup of the 200
25 area. With removal of institutional controls, the affected tribes assume they can resume access to
26 usual and accustomed areas.

27 Future decisions about land transfer must consider the implications for Usual and Accustomed
28 uses (aboriginal and treaty reserved rights) in the long-term management of resource areas.

29 The 50-year management time horizon of the CLUP does create permanent land use
30 designations. On the contrary, land use designations or their boundaries can be changed in the
31 interim at the discretion of DOE and/or Hanford stakeholders. The CLUP is often misused by
32 assuming designations are permanent. Also, it is important to not that the interim land use
33 designations in the CLUP cannot abrogate treaty rights. That requires an act of Congress.

34 **Hanford National Monument**

35 A Presidential Proclamation established the Hanford Reach National Monument (Monument)
36 (Presidential Proclamation 7319) and it directed the DOE and the U.S. Fish and Wildlife Service

1 (FWS) jointly manage the monument. The Monument covers an area of 196,000 acres on the
2 Department of Energy's (DOE) Hanford Reservation. DOE permits and agreements delegates
3 authorities to FWS for 165,000 acres. The DOE directly manages approximately 29,000 acres,
4 and the Washington Department of Fish and Wildlife currently manages the remainder
5 (approximately 800 acres) through a separate DOE permit.

6 The Monument is co-managed by the FWS and the DOE; each agency has several missions they
7 fulfill at the Hanford Site. The FWS is responsible for the protection and management of
8 Monument resources and people's access to Monument lands under FWS control. The FWS also
9 has the responsibility to protect and recover threatened and endangered species; administer the
10 Migratory Bird Treaty Act; and protect fish, wildlife and Native American and other trust
11 resources within and beyond the boundaries of the Monument.

12 The FWS developed a comprehensive conservation plan (CCP) for management of the
13 Monument as part of the National Wildlife Refuge System as required under the National
14 Wildlife Refuge System Improvement Act. The CCP is a guide to managing the Monument lands
15 (165,000 acres). It should be understood that FWS management of the Monument is through
16 permits or agreements with the DOE.

17 Tribes participated in the development of the CCP with regard to protection of natural and
18 cultural resources and tribal access. Based on the Presidential Proclamation that established the
19 Hanford Reach National Monument, Affected tribes assume that all of Hanford will be restored
20 and protected.⁴

21 **Operable Units (OUs)**

22 Hanford has delineated contamination areas called operable units (OUs) both subsurface
23 contamination OUs and surface contamination OUs. When describing the affected environment
24 for land use it is essential to reference this information that should be presented in the soils and
25 groundwater sections. By understanding the types and extent of surface and subsurface
26 contamination will give better understanding of the CLUP landuse designations. For example,
27 the proposed GTCC site at Hanford lies somewhere in or near the 200 ZP-1 groundwater OU.
28 This OU has contamination from uranium, technetium, iodine 129 and other radioactive and
29 chemical constituents.

30

⁴ FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

1 **Transportation**

2 **Traditional transportation:**

3 Indian people have been traveling this homeland to usual and accustomed areas for a very long
4 time. Early modes of transportation began with foot travel. Domesticated dogs were utilized to
5 carry burdens. Dugout canoes were manufactured and used to traverse the waterways when the
6 waters were amiable. Otherwise, trails along the waterways were used. The arrival of the horse
7 changed how people traveled. Numerous historians note its arrival to the Columbia Plateau in
8 the late 1700's but they are mistaken. The arrival of the horse was actually a full century earlier
9 in the late 1600's. Its acquisition merely quickened movement on an already extant and heavily
10 used travel network. This travel network was utilized by many tribal groups on the Columbia
11 Plateau and was paved by thousands of years of foot travel. Early explorers and surveyors
12 utilized and referenced this extensive trail network. Some of the trails have become major
13 highways and the Columbia and Snake Rivers are still a crucial part of the modern transportation
14 network.

15 The Middle Columbia Plateau of the Hanford area is the crossroads of the Columbia Plateau
16 located half way between the Great Plains and the Pacific Northwest Coast. In this area major
17 Columbia River tributaries the Walla Walla, Snake, and Yakima Rivers flow into this section of
18 the main stem Columbia River. These rivers formed a critical part of a complex transportation
19 network north, south, east, and west through the region including the Columbia River through
20 the Hanford site. The slow water at the Wallula Gap was one of the few places where horses
21 could traverse the river year round. The river crossing at Wallula provided access to a vast web
22 of trails that crossed the region. Portions of these trails are known to cross the Hanford site.

23 **Present Transportation:**

24 There are two interstate highways that near the site [Interstate 90 (I-90) and Interstate 84 (I-84)].
25 There are estimates of as many as 12,000 shipments of GTCC waste that would need to be
26 delivered to Hanford by rail, barge or highway. The Nez Perce Tribe believes that decision-
27 making criteria need to be presented in the EIS to clarify how rail, barge or highway routing will
28 be determined. Treaty resources and environmental protections are important criteria in
29 determining a preferred repository location. The public needs to be assured that the public health
30 and high valued resources like salmon and watersheds are going to be protected.

31 Northwest river systems have received significant federal and state resources over recent decades
32 in an attempt to recover salmon and rehabilitate damaged watersheds. DOE needs to describe
33 how public safety, salmon and watersheds "fit" into the criteria selection process for determining
34 a GTCC waste site and multiple shipping options. The protection and enhancement of existing
35 river systems are critical to sustaining tribal cultures along the Columbia River.

1 The interstate highway system is a primary transportation corridor for shipping nuclear waste
2 through the states of Oregon, Washington, and Idaho. Waste moving across these states will
3 cross many major salmon bearing rivers that are important to the Tribes. Major rail lines also
4 cross multiple treaty resource areas.

5 **Cultural Resources**

6 From a tribal perspective, all things of the natural environment are recognized as a cultural
7 resource. This is a different perspective from those who think of cultural resources as artifacts or
8 historic structures. The natural environment provides resources for a subsistence lifestyle for
9 tribal people. This daily connection to the land is crucial to Nez Perce culture and has been
10 throughout time. All elements of nature therefore are the connection to tribal religious beliefs.
11 Oral histories confirm this cultural and religious connection.

12 “According to our religion, everything is based on nature. Anything that grows or lives,
13 like plants and animals, is part of our religion...” *Horace Axtell (Nez Perce Tribal Elder)*.

14 **Landscape and Ethno-Habitat**

15 For thousands of years American Indians have utilized the lands in and around the Hanford Site.
16 Historically, groups such as the Yakama, the Walla Walla, the Wanapum, the Palouse, the Nez
17 Perce, the Columbia, and others had ties to the Hanford area. “The Hanford Reach and the
18 greater Hanford Site, a geographic center for regional American Indian religious activities, is
19 central to the practice of the Indian religion of the region and many believe the Creator made the
20 first people here (DOI 1994). Indian religious leaders such as Smoholla, a prophet of Priest
21 Rapids who brought the Washani religion to the Wanapum and others during the late 19th
22 century, began their teachings here (Relander 1986). Prominent landforms such as Rattlesnake
23 Mountain, Gable Mountain, and Gable Butte, as well as various sites along and including the
24 Columbia River, remain sacred. American Indian traditional cultural places within the Hanford
25 Site include, but are not limited to, a wide variety of places and landscapes: archaeological sites,
26 cemeteries, trails and pathways, campsites and villages, fisheries, hunting grounds, plant
27 gathering areas, holy lands, landmarks, important places in Indian history and culture, places of
28 persistence and resistance, and landscapes of the heart (Bard 1997). Because affected tribal
29 members consider these places sacred, many traditional cultural sites remain unidentified.”
30 NEPA 18 4.6.1.2 (p. 4.120).

31 **Viewshed**

32 The Nez Perce Tribe utilizes vantage points to maintain a spiritual connection to the land.
33 Viewsheds must remain in their natural state, they tend to be panoramic and are made special
34 when they contain prominent uncontaminated topography. The viewshed panorama is further
35 enhanced by abrupt changes in topography and or habitats.

36 Nighttime viewsheds are also significant to indigenous people who still use the Hanford Reach.
37 Each tribe has stories about the night sky and why stars lie in their respective places. The

1 patterns convey spiritual lessons via oral traditions. Often, light pollution from neighboring
2 developments diminishes the view of the constellations. It is getting difficult to find places to
3 simultaneously relate the oral traditions and view the corresponding constellations.

4 There are several culturally significant viewsheds located on the Hanford site. The continued use
5 of these sites brings spiritual renewal. Special considerations should be given to tribal elders and
6 youth to accommodate traditional ceremonies.

7 **Salmon**

8 Salmon remain a core part of the oral traditions of the tribes of the Columbia Plateau and still
9 maintains a presence in native peoples' diet just as it has for generations. Salmon are recognized
10 as the first food at tribal ceremonies and feasts. One example is the *ke'uyit*, which translates to
11 "first bite." It is a ceremonial feast that is held in spring to recognize the foods that return to take
12 care of the people. It is a long-standing tradition among the people and it is immersed in prayer
13 songs and dancing. Salmon is the first food that is eaten by the attendants. Extending gratitude to
14 the foods for sustaining the life of the people is among the tenets of plateau lifestyle. Nez Perce
15 life is perceived as being intertwined with the life of the Salmon. A parallel can be seen between
16 the dwindling numbers of the Salmon runs and the struggle of native people (Landeem and
17 Pinkham 1999).

18 **Waste Management**

19 The Nez Perce Tribe will continue to work with DOE via its cooperative agreement on cleanup
20 issues to ensure that treaty rights and cultural and natural resources are being protected and that
21 interim cleanup decisions are protective of human health and the environment.

22 **Cumulative Impacts**

23 Within this EIS process, a cumulative risk assessment needs to be developed for the Hanford
24 option. This risk assessment needs to utilize the existing Hanford Tribal risk scenarios (CTUIR,
25 Yakama Indian Nation, DOE default), and include existing Hanford risk values to determine
26 cumulative impacts.

27 Institutional control boundaries need to be clearly displayed in a map, showing the GTCC
28 proposed repository and the extent it will add to the size, scope, and timeframe of limiting
29 access. For tribal people, a 10,000-year repository extends institutional controls without
30 reasonable compensation or mitigation.

31

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2

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28

29

1 **Appendix A**

2 **Legal Framework**

3 **TREATY RIGHTS AND OBLIGATIONS**

4

5 The Nez Perce Tribe is a sovereign government whose territory comprises over 13 million acres
6 of what are today northeast Oregon, southeast Washington, and north-central Idaho. In 1855 the
7 Nez Perce Tribe entered into a treaty with the United States, securing, among other guarantees a
8 permanent homeland, as well as fishing, hunting, gathering, and pasturing rights. (Treaty with
9 the Nez Perces, June 11, 1855; 12 Stat. 957).

10

11 Since 1855, many federal and state actions have recognized and reaffirmed the Tribe's treaty-
12 reserved rights. The Tribe's treaty-reserved interests in the Hanford Reach area inform its
13 legal relationship with the United States. Aboriginal rights provided in the 1855 Treaty extend to
14 areas of land in Idaho and surrounding states, including the Columbia, Snake, and Salmon River
15 regions, which may be impacted by DOE activities. Because these rights are of enormous
16 importance to the Tribe's subsistence and cultural fabric, the ecosystems that support fish and
17 wildlife (including both flora and fauna) must remain undamaged and productive. DOE
18 recognizes the existence of reserved treaty rights and is committed to identifying and assessing
19 impacts of all DOE activities to both on and off-reservation lands.

20

21 The Nez Perce Tribe has the responsibility to protect the health, welfare, and safety of its
22 members, and the environment and cultural resources of the Tribe. Therefore, activities (such as
23 any release of hazardous/radioactive substances to the air, water, or soil column) related to the
24 Hanford operations and cleanup should avoid endangering the Tribe's environment and culture,
25 or impairing their ability to protect the health and welfare of Tribal members.

26

27 **The Nez Perce Tribe Treaty of 1855**

28 The Nez Perce Tribe Treaty of 1855 promulgated articles of agreement between the United
29 States and the Tribe. The Treaty is superior to any conflicting state laws or state constitutional
30 provisions under the Supremacy Clause of the U.S. Constitution (Art. VI. cl. 2).

31

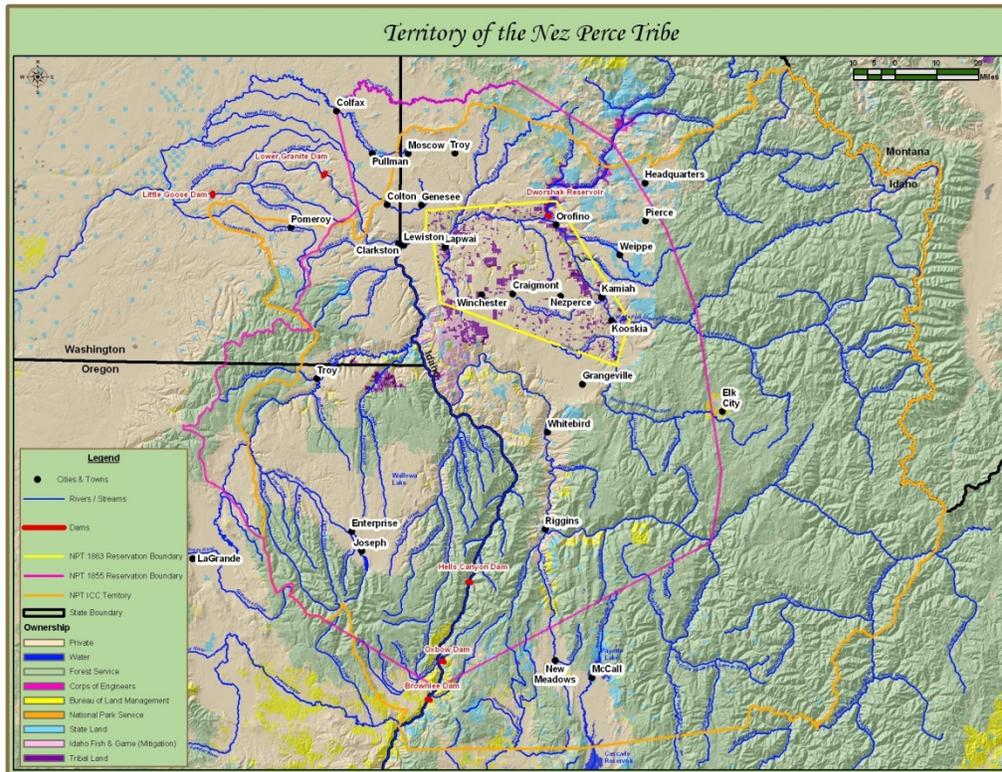
32 Under the Treaty of 1855, the Tribe ceded certain areas of its aboriginal lands to the United
33 States and reserved for its exclusive use and occupation certain lands, rights, and privileges; and
34 the United States assumed fiduciary responsibilities to the Tribe.

35

36 Rights reserved under the Treaty of 1855 include those found in Article 3 of the
37 Treaty, "*The exclusive right of taking fish in all the streams where running*
38 *through or bordering said reservation is further secured to said Indians; as also*
39 *the right of taking fish at all usual and accustomed places in common with*
40 *citizens of the Territory; and of erecting temporary buildings for curing, together*

1 with the privilege of hunting, gathering roots and berries, and pasturing their
 2 horses and cattle upon open and unclaimed land.”
 3
 4

5 The reserved rights to the aforementioned areas are a fundamental concern to the Nez Perce
 6 Tribe. The fish, roots, wild game, religious sites, and ancestral burial and living sites remain
 7 integral to the Nez Perce culture. The Tribe expects, accordingly, to be the primary consulting
 8 party in all federal actions related to Hanford that stand to affect or implicate the Tribe’s treaty-
 9 reserved or cultural interests.
 10
 11



12
 13 **Treaty Reserved Resources**

14
 15 Treaty reserved resources situated on and off the Reservation (hereinafter referred to as “Tribal
 16 Resources”) include but are not limited to:

17
 18 Tribal water resources located within the Columbia, Snake, and Clearwater River Basins
 19 including those water resources associated with the Tribe’s usual and accustomed fishing areas
 20 and Tribal springs and fountains described in Article 8 of the Nez Perce Tribe Treaty of 1863;
 21

22 Fishery resources situated within the Reservation, as well as those resources associated with the
 23 Tribe’s usual and accustomed fishing areas in the Columbia, Snake, and Clearwater River
 24 Basins;

1
2 Areas used for the gathering of roots and berries, hunting, and other cultural activities within
3 open and unclaimed lands including lands along the Columbia, Clearwater, and Snake River
4 Basins;
5
6 Open and unclaimed lands which are or may be suitable for domestic livestock grazing;
7
8 Forest resources situated on the Reservation and within the ceded areas of the Tribe;
9
10 Land holdings held in trust or otherwise located on and off the Nez Perce Reservation in the
11 States of Idaho, Oregon; and Washington;
12
13 Culturally sensitive areas, including, but not limited to, areas of archaeological, religious, and
14 historic significance, located both on and off the Reservation.
15

16 **FEDERAL RECOGNITION OF TRIBAL SOVEREIGNTY**

17
18 A unique political relationship exists between the United States and Indian Tribes, as defined by
19 treaties, the United States Constitution, statutes, federal policies, executive orders, court
20 decisions, , which recognize Tribes as separate sovereign governments.
21 As a fiduciary, the United States and all its agencies owe a trust duty to the Nez Perce Tribe and
22 other federally-recognized tribes. *See United States v. Cherokee Nation of Oklahoma*, 480 U.S.
23 700, 707 (1987); *United States v. Mitchell*, 463 U.S. 206, 225 (1983); *Seminole Nation v. United*
24 *States*, 316 U.S. 286, 296-97 (1942). This trust relationship has been described as “one of the
25 primary cornerstones of Indian law,” Felix Cohen, Handbook of Federal Indian Law 221 (1982),
26 and has been compared to one existing under the common law of trusts, with the United States as
27 trustee, the tribes as beneficiaries, and the property and natural resources managed by the United
28 States as the trust corpus. *See, e.g. Mitchell*, 463 U.S. at 225.
29
30 The United States’ trust obligation includes a substantive duty to consult with a tribe in decision-
31 making to avoid adverse impacts on treaty resources and a duty to protect tribal treaty-reserved
32 rights “and the resources on which those rights depend.” *Klamath Tribes v. U.S.*, 24 Ind. Law
33 Rep. 3017, 3020 (D.Or. 1996). The duty ensures that the United States conduct meaningful
34 consultation “in advance with the decision maker or with intermediaries with clear authority to
35 present tribal views to the ... decision maker.” *Lower Brule Sioux Tribe v. Deer*, 911 F. Supp
36 395, 401 (D. S.D. 1995).
37
38 Consistent with the United States’ trust obligation to Tribes, Congress has enacted numerous
39 laws to protect Tribal resources and cultural interests, including, but not limited to the National
40 Historic Preservation Act (NHPA) of 1966; the Archaeological Resources Protection Act of
41 1979; the Native American Graves Protection and Repatriation Act (NAPRA) of 1990; and the
42 American Indian Religious Freedom Act (AIRFA) of 1978.

1 **Executive Orders**

2 **Executive order, 13007**, May 24, 1996. Updated April 30, 2002.

3 *Section 1. Accommodation of Sacred Sites.* (a) In managing Federal lands, each executive branch
4 agency with statutory or administrative responsibility for the management of Federal lands shall,
5 to the extent practicable, permitted by law, and not clearly inconsistent with essential agency
6 functions, (1) accommodate access to and ceremonial use of Indian sacred sites by Indian
7 religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred
8 sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.

9 This Executive Order directs Federal land-managing agencies to accommodate Native
10 Americans' use of sacred sites for religious purposes and to avoid adversely affecting the
11 physical integrity of sacred sites. {267} Some sacred sites may be considered traditional cultural
12 properties and, if older than 50 years, may be eligible for the National Register of Historic
13 Places. Thus, compliance with the Executive Order may overlap with Section 106 and Section
14 110 of NHPA. Under the Executive Order, Federal agencies managing lands must implement
15 procedures to carry out the directive's intent. Procedures must provide for reasonable notice
16 where an agency's action may restrict ceremonial use of a sacred site or adversely affect its
17 physical integrity. {268} Federal agencies with land-managing responsibilities must provide the
18 President with a report on implementation of Executive Order No. 13007 one year from its
19 issuance.

20 Executive Order No. 13007 builds upon a 1994 Presidential Memorandum concerning
21 government-to-government relations with Native American tribal governments. The
22 Memorandum outlined principles Federal agencies must follow in interacting with federally
23 recognized Native American tribes in deference to Native Americans' rights to self-governance.
24 {269} Specifically, Federal agencies are directed to consult with tribal governments prior to
25 taking actions that affect federally recognized tribes and to ensure that Native American
26 concerns receive consideration during the development of Federal projects and programs. The
27 1994 Memorandum amplified provisions in the 1992 amendments to NHPA enhancing the rights
28 of Native Americans with regard to historic properties.

29

30 **Executive Order 11593**

31

32 Section 1. Policy. The Federal Government shall provide leadership in preserving, restoring and
33 maintaining the historic and cultural environment of the Nation. Agencies of the executive
34 branch of the Government (hereinafter referred to as "Federal agencies") shall (1) administer the
35 cultural properties under their control in a spirit of stewardship and trusteeship for future
36 generations, (2) initiate measures necessary to direct their policies, plans and programs in such a
37 way that federally owned sites, structures, and objects of historical, architectural or
38 archaeological significance are preserved, restored and maintained for the inspiration and benefit
39 of the people, and (3), in consultation with the Advisory Council on Historic Preservation (16
40 U.S.C. 4701), institute procedures to assure that Federal plans and programs contribute to the

1 preservation and enhancement of non-federally owned sites, structures and objects of historical,
2 architectural or archaeological significance.

