4.3.5.2.3 *Air Quality and Noise*

Operations related to the existing LWR facility would continue to generate criteria pollutants. Impacts for radiological airborne emissions are discussed in Section 4.3.5.2.9.

Noise impacts during operation are expected to be low. Air quality and noise impacts for this disposition alternative are described separately. Supporting data for the air quality and noise analyses are presented in Appendix F.

AIR QUALITY

The operation of the facility would result in the emission of some pollutants at each of the sites. Emissions would typically not exceed Federal, State, or local air quality regulations or guidelines.

Emission rates for operation of the existing LWR are presented in Table F.1.3–12. Air pollutant emissions sources associated with operations include:

- Operation of diesel generators and periodic testing of emergency diesel generators
- [Text deleted.]
- Small quantities of toxic/hazardous pollutant emissions from facility operations

During operation, concentrations of criteria and toxic/hazardous air pollutants are expected to continue to be in compliance with Federal, State, and local air quality regulations or guidelines. No additional operation or testing of diesel generators or emissions from support facilities would be expected to occur from the use of MOX fuel. Pollutant concentrations from operating an existing LWR with a MOX core rather than a uranium core would not change, as shown in Table F.1.3–12. The process would remain the same, and criteria and toxic/hazardous emissions are not related to the type of fuel being used (NRC 1996b:2-22).

NOISE

The location of the facilities associated with the existing LWR facility relative to the site boundary and sensitive receptors was examined in order to evaluate the potential contribution to noise levels at these locations and the potential for onsite and offsite noise impacts.

Non-traffic noise sources associated with reactor operation of these facilities include ventilation systems, cooling systems, vents, pumps, motors, emergency diesel generators, transformers, paging systems, and material handling equipment. There would be no discernible increase in noise levels as a result of operating an existing LWR with a MOX core rather than a uranium core.

4.3.5.2.4 *Water Resources*

Utilizing excess Pu as fuel in an existing commercial LWR should not cause any impacts to water resources outside of those identified in the site-specific environmental impact statements which have been prepared for these facilities. There would be no noticeable changes to current use of water resources. The facilities would continue to obtain raw water from either surface or groundwater sources that have an adequate supply to support them. Wastewater would continue to be treated, monitored, and discharged.

4.3.5.2.5 *Geology and Soils*

There would be no impacts to the geologic and soil resources resulting from the utilization of existing LWRs. A range of conditions from applicable sites were evaluated and used as the basis for this assessment. No ground-disturbing construction activities are proposed for this alternative although there would be modification of an existing building. Therefore, no construction or operational effects to the geologic and soil resource are anticipated, and no direct or indirect effects to the geologic or soil resource are anticipated.

4.3.5.2.6 *Biological Resources*

Representative existing LWR sites that could be utilized for the disposition of Pu in a MOX-fueled reactor are located within a number of the principal vegetation types, including deciduous forest, grassland, desert, and southeast evergreen forest. These principal vegetation types are described in Sections 3.10.6 and 3.11.6.

The use of an existing LWR to burn MOX fuel would not be expected to result in any additional impacts to biological resources at the selected site. This is the case since the reactor and all associated facilities are in place and operational. Although an addition to the fuel receiving and storage building may be required, construction would take place within a previously disturbed area of the site. Also, the design and operation of cooling and auxiliary water systems would not be affected by the use of MOX fuel. Thus, entrainment, impingement, and thermal impacts to aquatic organisms, or salt drift impacts to vegetation and soil, would not be expected to increase. Consultation with USFWS and State agencies would be conducted at the site-specific level, as appropriate.

4.3.5.2.7 *Cultural and Paleontological Resources*

This section discusses impacts to cultural and paleontological resources potentially resulting from the use of an existing LWR. For the discussion of impacts, the term cultural resources includes prehistoric, historic, and Native American resources. Utilization of an existing LWR is not expected to affect cultural or paleontological resources. Minor building modifications and ground-breaking activities are proposed, but new construction would be adjacent to existing facilities on previously disturbed ground. It is unlikely that the area contains NHRP-eligible or paleontological resources. No impacts to Native American resources are expected.

4.3.5.2.8 *Socioeconomics*

This section describes the potential socioeconomic effects resulting from the use of MOX as fuel in existing light water reactors. Representative sites, varying in size from one to three reactors, were selected for analysis.

Regional Economy Characteristics. Operation activities at these sites would create between 40 and 105 total new jobs (direct and indirect) for each reactor. Positions required during operation of any of these facilities would be filled by the REA's existing workforce, and there should not be any in-migration to the ROI as a result of this alternative. There would be a negligible increase in the REA's local economy and per capita income, and unemployment rates would decrease minimally (Socio 1996a).

Population and Housing, Community Services, and Local Transportation. There would be no in-migrating workers and therefore no impacts to population and housing or community services. There would also be no impacts to the local transportation networks.

4.3.5.2.9 *Public and Occupational Health and Safety*

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents involved with an existing commercial LWR whose core would be fueled with MOX instead of uranium oxide alone. The section first describes the impacts from normal facility operation of the MOX fueled reactor for a representative sample of existing commercial LWR sites followed by a description of impacts from reactor accidents at a generic site. The impacts associated with the ultimate disposal of the spent nuclear fuel form in a HLW repository are presented separately in technical documents that specifically address repository operations.

Summaries of the radiological impacts to the public and to workers associated with normal operation are presented in Tables 4.3.5.2.9–1 and 4.3.5.2.9–2, respectively; impacts associated with the applicable time duration (17 years, the assumed campaign time or 11 years for the Preferred Alternative) are presented in the text. Summaries of impacts associated with postulated accidents are given in Tables 4.3.5.2.9–3 and 4.3.5.2.9–4. Detailed results are presented in Appendix M.

The Preferred Alternative for disposition of surplus Pu is a dual technology strategy including immobilization and burning Pu as MOX fuel in existing reactors. Approximately 70 percent of the surplus Pu was identified to be in forms suitable for MOX fuel fabrication. Summaries of the radiological and hazardous chemical impacts to the public and to workers associated with normal operations and with postulated accidents in this section are presented for an assumed 17-year operational campaign for the disposition of 50 t (55.1 tons) of surplus Pu and for an assumed 11-year operational campaign for the analyzed case (70 percent).

The Preferred Alternative for disposition through the utilization of existing reactors would require a shorter reactor campaign to dispose of less material with the utilization of additional reactors. The impacts and risks associated with MOX fuel fabrication would therefore be reduced since the duration of operations would coincide with the reactor campaign.

Normal Operation. During normal operation of an existing LWR with a MOX core, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The resulting doses and potential health effects to the public and workers are described below.

Radiological Impacts. Table 4.3.5.2.9–1 presents the reported radiological impacts to the general public resulting from operation of the existing LWRs with uranium cores in 1994. Impacts involved in changing the core from a uranium core to a MOX core are also presented. To put the operational doses into perspective, comparisons with doses from natural background radiation are included in the table.

The doses and resulting fatal cancer risks to both the average and the maximally exposed member of the public, and also to the population, from annual commercial LWR operation with a MOX-fueled core would not be significantly different than present operations with a uranium core.

The dose to the maximally exposed member of the public from annual total site operations would be maintained within the radiological limits specified in Appendix I to 10 CFR 50 and 40 CFR 190 (if the reactor is licensed by NRC). This dose is estimated to be less than 0.17 mrem from all pathways. From 17 years of operation, the corresponding fatal cancer risk for this individual would be less than 1.5×10^{-6}. The impacts to the average individual would be much less. This activity would be included in a program to ensure that doses to the public are ALARA. As a result of annual total site operation, the population dose would be less than 2.0 person-rem. The corresponding number of fatal cancers in this population from 17 years of operation would be less than 0.017.

Table 4.3.5.2.9–1. Potential Radiological Impacts to the Public During Normal Operation of the Existing Light Water Reactor

Receptor	No Action (Reactors Using UO_2 Core)[a]	Reactor Using MOX Core: Increment[b]	Reactor Using MOX Core: Total Site[c]
Annual Dose to the Maximally Exposed Individual Member of the Public[d]			
Atmospheric release pathway (mrem)	4.2×10^{-4} to 0.091	2.5×10^{-5} to 0.023	4.4×10^{-4} to 0.10
Total liquid release pathway (mrem)	8.6×10^{-4} to 0.095	-0.020 to -2.8×10^{-4}	2.8×10^{-4} to 0.075
Atmospheric and liquid release pathways combined (mrem)	1.3×10^{-3} to 0.19	-1.1×10^{-2} to 0.020	7.2×10^{-4} to 0.17
Percent of natural background[e]	4.3×10^{-4} to 0.063	-3.8×10^{-3} to 6.8×10^{-3}	2.4×10^{-4} to 0.059
17-year fatal cancer risk	1.1×10^{-8} to 1.6×10^{-6}	-9.6×10^{-8} to 1.7×10^{-7}	5.9×10^{-9} to 1.5×10^{-6}
11-year fatal cancer risk[f]	7.1×10^{-9} to 1.0×10^{-6}	-6.2×10^{-8} to 1.1×10^{-7}	3.7×10^{-4} to 9.7×10^{-7}
Annual Population Dose Within 80 Kilometers			
Atmospheric release pathway (person-rem)	0.021 to 1.4	1.3×10^{-3} to 0.20	0.022 to 1.6
Total liquid release pathway (person-rem)	0.0 to 2.2	-0.48 to 0.0	0.0 to 1.7
Atmospheric and liquid release pathways combined (person-rem)	0.021 to 2.5	-0.046 to 0.20	0.022 to 2.0
Percent of natural background[e]	4.0×10^{-6} to 3.2×10^{-4}	-6.0×10^{-5} to 3.4×10^{-5}	4.3×10^{-6} to 2.6×10^{-4}
17-year fatal cancers	1.8×10^{-4} to 0.021	-3.8×10^{-3} to 1.7×10^{-4}	1.8×10^{-4} to 0.017
11-year fatal cancers[f]	1.2×10^{-4} to 0.014	$-2.5\times10^{-3}$to 1.1×10^{-4}	1.2×10^{-4} to 0.011
Annual Dose to the Average Individual Within 80 Kilometers[g]			
Atmospheric and liquid release pathways combined (mrem)	1.2×10^{-5} to 9.6×10^{-4}	-1.8×10^{-4} to 1.0×10^{-4}	1.3×10^{-5} to 7.8×10^{-4}
17-year fatal cancer risk	1.0×10^{-10} to 8.1×10^{-4}	-1.5×10^{-9} to 8.9×10^{-10}	1.0×10^{-10} to 6.7×10^{-9}
11-year fatal cancer risk[f]	6.5×10^{-11} to 5.2×10^{-9}	-9.7×10^{-10} to 5.8×10^{-10}	6.5×10^{-11} to 4.3×10^{-9}

[a] The No Action doses are based on 1994 reported doses from operation of all reactors at a site.

[b] Incremental doses represent the change in doses involved in changing from a uranium core to a MOX core.

[c] Combined or total impacts do not necessarily equal the sum of the individual components because different sites may be involved.

[d] The standards for individual members of the public are given in Appendix I to 10 CFR 50 and 40 CFR 190 for NRC licensed reactors. As discussed in Appendix I, 5 mrem/yr is the airborne emission guideline and 3 mrem/yr per reactor is the liquid release guideline. Meeting these guideline values serves as a numerical demonstration that doses are as low as reasonably achievable. A total dose of 25 mrem/yr is the limit from all pathways combined, as given in 40 CFR 190. If the reactor is owned by DOE, the applicable radiological limits for an individual member of the public from total site operations are 10 mrem per year from the air pathways as required by NESHAPS (40 CFR Part 61, Subpart H) under the CAA, 4 mrem per year from the drinking water pathway as required by the SDWA, and 100 mrem per year from all pathways combined. Refer to DOE Order 5400.5.

[e] Annual natural background radiation levels: the average individual receives a dose that could range from 296 to 299 mrem; the population within 80 km in the year 1994 received a dose that could have ranged from 130,000 to 760,000 person-rem.

[f] For the Preferred Alternative, for analysis purposes approximately 70 percent of the total surplus Pu was assumed to be used in existing LWRs. As a result, the 17-year campaign for the total Pu would be reduced to about an 11-year campaign for the Preferred Alternative.

[Text deleted.]

[g] Obtained by dividing the population dose by the number of people living within 80 km of the site (450,000 to 2,600,000).

Source: Section M.2.

Table 4.3.5.2.9–2. Potential Radiological Impacts to the Workers During Normal Operation of the Existing Light Water Reactor

Receptor	No Action (Reactor Using UO_2 Core)[a]	Reactor Using MOX Core	
		Increment[b]	Reactor Total[c]
Commercial LWR Workforce			
Average worker dose (mrem/yr)[d]	280 to 540	1.3 to 2.7	281 to 543
17-year risk of fatal cancer	1.9×10^{-3} to 3.7×10^{-3}	8.9×10^{-6} to 1.8×10^{-5}	1.9×10^{-3} to 3.7×10^{-3}
11-year risk of fatal cancer[e]	1.2×10^{-3} to 2.4×10^{-4}	5.8×10^{-6} to 1.2×10^{-5}	1.2×10^{-3} to 2.4×10^{-3}
Total dose (person-rem/yr)	170 to 600	1.6	172 to 602
17-year fatal cancers	1.2 to 4.1	0.011	1.2 to 4.1
11-year risk of fatal cancer[e]	0.78 to 2.7	7.1×10^{-3}	0.78 to 2.7
Total Site Workforce[f]			
Total dose (person-rem/yr)	327 to 1,190	1.6 to 4.8	331 to 1,193
17-year risk of fatal cancer	2.2 to 8.1	0.011 to 0.033	2.2 to 8.1
11-year fatal cancers[e]	1.4 to 5.2	7.1×10^{-3} to 0.021	1.4 to 5.2

[a] The No Action doses are based on measured doses from 1988 to 1993.
[b] The incremental doses represent the estimated increase in worker doses involved in changing from a uranium core to a MOX core.
[c] Combined or total impacts do not necessarily equal the sum of the individual components because different sites may be involved. [Text deleted.]
[d] The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20).
[e] For the Preferred Alternative, for analysis purposes approximately 70 percent of the total surplus Pu was assumed to be used in existing LWRs. The 17-year campaign for the total surplus Pu would be reduced to about an 11-year campaign.
[f] The impact to the total site workforce is the result of conversion of all reactors at the site to the burning of MOX fuel. [Text deleted.]

Note: The number of significant figures used in the impact values is dictated by the addition of small incremental values to relatively large No Action values.

Source: Section M.2.

Doses to onsite workers from normal operations with a uranium-fueled core are given in Table 4.3.5.2.9–2. Estimated incremental and total impacts to onsite workers resulting from a MOX core instead of a uranium core are also given. Included are involved workers directly associated with the operation of one MOX-fueled reactor, and the entire workforce if all the reactors at a generic site were converted to burn MOX fuel. All doses fall within regulatory limits. [Text deleted.]

The annual dose from operation of a reactor with a MOX core would range from 281 to 543 mrem to the average reactor worker and from 172 to 602 person-rem to the entire reactor workforce. The annual dose to the total site workforce would range from 331 to 1,193 person-rem. The risks and numbers of fatal cancers among the different workers from 17 years and 11 years of operation are included in Table 4.3.5.2.9–2. Dose to individual workers would be kept low by instituting badged monitoring and ALARA programs and also worker rotations. As a result of the implementation of these mitigation measures, the potential fatal cancers for the operation of this facility would be lower than calculated.

Hazardous Chemical Impacts. Existing commercial light reactors are currently in operation. If a change were made from burning uranium-based fuel to burning MOX fuel, which is part U and part Pu, the nonradiological chemical emissions would not change. Therefore the HIs and cancer risks would not change, which means the incremental HIs and cancer risks would be zero. There would be no incremental increase in the potential hazardous chemical impact to the public and workers from normal operations of existing commercial light water reactors would be lower than calculated.

Facility Accidents. The risks associated with existing commercial LWRs has been studied by the operating organizations in accordance with NRC guidance. The safety of these reactors has been analyzed and reported by plant operators in such documents as SARs and probabilistic risk assessments. In addition, the NRC has conducted probabilistic risk assessments on five existing reactors and issued the report *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NUREG-1150). According to this report, the estimated mean core damage frequencies would range from 4.0×10^{-6} to 3.4×10^{-4} caused by internal events (not including natural phenomena). Should such core damage occur, the potential consequences would range from 71 to 1,022 latent cancer fatalities for the offsite population according to this NRC report. The estimated risks to the offsite population from these accidents would range from 9.6×10^{-4} to 2.4×10^{-2}.

Reactor safety issues regarding the use of MOX fuel in existing LWRs are addressed in a recent report by the NAS. The report indicates that the potential influences on the safety of the use of MOX fuel in LWRs has been extensively studied in the United States in the 1970s. These influences on safety have also been extensively studied in Europe, Japan, and Russia. Regarding effects of MOX on accident probabilities, the report states,"... no important overall adverse impact of MOX use on the accident probabilities of the LWRs involved will occur; if there are adequate reactivity and thermal margins in the fuel, as licensing review should ensure, the main remaining determinants of accident probabilities that will involve factors not related to fuel composition and hence unaffected by the use of MOX rather than LEU fuel" (NAS 1995a:352). Regarding the effects of MOX on accident consequences, the report states, "... it seems unlikely that the switch from uranium-based fuel could worsen the consequences of a postulated (and very improbable) severe accident in a LWR by more than 10 to 20 percent. The influence on the consequence of less severe accidents, which probably dominate the spectrum value of population exposure per reactor-year of operation would be even smaller, because less severe accidents are unlikely to mobilize any significant quantity of plutonium at all" (NAS 1995a:355).

Analysis described in Appendix M.5 has been performed using the MACCS code to determine the effects of the use of MOX fuel in an existing LWR. The accident assumed conditions including a large population distribution near the existing LWR, and meteorology conditions for dispersal leading to large doses, and would not necessarily be reflective of actual site conditions. A sample of severe accident scenarios is illustrated in Table 4.3.5.2.9–3. The data shown are derived from a range of severe accidents that make up the release scenarios. Some accidents have frequencies much less than 1×10^{-8}/yr and large releases. These low frequency/high release accidents were included to reflect severe accident conditions leading to core damage and release of radioactive materials in order to obtain an estimate on the effects of using MOX fuel versus uranium fuel, as indicated by the ratios. To perform a comparison of existing commercial LWR impacts with other disposition alternatives, reactor accidents with frequencies less than 1×10^{-7}/yr would need to be done with site-specific meteorology, receptor, and population data.

Impacts are calculated in units of probability of cancer fatality for the maximum exposed individual and the worker and the number of cancer fatalities for the offsite population. The fatality data shown does not reflect site conditions and would differ if site-specific meteorology and population were used. The ratios of accident fatalities for MOX and UO_2 fueled LWRs are given in Table 4.3.5.2.9–4 only for the purpose of showing the relative impacts because the ratios would not be affected by meteorological or population data. Each scenario is based on releases taken from an existing commercial LWR probabilistic risk assessment of severe accidents. The releases were modeled using the MACCS code based on a large population distribution near a generic LWR and meteorological conditions for dispersal leading to large doses and would not necessarily be reflective of actual site conditions. Further site-specific NEPA and safety reviews would be performed should the Existing LWR Alternative be selected at the ROD.

Table 4.3.5.2.9–3. Accident Impacts for Existing Light Water Reactor with Mixed Oxide Fuels

		Worker at 1,000 m			Maximum Offsite Individual			Population Within 80 km		
Accident Release Scenarios[a]	**Accident Category Frequency[b] (per year)**	**Probability of Latent Cancer Fatality**	**Risk of Latent Cancer Fatality (per year)**	**Risk of Latent Cancer Fatality per 17 yr (per 11 yr)**	**Probability of Latent Cancer Fatality**	**Risk of Latent Cancer Fatality (per year)**	**Risk of Latent Cancer Fatality per 17 yr (per 11 yr)**	**Number of Latent Cancer Fatalities**	**Risk of Latent Cancer Fatalities (per year)**	**Risk of Latent Cancer Fatalities per 17 yr[c] (per 11 yr)**
Steam generator tube rupture	1.5×10^{-6}	1.0	1.5×10^{-6}	2.6×10^{-5} (1.7×10^{-5})	1.0	1.5×10^{-6}	2.6×10^{-5} (1.7×10^{-5})	5.9×10^{3}	0.0089	0.15 (0.098)
Large late containment failure-high RCS pressure	8.1×10^{-6}	0.79	6.4×10^{-6}	1.1×10^{-4} (7.2×10^{-5})	0.86	7.0×10^{-6}	1.2×10^{-4} (7.8×10^{-5})	1.3×10^{2}	0.0011	0.018 (0.012)
Large early containment failure-medium/low RCS pressure	7.0×10^{-7}	1.0	7.0×10^{-7}	1.2×10^{-5} (7.8×10^{-6})	1.0	7.0×10^{-7}	1.2×10^{-5} (7.8×10^{-6})	2.3×10^{3}	0.0016	0.027 (0.018)
Large early containment failure-high RCS pressure	8.7×10^{-7}	1.0	8.7×10^{-7}	1.5×10^{-5} (9.8×10^{-6})	1.0	8.7×10^{-7}	1.5×10^{-5} (9.8×10^{-6})	1.6×10^{3}	0.0014	0.024 (0.016)
Interfacing system loss of cooling accident	1.3×10^{-7}	1.0	1.3×10^{-7}	2.2×10^{-6} (1.4×10^{-6})	1.0	1.3×10^{-7}	2.2×10^{-6} (1.4×10^{-6})	7.3×10^{3}	0.00095	0.016 (0.010)
Small early containment failure	2.4×10^{-6}	1.0	2.4×10^{-6}	4.1×10^{-5} (2.7×10^{-5})	1.0	2.4×10^{-6}	4.1×10^{-5} (2.7×10^{-5})	1.2×10^{3}	0.0029	0.049 (0.032)

[a] Each release scenario is based on existing commercial LWR probabilistic risk assessment of severe accidents. The release scenarios were modeled using the MACCS code based on large population distribution near a generic site and meteorological conditions leading to large doses. Therefore, the fatality data shown are not relevant to nor indicative of fatalities that would be calculated if site-specific meteorological and population data were used in the model.

[b] A release scenario typically will contain many accident sequences that have a common outcome (for example a steam generator tube rupture). Each accident sequence has a frequency of occurrence that is derived from an event tree analysis and will include sequences with frequencies that are below those used in typical EISs.

[c] The population risk of latent cancer fatality, when compared with similar risk from the use of LEU reactor fuel, yields correct latent cancer fatality ratios of MOX-fuel relative to LEU-fuel. The accident conditions include a large population distribution near the existing LWR and meteorology conditions for dispersal leading to large doses and would not necessarily be reflective of actual site conditions. Further site-specific NEPA and safety documentation would be completed if the Existing LWR Alternative is selected.

Note: RCS = Reactor Coolant System. For the Preferred Alternative, for analysis purposes, approximately 70 percent of the Pu was assumed to be used for MOX fuel. The impacts projected for 50 t for the assumed 17-year existing LWR campaign would be proportionately reduced to those for an 11-year campaign; all values are mean values.

Source: HNUS 1996a.

Table 4.3.5.2.9–4. Ratio of Accident Impacts for Mixed Oxide Fueled and Uranium Fueled Reactors for Typical Severe Accidents (Mixed Oxide Impacts/Uranium Impacts)[a]

Accident Release Scenarios[b]	Worker at 1,000 m	Maximum Offsite Individual	Population Within 80 km
Steam generator tube rupture	0.94	0.94	0.94
Large late containment failure-high RCS pressure	1.08	1.07	1.08
Large early containment failure-medium/low RCS pressure	0.93	0.93	0.93
Large early containment failure-high RCS pressure	0.97	0.96	0.97
Interfacing system loss of cooling accident	0.93	0.92	0.93
Small early containment failure	0.96	0.95	0.96

[a] The ratio of accident fatalities for MOX- and UO_2-fueled LWRs are shown for the purposes of showing relative impacts. For example, 0.94 indicates that the impacts of the accident would be lower for a reactor with MOX fuel.

[b] Each release scenario is based on existing commercial LWR probabilistic risk assessment of severe accidents. The release scenarios were modeled using the MACCS code based on large population distribution near a generic site and meteorological conditions for dispersal leading to large doses. Therefore, the fatality data shown are not relevant to nor indicative of fatalities that would be calculated if site-specific meteorological and population data were used in the model.

Note: RCS=Reactor Coolant System.

Source: HNUS 1996a.

4.3.5.2.10 *Waste Management*

This section summarizes the waste management impacts resulting from the burning of MOX fuel in existing commercial pressurized LWRs. There would be no high-level or TRU wastes associated with the burning of MOX fuel in an LWR. Facilities that would support the existing commercial LWR would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with NRC regulations, RCRA, and other applicable statutes as outlined in section E.1.2.

Operation of the existing commercial light water reactors to include burning of MOX fuel is not expected to increase the amount or change the content of waste generated (ORNL 1995b:B-8). The use of a MOX fuel core results in a somewhat different distribution of fission products. Consequently, the details or radionuclide distribution would be different. However, system modifications are not expected to be needed in order to comply with current regulatory requirements.

Operation of the existing commercial LWR would generate spent nuclear fuel. The MOX fuels designed for serving Pu disposition would not stay in the reactors' cores so as to recover their full economic values. For this analysis it was assumed that the MOX fuel bundles would be removed as soon as the fuel had been irradiated to the point where it had met the Spent Fuel Standard. Therefore the MOX fuel cycle for each refueling would be shorter than the current typical commercial nuclear plant. This assumption was used in order to bound the impacts for spent fuel generation and to dispose of the excess weapons-usable fissile material as quickly as possible. Since the number of assemblies discharged per year for the MOX cycles is greater than that of the average LEU cycle, the amount of wet or dry storage required for the MOX cycles would be more than for the average of the LEU cycles. Data from existing PWR commercial reactors shows that the average number of assemblies discharged annually is 48. Assuming 0.43 t (0.47 tons) per assembly for PWRs, this equates to 21 t (23 tons) of residual heavy metal content. The increase in the number of assemblies discharged annually due to the burning of MOX fuel in a PWR would be approximately 32 assemblies on the average. This would result in an additional 14 t (15 tons) of residual heavy metal. Based on this average, an additional two rail or eight truck shipments of spent fuel would be required annually. The actual incremental increase would depend on the specific reactor selected. Data from existing BWR commercial reactors shows that the average number of assemblies discharged annually is 127. Assuming 0.18 t (0.20 tons) per assembly for BWRs, this equates to 23 t (25 tons) of residual heavy metal content. The increase in the number of assemblies discharged annually due to the burning of MOX fuel in a BWR would be approximately 15 on the average (ORNL 1995b:B-11). This would result in an additional 3 t (3.3 tons) of residual heavy metal annually. Based on this average, an additional one rail or two truck shipments of spent fuel would be required. As noted earlier, the actual incremental increase would depend on the specific reactor selected. The decay heat rate of discharged fuel assemblies initially charged with weapon-grade Pu is within a few percent of current LEU discharged fuel (ORNL 1995b:B-10). Consequently, there would be minimal negative impact on the cooling needed for irradiated fuel element storage due to the substitution of MOX fuel for LEU fuel. Spent nuclear fuel would have to be stored onsite until a Federal geologic repository is available. Spent nuclear fuel would be maintained in the spent fuel storage pool for a minimum of 10 years to allow for sufficient cooling. The annual increase of MOX spent nuclear fuel assemblies could necessitate an increase in the size of the storage pools to accommodate the number of additional assemblies. However, all of the plants considered have sufficient spent fuel pool capacity to accommodate additional assemblies resulting from the use of MOX fuel. Additionally, dry storage onsite would alleviate pool crowding until shipment of the spent fuel to a repository (ORNL 1995b:B-10). There could be design/safety and transportation impacts associated with packaging and shipping the increased volumes of spent nuclear fuel to another offsite location.

4.3.5.3 Partially Completed Light Water Reactor Alternative

The environmental impacts described in the following sections are based on the analysis of the partially completed LWR facility for the Partially Completed LWR Alternative described in Section 2.4.5.3. This alternative would require the operation of a minimum of two LWRs, which could be located at the same or different sites. Environmental impacts for this facility are described in the context of a generic range of conditions that could exist at potential locations.

In accordance with this alternative for surplus Pu disposition, two partially completed LWRs would be needed. The two LWRs could be at one site, or the reactors could be at two sites. If there are two reactors at one site, the impacts in Sections 4.3.5.3.1 through 4.3.5.3.10 would be approximately doubled unless otherwise indicated (for example, direct workers).

4.3.5.3.1 *Land Resources*

Land Use. Because this is an existing site, direct impacts to land use are not anticipated during completion of construction and during operation. Existing land use would not change; additional land area would not be disturbed for the facility nor required for a buffer zone. Since the reactor facility is partially completed, land use should be in conformance with site development/facility plans for the representative site. Additionally, development should be in conformance with land-use plans, policies, and controls at the Federal, State, and local levels. As discussed in Section 4.3.5.3.8, nonhousing units in excess of existing vacancies would be required to accommodate in-migration that would occur during both the construction and operational phases. No offsite land use would be affected during construction; therefore, indirect impacts would not occur.

Visual Resources. No impacts to visual resources would be caused by completion of the facility. The existing VRM classification would reflect that of a developed industrial facility (Class 5). It is unlikely that visual impacts would be caused by completion of construction. Facility operations could cause an increase in visual impacts to adjacent lands. An increase in visible stack plumes could impact viewpoints with high sensitivity levels including water-based recreational use urbanized areas, residential areas, and public roadways within the viewshed depending on distance, atmospheric conditions, and level of screening provided by vegetation and terrain.

[Text deleted.]

4.3.5.3.2 Site Infrastructure

The site infrastructure of the partially completed LWR would conform to the conditions described in Section 3.12.2. A site infrastructure at the partially completed site is already in place to support completion of the construction project. This includes roads, parking and facilities to accommodate approximately 4,500 site employees. The infrastructure would require only minor upgrades to accommodate the workforce needed to complete the project (see Table 4.3.5.3.2–1). The reactors would be completed essentially as if they were to be fueled with LEU fuel. The change to MOX fuel would have minimal impact on the partially completed LWR and would not affect the site infrastructure. The site is served with water and an existing power distribution system that would adequately support the power demands of plant equipment and employee facilities.

Table 4.3.5.3.2–1. Additional Site Infrastructure Needed for the Operation of the Partially Completed Light Water Reactor (Annual)

	Transportation		Electrical		Fuel		
	Roads (km)	**Railroads (km)**	**Energy (MWh/yr)**	**Peak Load (MWe)**	**Oil (l/yr)**	**Natural Gas (m^3/yr)**	**Coal (t/yr)**
Facility Requirement	<8	<6	700,000 to 1,100,000	96 to 140	Approximately 757,000	0	0
Range of resource availability	<8	<6	700,000 to 1,100,000	96 to 140	Approximately 757,000	0	0
Amount required in excess of low-end range of available resources	0	0	0	0	0	0	0

Source: LLNL 1996g; TVA 1995b:1.

4.3.5.3.3 *Air Quality and Noise*

Construction and operation of the partially completed LWR facility would generate criteria and toxic/hazardous pollutants. To evaluate the air quality impacts, criteria and toxic/hazardous concentrations from this facility have been compared with Federal standards. Impacts for radiological airborne emissions are discussed in Section 4.3.5.3.9.

Noise impacts during either construction or operation are expected to be low. Air quality and noise impacts are described separately. Supporting data for the air quality and noise analysis are presented in Appendix F.

AIR QUALITY

Remaining construction and operation of the facility would result in the emission of some pollutants at the representative sites. Emissions would typically not exceed Federal, State, or local air quality regulations or guidelines.

The principal sources of emissions during completion of construction include the following:

- Fugitive dust from wind erosion of exposed ground surfaces
- Exhaust from and road dust raised by construction equipment, vehicles delivering construction materials, and vehicles carrying construction workers

Appropriate control measures would be followed. It is expected that the site will continue to comply with applicable Federal and State ambient air quality standards during construction.

Emission rates for operation of partially completed LWR are presented in Table F.1.3–13. Air pollutant emissions sources associated with operations include the following:

- Operation of auxiliary steam generators
- Operation of diesel generators and periodic testing of emergency diesel generators
- [Text deleted.]
- Small quantities of toxic/hazardous pollutant emissions from various facility maintenance activities

During operation, concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal regulations. The estimated pollutant concentrations for operation of this facility are presented in Table 4.3.5.3.3–1.

NOISE

The location of the facilities associated with the partially completed LWR facility relative to the site boundary and sensitive receptors was examined for a partially completed reactor site. The potential contribution to noise levels at the site boundary was evaluated.

Noise sources during completion of construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along major offsite transportation routes used to bring construction material and workers to the site. Noise impacts associated with increased traffic on access routes were not evaluated.

Table 4.3.5.3.3–1. Estimated Incremental Operational Concentrations of Pollutants and Comparison With Most Stringent Regulations or Guidelines—Partially Completed Reactor

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Representative Site[b] (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000	<0.01
	1-hour	40,000	<0.01
Lead	Calendar Quarter	1.5	[c]
Nitrogen dioxide	Annual	100	0.05
Ozone	1-hour	235	[d]
Particulate matter less than or equal to 10 microns in diameter	Annual	50	<0.01
	24-hour	150	0.015
Sulfur dioxide	Annual	80	0.04
	24-hour	365	0.15
	3-hour	1,300	0.35
Hazardous and Other Toxic Compounds[e]			
[Text deleted.]			

[a] The Federal standards are presented.

[b] The concentration represents the alternative contribution only. No Action concentrations at a generic site cannot be determined since there is a range of possible pollutants and conditions that could be found at a potential site.

[c] No sources of this pollutant have been identified.

[d] Ozone, as a criteria pollutant, is not directly emitted or monitored by the sites. See Section 4.1.3 for a discussion of ozone-related issues.

[e] Emissions of unspecified hydrocarbons were not modeled.

Note: Concentrations are based on site contribution and do not include the contribution from nonfacility sources.

Source: 40 CFR 50; TVA 1974b.

Nontraffic noise sources associated with operation of this facility include ventilation systems, cooling systems, circuit breakers, pumps, motors, vents, diesel generators, transformers, paging systems, and material handling equipment. These noise sources would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would be small (TVA 1974b:2.6-14,8.2-13). Due to the size of the site, noise emissions from construction equipment and operations activities would not be expected to cause annoyance to the public. Some noise sources may result in impacts, such as disturbance of wildlife.

4.3.5.3.4 *Water Resources*

Utilizing excess Pu as fuel would have impacts from completion of construction and the operation of a partially completed LWR. Water resources requirements, provided in Table C.1.1.3–7, were used to assess impacts to surface water. The water requirements to complete the construction of both units would be 440 million l/yr (116 million gal/yr). The average water requirement for construction of a single partially completed LWR would be 220 million l/yr (58.1 million gal/yr). Impacts to the river flow would be negligible. [Text deleted.]

During operations, approximately 138,167 million l/yr (36,500 million gal/yr) of water would be required for the operation of both reactors (TVA 1974b:2.9-11). The average water withdrawal from the operation of a single partially completed LWR would be 69,084 million l/yr (18,250 million gal/yr) which is 0.2 percent of the average flow of the river (89 billion l/day [23.5 billion gal/day]). This withdrawal is not anticipated to have any impacts on downstream users. This amount would not curtail known or projected industrial water uses or affect the average flow by the site each day. Operational impacts have been identified in the site-specific EIS that has been prepared for these facilities.

During operations, sanitary wastewater would be discharged at the site. However, at a wet site, unlike water waste effluent from treatment facilities which is released on a continuous basis, cooling system blowdown activities would also occur. The normal blowdown rate from the cooling towers from both reactors would be approximately 2.09 m^3/s (74 ft^3/s) during periods of high evaporation (TVA 1974b:2.5-1). The average blowdown from the operation of a single partially completed LWR would be 1.05 m^3/s (37 ft^3/s) which is 0.1 percent of the average flow of the river (1,029 m^3/s [36,359 ft^3/s]). This blowdown is not anticipated to have any impacts on downstream users. Blowdown will be returned to the river through a diffuser system designed to provide good diffusion and to minimize environmental impacts due to the disturbance of aquatic life during construction and operation of the reactor (TVA 1974b:2.5-1).

Impacts to floodplains from the partially completed LWR (for both construction and operation) were not elevated in the site-specific EIS for the partially completed LWR because although the Bellefont site was used for analyses purposes, specific sites for floodplain analysis are not proposed at this time. If this alternative is selected for further consideration as a method of disposition, site-specific floodplain evaluations would be conducted in future tiered NEPA documents, as appropriate.

4.3.5.3.5 *Geology and Soils*

Effects to the geologic and soil resource as a result of construction and operational activities at a partially completed LWR for the final disposition of Pu are assessed for the representative site.

No direct or indirect effects from restricted access to potential geologic resources as a result of facility or site infrastructure improvements are anticipated because the site is partially completed and no new ground-disturbing construction is anticipated.

Implementation of this alternative would not involve ground-disturbing construction activities that will affect the soil erosion potential. Operational impacts to the soil resource would be minimal assuming typical landscaping and ground cover improvements were employed. Areas previously without ground cover would have some type of improvements (buildings, roads and landscapes). Soil erosion from stormwater runoff and wind action could occasionally occur during operation but are anticipated to be minimal.

4.3.5.3.6 *Biological Resources*

Terrestrial Resources. The assumed representative partially completed reactor site that could be utilized for the disposition of surplus Pu is located within the deciduous forest principal vegetation type. Although numerous construction activities would be required to complete the plant, such activities would generally take place on previously disturbed land. Construction could cause some disturbance to wildlife living immediately adjacent to the facility. During operation of the completed reactor, noise and human presence could continue to discourage some species from living nearby. Depending upon the type of cooling system used, operational impacts to vegetation are possible from salt drift.

Wetlands. Direct impacts to wetlands are unlikely since construction activities would generally take place on previously disturbed land. Indirect impacts from erosion and subsequent sedimentation could occur. However, implementation of a soil erosion and sedimentation control plan would limit such impacts. During operation, wastewater discharges could impact wetlands in the immediate vicinity of the outfall. Also depending upon the type of cooling system used, salt drift from cooling towers could impact wetland areas.

Aquatic Resources. Impacts from construction activities to aquatic species could result from sedimentation of nearby waterbodies. Effective erosion control would prevent damage to aquatic resources.

Operation of the LWR could lead to an increase in the impingement and entrainment of aquatic organisms. The extent to which this would impact local fish populations would be dependent upon the stream size, intake and discharge volumes, intake and discharge structure design, and the susceptibility of individual species to impingement and entrainment. Thermal impacts resulting from the discharge of cooling tower blowdown are possible. Thermal impacts would be controlled by the conditions of an NPDES permit.

Threatened and Endangered Species. Construction activities associated with completion of a reactor are unlikely to impact threatened and endangered species. This is the case since little or no additional habitat would be disturbed. Operational impacts, such as from operation of the cooling system, are possible but depend on the specific species present. Preactivity surveys and consultation with the USFWS and the appropriate State agency would be completed as necessary prior to construction or operation of the reactor.

4.3.5.3.7 *Cultural and Paleontological Resources*

This section discusses impacts to cultural and paleontological resources that may result from the construction and operation of a partially completed LWR. For the discussion of impacts, the term cultural resources includes prehistoric, historic, and Native American resources. Prehistoric resources that may occur in the vicinity of the partially completed LWR include remains of villages, cemeteries, and hunting and butchering sites. Historic sites may include cemeteries, remains of residential or commercial structures, or road traces. It is possible but unlikely that resources may be affected by the completion of the facility. Operation would not cause additional effects. Some Native American resources such as archaeological sites or traditional use areas may also occur in the areas.

No paleontological resources have been identified in the vicinity of the partially completed LWR. Cultural and paleontological resources may be affected directly through ground disturbance during construction, building modification, visual intrusion of the project into the historic setting or environmental context of historic sites, visual and audio intrusions into Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Minor modifications to existing facilities would be necessary under this alternative. Some infrastructure improvements may also be necessary. Specific concerns about the presence, type, and location of Native American resources would be addressed through consultation with the potentially affected Native American tribes.

4.3.5.3.8 *Socioeconomics*

Regional Economy Characteristics. Finishing the construction of the partially completed reactor would generate employment and income increases within the affected region. Facility construction would create 2,848 total jobs (1,525 direct and 1,323 indirect) for one reactor and 4,305 (2,305 direct and 2,000 indirect) for two. However, total employment and per capita income in the representative site's REA would increase by less than 1 percent under either scenario. Operation of one reactor would generate about 2,200 total jobs in the REA (847 direct and 1353 indirect) and 3,311 total jobs (1,275 direct and 2,036 indirect) would be created with the operation of two reactors. Operation of one or two reactors would increase employment in the REA by less than 1 percent over No Action projections. The unemployment rate would decrease slightly and there would be small increases in per capita income (Socio 1996a). Only the Two-Reactor Option is analyzed for population, housing, and community service because it would have a greater impact on the region.

Population and Housing. The resident labor force would not be sufficient to fill all of the newly created jobs during the construction and operation phases of the project. In-migrating workers and their families would increase population in the ROI during both phases of the project. About 180 construction-related workers would in-migrate, and population would increase by much less than 1 percent over to No Action population projections. During operation of the facility, approximately 300 workers would in-migrate to the ROI. Population growth would be less than 1 percent over No Action projections. No housing units, in excess of existing vacancies, would be required in the ROI during construction and operation of the project (Socio 1996a).

Community Services. Constructing and operating the partially completed LWR would slightly increase the demand for community services at the representative site.

School enrollments would increase in the representative ROI during construction and operation of the facility. To maintain the No Action student-to-teacher ratio of 15.5:1, two new teachers would be needed during peak construction of the two-reactor facility, and eight additional teachers would be needed during operation. The increase in teacher requirements would be distributed over several school districts in the ROI; therefore, no single school district would be significantly affected (Socio 1996a).

Only 1 additional police officer would be needed during both the construction and operation phases of the two-reactor facility to maintain the No Action service level of 1.5 officers per 1,000 persons in the representative site's ROI. One new firefighter would be needed during construction, and only 3 new firefighters would be needed during operation to maintain the current service level of 4.1 firefighters per 1,000 persons (Socio 1996a).

Projected hospital occupancy rates during peak construction and full operation would increase slightly over No Action levels, with existing hospital capacities capable of accommodating the small increase in patient load. No additional physicians would be needed during construction, and only one new physician will be needed during operation of the two-reactor facility (Socio 1996a).

Local Transportation. The two-reactor option's construction and operation may cause a decline in the level of service on some roads around the representative site. Some road improvements may be required (Socio 1996a).

4.3.5.3.9 *Public and Occupational Health and Safety*

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal performance or accidents involved with the operation of an LWR that is presently only partially completed. The section first describes the impacts from normal facility operation followed by a description of impacts from reactor accidents. The impacts associated with the ultimate disposal of the spent fuel in a high level waste repository are presented separately in technical documents that specifically address repository operations.

Summaries of the radiological impacts to the public and to workers associated with normal operation during the assumed 17-year campaign time are presented in Tables 4.3.5.3.9–1 and 4.3.5.3.9–2, respectively. Detailed results are presented in Appendix M.

Normal Operation. There would be no radiological releases associated with the construction needed to complete the reactor. Construction worker exposures to material potentially contaminated with radioactivity (for example, from construction activities involved with existing contaminated soil) would be limited to assure that doses are maintained as low as reasonably achievable. Toward this end, construction workers would be monitored as appropriate. Limited hazardous chemical releases are anticipated as the result of construction activities. However, concentrations would be within the regulated exposure limits.

During normal reactor operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The resulting doses and potential health effects to the public and workers are described below.

Radiological Impacts. Radiological impacts to the average and maximally exposed members of the public resulting from the normal operation of the reactor and its support facilities are presented in Table 4.3.5.3.9–1. Since there are no other nuclear activities at the site, the impacts from total site operations would be the same as the reactor facility impacts. The doses to the maximally exposed member of the public from annual operations are within the radiological limits specified in Appendix I to 10 CFR 50 and 40 CFR 190 (if the reactor is licensed by NRC). The dose would be 0.57 mrem from all pathways. From 17 years of operation, the associated risk of fatal cancer to this individual would be 4.9×10^{-6}. The impacts to the average individual would be less. this activity would be included in a program to ensure that doses to the public are ALARA. As a result of annual total site operation, the population dose would be 0.61 person-rem and the number of fatal cancers in the population from 17 years of operation would be 5.2×10^{-3}. To put the operational doses into perspective, comparisons with doses from natural background radiation are included in the table.

Doses to onsite workers from normal operations are given in Table 4.3.5.3.9–2. The annual average dose to the site worker would be 360 mrem. The dose to the entire workforce would be 380 person-rem. The risk and number of fatal cancers among the workers from 17 years of operation are included in Table 4.3.5.3.9–2.

Hazardous Chemical Impacts. There would be no increase in the potential hazardous impact to the public and workers from construction of the partially completed LWRs. The potential impacts of chemical emissions from operation would be as stated in the Bellefonte Final EIS dated May 1974. The source of chemicals and chemical quantities were reviewed and updated in connection with the renewal of the NPDES permit in 1992 (TVA 1993a:7). The computations and assumptions used for this review were consistent with those in this PEIS and potential impacts are still expected to be insignificant. This is confirmed by voluntary toxicant testing which is conducted on a semiannual basis. The *Letter Report FMDP LWR PEIS Data Report* (ORNL/MD/LTR-9, February 28, 1995) indicates that if a change were made from burning uranium-based fuel to burning MOX fuel in an LWR, the nonradiological chemical emissions would not change. Therefore the potential health impacts to the public and workers from hazardous chemicals emitted from the partially completed LWRs alternative facility would not change from the LWRs using UO_2 fuels.

Table 4.3.5.3.9–1. Potential Radiological Impacts to the Public During Normal Operation of the Partially Completed Light Water Reactor

Receptor	Generic Site	
	Reactor	Total Site[a]
Annual Dose to the Maximally Exposed Individual Member of the Public[b]		
Atmospheric release pathway (mrem)	0.56	0.56
Drinking water pathway (mrem)	1.4×10^{-3}	1.4×10^{-3}
Total liquid release pathway (mrem)	5.4×10^{-3}	5.4×10^{-3}
Atmospheric and liquid release pathways combined (mrem)	0.57	0.57
Percent of natural background[c]	0.19	0.19
17-year fatal cancer risk	4.9×10^{-6}	4.9×10^{-6}
Annual Population Dose Within 80 Kilometers		
Atmospheric release pathway (person-rem)	0.47	0.47
Total liquid release pathway (person-rem)	0.14	0.14
Atmospheric and liquid release pathways combined (person-rem)	0.61	0.61
Percent of natural background[c]	1.6×10^{-4}	1.6×10^{-4}
17-year fatal cancer risk	5.2×10^{-3}	5.2×10^{-3}
Annual Dose to the Average Individual Within 80 Kilometers[d]		
Atmospheric and liquid release pathways combined (mrem)	4.5×10^{-4}	4.5×10^{-4}
17-year fatal cancer risk	3.8×10^{-9}	3.8×10^{-9}

[a] Since there are no other nuclear activities at the site, the total site impacts are the same as the incremental impacts.

[b] The standards for individual members of the public are given in Appendix I to 10 CFR 50 and 40 CFR 190 for NRC licensed reactors. As discussed in Appendix I, 5 mrem/yr is the airborne emission guideline and 3 mrem/yr per reactor is the liquid release guideline. Meeting these guideline values serves as a numerical demonstration that doses are ALARA. A total dose of 25 mrem/yr is the limit from all pathways combined, as given in 40 CFR 190. If the reactor is owned by DOE, the applicable radiological limits for an individual member of the public from total site operations are 10 mrem per year from the air pathways as required by NESHAPS (40 CFR 61, Subpart H) under the CAA, 4 mrem per year from the drinking water pathway as required by the SDWA, and 100 mrem per year from all pathways combined. Refer to DOE Order 5400.5.

[c] Annual natural background radiation levels: the average individual receives 298 mrem; the population within 80 km receives 407,000 person-rem.

[Text deleted.]

[d] Obtained by dividing the population dose by the number of people projected to be living within 80 km of the site (1,365,000).

Source: Section M.2.

Table 4.3.5.3.9–2. Potential Radiological Impacts to Workers During Normal Operation of the Partially Completed Light Water Reactor

Receptor	Generic Site
Involved workforce[a]	
Average worker dose (mrem/yr)[b]	360
17-year risk of fatal cancer	2.4×10^{-3}
Total dose (person-rem/yr)	380
17-year fatal cancers	2.6

[a] An involved worker is a worker associated with operations of the proposed action.

[b] The radiological limit for an individual worker is 5,000 mrem/year (10 CFR 20).

[Text deleted.]

Source: NRC 1995b; ORNL 1995b.

Facility Accidents. For the partially completed commercial LWR, a Preliminary Safety Analysis Report (PSAR) has been prepared for the representative reactor in accordance with NRC Requirements. The PSAR does not reflect the potential effects on public and worker safety of using MOX fuel. An analysis, described in Section M.5, has been performed which indicates that the use of MOX fuel in a commercial LWR would have small effects. This can be seen from the information provided in Tables 4.3.5.2.9–3 and 4.3.5.2.9–4. For each of the three reactor cases of severe accidents listed, the MACCS code was run for the severe accidents identified based on a uranium-fueled core and a MOX-fueled core. Although the sets of severe accidents are not specifically for the partially completed reactors applicable to this alternative, the results of the MACCS code analysis are considered relevant. Each entry in the table is the ratio of impacts of severe accidents for a MOX-fueled reactor and a uranium-fueled reactor. The results indicate that the use of MOX fuel in place of uranium fuel in a LWR would have an effect on accident impacts ranging from an 8-percent decrease to an 8-percent increase depending on the accident that occurs.

4.3.5.3.10 *Waste Management*

This section summarizes the waste management impacts for the construction and operation resulting from the burning of MOX fuel in a partially completed commercial LWR. There is no high-level or TRU waste associated with the burning of MOX fuel in a LWR. Table 4.3.5.3.10–1 provides the total estimated operational waste volumes projected to be generated per reactor for burning MOX fuel in a partially completed commercial LWR. Waste generation volumes under No Action are from maintenance activities and the limited engineering design work. Facilities that would support the partially completed commercial LWR would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with NRC regulations, RCRA, and other applicable statutes as outlined in Section E.1.2.

Construction and operation of the partially completed commercial LWR would impact existing waste management activities at the site, by initiating the generation of spent nuclear fuel, LLW, and mixed LLW, and increasing the generation of hazardous and nonhazardous wastes. Wastes generated during construction would consist of wastewater and hazardous, low-level, and nonhazardous solid wastes. A small amount of solid LLW, 0.5 m^3 (0.7 yd^3) composed mainly of radioactive sources, would be generated during construction. Inert construction and demolition wastes ranging from 211 m^3 (276 yd^3) to 392 m^3 (513 yd^3) for concrete; 88 t (97 tons) to 208 t (229 tons) for steel; and 21,000 m^3 (27,500 yd^3) to 49,000 m^3 (64,100 yd^3) for block, brick, gravel, asphalt, gypsum board, and other materials, would be placed in dumpsters for disposal by the solid waste disposal contractor at an offsite permitted landfill or recycled if appropriate. Construction sanitary wastewater from the main plant (based on data from similar plants) range from 127,000 m^3 (33,500,000 gal) to 274,600 m^3 (72,500,000 gal) and would be routed to the local municipal sewage treatment system. Typical hazardous waste generated during construction of a partially completed reactor site (based on data from a similar plant) include paints, solvents, acids, oils, radiographic wastes and degreasers, and range from 3.4 t (3.7 tons) to 6.3 t (6.9 tons) for solid hazardous wastes and 30.6 m^3 (8,080 gal) to 56.7 m^3 (15,000 gal) for liquid hazardous wastes. The only waste treatment performed for construction waste onsite would be neutralization of acids. Hazardous wastes would be shipped to commercial RCRA-permitted treatment and disposal facilities (TVA 1995b:1).

Operation of the partially completed commercial LWR would generate spent nuclear fuel. The MOX fuels designed for serving Pu disposition would not stay in the reactors' cores for recovering their full economic values. For this analysis it was assumed that the MOX fuel bundles would be removed as soon as the fuel has been irradiated to the point where it had met the Spent Fuel Standard. Therefore the MOX fuel cycle for each refueling would be shorter than the original design. This assumption was used in order to bound the impacts for spent fuel generation and storage plus it would dispose of the excess weapons-usable fissile material as quickly as possible. Spent nuclear fuel would have to be stored onsite until a Federal geologic repository is available. Data from existing PWR commercial reactors of the same size show that the number of assemblies discharged annually could range from 50.7 to 108.5 (an average of 80 assemblies). Assuming 0.43 t (0.47 tons) per fuel assembly, the residual heavy metal content would range from 22 to 47 t (24 to 52 tons). The original onsite design capacity/availability of pool storage, or above-ground dry storage could be challenged due to the shorter fuel cycle.

Liquid LLW would be treated in an onsite radwaste treatment facility. Compactible solid LLW would either be taken offsite or remain onsite for volume reduction, prior to disposal. For disposal, all LLW would be transported in a solid form. Based on data from 8 existing PWR plants, a range of from 57 m^3 (75 yd^3) to 637 m^3 (833 yd^3) of LLW would be shipped offsite for disposal, as frequently as from 6 to 31 times each year. Assuming the LLW would be transported to a site within the DOE complex for disposal, land usage factors may vary from 3,300 m^3/ha (1,700 yd^3/acre) to 8,600 m^3/ha (4,500 yd^3/acre). Consequently, this would require a range of 0.01 ha/yr (0.03 acres/yr) to 0.07 ha/yr (0.2 acres/yr) of LLW disposal area. If the LLW is taken to a NRC or State disposal site, transportation impacts and land usage LLW disposal factors would vary according to the disposal site.