3

4 The Executive Order requires Federal agencies to administer cultural properties under their
5 control and direct their policies, plans, and programs in such a way that federally owned sites,
6 structures, and objects of historical, architectural, or archeological significance were preserved,
7 restored, and maintained. {250} To achieve this goal, Federal agencies are required to locate,
8 inventory, and nominate to the National Register of Historic Places all properties under their
9 jurisdiction or control that appear to qualify for listing in the National Register. {251} The courts
10 have held that Executive Order No. 11593 obligates agencies to conduct adequate surveys to
11 locate "any" and "all" sites of historic value, {252} although this requirement applies only to
12 federally owned or federally controlled properties. {253} Moreover, the Executive Order directs
13 agencies to reconsider any plans to transfer, sell, demolish, or substantially alter any property
14 determined to be eligible for the National Register and to afford the Council an opportunity to
15 comment on any such proposal. {254} Again, the requirement applies only to properties within
16 Federal control or ownership. {255} Finally, the Executive Order requires agencies to record any
17 listed property that may be substantially altered or demolished as a result of Federal action or
18 assistance and to take necessary measures to provide for maintenance of and future planning for
19 historic properties. {256}

20

21 **Executive Order 13175, November 6, 2000**

22

23 Executive Order 13175 establishes regular and meaningful consultation and collaboration with
24 tribal officials in the development of Federal policies that have tribal implications, to strengthen
25 the United States government-to-government relationships with Indian tribes, and to reduce the
26 imposition of unfunded mandates upon Indian tribes. The executive Order applies to all federal
27 programs, projects, regulations and policies that have Tribal Implications.

28

29 E.O. further provides that each "agency shall have an accountable process to ensure meaningful
30 and timely input by tribal officials in the development of regulatory policies that have tribal
31 implications." According to the President' April 29, 1994 memorandum regarding Government-
32 to-Government Relations with Native American Tribal Governments, federal agencies "shall
33 assess the impacts of Federal Government plans, projects, programs, and activities on tribal trust
34 resources and assure that Tribal government rights and concerns are considered during the
35 development of such plans, projects, programs, and activities." As a result, Federal agencies
36 must proactively protect tribal interest, including those associated with tribal culture, religion,
37 subsistence, and commerce. Meaningful consultation with the Nez Perce Tribe is a vital
38 component of this process.

39

40 On November 5, 2009 President Obama issued a Presidential Memorandum for the Heads of
41 Executive Departments and Agencies. That Memorandum affirms the United States'
42 government-to-government relationship with Tribes, and directs each agency to submit to the
43 Office of Management and Budget (OMB), within 90 days and following consultation with tribal
44

44

1 governments, “a detailed plan of actions the agency will take to implement the policies and
2 directives of Executive Order 13175.”
3

4 **U.S. Department of Energy American Indian Policy**

5 On November 29, 1991, DOE announced a seven-point American Indian Policy, which
6 formalizes the government-to-government relationship between DOE and federally recognized
7 Indian Tribes. A key policy element pledges prior consultation with Tribes where their interests
8 or reserved treaty rights might be affected by DOE activities. The DOE American Indian Policy
9 provides another basis for the Cooperative Agreement. The Cooperative Agreement will also
10 serve as an Office of Environmental Management Implementation Plan for the DOE American
11 Indian Policy regarding interactions with the Nez Perce Tribe.
12
13

14 **THE ROLES OF THE NEZ PERCE TRIBE AT HANFORD**

15 The Tribe has a duty to protect its reserved treaty rights and privileges, environment, culture, and
16 welfare as well as to educate its members and neighboring public to its activities. The Tribe
17 assumes many different roles. It is a governmental entity with powers and authorities derived
18 from its inherent sovereignty, from its status as the owner of land, and from legislative
19 delegations from the Federal government. The Tribe exercises its powers and authority to serve
20 its members and to regulate activities occurring within the reservation. The Tribe is also a
21 cultural entity and is accordingly charged with the responsibility of protecting and transmitting
22 that culture which is uniquely Nez Perce. The Tribe is also a beneficiary within the context of
23 federal trust relationship with, and obligations to Indian Tribes. The Tribe is a trustee
24 responsible for the protection and betterment of its members and the protection of its and their
25 rights and privileges. The Tribe is also party to treaties between itself and the United States
26 government.
27
28

29 **Nez Perce and DOE Relationship**

30
31 The relationship between the Tribe and DOE is defined by the trust relationship that exists
32 between the Federal government and the Tribe, by treaty, federal statute, executive orders,
33 administrative rules, caselaw, DOE’s American Indian Policy, and by the mutual and generally
34 convergent interests of the parties in the efficient and expeditious cleanup of the DOE weapons
35 complex, and by the Cooperative Agreement. The structured relationship embodied by the
36 Cooperative Agreement can best be described as a partnership grounded in the site-specific
37 cleanup of Hanford, and extends to all trust-related activities of the Department.
38

39 The Tribe sees itself not only as an advisor to DOE, but also as a technical resource available to
40 assist DOE. The Tribe sees its members and employees as a source of technically trained and
41 certified labor for environmental restoration and decontamination and decommissioning work.
42

1 The continuation of the Cooperative Agreement contemplates an approach that will integrate
2 these and other roles into a comprehensive Nez Perce-DOE program.

3
4 The Tribe is asked to review and comment on documents and activities by DOE implicates our
5 Treaty reserved rights and DOE's acknowledgement of other federal statutes, laws, regulations,
6 executive orders and memoranda governing the United States' relationship with Native
7 Americans and the Nez Perce people. Several tribal departments lend their respective technical
8 expertise to DOE Hanford issues and present recommendations to the Nez Perce Tribal
9 Executive Committee (NPTEC), for consideration and guidance. The NPTEC also may requests
10 formal consultation with the federal agency to discuss a proposal or issue further.

11 12 **Consultation with Native Americans**

13
14 DOE's consultation responsibilities to the Tribe are enumerated generally in the document
15 entitled, Consultation with Native Americans. This policy defines consultation in relevant part:

16
17
18 "Consultation includes, but is not limited to: prior to taking any action with
19 potential impacts upon American Indian and Alaska Native nations, providing
20 for mutually agreed protocols for timely communication, coordination,
21 cooperation, and collaboration to determine the impact on traditional and
22 cultural lifeways, natural resources, treaty and other federally reserved rights
23 involving appropriate tribal officials and representatives through the decision
24 making process."

25
26
27 In regard to security clearance, none of the various provisions of the continuation of the
28 Cooperative Agreement shall be construed as providing for the release of reports or other
29 classified information designated as "classified" or "Unclassified Controlled Nuclear
30 Information" to the Nez Perce Tribe, or as waiving any other security requirements. Classified
31 information includes National Security Information (10 CFR Part 1045) and Restricted Data (10
32 CFR Part 1016). Unclassified Controlled Nuclear Information is described in 10 CFR Ch. X,
33 Part 1017.

34
35 In the event that reports or information requested under the provisions of the continuation of the
36 Cooperative Agreement, while not "classified" or "Unclassified Controlled Nuclear
37 Information," are determined by DOE-RL to be subject to the provisions of the Privacy Act, or
38 the exemptions provided under the Freedom of Information Act, DOE-RL may, to the extent
39 authorized by law, provide such reports or information to the Tribes upon receipt of the Tribe's
40 written assurance that the Nez Perce Tribe will maintain the confidentiality of such data.

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**Greater Than Class C Radioactive Waste Environmental Impact
Statement**

Pueblo Views on Environmental Resource Areas

Los Alamos Meeting of Pueblo EIS Writers

June 7 – 12, 2009

Pueblo Writers Representatives

- Martin O. Hampshire, Nambe Pueblo**
- Ernestine Naranjo, Santa Clara Pueblo**
- Steven G. Rydeen, Pueblo de San Ildefonso**
- Brian A. Suazo, Santa Clara Pueblo**
- Lee R. Suina, Pueblo de Cochiti**
- Kevin Tafoya, Santa Clara Pueblo**
- Georgia A. Yates-Hampshire, Nambe Pueblo**
- John W. Yates, Nambe Pueblo**

Facilitated By

- Richard W. Arnold, Pahrump Paiute Tribe**
- Richard W. Stoffle, University of Arizona**

1

2

3 1.1 Climate

4 The Pueblo people, having lived since the beginning of time in the region of the proposed
5 GTCC waste disposal site, are concerned about meteorological climate shifts occurring
6 over hundreds of years and longer term climate changes occurring over thousands of
7 years. Such shifts impact vegetation. During dryer periods vegetation burns increase and
8 post-burn erosion is accelerated. The Cerro Grande fire (Grieggs, Ramos, and Percy
9 2001) increased post-fire storms' runoff flows in some drainages more than 1,000 times
10 the pre-fire levels (United States Department of Energy [DOE] 2008: 4-59). These higher
11 runoff flows increased erosion and moved radioactive and hazardous materials
12 downstream towards the Pueblo people.

13

14 During warmer periods, more intense rainfall episodes occur and less snow falls in
15 winter, thus increasing erosion. Tree ring data document shifts in annual rainfall between
16 1523 and today, with a rainfall high in 1597 of 40 inches to a low in 1685 of 2.4 inches
17 (Sean Rev 4.0: 2008 2-12).

18

19 During the Holocene, major shifts occurred in this region, and the GTCC disposal is to be
20 evaluated for a duration of 10,000 years. These climate shifts are both culturally
21 important to the Pueblo people who conduct ceremonies to balance climate and pertinent
22 to the consideration of GTCC proposal.

23

24 1.2 Existing Air Emissions

25 Contaminated air emissions either from fugitive dust, violent storms, dust devils,
26 emission stacks, bomb testing, burn pits, or from the Cerro Grande fire have spread to
27 surrounding Pueblo lands and communities. A Santa Clara Pueblo wind monitor
28 meteorological station recorded a wind of 70 miles per hour. Dust devils have been
29 recorded by LANL at 73 miles per hour. Santa Clara, Pueblo de San Ildefonso, Pueblo de
30 Cochiti, and Jemez perceive that they have received contaminated ash and air from the
31 Cerro Grande fire, from more than 110 historic and active LANL emission stacks, and
32 bomb testing detonations. Nambe, Pojoaque, and the surrounding Pueblos perceive that
33 they too received contaminated ash from the Cerro Grande fire. The contaminations from
34 these events exposed natural resource users ranging from hunters of animals to gatherers
35 of clay for pots. Even normal Pueblo residents were exposed in many ways from farming
36 to outdoor activities to everyday life.

37

38 The Pueblo de Cochiti is situated within Sandoval County, and emissions rates here were
39 not compared in the GTCC to emission rates of LANL. The Pueblo de Cochiti is located
40 south of LANL and adjacent to the PSD [Prevention of Significant Deterioration] Class I
41 Bandelier National Monument. The Pueblo de Cochiti could thus be considered a PSD
42 Class I area as well and all emissions pose a threat to this classification.

43

44 All the Accord Pueblos (Pueblo de San Ildefonso, Pueblo de Cochiti, Santa Clara, and
45 Jemez Pueblo) are currently conducting independent studies of air emissions from LANL.

46

1 These studies have been ongoing for about ten years. Some Pueblos have their findings
2 evaluated by independent laboratories. These studies are monitoring tritium, plutonium,
3 uranium, americium, and other radionuclides and metals. Some of the studies have
4 documented contaminated air emissions on Pueblo lands.

5

6 1.3 Existing Noise Environment

7

8 The Sacred Area is currently monitored for noise by Pueblo de San Ildefonso. Noise,
9 which from a Pueblo perspective is an unnatural sound, does disturb ceremony and the
10 place itself. Currently non-Indian voices, machinery, and processing equipment have
11 been recorded by Pueblo de San Ildefonso monitors as coming from Area G to the Sacred
12 Area.

13

14 1.4 Geology

15

16 The Pueblo people are aware of the occurrence of major earthquakes in the GTCC study
17 area (up to 2000 have been recorded in recent times). These cause vertical displacements,
18 large fissures, and small fractures. Water seeps into these fissures and plant roots follow
19 them to great depths (up to 66 feet). Pueblo people believe that plant roots will eventually
20 penetrate the GTCC facility.

21

22 1.5 Minerals and Energy Resources

23

24 The Pueblo people who visited the proposed GTCC disposal site note the likelihood of
25 traditionally used minerals occurring there. They assess that this is a medium to high
26 probability. There is a need for a cultural mineral assessment and study to identify the
27 existence of minerals of cultural significance and use.

28

29 Although there is no current Pueblo ethnogeology studies for the LANL, one was
30 recently developed for Bandelier National Monument (Stoffle et al. 2007). That study,
31 which was approved by the participating pueblos, documented that 96 geological
32 resources were found to have specific uses by Pueblo people, which is estimated to be the
33 bulk of the occurring minerals in Bandelier NM. The following are the ten most
34 frequently cited mineral resources, presented in order of frequency of reference. Included
35 also is the number of pueblos that were documented to have used the named resource (1)
36 Clay 17 times mentioned for 7 pueblos; (2) Turquoise 15 times mentioned for 7 pueblos;
37 (3) Basalt 15 times mentioned for 5 pueblos; (4) Obsidian 9 times mentioned for 4
38 pueblos; (5) Gypsum 8 times mentioned for 5 pueblos; (6) Rock Crystal 8 times
39 mentioned for 5 pueblos; (7) Salt 7 times mentioned for 4 pueblos; (8) Mica 6 times
40 mentioned for 5 pueblos; (9) Sandstone 6 times mentioned for 5 pueblos; and (10)
41 Hematite 6 times mentioned for 4 pueblos. Just as there are certain minerals that are more
42 frequently documented, certain pueblos were more often the subject of observations and
43 ethnographies (Stoffle et al. 2007: 33).

44

45

46 1.6 Surface Water

1
2 Pueblo people know that drainages in LANL flow during major runoff and storm events.
3 These flows, though at times low in volume, have a potential to reach the Rio Grande and
4 lower water bodies. In 1996, the Pueblo of Cochiti conducted a cooperative sediment
5 study with LANL and the USGS in which Pre-1960s Legacy Waste was identified using
6 the Thermal Ionization Mass Spectroscopy (TIMS) method. This Pre-1960s Legacy
7 Waste has been recorded on the up-river portion of the Cochiti Reservoir, which is on the
8 Rio Grande as it passes through the Cochiti Reservation.

9
10 There exists high potential for continuing pollution flows as indicated in the GTCC text
11 above, and now the Cerro Grande fire has increased the potential for constituent
12 movement as indicated in the Site-Wide EIS (DOE 2008: 4-59, 4-60). Evidence of
13 radioactivity and hazardous waste (PCBs) movement from LANL has led to fish
14 consumption warnings on eating fish from the Rio Grande.

15

16

17 1.7 Groundwater

18

19 Pueblo people know that extensive work has been completed to map and determine flow
20 rates, direction, and quality of groundwater systems. There are independent studies
21 published which challenge these findings. These other studies maintain that monitoring at
22 sites is inadequate and that the drilling practices influence the results (see Bob Gilkeson
23 Reports).

24

25 Santa Clara Pueblo is concerned that their groundwater is being contaminated by LANL
26 – especially from TA 54 waste deposits. Even though Santa Clara Pueblo is upstream
27 when only surface water is considered, known faults between LANL and SCP are
28 suspected to connect reservation groundwater and TA 54 wastes in LANL groundwater.
29 Current investigations by Santa Clara Pueblo science teams and funded by the Pueblo are
30 on-going to determine if Santa Clara Pueblo groundwater is connected through water
31 bearing faults.

32

33 1.8 Human Health

34

35 Standard calculations of human health exposure as used for the General Public are not
36 applicable to Pueblo populations. The concept General Public is an EPA term that is a
37 generalization that derives from studies of average adult males. Residency time for the
38 General Public tends to be a short period of an individual's lifetime and exposure is
39 voluntary. Pueblo people live here in their Sacred Home Lands for their entire lives and
40 will continue to reside here forever.

41

42 Pueblo people use their resources differently than average US citizens so standard dosing
43 rates do not apply. For ceremonial purposes, for example, water is consumed directly
44 from surface water sources and natural springs. Potters, for example, have direct and
45 intimate contact with stream and surface clay deposits. Natural pigment paints, for

1 example, are placed on people's bodies and kept there through long periods of time
 2 during which strenuous physical activities opens the pores.

3

4

5 1.9 Ecology

6

7 Pueblo People know that they have many traditional plants and animals located on and
 8 near to the GTCC proposal area. During a brief visit to the proposed GTCC site, Pueblo
 9 EIS writers identified traditional use plants, which include medicinal, ceremonial, and
 10 domestic use plants. These plants were identified in a brief period and it was noted that
 11 many plants could be identified were a full ethnobotany of the site to be conducted.
 12 During this site visit the Pueblo EIS writers identified the presence of traditional animals,
 13 but noted that more could easily be identified during a full ethnozoological study.

14

15 While a full list of the traditional use plants was not available at the time of this analysis,
 16 a recent study conducted on the adjacent Bandelier National Monument identified 205
 17 Pueblo use plants there (Stoffle et al. 2007). These use plants represent 59% of the known
 18 plants on the official plant inventory of Bandelier.

19

20 A Pueblo Writers' GTCC site visit and a draft LANL LLRW study for Area G
 21 documented the presence of the following plants:

22

23

24

Plants From LLRW Areas	Listed in Area G LLRW Study	Observed by Pueblo Writer's Group
Blue Grama (<i>Bouteloua gracilis</i>)	X	P
Indian Rice Grass (<i>Oryzopsis hymenoides</i>)		P
Cutleaf evening primrose (<i>Oenothera caespitosa</i>)	X	
Mullein Amaranth (<i>Verbascum thapsus</i>)	X	P
Indian Paintbrush (<i>Castilleja sp.</i>)		P
4-O'clock (<i>Mirabilis jalapa</i>)		P
Narrowleaf Yucca (<i>Yucca angustissima</i>)	X	P
Penstemon spp.		P
Prickly Pear (<i>Opuntia polyacantha</i>)	X	P
Small Barrel (<i>Sclerocactus</i>)		P
Sunflower (<i>Helianthus petiolaris</i>)	X	P
Apache Plume (<i>Fallugia paradoxa</i>)	X	P
Big Sage (<i>Artemisia tridentate</i>)	X	P
Chamisa (<i>Chrysothamnus nauseosus</i>)	X	P

Four-wing Saltbush (<i>Atriplex canescens</i>)	X	P
Mountain Mahogany (<i>Cercocarpus montanus</i>)	X	
New Mexico Locust (<i>Robinia neomexicana</i>)	X	
Oak (<i>Quercus spp.</i>)	X	
Snakeweed (<i>Gutierrezia sarthrae</i>)	X	
Squawberry (<i>Rhus trilobata</i>)	X	
Wax Currant (<i>Ribes cereum</i>)	X	
Wolfberry (<i>Lycium barbarum</i>)		P
One-seed Juniper(<i>Juniperus monosperma</i>)	X	P
Pinon Pine (<i>Pinus edulis</i>)	X	P
Ponderosa Pine (<i>Pinus ponderosa</i>)	X	P

1

2

3 While a full list of the traditional use animals was not available at the time of this
 4 analysis, a recent study conducted on the adjacent Bandelier National Monument
 5 identified 76 Pueblo use animals there (Stoffle et al. 2007). The use animals represent
 6 76% of the animals on the official animal inventory.

7

8 A Pueblo GTCC site visit and a LANL LLRW study for Area G documented the
 9 presence of the following animals:

10

11 Deer

12 Elk

13 Lizards

14 Harvester Ants

15 Rattlesnake

16 Cicadas

17 Mocking Bird

18 Pocket Mice and Kangaroo Rats

19 Pocket Gophers

20 Chipmunks and Ground Squirrels

21

22

23 Pueblo people note that LANL intends to use cover plants such as grasses on disposal pits
 24 at closure. These reseeding efforts have caused the intrusion of non-Native plants as well
 25 as the intended stabilization grasses. This is a cultural violation because the artificial
 26 intrusion of plant seed not normally found in an area is inappropriate. In addition, while
 27 grasses are the initial reseeding plants, other plants, trees and woody plants will soon
 28 establish in the soft pit closure soils putting deep roots into the disturbed subsoil.

29

1 1.10 Environmental Justice

2

3 As Indian peoples culturally affiliated with land currently occupied by LANL, the Pueblo
4 people would like to expand the definition of Environmental Justice so that it reflects the
5 unique burdens borne by them. This definition is defined more fully below.

6

7 Pueblo people and their lands have been encroached upon by Europeans since the 1500s.
8 During this time they have experienced loss of control over many aspects of their lives
9 including (1) loss of traditional lands, (2) damage to Sacred Home Lands, (3) negative
10 health effects due to European diseases and shifting diet, and (4) lack of access to
11 traditional places. Negative encroachments that occurred during the Spanish period were
12 continued after 1849 under the United States of America's federal government. The
13 removal of lands for the creation of LANL in 1942 were a major event causing great
14 damage to Pueblo peoples. Resulting pollution to the natural environment and ground
15 disturbances from LANL activities constitute a base-line of negative Environmental
16 Justice impacts. The GTCC proposal needs to be assessed in terms how it would continue
17 these Environmental Justice impacts and thus further increase the differential emotional,
18 health, and cultural burdens borne by the Pueblo peoples.

19

20 The Congress of the United States recognized this violation of their human, cultural, and
21 national rights when the American Indian Religious Freedom Act (AIRFA) was passed in
22 1978. In the AIRFA legislation Congress told all Federal agencies to submit plans which
23 would assure they would no longer violate the religious freedom of American Indian
24 peoples (Stoffle et al. 1990). Subsequent legislation like the Native American Graves
25 Protection and Repatriation Act (NAGPRA) (1990) and Executive Order 13007 – Sacred
26 Sites Access (1996) have further defined their rights to Sacred Home Lands and
27 traditional resources. The Federal Government also has a Trust Responsibility to
28 American Indian peoples which is recognized in the DOE American and Alaska Native
29 policy (<http://www.em.doe.gov/pages/emhome.aspx>). Environmental Justice is one point
30 of analysis where these concerns can be expressed by Pueblo peoples and the obligations
31 addressed by Federal Agencies during the NEPA EIS process.