Table 4.3.5.3.10–1. Estimated Annual Waste Volumes Generated Per Reactor for Mixed Oxide Fuel in Partially Completed Light Water Reactors

Category	With MOX Fuel (m^3)	No Action (m^3)
Spent Nuclear Fuel	50.7 to 108.5[a] assemblies	None
Low-Level		
Liquid	18,930[b]	None
Solid	57 - 637	None
Mixed Low-Level		
Liquid	0	None
Solid	102	None
Hazardous		
Liquid	Included in solid	Included in solid
Solid	27	2
Nonhazardous (Sanitary)		
Liquid	341,000	3,780[c]
Solid	5,280	51[d]
Nonhazardous (Other)		
Liquid	Included in sanitary	None
Solid	4,430[e]	1.8-3.6[f]

[a] Residual heavy metal content of 22 to 47 t, assuming 0.43 t per assembly for PWR.

[b] Liquid LLW would be treated and solidified prior to disposal.

[c] Estimate based on 80 employees, 189 l/day/employee and 250 days per year of operations.

[d] Estimate based on 80 employees, 0.0085 m^3/day/employee and 250 days per year of operations.

[e] Recyclable wastes.

[f] One to two tons of desiccants. Estimate based on density at 500 kg/m^3.

Source: DOE 1995f; ORNL 1995b; TVA 1995b:2.

Approximately 102 m^3 (133 yd^3) of mixed LLW, consisting primarily of decontamination wastes and ion exchange resins, would be stored onsite until treatment and disposal is available at an offsite RCRA-permitted facility, or shipped to another facility in the DOE complex for treatment and disposal; in accordance with their site treatment plan that was developed pursuant to the requirements of the *Federal Facility Compliance Act*. Hazardous and nonhazardous waste would be managed in accordance with site practice.

4.3.5.4 Evolutionary Light Water Reactor Alternative

The environmental impacts described in the following sections are based on the analysis of the evolutionary LWR facility for the Evolutionary LWR Alternative as described in Section 2.4.5.4. This alternative would require the operation of two to four LWRs, which could be located at the same or different sites. The representative sites used for this facility are: Hanford, NTS, INEL, Pantex, ORR, and SRS. Multiple reactors could be located at a site, or multiple sites could have one reactor. If there are multiple reactors at a site than the total reactor impacts would be approximately the impacts in Section 4.3.5.4.1 through 4.3.5.4.10 times the number of reactors at the site (for example, land use or direct workers).

4.3.5.4.1 *Land Resources*

This section describes the impacts of constructing and operating the evolutionary LWR. The evolutionary LWR could be constructed in either a large or small reactor option. During construction, 284 ha (700 acres) of land would be disturbed for a two-unit large or small evolutionary LWR. A one-unit large or small evolutionary LWR would disturb 142 ha (350 acres) of land during construction. Total land area requirements during operation for the large or small two-unit evolutionary LWR would be 138 ha (340 acres). Increasing the facility to four units (small reactor option) would increase the operation land area requirement to 227 ha (560 acres). Buffer zones would be established in accordance with applicable NRC regulations. Land-use impacts would be similar for the two-unit large or small reactor options, however, visual impacts for the two-unit large reactor option could be greater because the increased magnitude and extent of site development. Land resources impacts from the four-unit facility would be anticipated to be greater than either of the two-unit options.

Construction and operation of the evolutionary LWR would not cause indirect land-use impacts at the analysis sites. As discussed in Section 4.3.5.4.8, in-migration of workers would be required during both the construction and operational phases. Historic housing construction rates indicate there would be sufficient housing units available to accommodate in-migrating population at each site. Therefore, offsite land use would not be affected.

Hanford Site

Land Use. Vacant land adjacent to the site of the 65-percent complete WNP-1 reactor and the operating WNP-2 reactor on the WPPSS lease would be the potential location for the evolutionary LWR. Operation of the facility would be consistent with existing and proposed land uses pursuant to the current *Hanford Site Development Plan*, which designates this area for reactor operations (HF DOE 1993c:13,14). Therefore, direct impacts to land use would not occur.

The alternative would not affect other Hanford or offsite land uses. No prime farmlands exist onsite. Construction and operation would be consistent with State and local (Benton, Franklin, and Grant Counties and the City of Richland) land-use plans, policies, and controls since Hanford provides information to these jurisdictions for use in their efforts to comply with GMA (HF DOE 1993c:17).

Visual Resources. [Text deleted.] Construction and operation of the evolutionary LWR would be compatible with the industrial landscape character and VRM Class 5 designation of the existing WNP reactor area. A potential visual impact during operations would be from the additional stack plumes. However, due to the existing reactor activities, the visual impact would not occur.

Nevada Test Site

Land Use. A potential location for the evolutionary LWR would be on undeveloped land in Area 6 adjacent to the DAF. Construction and operation of the facility in Area 6 would not be in conformance with the current *Nevada Test Site Development Plan*, which designates the southeast area of NTS as a nonnuclear test area.

However, Area 6 is a potential site for long-term storage and disposition of weapons-usable fissile materials as part of the NTS defense program material disposition activities considered under the Expanded Use Alternative (part of the Preferred Alternative) of the NTS EIS (NT DOE 1996c:3-8, 3-9; NT DOE 1996e:4-18). [Text deleted.]

Construction and operation would not affect other NTS or offsite land uses. No prime farmlands exist onsite. The alternative would not be in conflict with land-use plans, policies, and controls of adjacent jurisdictions since none of the counties or municipalities currently undertakes land-use planning.

Visual Resources. [Text deleted.] Construction and operation of the facility would be compatible with the industrial landscape character of the adjacent DAF and the current VRM Class 5 designation of Area 6. [Text deleted.] Views of the proposed action would be blocked from sensitive viewpoints accessible to the public by mountains terrain.

Idaho National Engineering Laboratory

Land Use. The proposed evolutionary LWR would be located on undeveloped land northwest of the Power Burst Facility (PBF) in the central core area/Prime Development Land Zone of INEL (IN DOE 1992g:12). This zone designation applies to land most suitable for development due to an absence of physical constraints and because of the land's proximity to site infrastructure. [Text deleted.]

Construction would not affect other INEL or offsite land uses. No prime farmlands exist onsite. Construction and operation would not be in conflict with the land-use plans, policies, and controls of adjacent counties and the city of Idaho Falls since they do not address the potential site.

Visual Resources. [Text deleted.] Construction and operations, including the additional stack plumes, would be compatible with the existing visual character of the Prime Development Land Zone. The proposal would be consistent with the existing VRM Class 5 classification.

Pantex Plant

Land Use. The evolutionary LWR would be located on land in agricultural use in the northwest portion of Pantex, west of the Burning Ground and Zone 5. Construction of the evolutionary LWR would change current agricultural land use. A service agreement allows Texas Tech University to use any DOE land for agricultural use if it is not being used for defense purposes. The DOE-owned acreage used for agricultural purposes is variable and subject to periodic changes; therefore, no impact would be anticipated (PX DOE 1995i:2-5).The master plan of the current *Pantex Site Development Plan* designates this area for tritium production (PX DOE 1995g:16). Tritium production is no longer an option at Pantex. However, Pantex could revise the site development plan should Pantex be selected for this alternative.

Construction would not affect other Pantex or offsite land uses. There would be no impacts to prime farmland. The alternative would not be in conflict with City of Amarillo land-use plans, policies, and controls since they do not address Pantex.

Visual Resources. Construction and operation could cause potential impacts, including additional stack plumes. The current VRM Class 4 designation of proposed site would change to Class 5.

Oak Ridge Reservation

Land Use. [Text deleted] The evolutionary LWR is proposed to be located on undeveloped land south of Bear Creek Road along the Clinch River. The potential site is not within the ORR boundary, but it is owned by the TVA. An agreement between DOE and TVA has reserved the site for a nuclear application and it is anticipated that the land area would be transferred from TVA to DOE. Nonetheless, the future land-use plan of the current *ORR Site Development and Facilities Utilization Plan* designates the site as a major waste management area (OR DOE 1991f:1-7). The site development plan could be revised in accordance with the proposal. The proposed action would be in compliance if this change is approved. However, ownership of the potential site could be a potential impact.

Construction would not affect other ORR land uses. No prime farmlands exist onsite. The evolutionary LWR would not be in conflict with the City of Oak Ridge land-use plans, policies, and controls since the *Oak Ridge Area Land Use Plan* designates the potential site for Industrial and Public land use. Offsite land use would not be affected.

Visual Resources. [Text deleted.] Construction and operation activities would change the current VRM classification of the potential site from Class 3 to Class 5. Visual impacts would occur to Watts Bar Lake, Clinch River, and low density residential development on the opposite side of the Clinch River. Additionally, stack plumes could be visible from I-40, a public roadway with a high sensitivity level. Visual impact would not occur to Clark Center Recreational Park and other public/quasi-public lands (cemeteries and water treatment facilities), forest management area, Melton Hill Lake, and Clinch River Bluffs because of viewing distance, hilly terrain, and forested areas.

Savannah River Site

Land Use. The evolutionary LWR would be located northeast of the N-Area on land presently forested/ undeveloped. Facility construction would be in conformance with existing and future land use as designated by the current *Savannah River Site Development Plan.* According to the plan, the future land-use category for the proposed site is primary industrial mission (SR DOE 1994d:11,12). [Text deleted.]

Construction would not affect other SRS or offsite land uses. There is no prime farmland on SRS. Construction would not be in conflict with the land-use plans, policies, and controls of adjacent counties and cities since they do not address SRS.

Visual Resources. Potential impacts to visual resources including additional stack plumes would be anticipated. The current VRM Class 4 designation of the proposed site would change to Class 5. However, views from State Highway 125 and U.S. Highway 278 would be blocked by heavy vegetation, forested cover, and hilly terrain.

[Text deleted.]

4.3.5.4.2 *Site Infrastructure*

The representative evolutionary LWR sites would require an infrastructure similar to that described in Section 2.4.5.4 for large or small evolutionary LWRs. The length of the Pu disposition campaign and reactor capacities will determine the number of reactors required. At a specific site, existing infrastructure such as roads, railroads, and power line rights-of-way would determine additional requirements for connectivity. Site characteristics such as the availability of water and its bearing on reactor cooling, would also affect site infrastructure.

Changes to the existing infrastructure at representative sites due to the construction and operation of an evolutionary LWR are presented in Tables 4.3.5.4.2–1, 4.3.5.4.2–2, and 4.3.5.4.2–3. The site infrastructure changes associated with locating a single large or small evolutionary LWR at a DOE site follow.

Hanford Site

Electrical, fuel, and water requirements for construction would represent a small percentage of site usage. Transmission lines would be constructed and upgraded for the increased and redistributed electrical load. Additional primary and secondary access roads as well as railroad right-of-way would be required. The requirements can be accommodated with minimal site impact over the 6-year construction period. Operational electrical requirements increase significantly, but are within the capacity of the sub-regional power pool. New and upgraded transmission lines would be put in place for the increased and redistributed electrical load as part of the construction phase. Fuel requirements would not exceed current site availability. Required primary and secondary access roads and railroad right-of-way would be available. Facility requirements can be accommodated without significant site impact.

Nevada Test Site

Electrical requirements for construction would double the projected site usage. Transmission lines would be constructed and upgraded for the increased and redistributed electrical load. Increased fuel requirements can be easily met. Additional fuel required for construction could easily be obtained through contractual means. Additional primary and secondary access roads would also be required. The shipment of large and outsize components would pose a significant problem because of the lack of railroad service. Construction requirements, unique in some cases, can be accommodated over the 6-year construction period. Operational electrical requirements increase significantly over site availability, but are within the capacity of the sub-regional power pool. New and upgraded transmission lines would be put in place for the increased and redistributed electrical load as part of the construction phase. Fuel oil requirements would exceed current site availability, but can be accommodated through normal contractual means. Required primary and secondary access roads would be available. There would not be railroad service available.

Idaho National Engineering Laboratory

Electrical requirements for construction would not exceed site availability. [Text deleted.] Additional primary and secondary access roads as well as railroad right-of-way would be required. These requirements can be accommodated with moderate site impact over the 6-year construction period. Operational electrical requirements increase over site availability, but are within the capacity of the sub-regional power pool. New and upgraded transmission lines would be put in place for the increased and redistributed electrical load as part of the construction phase. Required primary and secondary access roads and railroad rights-of-way would be available.

Table 4.3.5.4.2–1. Additional Site Infrastructure Needed for the Construction of the Large or Small Evolutionary Light Water Reactor (Annual)

	Electrical		Fuel		
	Energy (MWh/yr)	Peak Load (MWe)	Oil (l/yr)	Natural Gas (m^3/yr)	Coal (t/yr)
Facility Requirements	20,000	20	946,000	0	0
Hanford Site					
Site availability	1,678,700	281	14,775,000	21,039,531	91,708
Projected usage without facility	345,500	58	9,334,800	21,039,531	0
Projected usage with facility	365,500	78	10,280,800	21,039,531	0
Amount required in excess to site availability	0	0	0	0	0
Nevada Test Site					
Site availability	176,844	45	5,716,000	0	0
Projected usage without facility	124,940	25	5,716,000	0	0
Projected usage with facility	144,940	45	6,662,000	0	0
Amount required in excess to site availability	0	0	946,000[a]	0	0
Idaho National Engineering Laboratory					
Site availability	394,200	124	16,000,000	0	11,340
Projected usage without facility	232,500	42	5,820,000	0	11,340
Projected usage with facility	252,500	62	6,776,000	0	11,340
Amount required in excess to site availability	0	0	0	0	0
Pantex Plant					
Site availability	201,480	23	1,775,720	289,000,000	0
Projected usage without facility	46,266	10	795,166	7,200,000	0
Projected usage with facility	66,266	30	1,741,166	7,200,000	0
Amount required in excess to site availability	0	7	0	0	0
Oak Ridge Reservation					
Site availability	13,880,000	2,100	416,000	250,760,000	16,300
Projected usage without facility	726,000	110	379,000	95,000,000	16,300
Projected usage with facility	746,000	130	1,325,000	95,000,000	16,300
Amount required in excess to site availability	0	0	909,000[a]	0	0
Savannah River Site					
Site availability	1,672,000	330	28,390,500	0	244,000
Projected usage without facility	794,000	116	28,390,500	0	221,352
Projected usage with facility	814,000	136	29,336,500	0	221,352
Amount required in excess to site availability	0	0	946,000[a]	0	0

[a] Fuel oil requirements in excess to site availability could be procured through normal contractual means.

Source: HF 1995a:1; INEL 1995a:1; LLNL 1996g; NTS 1993a:4; OR LMES 1995e; PX 1995a:1; SRS 1995a:2.

Table 4.3.5.4.2–2. Additional Site Infrastructure Needed for the Operation of the Large Evolutionary Light Water Reactor (Annual)

	Transportation		Electrical		Fuel		
	Roads (km)	Rail-roads (km)	Energy (MWh/yr)	Peak Load (MWe)	Oil (l/yr)	Natural Gas (m^3/yr)	Coal (t/yr)
Facility Requirements	< 5	< 5	1,100,000	140	757,000	0	0
Hanford Site							
Site availability	420	204	1,678,700	281	14,775,000	21,039,531	91,708
Projected usage without facility	420	204	345,500	58	9,334,800	21,039,531	0
Projected usage with facility	425	209	1,445,500	198	10,091,800	21,039,531	0
Amount required in excess to site availability	< 5	< 5	0	0	0	0	0
Nevada Test Site							
Site availability	1,100[a]	0	176,844	45	5,716,000	0	0
Projected usage without facility	645	0	124,940	25	5,716,000	0	0
Projected usage with facility	650	0	1,224,940	165	6,473,000	0	0
Amount required in excess to site availability	<5	0	1,048,096	120	757,000[b]	0	0
Idaho National Engineering Laboratory							
Site availability	445	48	394,200	124	16,000,000	0	11,340
Projected usage without facility	445	48	232,500	42	5,820,000	0	11,340
Projected usage with facility	450	53	1,332,500	182	6,577,000	0	11,340
Amount required in excess to site availability	< 5	< 5	938,300	58	0	0	0
Pantex Plant							
Site availability	76	27	201,480	23	1,775,720	289,000,000	0
Projected usage without facility	76	27	46,266	10	795,166	7,200,000	0
Projected usage with facility	81	32	1,146,266	150	1,552,166	7,200,000	0
Amount required in excess to site availability	< 5	< 5	944,786	127	0	0	0
Oak Ridge Reservation							
Site availability	71	27	13,880,000	2,100	416,000	250,760,000	16,300
Projected usage without facility	71	27	726,000	110	379,000	95,000,000	16,300
Projected usage with facility	76	32	1,826,000	250	1,136,000	95,000,000	16,300
Amount required in excess to site availability	< 5	< 5	0	0	720,000[b]	0	0
Savannah River Site							
Site availability	230	103	1,672,000	330	28,390,500	0	244,000
Projected usage without facility	230	103	794,000	116	28,390,500	0	221,352
Projected usage with facility	235	108	1,894,000	256	29,147,500	0	221,352
Amount required in excess to site availability	< 5	< 5	222,000	0	757,000[b]	0	0

[a] Includes paved and unpaved roads.

[b] Fuel oil requirements in excess to site availability could be procured through normal contractual means.

Source: HF 1995a:1; INEL 1995a:1; LLNL 1996g; NTS 1993a:4; OR LMES 1995e; PX 1995a:1; SRS 1995a:2.

Table 4.3.5.4.2–3. Additional Site Infrastructure Needed for the Operation of the Small Evolutionary Light Water Reactor (Annual)

	Transportation		Electrical		Fuel		
	Roads (km)	Rail-roads (km)	Energy (MWh/yr)	Peak Load (MWe)	Oil (l/yr)	Natural Gas (m^3/yr)	Coal (t/yr)
Facility Requirements	< 5	< 5	580,000	75	416,000	0	0
Hanford Site							
Site availability	420	204	1,678,700	281	14,775,000	21,039,531	91,708
Projected usage without facility	420	204	345,500	58	9,334,800	21,039,531	0
Projected usage with facility	425	209	925,500	133	9,750,800	21,039,531	0
Amount required in excess to site availability	< 5	< 5	0	0	0	0	0
Nevada Test Site							
Site availability	1,100[a]	0	176,844	45	5,716,000	0	0
Projected usage without facility	645	0	124,940	25	5,716,000	0	0
Projected usage with facility	650	0	704,940	100	6,132,000	0	0
Amount required in excess to site availability	0	0	528,096	55	416,000[b]	0	0
Idaho National Engineering Laboratory							
Site availability	445	48	394,200	124	16,000,000	0	11,340
Projected usage without facility	445	48	232,500	42	5,820,000	0	11,340
Projected usage with facility	450	53	812,500	117	6,236,000	0	11,340
Amount required in excess to site availability	< 5	< 5	418,300	0	0	0	0
Pantex Plant							
Site availability	76	27	201,480	23	1,775,720	289,000,000	0
Projected usage without facility	76	27	46,266	10	795,166	7,200,000	0
Projected usage with facility	81	32	626,266	85	1,211,166	7,200,000	0
Amount required in excess to site availability	< 5	< 5	424,786	62	0	0	0
Oak Ridge Reservation							
Site availability	71	27	13,880,000	2,100	416,000	250,760,000	16,330
Projected usage without facility	71	27	726,000	110	379,000	95,000,000	16,330
Projected usage with facility	76	32	1,306,000	185	795,000	95,000,000	16,330
Amount required in excess to site availability	< 5	< 5	0	0	379,000[b]	0	0
Savannah River Site							
Site availability	230	103	1,672,000	330	28,390,500	0	244,000
Projected usage without facility	230	103	794,000	116	28,390,500	0	221,352
Projected usage with facility	235	108	1,374,000	191	28,806,500	0	221,352
Amount required in excess to site availability	< 5	< 5	0	0	416,000[b]	0	0

[a] Includes paved and unpaved roads.

[b] Fuel oil requirements in excess to site availability could be procured through normal contractual means.

Source: HF 1995a:1; INEL 1995a:1; LLNL 1996g; NTS 1993a:4; OR LMES 1995e; PX 1995a:1; SRS 1995a:2.

Pantex Plant

Electrical requirements for construction would require transmission lines to be constructed and upgraded for the increased and redistributed electrical load. Additional primary and secondary access roads as well as railroad right-of-way would be needed. These requirements can be accommodated with minimal site impact over the 6-year construction period. Electrical requirements for operations increase over site availability, but are within the capacity of the sub-regional power pool. New and upgraded transmission lines would be put in place for the increased and redistributed electrical load as part of the construction phase. [Text deleted.] Required primary and secondary access roads and railroad right-of-way would be available.

Oak Ridge Reservation

[Text deleted.] Additional oil would be required during the period of construction and during operations. Since oil availability is governed by usage and not by storage capacity onsite, the additional oil required could be procured through normal contracts or the construction companies could provide for this additional oil from local suppliers from construction use. Required primary and secondary access roads and railroad rights-of-way would be available.

Savannah River Site

Fuel oil requirements for construction would represent a small percentage of site usage. [Text deleted.] Additional primary and secondary access roads as well as railroad rights-of-way would be required. These added requirements can be accommodated with minimal site impact over the 6-year construction period. Electrical requirements for large LWR, but not small LWR, operations would increase over site availability, but are within the capacity of the sub-regional power pool. New and upgraded transmission lines would be put in place for the increased and redistributed electrical load as part of the construction phase. Fuel oil requirements would exceed current site availability, but can be accommodated through normal contractual means. Required primary and secondary access roads and railroad rights-of-way would be available. Facility requirements could be accommodated without site impact.

4.3.5.4.3 *Air Quality and Noise*

Construction and operation of an evolutionary LWR would generate criteria and toxic/hazardous pollutants. To evaluate the air quality impacts, criteria and toxic/hazardous concentrations from this facility have been compared with Federal and State standards and guidelines for each site. Impacts for radiological airborne emissions are discussed in Section 4.3.5.4.9.

Noise impacts during either construction or operation are expected to be low. Air quality and noise impacts are described separately. Supporting data for the air quality and noise analysis are presented in Appendix F.

AIR QUALITY

Construction and operation of the facility would result in the emission of some pollutants at each of the sites. Emissions would typically not exceed Federal, State, or local air quality regulations or guidelines.

The principal sources of emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and possible operation of a concrete batch plant

- Exhaust and road dust generated by construction equipment, vehicles delivering construction materials, and vehicles carrying construction workers

The PM_{10} and TSP concentrations are expected to increase during the peak construction period. Appropriate control measures would be followed. It is expected that the sites will continue to comply with applicable Federal and State ambient air quality standards during construction.

Emission rates for operation of the evolutionary LWR are presented in Table F.1.3–14. Air pollutant emissions sources associated with operations include the following:

- Operation of diesel generators and periodic testing of emergency diesel generators

- [Text deleted.]

- Small quantities of toxic/hazardous pollutant emissions from facility operations

During operation, concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal, State, and local air quality regulations or guidelines. The estimated pollutant concentrations from reactor operations plus the No Action concentrations are presented in Table 4.3.5.4.3–1. There are no toxic/hazardous chemical emissions associated with this facility.

NOISE

The location of the facilities associated with the evolutionary LWR facility relative to the site boundary and sensitive receptors was examined for each site to evaluate the potential contribution to noise levels at these locations and the potential for onsite and offsite noise impacts. Noise sources during construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along offsite major transportation routes used to bring construction material and workers to the site.

Nontraffic noise sources associated with operation of these facilities include ventilation systems, cooling systems, vents, pumps, motors, emergency diesel generators, transformers, paging systems, and material

Table 4.3.5.4.3–1. Estimated Operational Concentrations of Pollutants and Comparison With Most Stringent Regulations or Guidelines—Evolutionary Light Water Reactor and No Action Alternative

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] (μg/m³)	Hanford No Action (μg/m³)	Hanford Total (μg/m³)	NTS No Action (μg/m³)	NTS Total (μg/m³)	INEL No Action (μg/m³)	INEL Total (μg/m³)	Pantex No Action (μg/m³)	Pantex Total[b] (μg/m³)	ORR No Action (μg/m³)	ORR Total (μg/m³)	SRS No Action (μg/m³)	SRS Total (μg/m³)
Criteria Pollutants														
Carbon monoxide	8-hour	10,000	0.08	0.09	2,290	2,290.01	284	284.02	602	602.07	5	5	22	22.06
	1-hour	40,000	0.3	0.36	2,748	2,748.04	614	614.05	2,900	2,900.36	11	11	171	171.29
Lead	Calendar Quarter	1.5	<0.01	<0.01	b	b	0.001	0.001	0.09	0.09	0.05	0.05	<0.01	<0.01
	24-hour	0.5	<0.01	<0.01	c	c	c	c	c	c	c	c	c	c
Nitrogen dioxide	Annual	100	0.03	0.04	b	<0.01[d]	4	4.02	2.15	2.23	3	3	5.7	5.7
Ozone	1-hour	235	e	e	e	e	e	e	e	e	e	e	e	e
Particulate matter less than or equal to 10 microns in diameter	Annual	50	<0.01	<0.01	9.4	9.4	5	5	8.73	8.73	1	1	3	3
	24-hour	150	0.02	0.02	106	106	80	80	88.5	88.5	2	2	50.6	50.6
Sulfur dioxide	Annual	52	<0.01	<0.01	8.4	8.4	6	6	<0.01	0.01	2	2	14.5	14.51
	24-hour	260	<0.01	0.03	94.6	94.6	135	135.07	<0.01	0.24	32	32	196	196.22
	3-hour	1,300	0.01	0.2	725	725	579	579.28	<0.01	1.35	80	80.02	823	824.39
	1-hour	1,018	0.02	0.59	c	c	c	c	c	c	c	c	c	c
	1-hour	655[f]	0.02	0.59	c	c	c	c	c	c	c	c	c	c
	30-minute	1,045	c	c	c	c	c	c	<0.01	3.63	c	c	c	c
Mandated by State														
Hydrogen fluorides (as HF)	30-day	0.8	b	b	c	c	c	c	<0.75	<0.75	0.2	0.2	0.09	0.09
	7-day	1.6	b	b	c	c	c	c	<0.75	<0.75	0.3	0.3	0.39	0.39
	24-hour	2.9	b	b	c	c	c	c	0.75	0.75	0.6[g]	0.6[g]	1.04	1.04
	12-hour	3.7	b	b	c	c	c	c	1.05	1.05	0.6[g]	0.6[g]	1.99	1.99

Table 4.3.5.4.3–1. *Estimated Operational Concentrations of Pollutants and Comparison With Most Stringent Regulations or Guidelines—Evolutionary Light Water Reactor and No Action Alternative—Continued*

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] (μg/m³)	Hanford No Action (μg/m³)	Hanford Total (μg/m³)	NTS No Action (μg/m³)	NTS Total (μg/m³)	INEL No Action (μg/m³)	INEL Total (μg/m³)	Pantex No Action (μg/m³)	Pantex Total[b] (μg/m³)	ORR No Action (μg/m³)	ORR Total (μg/m³)	SRS No Action (μg/m³)	SRS Total (μg/m³)
Hydrogen fluoride (as HF) (continued)														
	8-hour	250	b	b	c	c	c	c	c	c	0.6	0.6	c	c
	3-hour	4.9	b	b	c	c	c	c	4.21	4.21	c	c	c	c
Hydrogen sulfide	1-hour	112	c	c	b	b	c	c	c	c	c	c	c	c
	30-minute	111	c	c	c	c	c	c	b	b	c	c	c	c
Total suspended particulates	Annual	60	<0.01	<0.01	c	c	5	5	c	c	c	c	12.6	12.6
	24-hour	150	0.02	0.02	c	c	80	80	c	c	2	2	c	c
	3-hour	200	c	c	c	c	c	c	b	<0.01[d]	c	c	c	c
	1-hour	400	c	c	c	c	c	c	b	<0.01[d]	c	c	c	c
[Text deleted.]														

[a] The more stringent of the Federal and State standards is presented for the averaging time.
[b] No sources of this pollutant have been identified.
[c] No State standard for indicated averaging time.
[d] The concentration represents the alternative contribution only.
[e] Ozone, as a criteria pollutant, is not directly emitted nor monitored by the sites. See Section 4.1.3 for a discussion of ozone-related issues.
[f] At Hanford, the level is not to be exceeded more than twice in any 7 consecutive days.
[g] Eight-hour averaging time concentration was used.

Note: Total concentrations are based on site contribution, including concentrations from ongoing activities (No Action), and do not include the contribution from nonfacility sources. Concentration for other hazardous/toxic pollutants reported for No Action in Section 4.2 are unchanged for this alternative and are not shown here.

Source: 40 CFR 50; ID DHW 1995a; ID DHW 1995b; LLNL 1996g; NV DCNR 1995a; SC DHEC 1991a; SC DHEC 1992b; TN DEC 1994a; TN DHE 1991a; TX ACB 1987a; TX NRCC 1992a; TX NRCC 1995a; WA Ecology 1994a.

handling equipment. These noise sources would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Due to the size of the site, noise emissions from construction equipment and operations activities would not be expected to cause annoyance to the public. Some noise sources may result in impacts such as disturbance of wildlife.

4.3.5.4.4 *Water Resources*

The construction and operation of an evolutionary LWR would affect water resources. Water resource requirements, and discharges provided in Tables C.1.1.3–8 and C.2.1.3–7 and Tables E.3.3.7–1 and E.3.3.7–2, were used to assess impacts to surface and groundwater. The discussion of impacts are provided for each site separately. Tables 4.3.5.4.4–1 and 4.3.5.4.4–2 present projected No Action surface and groundwater uses and discharges at each site, and the potential changes resulting from construction and operation of the proposed large or small evolutionary LWR.

Hanford Site

Surface Water. Surface water from the Columbia River would be used as the water source for construction and operation of the evolutionary LWRs. During construction, the quantity of water required for large and small LWRs would be approximately 126 million l/yr (33 million gal/yr) and 76 million l/yr (20 million gal/yr), respectively, which would represent less than 0.9- and 0.6-percent increases, respectively, over the projected No Action surface water withdrawal. These amounts would also be approximately 0.001 percent and 0.0007 percent, respectively, of the average flow of the Columbia River (3,360 m^3/s [118,642 ft^3/s]). These additional withdrawals would have negligible impacts on surface water availability.

During operation, annual water requirements for the large and small evolutionary LWRs would be approximately 60,560 million l/yr (15,988 million gal/yr) and 27,252 million l/yr (7,199 million gal/yr), respectively, which would represent 448- and 202-percent increases, respectively, over the projected annual No Action surface water withdrawals. The larger of these withdrawals would increase Hanford's total withdrawals to 0.05-percent of the annual average flow of the Columbia River (3,360 m^3/s [118,642 ft^3/s]); minimal impacts would occur to surface water availability.

[Text deleted.]

During construction of the evolutionary LWRs, sanitary wastewater from large or small reactors (104 million l/yr [27.5 million gal/yr] and 59 million l/yr [15.6 million gal/yr], respectively) would be generated and discharged to the Columbia River. The larger of these annual quantities would be 0.001 percent of the average minimum daily flow of the Columbia River. All discharges would be monitored to comply with NPDES permit limits and other discharge requirements. [Text deleted.] During operation, approximately 341 million l/yr (90 million gal/yr) and 189 million l/yr (50 million gal/yr) of sanitary and other wastewater effluent from the large or small reactor, respectively, would be recycled to the greatest extent possible and the remainder would be discharged to the Columbia River. All discharges would be monitored to comply with NPDES permit limits and other discharge requirements.

Unlike wastewater effluent from treatment facilities, which is released on a continuous basis, cooling system blowdown activities discharge greater quantities over a shorter period of time. The large or small reactor would release approximately 97.8 million l (25.8 million gal) or 44.2 million l (11.7 million gal), respectively, of treated blowdown water once a day over a 1-hour period. Without engineering measures such as those described below, these blowdown releases would increase the average flow rate of the receiving river (Columbia River) by 0.02 and 0.01 percent, respectively. Although these increases are small, the velocity of the discharges could cause erosion of the channel and increased turbidity. In addition to the impacts from the discharge velocity of the blowdown, the high temperature of the releases could also affect receiving waters. In addition, treatment of the water to be returned to the Columbia River is necessary even if the plant does not add anything. Agricultural runoff along the path of the river creates higher than "allowed" levels of nitrate and phosphate. These alone must be reduced before the water (as taken from the river) could be returned. Engineering measures incorporated in technology design adapted to site conditions could significantly reduce these impacts. Various cooling system

Table 4.3.5.4.4–1. Potential Changes to Water Resources Resulting From the Large Evolutionary Light Water Reactor

Affected Resource Indicator	Hanford	NTS	INEL	Pantex	ORR	SRS	SRS
Water Source	Surface	Ground	Ground	Ground	Surface	Surface	Ground
No Action water requirements (million l/yr)	13,511	2,400	7,570	249	14,760	127,000	13,247
No Action wastewater discharge (million l/yr)	246	82	540	141	2,277	700	0
Construction							
Water Availability and Use							
Total water requirement (million l/yr)	126	126	126	126	126	NA	126
Percent increase in projected water use[a]	0.9	5.3	1.7	50.6	0.9	NA	1.0
Water Quality							
Total wastewater discharge (million l/yr)	104	104	104	104	104	104	NA
Percent change in wastewater discharge[b]	42	127	19.4	96.7	4.5	15	NA
Percent change in streamflow	neg	NA	NA	NA	0.23[c]	24[d]	NA
Operation							
Water Availability and Use							
Total water requirement (million l/yr)	60,560	341	341	341	60,560	60,219	341
Percent increase in projected water use[e]	448	14.2	4.5	137	410	47.4	2.6
Water Quality							
Total sanitary wastewater discharge (million l/yr)	341[f]	341	341	341	341[f]	341[f]	NA
Percent change in wastewater discharge[g]	138.6	415.9	63.1	241.8	15.0	48.7	NA
Percent change in streamflow from wastewater discharge	NA	NA	NA	NA	0.7[c]	6.8[d]	NA
Blowdown discharge to surface waters (million l/yr)[h]	23,470	NA	NA	NA	23,470	23,470	NA
Percent change in annual streamflow from blowdown water discharge	0.02[i]	NA	NA	NA	49.6[c]	465[d]	NA

Table 4.3.5.4.4–1. Potential Changes to Water Resources Resulting From the Large Evolutionary Light Water Reactor—Continued

Affected Resource Indicator	Hanford	NTS	INEL	Pantex	ORR	SRS	SRS
Floodplain							
Is action in 100-year floodplain?	No	No	No	No	No	NA	No
Is critical action in 500-year floodplain?	No	Uncertain	No	No	Uncertain	Uncertain	Uncertain

[a] Percent increases in water requirements during construction of an evolutionary LWR are calculated by dividing water requirements for the facility (126 million l/yr) with that for each site: Hanford (13,511 million l/yr), NTS (2,400 million l/yr), INEL (7,570 million l/yr), Pantex (249 million l/yr), ORR (14,760 million l/yr), and SRS (13,247 million l/yr).

[b] Percent changes in wastewater discharged during construction of an evolutionary LWR are calculated by dividing wastewater discharge of the facility (104 million l/yr) with that for each site: Hanford (246 million l/yr), NTS (82 million l/yr), INEL (540 million l/yr), Pantex (141 million l/yr), ORR (2,277 million l/yr), and SRS (700 million l/yr).

[c] Percent changes in stream flow from wastewater/blowdown discharges are calculated from the average flow of Clinch River (132 m^3/s) and East Fork Poplar Creek (1.5 m^3/s). The comparison for East Fork Poplar Creek is shown in the table.

[d] Percent changes in stream flow from wastewater/blowdown discharges are calculated from the minimum flow of the Fourmile Branch (0.16 m^3/s).

[e] Percent increases in water requirements during operation of an evolutionary LWR are calculated by dividing water requirements (341 million l/yr) for a dry site; and (60,560 million l/yr) for a wet site with that for each site: Hanford (13,511 million l/yr), NTS (2,400 million l/yr), INEL (7,570 million l/yr), Pantex (249 million l/yr), ORR (14,760 million l/yr), and SRS (13,247 million l/yr) of groundwater and 127,000 million l/yr of surface water. At SRS, only cooling water make-up will be supplied from surface water.

[f] Does not include cooling tower blowdown that would be treated and discharged to the river.

[g] Percent changes in wastewater discharged during operation of an evolutionary LWR are calculated by dividing wastewater discharge rate for the new facility (341 million l/yr) with that for each site: Hanford (246 million l/yr), NTS (82 million l/yr), INEL (540 million l/yr), Pantex (141 million l/yr), ORR (2,277 million l/yr), and SRS (700 million l/yr).

[h] Blowdown is expected to occur once a day over a 1-hour period, rather than continuously over the course of the day. As such, the discharge rate would be much greater for a shorter period of time.

[i] Percentage change from blowdown is calculated from the annual average flow of the Columbia River (3,360 m^3/s).

Note: NA=not applicable; neg=negligible. Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: HF 1995a:1; INEL 1995a:1; LLNL 1996g; NTS 1993a:4; OR LMES 1995e; PX 1995a:1; SRS 1995a:2.

*Table 4.3.5.4.4–2. **Potential Changes to Water Resources Resulting From the Small Evolutionary Light Water Reactor***

Affected Resource Indicator	Hanford	NTS	INEL	Pantex	ORR	SRS	SRS
Water Source	Surface	Ground	Ground	Ground	Surface	Surface	Ground
No Action water requirements (million l/yr)	13,511	2,400	7,570	249	14,760	127,000	13,247
No Action wastewater discharges (million l/yr)	246	82	540	141	2,277	700	NA
Construction							
Water Availability and Use							
Total water requirement (million l/yr)	76	76	76	76	76	NA	76
Percent increase in projected water use[a]	0.6	3.2	1.0	30.5	0.5	NA	0.6
Water Quality							
Total wastewater discharge (million l/yr)	59	59	59	59	59	59	NA
Percent change in wastewater discharge[b]	24	72	10.9	41.8	2.6	8.4	NA
Percent change in streamflow	neg	NA	NA	NA	0.1[c]	1.2[d]	NA
Operation							
Water Availability and Use							
Total water requirement (million l/yr)	27,252	189.3	189.3	189.3	27,252	27,063	189.3
Percent increase in projected water use[e]	202	7.9	2.5	75.9	185	21.3	1.4
Water Quality							
Total sanitary wastewater discharge (million l/yr)	189[f]	189	189	189	189[f]	189[f]	NA
Percent change in wastewater discharge[g]	77	230	35	134	8.3	27	NA
Percent change in streamflow	NA	NA	NA	NA	0.4[c]	3.7[d]	NA
Blowdown discharge to surface waters (million l/yr)[h]	10,598	NA	NA	NA	10,598	10,598	NA
Percent change in annual streamflow from blowdown water discharge	0.01[i]	NA	NA	NA	22.4[c]	210[d]	NA

Table 4.3.5.4.4–2. Potential Changes to Water Resources Resulting From the Small Evolutionary Light Water Reactor—Continued

Affected Resource Indicator	Hanford	NTS	INEL	Pantex	ORR	SRS	SRS
Floodplain							
Is action in 100-year floodplain?	No	No	No	No	No	No	NA
Is critical action in 500-year floodplain?	No	Uncertain	No	No	Uncertain	Uncertain	Uncertain

[a] Percent increases in water requirements during construction of an evolutionary LWR are calculated by dividing water requirements (76 million l/yr) with that for No Action water requirements at each site: Hanford (13,511 million l/yr), NTS (2,400 million l/yr), INEL, (7,570 million l/yr), Pantex (249 million l/yr), ORR (14,760 million l/yr), and SRS (13,247 million l/yr).

[b] Percent changes in wastewater discharged during construction of an evolutionary LWR are calculated by dividing water discharges (59 million l/yr) with that for No Action water requirements at each site: Hanford (246 million l/yr), NTS (recycled 82 million l/yr), INEL (540 million l/yr), Pantex (141 million l/yr), ORR (1,657 million l/yr), and SRS (700 million l/yr).

[c] Percent changes in stream flow from wastewater/blowdown discharges are calculated from the average flow of Clinch River (132 m^3/s) and East Fork Poplar Creek (1.5 m^3/s). The comparison for the East Fork Poplar Creek is shown in the table.

[d] Percent changes in stream flow from wastewater/blowdown discharges are calculated from the minimum flow of Fourmile Branch (0.16 m^3/s).

[e] Percent increases in water requirements during operation of an evolutionary LWR are calculated by dividing water requirements (189.3 million l/yr for a dry site; 27,252 million l/yr for a wet site) with that for each No Action water requirements at each site: Hanford (13,511 million l/yr), NTS (2,400 million l/yr), INEL (7,570 million l/yr), Pantex (249 million l/yr), ORR (14,760 million l/yr), and SRS (13,247 million l/yr of groundwater and 127,000 million l/yr of surface water). At SRS, only cooling water make-up will be supplied from surface water.

[f] Does not include cooling tower blowdown that would be treated and discharged to the river.

[g] Percent changes in wastewater discharged during operation of an evolutionary LWR are calculated by dividing water discharges (189 million l/yr) with that for No Action discharge at each site: Hanford (246 million l/yr), NTS (82 million l/yr), INEL (540 million l/yr), Pantex (141 million l/yr), ORR (2,277 million l/yr), and SRS (700 million l/yr).

[h] Blowdown is expected to occur once a day over a 1-hour period, rather than continuously over the course of the day. As such, the discharge rate would be much greater for a shorter period of time.

[i] Percent change from blowdown is calculated from the annual average flow of the Columbia River (3,360 m^3/s).

Note: NA=not applicable; neg=negligible; construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: HF 1995a:1; INEL 1995a:1; LLNL 1996g; NTS 1993a:4; OR LMES 1995e; PX 1995a:1; SRS 1995a:2.

blowdown disposal options would be evaluated in detail in the future site-specific documents. All discharges to surface waters would be monitored to comply with discharge requirements.

The evolutionary LWRs would be located near the WNP-1, an area which is above the 100-year, 500-year, and probable maximum flood boundaries; flooding from dam failures; and flooding from a landslide resulting in river blockage.

Groundwater. No groundwater would be used for construction or operation of the evolutionary LWRs; therefore there would be no impact to groundwater availability.

Construction and operation of the evolutionary LWRs would not result in direct discharges to groundwater. Treated wastewater discharged to disposal ponds which does not evaporate, however, could percolate downward into the near surface aquifer groundwater. This water would be monitored and would not be discharged until contaminant levels are within the limits specified. Impacts to groundwater quality are therefore not expected. In addition, other factors limiting potential impacts to groundwater quality are the combined effects of a deep water table, low discharge volumes, and high evaporation rates.

[Text deleted.] Although the Columbia River is composed of fresh water, it does contain very small quantities of naturally occurring salts. These salts would be concentrated in a wet cooling tower and released with stream emissions from the tower. This is known as salt drift and may damage vegetation in a small area near the facility. Because rainfall at Hanford is minimal, these salts may not be adequately flushed from the soil column. Impacts would be analyzed in future tiered, site-specific NEPA documents, as appropriate.

Nevada Test Site

Surface Water. No surface water would be withdrawn for any construction or operation activities associated with the facility; groundwater would be used as the water source for the evolutionary LWRs. Therefore, there would be no impacts to surface water availability.

[Text deleted.]

During construction of the large and small evolutionary LWRs, sanitary wastewater (104 million l/yr [27.5 million gal/yr] and 59 million l/yr [15.6 million gal/yr], respectively) would be generated. During operation, approximately 341 million l/yr (90 million gal/yr) and 189 million l/yr (50 million gal/yr) of sanitary and other wastewater from the large or small reactors, respectively, would be discharged to a new wastewater treatment system. After treatment, all wastewater generated during construction and operation would be available for recycle as makeup to the cooling tower or boiler.

There have been no studies conducted to assess the 500-year floodplain boundaries at NTS. Studies of the 100-year floodplain showed it to be confined to the Jackass Flats and Frenchman Lake areas. The proposed site for the evolutionary LWRs is not located in either of these areas. However, since the NTS is in a region where most flooding occurs by locally intense thunderstorms which can create brief (less than 6 hours) flash floods, the facilities would be designed to withstand such flooding. An assessment of the 500-year floodplain at NTS could be accomplished in future environmental studies.

Groundwater. All water required for construction and operation would be supplied from groundwater. Construction water requirements for the large and small reactors (126 million l/yr [33 million gal/yr] and 76 million l/yr [20 million gal/yr], respectively) would represent 5.3- and 3.2-percent increases over the projected annual groundwater usage. Annual operation water requirements for the large and small reactors (341 million l/yr [90 million gal/yr] and 189.3 million l/yr [50 million gal/yr], respectively) would represent approximately 14.2- and 7.9-percent increases over the projected groundwater usage, respectively.

Based on the minimum estimated recharge (38 billion l/yr [10 billion gal/yr]), the increases in groundwater withdrawal attributed to operation of the large and small reactors would be 0.9- and 0.5-percent of the estimated annual recharge, respectively. Either of these additional withdrawals would not have any impact on groundwater availability.

Construction and operation of the evolutionary LWRs would not result in direct discharges to groundwater. Treated wastewater discharged to disposal ponds, however, could percolate downward toward the groundwater of the Valley-Fill Aquifer. This water would be monitored and would not be discharged to the ponds until contaminant levels are within the limits specified. Impacts to groundwater quality are therefore not expected. In addition, other factors limiting potential impacts to groundwater are the combined effects of a deep water table, low discharge volumes, and high evaporation rates.

Because dry cooling towers would be used, salt would not be released from the cooling tower. Blowdown recycle would couple reverse osmosis with an evaporator and crystallizer system that would remove the dissolved solids from blowdown so the water could be recycled to the cooling tower. This system would reduce requirements for makeup water, and discharge would not require disposal. The solids from the crystallization processes would be disposed of as solid waste. This system would reduce the salt from blowdown.

Idaho National Engineering Laboratory

Surface Water. No surface water would be withdrawn for any construction or operation activities associated with the facility; groundwater would be used as the water source for the evolutionary LWRs. Therefore, there would be no impacts to surface water availability.

[Text deleted.]

During construction of the large and small evolutionary LWRs, sanitary wastewater (104 million l/yr [27.5 million gal/yr] and 59 million l/yr [15.6 million gal/yr]), respectively, would be generated, treated, and discharged to evaporation/percolation ponds, or be available for recycle. During operation, approximately 341 million l/yr (90 million gal/yr) and 189 million l/yr (50 million gal/yr) of sanitary and other wastewater from the large or small reactors, respectively, would be discharged to this wastewater treatment system. After treatment, all wastewater generated during construction and operation would be available for recycle as makeup to the cooling tower or boiler. If not recycled, all discharges would be monitored to comply with discharge limits.

The potential site for the evolutionary LWRs is not located in an area historically prone to flooding or within the flood zone which could occur as a result of the failure of the MacKay Dam during a maximum probable flood which would be more critical than either the 100- or 500-year flood. However, because INEL is in a region where flash floods could occur, the facilities would be designed to withstand such flooding.

Groundwater. All water required for construction and operation would be supplied from groundwater from the Snake River Plain Aquifer. As shown in Tables 4.3.5.4.4–1 and 4.3.5.4.4–2, construction water requirements for the large and small reactors (126 million l/yr [33 million gal/yr] and 76 million l/yr [20 million gal/yr], respectively) would represent 1.7- and 1.0-percent increases over the projected annual No Action groundwater usage and are within INEL's permitted allotment. Operation water requirements for the large and small reactors (341 million l/yr [90 million gal/yr] and 189.3 million l/yr [50 million gal/yr], respectively) would represent 4.5- and 2.5-percent increases over the projected annual No Action groundwater usage, respectively. The larger of these withdrawals would increase the total projected amount to be pumped at INEL to 18.4-percent of the allotment during operation; INEL would still be well within the total groundwater allotment. As discussed in Section 3.4.4, a groundwater allotment not to exceed 43,000 million l/yr (11,360 million gal/yr), has been negotiated by DOE with the Idaho Department of Water Resources (DOE 1991c:4-73).

Construction and operation of the evolutionary LWRs would not result in direct discharges to groundwater and would not be expected to contribute to existing near surface contamination. Treated wastewater discharged to disposal ponds, however, would percolate downward toward the groundwater of the Snake River Plain Aquifer. This water would be monitored and would not be discharged until contaminant levels are within the limits specified. Impacts to groundwater quality are therefore not expected. In addition, other factors limiting potential impacts to groundwater are the combined effects of a deep water table, low discharge volumes, and high evaporation rates.

Because dry cooling towers would be used, salt would not be released from the cooling tower. Blowdown recycle would couple reverse osmosis with an evaporator and crystallizer system that would remove the dissolved solids from blowdown so the water could be recycled to the cooling tower. This system would reduce requirements for makeup water, and discharge would not require disposal. The solids from the crystallization processes would be disposed of as solid waste. This system would reduce the salt from blowdown.

Pantex Plant

Surface Water. All water required for construction or operation of a large or small evolutionary LWR would be supplied from either groundwater or possibly reclaimed wastewater. If reclaimed wastewater from the city of Amarillo Hollywood Road Wastewater Treatment Plant is used to accommodate water requirements at Pantex, the available reclaimed wastewater is anticipated to increase from 9,671 million l/yr (2,555 million gal/yr) to 16,580 million l/yr (4,380 million gal/yr) by the year 2010.

All wastewater would be treated and either recycled for cooling system make-up or released to playa lakes. No wastewater would be discharged to surface water during operation of the facilities. During construction, treated sanitary wastewater would be discharged to playa lakes. [Text deleted.] Nonhazardous wastewater discharges would range from 104 million l/yr (27.5 million gal/yr) for the large and 59 million l/yr (15.6 million gal/yr) for the small evolutionary LWR. Discharge of wastewater generated during construction of these facilities to playas would not result in an exceedance of the monthly average limit of 2.46 million l/day (0.65 million gal/day).

During operation, utility, process and sanitary wastewater for the small and large evolutionary LWR not recycled would be treated prior to discharge into the playas. Treated effluent would be monitored to comply with discharge requirements. The extent to which treated effluent or stormwater would be recycled for reuse within the plant would be determined during site-specific studies.

The proposed location for the evolutionary LWR is in the northwest corner of the Pantex facility, west of the burning grounds. Since no 100-year, 500-year, or standard project flood boundaries have been delineated in this area, there would be no impacts to floodplains. However, flooding in other areas of Pantex could occur due to the runoff associated with precipitation and ponding in local playas (LLNL 1988a:XVI).

Groundwater. Either groundwater or reclaimed wastewater would be used for construction and operation of the facility. The city of Amarillo is currently considering supplying Pantex with tertiary treated sanitary wastewater from the city of Amarillo Hollywood Road Wastewater Treatment Plant. Although not strictly groundwater or surface water, the reclaimed wastewater is discussed in this section because Pantex would still be withdrawing approximately 249 million l/yr (65.8 million gal/yr) from the aquifer in 2005.

As shown in Tables 4.3.5.4.4–1 and 4.3.5.4.4–2, construction of either a large LWR or a small LWR would represent a 50.6 and 30.5 percent increase in the projected water use, which would be 6.6 and 4.0 percent of the capacity of the groundwater system (1,900 million l/yr [502 million gal/yr]) or less than 0.76 and 0.46 percent of the projected available reclaimed wastewater (16,580 million l/yr [4,380 million gal/yr]). Operation of either a large or small evolutionary LWR would increase groundwater withdrawals by 137 and 75.9 percent, respectively, which would represent 17.9 and 9.9 percent, respectively, of the capacity of the groundwater system, or approximately 2.0 and 1.3 percent, respectively, if reclaimed wastewater were used as the water source. Previous studies have shown that when the Amarillo City Well Field pumped 18.5 billion l/yr (4.9 billion gal/yr) from the Ogallala aquifer, an average of 1.8 m/yr (5.9 ft/yr) decline in the water table occurred over a 10-year period. Operating the large or small evolutionary LWR at Pantex would result in minor drawdowns. Either of these additional groundwater withdrawals would add to the existing decline in water levels of the Ogallala Aquifer. However, there should be no regional impacts to groundwater levels from either of these additional water withdrawals. The total groundwater withdrawal including this facility at Pantex would be 590 million l/yr (156 million gal/yr) for a large evolutionary LWR and 438 million l/yr (116 million gal/yr) for a small evolutionary LWR. Because of expected cutbacks in other programs, the amounts for either a large or small evolutionary LWR would be 29.5 and 47.6 percent, respectively, less than what is currently being withdrawn (836 million l/yr [221 million gal/yr]) from wells at Pantex.

Construction and operation of the evolutionary LWRs would not result in direct discharges to groundwater. As discussed previously, treated wastewater discharged to playas could, however, percolate downward toward the groundwater of the near surface aquifer. All contaminants that have entered the near surface aquifer are expected to move downgradient to the north, away from existing facilities. Because no groundwater would be withdrawn for the project from the perched aquifer, no effect on plume migration would occur. Pantex will continue to evaluate groundwater contamination in both the perched and Ogallala Aquifers.

Although the expected drawdowns caused by withdrawing the water required for this alternative are small, the overall decline in groundwater levels in the Amarillo area is of concern. Possible groundwater conservation measures at Pantex that could be considered, including decreasing research farm irrigation demands through dry farming, installing dripless faucets, and process water reuse. in addition, to alleviate some of the effects from pumping groundwater from the Ogallala Aquifer, the city of Amarillo is considering supplying treated wastewater to Pantex from the Hollywood Road Wastewater Treatment Plant for industrial use. However, details of this measure have not been determined.

Because dry cooling towers would be used, salt would not be released from the cooling tower. Blowdown recycle would couple reverse osmosis with an evaporator and crystallizer system that would remove the dissolved solids from blowdown so the water could be recycled to the cooling tower. This system would reduce requirements for makeup water, and discharge would not require disposal. The solids from the crystallization processes would be disposed of as solid waste. This system would reduce the salt from blowdown.

Oak Ridge Reservation

Surface Water. Water required for construction and operation of the evolutionary LWRs would be obtained from the Clinch River and its tributaries. [Text deleted.]

During construction of the large and small evolutionary LWRs, the quantity of water required would be approximately 126 million l/yr (33 million gal/yr) and 76 million l/yr (20 million gal/yr), respectively. These quantities would represent 0.9- and 0.5-percent increases over the projected No Action surface water withdrawal. The largest increase would cause the total ORR withdrawals to increase to 0.4-percent of the average flow of the Clinch River. Minimal impacts to surface water availability would occur. During operation of the large and small reactors, water requirements would be approximately 60,560 million l/yr (16,000 million gal/yr) and 27,252 million l/yr (7,200 million gal/yr), respectively. These quantities would represent 410- and 185-percent increases over the projected annual No Action water withdrawal. The largest increase would cause the total ORR withdrawals to increase to 1.8-percent of the average flow of the Clinch River (132 m^3/s [4,647 ft^3/s]). Minimal impacts to surface water availability would occur.