32

33 Pueblo people believe that their health has been adversely affected by LANL operations
34 including different types of cancers. These concerns were publicly recorded in videos
35 produced with Closing the Circle grants provided by the National Park Service and the
36 DOE (Pueblo de San Ildefonso 2000; Santa Clara 2001). Documentation of these adverse
37 health affects is difficult because post-mortem analysis is not normal due to cultural rules
38 regarding the treatment of the deceased and burial practices.

39

40 1.11 Land Use

41

42 There are two major power transmission lines, the Norton and Reeves Power lines, which
43 exist on both mesas that are considered by the proposed GTCC (see DOE 2008: 4-136, 4-
44 137). One line goes through GTCC Zone 6 and the other through GTCC North Side and
45 North Side Expanded. These major district power lines occupy the centers of both mesas
46 and greatly reduce the potential areas of the GTCC. Along both lines are a series of

1 Pueblo archaeology sites, which are currently signed as restricted access areas protected
2 under the National Historic Protection Act.

3

4 1.12 Transportation

5

6 Pueblo people note that all waste shipments move by highway. There are no local
7 railroads. Pueblo people believe that GTCC waste shipments will adversely impact
8 natural resources, reservation communities, tribal administration activities, public
9 schools, day schools, and businesses located along Highway 502 and Highway 84/285.

10

11 The Pueblo of Nambe is located on Highway 84/285 between the Pueblos of Pojoaque
12 and Tesuque. The Pueblo of Nambe is located on the Rio Nambe, which joins the Rio
13 Grande a few miles downstream. The Rio Nambe is the major water source for the
14 Pueblo. Nambe Falls is on the reservation is an eco-tourism destination. Also on the
15 reservation is Nambe Lake, which is used for irrigation of fields (crops) and recreation.
16 Nambe has established several businesses on Highway 84/285, such as the Nambe Pueblo
17 Development Corporation, Nambe Falls Travel Center, Hi-Tech, and many more
18 businesses are planned for this location. New businesses include a water bottling factory,
19 a housing complex, and solar and wind energy projects.

20

21 The Pueblo of Nambe raises the issue of security. The Pueblo government wants to know
22 when radioactive waste is being transported past the reservation lands. We have a “need
23 to know” and this information should be provided to appropriate tribal authorities such as
24 First Responders and Emergency Managers. The tribes with Indian Land on
25 transportation routes should be funded by the DOE to train their own radiation monitor
26 teams, to maintain capability for their own safety and to protect sovereign immunity of
27 Native American Tribes as independent Nations within the United States. This would
28 enable tribes to be effective participants in handling hazards and threats as mandated by
29 US. Department of Homeland Security in the “Metrics for Tribes” to be compliant with
30 NIMS. Tribes should be able to participate in the preparations of waste materials for
31 transportation at DOE sites. This participation/observation would give Tribes confidence
32 that proper packing techniques and guidelines are adhered to. Currently Tribes are
33 expected to “trust” that State and Federal authorities are doing this phase properly. The
34 Indian people will feel more comfortable if we have some role in observing the
35 process/procedures particularly if our observers are properly trained to understand the
36 scientific reasons associated with packaging methodology.

37

38

1 The Pueblo of Nambe wants to monitor the transportation of GTCC materials in the same
2 way that transuranic waste is monitored on its route from LANL to WIPP site at
3 Carlsbad.

4
5 The Pueblo of Santa Clara is traversed by NM 30. Near this road are tribal residential
6 areas, tribal businesses, schools, and economic developments. This highway is not an
7 alternate route for radioactive waste hauling. A violation of this rule occurred in 2006
8 when three semi-trailer trucks loaded with radioactive soils from LANL were seen using
9 NM30 as a short-cut route (they should have remained on NM 502) Drivers had
10 disregarded tribal regulations. A tribal representative caught up with them nearby and
11 recorded the violation.

12
13 Other Pueblo people have business and tribal resources along potential transportation
14 routes. The Pueblo de San Ildefonso, for example, is concerned about radioactive waste
15 transportation along Highway 502. The Totavi Business Plaza, is an area that was
16 traditionally occupied, and is now a restaurant and gas station and may be a location for
17 new tribal housing. The Pueblo de San Ildefonso youth attend a Day School, a District
18 High School, Middle School, and Elementary Schools along 502. Pojoaque has a
19 business park and two gas stations along 502 and 84/285 as well as their youth attend
20 these schools.

21

22

23 1.13 Cultural Resources

24

25 Pueblo oral histories document that they have lived in and used the entire area of LANL
26 including the GTCC proposed site since the beginning of time. Because of this Pueblo
27 people are the descendants of the people who have lived here throughout time and
28 included time periods referred by LANL archaeologists by the terms (1) Paleo-Indian, (2)
29 Archaic, (3) Ancestral Pueblo, (4) American Indian, and (5) Federal Scientific Laboratory
30 (See DOE 2008). Pueblo people lived in the area before the Ancestral Pueblo period,
31 which is dated at 1600AD. Pueblo people continue to know about and value lands,
32 natural resources, and archaeological materials located on LANL. Pueblo people continue
33 to desire and have a culturally important role and responsibilities in the management of
34 all of these traditional lands.

35

36 Recent cultural resource surveys have been conducted on LANL, which have identified
37 some sites that were not identified when LANL was established after 1943. Pueblo
38 people believe that these sites are connected with other much larger sites that were
39 destroyed when the LANL facility was built and operated. The Pueblo people express
40 concern that many early LANL developments destroyed culturally significant sites and
41 that no effort has been made to conduct ceremonies that may alleviate the violations
42 association with site destruction.

43

44

1 A known Sacred Area, primarily identified with Pueblo de San Ildefonso, is located on
2 the next mesa to the north of the proposed GTCC waste site. It is spiritually connected to
3 the surrounding area and is not bounded any federal boundaries. It is recognized as a
4 Sacred Area on old USGS quads. The Sacred Area is continually monitored by Pueblo de
5 San Ildefonso to constantly check on its cultural integrity. It has visual, auditory, and
6 spiritual dimensions. Pueblo de San Ildefonso air quality program consistently monitors
7 for tritium releases, which derive from nearby area G on TA 54 on LANL. Winds blow
8 across this area from the Southwest from LANL on to the Sacred Area. The Cerro Grande
9 fire brought ash debris which contained radionuclides to the Sacred Area. The Sacred
10 Area is thus believed to have been contaminated by the ash from Cerro Grande fire. Dust
11 contaminated from ongoing operations from area G has blown into the Sacred Area.
12

13 Although four American Indian pueblos, called by LANL the Accord Tribes: Santa Clara
14 Pueblo, Pueblo de San Ildefonso, Jemez Pueblo, and Pueblo de Cochiti have been singled
15 out during the GTCC consultation process as being both nearby and culturally connected
16 with LANL, there is a widely recognized understanding that other American Indian tribes
17 are also culturally connected with LANL. These include but are not limited to (1) all 8
18 northern pueblos including San Juan O'Hkayowingee, Nambe O-weenge, Pojoaque,
19 Picuris; (2) Jicarilla Apache; (3) southern Pueblos like Santo Domingo; and (4) western
20 pueblos like Zuni and Hopi. Important LANL actions like the GTCC EIS undergoing a
21 major analysis should include all the culturally connected (affiliated) American Indian
22 tribes.
23

24 The LANL NAGPRA consultation report includes the following statement "It is noted
25 that since around 1994, LANL has consistently consulted with five tribes on issues
26 relating to cultural resources management, or at least have informed them of proposed
27 construction projects and other issues surrounding cultural resources management at
28 LANL." These include the "Accord Pueblos" of San Ildefonso, Santa Clara, Cochiti, and
29 Jemez, each of which has signed agreements with LANL, along with the Mescalero
30 Apache Tribe. In addition, the Pueblo of Acoma and the Jicarilla Apache Nation have
31 been recognized as having an active interest in cultural resources management at LANL.
32 A draft version of that NAGPRA report was subsequently also sent in January 2002 to all
33 New Mexico Pueblos and to the Pueblos of Hopi in Arizona and Ysleta del Sur in Texas,
34 as well as to the Jicarilla Apache Nation, the Mescalero Apache Tribe, the Navajo
35 Nation, and the Ute Mountain and Southern Ute Tribes. The pueblo writers find the
36 patterns of consultation by LANL to be confusing and not clearly grounded in a formal
37 policy based on an agreed to Cultural Affiliation study.
38

39 Meaning of Artifacts, Places, and Resources – There is a general pueblo concern for pre-
40 agricultural period Indian artifacts and the places where they were left. These include the
41 role of ceremony itself as an act of sanctifying places, such as has been conducted and
42 occurred near Sacred Area over the past thousands of years. Pueblo people believe they
43 have been in the area since the beginning of time. This connection back in time thus
44 connects them to all places, artifacts, and resources in the area.
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1.14 Waste Management

The Pueblo people would like to point out a direct conflict in current LANL policy and the GTCC proposal. Today LANL is officially remediating contaminated areas. These actions result in the waste being moved to new sites such as WIPP. Some of this may be transported past Pueblo communities and economic business along transportation routes. LANL has already agreed to remove radioactive waste from Area G to WIPP. Currently LANL is shipping most kinds of radioactive and TRU waste off-site (DOE 2008: 4-160). This current LANL policy is in conflict with the GTCC proposal, which would place radioactive waste and TRU waste on LANL and near Area G. In addition, the Pueblos along the transportation routes will now be exposed twice – once to current LANL waste leaving for elsewhere like the WIPP site, and secondly to new GTCC waste shipments that are arriving from elsewhere.

The Pueblo people note that one of the potential GTCC sites, indicated as Zone 4, that is being considered in the EIS appears to have been withdrawn (June 2009) from consideration for GTCC waste because LANL is continuing to dispose of LLRW waste there (DOE 2008: 4-151). This is LLRW that has been or will be produced by LANL. These additional LANL wastes add to perceived contamination risks by the Pueblo people.

The Pueblo people note that the potential site for the GTCC waste disposal is already leaking radioactive contaminants around the perimeter of Area G and DARHT (DOE 2008: 4-32). GTCC waste could only increase the contamination of this area and add to the off-site flow of contaminants.

There is a known Sacred Area on the next ridge next to the existing LANL Area G radioactive waste isolation facility and also across from the proposed GTCC site. This Sacred Area is spiritually connected to the surrounding area and is not bounded any federal boundaries (it is even recognized as a sacred area on old USGS quads). Area is constantly monitored by Pueblo de San Ildefonso to check on its integrity. The Sacred Area has visual, auditory dimension, which are consistently monitoring for tritium from nearby areas. Winds blow across this area. The Cerro Grande fire brought ash debris, which contained radionuclides to the Sacred Area, thus the area is believed to have been contaminated by the ash from Cerro Grande fire. Radioactive Dust has blown away from Area G and has been recorded near Sacred Area. The Pueblo de San Ildefonso and other pueblo people believe that locating a GTCC facility in this area will further diminish the spiritual integrity of the Sacred Area.

1 Radioactivity studies using the TIMS (Thermo Ionization Mass Spectrometry) method
2 have been fingerprinted and thus identified the source (1996) of radioactivity found in the
3 sediments of Cochiti Reservoir as coming from LANL. This is a major concern for the
4 Cochiti people. Storm and snow run off bring LANL radioactivity downstream to places
5 where clay is deposited. There has even been a 100-year runoff event since the Cerro
6 Grande fire. Automated recorders have documented radioactivity being recently brought
7 down as far as the Pueblo de San Ildefonso. Jemez Pueblo potters also express concerns
8 they these radioactive movement will impact them when they dig through these deposits
9 while collecting clay for pottery and minerals for other uses.

10

11

12 1.15 Cumulative Impacts from the GTCC Proposed Action at LANL

13

14 Pueblo people express a concern that negative *stigmas* have been attached and will
15 continue to be attached to their Sacred Home Lands, the natural resources from these
16 lands, their businesses, and even themselves. The concept of having something, some
17 place, or some people stigmatized is well documented in the NEPA-based literature
18 (Grieggs, Ramos, and Percy 2001; Gregory, Flynn, and Slovic 1995; Messer et al. 2006;
19 Metz 1994; Slovic, Flynn, and Gregory 1994). Projects having a significant potential for
20 causing harm are recognizing as having the potential of attaching negative evaluations to
21 the places, people, and resources near where they are located. This has been especially
22 true of hazardous and radioactivity related projects.

23

24 The Pueblo people believe that the presence and activities of LANL has caused a variety
25 of negative stigmas, which Pueblo people constantly attempt to address. All of the
26 Accord Pueblos received Federal Closing the Circle grants to both document and address
27 tribal concerns about what LANL has caused. Both NPS and DOE funds were provided
28 to the Accord Pueblos to videotape oral histories regarding what impacts Indian people
29 perceive that the establishment and operation of LANL have had on traditional
30 environmental uses, cultural activities, and spiritual life
31 (<http://www.nps.gov/history/hps/HPG/Tribal/index.htm>). One set of these impacts can be
32 termed *stigmas*.

33

34 Since 1943, when LANL was established, these former pristine Pueblo lands have been
35 disturbed and polluted. This process began immediately during the development of the
36 atomic bomb when sub-critical explosions and radioactive materials processing released
37 radioactivity and mixed wastes. During this period waste disposal was weakly regulated
38 with many disposal sites being poorly documented and contained. The Center for Disease
39 Control is currently reconstructing waste releases during this early period of LANL
40 operations in order to determine whether or not a Dose Reconstruction Study should be
41 formally conducted for LANL (<http://www.lahdra.org>). Public perceptions of the LANL
42 area as being polluted have grown through time. Recently studies have added to rather
43 than reduced this perception.

44

45

1 Pueblo people document existing and potential kinds of stigmas. Some Pueblos sponsor
2 elk hunting for fundraisers. Recent newspaper discussions of radioactivity being present
3 in area plants, water, and animals have caused, according to Pueblo accounts, reduced
4 participation in such hunts. One tribal fishing lake was identified in a newspaper account
5 as having radioactive fish, which greatly reduced fishing at that lake. Food pollution fears
6 are widely documented. Tribal members also express concerns about using animals.
7 Many Pueblos are moving towards commercial sales of garden products, which are
8 marketed as local Indian-produced organic products. Concerns were expressed that were
9 contaminated clay to be used by a Pueblo potter and the pot subsequently found to be
10 contaminated that this event could greatly reduce all area pottery sales. Other Pueblo
11 people with commercial businesses along highways are concerned that radioactive waste
12 transportation accidents could reduce customer's willingness to stop at tribal businesses.
13 Even Pueblo people themselves believe that there are polluted areas which they currently
14 not do not visit because of their concern for contamination.

15

16 Pueblo people believe that the existing background of awareness of contamination would
17 be increased were the public to become aware that GTCC wastes were being transported
18 to and deposited at LANL.

19

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21

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Umatilla Input from NEPA Analysis for CTUIR at Hanford

Note to EIS preparers. The following information is intended to supplement the Hanford NEPA boilerplate¹ by adding tribal perspectives. This material evolved significantly from the materials submitted by the GTCC Tribal Writers group, but has not been reviewed by them. For questions, please call Stuart Harris (541-966-2400) or Barbara Harper (541-966-2804).

A. CTUIR Introduction to Affected Resources

A.1 History and Standing

For at least 12,000 years, the Columbia River Plateau has supported the survival and thriving for many indigenous peoples. The Columbia River flows through what was a cultural and economic center for the Plateau communities. The indigenous communities were part of the land and its cycles, and it was part of them. The land and its many entities and attributes provided for all their needs: hunting and fishing, food gathering, and endless acres of grass on which to graze their horses, commerce and economy, art, education, health care, and social systems. All of these services flowed among the natural resources, including humans, in continuous interlocking cycles. These relationships form the basis for the unwritten laws or *Tamanwit* that were taught by those who came before, and are passed on through generations by oral tradition in order to protect those yet to arrive. The ancient responsibility to respect and uphold these teachings is directly connected to the culture, the religion, and the landscape along the Columbia Plateau. The cultural identity, survival, and sovereignty of the native nations along the Columbia River and its tributaries are maintained by adhering to, respecting, and obeying these ancient unwritten laws here in this place along the N'Chi Wana, or Big River.

In contemporary times, Indian life along the Columbia River and its tributaries continues to be based on the responsibility to manage modern daily affairs and environmental management practices in a manner consistent with the ancient teachings. This responsibility is to protect, preserve, and enhance this earth including the air, water, and ground, and all that grows and lives here. In order to fulfill this responsibility, the native sovereign nations need cold, clean, uncontaminated water; clean, clear uncontaminated air; uncontaminated soil; clean, vibrant, and uncontaminated biological resources; clean, uncontaminated, and wholesome foods; and clean, uncontaminated, and healthful medicines.

¹ Duncan, J.P. (ed.) (2007) Hanford Site National Environmental Policy Act (NEPA) Characterization. PNNL-6415 Rev. 18.

1 **A.1.1 Treaties of 1855**

2
3 In 1855, representatives of the U.S. Government signed treaties with representatives from
4 many of the different Indian groups in the southern Plateau. The Indian groups ceded
5 ownership of huge tracts of land to the federal government in return for promises food,
6 education, health care, and other services, and retained the perpetual right to fish, hunt,
7 erect fish-curing structures, gather food, and graze stock throughout the region, including
8 the area in and around Hanford. Through the Treaties, the native nations sought to
9 protect their homeland and food gathering rights within the traditional use areas
10 necessary to sustain their citizens, preserve their cultural, subsistence, and ceremonial
11 practices, and ensure the survival of future generations. The Treaties are legal contracts
12 binding the native sovereign nations and the United States of America, and bring forth
13 Federal fiduciary and trusteeship responsibilities to protect these interests.

14 15 **A.1.2 Nuclear Waste Policy Act of 1982 and Tri-Party Agreement of 1989**

16
17 The Nuclear Waste Policy Act of 1982 recognized the three native nations (the
18 Confederated Tribes of the Umatilla Indian Reservation, the Yakama Nation, and the Nez
19 Perce Tribe) as “affected Indian Tribes” at Hanford because they have “federally defined
20 possessory or usage rights to other lands outside of the reservation’s boundaries arising
21 out of congressionally ratified treaties” and could be “substantially and adversely affected
22 by the locating of such a facility.” (Title 42, Chapter 108).

23
24 In 1989, the cleanup of the Site began with the Hanford Federal Facility and Consent
25 Order, also known as the Tri-Party Agreement, which is the legal framework for cleanup
26 of the Site. Through the original NWSA designation, these three native sovereign nations
27 were recognized as having vital interests in the cleanup process. In 1992, cooperative
28 agreements between the U.S. DOE-Headquarters and the three affected tribes were
29 agreed upon to enable tribal participation in Hanford cleanup issues and decisions,
30 protection of cultural resources, and (more recently) to engage in natural resource injury
31 assessment and restoration activities as Natural Resource Trustees.

32 33 **A.1.3 Policy on American Indian and Alaskan Native Tribal Government** 34 **(2000) and DOE Order 1230.2 (1992).**

35
36 In this policy DOE formalized its commitment to meeting its government-to-
37 government relationships. The most important doctrine derived from this relationship
38 is the trust responsibility of the United States to protect tribal sovereignty and self-
39 determination, tribal lands, assets, resources, and treaty and other federally recognized
40 and reserved rights. These aspects carry through the evaluation of affected resources.

41 42 **A.1.4 Framework to Provide Guidance for Implementation of US DOE’s** 43 **Policy (2007) and DOE Order 144.1**

44
45 This framework enhances DOE's government-to-government working relationship with
46 Indian Nations. DOE offices of EM, NE, SC, and NNSA will work to foster the

1 government-to-government relationship with Indian Nations impacted by its activities
2 and to maintain DOE'S trust responsibilities including: (a) protecting tribal people
3 and tribal resources from EM, NE, SC, or NNSA actions that could harm their health,
4 safety, or sustainability; and (b) protecting cultural and religious artifacts and sites on
5 lands managed by DOE. DOE will endeavor to protect natural resources which
6 include plants, animals, minerals, and natural features that have religious significance
7 to Indian tribes and/or are held in trust by the Federal Government. The aspects of
8 health and resource protection carry through the evaluation of affected resources.
9

10

11 **A.2 The Fiduciary Trust Relationship**

12

13 “The Federal Government has enacted numerous statutes and promulgated numerous
14 regulations that establish and define a trust relationship with Indian tribes. The United
15 States continues to work with Indian tribes on a government-to-government basis to
16 address issues concerning Indian tribal self-government, tribal trust resources, and Indian
17 tribal treaty and other rights” (Executive Order 13175, 65 Fed. Reg. 67249 (November 9,
18 2000)).

19

20 The Ninth Circuit has underscored the importance of trust responsibility for all agencies:

21

22 “We have noted, with great frequency, that the federal government is the trustee
23 of the Indian tribes' rights, including fishing rights. *See, e.g., Joint Bd. of Control*
24 *v. United States*, 862 F.2d 195, 198 (9th Cir. 1988). This trust responsibility
25 extends not just to the Interior Department, but attaches to the federal government
26 as a whole.”

27

28 Tribal trust law is most well developed in the arena of trust property and money². Indian
29 Trust assets include, but are not limited to money, lands, rights, and water. The federal
30 Indian trust doctrine is considered the “cornerstone” of federal Indian law.

31

32 *See Dep't of the Interior v. Klamath Water Users Protective Ass'n*, 532 U.S. 1, 11
33 (2001) (“The fiduciary relationship has been described as ‘one of the primary
34 cornerstones of Indian law,’ and has been compared to one existing under a
35 common law trust, with the United States as trustee, the Indian tribes or
36 individuals as beneficiaries, and the property and natural resources managed by
37 the United States as the trust corpus.”).

38

39 The courts have made it clear that certain kinds of Indian property and monies are held by
40 the United States in trust. In such cases, the government must assume the obligations of a
41 fiduciary or trustee. The courts have imposed trust duties with respect to tribal funds.
42 Additionally, as the Indian Claims Commission noted, “the fiduciary obligations of the
43 United States toward restricted Indian reservation land, including minerals and timber,
44 are established by law and require no proof.” *Blackfeet and Gros Ventre Tribes of*

² <http://www.msaj.com/papers/43099.htm>

1 *Indians*, 32 Ind. Cl. Comm. 65, 77 (1973). As a general matter, the United States must
2 properly manage and, protect such resources as: tribal land, *United States v. Shoshone*
3 *Tribe of Indians*, 304 U.S. 111 (1938); *Lane v. Pueblo of Santa Rosa*, 249 U.S. 110
4 (1919); tribal minerals, *Navajo Tribe of Indians v. United States*, 9 Cl. Ct. 227 (1985); oil
5 and gas, *Navajo Tribe of Indians v. United States*, 610 F.2d 766 (Ct. Cl. 1979); grazing
6 lands, *White Mountain Apache Tribe v. United States*, 8 Cl. Ct. 677 (1985); water, *Id.*,
7 and timber, *United States v. Mitchell*, (*Mitchell II*), *supra*.

8
9 “An Indian Trust Asset (ITA) is defined by the Bureau of Reclamation
10 (Reclamation) as a legal interest in an asset that is held in trust by the U.S.
11 Government for Indian Tribes or individual Tribal members. Examples of ITA’s
12 include water rights, lands, minerals, hunting and fishing rights, money, and
13 claims.”³

14
15 Fiduciary trustee must always act in the interests of the beneficiaries (*Covelo Indian*
16 *Community v. FERC*, 895 F.2d 581 (9th Cir. 1990 at 586). A trustee is obligated to not
17 waste the trust asset. The Trust responsibility means that the federal government needs to
18 be on the side of the Tribes. The federal government must act on behalf of the tribe, and
19 is not supposed to treat tribes as stakeholders to be considered.

20
21 The Supreme Court, in defining the trust responsibility, has held that:

22
23 [The federal government] has charged itself with moral obligations of the highest
24 responsibility and trust. Its conduct, as disclosed in the acts of those who
25 represent it in dealing with the Indians, should therefore be judged by the most
26 exacting fiduciary standards. *Seminole Nation v. United States*, 316 U.S. 286,
27 296-97 (1941).

28
29 *United States v. White Mountain Apache Tribe*, 537 U.S. 465, 475 (2003) recognizes that
30 the fundamental common law duty of a trustee is to maintain trust assets. *Fort Mojave*
31 *Indian Tribe v. United States*, 23 Cl. Ct. 417, 426 (Cl. Ct. 1991) found the federal trust
32 duty to protect Indian water rights because “the title to plaintiffs’ water rights constitutes
33 the trust property which the government, as trustee, has a duty to preserve.”

34
35 The same trust principles that govern private fiduciaries also define the scope of the
36 federal government’s obligations to the Tribe. *See Covelo Indian Community v. F.E.R.C.*,
37 895 F.2d 581, 586 (9th cir. 1990). These include: 1) preserving and protecting the trust
38 property; 2) informing the beneficiary about the condition of the trust resource; and 3)
39 acting fairly, justly and honestly in the utmost good faith and with sound judgment and
40 prudence. *See Assiniboine and Sioux Tribes v. Board of Oil and Gas Conservation*, 792
41 F.2d 782, 794 (9th Cir. 1986); *Trust*, 89 C.J.S. §§ 246-62. Additionally, a long line of
42 cases imposes a trust duty of protection on agencies when their off-reservation actions
43 threaten the use and enjoyment of Indian land. *See, e.g., Northern Cheyenne Tribe v.*
44 *Hodel*, 851 F.2d 1152 (9th Cir. 1988); *Joint Tribal Council of Passomoquaddy Tribe v.*
45 *Morton*, 528 F.2d 370, 379 (1st Cir. 1975).

³ <http://www.ose.state.nm.us/water-info/AamodtSettlement/Appendix21.pdf>

1 In addition to the fiduciary trust obligations of the federal government to the Hanford
2 tribes, the Confederated Tribes of the Umatilla Indian Reservation, Yakama Nation, and
3 the Nez Perce Tribe are recognized by the federal government as trustees of the natural
4 resources at Hanford.⁴

5
6 “The concept of natural resource trustees is derived from the public trust doctrine.
7 This ancient principal of law provides that governments hold certain property and
8 natural resources in trust for the benefit of the public. Furthermore, the
9 governments have the duty and authority to protect and preserve such property
10 and resources for public uses.”

11
12 Both CERCLA and OPA define "natural resources" broadly to include "land, fish,
13 wildlife, biota, air, water, ground water, drinking water supplies, and other such
14 resources..." Both statutes limit "natural resources" to those resources held in trust for the
15 public, termed Trust Resources. While there are slight variations in their definitions, both
16 CERCLA and OPA state that a "natural resource" is a resource "belonging to, managed
17 by, held in trust by, appertaining to, or otherwise controlled by" the United States, any
18 State, an Indian Tribe, a local government, or a foreign government [CERCLA §101(16);
19 OPA §1001(20)].⁵

20
21 In summary, it is the opinion of the CTUIR and the Indian Writer’s Group that the
22 “reference location” for the GTCC disposal at Hanford involves a Trust Resource under
23 natural resource trusteeship rules, and has associated obligations of the federal fiduciary
24 trustee (the federal government) to the Tribes, and of the natural resource trustees
25 (Tribes, states, and federal government) to each other and their constituencies.

26
27

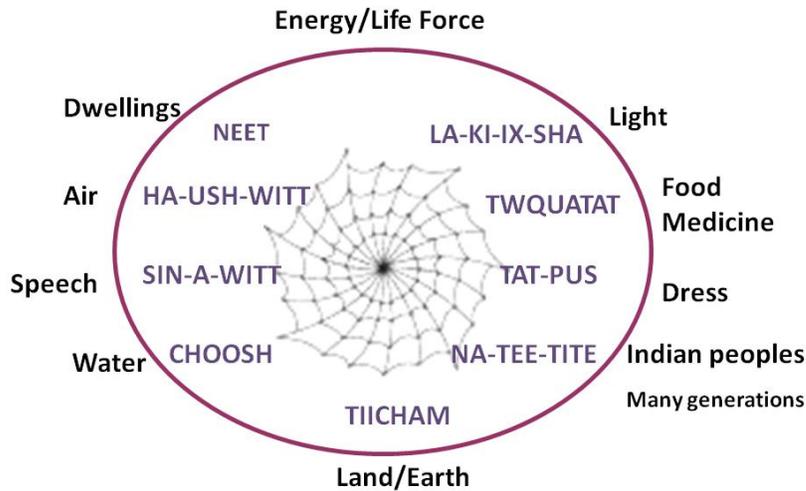
28 **A.3 Regional and Sitewide Tribal Context**

29
30 The natural law, or Tamanwit, teaches that American Indian people are not separate from
31 the environment. A tremendous amount of tribal knowledge is contained and taught
32 through oral traditions. Some stories and oral histories contain factual information, while
33 others contain social principles and cultural values. Traditional environmental knowledge
34 reflects tribal science and keen observation, sometimes expressed as accurate
35 explanations of environmental processes, and sometimes expressed in symbolic terms.
36 These teachings have been built over thousands of years, and teach each generation how
37 to live and behave to sustain themselves and the community. This lifestyle is resilient,
38 having persisted through floods, droughts, cataclysms, upheavals, and warfare.

39
40

⁴ <http://www.hanford.gov/?page=292&parent=291>

⁵ <http://www.epa.gov/superfund/programs/nrd/primer.htm>



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Figure. Depiction of CTUIR Tamanwit, the Natural Law.

Native American ties to the environment are much more complex and intense than is generally understood by risk assessors (Harris 1998). All of the foods and implements gathered and manufactured by the traditional American Indian are interconnected in at least one way, but more often in many ways. Everything is woven together in a web that extends across space-time. To many American Indians, individual and collective well-being is derived from membership in a healthy community that has access to, and utilization of, ancestral lands and traditional resources, so that they may fulfill their part of the natural cycles and their responsibility to uphold the natural law. Adverse impacts to one resource ripple through the entire web and through interconnected biological and human communities. Therefore, if the link between a person and his/her environment is severed through the introduction of contamination or physical or administrative disruption, natural resource service flows may be interrupted, the person's health suffers, and the well being of the entire community is affected.

B. CTUIR Affected Resources – Features, Attributes, Goods, and Services

B.1 Climate and Ethnohistory

6 People have inhabited the Columbia Basin throughout the entire Younger Dryas era
7 (from 10,000 years ago to the present). Several even earlier archaeological sites are
8 known. Mammoth and bison harvest sites are found throughout the Columbia Plateau.
9 As the temperatures rose throughout this period, the Pleistocene lakes began to shrink and
10 wither away into alkali basins. The post-glacial grasslands of the Great Basin and
11 Columbia Basin were replaced by desert grasses, juniper, and sage, and megafauna
12 likewise decreased through ecological and hunting pressure. The glaciers in the Cascades,
13 Wallowa and Steens mountains rapidly disappeared.⁶

14 After about 5400 B.P. increasing precipitation and rising water tables were apparent
15 again on both sides of the Cascades. Pollen history indicates continual short, sharp
16 climatic shifts that, directly (e.g., soil moisture) or indirectly (e.g., fire and disease),
17 produced rapid changes in the Northwest's vegetation. The plants and animals were now
18 modern in form. Hunters switched to deer, elk, antelope and small game such as rabbits
19 and birds. Fishing also became important along the coastal streams and in the Columbia
20 River system, with an increasing emphasis on the annual runs of the salmon even though
21 salmon runs date considerably farther back.⁶

22
23 The human ethnohistory in the Columbia Basin is divided into cultural periods that
24 parallel the climatic periods and represent cultural adaptations to changing environmental
25 conditions. Throughout this entire period the oral history continually added information
26 needed for survival and resiliency as the climate fluctuated. The oral history of local
27 native people is consistent with contemporary scientific and historic knowledge of the
28 region and validates the extreme climate changes that have occurred in the region over
29 thousands of years. Cameron (2008)⁷ examined archaeological, ethnographic, paleo-
30 environmental, and oral historical studies from the Interior Plateau of British Columbia,
31 Canada, from the Late Holocene period, and found correlations among all four sources of
32 information.

33
34 Tribal stories tell of eruptions, volcanoes, great floods, and animals now extinct. Indian
35 people on the Columbia Plateau have stories about the world being destroyed by fire and
36 water. Some of these were directly experienced, for example, the Mazama eruption

⁶ <http://www.oregon-archaeology.com/archaeology/oregon/>;
http://www.wac6.org/livesite/precirculated/1803_precirculated.pdf;
Mehring, P.J. (1996) "Columbia River Basin Ecosystems Late Quaternary."
<http://www.icbemp.gov/science/mehring.pdf>.

⁷ Cameron, I (2008) "Late Holocene environmental change on the Interior Plateau of Western Canada as seen through the archaeological and oral historical records." World Archaeological Congress 6, Dublin, Ireland.

1 6,800 years ago, and the last of the Missoula floods 13,000 years ago. A major landscape
2 feature at Hanford, Gable Mountain or Nookshia (Relander 1986: 305), is remembered
3 when it rose out of the flood waters. Older events were accurately inferred from geologic
4 features and then taught, either as literal explanations of the physiography or in symbolic
5 terms as stories or fables (i.e., taking the opportunity to teach a beneficial eco-behavioral
6 lesson).

7 Large scale manipulation of plants and animals through fire as a tool to reduce plants tied
8 up in climax vegetation and to increase valued plant (and animals that depended on them)
9 started perhaps 3500-3000 years ago, particularly in moister areas where burning out
10 climax vegetation reduced the biomass tied up in cellulose (trees), and increased the
11 diversity of the natural habitat. Important species such as elk, camas (a root food),
12 tarweed (a seed food) and oak were enhanced with periodic burning. Other plants used
13 for food, medicine, and fiber also increase in relative abundance with the use of fire.

14 Climate change that will occur over the next 10,000 years will inevitably draw on
15 knowledge from the past, whether the climate becomes wetter or drier. Evaluation of
16 future climate scenarios will need to include as much variation as occurred in the last
17 10,000 years.

18
19

20 **B.2 Air Quality**

21

22 The importance of clean fresh air is often overlooked in NEPA analysis. For example,
23 while wind and fire are part of the natural regime, and an intact soil surface with a
24 cryptogam crust in the desert reduces dust resuspension during wind events.

25

26 While chemical and radioactive air emissions are relatively low at Hanford presently, the
27 extensive cleanup and construction activities on Hanford contribute to blowing dust,
28 increased traffic, diesel emissions, deposition or re-deposition of radionuclides, and
29 generation of ozone, particulate matter, and other air pollutants with unknown human and
30 environmental health effects. Viewshed and haze are also affected.

31

32

33 **B.3 Physical Resources**

34

35 It is well known that environmental attributes or qualities such as wilderness, solitude,
36 peace, calm, quiet, and darkness are important to individual species that need large
37 undisturbed habitat as well as to humans who value those experiential qualities⁸. These
38 qualities are very fragile, and once lost are hard to recover. A single light at night breaks
39 the quality of darkness, just as the first drop of contamination changes the quality of
40 water from pure to impure. CTUIR recommends that more attention be paid to the value
41 of unfragmented and undisturbed shrub steppe habitat and natural resources.

42

⁸ http://findarticles.com/p/articles/mi_m1145/is_n8_v29/ai_15769900/;
http://findarticles.com/p/articles/mi_m1145/is_n8_v29/ai_15769900/

1 **B.3.1 Quiet**

2

3 Noise can affect living organisms in the ecosystem through interruption of reproductive
4 cycles and migration patterns, and driving away species that are sensitive to human
5 presence. Non-natural noise can be offensive while traditional ceremonies are being
6 held. The noise generated by the Hanford facility may presently create noise interference
7 for ceremonies held at sites like Gable Mountain and Rattlesnake Mountain by
8 interrupting the thoughts and focus and thus the spiritual balance and harmony of the
9 community participants of a ceremony (Greider 1993)⁹.

10

11 **B.3.2 Darkness**

12

13 Light at night affects nocturnal animals such as bats, owls, night crawlers and other
14 species. Night light also has known affects on diurnal creatures and plants by
15 interrupting their natural patterns. Light can affect reproduction, migration, feeding and
16 other aspects of a living organism's survival. Light at night also disrupts the quality of
17 human experience, including star gazing and cultural activities. Extensive light pollution
18 is already being produced from by the Hanford site.

19

20 **B.4 Geological Resources**

21

22 Geological resources include soils, sediments, minerals, geological landscapes and
23 associated features, borrow materials, gas, and petroleum.

24

25 **B.4.1 Soils, Minerals**

26

27 Native Peoples understand the importance of soils and minerals. Many uses of soils are
28 included in the attached material on exposure pathways. At Hanford, material from the
29 White Bluffs was used for cleaning hides, making paints, and whitewashing villages.
30 Borrow material for caps, barriers, and clean fill is a particular concern, and needs to be
31 part of each NEPA analysis.

32

33 **B.4.2 Landscapes**

34

35 The human aspects of Hanford landscapes are discussed briefly here. The CTUIR
36 recommend that DOE pay more attention to landscape features and visual and aesthetic
37 services that flow from the geologic formations at Hanford. Cultural and sacred
38 landscapes may be invisible unless they are disclosed by the peoples to whom they are
39 important. Tribal values lie embedded within the rich cultural landscape and are
40 conveyed to the next generation through oral tradition by the depth of the Indian
41 languages. Numerous landmarks are mnemonics to the events, stories, and cultural
42 practices of native peoples. Oral histories impart basic beliefs, taught moral values and
43 the land ethic, and helped explained the creation of the world, the origin of rituals and
44 customs, the location of food, and the meaning of natural phenomena. The oral tradition

⁹ Greider, T (1993) Aircraft Noise and the Practice of Indian Medicine: The Symbolic Transformation of the Environment. Human Organization 52(1): 76-82.

1 provides accounts and descriptions of the region's flora, fauna, and geology. Within this
2 landscape are songs associated with specific places; when access is denied a song may be
3 lost.

4
5 "At Hanford there are three overlapping cultural landscapes that overlie the natural
6 landscape. These are not displacements of a previous landscape by a new landscape, but
7 a coexistence of all three simultaneously even if one landscape is more visible in a
8 particular area. The first represents the American Indians, who have created a rich
9 archeological and ethnographic record spanning more than 10,000 years. This is the only
10 stretch of the Columbia River that is still free-flowing, and one of the few areas in the
11 Mid-Columbia Valley without modern agricultural development. As a result, this is one
12 of the few places where native villages and campsites can still be found. Still today, local
13 American Indian tribes revere the area for its spiritual and cultural importance, as they
14 continue the traditions practiced by their ancestors." The second landscape was created
15 by early settlers, and the third by the Manhattan Project. Today, DOE is removing much
16 of the visible portion of the Manhattan landscape, returning the surface of the site to a
17 more natural state (restoration and conservation) and thus revealing the cultural landscape
18 that remains underneath.¹⁰

19
20 The Hanford Reach and the greater Hanford Site, a geographic center for regional
21 American Indian religious activities, is central to the practice of the Indian religion of the
22 region and many believe the Creator made the first people here. Indian religious leaders
23 such as Smoholla, a prophet of Priest Rapids who brought the Washani religion to the
24 Wanapum and others during the late 19th century, began their teachings here. Prominent
25 landforms such as Rattlesnake Mountain, Gable Mountain, and Gable Butte, as well as
26 various sites along and including the Columbia River, remain sacred. American Indian
27 traditional cultural places within the Hanford Site include, but are not limited to, a wide
28 variety of places and landscapes: archaeological sites, cemeteries, trails and pathways,
29 campsites and villages, fisheries, hunting grounds, plant gathering areas, holy lands,
30 landmarks, important places in Indian history and culture, places of persistence and
31 resistance, and landscapes of the heart. Because affected tribal members consider these
32 places sacred, many traditional cultural sites remain unidentified.

33
34 More generally, cultural landscapes have been defined by the World Heritage Committee
35 as distinct geographical areas or properties uniquely representing the combined work of
36 nature and of man. They identified and adopted three categories of landscape: the purely
37 natural landscape, the human-created landscape, and an associative cultural landscape
38 which may be valued because of the religious, artistic or cultural associations of the
39 natural and/or human elements.

40
41 Sacred natural sites are natural places recognized by indigenous and traditional peoples as
42 having spiritual or religious significance. They can be mountains, rivers, lakes, caves,
43 forest groves, coastal waters, and entire islands. The reasons for their sacredness are
44 diverse. They may be perceived as abodes of deities and ancestral spirits; as sources of
45 healing water and plants; places of contact with the spiritual, or communication with the

¹⁰ <http://www.hanford.gov/doe/history/?history=archaeology>.

1 'beyond-human' reality; and sites of revelation and transformation. As a result of access
2 restrictions, many sacred places are now important reservoirs of biological diversity.
3 Sacred natural sites such as forest groves, mountains and rivers, are often visible in the
4 landscape as vegetation-rich ecosystems, contrasting dramatically from adjoining, non-
5 sacred, degraded environments.¹¹

6
7

8 **B.4.3 Viewsheds**

9

10 Viewscapes tend to be panoramic and are made special when they contain prominent
11 topography. Viewscapes are tied with songscapes and storyscapes, especially when the
12 vantage point has a panorama composed of multiple locations from either song or story.
13 Viewscapes are critical to the performance of some Indian ceremonies. As told by a
14 Wanapum elder, within the Hanford viewshed (at an undisclosed location) is at least one
15 calendar wheel that guided native residents in their movements and activities. The wheel
16 had spokes which were duplicated at villages. At each village a white stone was placed
17 in the ground and atop this stood a high post. The post would cast a shadow which was
18 read. When it reached a certain angle, like the spoke in the wheel, the people would
19 respond with the proper action. The wheel was a reference point that held time schedules.
20 Gable Mountain is a central area which is also a point of reference for many ceremonies.
21 Many of the reference points that were set on the ground are organized like the stars –
22 they are related in important ways that are described in detailed songs and stories.
23 Interruption of the vista by large facilities or bright lights impairs the cultural services
24 associated with the viewshed.

25

26 A viewshed map is included in the Hanford NEPA boilerplate document (Duncan 2007).

27

28

29

30

31 **B.5 Water**

32

33 Water sustains all life. As with all resources, there is both a practical and a spiritual
34 aspect to water. Water is sacred to the Indian people, and without it nothing would live.
35 When having a feast, a sip of water is taken either first or after a bite of salmon, then a bit
36 of salmon, then small bites of the four legged animals, then bites of roots and berries, and
37 then all the other foods.

¹¹ Oviedo, G. (2002). member of the Task Force of Non-Material Values of Protected Areas of the World Commission on Protected Areas (WCPA), at the Panel on Religion, Spirituality and the Environment of the World Civil Society Forum, Geneva, 17 July 2002.

Stoffle, R.W., Halmo, D.B., Austin, D.E. (1998). Cultural Landscapes and Traditional Cultural Properties: a Southern Paiute View of the Grand Canyon and Colorado River. *American Indian Quarterly*, Vol. 21: 229-250.

Walker, D.E., 1991. "Protection of American Indian Sacred Geography," in: *Handbook of American Indian Religious Freedom*, Vecsey, C., Ed., Crossroad, New York, NY, pp. 100-115.