During construction of the large and small evolutionary LWRs, sanitary wastewater (approximately 104 million l/yr [27.5 million gal/yr] and 59 million l/yr [15.6 million gal/yr], respectively) would be generated. During operation, 341 million l/yr (90 million gal/yr) and 189 million l/yr (50 million gal/yr), respectively, of wastewater effluent would be generated by the facility. The total quantity of wastewater discharged to the Clinch River from ORR would increase to a maximum of 0.008 percent of the Clinch River's average flow and 0.7 percent of the East Fork Poplar Creek flow. No impacts are expected. All discharges would be monitored to comply with discharge requirements.

Unlike wastewater effluent from treatment facilities, which is released on a continuous basis, cooling system blowdown activities discharge greater quantities over a shorter period of time. The large and small reactors would release approximately 97.8 million l/day (25.8 million gal/day) and 44.2 million l/day (11.7 million gal/day), respectively, of blowdown water once a day over a 1-hour period or 23,470 million l/yr (6,200 million gal/yr) and 10,598 million l/yr (2,800 million gal/yr). Without engineering measures such as those described below, the blowdown releases from the large reactor would temporarily increase the average flow rate of the receiving streams by approximately 20 percent (Clinch River) and 1,880 percent (East Fork Poplar Creek). Increases from the small reactor blowdown would be approximately 9.3 percent (Clinch River) and 820 percent (East Fork Poplar Creek). These discharges would cause scouring of the streambeds, erosion of stream channels, increased turbidity, and potential flooding of areas. In addition to impacts from the discharge velocity of the blowdown, the high temperature of the releases could also affect receiving waters. As discussed in Section 3.6.4, DOE is currently involved with remediation of East Fork Poplar Creek under CERCLA. Any discharges including cooling tower blowdown, that may potentially impact East Fork Poplar Creek would require engineering design mitigation measures to avoid interference with the goals of the remediation effort. Engineering measures incorporated in technology design adapted to site conditions could significantly reduce these impacts. Various cooling system blowdown disposal options would be evaluated in detail in future site-specific documents. All discharges to surface waters would be monitored to comply with discharge requirements.

The evolutionary LWRs would be located outside the 100-year floodplain; there would be no impact to the floodplain. The 500-year floodplain has not been determined in this area but could developed in future studies.

Groundwater. All water for construction and operation would be taken from the Clinch River; groundwater availability would not be affected. All process, utility and sanitary wastewater would be treated prior to discharge into East Fork Poplar Creek. Minimal impact to groundwater quality is expected.

Any salt coming from the cooling towers would have originated from the Clinch River. Because the salt is concentrated in a wet cooling tower, it can potentially damage vegetation in a small area near the facility. At ORR, there is adequate rainwater and groundwater flow such that the salt generated from the cooling tower would be flushed into the groundwater and diluted. The groundwater and surface water systems are connected such that the salt originating from the Clinch River and reaching the groundwater will eventually return to the river, with no net change in the total amount of salt in the ecological system.

Savannah River Site

Surface Water. Groundwater would be used for construction and operation of the evolutionary LWRs and surface water from the Savannah River would be used for cooling water makeup. Operation of a large and small evolutionary LWR would require approximately 60,219 million l/yr (15,908 million gal/yr) and 27,063 million l/yr (7,150 million gal/yr) of cooling water. These amounts would represent a 47.4- and a 21.3-percent increase, respectively, over the projected no action surface water use at SRS. These amounts are also approximately 1.2- and 0.6-percent, respectively, of the Savannah River's minimum flow, and would not be expected to affect downstream users. [Text deleted.]

During construction of the large and small evolutionary LWRs, sanitary wastewater (approximately 104 million l/yr [27.5 million gal/yr] and 59 million l/yr [15.6 million gal/yr], respectively) would be generated and discharged to the sitewide wastewater treatment system. During operation, a total of 341 million l/yr (90 million gal/yr) and 189 million l/yr (50 million gal/yr) of wastewater would be generated by the new large and small facilities, respectively, causing increases of up to 48.7 and 27 percent in the discharge from the site-wide wastewater treatment system. The possibility of these increases causing exceedance of the NPDES-permitted maximum discharge would be addressed in site-specific NEPA documents, as appropriate.

Unlike wastewater effluent from treatment facilities, which is released on a continuous basis, cooling system blowdown activities discharge greater quantities over a shorter period of time. The large or small reactor would release approximately 97.8 million l (25.8 million gal) or 44.2 million l (11.7 million gal), respectively, of blowdown water once a day over a 1-hour period. Without engineering measures such as those described below, these blowdown releases would increase the average flow rate of the receiving stream (Fourmile Branch) by over 17,000 and 7,600 percent, respectively. These discharges would cause scouring of the streambeds, erosion of stream channels, increased turbidity, and potential flooding of areas. In addition to impacts from the discharge velocity of the blowdown, the high temperature of the releases could also affect receiving waters. Engineering measures incorporated in technology design adapted to site conditions could significantly reduce these impacts. Various cooling system blowdown disposal options would be evaluated in detail in future site-specific documents. All discharges to surface waters would be monitored to comply with discharge requirements.

As an alternative to discharging blowdown water to Fourmile Branch, water from cooling tower blowdown could be discharged to Par Pond via pre-cooling ponds (that is, Pond 2, Pond 5, and Pond C). Makeup water currently is pumped into Par Pond from the Savannah River to maintain its level and the proper rate of flow in Lower Three Runs Creek (DOE 1992e:5-216). If blowdown water from the reactor were sent to Par Pond, no impacts to wetlands would be anticipated since there would be no change in the level of Par Pond or the flow rate of Lower Three Runs Creek.

Fire sprinkler water and truck hose-down water would be collected in tanks, monitored for radioactivity, and then transferred by pipeline or tanker to treatment facilities as required. Uncontaminated water would be pumped to storm drains.

The evolutionary LWRs would not be located in the 100-year floodplain. Information on the location of the 500-year floodplain at SRS is currently available only for a limited number of specific project areas. Information on the 500-year floodplain could be developed in future environmental studies.

Groundwater. Groundwater from the Cretaceous aquifer would be used as the water source for construction and operation of the new evolutionary LWRs. During construction, the quantity of water required for the large and small reactors would be approximately 126 million l/yr (33 million gal/yr) and 76 million l/yr (20 million gal/yr), respectively, which would represent 1.0- and 0.6-percent increases over the projected No Action groundwater withdrawal. Neither of these additional withdrawals would impact groundwater availability.

Water requirements during operation for the large and small reactors would be approximately 341 million l/yr (90.0 million gal/yr) and 189.3 million l/yr (50 million gal/yr), respectively. These increases would represent 2.6- and 1.4-percent increases in the projected groundwater usage at SRS. The water withdrawals from groundwater would not impact regional groundwater levels. Previous studies using numerical simulations of groundwater withdrawals from the Cretaceous aquifer up to 6 times greater than that required for the large reactor indicate drawdown of almost 2.1 m (6.9 ft) at the well head, but smaller in overlying aquifers and not extending beyond SRS boundaries in any aquifer (DOE 1991c:5-196). Therefore, it is expected that the withdrawals attributed to the large reactor would cause a small drawdown at the well head and would not impact any aquifers in the area. Withdrawals attributed to the small reactor would cause slightly less drawdown at the well head. No wastewater would be discharged directly to groundwater; therefore, groundwater quality would not be affected.

Any potential salt coming from the cooling tower would have originated from the Savannah River. Because the salt is concentrated in a wet cooling tower, it may damage vegetation in a small area near the facility. At SRS, there is adequate rainwater and groundwater flow such that any salt concentrations from the cooling tower would be flushed into the groundwater and diluted. The groundwater and surface water systems are connected such that the salt originating from the Savannah River and reaching the groundwater would eventually return to the river, with no net change in the total amount of salt in the ecological system.

[Text deleted.]

4.3.5.4.5 *Geology and Soils*

This section discusses the environmental impacts to the geologic and soil resource as related to the construction and operation of an evolutionary LWR. An evolutionary LWR, at any of the sites analyzed, would involve some ground-disturbing construction activities (284 ha [700 acres]) for two unit large or small, and 142 ha [350 acres] for one unit large or small) that would affect the soil erosion potential. The key factors affecting soil erosion potential are the amount of land disturbed and climate. Specifically, the relative annual amount of precipitation (rain) is greater at ORR and SRS than at Pantex, Hanford, INEL, and NTS. Combining these key factors together, the relative soil erosion potential for a site can be categorized as slight, moderate, or severe. Implementation of this alternative requires that a greater amount of land be disturbed relative to the other reactor alternatives. Therefore, this alternative has the greater relative impact to the soil erosion potential.

No apparent direct or indirect effects on the geologic resource are anticipated. Neither facility construction and operational activities nor site infrastructure improvements would restrict access to potential geologic resources.

The soil erosion potential from direct (facility construction) and indirect (site infrastructure improvements) impacts associated with construction and operational activities is low for Pantex, Hanford, INEL, and NTS. The soil erosion potential for ORR and SRS during construction and operational activities is moderate due primarily to greater relative annual precipitation. Soil disturbance would occur primarily from ground-disturbing construction activities (foundation preparation) and associated building construction laydown areas that can expose the soil profile and lead to a possible increase in soil erosion as a result of wind and water action. Soil loss would depend on wind velocities (increased wind velocities and durations increase potential soil erosion), the frequency and severity of rain, and the size and location of ground-breaking activities with respect to local drainage and wind patterns.

Operational effects to the soil resource would be minimal, assuming typical landscaping and ground cover improvements were employed. Net soil disturbance during operation would be considerably less than that during construction, because areas previously without ground cover would have some type of improvement (buildings, roads and landscaping). Although erosion from stormwater runoff and wind action could occasionally occur during operation, it is anticipated to be minimal.

[Text deleted.]

4.3.5.4.6 *Biological Resources*

Construction of the evolutionary LWR would require 284 ha (700 acres) of land for two units large or small, and 142 ha (350 acres) for one unit large or small at each of the DOE sites analyzed. This includes areas on which plant facilities would be constructed, as well as areas used for construction laydown. Consultation with USFWS and State agencies would be conducted at the site-specific level, as appropriate to avoid potential impacts to threatened and endangered species, and other protected species and habitat.

Hanford Site

It is assumed that either the large or small evolutionary LWR would be located near the WNP-1 and WNP-2 sites. Impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species are discussed below.

Terrestrial Resources. Use of the existing WNP-1 site for either the large or small evolutionary LWR would result in some impact to terrestrial resources at Hanford. Less mobile animals, such as reptiles and small mammals, would not be expected to survive while more mobile animals, such as larger mammals and birds, could move from the area. The survival of the latter group of animals would depend on the carrying capacity of surrounding areas. Nests and young animals living within disturbed areas may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction.

The operation of cooling towers associated with either the large or small evolutionary LWR would create salt drifts that could, if deposited at a high enough rate, affect plants growing in the vicinity of the towers. Previous studies of a tritium production LWR at the WNP-1 site predicted that up to about 13 ha (32 acres) could be affected by deposition rates of 17.1 kg/ha (15.2 lb/acre) per month (DOE 1992e:5-55). This is the rate at which salt stress symptoms can become visible in sensitive plant species. Salt drift impacts which may be associated with either evolutionary LWR option will be evaluated in site-specific NEPA documentation.

Wetlands. Impacts to wetlands from either the large or small evolutionary LWR would not be expected since the WNP-1 site is not located near wetlands and the intake and discharge lines for this facility are already built.

Aquatic Resources. Although no aquatic habitat occurs on the WNP-1 site, past studies of a tritium production LWR at the site suggest the operation of the water intake and discharge structures could impact aquatic organisms and habitats associated with the Columbia River (DOE 1992e:5-58). Impacts from the small evolutionary LWR would be less than for the large reactor since water requirements are lower. Removal of cooling water from the river would cause the entrainment and subsequent mortality of planktonic organisms, including the eggs and larvae of certain fish species. Fish species in the Hanford Reach of the Columbia River that have planktonic egg and larval stages, and thus would be most affected by entrainment, include minnows, suckers, and mountain white fish. Eggs and fry of salmonid species are less likely to be entrained because they are not planktonic. It is not expected that free swimming salmon fry would be entrained because they typically occupy shallow, gravel areas near the stream bank away from the intake structure, which would be located away from the shore. Because a relatively small percentage of the total water volume passing the site would enter the intake, entrainment losses would not be expected to affect the viability of any populations of aquatic organisms in the Hanford Reach.

Larger fish in the immediate vicinity of the intake structure could be impinged and killed on the water intake screens. Past experience indicates that operation of the WNP-2 reactor at Hanford has resulted in only minimal loss of fish from impingement (DOE 1992e:5-58).

An additional potential source of impact to aquatic resources is the discharge of cooling tower blowdown to the Columbia River. Impacts to aquatic organisms from this source would likely be limited since thermal limits would be established as part of the NPDES permit and because heat (and chemicals) would be readily dissipated as the discharge plume mixed with river water. Past studies associated with the WNP-2 Plant have indicated that temperatures were within 0.7 °C (1.9 °F) of the ambient river temperature at all monitoring stations downstream of the outfall. It would be expected that relatively immobile organisms, such as benthic macroinvertebrates, would be most affected. Studies of Chinook salmon and steelhead trout migrating past Hanford reactor discharge outfalls suggest that thermal discharges to the Columbia River would not affect fish. These studies have demonstrated that (1) the spawning run was unaffected by either on-shore or mid-river thermal discharges, (2) migration was unaffected when fish encountered warmer waters; and (3) salmonids were able to avoid areas with adverse temperatures and continue their migratory runs (DOE 1992e:5-58,5-59). Potential impingement, entrainment, and thermal impacts will be analyzed in detail in site-specific NEPA documentation if the Hanford site is chosen for the evolutionary LWR.

Threatened and Endangered Species. It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of either the large or small evolutionary LWR near the existing WNP-1 site. Most new construction would take place in previously disturbed areas for the WNP-1 site. However, if sagebrush habitat is disturbed, several State-listed and candidate species could lose breeding and foraging habitat, including the ferruginous hawk, loggerhead shrike, pygmy rabbit, sage sparrow, sage thrasher, western burrowing owl, and western sage grouse. Preactivity surveys would be completed as appropriate prior to construction to determine the existence of special status plant or animal species in the area to be disturbed. Since existing intake and discharge facilities would be used, special status species found on or near the Columbia River would not be impacted by construction activities.

During operation, water withdrawals and discharge may cause impacts to several special status species. Water withdrawal from existing intake structures could cause entrainment and impingement impacts to several State-monitored fish species. The discharge of heated effluent could cause the great Columbia River spire snail and giant Columbia River limpet to avoid the immediate area of the discharge. The potential for these impacts would be less for the small evolutionary LWR since its water requirements would be less.

Nevada Test Site

It is assumed that either the large or small evolutionary LWR would be located in the Frenchmen Flat area of NTS. Impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species are discussed. Impacts described below would be similar for either reactor alternative since the land area disturbed would be the same for both and each would use a dry cooling system.

Terrestrial Resources. Construction and operation of the evolutionary LWR at NTS would result in the disturbance of terrestrial habitat equaling about 0.08 percent of NTS. This includes areas on which plant facilities would be constructed as well as areas revegetated following construction. Vegetative cover within the assumed facility location, which is primarily creosote bush (Figure 3.3.6–1), would be destroyed during land clearing operations. Creosote bush communities are well represented on NTS.

Construction of the evolutionary LWR would affect animal populations. Less mobile animals, such as reptiles and small mammals, within the project area would not be expected to survive. Construction activities and noise could cause larger mammals and birds in construction and adjacent areas and would move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area was already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of the excess population. Nests and young animals living within the assumed site may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction. Areas disturbed by construction but not occupied by facility structures would be of minimal value to wildlife because of the difficulty in establishing vegetative cover in a desert environment.

Activities associated with operation, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area. Disturbance to wildlife living adjacent to the facility would be minimized by preventing workers from entering undisturbed areas. Impacts to vegetation from salt drift would not occur since a closed cycle cooling system would be used.

Wetlands. Construction and operation of the evolutionary LWR would not affect wetlands because there are no wetlands near the assumed facility location.

Aquatic Resources. Construction and operation of the evolutionary LWR would not affect aquatic resources because there are no permanent surface water bodies near the assumed facility location. Temporary aquatic habitat may develop in evaporation and retention ponds, as well as in natural channels in the immediate vicinity of NPDES-permitted outfalls.

Threatened and Endangered Species. The threatened desert tortoise is a federally listed species that could be affected by construction of the evolutionary LWR at NTS. Construction activities such as land clearing operations, trenches, and excavation could pose a threat to any tortoises residing within the disturbed area. An increase in vehicle traffic is an additional hazard to the tortoise. Measures designed to avoid impacts to the desert tortoise from previous projects at NTS have been implemented as a result of a Biological Opinion issued by the USFWS (NT DOI 1992b:8-15). Recommended mitigation measures included providing worker training; putting restrictions on vehicle speeds and off-road movement; conducting clearance surveys prior to surface disturbance; approving stop work authority if tortoises are found within work areas; removing tortoises from roadways and work area; placing permanent and temporary tortoise-proof fencing around trenches, landfills, and treatment ponds; inspecting trenches; and having biologists survey when heavy equipment is in use. The USFWS would be consulted, and USFWS recommendations would be implemented if NTS were selected as the location for the evolutionary LWR.

[Text deleted.] Any listed plant species (Table 3.3.6–1) located within the construction area would be lost during land-clearing activities. Preactivity surveys would be completed as appropriate prior to construction to determine the existence of these species in the area to be disturbed.

During facility operation, vehicle traffic would pose a hazard to the desert tortoise similar to the hazard caused by current traffic. Extensive measures, including personnel training, are presently being taken to ensure that drivers on NTS avoid the tortoise. [Text deleted.] Groundwater levels in Devils Hole cavern are not expected to change due to operation of the evolutionary LWR (Section 4.3.5.4.4); therefore, impacts to the Devils Hole pupfish are not expected. Similarly, other rare endemic aquatic species found in the Ash Meadows area would not be affected.

Idaho National Engineering Laboratory

It is assumed that either the large or small evolutionary LWR would be located in the south central part of INEL, 3.2 km (2 mi) northeast of the ICPP. Impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species are discussed. Impacts described below would be similar for either reactor alternative since the land would be the same for both and each would use a dry cooling system.

Terrestrial Resources. Construction and operation of the evolutionary LWR would result in the disturbance of terrestrial habitat equaling about 0.1 percent of INEL. Vegetation within the assumed site would be destroyed during land clearing operations. Big sagebrush is the dominant plant within the proposed site. Plant communities in which big sagebrush is the dominant overstory species are well represented on INEL, but are relatively uncommon regionally because of widespread conversion of shrub-steppe habitats to agriculture.

Construction of the evolutionary LWR would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Construction activities and noise would cause larger mammals and birds in the construction and adjacent areas to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area was already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of the excess population. Because pronghorn use of the assumed site is relatively low, the facility should not have a lasting impact on these species. Nests and young animals living within the project area may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction. Areas disturbed by construction but not occupied by facility structures would be of minimal value to wildlife because they would be maintained as landscaped areas.

Activities associated with facility operations, such as noise and human presence, could affect wildlife living immediately adjacent to the evolutionary LWR. These disturbances may cause some species to move from the area. Disturbance to wildlife living adjacent to the facility would be minimized by preventing workers from entering disturbed areas. Impacts to vegetation from salt drift would not occur since dry cooling towers would be used.

Wetlands. Construction and operation of the evolutionary LWR would not affect wetlands since there are no wetlands near the assumed facility location. Wetlands associated with the Big Lost River are located 2.4 km (1.5 mi) from the site; therefore, impacts to these wetlands are not expected.

Aquatic Resources. Construction and operation of the evolutionary LWR would not impact aquatic resources since there are no surface water bodies near the assumed facility location. The nearest surface water body is in the Big Lost River which is located 2.4 km (1.5 mi) from the facility location. Temporary aquatic habitat may develop in evaporation and retention ponds, as well as in natural channels in the immediate vicinity of NPDES permitted outfalls.

Threatened and Endangered Species. It is unlikely that federally listed threatened or endangered species would be affected by construction of the evolutionary LWR, but several State-status species may be affected. [Text deleted.] Burrows and foraging habitat for the pygmy rabbit would be lost. Bat species, such as the Townsend's western big-eared bat, may roost in caves and forage throughout the proposed site. One State-listed sensitive plant species could potentially be affected by construction of the facility. The plant species, tree-like oxytheca, has been collected at eight sites on INEL and at only two other sites in Idaho (IN DOE 1984a:34,36). If present, individual plants of this species could be destroyed during land clearing activities. Preactivity surveys would be completed as appropriate prior to construction to determine the existence of these species in the area to be disturbed.

During operation of the new facility, several bat species could forage at evaporation and stormwater retention ponds. No impacts to threatened and endangered species are expected due to facility operation.

Pantex Plant

It is assumed that the potential site for the evolutionary LWR is located in the northwest portion of Pantex. Impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species are discussed below.

Terrestrial Resources. Construction and operation of either the large or small evolutionary LWR at Pantex would result in the disturbance of terrestrial habitat equaling about 8.0 percent of the site. Land on which the facility would be built is presently used for agricultural purposes.

Construction of either the large or small evolutionary LWR would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Construction activities and noise would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area was already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of the excess population. Nests of migratory birds and young animals living within the assumed site may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction. Areas that would be reestablished as farmland or revegetated upon completion of construction would be recolonized by animal species present in nearby, undisturbed habitats.

Activities associated with facility operation, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area. Disturbance to wildlife living adjacent to the facility would be minimized by preventing workers from entering undisturbed areas. Impacts to vegetation from salt drift would not occur since dry cooling towers would be used.

Wetlands. Impacts to wetlands may result from land disturbances and treated wastewater disposal during construction. Construction-related ground disturbance may increase the potential for sediment runoff to the playa wetlands. This impact would be controlled through the implementation of standard soil erosion and sediment control measures. Site playas would be avoided during construction. A small area designated as a pristine wetland on NWI maps is located in the site area. If this area is determined to be a jurisdictional wetland, any potential impacts would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with COE permit requirements.

During construction and operation, treated wastewater would be discharged to the playas. Although part of the discharged water would be lost to the atmosphere due to high evapotranspiration rates, it could cause shifts in the composition of wetland plant communities and increases in the area of open water. The plant community shifts would favor plants tolerant of longer and deeper inundation. Furthermore, disturbed plant communities provide an opportunity for establishment of invasive exotic plant species. The potential for these impacts would be less for a small evolutionary LWR since less water would be discharged to site playas. All wastewater discharges would be treated as necessary to meet NPDES-permit requirements.

Aquatic Resources. Construction and operation of either the large or small evolutionary LWR facility would result in discharges of wastewater to the playas. As discussed for wetlands, the discharges could potentially result in an increase in open water area which would provide some additional aquatic habitat. Playas could also be affected by sediment runoff during construction; however, this impact would be controlled through the use of soil erosion and sediment control measures.

Threatened and Endangered Species. The bald eagle is a consistently occurring federally listed species at Pantex that has the potential to be affected by construction or either the large or small evolutionary LWR. Bald eagles avoid areas where humans are active; thus, wintering eagles observed at Pantex would be disturbed by increased activity.

Several Federal candidate or State-listed species may be affected by construction activities. Similar to the bald eagle, white-faced ibis may be discouraged from foraging at site playas during construction. [Text deleted.] The swift fox would also lose potential foraging and denning habitat. During operation, the swift fox would not use areas in proximity to the operating plant. The Texas horned lizard is less mobile and would be lost during land-clearing activities. Preactivity surveys would be completed, as appropriate, prior to construction to determine the existence of these species in the area to be disturbed. Consultation with USFWS would occur as required and, if necessary, a detailed mitigation plan would be developed.

[Text deleted.]

Oak Ridge Reservation

For analytical purposes it is assumed that either the large or small evolutionary LWR would be located at the former breeder reactor site. Impacts to terrestrial resources, wetlands, aquatics resources, and threatened and endangered species are discussed below.

Terrestrial Resources. Although the assumed evolutionary LWR site is located within an area that has been designated as pine and pine hardwood forest (Figure 3.6.6–1), it was disturbed in the past by clearing and grading activities for the breeder reactor. Presently, the site could be classified as an old field. Construction of evolutionary LWR would result in this area being redisturbed. It is also possible that some undisturbed vegetation, primarily pine and pine hardwood forest, immediately surrounding the site would also be cleared.

Salt drift from wet cooling towers associated with either the large or small evolutionary LWR could cause salt deposition on surrounding land areas and vegetation. At present, the reactor design has not advanced sufficiently to predict the area that could be affected by salt drift at ORR; however, previous studies for a proposed tritium reactor at SRS, which was designed for the southeastern United States, would be expected to be applicable to ORR. The proposed SRS reactor was predicted to impact 5 ha (12 acres) at a deposition rate of 17.1 kg/ha/month (15.2 lb/acre/month) (DOE 1992e:5-213). This is the level at which salt stress symptoms could become evident on sensitive plants. Salt drift impacts which may be associated with either evolutionary LWR option will be evaluated in site-specific NEPA documentation.

Construction of the proposed facility would affect animal populations. Less mobile animals within the proposed project area, such as amphibians, reptiles, and small mammals, would not be expected to survive. Construction activities and noise would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area was already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of the excess population. Nests and young animals living within the assumed site may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction. Upon completion of construction, revegetated areas would be of minimal value to most wildlife since they would be maintained as landscaped areas.

Activities associated with facility operation, such as noise and human presence, could affect wildlife living immediately adjacent to the proposed facility. These disturbances may cause some species to move from the area. Disturbance to wildlife living adjacent to the facility would be minimized by preventing workers from entering undisturbed areas.

Wetlands. Because the majority of the land in the site area is upland, it is expected that direct impacts to wetlands from construction of either a large or small evolutionary LWR could largely be avoided. Minor impacts could occur from the construction of rights-of-way. Indirect impacts to wetlands from stormwater runoff during construction and operation are possible. Impacts on wetlands would not be expected from salt deposition due to the limited area that would likely be affected. It may be necessary to cross wetlands when constructing intake or outfall structures; however, impacts would be temporary. Any unavoidable impacts to wetlands would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with the COE permit requirements.

Construction-related discharges (for example, from foundation dewatering) would be directed to the Clinch River. Discharges to the Clinch River would have minimal impact on the flow of the river and would not be expected to affect associated wetlands.

During operation, blowdown water from the cooling system would also be discharged to the Clinch River. Discharges to the Clinch River, which for the large evolutionary LWR option would represent up to 20 percent of the flow of the river during each discharge period, could lead to streambed scouring in the vicinity of the outfall and subsequent downstream sedimentation. This could alter wetlands present in the vicinity of the outfall, as well as those located downstream. The use of detention ponds and engineered energy dissipating structures would reduce impacts of discharges. Thermal impacts to wetland vegetation could occur with the release of large volumes of cooling tower blowdown. All wastewater discharges would be treated as necessary to meet NPDES-permit requirements.