1
2 The quality of purity is very important for ceremonial use of water. For example, making
3 a sweat lodge and sweating is a process of cleansing and purification. The sweat lodge
4 should be made with clean natural materials and the water used for sweat-bathing should
5 also be uncontaminated. The concept of sacred water or holy water is global, and often
6 connects people, places, and religion; religions that are not land-connected may lose this
7 concept.¹² Additionally, concepts related to the flow of services from groundwater and
8 the valuation of groundwater are receiving increased attention.¹³

9
10 Although DOE's threshold for groundwater injury may be regulatory standards based on
11 human or biological health, perhaps the most important criterion for contamination from
12 a tribal perspective is the first drop of contamination, which moves the water from a
13 condition of purity to a condition of degraded. This concept sets a threshold of injury at
14 background or the detection limit.

15
16 From the CTUIR's perspective, contamination in the groundwater at the Hanford site is
17 the greatest long-term threat to the Columbia River. There is a tremendous volume of
18 radioactive and chemical contamination in the vadose zone and the groundwater. The
19 mechanics of transport of contaminants through the soil to the ground water is still
20 largely unknown. The actual volumes of contamination within the ground water and the
21 direction of ground water flow are not fully characterized. The uncertainty due to this
22 lack of knowledge and the limited technical ability to remediate the vadose zone and
23 ground water puts the Columbia River and its biota at continual risk. The tremendous
24 importance of groundwater means that the uncertainty about present and future
25 contamination must play a key role in the risk assessment – the severity of the
26 consequences if groundwater and the river become more contaminated is high (risk =
27 probability x severity).

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¹² Altman, N. (2002) Sacred Water: the Spiritual Source of Life. Mahwah, NJ: Hidden Spring Publ.;
Marks, W.E. (2001) The Holy Order of Water. Vancouver BC: Steiner Books Inc.;
Burmil, S., Daniel, T.C., and Hetherington, J.D. (1999). Human values and perceptions of water in arid
landscapes. *Landscape and Urban Planning*, 44: 99-109;
Mazumdar, S. and Mazumdar, S. (2004). Religion and place attachment: A study of sacred places. *Journal
of Environmental Psychology*, 24: 385-397.

¹³ National Research Council (1997) Valuing Ground Water: Economic Concepts and Approaches.
Washington D.C.: National Academy Press.

1 B.6 Biological Resources

2

3

4

5 **B.6.1 Ethno-Habitat**

6 Natural resources are integral to many traditional practices and celebrations throughout
 7 the year, many of which honor the traditional foods or First Foods. Based on the
 8 importance and many uses of the natural resources, an exposure scenario reflecting the
 9 underlying **ethnohabitat or eco-cultural system** was developed for use in dose and risk
 10 assessments at Hanford (Harper and Harris 1997; Harris and Harper 2000; CTUIR
 11 2004)¹⁴. Ethno-habitats can be defined as the set of cultural, religious, nutritional,
 12 educational, psychological, and other services provided by intact, functioning ecosystems
 13 and landscapes. Although the concept of ethnohabitat or ethnoecology has been used
 14 various forms in anthropological disciplines for many years, it had never been used in
 15 risk assessment.

16

17 A healthy ethno-habitat or eco-cultural system is one that supports its natural plant and
 18 animal communities and also sustains the biophysical and spiritual health of its native
 19 peoples. Ethno-habitats are places clearly defined and well understood by groups of
 20 people within the context of their culture. These are living systems that serve to help
 21 sustain modern Native American peoples' way of life, cultural integrity, social cohesion,
 22 and socio-economic well-being. The lands, which embody these systems, encompass
 23 traditional Native American homelands, places, ecological habitats, resources, ancestral
 24 remains, cultural landmarks, and cultural heritage. Larger ethno-habitats can include
 25 multiple interconnected watersheds, discrete geographies, seasonal use areas, and access
 26 corridors.¹⁵ A depiction of the eco-cultural system for the CTUIR is shown as a seasonal
 27 round that includes both terrestrial and aquatic resources.

28

29



30

31

32 Figure. Umatilla Seasonal Round

33

¹⁴ Harris, S.G. and Harper, B.L. "A Native American Exposure Scenario." Risk Analysis, 17(6): 789-795, 1997; S Harris and B Harper. "Using Eco-Cultural Dependency Webs in Risk Assessment and Characterization." Environmental Science and Pollution Research, 7(Special 2): 91-100, 2000; <http://www.hhs.oregonstate.edu/ph/tribal-grant-main-page>.

¹⁵ Modified from the East-Side EIS of the Interior Columbia Environmental Management Plan (ICBEMP).

1 **B.6.2 Terrestrial Resources of the Plateau Culture Area**

2
3 An ethnoecological approach to describing terrestrial resources begins with a description
4 of the potential natural vegetation within the Columbia Basin ecozones, and then
5 describes the natural resource usage patterns of the Plateau Culture Area.¹⁶

6
7 All natural resources are significant to tribal culture as part of functioning ecosystems,
8 and many are individually important as useful for food, medicines, materials, or other
9 uses. A comprehensive list of potentially injured biota was compiled for the tribal natural
10 resource trustees, including 13 algae species, 56 fish species, 269 bird species, 52
11 mammal species, 21 amphibian and reptile species, over 800 aquatic and terrestrial plant
12 species, and dozens of orders, families, and genera of aquatic and terrestrial insects.

13
14 The Hanford shrub steppe is a Washington State priority habitat¹⁷ due to its large and
15 largely unfragmented nature, which is now rare. In the 1970s, the National
16 Environmental Research Park (NERP) program created seven NERPs to set aside land for
17 ecosystem preservation and study. The Hanford NERP, managed by the Department of
18 Energy, includes the Fitzner/Eberhardt Arid Lands Ecology Reserve, which is the only
19 remaining sizable remnant (312 square kilometers, 120 square miles) of the Washington
20 shrub-steppe landscape that is still in a relatively pristine condition, the industrial zone of
21 the Hanford Site, which contains nuclear production facilities in various stages of cleanup
22 and closure, and buffer zones on the opposite shore of the Columbia River: the US
23 Department of the Interior's Saddle Mountain Wildlife Reserve and the Washington State
24 wildlife management area.¹⁸ Ecological functions that require this degree of intactness is
25 make Hanford very valuable, and make contiguity, biodiversity, and attributes of a
26 similar scale very important to preserve and enhance.

27
28 Based on the Presidential Proclamation that established the Hanford Reach National
29 Monument, the CTUIR policy seeks to ensure that all of Hanford will be restored and
30 protected:¹⁹

31 “The area being designated as the **Hanford Reach** National Monument
32 forms an arc surrounding much of what is known as the central
33 **Hanford** area. While a portion of the central area is needed for
34 Department of Energy missions, much of the area contains the same
35 shrub-steppe habitat and other objects of scientific and historic
36 interest that I am today permanently protecting in the monument.
37 Therefore, I am directing you to manage the central area to
38 protect these important values where practical. I further direct
39 you to consult with the Secretary of the Interior on how best to
40 permanently protect these objects, including the possibility of
41 adding lands to the monument as they are remediated.”
42
43

¹⁶ <http://www.fs.fed.us/land/pubs/ecoregions/ch48.html#342I>

¹⁷ <http://www.fws.gov/hanfordreach/natural-resources.html>

¹⁸ <http://www.pnl.gov/nerp/>

¹⁹ FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

1 In addition to biological resources and natural resource goods, ecological functions and
2 services that flow to people may be injured by contamination or physical disturbance.
3 For tribal members, human use services that natural resources provide include both direct
4 use of resources (e.g., hunting, fishing, and gathering of edible plants) and nonuse
5 services (e.g., spiritual identity). Because Tribal identity is so strongly defined by their
6 relationship to their natural environment, natural resources provide more services (on
7 average) to Tribal members than to other members of the general public.

8
9 An overview of the resources that can serve as conduits of exposure to native peoples is
10 presented in the CTUIR and Yakama Nation exposure scenarios. The CTUIR exposure
11 factors based on natural resources is presented in the “Reference Indian” section.

12
13
14

15 **B.6.3 Aquatic Resources of the Plateau Culture Area**

16

17 The Columbia River, which cuts through the Hanford site, is the life blood of the region,
18 with rich diverse fisheries delicately balanced on thriving aquatic ecosystems. The
19 Hanford Reach is the last free-flowing segment of the Columbia River and is home of the
20 last remaining naturally spawning fall Chinook. Ancestral CTUIR fisheries sites are
21 located throughout the Hanford Reach. The health of the Hanford Reach is the keystone
22 essential to the survival of Columbia Basin fisheries and CTUIR Treaty rights and
23 resources.

24

25 Use of the Hanford site and surrounding areas by tribes was tied primarily to the robust
26 Columbia River fishery. Past social activities of native people include gatherings for
27 such activities like marriages, trading, feasts, harvesting, fishing, and mineral collection.
28 Tribal families and bands lived along the Columbia either year round or seasonally for
29 catching, drying and smoking salmon. The reduction of salmon runs, loss of fishing sites
30 due to dam impoundments and 70 years of DOE institutional controls at Hanford have
31 contributed to the degradation of the supplies necessary for this gifting and barter system
32 of CTUIRculture.

33

34 Salmon remains a core part of the oral traditions of the tribes of the Columbia Plateau and
35 it still maintains a presence in native peoples’ diet just as it has for thousands of
36 generations. Salmon is among those foods regularly recognized ceremonially. One
37 example is the *ke’uyit* which translates to “first bite.” It is a ceremonial feast that is held
38 in spring to recognize the foods that return to take care of the people. It is a long standing
39 tradition among the people and it is immersed in prayer songs and dancing. Salmon is the
40 first food that is eaten by the attendants. Extending gratitude to the foods for sustaining
41 the life of the people is among the tenets of plateau lifestyle. Life is perceived as
42 intertwined with the life of the Salmon. A parallel can be seen between the dwindling
43 numbers of the Salmon runs and the struggle of native people. *from Salmon and His*
44 *People*²⁰

45

²⁰ Landeen, D. (1999) *Salmon and His People: Fish and Fishing in Nez Perce Culture*. Lewiston, ID: Lewis and Clark State College Press.

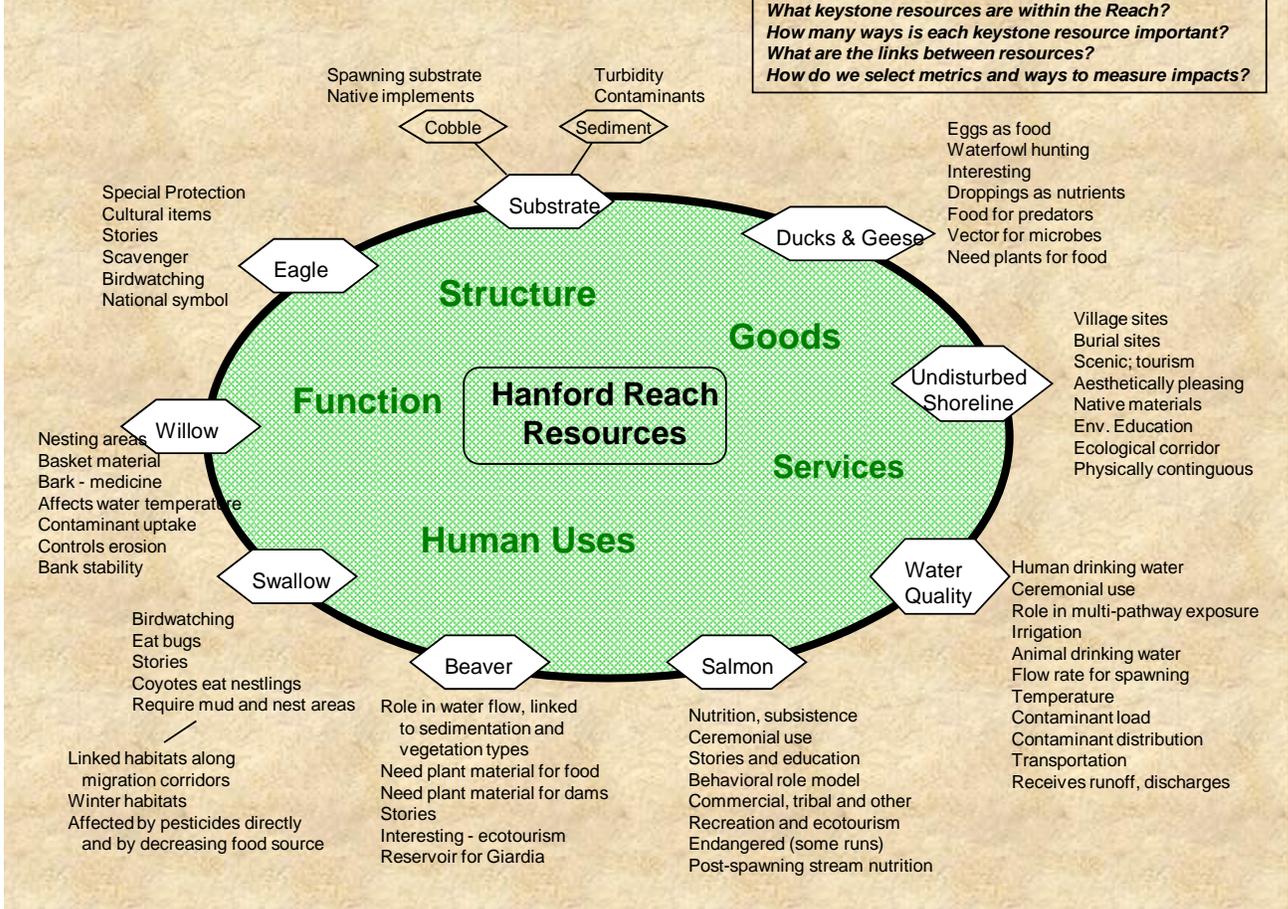
1 The people of the Columbia River tribes have always shared a common understanding --
2 that their very existence depends on the respectful enjoyment of the Columbia River
3 Basin's vast land and water resources. Indeed, their very souls and spirits were and are
4 inextricably tied to the natural world and its myriad inhabitants. Among those inhabitants,
5 none were more important than the teeming millions of anadromous fish enriching the
6 basin's rivers and streams. Despite some differences in language and cultural practices,
7 the people of these tribes shared the foundation of a regional economy based on salmon.
8 The Treaties of 1855 between the Tribes and the federal government explicitly reserved
9 the right to continue fishing forever. Over the next century, settlers encroached on most
10 tribal fishing grounds, blocked access, stole nets, destroyed boats, arrested Indians, over-
11 fished, destroyed habitat, and built dams. In 1974 Judge George Boldt decided in *United*
12 *States v. Washington* (384 F. Supp. 312) that the "fair and equitable share" of fish for
13 tribes was, in fact, 50 percent of all the harvestable fish destined for the tribes' traditional
14 fishing places. The following year, Judge Belloni applied the 50/50 standard to *U.S. v.*
15 *Oregon* and the Columbia River. Judge Boldt's decision also affirmed tribal rights to self-
16 regulation when in compliance with specific standards. In 1988, Public Law 10- 581,
17 Title IV Columbia River Treaty Fishing Access Sites, was enacted. The primary purpose
18 of the legislation is to provide an equitable satisfaction of the United States' commitment
19 to provide lands for Indian treaty fishing activities in lieu of those inundated by
20 construction of Bonneville Dam (www.critfc.org).

21
22 Salmon will always be important and necessary for physical health and for spiritual well-
23 being. Tribal people continue to fish for ceremonial, subsistence and commercial
24 purposes employing, as they always have, a variety of technologies. Tribal people fish
25 from wooden scaffolds and boats, and use set nets, spears, dip nets and poles and lines.
26 Tribal people still maintain a dietary preference for salmon, and its role in ceremonial life
27 remains preeminent.

28
29 Aquatic resources in the Hanford Reach (the area of the river flowing through the
30 Hanford site) include many species, including people. An illustration of resource
31 interconnections and services is shown in figure X.

32
33

Why is the Hanford Reach Important?



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1 **TRANSPORTATION**

2

3 The Middle Columbia Plateau of the Hanford area is the crossroads of the Columbia
4 Plateau, being located half way between the Great Plains and the Pacific Northwest
5 Coast. In the Hanford area major Columbia River tributaries (the Walla Walla, Snake,
6 and Yakima Rivers) flow into this section of the main stem Columbia River. The slow
7 water at the Wallula Gap was one of the few places where the river could be traversed by
8 horses year round including during the spring melt. The river crossing at Wallula
9 provided access to a vast web of trails that crossed the region.

10

11 This travel network was utilized by many tribal groups on the Columbia Plateau for
12 thousands of years of foot travel. Early explorers and surveyors utilized and referenced
13 this extensive trail network. Some of the trails have become major highways and rail
14 lines. Part of the ancient trail system, at one time called the Oregon Trail, now Interstate
15 84 (I-84) is a primary transportation corridor for nuclear waste enters the State of Oregon
16 at Ontario, Oregon. I-84 and a Union Pacific rail line also cross the Umatilla Indian
17 Reservation, including some steep and hazardous grades that are notorious nationally for
18 fog and freezing fog, freezing rain and snow.

19

20 Any waste traveling to Hanford will cross many major rivers that are important salmon
21 bearing watersheds including the Snake River, the Burnt River, the Grande Ronde River
22 (Tributaries of the Snake River), the Umatilla River and Columbia River main stem. All
23 of these river systems have threatened and endangered species issues.

24

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Consequence Evaluation

Recommendations for features and measures are presented in a format similar to the Features-Events-Processes (FEPs) method, but reflecting the tribally-important or eco-cultural attributes of each resource. More detail is contained in the text of various other sections.

Resource or Topic	Features, Attributes, Functions, Goods, Services	Measures of loss or benefit (positive or negative movement; degree of movement)
Sitewide Whole	Support services for traditional lifeways; Intact webs of resources, goods, service flows.	Degree of impact (or enhancement) of traditional lifeways by cultural QALY measure (under development); Loss or recovery of individual traditional activities (hunting, gathering, fishing); Loss or recovery of access to areas or media such as groundwater; Security of protection from development or other loss of acreage, resources, or rights.
Landscape	Intact scape for places, names, songs, calendar, other services. Undisturbed physiographic profile.	Loss or preservation of future land use options. Loss or enhancement of conservation potential; Impact on physiographic profile; Loss or recovery of native scapes.
Light, Noise, other aesthetic attributes.	Quiet needed for ceremonies, experiential quality; Darkness needed for same; Buffer of solitude, isolation, safety from intrusion	Degradation or improvement in quiet during transportation and storage; Degradation or improvement in darkness at night during transport and storage; Duration of impacts (lifecycle of operation); Quality of recovery plan after operation is over.
Viewshed	Uninterrupted viewshed	Degrees in visual field without impact x volume of space with natural features; Significance of direction or features of interruption (line of sight).
Air quality, dust	Clean fresh air for life support and quality of life, without toxics, haze, or dust.	More or fewer emissions during construction, transport, operations, closure. Potential for dust resuspension during each phase. Indirect impacts from energy production, ozone emissions, diesel use. Contribution or benefit to PSD area or attainment status. Greenhouse gas emissions.
Soil,	Clean shallow and deep soil; special materials (White Bluffs);	Mass of contaminated soil x degree of exceedance of human health standards x duration of contamination; Undisturbed soil profile; Intactness of cryptogam crust. Access to special materials.
Minerals, gravel, fill, barrier material		Volume and area of clean fill; Quality of resource mitigation actions;

		Minimization of linked resource impacts.
Sediments	Clean sediment	Present or future exceedance of a standard, including tribal health standard; Function in aquatic ecosystems.
Water	Clean, clear, cold water for drinking, ceremonies	Comparison to tribal standards; Gallon-years above detection limit or background.
Terrestrial Ecosystems	Large-scale ecoregion preservation; Support for tribal lifeways components;	Evaluation of NRDA impacts; Preservation of biodiversity; Reduction in ecological stressors; Loss or benefit in contiguity (fragmentation); Formal process for stressor identification; Identification of valued ecological components.
Terrestrial habitats and species	Provision of goods for food, clothing, shelter, ceremonies, mental health, peace of mind, and so on.	Selection of habitat suitability index; Number of impacted ecological acre-years; Consideration of tribally-important species; Number of impacted cultural acre-years; Time to full recovery.
Aquatic Ecosystems	Large-scale ecoregion preservation; Support for tribal lifeways components;	Proximity of action to river; Evaluation of NRDA impacts; Formal process for stressor identification; Identification of valued ecological components.
Aquatic habitats and species, shorelines	Provision of goods for food, clothing, shelter, ceremonies, mental health, peace of mind, and so on.	Impacted number of river-miles Consideration of tribally-important species; Number of impacted cultural acre-years Time to full recovery
Transportation	Features and events related to safety and vulnerability of adjacent areas.	General transportation risks; Routes through tribal lands; Routes near critical habitats, rivers.
Hazardous substances; safety aspects	Baseline (target) is lack of contamination but current condition is tremendous contamination.	Amount of hazardous material imported, generated, stored, or disposed. Amount of hazardous material already on site, both permitted and contaminated.
Human Health	Target is both lack of excessive exposure and active multi-dimensional health promotion.	Individual and community doses and risks using Tribal scenarios, Multigenerational exposures and risk, Consideration of broader health context.
Env Justice	Tribally-appropriate EJ analysis needed to understand disproportionate impacts.	Compliance with Treaty and Trust; Presence of disadvantaged or disproportionately affected groups-Tribes; Eco-spatial basis for tribal EJ analysis.
Economic	Recognition of subsistence economy methods.	Convention analysis for general pop; Impacts to subsistence for tribes.
Cultural Resources	Need evaluation of likelihood of adverse or beneficial impacts to sites, zones, districts.	Amount of activity in TCP, archaeological zone, sacred sites, and NHPA sites.
Energy and Infrastructure	Need lifecycle energy and infrastructure evaluation, including adequacy of closure plans.	Energy requirement Infrastructure footprint Replacement-mitigation of resources Road needs, water and sewer needs. Intensity of security needs
Climate-Energy Values	Targets of energy efficiency, net zero, sustainability, planning for	Net-zero operations Carbon footprint

	climate change.	
Cumulative	Lifeways support	Impacts to health, ecology, cultural, socio-economic, other analyses. Space-time mapping of impacts. Lifecycle impacts and costs. Sitewide totals of hazardous materials, footprints; Impact on the ability to reach a fully restored endstate.