Aquatic Resources. Construction of either the large or small evolutionary LWR could cause water quality changes, primarily sediment loading and resulting turbidity, to the Clinch River. These potential impacts would be reduced by implementing a soil erosion and sediment control plan. Construction water withdrawal would represent a very small percentage of the average flow of the Clinch River and, thus, would have little affect on its flow. Impingement and entrainment impacts would, therefore, be minimal and would be unlikely to affect fish populations in the Clinch River. During construction, dewatering discharges would be directed to the Clinch River. Impacts to the river would be expected to be minimal.

During operation, water withdrawals could increase entrainment and impingement of fish in the Clinch River. However, the volume of the water withdrawn for either reactor alternative would comprise a small percentage of the flow of the river and is unlikely to affect fish populations. Further, intake structures would be designed to reduce intake flow rates, thereby reducing impingement and entrainment losses.

Blowdown water from the cooling system of the evolutionary LWR would be released to the Clinch River. Discharge to the river from the large evolutionary LWR would represent about 20 percent of the flow of the river during each discharge period. This could result in streambed scouring in the vicinity of the outfall and subsequent downstream sedimentation. Although fish would likely return to the disturbed area between periods of discharge, this would not be possible for benthic organisms. Thermal impacts may also occur as the result of the release of large intermittent volumes of cooling water. Detention ponds may be necessary to reduce peak flows to the Clinch River. Chemical constituents and temperature of the discharges would be required to meet NPDES permit limits.

Threatened and Endangered Species. It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of either the large or small evolutionary LWR at the former breeding reactor site on ORR. Since this site is located within previously disturbed habitat, there is less potential for impact to special status species. Any special status plant species found in the pine and pine hardwood forest habitat adjacent to the disturbed site area could be destroyed if additional land is required. Prior to development, a survey would be conducted to determine the occurrence of listed plant species. Small, relatively immobile animal species, such as the Allegheny woodrat and southeastern shrew, could be destroyed during land-clearing activities. Preactivity surveys would be conducted as appropriate prior to construction to determine the existence of these and other special status species.

Savannah River Site

It is assumed that either the large or small evolutionary LWR would be constructed just to the northeast of the N-Area. Impacts to terrestrial resources, wetlands, aquatic resources, and threatened and endangered species are discussed below.

Terrestrial Resources. Construction and operation of the evolutionary LWR at SRS would result in the disturbance of terrestrial habitat equaling about 0.4 percent of the site. Since the majority of the site is covered by pine plantations, it is this vegetation type that would be most affected. However, other upland types, such as old-field, and mixed forest and grassland could also be impacted. Bottomland hardwoods and wetlands would be avoided to the extent possible.

Salt drift from wet cooling towers associated with either the large or small evolutionary LWR could cause salt deposition on surrounding land areas and vegetation. At present, the reactor design has not advanced sufficiently to predict the area that could be affected by salt drift at SRS; however, previous studies for a proposed tritium reactor at SRS predicted that 5 ha (12 acres) would be affected at a deposition rate of 17.1 kg/ha/month (15.2 lb/acre/month) (DOE 1992e:4-126). This is the level at which salt stress symptoms could become evident on sensitive plants. Salt drift impacts which may be associated with either evolutionary LWR option will be evaluated in site-specific NEPA documentation.

Construction of an evolutionary LWR would affect animal populations. Less mobile animals, such as amphibians, reptiles, and small mammals, within the project area would not be expected to survive. Construction activities and noise would cause larger mammals and birds to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area was already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of the excess population. Nests of migratory birds and young animals living within the assumed site may not survive. The site would be surveyed as necessary for the nests of migratory birds prior to construction. Upon completion of construction, revegetated areas would be of minimal value to most types of wildlife because they would be maintained as landscaped areas.

Activities associated with facility operations, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area. Disturbance to wildlife living adjacent to the facility would be minimized by preventing workers from entering undisturbed areas.

Wetlands. Since the majority of the assumed evolutionary LWR site is upland, it is expected that direct impacts to wetlands from construction of either reactor alternative could be largely avoided. Implementation of soil erosion and sediment control measures would control secondary impacts. Impacts to wetlands resulting from the construction of intake or outfall structures would be temporary. Any unavoidable impacts to wetlands would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with COE permit requirements. Construction wastewater discharge to Fourmile Branch would be minimal and would not be expected to affect wetlands associated with the stream.

Cooling system blowdown would be directed to either Fourmile Branch or Par Pond. Intermittent discharges of large volumes of water from cooling system blowdown to Fourmile Branch could impact wetlands bordering the stream and the Savannah River Swamp. Sediment build up in the Savannah River Swamp resulting from streambed scouring could result in swamp forest vegetation being replaced by scrub/shrub or emergent vegetation. Also, erosion of stream banks could result in the loss of wetland vegetation. These impacts would be less for the small evolutionary LWR since a smaller discharge volume is involved. The use of detention ponds and engineered energy dissipating structures would reduce impacts of discharges. Thermal impacts to wetlands were not predicted for a previous tritium reactor planned for SRS (DOE 1992e:5-215); such impacts are also not expected for the proposed reactor. All wastewater discharges would be treated as necessary to comply with NPDES-permit requirement.

As an alternative to discharging blowdown water to Fourmile Branch, water from cooling tower blowdown could be discharged to Par Pond via pre-cooling ponds (that is, Pond 2, Pond 5, and Pond C). Makeup water currently is pumped into Par Pond from the Savannah River to maintain its level and the proper rate of flow in Lower Three Runs Creek (DOE 1992e:5-216). If blowdown water from either reactor alternative were sent to Par Pond, no impacts to wetlands would be anticipated since there would be no change in the level of Par Pond or the flow rate of Lower Three Runs Creek.

Aquatic Resources. Stormwater runoff during construction of either the large or small evolutionary LWR could cause temporary water quality changes in Fourmile Branch and Pen Branch. Increased turbidity could impact some fish spawning and feeding habitat. Fish populations would probably move to less disturbed areas of the stream and recolonize disturbed areas shortly after construction is complete and water quality improves. Construction of intake and discharge facilities would result in the temporary loss of habitat in the affected waterbodies. During construction, wastewater would be discharged to Fourmile Branch. These discharges would be minimal and would not be expected to affect aquatic resources.

During operation of either Evolutionary LWR Alternative, water would be withdrawn from the Savannah River. For both alternatives, the volume of water withdrawn represents a small percentage of the average flow of the river and would not affect its flow. However, an increase in entrainment and impingement of fish could occur. Based on previous studies for a tritium production reactor at SRS (DOE 1992e:5-218) and monitoring of past SRS operations (WSRC 1989e:4-506), fish populations should not be affected by entrainment losses from operation of the evolutionary LWR. Similarly, impingement losses should not impact fish populations. Impacts to anadromous fish (for example, striped bass and several species of shad) due to entrainment and impingement, would also be relatively low and would not affect their populations. In compliance with the *Anadromous Fish Conservation Act*, populations of anadromous fish species would be sustained and their movement unobstructed by project construction and operation.

During operation, blowdown from the cooling system of either the large or small evolutionary LWR would be released to either Fourmile Branch or Par Pond. Impacts would be less for the small evolutionary LWR since it would discharge a smaller volume of water. Intermittent discharges of large volumes of water from blowdown would greatly increase the flow rate of Fourmile Branch which would cause flooding and stream bed scouring. This could alter the aquatic ecosystem by displacing existing plant and animal communities. Previous studies for a tritium production reactor at SRS indicated that water temperatures of discharges were expected to be within the thermal tolerance limits of native warmwater fish species. The temperature of water from blowdown discharges was also expected to be within normal water temperatures of each season and were not expected to alter the distribution or abundance of aquatic organisms in receiving waters. However, the temperature of blowdown water discharged to Fourmile Branch was predicted to exceed the maximum temperature differential of 2.8 °C (7.5 °F) between effluent and receiving stream during the cooler months of the year. Such an exceedance would require a Section 316(a) demonstration of balanced biotic community (DOE 1992e:5-218, 5-219).

Discharge to Par Pond would have no flow impacts since it currently receives makeup water to maintain its level. In fact, projected discharges would reduce the need to pump makeup water to Par Pond. Thermal impacts to Par Pond would not be expected since discharged water would pass through a series of precooling ponds designed to meet the State of South Carolina requirements for thermal releases to Class B waters; however, the recovery of the precooling ponds from past thermal discharges would be affected.

Threatened and Endangered Species. The only federally listed threatened or endangered species that could be affected by construction of either the large or small evolutionary LWR at SRS is the smooth purple coneflower. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the assumed site that this species would not be directly impacted by the reactor. Other special status species that would potentially be impacted by construction activities include the green-fringed orchid, eastern tiger salamander, Florida false loosestrife, beak-rush, star-nosed mole, and Cooper's hawk. If present, individuals of each of these species could be destroyed, except the hawk which could be temporarily displaced during construction.

During operation, there is potential for impacts to the federally listed short nose sturgeon and wood stork. The short nose sturgeon has been observed in the Savannah River where cooling water would be withdrawn. However, sturgeon eggs tend to sink and are strongly adhesive and gelatinous, which limits their downstream transport and dispersal through the water column. Thus, sturgeon eggs do not have a high entrainment risk. The preference of sturgeon larva for benthic habitat and the ability of juvenile and adult sturgeon to attain swimming speeds above the water intake velocity demonstrate the unlikelihood of impingement losses of this species

(DOE 1992e:5-222). Cooling system blowdown discharged to Fourmile Branch from either reactor alternative could cause an increase in stream depth which could disrupt the foraging activities of the wood stork. Preactivity surveys would be conducted as appropriate prior to construction to determine the occurrences of these and other special status species within the construction and water discharge areas. Consultation with USFWS would occur as required and, if necessary, a detailed mitigation plan would be developed.

4.3.5.4.7 *Cultural and Paleontological Resources*

This section discusses construction and operational impacts to cultural and paleontological resources that may result from the Evolutionary LWR Alternative at each of the representative sites analyzed. Land to be disturbed during construction of the large or small two-unit evolutionary LWR totals 284 ha (700 acres). Construction of a large or small one-unit evolutionary LWR would disturb 142 ha (350 acres). Total land area requirement during operation for the large or small two-unit evolutionary LWR would be 138 ha (340 acres), and increasing the facility to four units (small) would increase operation land area to 227 ha (560 acres). [Text deleted.]

Because there is no difference in plant footprint or land disturbance between the large and small reactors, impacts to cultural and paleontological resources would not differ. For the discussion of impacts, the term cultural resources includes prehistoric, historic, and Native American resources. Cultural and paleontological resources at the proposed sites may be affected directly through ground disturbance during construction, visual intrusion of the project to the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism.

Hanford Site

The evolutionary LWR would be constructed adjacent to the WNP-1 and WNP-2 reactors. An archaeological surface survey was completed in the area of the WNP-1 reactor, including the staging area and pumphouse site, in 1974 and no archaeological sites were identified. However, archaeological monitoring during construction identified historic and prehistoric artifacts (HF WPPSS 1983a:66,68). Prehistoric resources that may occur at Hanford include remains of campsites, burials, and hunting/kill sites. Historic resources may include remains of ranches, homesteads, or trash dumps.

Native American resources potentially affected by the construction and operation of the proposed facility would be identified through consultation with interested parties. Impacts may include disturbance of important Native American plant communities, reduced access to traditional use areas, or visual and audio intrusion into sacred spaces.

Construction may affect some paleontological remains. Pliocene and Late Pleistocene remains have been found in and around Hanford. These remains have high research potential. There would be no additional impacts to paleontological resources from operation as it does not involve additional ground disturbance.

Nevada Test Site

The evolutionary LWR would be constructed in Area 6, near the DAF on Frenchman Flat. In 1984, a Class III cultural resources survey was conducted across the 660-ha (1,610-acre) DAF site, and no NRHP-eligible sites were identified. Although no resources were identified within the DAF project area, Frenchman Flat contains 49 sites which have been determined eligible for inclusion on the NRHP. Recorded prehistoric sites within Frenchman Flat include base and temporary camps, quarries, and lithic reduction areas. Identified historic resources include sites associated with nuclear testing and research. Additional unsurveyed land necessary for the proposed facility may contain similar prehistoric or historic resources. Impacts to resources would occur during construction of the proposed facility. Operation would not result in additional impacts as it does not involve ground disturbance or increased activity.

The CGTO has conducted surveys over portions of Frenchman Flat and identified at least 20 plant species of importance to Native Americans. Additional project-specific consultations would be necessary to identify impacts to Native American resources resulting from the construction and operation of the facility. Potential impacts include reduced access to traditional use areas and visual or auditory intrusions to sacred space.

Although none have been identified to date, Quaternary deposits containing scientifically valuable paleontological remains may occur in the area to be disturbed during construction. Such remains have been found near NTS. Paleontological remains may be affected by construction, but not operation, of the facility.

Idaho National Engineering Laboratory

The facility would be constructed northwest of the PBF in the Central Core Area/Prime Development Land Zone of INEL. This area has been developed and disturbed and the probability of finding NRHP-eligible archaeological sites or paleontological remains is low, but possible. Construction and operation are not expected to have an effect on these resources. Some Native American resources such as traditional use areas and sacred space may be affected by the construction and operation of the facility. Some paleontological remains may be affected by construction. There are 31 known fossil localities at INEL. Operation would not have an additional effect on these resources.

Pantex Plant

The evolutionary LWR would be constructed in the northwest portion of Pantex, west of the burning ground. This area is currently used for agriculture. Some NRHP-eligible resources may be affected by the construction of this facility. Any resources would be identified during the NHPA Section 106 compliance process. There would be no operational impacts to archaeological remains because operation does not involve additional ground disturbance. Construction and operation of these facilities may affect some Native American resources. Native American resources would be identified through project-specific consultation with potentially affected groups. Some paleontological resources may occur in the area to be affected by construction. Operation would not have an additional impact.

Oak Ridge Reservation

This facility would be constructed in the western portion of ORR, south of Bear Creek Road along the Clinch River. A portion of this area was reviewed for archaeological and historic resources as part of the EIS for construction of the proposed Clinch River Breeder Reactor. At that time four historic sites, five archaeological sites, and one cemetery were identified (OR NRC 1977a:2-7). One of the archaeological sites was a prehistoric burial mound. Additional resources may be identified through the NHPA Section 106 compliance process. Construction poses the greatest threat to archaeological resources. Operation would not directly affect these resources.

Construction and operation could have an effect on Native American resources by disturbing traditional plant and animal communities through construction and by reducing access to traditional use areas during operation. These resources could be identified through project-specific consultation with potentially affected tribes.

Paleontological resources could also be affected through new construction, however, those known to occur at ORR are relatively common fossils with low research potential. Operation would not have an impact on these resources.

Savannah River Site

The evolutionary LWR would be located east of the N-Area on undeveloped/forested land previously assessed for the New Production Reactor. This tract contains three NRHP-eligible historic sites. Additional NRHP-eligible resources may occur within unsurveyed areas to be disturbed by construction. Prehistoric site types that may occur at SRS include villages, base camps, limited activity sites, quarries, and workshops. Historic site types that may occur at SRS include cattle ranches, farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, cattle pens, dams, towns, churches, cemeteries, trash scatters and roads. In addition, some Native American resources such as remains of villages, traditional plant gathering areas, cemeteries, and isolated burials may be affected by construction and operation of the facility. No scientifically valuable fossil remains have been recorded at SRS to date. Facility construction and operation are not expected to affect paleontological resources.

[Text deleted.]

4.3.5.4.8 *Socioeconomics*

This section analyzes the socioeconomic effects of the Evolutionary LWR for each of the candidate sites. Only the sites with the greatest socioeconomic effects are discussed. The effects at all of the candidate sites are found in the Supplemental Socioeconomic Data Report (Socio 1996a). The large-reactor option will be analyzed in this section because it would have a greater impact on the region than the smaller-reactor option.

Regional Economy Characteristics. Constructing an evolutionary LWR at any of the sites analyzed would generate employment and income increases within the affected REA. Constructing the facility would require 3,500 workers in the peak year of construction at any site. The largest increases in regional employment (about 4 percent) would occur at INEL while the largest increase in regional per capita income (less than 1 percent) would occur at ORR. A total of 7,106 new jobs (3,500 direct and 3,606 indirect) would be generated and regional unemployment would fall from 5.4 to 3.0 percent at INEL (Socio 1996a).

A workforce of 830 would be required to operate the facility at any site. Operating the facility at Pantex would generate the greatest change in regional employment (approximately 1 percent). A total of 3,540 new jobs (830 direct and 2,710 indirect) would be created by the operational activities, and regional unemployment would fall to 3.7 percent. The largest increase in regional per capita income would occur as a result of operating the facility at INEL, but the increase would still be less than 1 percent over No Action (Socio 1996a).

Population and Housing. At all of the sites analyzed, workers would in-migrate to fill some of the newly created positions during both construction and operation. Project-related population increases would be greatest at INEL during construction of the reactor. Population in the ROI would increase by approximately 3 percent during this period. Pantex would require the largest number of in-migrating workers during operation; however, the population increase would be less than 1 percent. During construction, housing units, in excess of existing vacancies, would be required at all of the sites analyzed, except NTS. Additional housing construction would also be required during operation at all of the sites analyzed, except NTS and ORR, to accommodate the in-migrating population. The greatest increase in housing requirements (approximately 3 percent during construction and much less than 1 percent during operation) would be in the INEL ROI. Historic housing construction rates indicate there would be sufficient housing units available to accommodate the in-migrating population at all of the sites analyzed. (Socio 1996a).

Community Services. Constructing an evolutionary LWR would increase demand for community services at all the sites analyzed. The effects of population increases due to in-migrating workers during construction or operation on community services at any of the sites analyzed would be minor. The following discussion focuses on the Pantex and INEL ROIs where the greatest increased demand for community services would occur.

School districts in the Pantex ROI would need an additional 85 teachers during peak construction, and Pantex school districts would also require 21 additional teachers during operations to maintain the Pantex ROI No Action level of service. However, the additional teachers would be distributed over several school districts in the ROI; therefore, no single district would be significantly affected (Socio 1996a).

Twelve additional sworn police officers would be required in the INEL ROI during construction to maintain the No Action service level of 1.6 police officers per 1,000 persons, while 2 additional police officers would be required during operation. Eighteen additional firefighters would be required in the Pantex ROI during construction to maintain the No Action service level of 2.3 firefighters per 1,000 persons, while 3 additional firefighters would be required during operation (Socio 1996a).

Projected hospital occupancy rates during construction and operation would increase slightly over the No Action levels at all the sites analyzed. Projected capacities would be capable of accommodating the increase in patient load. Eleven additional physicians would be needed to maintain the No Action service level of 1.2 physicians per 1,000 persons in the INEL ROI during construction, while 2 would be needed during operation at Pantex to maintain the No Action service level of 2.0 (Socio 1996a).

Local Transportation. The ORR local transportation network would experience the most noticeable effects from siting the evolutionary LWR. A total of 6,720 and 1,594 vehicle trips per day would be generated during the construction and operation phases, respectively. Vehicle traffic during construction would cause changes in four local road segments. I-275 from I-40 at Knoxville to I-75/640 at Knoxville as well as from I-75 at Knoxville to I-40 would both experience a drop in level of service from D to E. U.S. 70 from U.S. 321 to U.S. 11 would experience a drop in level of service from B to C. Tennessee State Route 58 from Tennessee State Region 95 to I-40 would experience a drop in level of service from E to F. Finally, Tennessee State Route 62 from Tennessee State Route 95 at Oak Ridge to Tennessee State Route at 170 would experience a significant increase in its volume-to-capacity ratio while operating at level of service F.

Drops in level of service for local roads would also occur at Hanford, NTS, INEL, Pantex, and SRS during construction. The INEL local transportation network would experience the most noticeable effects from operations of the evolutionary LWR. One thousand five hundred ninety-four vehicle trips per day would be generated during the operations phase at INEL. US 20 from US 26/91 at Idaho Falls to US 26 East would experience a drop in level of service from D to E. US 20/26 from US 26 East to ID State Route 22/33 would experience a drop in level of service from B to C (Socio 1996a).

4.3.5.4.9 *Public and Occupational Health and Safety*

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents involved with the evolutionary LWRs. The section first describes the impacts from normal reactor operation at each potential site followed by a description of impacts from reactor accidents. The impacts associated with the ultimate disposal of the spent fuel in a HLW repository are presented separately in technical documents that specifically address repository operations.

Summaries of the radiological impacts to the public associated with normal operation during the assumed 17-year campaign time are presented in Tables 4.3.5.4.9–1 and 4.3.5.4.9–2 for a single large and small evolutionary LWRs, respectively. Summaries of radiological impacts to workers are given in Tables 4.3.5.4.9–3 and 4.3.5.4.9–4 for large and small evolutionary LWRs, respectively. Impacts from hazardous chemicals to these same groups are given in Table 4.3.5.4.9–5. Summaries of impacts associated with postulated accidents are given in Table 4.3.5.4.9–6 through Table 4.3.5.4.9–11. Detailed results are presented in Appendix M.

Normal Operation. There would be no radiological releases associated with the construction of an evolutionary LWR at any of the sites analyzed. Construction worker exposures to material potentially contaminated with radioactivity (for example, from construction activities involved with existing contaminated soil) would be limited to assure that doses are maintained as low as reasonably achievable. Toward this end, construction workers would be monitored as appropriate. Limited hazardous chemical releases are anticipated as a result of construction activities. However, concentrations would be within the regulated exposure limits. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The resulting doses and potential health effects to the public and workers at each site are described below.

Radiological Impacts. Radiological impacts to the average and maximally exposed members of the public resulting from the normal operation of the large and small evolutionary LWRs at each of the sites are presented in Tables 4.3.5.4.9–1 and 4.3.5.4.9–2, respectively. The impacts from all site operations, including the evolutionary LWR, are also given in these tables. To put operational doses into perspective, comparisons with doses from natural background radiation are included in the tables.

The dose to the maximally exposed member of the public from annual large evolutionary LWR operation would range from 0.034 mrem at the NTS site to 4.8 mrem at the ORR site. From 17 years of operation, the corresponding risks of fatal cancer to this individual would range from 2.9×10^{-7} to 4.1×10^{-5}. The impacts to the average individual would be less. As a result of annual operations, the population dose would range from 0.032 person-rem at NTS to 32 person-rem at SRS. The corresponding numbers of fatal cancers in these populations from 17 years of operation would range from 2.7×10^{-4} to 0.27.

The doses to the maximally exposed member of the public from annual total site operations, including the large evolutionary LWR, are all within the radiological limits specified in NESHAPS (40 CFR 61, Subpart H) and DOE Order 5400.5, and would range from 0.035 mrem at NTS to 6.7 mrem at the ORR site. From 17 years of operation, the corresponding risks of fatal cancers to this individual would range from 3.0×10^{-7} to 5.7×10^{-5}. The impacts to the average individual would be less. This activity would be included in a program to ensure that doses to the public are as ALARA. As a result of annual total site operations, the population doses would be within the limit in proposed 10 CFR 834 and would range from 0.036 person-rem at the NTS site to 76 person-rem at the SRS site. The corresponding numbers of fatal cancers in these populations from 17 years of operation would range from 3.0×10^{-4} to 0.65.

The dose to the maximally exposed member of the public from annual small evolutionary LWR operation would range from 0.025 mrem at NTS to 2.8 mrem at the ORR site. From 17 years of operation, the corresponding risks of fatal cancer to this individual would range from 2.1×10^{-7} to 2.4×10^{-5}. The impacts to the average

Table 4.3.5.4.9–1. Potential Radiological Impacts to the Public During Normal Operation of the Large Evolutionary Light Water Reactor

Receptor	Hanford		NTS		INEL		Pantex		ORR		SRS	
	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]
Annual Dose to the Maximally Exposed Individual Member of the Public[b]												
Atmospheric release pathway (mrem)	0.33	0.33	0.034	0.035	0.046	0.053	1.5	1.5	4.8	5.0	0.26	0.61
Drinking water pathway (mrem)	0	0	0	0	0	0	0	0	1.0×10^{-3}	0.10	4.3×10^{-4}	0.081
Total liquid release pathway (mrem)	0.014	0.015	0	0	0	0	0	0	0.060	1.8	0.015	0.39
Atmospheric and liquid release pathways combined (mrem)	0.34	0.35	0.034	0.035	0.046	0.053	1.5	1.5	4.9	6.7	0.27	1.0
Percent of natural background[c]	0.11	0.12	0.011	0.011	0.014	0.016	0.45	0.45	1.6	2.3	0.092	0.34
17-year fatal cancer risk	2.9×10^{-6}	2.9×10^{-6}	2.9×10^{-7}	3.0×10^{-7}	3.9×10^{-7}	4.5×10^{-7}	1.3×10^{-5}	1.3×10^{-5}	4.1×10^{-5}	5.7×10^{-5}	2.3×10^{-6}	8.5×10^{-6}
Annual Population Dose Within 80 Kilometers[d]												
Atmospheric release pathway (person-rem)	30	30	0.032	0.036	9.6	12.0	8.9	8.9	5.1	34	32	72
Total liquid release pathway (person-rem)	1.5	2.6	0	0	0	0	0	0	0.078	4.8	0.096	3.7
Atmospheric and liquid release pathways combined (person-rem)	32	33	0.032	0.036	9.6	12.0	8.9	8.9	5.2	39	32	76
Percent of natural background[c]	0.017	0.018	3.5×10^{-4}	3.9×10^{-4}	0.011	0.013	7.6×10^{-3}	7.6×10^{-3}	1.4×10^{-3}	0.010	0.012	0.029
17-year fatal cancers	0.27	0.28	2.7×10^{-4}	3.0×10^{-4}	0.082	0.10	0.076	0.076	0.044	0.33	0.27	0.65

Table 4.3.5.4.9–1. Potential Radiological Impacts to the Public During Normal Operation of the Large Evolutionary Light Water Reactor—Continued

Receptor	Hanford		NTS		INEL		Pantex		ORR		SRS	
	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]
Annual Dose to the Average Individual Within 80 Kilometer[e]												
Atmospheric and liquid release pathways combined (mrem)	0.052	0.053	1.1×10^{-3}	1.2×10^{-3}	0.036	0.045	0.025	0.025	4.0×10^{-3}	0.030	0.036	0.085
17-year fatal cancer risk	4.4×10^{-7}	4.5×10^{-7}	9.3×10^{-9}	1.0×10^{-8}	3.0×10^{-7}	3.8×10^{-7}	2.2×10^{-7}	2.2×10^{-7}	3.4×10^{-8}	2.6×10^{-7}	3.0×10^{-7}	7.2×10^{-7}

[a] Includes impacts from No Action facilities (refer to Sections 4.2.1.9 through 4.2.6.9). The location of the MEI may be different under No Action than for operation of the reactor. Therefore, the impacts may not be directly additive.

[b] The applicable radiological limits for an individual member of the public from site operations are 10 mrem per year from the air pathways, as required by NESHAPS (40 CFR 61, Subpart H) under the CAA; 4 mrem per year from the drinking water pathway, as required by the SDWA; and 100 mrem per year from all pathways combined. Refer to DOE Order 5400.5.

[c] The annual natural background radiation level at Hanford is 300 mrem for the average individual; the population within 80 km receives 186,400 person-rem; at NTS is 313 mrem for the average individual; the population within 80 km receives 9,190 person-rem; at INEL is 338 mrem for the average individual; the population within 80 km receives 90,800 person-rem; at Pantex is 334 mrem for the average individual; the population within 80 km receives 116,900 person-rem; at ORR is 295 mrem for the average individual; the population within 80 km receives 379,000 person-rem; at SRS is 298 mrem for the average individual; the population within 80 km receives 266,000 person-rem.

[d] For DOE activities, proposed 10 CFR 834 (see 58 FR 16268) would generally limit the potential annual population dose to 100 person-rem from all pathways combined, and would require an ALARA program.

[Text deleted.]

[e] Obtained by dividing the population dose by the number of people projected to be living within 80 km of the site (621,000 at Hanford; 29,400 at NTS; 269,000 at INEL; 350,000 at Pantex; 1,285,000 at ORR; and 893,000 at SRS).

Source: Section M.2.

Table 4.3.5.4.9–2. Potential Radiological Impacts to the Public During Normal Operation of the Small Evolutionary Light Water Reactor

Receptor	Hanford		NTS		INEL		Pantex		ORR		SRS	
	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]	Reactor	Total Site[a]
Annual Dose to the Maximally Exposed Individual Member of the Public[b]												
Atmospheric release pathway (mrem)	0.23	0.23	0.025	0.026	0.033	0.041	1.0	1.0	2.3	2.5	0.16	0.54
Drinking water pathway (mrem)	0	0	0	0	0	0	0	0	0.011	0.11	4.9×10^{-3}	0.086
Total liquid release pathway (mrem)	0.024	0.025	0	0	0	0	0	0	0.47	2.2	0.067	0.44
Atmospheric and liquid release pathways combined (mrem)	0.25	0.26	0.025	0.026	0.033	0.041	1.0	1.0	2.8	4.7	0.23	0.98
Percent of natural background[c]	0.085	0.085	8.0×10^{-3}	8.4×10^{-3}	9.8×10^{-3}	0.012	0.30	0.30	0.94	1.6	0.076	0.33
17-year fatal cancer risk	2.1×10^{-6}	2.2×10^{-6}	2.1×10^{-7}	2.2×10^{-7}	2.8×10^{-7}	3.5×10^{-7}	8.5×10^{-6}	8.5×10^{-6}	2.4×10^{-5}	4.0×10^{-5}	1.9×10^{-6}	8.3×10^{-6}
Annual Population Dose Within 80 Kilometers[d]												
Atmospheric release pathway (person-rem)	20	20	0.022	0.026	6.9	9.3	7.4	7.4	2.8	32	24	64
Total liquid release pathway (person-rem)	2.6	3.7	0	0	0	0	0	0	0.50	5.2	0.39	4.0
Atmospheric and liquid release pathways combined (person-rem)	23	24	0.022	0.026	6.9	9.3	7.4	7.4	3.3	37	24	68
Percent of natural background[c]	0.012	0.013	2.4×10^{-4}	2.8×10^{-4}	7.6×10^{-3}	0.010	6.3×10^{-3}	6.3×10^{-3}	8.7×10^{-4}	9.8×10^{-3}	9.2×10^{-3}	0.026
17-year fatal cancers	0.19	0.20	1.9×10^{-4}	2.2×10^{-4}	0.059	0.079	0.063	0.063	0.028	0.32	0.21	0.58

Table 4.3.5.4.9–2. Potential Radiological Impacts to the Public During Normal Operation of the Small Evolutionary Light Water Reactor—Continued

Receptor	Hanford Reactor	Hanford Total Site[a]	NTS Reactor	NTS Total Site[a]	INEL Reactor	INEL Total Site[a]	Pantex Reactor	Pantex Total Site[a]	ORR Reactor	ORR Total Site[a]	SRS Reactor	SRS Total Site[a]
Annual Dose to the Average Individual Within 80 Kilometers[e]												
Atmospheric and liquid release pathways combined (mrem)	0.037	0.039	7.5×10^{-4}	8.8×10^{-4}	0.026	0.035	0.021	0.021	2.6×10^{-3}	0.029	0.027	0.076
17-year fatal risk	3.1×10^{-7}	3.3×10^{-7}	6.4×10^{-9}	7.5×10^{-9}	2.2×10^{-7}	2.9×10^{-7}	1.8×10^{-7}	1.8×10^{-7}	2.2×10^{-8}	2.4×10^{-7}	2.3×10^{-7}	6.5×10^{-7}

[a] Includes impacts from No Action facilities (refer to Sections 4.2.1.9 through 4.2.6.9).

[b] The applicable radiological limits for an individual member of the public from site operations are 10 mrem per year from the air pathways, as required by NESHAPS (40 CFR 61, Subpart H) under the CAA; 4 mrem per year from the drinking water pathway, as required by the SDWA; and 100 mrem per year from all pathways combined. Refer to DOE Order 5400.5.

[c] The annual natural background radiation level at Hanford is 300 mrem for the average individual; the population within 80 km receives 186,400 person-rem; at NTS is 313 mrem for the average individual; the population within 80 km receives 9,190 person-rem; at INEL is 338 mrem for the average individual; the population within 80 km receives 90,800 person-rem; at Pantex is 334 mrem for the average individual; the population within 80 km receives 116,900 person-rem; at ORR is 295 mrem for the average individual; the population within 80 km receives 379,000 person-rem; at SRS is 298 mrem for the average individual; the population within 80 km receives 266,000 person-rem.

[d] For DOE activities, proposed 10 CFR 834 (see 58 FR 16268) would generally limit the potential annual population dose to 100 person-rem from all pathways combined, and would require an ALARA program.

[Text deleted.]

[e] Obtained by dividing the population dose by the number of people projected to be living within 80 km of the site (621,000 at Hanford; 29,400 at NTS; 269,000 at INEL; 350,000 at Pantex; 1,285,000 at ORR; and 893,000 at SRS).

Source: Section M.2.

individual would be less. The population dose would range from 0.022 person-rem at NTS to 24 person-rem at SRS. The corresponding numbers of fatal cancers in these populations from 17 years of operation would range from 1.9×10^{-4} to 0.21.

The doses to the maximally exposed member of the public from annual total site operations, including the small evolutionary LWR, are also all within radiological limits and would range from 0.026 mrem at the NTS site to 4.7 mrem at the ORR site. From 17 years of operation, the corresponding risks of fatal cancers to this individual would range from 2.2×10^{-7} to 4.0×10^{-5}. The impacts to the average individual would be less. As a result of annual total site operations, the population doses are also within the proposed reporting limit, and would range from 0.026 person-rem at NTS to 68 person-rem at SRS. The corresponding numbers of fatal cancers in these populations from 17 years of operation would range from 2.2×10^{-4} to 0.58.

Doses to onsite workers from normal operations are given in Tables 4.3.5.4.9–3 and 4.3.5.4.9–4 for the large and small evolutionary LWRs, respectively. Included are involved workers directly associated with the evolutionary LWR, workers who are not involved with the reactor and the entire workforce at each site. All doses fall within regulatory limits.

For the large evolutionary LWR alternative, the annual dose to reactor workers is site-independent and would be 810 mrem to the average worker associated with the evolutionary LWR and 170 person-rem to entire evolutionary LWR workforce. The annual average dose to the noninvolved worker would range from 2.6 mrem at ORR to 32 mrem at SRS. The annual total dose to all noninvolved workers would range from 3.0 person-rem at the NTS site to 250 person-rem at the Hanford site. The annual dose to the total site workforces would range from 173 person-rem at the NTS site to 420 person-rem at the Hanford site.

For the small evolutionary LWR alternative, the annual incremental dose to reactor workers is site-independent and would be 800 mrem to the average worker associated with the evolutionary LWR and 100 person-rem to entire evolutionary LWR workforce. The annual average dose to the noninvolved worker would range from 2.6 mrem at ORR to 32 mrem at SRS. The annual total dose to all noninvolved workers would range from 3.0 person-rem at NTS to 250 person-rem at Hanford. The annual dose to the total site workforces would range from 103 person-rem at NTS to 350 person-rem at Hanford.

The risks and numbers of fatal cancers among the different workers from 17 years of operation are included in Tables 4.3.5.4.9–3 and 4.3.5.4.9–4 for the large and small evolutionary LWRs, respectively. Dose to individual workers would be kept low by instituting badged monitoring and ALARA programs and also worker rotations. As a result of the implementation of these mitigation measures, the actual number of fatal cancers calculated would be lower for the operation of this facility.

Hazardous Chemical Impacts. The hazardous chemical impacts to the public resulting from normal operation of the large and small evolutionary LWR facilities at each of several sites are presented in Table 4.3.5.4.9–5. Included is the impact due only to operation of the evolutionary LWR facilities and the site's total hazardous chemical impact. The total site impacts are provided to demonstrate the estimated level of health effects expected and the risk of cancer due to the total chemical exposures on each site. All supporting impact analyses are provided in Section M.3.

For the large or small evolutionary LWR facilities, exposure data are identical and the HIs to the MEIs range from 2.8×10^{-8} at NTS to 1.1×10^{-6} at ORR and Pantex. The incremental cancer risk from hazardous chemicals to the MEI is 0 at all sites. The HI to the onsite worker ranges from 7.8×10^{-6} at Pantex to 1.6×10^{-5} at the Hanford, INEL, and ORR sites and the cancer risk to the onsite worker is zero (because no carcinogens are released from hazardous chemicals) at all sites.

Table 4.3.5.4.9–3. Potential Radiological Impacts to Workers During Normal Operation of the Large Evolutionary Light Water Reactor

Receptor	Hanford	NTS	INEL	Pantex	ORR	SRS
Involved Workforce[a]						
Average worker dose (mrem/yr)[b]	810	810	810	810	810	810
17-year fatal cancer risk	5.5×10^{-3}	5.5×10^{-3}	5.5×10^{-3}	5.5×10^{-3}	5.5×10^{-3}	5.5×10^{-3}
Total dose (person-rem/yr)	170	170	170	170	170	170
17-year fatal cancers	1.2	1.2	1.2	1.2	1.2	1.2
Noninvolved Workforce[c]						
Average worker dose (mrem/yr)[b]	27	5.0	30	10	2.6	32
17-year fatal cancer risk	1.8×10^{-4}	3.4×10^{-5}	2.0×10^{-4}	6.8×10^{-5}	1.8×10^{-5}	2.2×10^{-4}
Total dose (person-rem/yr)	250	3.0	220	14	44	226
17-year fatal cancers	1.7	0.020	1.5	0.095	0.30	1.5
Total Site Workforce[d]						
Dose (person-rem/yr)	420	173	390	184	214	396
17-year fatal cancers	2.9	1.2	2.7	1.3	1.5	2.7

[a] The involved worker is a worker associated with operations of the proposed action.

[b] The radiological limit for an individual worker is 5,000 mrem/year (10 CFR 835). However, DOE has also established an administrative control level of 2,000 mrem per year (DOE 1992t); the sites must make reasonable attempts to maintain worker doses below this level.

[c] The noninvolved worker is a worker onsite but not associated with operations of the proposed action. The noninvolved workforce is equivalent to the No Action workforce.

[d] The impact to the total workforce is the summation of the involved worker impact and the noninvolved worker impact.

[Text deleted.]

Source: Section M.2.

Table 4.3.5.4.9–4. Potential Radiological Impacts to Workers During Normal Operation of the Small Evolutionary Light Water Reactor

Receptor	Hanford	NTS	INEL	Pantex	ORR	SRS
Involved Workforce[a]						
Average worker dose (mrem/yr)[b]	800	800	800	800	800	800
17-year fatal cancer risk	5.4×10^{-3}	5.4×10^{-3}	5.4×10^{-3}	5.4×10^{-3}	5.4×10^{-3}	5.4×10^{-3}
Total dose (person-rem/yr)	100	100	100	100	100	100
17-year fatal cancers	0.68	0.68	0.68	0.68	0.68	0.68
Noninvolved Workforce[c]						
Average worker dose (mrem/yr)[b]	27	5.0	30	10	2.6	32
17-year fatal cancer risk	1.8×10^{-4}	3.4×10^{-5}	2.0×10^{-4}	6.8×10^{-5}	1.8×10^{-5}	2.2×10^{-4}
Total dose (person-rem/yr)	250	3.0	220	14	44	226
17-year fatal cancers	1.7	0.020	1.5	0.095	0.30	1.5
Total Site Workforce[d]						
Dose (person-rem/yr)	350	103	320	114	144	326
17-year fatal cancers	2.4	0.70	2.2	0.78	0.98	2.2

[a] The involved worker is a worker associated with operations of the proposed action.

[b] The radiological limit for an individual worker is 5,000 mrem/year (10 CFR 835). However, DOE has also established an administrative control level of 2,000 mrem per year (DOE 1992t); the sites must make reasonable attempts to maintain worker doses below this level.

[c] The noninvolved worker is a worker onsite but not associated with operations of the proposed action. The noninvolved workforce is equivalent to the No Action workforce.

[d] The impact to the total workforce is the summation of the involved worker impact and the noninvolved worker impact.

[Text deleted.]

Source: Section M.2.

Table 4.3.5.4.9–5. Potential Hazardous Chemical Impacts to the Public and Workers During Normal Operation of the Large or Small Evolutionary Light Water Reactor

Receptor	Hanford		NTS		INEL		Pantex		ORR		SRS	
	Facility[a]	Total Site[b]	Facility[a]	Total Site[b]	Facility[a]	Total Site[b]	Facility[a]	Total Site[b]	Facility[a]	Total Site[b]	Facility[a]	Total Site[b]
Maximally Exposed Individual (Public)												
Hazard index[c]	1.9×10^{-7}	6.2×10^{-5}	2.8×10^{-8}	2.8×10^{-8}	4.1×10^{-7}	0.015	1.1×10^{-6}	5.7×10^{-3}	1.1×10^{-6}	0.040	5.2×10^{-8}	5.2×10^{-3}
Cancer risk[d]	0	0	0	0	0	0.036	0	1.1×10^{-8}	0	0	0	1.3×10^{-7}
Worker Onsite												
Hazard index[e]	1.6×10^{-5}	4.0×10^{-3}	8.0×10^{-6}	8.0×10^{-6}	1.6×10^{-5}	0.22	7.8×10^{-6}	6.1×10^{-3}	1.6×10^{-5}	0.15	1.4×10^{-5}	1.2
Cancer risk[f]	0	0	0	0	0	7.7×10^{-4}	0	4.5×10^{-7}	0	0	0	1.9×10^{-4}

[a] Facility=Contribution from the proposed new facility operation only.

[b] Total=Includes the contributions from the No Action and the proposed new facility operation.

[c] Hazard Index for MEI=sum of individual Hazard Quotients (noncancer health effects) for MEI.

[d] Cancer Risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (Slope Factor).

[e] Hazard Index for workers=sum of individual Hazard Quotients (noncancer health effects) for workers.

[f] Cancer Risk for workers=(emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (Slope Factor).

Note: Where there are no known carcinogens among the hazardous chemicals emitted, there are no slope factors; therefore, the calculated cancer risk value is 0.

Source: Section M.3, Large Evolutionary LWRs: Tables M.3.4–68 through M.3.4–73 and Small Evolutionary LWRs: Tables M.3.4–74 through M.3.4–79.

Facility Accidents. A set of potential accidents for evolutionary light water reactors for which there may be releases of radioactivity that may impact noninvolved onsite workers and the offsite population has been postulated. The accident consequences and risks to a worker located 1,000 m (3,280 ft) from the accident release point, the maximum offsite individual located at the site boundary, and the population located within 80 km of the accident release point are summarized in Tables 4.3.5.4.9–6 through 4.3.5.4.9–11 for the candidate sites (Hanford, NTS, INEL, Pantex, ORR, and SRS). In the event that the site boundary is less than 1,000 m (3,280 ft) from the accident release point, the worker is placed at the site boundary. For the set of accidents analyzed, the maximum number of cancer fatalities in the population within 80 km (50 mi) would be 22.0 at ORR for the large break loss of coolant and loss of core cooling accident scenario with a probability of $2.1x10^{-8}$ per year. The corresponding 17 year facility lifetime risk from the same accident scenario for the population, maximum offsite individual, and worker at 665 m (2,200 ft) would be $7.9x10^{-6}$, $2.6x10^{-8}$, and $2.1x10^{-8}$, respectively. Appendix M.5 presents summary descriptions of the accident scenarios identified in Tables 4.3.5.4.9–6 through 4.3.5.4.9–11.

[Text deleted.] The location of workstations, number of workers, personnel protective features, engineered safety features, and other design details affect the extent of worker exposures to accidents. Certain accidents such as fires and explosions could cause fatalities to workers close to the accident. Prior to construction and operation of a new facility, DOE Orders require detailed safety analyses to assure that facility designs and operating procedures limit the number of workers in hazardous areas and minimize risk of injury or fatality in the event of an accident.

Aircraft Crash. The probability of an aircraft crash into a new disposition facility at Pantex will depend upon its specific location relative to the airport and airplane traffic patterns. In the future, there is the possibility that air traffic patterns may change and cause a change in the probability of a crash into a specific facility. [Text deleted.] A discussion of aircraft crash accidents for this PEIS is contained in Appendix R.

Table 4.3.5.4.9–6. Evolutionary Light Water Reactor Accident Impacts at Hanford Site

	Worker at 1,000 m		Maximum Offsite Individual		Population to 80 km		
Accident Description	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/ Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatalities (per 17 yr)[a]**	**Number of Latent Cancer/ Prompt Fatalities[c]**	**Accident Frequency (per yr)**
Failure of small primary coolant line outside containment	3.8×10^{-8}/ 0	2.2×10^{-6}/ 0	4.8×10^{-9}/ 0	2.8×10^{-7}/ 0	8.9×10^{-7}/ 0	5.2×10^{-5}/ 0	1.0×10^{-3}
Scram system piping break outside containment	4.2×10^{-9}/ 0	2.5×10^{-5}/ 0	5.3×10^{-10}/ 0	3.1×10^{-6}/ 0	9.4×10^{-8}/ 0	5.5×10^{-4}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	1.1×10^{-10}/ 0	6.7×10^{-7}/ 0	1.4×10^{-11}/ 0	8.4×10^{-8}/ 0	3.1×10^{-9}/ 0	1.8×10^{-5}/ 0	1.0×10^{-5}
Fuel handling	4.8×10^{-9}/ 0	2.8×10^{-5}/ 0	7.3×10^{-10}/ 0	4.3×10^{-6}/ 0	1.7×10^{-7}/ 0	1.0×10^{-3}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	4.7×10^{-8}/ 0	0.021/ 0	5.9×10^{-9}/ 0	2.7×10^{-3}/ 0	1.8×10^{-6}/ 0	0.82/ 0	1.7×10^{-7}
Large break loss of coolant accident and loss of core cooling	3.2×10^{-8}/ 1.4×10^{-7}	0.089/ 0.040	2.9×10^{-8}/ 3.5×10^{-9}	0.082/ 9.7×10^{-3}	2.1×10^{-6}/ 0	5.9/ 0	2.1×10^{-8}
Expected risk[d]	1.3×10^{-7}/ 1.4×10^{-7}	–	4.1×10^{-8}/ 3.5×10^{-9}	–	5.1×10^{-6}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 1,000 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary, whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

Table 4.3.5.4.9–7. Evolutionary Light Water Reactor Accident Impacts at Nevada Test Site

	Worker at 1,000 m		Maximum Offsite Individual		Population to 80 km		
Accident Description	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatalities (per 17 yr)[a]**	**Number of Latent Cancer/ Prompt Fatalities[c]**	**Accident Frequency (per yr)**
Failure of small primary coolant line outside containment	2.7×10^{-8}/ 0	1.6×10^{-6}/ 0	7.0×10^{-10}/ 0	4.1×10^{-8} 0	2.7×10^{-8}/ 0	1.6×10^{-6}/ 0	1.0×10^{-3}
Scram system piping break outside containment	2.9×10^{-9}/ 0	1.7×10^{-5}/ 0	7.7×10^{-11}/ 0	4.5×10^{-7}/ 0	2.8×10^{-9}/ 0	1.7×10^{-5}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	7.9×10^{-11}/ 0	4.6×10^{-7}/ 0	2.1×10^{-12}/ 0	1.2×10^{-8}/ 0	9.6×10^{-11}/ 0	5.6×10^{-7}/ 0	1.0×10^{-5}
Fuel handling	3.3×10^{-9}/ 0	1.9×10^{-5}/ 0	1.3×10^{-10}/ 0	7.6×10^{-7}/ 0	4.3×10^{-9}/ 0	2.6×10^{-5}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	3.0×10^{-8}/ 0	0.014/ 0	1.1×10^{-9}/ 0	5.0×10^{-4}/ 0	5.6×10^{-8}/ 0	0.026/ 0	1.3×10^{-7}
Large break loss of coolant accident and loss of core cooling	3.1×10^{-8}/ 8.9×10^{-8}	0.087/ 0.25	5.4×10^{-9}/ 8.4×10^{-11}	0.015/ 2.4×10^{-4}	2.1×10^{-8}/ 0	0.059/ 0	2.1×10^{-8}
Expected risk[d]	9.4×10^{-8}/ 8.9×10^{-8}	– –	7.4×10^{-9}/ 8.4×10^{-11}	– –	1.1×10^{-7}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 1,000 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary, whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

Table 4.3.5.4.9–8. Evolutionary Light Water Reactor Accident Impacts at Idaho National Engineering Laboratory

	Worker at 1,000 m		Maximum Offsite Individual		Population to 80 km		
Accident Description	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatalities (per 17 yr)[a]**	**Number of Latent Cancer/ Prompt Fatalities[c]**	**Accident Frequency (per yr)**
Failure of small primary coolant line outside containment	3.8×10^{-8}/ 0	2.2×10^{-6}/ 0	4.3×10^{-10}/ 0	2.5×10^{-8}/ 0	3.7×10^{-7}/ 0	2.2×10^{-5}/ 0	1.0×10^{-3}
Scram system piping break outside containment	4.1×10^{-9}/ 0	2.4×10^{-5}/ 0	4.6×10^{-11}/ 0	2.7×10^{-7}/ 0	3.8×10^{-8}/ 0	2.3×10^{-4}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	1.1×10^{-10}/ 0	6.6×10^{-7}/ 0	1.3×10^{-12}/ 0	7.6×10^{-9}/ 0	1.3×10^{-9}/ 0	7.6×10^{-6}/ 0	1.0×10^{-5}
Fuel handling	4.7×10^{-9}/ 0	2.7×10^{-5}/ 0	8.7×10^{-11}/ 0	5.1×10^{-7}/ 0	5.5×10^{-8}/ 0	3.3×10^{-4}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	4.4×10^{-8}/ 0	0.020/ 0	7.3×10^{-10}/ 0	3.3×10^{-4}/ 0	7.6×10^{-7}/ 0	0.34/ 0	1.3×10^{-7}
Large break loss of coolant accident and loss of core cooling	2.5×10^{-8}/ 1.3×10^{-7}	0.071/ 0.36	3.7×10^{-9}/ 0	0.010/ 0	2.0×10^{-7}/ 0	0.57/ 0	2.1×10^{-8}
Expected risk[d]	1.2×10^{-7}/ 1.3×10^{-7}	–	5.0×10^{-9}/ 0	–	1.4×10^{-6}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 1,000 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary, whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

Table 4.3.5.4.9–9. Evolutionary Light Water Reactor Accident Impacts at Pantex Plant

	Worker at 1,000 m		Maximum Offsite Individual		Population to 80 km		
Accident Description	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]**	**Probability of Latent Cancer/ Prompt Fatality[b]**	**Risk of Latent Cancer/Prompt Fatalities (per 17 yr)[a]**	**Number of Latent Cancer/ Prompt Fatalities[c]**	**Accident Frequency (per yr)**
Failure of small primary coolant line outside containment	1.5×10^{-8}/ 0	8.8×10^{-7}/ 0	1.3×10^{-8}/ 0	7.9×10^{-7}/ 0	5.4×10^{-7}/ 0	3.2×10^{-5}/ 0	1.0×10^{-3}
Scram system piping break outside containment	1.6×10^{-9}/ 0	9.7×10^{-6}/ 0	1.5×10^{-9}/ 0	8.7×10^{-6}/ 0	5.7×10^{-8}/ 0	3.4×10^{-4}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	4.5×10^{-11}/ 0	2.6×10^{-7}/ 0	4.0×10^{-11}/ 0	2.3×10^{-7}/ 0	1.8×10^{-9}/ 0	1.1×10^{-5}/ 0	1.0×10^{-5}
Fuel handling	1.9×10^{-9}/ 0	1.1×10^{-5}/ 0	1.7×10^{-9}/ 0	9.9×10^{-6}/ 0	8.3×10^{-8}/ 0	4.9×10^{-4}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	1.6×10^{-8}/ 0	7.2×10^{-3}/ 0	1.4×10^{-8}/ 0	6.5×10^{-3}/ 0	9.0×10^{-7}/ 0	0.41/ 0	1.3×10^{-7}
Large break loss of coolant accident and loss of core cooling	3.4×10^{-8}/ 2.9×10^{-8}	0.095/ 0.080	3.6×10^{-8}/ 1.7×10^{-8}	0.10/ 0.047	8.4×10^{-7}/ 0	2.3/ 0	2.1×10^{-8}
Expected risk[d]	6.8×10^{-8}/ 2.9×10^{-8}	–	6.7×10^{-8}/ 1.7×10^{-8}	–	2.4×10^{-6}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 1,000 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary, whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

Table 4.3.5.4.9–10. Evolutionary Light Water Reactor Accident Impacts at Oak Ridge Reservation

Accident Description	Worker at 665 m: Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]	Worker at 665 m: Probability of Latent Cancer/Prompt Fatality[b]	Maximum Offsite Individual: Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]	Maximum Offsite Individual: Probability of Latent Cancer/Prompt Fatality[b]	Population to 80 km: Risk of Latent Cancer/Prompt Fatalities (per 17 yr)[a]	Population to 80 km: Number of Latent Cancer/Prompt Fatalities[c]	Accident Frequency (per yr)
Failure of small primary coolant line outside containment	4.7×10^{-8}/ 0	2.8×10^{-6}/ 0	5.9×10^{-8}/ 0	3.5×10^{-6}/ 0	3.7×10^{-6}/ 0	2.2×10^{-4}/ 0	1.0×10^{-3}
Scram system piping break outside containment	5.2×10^{-9}/ 0	3.0×10^{-5}/ 0	6.4×10^{-9}/ 0	3.8×10^{-5}/ 0	3.9×10^{-7}/ 0	2.3×10^{-3}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	1.4×10^{-10}/ 0	8.3×10^{-7}/ 0	1.8×10^{-10}/ 0	1.0×10^{-6}/ 0	1.3×10^{-8}/ 0	7.4×10^{-5}/ 0	1.0×10^{-5}
Fuel handling	5.8×10^{-9}/ 0	3.4×10^{-5}/ 0	7.3×10^{-9}/ 0	4.3×10^{-5}/ 0	6.6×10^{-7}/ 0	3.9×10^{-3}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	6.1×10^{-8}/ 0	0.028/ 0	7.7×10^{-8}/ 0	0.035 0	6.9×10^{-6}/ 0	3.1/ 0	1.3×10^{-7}
Large break loss of coolant accident and loss of core cooling	2.1×10^{-8}/ 2.0×10^{-7}	0.058/ 0.56	2.6×10^{-8}/ 2.0×10^{-7}	0.073/ 0.56	7.9×10^{-6}/ 0	22/ 0	2.1×10^{-8}
Expected risk[d]	1.4×10^{-7}/ 2.0×10^{-7}	–	1.8×10^{-7}/ 2.0×10^{-7}	–	2.0×10^{-5}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 665 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary [665 m for the facility at ORR], whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

Table 4.3.5.4.9–11. Evolutionary Light Water Reactor Accident Impacts at Savannah River Site

	Worker at 1,000 m		Maximum Offsite Individual		Population to 80 km		
Accident Description	Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]	Probability of Latent Cancer/ Prompt Fatality[b]	Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]	Probability of Latent Cancer/ Prompt Fatality[b]	Risk of Latent Cancer/Prompt Fatality (per 17 yr)[a]	Number of Latent Cancer/ Prompt Fatalities[c]	Accident Frequency (per yr)
Failure of small primary coolant line outside containment	2.4×10^{-8}/ 0	1.4×10^{-6}/ 0	3.5×10^{-10}/ 0	2.1×10^{-8}/ 0	1.3×10^{-6}/ 0	7.5×10^{-5}/ 0	1.0×10^{-3}
Scram system piping break outside containment	2.6×10^{-9}/ 0	1.6×10^{-5}/ 0	3.8×10^{-11}/ 0	2.3×10^{-7}/ 0	1.3×10^{-7}/ 0	7.9×10^{-4}/ 0	1.0×10^{-5}
Cleanup water line break outside containment	7.2×10^{-11}/ 0	4.2×10^{-7}/ 0	1.1×10^{-12}/ 0	6.3×10^{-9}/ 0	4.5×10^{-9}/ 0	2.6×10^{-5}/ 0	1.0×10^{-5}
Fuel handling	3.0×10^{-9}/ 0	1.8×10^{-5}/ 0	6.6×10^{-11}/ 0	3.9×10^{-7}/ 0	2.1×10^{-7}/ 0	1.3×10^{-3}/ 0	1.0×10^{-5}
Anticipated transient with scram and loss of core cooling	3.0×10^{-8}/ 0	0.013/ 0	5.8×10^{-10}/ 0	2.6×10^{-4}/ 0	2.5×10^{-6}/ 0	1.1/ 0	1.3×10^{-7}
Large break loss of coolant accident and loss of core cooling	3.4×10^{-8}/ 7.4×10^{-8}	0.096/ 0.21	1.7×10^{-9}/ 0	4.9×10^{-3}/ 0	1.5×10^{-6}/ 0	4.3/ 0	2.1×10^{-8}
Expected risk[d]	9.3×10^{-8}/ 7.4×10^{-8}	–	2.8×10^{-9}/ 0	–	5.7×10^{-6}/ 0	–	–

[a] The risk values are calculated by multiplying the probability of cancer fatality (for the worker at 1,000 m or the maximum offsite individual) or the number of cancer fatalities (for the population to 80 km) by the accident frequency and the number of year of operation.