1
2

1

2 **PLATEAU SUBSISTENCE ECONOMY**

3

4 The eco-cultural system described in other sections includes human, biological, and
5 physical components, and supports the flow of nutritional, religious, spiritual,
6 educational, sociological, and economic services. No component or service is separable
7 from any other. It is well-recognized in anthropology that indigenous cultures include
8 networks of materials interlinked with networks of obligation and trust. Indian people
9 engage in a complex web of exchanges that are the foundation of community and
10 intertribal relationships. Together these networks determine how materials, services, and
11 information flow within the community and between the environment and the
12 community.

13

14 In economic terms, this system is called a subsistence economy. An explanation of
15 “subsistence” developed by the EPA Tribal Science Council is as follows.²¹

16

17 “Subsistence is about relationships between people and their surrounding
18 environment, a way of living. Subsistence involves an intrinsic spiritual
19 connection to the earth, and includes an understanding that the earth’s resources
20 will provide everything necessary for human survival. People who subsist from
21 the earth’s basic resources remain connected to those resources, living within the
22 circle of life. Subsistence is about living in a way that will ensure the integrity of
23 the earth’s resources for the beneficial uses of generations to come.

24

25 As the National Park Service explains,

26

27 “While non-native people tend to define subsistence in terms of poverty or the
28 minimum amount of food necessary to support life, native people equate
29 subsistence with their culture. It defines who they are as a people. Among many
30 tribes, maintaining a subsistence lifestyle has become the symbol of their survival
31 in the face of mounting political and economic pressures. To Native Americans
32 who continue to depend on natural resources, subsistence is more than eking out a
33 living. The subsistence lifestyle is a communal activity that is the basis of cultural
34 existence and survival. It unifies communities as cohesive functioning units
35 through collective production and distribution of the harvest. Some groups have
36 formalized patterns of sharing, while others do so in more informal ways. Entire
37 families participate, including elders, who assist with less physically demanding
38 tasks. Parents teach the young to hunt, fish, and farm. Food and goods are also
39 distributed through native cultural institutions. Young hunters, gatherers, and
40 fisherman are required to distribute their first catch or harvest throughout the
41 community at a first feast ceremony. It is a ceremony that illustrates the young
42 person is now a provider for his community. Subsistence embodies cultural values
43 that recognize both the social obligation to share as well as the special spiritual

²¹ Tribal Science Council (2002). “Subsistence: A Scientific Collaboration between Tribal Governments and the USEPA.” Provided by John Persell (jpersell@lldrm.org).

1 relationship to the land and resources. This relationship is portrayed in native art
2 and in many ceremonies held throughout the year.”²²
3
4 The terms “fish, hunt or gather” are shorthand labels that identify some of the most
5 visible activities within this personally self-sufficient or subsistence economy, but they
6 also include a wide range of associated activities such as preparation, processing, using or
7 consuming, and various traditional and cultural activities. A subsistence economy
8 includes people with a wide range of ‘jobs’ such as food procurement, processing, and
9 distribution; transportation (pasturing and veterinary); botany/apothecary services;
10 administration and coordination (chiefs); education (elders, linguists); governance
11 (citizenship activities, conclaves); finance (trade, accumulation and discharge of
12 obligations); spiritual health care; social gathering organization; and so on. The
13 categories of ‘fish, hunt, and gather’ each include a full cross section of these activities.
14 This is why ‘hunting’ is not just the act of shooting and eating an animal, but includes a
15 full cross-section of all the activities that a hunter-specialist does within their community.
16
17 The natural resources that are located on Hanford are essential to this system of
18 relationships. When access and resources needed for personal enterprise associated with
19 salmon or any other resource are blocked, there are psychological, nutritional, monetary,
20 social, welfare, self-esteem, and many other impacts that ripple through the entire
21 community. This includes collection and preparation of animals, plants or other raw
22 materials for foods, ceremonial, medicinal, beadwork, hide work, tule mats and many
23 other items along with the associated trading or gifting. The number of individuals that
24 participate in these personal enterprises would greatly increase if access to Hanford is
25 regained and resources restored.
26
27 The more concrete aspects of a subsistence lifestyle are important to understanding the
28 degree of environmental contact and how subsistence is performed in contemporary
29 times. Today, there is an integrated interdependence between formal (cash-based) and
30 informal (barter and subsistence-based) economic sectors that exists and must be
31 considered when thinking of economics and employment of tribal people.²³ Today's
32 subsistence family generates may include members engaged in both monetary and
33 subsistent activities as wage-laborers, part-time workers, professional business people,
34 traditional craft makers, seasonal workers, hunters, fishers, artisans, and so on. Today’s
35 subsistence utilizes traditional and modern technologies for harvesting and preserving
36 foods as well as for distributing the produce through communal networks of sharing and
37 bartering. This information is used when describing the lifestyle and developing the
38 dietary and direct exposure factors in the “reference Indian” scenario.
39
40

²² National Park Service: http://www.cr.nps.gov/aad/cg/fa_1999/Subsist.htm

²³ <http://arcticcircle.uconn.edu/NatResources/subsistglobal.html>

1 **Environmental Justice Analysis**

2
3
4 DOE analysis of Environmental Justice is uniformly inadequate to address Native
5 American rights, resources, and concerns. At Hanford, Tribal rights, health, and
6 resources are always more impacted than those of the general population due to the
7 traditional lifeways, close connections to the natural and cultural resources, and natural
8 resource trusteeship. Thus, Hanford EJ analyses generally find that beneficial impacts of
9 new missions, such as new jobs or more taxes, accrue to the local non-native community,
10 yet fail to recognize that the majority of negative impacts accrue to Native Americans,
11 such as higher health risk, continuation of restricted access, lack of natural resource
12 improvement, and so on.

13
14 President Clinton signed Executive Order 12898 to address Environmental Justice issues
15 and to commit each federal department and agency to “make achieving Environmental
16 Justice part of its mission.” According to the Executive Order, no single community
17 should host disproportionate health and social burdens of society’s polluting facilities.
18 Many American Indians and Alaskan Natives are concerned about the interpretation of
19 “environmental justice communities” by the U.S. Federal Government in relation to
20 tribes. By this definition, tribes are included as a minority group. However, the definition
21 as a minority group fails to recognize tribes’ sovereign nation-state status, identify the
22 federal trust responsibility to tribes, promote economic and social development, or
23 protect the treaty and statutory rights of American Indians and Alaskan Natives.

24
25 The identification of rural EJ populations, particularly Native Americans, is not always
26 obvious if an impacted area is not directly on a reservation. If natural resources
27 appertaining to tribes are present, or if cultural resources or traditional sites within a
28 ceded or usual and accustomed are affected, then an “EJ Community” is present. Further,
29 Native American communities face environmental exposures that are greater than those
30 faced by other EJ communities because of their greater contact with the environment that
31 occurs during traditional practices and resource uses.

32
33 Thus, the EJ analysis begins with an identification of resources and who uses them, not
34 with county demographics. The first step in evaluating EJ for Native Americans at
35 Hanford is to answer the following questions:

- 36
- 37 • Do tribal members live in (now or in the past), visit, or use resources from the
 - 38 impacted zone?
 - 39 • Is the affected area within a tribal historic area, a traditional cultural property, or a
 - 40 tribally important landscape?
 - 41 • Is the affected area linked ecologically, culturally, visually, or hydrologically to
 - 42 tribal or other EJ population resources or uses?
 - 43 • Is a tribe a Natural Resource Trustee of the affected resource or lands?
- 44

45 If the answer to any of these questions is positive (the answers are all ‘yes’ at Hanford),
46 the EJ analysis may proceed with more detailed evaluation.

1

2 • *Resource identification and quantification.* Likelihood that cultural resources are
3 present within an impact zone or that the site or resource has tribal or community
4 significance, including sacred sites, historical/ archaeological sites, burial sites, and
5 sites containing important traditional foods, medicines, or cultural materials or with
6 associated cultural uses or history, or general community importance (values
7 recreational areas, physical features by which the community identifies itself, etc.).
8 The quantity of goods and services, or acreage, is quantified in this step.

9

10 • *Damage Potential.* The probability and severity of the damage in terms of physical
11 disturbance, existing stressors, contamination, desecration, or degradation. Predicted
12 peak concentrations, time to impact, and resiliency of the affected system are also
13 estimated. This is a vulnerability index that includes aspects of imminence, severity,
14 and resiliency or reversibility. Are tribal exposure factors higher than for a rural
15 residential population?

16

17 • *Consequence Potential.* The consequences of the damage on cultural activities,
18 resources or values. This parameter represents the combination of the first two
19 parameters (the probability of a resource being present and the probability of
20 damage). Consequence might be restricted access or loss of future use options, and
21 associated impacts such as loss of place names or a cultural skill associated with loss
22 of access, or interruption of other goods and services. It may also include how much
23 the Trust is fulfilled or not, and the potential for multiple generations to be
24 inequitably affected.²⁴

25

26 Economic Analysis. Conventional EJ evaluates impacts to local economy and jobs.
27 When Native American resources are impacted, the economic analysis of the subsistence
28 economy is appropriate (see section on Subsistence Economy).

29

30 Equity analysis. Evaluating disproportionate impacts to Native Americans involves the
31 following:

32

- 33 • Are the exposures different when the tribal subsistence scenario is used as
34 compared to the rural residential or other non-native scenario? Whose risks are
35 highest?
- 36 • Are the natural resources of tribal interest more impacted than those identified by
37 the general population? How important are those resources or places? How many
38 ways are those resources or places important? How large is the impacted area
39 from a tribal perspective?
- 40 • Do disparities in impact accumulate over many generations, and do they
41 accumulate at a higher rate in the EJ communities? Have the next seven or more
generations been taken into consideration?

²⁴ Harper, B. and Harris, S. (2001) An Integrated Framework for Characterizing Cumulative Tribal Risks. Posted at www.iiirm.org; Harper, B.L. and Harris, S.G., "Measuring Risks to Tribal Community Health and Culture," *Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport, Ninth Volume, ASTM STP 1381*, F. T. Price, K. V. Brix, and N. K. Lane, Eds., American Society for Testing and Materials, West Conshohocken, PA, 1999.

- 1 • Is the tribe already vulnerable (at risk) due to existing health disparities, economic
- 2 disadvantages, higher exposure to other toxics, or existence of several dozen co-
- 3 risk factors (e.g., poor housing, high unemployment, etc – contact authors for
- 4 more details)?
- 5 • What proportion of tribal members is affected (rather than absolute numbers of
- 6 people)?
- 7 • Is the federal fiduciary Trust obligation being met?
- 8 • Is cultural awareness and respect shown equitably to the affected tribes as to the
- 9 local civic entities?²⁵
- 10
- 11

²⁵ From: AMERICAN INDIAN ALASKAN NATIVE ENVIRONMENTAL JUSTICE ROUNDTABLE
Albuquerque, New Mexico August 3-4, 2000; Final Report, January 31, 2001. Edited by the
Environmental Biosciences Program, Medical University of South Carolina Press.

1 **Cumulative Tribal Impacts**

2
3 There is a growing recognition that conventional risk assessment methods do not address
4 all of the things that are “at risk” in communities facing the prospect of contaminated
5 waste sites, permitted chemical or radioactive releases, or other environmentally harmful
6 situations. Conventional risk assessments do not provide enough information to "tell the
7 story" or answer the questions that people ask about risks to their community, health,
8 resource base, and way of life. As a result, cumulative risks, as defined by the
9 community, are often not described, and therefore the remedial decisions may not be
10 accepted. The full span of risks and impacts needs to be evaluated within the risk
11 assessment framework in order for cumulative risks to be adequately characterized. This
12 is in contrast to a more typical process of evaluating risks to human health and ecological
13 resources within the risk assessment phase and deferring the evaluation of risks to socio-
14 cultural and socioeconomic resources until the risk management phase (National
15 Research Council, 1994, 1996; President's Commission, 1997).

16
17 Because many communities need more information than simply risk and dose results, the
18 Environmental Protection Agency developed a Comparative Risk method over a decade
19 ago for adding a community welfare or quality of life component (EPA, 1993). The
20 Comparative Risk field has been developing methods for community Quality of Life
21 (QOL) that combine cultural, social, and economic measures along with aesthetics and
22 any other factor the community identifies as important. The original Manual (EPA 1993)
23 and many Comparative Risk Projects across the country were developed for situations
24 where environmental planning and prioritization was needed. Several of the Comparative
25 Risk Projects have been done by or for tribes such as the Coeur d'Alene Tribe. The QOL
26 metrics identified in that report included the categories of Localized Effects, Economy/
27 Subsistence, Aesthetics, Fairness and Equity, Trends (annual and multi-year), Degree of
28 Uncertainty, Personal Well-Being, and Spiritual/Moral factors.

29
30 We have modified this concept to reflect traditional tribal cultural values as well as
31 secular or social community aspects that apply to suburban as well as to tribal
32 communities (Harper et al., 1995; Harper and Harris, 2000). We envisioned three or four
33 components to the risk assessment process: human health (using appropriate exposure
34 scenarios), ecological health, and socio-cultural/socio-economic health, all of which are
35 elements of the overall eco-cultural system (Figure).

36
37 One of the premises of cumulative impact analysis is that risks to the entire tribal
38 community, not just to a maximally exposed individual, must be evaluated. It is not
39 necessarily true that protecting a MEI protects the entire community, or that protecting
40 threatened and endangered species protects an entire ecosystem. Thus, we need to define
41 tribal community health. John M. Last defines individual human health as “a state
42 characterized by anatomic integrity, ability to perform personal, family, work, and
43 community roles; ability to deal with physical, biological, and social stress; a feeling of
44 well-being; and freedom from the risk of disease and untimely death” (Last 1998). This
45 definition is broader than the regulatory approach which tends to equate good health with
46 lack of excessive exposure. Definitions of health and functionality from the public health

1 literature include a variety of medical and functional measures, but may not specifically
2 call out the fact that the survival and well-being of every individual and culture depends
3 on a healthy environment.

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When risk assessments take a public health approach to defining community and individual health, they integrate human, ecological, and cultural health into an overall definition of community health and well-being. This broader approach used with risk assessments is adaptable to indigenous communities that, unlike westernized communities, turn to the local ecology for food, medicine, education, religion, occupation, income, and all aspects of a good life (Harris, 1998, 2000; Harper and Harris, 2000). The attributes of the eco-cultural system that support these services are described in affected resources as clean fresh air, clean cold water, unimpacted landscapes, clean wholesome foods, clean healthful medicines, and robust thriving habitats and ecosystems.

1 **Human Health-Related Goods and Services:** This category includes the provision of
2 water, air, food, and native medicines. In a tribal subsistence situation, the land provided
3 all the food and medicine that was necessary to enjoy long and healthy lives. From a risk
4 perspective, those goods and services can also be exposure pathways.

5
6 **Environmental Functions and Services:** Ecological risk assessment includes narrow
7 examination of exposure pathways to biota as well as examination of impacts to the
8 quality of ecosystems and the services provided by individual biota, ecosystems, and
9 ecology. Broader than this, intact ecosystems provide many functions such as soil
10 stabilization and the human services that result from them. For example, the function of
11 erosion control or dust reduction would provide a human health service related to asthma
12 reduction. Other environmental functions such as nutrient production and plant cover
13 would provide wildlife services such as shelter, nesting areas, and food for people and
14 animals, which in turn might contribute to the health of a species important to
15 ecotourism.

16
17 **Social and Cultural Goods, Functions, Services, and Uses:** This category includes
18 many things valued by suburban and tribal communities about Introduction particular
19 places or resources associated with intact ecosystems and landscapes. Some values are
20 common to all communities, such as the aesthetics of undeveloped areas, intrinsic
21 existence value, environmental education, and so on. Because social impact assessment
22 and other aspects of community health are unfamiliar to risk assessors, several measures
23 are suggested as follows:

- 24
- 25 • Impact on societal structure and cohesion (hours per year unavailable for social
26 interaction through loss or reduced value of the resource or area)
 - 27 • Educational opportunity (lost study areas associated with traditional stories or
28 place names or family history or traditional practices; lost R&D opportunity)
 - 29 • Integrity of cultural resources: number of sites with any disturbance or
30 contamination, weighted by type and years of history associated with the site.
 - 31 • Access to traditional lands: degree of restricted access (full restriction to any area
32 or resource evidenced by institutional controls or barriers or reduced visits),
33 fraction of ceremonial resources available relative to original quantity and quality
 - 34 • Cultural landscape quality: proxy scale (1-10?) with elicited judgment based on
35 original condition; total remaining landscape size without encroachments
 - 36 • Degree of compliance with Treaty rights (proxy scale based on access, safety,
37 natural and cultural resource integrity and quality, freedom from encroachments,
38 hassle-free exercise of rights)
 - 39 • Degree of Compliance with Trusteeship obligations (basis for NRDA injury,
40 restoration costs, human use of natural resources)
 - 41 • Preservation of future land use and remedial options (acres of permanent losses
42 including plumes, number of uses no longer viable, number of curies x half-life in
43 irretrievable waste forms)
 - 44 • Degree of sustainability of the resource, its degree of permanent administrative
45 protection, and associated exercise of Treaty rights of access and use.

1 **Economic Goods and Services:** This category includes conventional dollar-based items
2 such as jobs, education, health care, housing, and so on. There is also a parallel non-
3 dollar indigenous economy that provides the same types of services, including
4 employment (i.e., the functional role of individuals in maintaining the functional
5 community and ensuring its survival), shelter (house sites, construction materials),
6 education (intergenerational knowledge required to ensure sustainable survival
7 throughout time and maintain personal and community identity), commerce (barter items
8 and stability of extended trade networks), hospitality, energy (fuel), transportation (land
9 and water travel, waystops, navigational guides), recreation (scenic visitation areas), and
10 economic support for specialized roles such as religious leaders and teachers.

11
12 **Cumulative Space-Time evaluation** often leads to impacts expressed as service-acre-
13 years. This is the most common unit of quantification for habitat-scale natural resource
14 injury. In our experience, it is most logical to use cultural service-acre-years as the
15 ecological dimension of tribal impacts. The environmental perspective held by
16 indigenous communities mean that eco-spatial characteristics should be identified and
17 evaluated for the extent, magnitude and duration of eco-cultural impairment of each
18 service. In a cultural evaluation, specific cultural services associated with a site or
19 resource can be identified by tribal elders or other community leaders according to
20 general importance (thus avoiding trespass on intellectual property and proprietary
21 information). As a simple surrogate for many of these services, the areal extent and
22 duration of contamination (i.e., outer boundary at the detection limit) can be measured
23 and graded accorded to the size of the area degraded or the percent of degradation, and
24 the duration for which each gradation of impact persists can be estimated.

25
26 The functions and services provided by an intact and functioning habitat have been
27 receiving increased attention recently (Costanza and Folke 1997, Scott et al. 1998, Daly
28 1996, Daily 1997). Many of the metrics used in natural resource valuation require spatial
29 and temporal descriptors in addition to concentrations at individual points of compliance
30 because they deal with ecosystems. Many of the concerns raised as cultural risk issues
31 are parallel and also related to areas, ecosystems, or landscapes as well as to the duration
32 of the contamination or the effect. Many of the concepts used in natural resource
33 valuation are applicable to the evaluation of cultural risk and the culturally-related goods
34 and cultural services provided by a healthy environment.

35
36

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40

1 **Human Health Risk Assessment -- Reference Indian**

2

3 **Title:** A “Reference Indian” for use in radiological and chemical risk assessment.

4

5 **Authors:** B. Harper and S. Harris (CTUIR)

6

7 Two tribal exposure scenarios have been developed for use at Hanford by the
8 Confederated Tribes of the Umatilla Indian Reservation (CTUIR 2004) and the Yakama
9 Nation (Ridolfi 2007) in Hanford risk assessments.²⁶ Both of these scenarios reflect
10 traditional tribal uses of the lands and resources on the Hanford Site, including hunting,
11 fishing, gathering, and use of the sweat lodge. They are multimedia (air, dust, surface
12 soil, vadose soil, surface water, groundwater, plants, and animals) and are full-time
13 residential scenarios. These scenarios should be used to evaluate risks to tribal members
14 at the location of the proposed federal and any impacted areas, i.e., ‘Reference Indian’
15 scenarios. These scenarios can also be considered baseline and inadvertent intruder
16 scenarios, as required by DOE Order 435.1.

17

18 EPA is required to identify populations who are more highly exposed; for example,
19 subsistence populations and subsistence consumption of natural resources (Executive
20 Order 12898²⁷). EPA is also required to protect sensitive populations.²⁸ Some of the
21 factors known to increase sensitivity include developmental stage, age (very young and
22 very old), gender, genetics, and health status²⁹, and this is part of EPA’s human health
23 research strategy.³⁰

24

25 “The Superfund law requires cleanup of the site to levels which are protective of
26 human health and the environment, which will serve to minimize any
27 disproportionately high and adverse environmental burdens impacting the EJ
28 community”³¹.

29

30 This scenario reflects an active, outdoor lifestyle with a subsistence economic base.
31 Subsistence food sources include gathering, gardening, hunting, pasturing livestock, and
32 fishing. The forager relies all or in part on native foods and medicines, while the
33 residential farmer relies on domesticated but self-produced foods. Thus, the CTUIR
34 scenario is at the foraging end of the subsistence spectrum, while the residential farmer is
35 at the domesticated end of the subsistence spectrum. Both are active, outdoor lifestyles,

²⁶ CTUIR (2004) Exposure Scenario for CTUIR Traditional Subsistence Lifeways. Report prepared by the CTUIR Department of Science & Engineering, October. <http://www.hhs.oregonstate.edu/ph/tribal-grant/index.html>.

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²⁷ White House, 1994. Federal Actions To Address Environmental Justice In Minority Populations And Low income Populations: Feb. 11, 1994; 59 FR 7629, Feb. 16, 1994.

²⁸ *Superfund Exposure Assessment Manual*. EPA/540/1-88/001 OSWER directive 9285.5-1. U.S. Environmental Protection Agency Office of Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 1988.

²⁹ http://www.epa.gov/nheerl/research/childrens_health.html

³⁰ EPA/600/R-02/050, September 2003 (posted at <http://www.epa.gov/nheerl/publications/>).

³¹ <http://www.epa.gov/region02/community/ej/superfund.htm>

1 and are consistent with the reasonable maximum exposure (RME) approach to baseline
 2 risk assessment. Traditional or subsistence scenarios are similar in format to existing
 3 residential recreational, or occupational exposure scenarios, but reflect and are inclusive
 4 of tribal cultural and lifestyle activities. They are comprised of:

- 5
- 6 1. standard exposure pathways and exposure factors (such as inhalation or soil
 7 ingestion but with increased environmental contact rates),
- 8 2. traditional diets composed of native plants and animals possibly supplemented
 9 with a home garden, and
- 10 3. unique pathways such as the sweatlodge.

11
 12 Tribal exposure scenarios pose a unique problem in that much of the specific cultural
 13 information about the uses of plants and animals for food, medicine, ceremonial, and
 14 religious purposes is proprietary. However, major activities in the generally-recognized
 15 activity categories can be described in enough detail to understand the basic frequency,
 16 duration, and intensity of environmental contact within each category and habitat.

17
 18 Table 1. Major Activity Categories

<i>Activity Type</i>	<i>General Description</i>
Hunting	Hunting includes a variety of preparation activities of low to moderate intensity. Hunting occurs in terrain ranging from flat and open to very steep and rugged. It may also include setting traplines, waiting in blinds, digging, climbing, etc. After the capture or kill, field dressing, packing or hauling, and other very strenuous activities occur, depending on the species. Subsequent activities include cutting, storing (e.g., smoking or drying), etc.
Fishing	Fishing includes building weirs and platforms, hauling in lines and nets, gaffing or gigging, wading (for shellfish), followed by cleaning the fish and carrying them to the place of use. Activities associated with smoking and constructing drying racks may be involved.
Gathering	A variety of activities is involved in gathering, such as hiking, bending, stooping, wading (marsh and water plants), digging, and carrying.
Sweatlodge Use	Sweatlodge building and repairing is intermittent, but collecting firewood is a constant activity.
Materials and Food Use	Many activities of varying intensity are involved in preparing materials for use or food storage. Some are quite vigorous such as pounding or grinding seeds and nuts into flour, preparing meat, and tanning hides. Many others are semi-active, such as basket making, flintknapping, construction of storage containers, cleaning village sites, sanitation activities, home repairs, and so on.

20
 21 Once the activities comprising a particular subsistence lifestyle are known, they are
 22 translated into a format that is used for risk assessment. This translation captures the
 23 degree of environmental contact that occurs through activities and diet, expressed as
 24 numerical “exposure factors.” Direct exposure pathways include exposure to abiotic
 25 media (air, water, and soil), which can result in inhalation, soil ingestion, water ingestion,
 26 and dermal exposure. Indirect pathways refer to contaminants that are incorporated into
 27 biota and subsequently expose people who ingest or use them. There are also unique
 28 exposure pathways that are not accounted for in scenarios for the general public, but may
 29 be significant to people with certain traditional specialties such as pottery or basket
 30 making, flint knapping, or using natural medicines, smoke, smudges, paints and dyes.

1 These activities may result in increased dust inhalation, soil ingestion, soil loading onto
2 the skin for dermal exposure, or exposure via wounds, to give a few examples. While the
3 portals of entry into the body are the same (primarily via the lungs, skin, mouth), the
4 amount of contaminants may be increased, and the relative importance of some activities
5 (e.g., basketmaking, wetlands gathering), pathways (e.g., steam immersion or medicinal
6 infusions) or portals of entry (e.g., dermal wounding) may be different than for the
7 general population.

8
9 Together, this information is then used to calculate the direct and indirect exposure
10 factors. This process follows the general sequence:

- 11
- 12 1. Environmental setting – identify what resources are available;
 - 13 2. Lifestyle description – activities and their frequency, duration and intensity, and
14 uses of natural resources;
 - 15 3. Diet (indirect exposure factors);
 - 16 4. Pathways and media;
 - 17 5. Exposure factors - Crosswalk between pathways and direct exposure factors;
18 cumulative soil, water and air exposures.

19
20 The basic components of the exposure scenario are given below. A great deal of peer-
21 reviewed documentation has been provided to DOE, and the CTUIR and YN scenarios
22 are being used at Hanford.

- 23
- 24 • Soil ingestion = 400 mg/d for all age groups
 - 25 • Inhalation rate = 25 m³/d for adults, with children scaled from the adult value
 - 26 • Drinking water = 3L/d for adults, with children scaled from the adult value; an
27 additional 1L is ingested during each use of the sweat lodge.
 - 28 • Based on the ecological resources and on the anthropological literature, the
29 CTUIR developed two relevant diets, one for the Columbia River regions where
30 salmon forms a large percentage of the protein source, and one for upland and
31 mountain areas with resident fish and spawning areas for anadromous species.

32

CTUIR Columbia River Diet					CTUIR Blue Mountain Diet				
Food Category	gpd	kcal/100g	kcal/d	Percent of calories	Food Category	gpd	kcal/100g	kcal/d	Percent of calories
Fish	620	175	1085	49%	Fish	142	175	249	11%
Game, large and small	125	175	219	10%	Game, large and small	600	175	1050	48%
Fowl & Eggs	62	200	124	6%	Fowl & Eggs	62	200	124	6%
Bulbs (onions, other)	40	30	12	1%	Bulbs (onions, other)	40	30	12	1%
Berries, Fruits	125	100	125	6%	Berries, Fruits	125	100	125	6%
Other vegetation (lichen, pith, cambium)	40	100	40	2%	Other vegetation (lichen, pith, cambium)	40	100	40	2%
Greens, Tea, Medicines, Spices	133	30	40	2%	Greens, Tea, Medicines, Spices	133	30	40	2%
Honey, Sweeteners	15	275	41	2%	Honey, Sweeteners	15	275	41	2%
Seeds, Nuts, Grain	24	500	120	5%	Seeds, Nuts, Grain	24	500	120	5%
Roots, Tubers	400	100	400	18%	Roots, Tubers	400	100	400	18%
TOTALS	1584		2206		TOTALS	1584		2201	

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1 **Human Health Reference Indian ADDENDUM – SOIL INGESTION**

2

3 Ingestion of soil, sediment, or dust is the result of hand-to-mouth contact, swallowing inhaled
4 dust, mouthing of objects, and ingestion of dirt or dust on food. The recommended subsistence
5 soil ingestion rate of 400 mg/d is based on a review of EPA guidance, soil ingestion studies in
6 suburban and indigenous populations, military, construction and utility worker studies, and local
7 climatic, habitat, and geologic conditions. Components of the traditional lifestyle that contribute
8 to soil ingestion include hunting, gathering, digging roots, processing and eating wild foods,
9 preparing and using natural materials such as basket materials, tending livestock, building and
10 repairing sweat lodges, tending cemeteries, and social gatherings. It also considers occupational
11 activities such as wildlife field work, construction or road work, sample collection, and cultural
12 resource field work.

13

14 **1.0 EPA Guidance**

15

16 EPA reviewed studies relevant to suburban populations and published summaries in its Exposure
17 Factors Handbook (1989, 1991, and 1997). In the current iteration of the Exposure Factors
18 Handbook³², EPA recommends 100 mg/d as a mean value for children in suburban settings, 200
19 mg/day as a conservative estimate of the mean, and a value of 400 mg/day as an “upper bound”
20 value (exact percentile not specified). Most state and federal guidance uses 200 mg/d for children
21 and 100 mg/d for adults in residential or agricultural settings.

22

23 A value for an ingestion rate for adult outdoor activities is no longer given in the 1997 Exposure
24 Factors Handbook for adults as “too speculative.” However, EPA’s soil screening guidance
25 recommends 330 mg/d for a construction or other outdoor worker. Risk assessments for
26 construction workers typically use a rate of 480 mg/d. Some states recommend the use of 1 gram
27 per acute soil ingestion event³³ to approximate a non-average day for children, such as an outdoor
28 day.

29

30 **2.0 Military Guidance**

31

32 The US military assumes 480 mg per exposure event³⁴ or per field day (Technical Guide 230).³⁵
33 Department Of Defense (2002)³⁶ recommendations for certain activities such as construction,
34 landscaping, or other field activities is 480 mg/day. During deployment, DOD assumes that half

³² Environmental Protection Agency. 1997. Exposure Factors Handbook. Volumes I, II, III. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/P-95/002Fa.

³³ MADEP (1992). Background Documentation For The Development Of An "Available Cyanide" Benchmark Concentration. http://www.mass.gov/dep/ors/files/cn_soil.htm

³⁴ http://www.gulflink.osd.mil/pesto/pest_s22.htm, citing US Environmental Protection Agency, Office of Research and Development, Exposure Factors Handbook, Volume I, EPA/600/P-95/002a, August 1997 as the basis for the 480 mg/d.

³⁵ USACPPM TG 230A (1999). Short-Term Chemical Exposure Guidelines for Deployed Military Personnel. U.S. Army Center for Health Promotion and Preventive Medicine. Website: <http://www.grid.unep.ch/btf/missions/september/dufinal.pdf>

³⁶ Reference Document (RD) 230, “Exposure Guidelines for Deployed Military” A Companion Document to USACHPPM Technical Guide (TG) 230, “Chemical Exposure Guidelines for Deployed Military Personnel”, January 2002. Website: <http://chppm-www.apgea.army.mil/desp/>; and <http://books.nap.edu/books/0309092213/html/83.html#pagetop>.

1 of a soldier's time is spent in these higher-contact activities. The UN Balkans Task Force assumes
2 that 1 gram of soil can be ingested per military field day³⁷.

3

4 **3.0 Studies in suburban or urban populations**

5

6 Written knowledge that humans often ingest soil dates back to the classical Greek era. Soil
7 ingestion has been widely studied from a perspective of exposure to soil parasite eggs and other
8 infections. More recently, soil ingestion was recognized to be a potentially significant pathway of
9 exposure to contaminants. Several early studies estimated intakes by children. Estimates based
10 on observation of 'sticky sweets' (Day et al., 1975), outdoor activities (Hawley, 1985), or
11 camping (Van Wijnen et al., 1990). Other studies used tracer elements (Binder, et al., 1986;
12 Clausing et al., 1987; Thompson and Burmaster, 1991; Calabrese et al., 1989; Stanek and
13 Calabrese (1995a, 1997). These studies estimated a wide range of soil ingestion rates.

14

15 Pica (ingestion of more than 5000 mg/d) is generally thought of as a pediatric condition. ATSDR
16 estimates that between 10 and 50% of children may exhibit pica behavior at some point.

17 Regulatory guidance recommends using a soil ingestion rate of 5 or 10g/d for pica children.

18 Some examples are:

19

20 (1) EPA (1997) recommends a value of 10g/d for a pica child.

21 (2) Florida recommends 10g per event for acute toxicity evaluation³⁸.

22 (3) ATSDR uses 5 g/day for a pica child³⁹.

23

24

25 **4.0 Studies in Indigenous Populations**

26

27 Studies of soil ingestion in indigenous populations have largely centered on estimates of past
28 exposure (or dose reconstruction) of populations affected by atomic bomb tests. Haywood and
29 Smith (1992) estimated potential doses to aboriginal inhabitants of the Maralinga and Emu areas
30 of South Australia by considering the number of hours per week spent in sleeping, sitting, hunting
31 or driving, cooking or butchering, and other activities. They noted that virtually all food, whether
32 of local origin or purchased, has some dust content by the time of consumption due to methods of
33 preparation and the nature of the environment. They recommend a soil intake of 1 to 10 gpd.
34 Other authors have used estimates of 0.5 or 1 gpd in other indigenous populations such as the
35 Marshall Islanders (Sun and Meinhold, 1997; LaGoy, 1987). Simon (1998) recommended using
36 a soil ingestion rate for indigenous people in hunters/food gathering/nomadic societies of 1g/d in
37 wet climates and 2 g/d in dry climates, and 3 g/d for all indigenous children, and 5 g/d if
38 geophagia is common.

39

40 These estimates are supported by studies of human coprolites from archaeological sites. For
41 instance, Nelson (1999) noted that human coprolites from a desert spring-fed aquatic system
42 included obsidian chips (possibly from sharpening points with the teeth), grit (pumice and
43 quartzite grains from grinding seeds and roots), and sand (from mussel and roots consumption).
44 Her conclusions are based on finding grit in the same coprolites as seeds, and sand in the same

³⁷ UNEP/UNCHS Balkans Task Force (BTF) (1999). The potential effects on human health and the environment arising from possible use of depleted uranium during the 1999 Kosovo conflict. www.grid.unep.ch/btf/missions/september/dufinal.pdf

³⁸ Proposed Modifications To Identified Acute Toxicity-Based Soil Cleanup Target Level, December 1999, www.dep.state.fl.us/waste/quick_topics/publications/wc/csf/focus/csf.pdf.

³⁹ For Example: El Paso Metals Survey, Appendix B, www.atsdr.cdc.gov/HAC/PHA/el Paso/epc_toc.html.

1 coprolites as mussels and roots. She concludes that “the presence of sand in coprolites containing
2 aquatic root fibers suggests that the roots were not well-cleaned prior to consumption.

4 **5.0 Geophagia**

6 Despite the limited awareness of geophagia in western countries, the deliberate consumption of
7 dirt, usually clay, has been recorded in every region of the world both as idiosyncratic behavior of
8 isolated individuals and as culturally prescribed behavior (Abrahams, 1997; Callahan, 2003;
9 Johns and Duquette, 1991; Reid, 1992). It also routinely occurs in primates (Krishnamani and
10 Mahaney (2000). Indigenous peoples have routinely used montmorillonite clays in food
11 preparation to remove toxins (e.g., in acorn breads), as condiments or spices, or to aid digestion
12 (e.g., kaolin clay in Kaopectate) (Reid, 1992; Krishnamani and Mahaney, 2000). Callahan (2003)
13 also suggests that certain soils may reduce parasite loads (demonstrated in monkeys) through
14 immune enhancement, and clays with aluminum salts may have an adjuvant effect as they do in
15 commercial vaccines.

17 Pregnancy is the most common occasion for eating dirt in many societies, especially kaolin and
18 montmorillonite clays in amounts of 30g to 50g a day. In some cultures, well-established trade
19 routes and clay traders make rural clays available for geophagy even in urban settings. Clays from
20 termite mounds are especially popular among traded clays, perhaps because they are rich in
21 calcium (Callahan, 2003; Johns and Duquette, 1991). In countries such as Uganda where
22 modern pharmaceuticals are either unobtainable or prohibitively expensive, ingested soils may be
23 very important as a mineral supplement, particularly iron and calcium (Abrahams, 1997;
24 Krishnamani and Mahaney, 2000; Johns and Duquette, 1991).

27 **7.0 Data from dermal adherence**

29 Dermal adherence of soil is generally studied in relation to dermal absorption of contaminants,
30 but soil on the hands and face can be ingested, as well. Kissel, et al. (1996) included reed
31 gatherers in tide flats. “Kids in mud” at a lakeshore had by far the highest skin loadings. Reed
32 gatherers were next highest, followed by farmers and rugby players and irrigation installers.
33 Holmes et al. (1999) studied a variety of occupations. Farmers, reed gatherers and kids in mud
34 had the highest overall skin loadings, followed by equipment operators, gardeners, construction,
35 and utility workers. Archaeologists and several other occupations had somewhat lower skin
36 loadings.

38 Grain size affects adherence and tactile responses to ingested soil. Particles below the sand-silt
39 size division (0.075 mm) adhering more than smaller sizes (see EPA, 1992⁴⁰ for more details).
40 Sieving is recommended, and data for particle size <0.044 cm (RAGSe, App. C, Table C-4).

42 **8.0 Data from washed or unwashed vegetables.**

44 Direct soil ingestion also occurs via food, for example from dust blowing onto food (Hinton,
45 1992), residual soil on garden produce or gathered native plants, particles on cooking utensils,
46 and so on. Beresford and Howard (1991) found that soil adhesion to vegetation was highly

⁴⁰ EPA (1992). Interim Report: Dermal Exposure Assessment: Principles And Applications.
Office of Health and Environmental Assessment, Exposure Assessment Group. /600/8-91/011B

1 seasonal, being highest in autumn and winter, and is important source of deposited radionuclides
2 to grazing animals.

4 **9.0 Subsistence lifestyles and rationale for soil ingestion rate**

6 The derivation of the soil ingestion rate is based on the following points:

- 8 • The foraging-subsistence lifestyle is lived in close contact with the environment.
- 9 • Plateau winds and dust storms are fairly frequent. Incorporated into overall rate, rather
10 than trying to segregate ingestion rates according to number of high-wind days per year
11 because low-wind days are also spent in foraging activities.
- 12 • The original Plateau lifestyle – pit houses, caches, gathering tules and roots - includes
13 processing and using foods, medicines, and materials. This is considered but not as
14 today’s living conditions.
- 15 • The house is assumed to have little landscaping other than the natural conditions or
16 xeriscaping, some naturally bare soil, a gravel driveway, no air conditioning (more open
17 windows), and a wood burning stove in the winter for heat.
- 18 • All persons participate in day-long outdoor group cultural activities at least once a month,
19 such as pow-wows, horse races, and seasonal ceremonial as well as private family
20 cultural activities. These activities tend to be large gatherings with a greater rate of dust
21 resuspension and particulate inhalation. These are considered to be 1-gram events or
22 greater.
- 23 • 400 mg/d is based on the following:
 - 24 1. 400 mg/d is the upper bound for suburban children (EPA); traditional or
25 subsistence activities are not suburban in environs or activities
 - 26 2. This rate is within the range of outdoor activity rates for adults (between 330 and
27 480); subsistence activities are more like the construction, utility worker or
28 military soil contact levels. However, it is lower than 480 to allow for some low-
29 contact days.
 - 30 3. The low soil-contact days are balanced with many 1-gram days and events (as
31 suggested by Boyd et al., 1999) such as root gathering days, tule and wapato
32 gathering days, pow wows, rodeos, horse training and riding days, sweat lodge
33 building or repair days, grave digging, and similar activities. There are also
34 likely to be many high or intermediate-contact days, depending on the occupation
35 (e.g., wildlife field work, construction or road work, cultural resource field
36 work).
 - 37 4. This rate does not account for pica or geophagy
 - 38 5. Primary data is supported by dermal adherence data in gatherers and ‘kids in
39 mud’. Tule and wapato gathering are kid-in-mud activities
 - 40 6. This rate includes a consideration of residual soil on roots (a major food
41 category) through observation and anecdote, but there is no quantitative data.

43 **Human Health Reference Indian ADDENDUM - INHALATION RATE**

44
45 Many risk assessments use the EPA default value of 20m³/d (EPA 1997), which reflects
46 contemporary lifestyles of the general population. However, EPA recognizes that inhalation rates
47 may be higher in certain populations, such as athletes or outdoor workers, because levels of
48 activity outdoors may be higher over long time periods. “If site-specific data are available to
49 show that subsistence farmers and fishers have higher respiration rates due to rigorous physical

1 activities than other receptors, that data may be appropriate.”⁴¹ Such subpopulation groups are
 2 considered ‘high risk’ subgroups.⁴²

3
 4 In order to develop inhalation rates more appropriate to traditional lifestyles, we evaluated the
 5 approach that uses specific activity levels to estimate short-term and long-term inhalation rates.
 6 Several examples of this approach are:

- 7
- 8 • EPA’s National Air Toxics Assessment (homepage: <http://www.epa.gov/ttn/atw/nata/natsa3.html>) uses the CHAD database to estimate national average air toxics exposures
 9 by selecting a series of single day's patterns to represent an individual's annual activity
 10 pattern.
- 11 • The California Air Resources Board (CARB, 2000) reviewed ventilation rates for many
 12 activities in the CHAD database and concluded that 20 m³/d represents an 85th percentile
 13 of typical adult activity lifestyles reflecting 8 hours sleeping and 16 hours of light activity
 14 with little moderate or heavy activity.
- 15 • In their technical guidance document, "Long-term Chemical Exposure Guidelines for
 16 Deployed Military Personnel," the US Army Center for Health Promotion and Preventive
 17 Medicine (USACHPPM) recommended an inhalation rate of 29.2 m³/d for US Armed
 18 Service members that includes 8 hours of moderate duties.⁴³
- 19 • EPA used 30 m³/day for a year-long exposure estimate for the general public at the
 20 Hanford Superfund site in Washington state, based on a person doing 4 hours of heavy
 21 work, 8 hours of light activity, and 12 hours resting.⁴⁴
- 22 • The DOE’s Lawrence Berkeley Laboratory also used 30 m³/d: “the working breathing
 23 rate is for 8 hours of work and, when combined with 8 hours of breathing at the active
 24 rate and 8 hours at the resting rate, gives a daily equivalent intake of 30 m³ for an
 25 adult.”⁴⁵
- 26 • The Rocky Flats Oversight Panel recommended using 30 m³/d.⁴⁶

27
 28
 29 Using EPA guidance on hourly inhalation rates for different activity levels, a reasonable
 30 inhalation rate for an average tribal member’s active lifestyle is an average rate of 26.2 m³/d,
 31 based on 8 hours sleeping at 0.4 m³/hr, 2 hours sedentary at 0.5 m³/hr, 6 hours light activity at 1
 32 m³/hr, 6 hours moderate activity at 1.6 m³/hr, and 2 hours heavy activity at 3.2 m³/hr. Unlike
 33 most other exposure factors, which are upper bounds, the inhalation rate is an average rate, so to
 34 be consistent with national methodology, we have rounded the rate down to 25 m³/day.

⁴¹ EPA (OSWER) “Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Support Materials Volume 1: Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities” page 6-4, at (http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/volume_1/chpt6-hh.pdf)

⁴² Exposure Factors Handbook, 1997, Volume 1. page 5-24

⁴³ http://www.gulflink.osd.mil/particulate_final/particulate_final_s06.htm and
http://www.gulflink.osd.mil/pm/pm_en.htm.

⁴⁴ “Report of Radiochemical Analyses for Air Filters from Hanford Area” Memorandum from Edwin L. Sensintaffar, Director of the National Air and Radiation Environmental Laboratory to Jerrold Leitch, Region 10 Radiation Program Manager
 (<http://yosemite.epa.gov/R10/AIRPAGE.NSF/webpage/Hanford+Environmental+Perspective>)

⁴⁵ (www.lbl.gov/ehs/epg/tritium/TritAppB.html)

⁴⁶ RAC (Risk Assessment Corporation). 1999. *Task 1: Cleanup Levels at Other Sites. Rocky Flats Citizens Advisory Board, Rocky Flats Soil Action Level Oversight Panel*. RAC Report No. 3-RFCAB-RFSAL-1999’ <http://www.itrcweb.org/Documents/RAD-2.pdf>

1 The estimate of the activity levels associated with traditional lifestyles is based on
2 anthropological studies, ethnographic literature on foraging theory and hunting-gathering
3 lifestyles, and confirmatory interviews with Tribal members. The inhalation rate reflects a wide
4 range of traditional indoor and outdoor activities, including (a) youth who are learning traditional
5 subsistence skills, (b) adults who hunt, gather, fish, and work in environmental management
6 occupations, and (c) elders who gather plants and medicines, prepare and use them, and teach
7 traditional activities. At present, it is not possible to extrapolate directly from the CHAD
8 database from window washing, for example, to hide scraping; research is underway to fill this
9 data gap using heart rate monitors keyed to respiration rate during specific traditional activities.

10
11 Finally, there may be some ethnic specificity in the link between metabolic and inhalation rates
12 such as thrifty genotype(s) and oxidation adiposity patterns (Goran, 2000; Fox et al., 1998;
13 Muzzin et al., 1999; Rush et al., 1997; Saad et al., 1991; Kue Young et al., 2002), as well as
14 ethnic differences in spirometry (Crapo et al., 1988; Lanese et al., 1978; Mapel et al., 1997;
15 Aidaraliyev et al., 1993; Berman et al., 1994). There are several stress response genes that enable
16 indigenous populations to respond to environmental stresses and to the rapid transition between
17 extremes, including feast and famine, heat and cold, disruption in circadian rhythms, dehydration,
18 seasonality, and explosive energy output or rapid transitions between minimum and maximum
19 exercise and VO_{2max} (Kimm et al., 2002; Snitker et al., 1998). This may affect inhalation rate,
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Wanapum Overview and Perspectives

Developed During Tribal Narrative Workshop (June 15-19, 2009)

Hanford, WA

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Wanapum Introduction

Before the Columbia, there was Chiwana. Wanapum, which means the River People, are part of the river and the land through which it flows. They are a part of the people who lived there and those who continue to live along the river's shores. Coyote created the river in his efforts to care for the Wanapum. The Columbia is the river of life and myth. The Wanapum people have been supported by the river's bounty for thousands of years – honor the spirit of the river. Teachings of the Wanapum tell all who will listen to be responsible to the land, to the creatures that live within the water and on the land, to the ancestors that are buried in the land, and to those who have not yet been born. The Wanapum are the caretakers responsible for the land and passing on the teachings of the natural world to the next generation.

The Wanapum live on the Columbia River; it has been their home from time immemorial. As Indian people, they were put there to protect and preserve the land and river for themselves, their children, and those not yet born. As spiritual people the Wanapum continue to practice their religion. Friendly, understanding, and respectful of all people and things, the Wanapum only wish to live in peace. Through strenuous and prudent efforts the Wanapum have successfully built relationships with federal, state, and local agencies. The respect, trust, and mutual understanding that results from these relationships allow the Wanapum to actively participate in decision-making processes that affect their responsibilities to care for all things put here by the Creator.

Wanapum Background

The Wanapum made their homes along the Columbia River in an area known as the Columbia Plateau. They traditionally lived in small villages. The villages included mat lodges made from tules for housing and a longhouse for spiritual ceremonies.

Priest Rapids became a central location for the Wanapum because the location offered optimal fishing conditions. The Wanapum traveled regularly up and down the coast of the Columbia River for food and other resources. Their proximity to the river allowed the Wanapum to catch plentiful salmon. The Wanapum learned the ways of the land and discovered hundreds of ways to create medicines and other remedies from plants.

In 1870, an outbreak of smallpox left the Wanapum with just 300 living members. Within 30 years many of the Wanapum people became members of nearby reservations because of health,

1 family connections, or employment opportunities. In 1930, the Wanapum population reached an
2 all-time low with just 30 to 50 members. The Wanapum managed to preserve their traditions
3 throughout the 1940s.

4
5 In the decades that followed, the Wanapum experienced various impositions on their land. The
6 construction of the Hanford Plutonium Plant and the U.S. Army Training Center took nearly
7 1,000 square miles of Wanapum land. The Priest Rapid Dam and the Wanapum Dam forever
8 changed their fishing and living routines.

9
10 The self-sufficient Wanapum chose to remain an unrecognized tribe, meaning they do not have
11 obligations to nor receive support from the U.S. government. The Wanapum frequently join
12 forces with other recognized tribes to further common causes. They work within their own group
13 to preserve their own culture and traditions. The survival of the Wanapum culture is evidence of
14 the determination and strength of the people.

15 16 *Tribal Values*

17
18 In essence, tribal values are intent on protecting, preserving and perpetuating resources for the
19 sake of traditional and cultural existence. Each resource had a time or a season on when to
20 gather, store, and properly use. This harmony and connection to the land is our culture and is
21 captured and passed down in our oral history. It is imperative that materials available for use in
22 from Hanford for a substance lifestyle be uncontaminated. Once resources become contaminated
23 or lost then part of our connection to the land and part of our culture is lost.

24 25 *General Comments*

- 26
- 27 • We assume that all of Hanford will be eventually restored and protected¹.
 - 28
 - 29 • Any new proposals at Hanford should at a minimum utilize the “Hanford Site NEPA
30 Guidance Document” as a primary reference for creating any NEPA document, especially the
31 Affected Environment section.
 - 32
 - 33 • We expect to be proactively engaged by DOE during the scoping and alternatives
34 development for Hanford proposals. Tribes are part trustees of Hanford and should be
35 informed and have opportunity to be engaged beyond the NEPA public involvement process.
 - 36
 - 37 • NEPA documents at Hanford need to include sections describing Viewscapes and
38 Soundscapes that are important to our tribal culture.
 - 39
 - 40 • Socioeconomic Section of a NEPA EIS should be separated into sections *Social* and
41 *Economics*.
 - 42
 - 43 • A GTCC repository at Hanford is a conflicting mission with present DOE cleanup efforts.
 - 44

¹ FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

- 1 • Salmon and water are important cultural resource that are intertwined with the subsistence
2 lifestyle of affected tribes.
3
- 4 • Affected Tribes and the trust responsibilities of DOE and other federal agencies (NEPA 18,
5 section 6) need to be clearly described in the GTCC EIS. It needs to include tribal aboriginal
6 rights, treaty rights and Executive Orders 12898, 13007, and 13175.
7
- 8 • Climate is simply not a snapshot in time. Archeological evidence supports tribal oral history
9 that speaks of a time when the region had extreme climate and weather changes. We have
10 stories of volcanic activity, glacial periods, times of great floods, and what we know today. A
11 GTCC repository should consider climate change and extreme weather changes expected
12 over 10,000 year period.
13
- 14 • We recommend that quiet zones and time periods should be identified for known Native
15 American ceremonial locations on and near the Hanford Reservation.
16
- 17 • Not all ceremonial sites at Hanford have been shared with DOE beyond Gable Mountain and
18 Rattlesnake Mountain.
19
- 20 • Hanford in general is composed of sandy soils that do not retain water very well and
21 consideration must be made for the potential long-term moisture percolation affecting any
22 underground structure.
23
- 24 • Some soils have medicinal purposes for healing like the White Bluffs area. Care should be
25 taken to recognize those with such properties.
26
- 27 • Proposal of any new risk of further contamination of the Columbia River system will receive
28 high priority review.
29
- 30 • The affected environment needs to fully describe and graphically illustrate known
31 groundwater plumes surrounding the Area of Potential Effect (APE). Contamination in the
32 ground water is the greatest long-term threat at the Hanford site. The groundwater section
33 needs to also identify where groundwater and its contaminant are not fully characterized.
34 This uncertainty and limited technical ability to remediate the vadose zone and ground water
35 puts the Columbia River at increased risk.
36
- 37 • Indian health is sustained through a balanced traditional lifestyle. Any contamination or
38 restriction is a negative affect on tribal health. We are against adding any waste to the
39 Hanford site that adds risk to tribal health.
40
- 41 • “Reference Indian” scenarios should be considered in any risk assessment development.
42 These scenarios can also be considered inadvertent intruder scenarios, as required by DOE
43 Order 435.1.
44
- 45 • Biodiversity within National Monument include rare plant and wildlife species.
46

- 1 • We expect DOE to comply with Comprehensive Conservation Plan (CCP).
- 2
- 3 • Columbia River Tribes have created a salmon recovery plan called the Wy-Kan-Ush-Mi Wa-
- 4 Kish-Wit (Spirit of the Salmon). We expect that DOE's potential placement of a repository to
- 5 not conflict with elements of this Plan.
- 6
- 7 • A tribal subsistence economy needs to be described in terms of long-term "personal"
- 8 enterprise. ("Personal enterprise" is the term for self and community reliance on the
- 9 environment for existence as opposed to employment or modern economies.)
- 10
- 11 • The potential for large returning salmon runs should be considered part of potential changes
- 12 to the economy. A goal of tribes, federal and state governments, is to dramatically improve
- 13 salmon returns in the Columbia River.
- 14
- 15 • Tribal employment at Hanford and surrounding area should be part of the employment
- 16 description.
- 17
- 18 • Environmental justice (EJ) in Indian country needs to be better defined to clarify sovereign
- 19 nation-state status, federal trust responsibility to tribes, and include treaty and aboriginal
- 20 rights.
- 21
- 22 • We maintain that aboriginal rights allow for the protection, access to, and use of open and
- 23 unclaimed lands of the Hanford Reservation when human health and safety are not in
- 24 jeopardy.
- 25
- 26 • There are sites or locations within the existing Hanford reservation boundary that should be
- 27 considered for special protections or set aside for tribal ceremonial uses.
- 28
- 29 • We propose that ceremonial sites be placed in co-stewardship with DOE, USFWS and
- 30 affected tribes for long-term management and protection.
- 31
- 32 • The Comprehensive Land Use Plan (CLUP) has institutional controls (ICs) that limit present
- 33 and future use by Native Americans. These ICs should be described as part of the affected
- 34 environment. Any new proposals that extend, expand, or create new IC should be considered
- 35 cumulative impacts to native people.
- 36
- 37 • The 50-year management time horizon of the CLUP and its land use designations are often
- 38 incorrectly assumed to be permanent designations. CLUP landuse designations and their
- 39 boundaries can be changed at the discretion of DOE with recommendations by Hanford
- 40 stakeholders, including affected tribes.
- 41
- 42 • According to the *American Indian Religious Freedom Act*, tribal members have a protected
- 43 right to conduct religious ceremonies at locations on public lands where they are known to
- 44 have occurred.
- 45
- 46 • *Executive Order 13007* states that Tribal members have the right to access ceremonial sites.

- 1
- 2 • DOE and USFWS must maintain trails or roads that are presently providing access to known
- 3 ceremonial sites.
- 4
- 5 • New culturally significant findings are required to be added to the list of sites and locations
- 6 with special cultural protections that override any land use designation of the CLUP or other
- 7 documents.
- 8
- 9 • Shipment routes need to be described for proposed Hanford site. Travel routes will cross
- 10 many major rivers and salmon-bearing watersheds that are important to Tribes.
- 11
- 12 • All things of the natural environment we recognize as cultural resources. Nature provides for
- 13 a subsistence live style, and thus, the daily interaction with the land is our culture, and our
- 14 foundation of our religious beliefs.
- 15
- 16 • *Cultural Landscapes* have been defined by the World Heritage Committee as distinct
- 17 geographical areas or properties uniquely representing the combined work of nature and of
- 18 man.
- 19
- 20 • There are three overlapping cultural landscapes that overlie the natural landscape at Hanford.
- 21 The first is the tribal archeological and ethnographic record spanning more than 10,000
- 22 years. The second was created by early settlers, and the third by the Manhattan Project. DOE
- 23 is presently removing much of the Manhattan landscape to a more *natural* state (restoration
- 24 and conservation).
- 25
- 26 • We recognize culturally significant viewsapes as described in the Hanford Cultural
- 27 Resources Management Plan. Special protections and visit considerations should be given to
- 28 tribal elders and youth to maintain and accommodate educational opportunities of tribal
- 29 cultural and ceremonial activities.
- 30
- 31 • A proposed Repository must consider local DOE strategies of Hanford recovery, including
- 32 the 200 Area 7th ROD and the 2015 Vision for the River Corridor. These long-term recovery
- 33 strategies must be part of the NEPA evaluation for a repository.
- 34
- 35 • The APE for the cultural landscape should include areas across the lower Columbia Plateau
- 36 from the Wallula Gap to the Sentinel Gap.
- 37
- 38 • There are many cemeteries, ceremonial sites, and areas of spiritual significance within the
- 39 Hanford Boundary. Not all sites are known to DOE.
- 40
- 41

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APPENDIX H:

**PUBLIC DISTRIBUTION FOR THE DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE DISPOSAL OF GREATER-THAN-CLASS C (GTCC)
LOW-LEVEL RADIOACTIVE WASTE AND GTCC-LIKE WASTE**

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Name	Education/Expertise	Contribution
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Arnold Edelman	M.A., Physical Geography/Geomorphology; 37 years of experience in multimedia environmental regulation, pollution prevention, waste management, environmental management, safety and health	DOE Document Manager
Christine Gelles	B.A., Literature, Philosophy, Communications; 17 years of experience in environmental management policy and oversight; 6 years of experience in radioactive waste management strategy and policy development	DOE Senior Manager
James Joyce	B.S., Geological Engineering; 22 years of experience in environmental remediation, waste management, and program and project management	DOE Project Manager
<i>Argonne National Laboratory</i>		
Timothy Allison	M.S., Mineral and Energy Resource Economics; M.A., Geography; 26 years of experience in regional analysis and economic impact analysis	Socioeconomics, environmental justice
Georgia Anast	B.A., Mathematics/Biology; 20 years of experience in environmental assessment	Quality assurance coordinator
Bruce Biwer	Ph.D., Chemistry; 19 years of experience in environmental assessment and transportation risk analysis	Transportation, accidents, facility design, inventory database

Name	Education/Expertise	Contribution
Brian Cantwell	B.S., Forestry, 26 years of experience in cartography and GIS	Environmental justice maps and tables
Young-Soo Chang	Ph.D., Chemical Engineering; 21 years of experience in air quality and noise impact analysis	Climate, air quality, noise
Shih-Yew Chen	Ph.D., Nuclear Engineering; 24 years of experience in environmental assessment, waste and risk analysis	Senior technical advisor
Jing-Jy Cheng	Ph.D., Polymer Science and Engineering; 19 years of experience in computer model development and applications for human health and ecological risk assessments	RESRAD model, human health impacts
Deborah Elcock	B.A., Mathematics; M.B.A.; 21 years of experience in regulatory analysis	Applicable laws, regulations, and other requirements
Stephen Folga	Ph.D., Gas Engineering; 13 years of experience in technology assessment and waste management	Technology assessment, accident assessment, resource materials
Elizabeth Hocking	J.D.; 18 years of experience in environmental and energy policy analysis	Applicable laws, regulations, and other requirements
Timothy Klett	M.S., Computer Science; 9 years of experience in software development and data management	Inventory database
Mary Moniger	B.A., English; 30 years of experience in editing and writing	Lead technical editor
Michele Nelson	Certificate of Design; 32 years of experience in graphic design	Graphics
Daniel O'Rourke	M.S., Industrial Archaeology; 16 years of experience in cultural resource management, 10 years in historical property issues	Cultural resources
Terri Patton	M.S., Geology; 19 years of experience in environmental research and assessment	Geology, water resources; cumulative impacts

Name	Education/Expertise	Contribution
John Peterson	M.S., Nuclear Engineering; Certified Health Physicist (CHP); 31 years of experience in nuclear engineering and health physics	Technical coordinator, waste inventory, human health impacts
Mary Picel	M.S., Environmental Health Sciences; 23 years of experience in environmental assessment, risk assessment, and waste management	Project manager, document manager, human health impacts, waste management, cumulative impacts
Albert Smith	Ph.D., Physics; 34 years of experience in environmental assessment	Climate, air quality, noise
David Tomasko	Ph.D., Civil Engineering; 28 years of experience in hydrogeology and fluid mechanics	Water resources
William Vinikour	M.S. and B.S., Biology with environmental emphasis; 34 years of experience in ecological research and environmental assessment	Ecology, land use

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APPENDIX J:

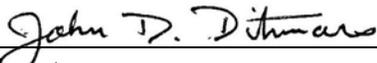
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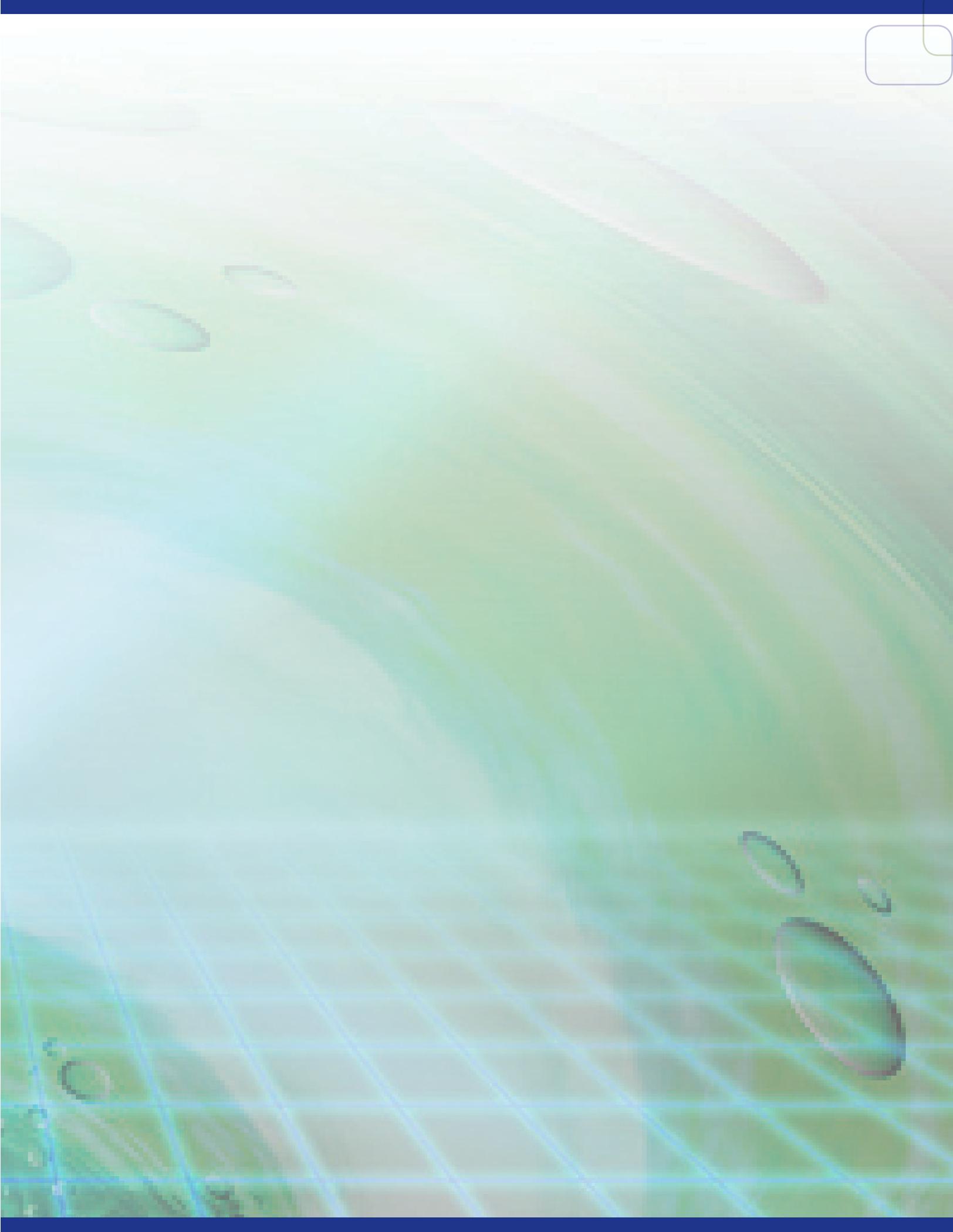
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