[b] Increase likelihood (or probability) of cancer or prompt fatality to a hypothetical individual (a single onsite worker at a distance of 1,000 m or the site boundary, whichever is smaller, or to a hypothetical individual in the offsite population located at the site boundary) if exposed to the indicated dose. The value assumes the accident has occurred.

[c] Estimated number of cancer fatalities in the entire offsite population out to a distance of 80 km if exposed to the indicated dose. The value assumes the accident has occurred.

[d] Expected risk is the sum of the risks over the lifetime of the facility.

Note: All values are mean values. Advanced BWR data was used as surrogate data for the evolutionary LWR.

Source: Calculated using the source terms in Tables M.5.3.8.1–1 and M.5.3.8.1–2 and the MACCS computer code.

4.3.5.4.10 *Waste Management*

This section summarizes the waste management impacts for the construction and operation of a new single unit large or small evolutionary LWR. There are no high-level or TRU wastes associated with the operation of a large or small evolutionary LWR. Tables 4.3.5.4.10–1 and 4.3.5.4.10–2 provide the estimated operational waste volumes projected to be generated at the sites analyzed as a result of a large or small evolutionary LWR. Facilities that would support the evolutionary LWR would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with the regulatory requirements of RCRA and other applicable statutes. Depending in part on decisions in waste-type-specific RODs for the Waste Management PEIS, wastes could be treated, and depending on the type of waste, disposed of onsite or at regionalized or centralized DOE sites. For the purposes of analyses only, this PEIS assumes that TRU and mixed TRU waste would be treated on-site to the current planning-basis WIPP WAC, and shipped to WIPP for disposal. This PEIS also assumes that LLW, mixed LLW, hazardous, and nonhazardous waste would be treated and disposed on in accordance with current site practice. The incremental waste volumes generated from the evolutionary LWR and the resultant waste effluent used for the waste impacts can be found in Section E.3.3.7. A detailed description of the waste management activities that would be required to support the evolutionary LWR can also be found in Section E.3.3.7.

Construction and operation of a large or small evolutionary LWR would impact existing waste management activities at each of the sites analyzed, increasing the generation of spent nuclear fuel, low-level, mixed, hazardous, and nonhazardous wastes. Wastes generated during construction would consist of wastewater, and solid nonhazardous and hazardous wastes. The nonhazardous waste would be disposed of as part of the construction project by the contractor and the hazardous waste would be shipped to commercial RCRA-permitted treatment and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any contaminated soil is generated it would be managed in accordance with site practice and all applicable Federal and State regulations.

A new large or small evolutionary LWR would generate 10 m^3 (13 yd^3) or 5 m^3 (6.5 yd^3) of spent nuclear fuel annually per unit, resulting in impacts associated with spent nuclear fuel management and storage. The total residual heavy metal content for the entire disposition mission is estimated to be 1,300 t (1,430 tons) for the large reactor and 1,200 t (1,320 tons) for the small reactor. NTS and Pantex do not possess existing inventories of spent nuclear fuel. These sites would need to develop the necessary storage infrastructure for safe and efficient management of spent nuclear fuel. Hanford, INEL, ORR, and SRS each possess existing inventories of spent nuclear fuel, and both INEL and SRS will receive additional spent nuclear fuel from other offsite locations. The sites with existing inventories of spent nuclear fuel may or may not have adequate existing or planned facilities that could manage the additional spent nuclear fuel until a decision regarding its ultimate disposition is made and implemented.

For the large evolutionary LWR at wet or dry sites, following treatment and volume reduction, approximately 70 m^3 (92 yd^3) per reactor of LLW from solidified liquid LLW (from primary and secondary coolant systems, spent fuel pools, and laboratory operations), protective clothing, soil, and small equipment would require disposal annually. All of the sites analyzed except Pantex have existing or planned facilities that could manage the quantities of LLW. Using the land usage factors from Section E.1.4, the area required for LLW disposal would be 0.008 ha/yr (0.02 acre/yr) for SRS, 0.01 ha/yr (0.03 acre/yr) for INEL and NTS, and 0.02 ha/yr (0.05 acre/yr) for Hanford and ORR. With no onsite LLW disposal capability, Pantex would require 5 additional LLW shipments per year to NTS. The ultimate disposal of LLW will be in accordance with the ROD(s) from the Waste Management PEIS.

For the small evolutionary LWR at wet or dry sites, following treatment and volume reduction, approximately 40 m^3 (52 yd^3) per reactor of LLW from solidified liquid LLW, protective clothing, soil, and small equipment would require disposal annually. Using the land usage factors from Section E.1.4, the area required for LLW disposal would be 0.005 ha/yr (0.01 acre/yr) for SRS, 0.006 ha/yr (0.02 acre/yr) for INEL and NTS, and

Table 4.3.5.4.10–1. Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for the Large Evolutionary Light Water Reactor[a]

	Hanford		NTS	INEL	Pantex	ORR	SRS
Category	**New Facility (m^3)**	**No Action (m^3)**	**No Action (m^3)**	**No Action (m^3)**	**No Action (m^3)**	**No Action (m^3)**	**No Action (m^3)**
Spent Nuclear Fuel	10[b]	None	None	None (offsite receipts expected)	None	None	None (offsite receipts expected)
Low-Level							
Liquid	18,900[c]	None	Dependent on restoration activities	None	1	2,970	74,000
Solid	500	3,390	15,000	7,200	19	7,320	16,400
Mixed Low-Level							
Liquid	0	3,760	None	4	<1	87,600	1,330
Solid	5	1,510	50	170	4	432	7,700
Hazardous							
Liquid	Included in solid	Included in solid	Included in solid	Included in solid	2	6,460	1,260
Solid	27	560	212	1,200	31	26	15,100
Non-hazardous (Sanitary)							
Liquid	d	414,000	Not reported separately, included in solid	Not reported separately, included in solid	141,000	550,000	703,000
Solid	5,280	5,107	2,120	52,000	339	53,100	61,200
Non-hazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	None	None	Included in sanitary	650,000	Included in sanitary
Solid	4,430[e]	Included in sanitary	76,500	Included in sanitary	Included in sanitary	321	Included in sanitary

[a] The No Action volumes are from Tables 4.2.1.10–1,4.2.2.10–1, 4.2.3.10–1, 4.2.4.10–1, 4.2.5.10–1, and 4.2.6.10–1. Incremental waste generation volumes for evolutionary LWR (large) are derived from Table E.3.3.7–1 and are for one reactor. Waste effluent volumes (that is, after treatment and volume reduction) that are used in the narrative description of the impacts are also provided in Table E.3.3.7–1.

[b] Spent nuclear fuel per unit. Total spent fuel for disposition mission (2 units) is 337 m^3. Residual heavy metal content in spent nuclear fuel is 38.2 t per reactor per year.

[c] Liquid LLW would be treated and solidified prior to disposal.

[d] For wet sites (Hanford, ORR, and SRS) the liquid nonhazardous waste generation is 23,900,000 m^3 and for dry sites (NTS, INEL, and Pantex) it is 342,000 m^3.

[e] Recyclable wastes.

Table 4.3.5.4.10–2. Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for the Small Evolutionary Light Water Reactor[a]

Category	New Facility (m³)	Hanford No Action (m³)	NTS No Action (m³)	INEL No Action (m³)	Pantex No Action (m³)	ORR No Action (m³)	SRS No Action (m³)
Spent Nuclear Fuel	5[b]	None	None	None (offsite receipts expected)	None	None	None (offsite receipts expected)
Low-Level							
Liquid	2,990[c]	None	Dependent on restoration activities	None	8	2,970	74,000
Solid	270	3,390	15,000	7,200	32	7,320	16,400
Mixed Low-Level							
Liquid	0	3,760	None	4	4	87,600	1,330
Solid	5	1,510	50	170	46	432	7,700
Hazardous							
Liquid	Included in solid	Included in solid	Included in solid	Included in solid	2	6,460	1,260
Solid	27	560	212	1,200	31	26	15,100
Nonhazardous (sanitary)							
Liquid	d	414,000	Not reported separately, included in solid	Not reported separately, included in solid	141,000	550,000	703,000
Solid	3,210	5,107	2,120	52,000	339	53,100	61,200
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	None	None	Included in sanitary	650,000	Included in sanitary
Solid	2,680[e]	Included in sanitary	76,500	Included in sanitary	Included in sanitary	321	Included in sanitary

[a] The No Action volumes are from Tables 4.2.1.10–1, 4.2.2.10–1, 4.2.3.10–1, 4.2.4.10–1, 4.2.5.10–1, and 4.2.6.10–1. Incremental waste generation volumes for evolutionary LWR (small) are from Table E.3.3.7–2 and are for one reactor. Waste effluent volumes (that is, after treatment and volume reduction) that are used in the narrative description of the impacts are also provided in Table E.3.3.7–2.

[b] Spent nuclear fuel per unit. Total spent fuel for disposition mission (4 units) is 338 m^3. Residual heavy metal content in spent nuclear fuel is 17.7 t per reactor per year.

[c] Liquid LLW would be treated and solidified prior to disposal.

[d] For wet sites (Hanford, ORR, and SRS) the liquid nonhazardous waste generation is 11,000,000 m^3 and for dry sites (NTS, INEL, and Pantex) it is 190,000 m^3.

[e] Recyclable wastes.

0.01 ha/yr (0.03 acre/yr) for Hanford and ORR. With no onsite LLW disposal capability, Pantex would require three additional LLW shipments per year to NTS. The ultimate disposal of LLW will be in accordance with the ROD from the Waste Management PEIS.

An estimated 5 m^3 (7 yd^3) of solid mixed LLW per reactor consisting of solvent rags and equipment that has been contaminated with both radioactive and hazardous constituents would require treatment to meet the land disposal restrictions of RCRA. Mixed LLW would be managed in accordance with the Tri-Party Agreement for Hanford and the respective site treatment plan that was developed to comply with the *Federal Facility Compliance Act* for the remainder of the sites analyzed.

Approximately 27 m^3 (35 yd^3) of hazardous waste would consist primarily of analytical solutions and solvent rags contaminated with methylene chloride, acetonitrile, and acetone. Other hazardous waste would include paint solvents, various laboratory chemicals, and organic waste from nonradioactive testing. Hazardous waste would be stored in RCRA-permitted facilities until sufficient quantity accumulated to warrant shipment to a RCRA-permitted treatment and disposal facility.

For the large evolutionary LWR (wet site), approximately 23.9 million m^3 (6.32 billion gal) of liquid nonhazardous sanitary and industrial wastewater, cooling tower blowdown, and estimated stormwater runoff per reactor would require treatment in accordance with site practice and discharge permits. Construction of sanitary, utility, and process wastewater treatment systems would be required at Hanford, ORR, or SRS. At Hanford, only cooling tower blowdown would be discharged. All other wastewater would be recycled. For the large evolutionary LWR (dry site), approximately 342,000 m^3 (90.3 million gal) of liquid nonhazardous sanitary and industrial wastewater, and estimated stormwater runoff per reactor would require treatment in accordance with site practice and discharge permits. Construction of, or major upgrades to, sanitary, utility, and process wastewater treatment systems would be required at NTS, INEL, and Pantex. After volume reduction, 1,760 m^3 (2,300 yd^3) of solid nonhazardous wastes per reactor such as paper, glass, discarded office material, and cafeteria waste that is not recycled or salvageable would be shipped to an onsite or offsite landfill in accordance with site-specific practice.

For the small evolutionary LWR (wet site), approximately 11 million m^3 (2.91 billion gal) of liquid nonhazardous sanitary and industrial wastewater, cooling tower blowdown, and estimated stormwater runoff per reactor would require treatment in accordance with site practice and discharge permits. Construction of sanitary, utility, and process wastewater treatment systems would be required at Hanford, ORR, or SRS. At Hanford, only cooling tower blowdown would be discharged. All other wastewater would be recycled. For the small evolutionary LWR (dry site), approximately 190,000 m^3 (50.2 million gal) of liquid nonhazardous sanitary and industrial wastewater, and estimated stormwater runoff per reactor would require treatment in accordance with site practice and discharge permits. Construction of, or major upgrades to, sanitary, utility, and process wastewater treatment systems would be required at NTS, INEL, and Pantex. After volume reduction, 1,070 m^3 (1,400 yd^3) of solid nonhazardous wastes per reactor such as paper, glass, discarded office material, and cafeteria waste that is not recycled or salvageable would be shipped to an onsite or offsite landfill in accordance with site-specific practice.

4.3.5.5 Canadian Deuterium Uranium Reactor Alternative (Retained Under the Preferred Alternative)

Ontario Hydro operates 20 CANDU reactors capable of using MOX fuel at five nuclear generating stations in the Province of Ontario. The use of the CANDU reactors would be subject to the approval, policies, and regulations of the Canadian Federal and Provincial Governments. Eight of these units are located at the Bruce-A and Bruce-B Nuclear Generating Stations, a 930-ha (2,300-acre) site on Lake Huron about 300 km (186 mi) northeast of Detroit, Michigan. In addition, there is one CANDU reactor in the Province of Quebec and another CANDU reactor in New Brunswick. Ontario Hydro Bruce-A Nuclear Generating Station has been identified as a reference facility by the Government of Canada and is used as a representative site for evaluation of the CANDU Reactor Alternative and the CANFLEX fuel bundle. Other CANDU reactors could be used if the Canadian authorities choose to use a different site. Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/conversion or Pu conversion facility, packaged, transported to the MOX fuel fabrication facility, and converted into MOX fuel.

The Bruce-A Nuclear Generating Station, which contains four 769 MWe electric reactors, a common powerhouse with four turbine generators, a heavy water plant, a process steam transformer plant, a central services area, pumphouses, standby generators, and other support facilities, is used as the reference site for the disposition alternative evaluation. One or up to four of these units could be used for Pu disposition for this alternative. The reference reactor MOX fuel cycle, adapting the standard CANDU fuel bundle in the four reactors, would dispose of approximately 2 t/yr (2.2 tons/yr) of Pu and eliminate the mining and refining of approximately 6,000 t/yr (6,600 tons/yr) of uranium ore.

An alternate fuel bundle design using uranium fuel (the CANFLEX fuel bundle), which is currently undergoing reactor qualification, might be used. This fuel bundle has smaller diameter elements in the outer rings that would operate at a lower linear power rating, permitting higher Pu concentrations. Both designs have essentially the same Pu disposition capacity. The design is expected to reduce the number of fuel bundles and waste volumes by half.

As in the U.S. LWR alternatives, no CANDU reactors are currently licensed to use MOX fuel, and favorable regulatory review of the safety of their operation in this mode would be required. While the CANDU reactor design is in principle even more easily adaptable to full-core MOX operation than most LWRs, at the same time the technical uncertainties concerning MOX use in CANDUs is considered somewhat larger than in the LWR case, given the lack of MOX operating experience in CANDU reactors. There are also considerable uncertainties concerning the economics, as no one has ever produced CANDU MOX fuel before. Gaining approval of the various Canadian institutions and the Canadian public would be a major hurdle for the CANDU option. Licensing reactor operations with Pu would probably be a less difficult issue than securing agreement on the basic approach. Licensing procedures and standards for Pu use in Canada, set by the Atomic Energy Control Board, are different from those used by the NRC. In general, the process in Canada relies more on cooperation between licensees and the board, and less on an adversarial process.

The distance over which Pu would have to be transported to be burned in CANDU reactors would be greater than that in using U.S. LWRs, even if all the CANDU reactors involved were at a single site. The attendant controversies and risks of theft would be correspondingly larger. Possibly more important in political terms than the sheer distances is the need for the material to be shipped across international borders, to a nonnuclear-weapon state.

The safeguards concerns regarding fuel fabrication are similar for LWRs and CANDU reactors. Because of the need to transport Pu over longer distances, transport risks would be somewhat greater for CANDU reactors, and because of the reactor's online refueling capability and the portability of the fuel elements, the risks of theft or diversion of fabricated fuel from the reactor could be somewhat greater as well. Both of these risks could be reduced to very low levels with the application of sufficient resources. This alternative would make the Pu roughly as difficult to recover as the Pu in commercial spent fuel.

Because of the relatively low burnup (even when enriched with Pu) and small size of the CANDU MOX bundles, the gamma-radiation dose rates from them would be somewhat lower than those from LWR spent fuel of equal age. The surface dose rate 10 years after discharge from a single bundle irradiated to 9,700 MW-days/t is about 5,500 rem/hr, compared to a surface dose rate of 18,000 rem/hr at the same time for a pressurized-water reactor fuel bundle irradiated to 40,000 MW-days/t. The dose rate also falls off more rapidly with distance for the CANDU fuel bundle, because of its more compact size. The spent CANDU MOX, however, would have substantially higher dose rates for several decades than the large quantities of much older LWR spent fuel that will exist at the time the CANDU MOX spent fuel would be discharged.

Fuel can be removed from CANDU reactors at any time without shutdown of the reactor, and the fuel elements are substantially smaller and more portable than is the case for LWRs. Therefore, CANDUs require more intensive safeguarding than do LWRs. For fuel containing more Pu, still more intensive safeguarding would be needed. Both CANDU reactors and the fresh MOX fuel stored at either an LWR or a CANDU, however, require continuous safeguarding. In addition, the task of accounting for and securing complete fuel assemblies for either a CANDU reactor or an LWR is substantially easier than that of accounting for bulk Pu at a MOX fabrication plant. Therefore, the net additional security risks of using CANDU reactors for this mission compared to using LWRs would be relatively small (NAS 1995a:146,150–152).

4.3.5.5.1 *Effects Within the United States and Canada*

This section describes the environmental impacts of converting weapons-grade Pu to MOX fuel bundles for use in CANDU reactors. The impacts associated with transporting of the fuel bundles to the Canadian border are described in Section 4.4. The changes in CANDU reactor operations due to the use of MOX fuel are described in Appendix I.

MOX fuel rods would be manufactured in the United States for the four CANDU reactors located at the Bruce-A generating station in Ontario. Conversion of weapons-grade Pu to MOX fuel would require the availability of a pit disassembly/conversion facility, a Pu conversion facility, and a MOX fuel fabrication facility. Facilities with these capabilities are not currently available in the United States. The MOX fuel fabrication facility could be constructed at a DOE site (Hanford, NTS, INEL, Pantex, ORR, or SRS), or at a non-DOE site within the United States. [Text deleted.] Impacts associated with construction and operation of the pit disassembly/conversion facility, the Pu conversion facility, and a MOX fuel fabrication facility located within the United States are presented in Sections 4.3.1, 4.3.2, and 4.3.5.1, respectively. [Text deleted.]

Health and Safety. The intent of protecting the health and safety of workers and the public is the same in the United States and Canada. The Canadian Atomic Energy Control Board would ensure adequate protection is provided for the public and workers during the conversion and operation of MOX fueled CANDU reactors. Specific health and safety concerns regarding the use of MOX fuel in CANDU reactors is addressed in the following:

Worker Exposure. The radiological doses to workers at the reactor site would be the same, if not smaller, for a MOX-fueled CANDU reactor than for the natural uranium CANDU reactor. This is the result of the smaller annual gaseous and liquid releases to the environment predicted for a MOX core. The MOX core has a relatively smaller isotopic inventory and also a higher retardation for fission product migration that reduces the fraction of fission products that would reach the primary coolant (ORNL 1995a:14).

Public Exposure. As it is for workers, the radiological doses to the public during normal operations, for both the MEI and the population within 80 km (50 mi), are also expected to be somewhat smaller with a MOX core than with a natural uranium core.

Facility Accidents. The accident risks and consequences of operating the CANDU reactor are documented in safety reports prepared by the operating organization. Additional studies have been performed to assess any changes in risks and consequences that would be attributed to the use of MOX fuel in the event of both design basis and severe (beyond design basis) accidents (NAS 1995a:350-356; ORNL 1995a:17-21). These studies indicate that the dose consequence to members of the public and environmental impacts of accident releases from MOX-fueled reactors at Bruce-A will not differ significantly from the consequences of the same accident occurring in a natural uranium-fueled reactor.

Waste Management. Externally, MOX fuel and natural uranium fuel bundles are identical. The only difference, besides their fuel content, is the higher external radiation level of the MOX fuel bundle. The difference will not result in any increase in the quantity of waste produced, processes employed, or facilities required for interim storage or disposal.

The Bruce Nuclear Generating Station has facilities for the storage of low-, medium-, and high-level radioactive MOX wastes. Spent MOX bundles would be stored in CANDU wet storage spent fuel modules, equivalent to LWR spent fuel storage racks. Spent MOX fuel decay heat generation and fission product concentration would be similar to current CANDU fuel. The disposition of spent MOX fuel will be left to the discretion of the Canadian Government.

Transportation. Transport of fresh MOX fuel to Canada would be the responsibility of DOE Transportation Safeguards Division (TSD) and would be coordinated with the Canadian Federal and Provincial Governments. Transport would utilize a DOE SST to the United States border. Material transport within Canada would be done in a TSD SST or equivalent. Fresh MOX fuel bundles would be packaged in a standard stainless steel 208-l (55-gal) drum. The container would be capable of holding seven CANDU MOX fuel bundles. The container would have to be certified as a Type B package and approved for use within both Canada and the United States. The package would have to undergo certification by DOE, the NRC, and the DOT, as well as the Canadian Atomic Energy Control Board and the Canadian Ministry of Transport. While the above package has been approved for bulk shipment of Category 1 materials, it has not yet been approved for the transport of CANDU MOX fuel bundles. Based on the annual fuel requirement of 9,052 bundles, approximately 54 SST shipments per year would be required (slightly more than one per week) (ORNL 1995a:26). Under the Preferred Alternative, which would preserve the CANDU Alternative, the amount of surplus Pu dispositioned and the number of shipments of MOX fuel to Canadian reactors would likely be less.

In terms of transportation risks, the greater the distance travelled the higher the risk. The health impacts from the transport of MOX fuel from a fabrication site in the United States to a CANDU reactor site in Canada would be similar to the risk encountered from routine CANDU fuel transport operations covering the same distance. The estimated risk to transport MOX fuel hypothetical distances of 1,000, 2,000, and 4,000 km (621, 1,243, and 2,486 mi, respectively) is included in Section 4.4 of this PEIS. Potential intersite transportation impacts related to the transportation of MOX fuel could occur because of the increased risk of traffic accident fatalities. The highest number of potential fatalities, which includes both radioactive and nonradioactive impacts for normal operations and accident conditions, is 5.00. This represents the total fatalities for transportation with MOX fuel fabrication in the United States and shipped to the Canadian border based on a hypothetical distance of 4,000 km (2,486 mi). This does not include transportation impacts in Canada.

4.4 INTERSITE TRANSPORTATION OF FISSILE MATERIALS

For the storage and disposition alternatives, intersite transportation is the transport between sites with fissile and other radioactive materials (including waste) in truckload shipments by DOE SST or commercial conveyance. For overseas shipments of Pu to European fuel fabricators, port handling and ocean transport is included. [Text deleted.] Supporting analyses and information are contained in Appendix G. Intrasite transportation of pits between Zone 4 and Zone 12 at Pantex to support storage of RFETS pits for the Preferred Alternative is described in Appendix Q.

4.4.1 METHODOLOGY

The analysis for the storage and disposition alternatives evaluates the potential risks from transporting shippable forms of fissile materials (Pu and HEU) that have been stabilized and packaged for shipment at the originating site to meet DOT, NRC, and DOE requirements. Baseline information, the existing transportation serving each site, and the types of containers required for shipment of the materials are included in the analysis, as appropriate.

Actual and projected inventories provided by DOE were used for the transportation risk analysis. The health impacts from the transport of materials were estimated using an assumed homogeneous population along specific routes when sites were known, or along an assumed route distribution of 84 percent rural, 15 percent suburban, and 1 percent urban for generic sites; average container, truckload, or rail carload of material; and a unit measure for traffic fatalities (the risk per kilometer). The assessment provides the total potential fatalities over the life of the project for a comparison of transportation impacts for the alternatives considered.

The analysis to estimate health risks in terms of potential total fatalities due to transportation of fissile materials between the sites is accomplished by the method best suited for the alternative. The RADTRAN Version 4 computer code, developed and maintained by SNL at Albuquerque, NM, was used to estimate radiological health risks (SNL 1992b). Unit risk factors were developed for each type of material to estimate the potential risk of transporting truckload shipments by SST over intersite routes. These unit risk factors were used, in conjunction with distance and the number of shipments, to estimate potential radiological and nonradiological (from air pollution and highway accidents) impacts to transport crew members and the public. Transportation impacts, in terms of total potential fatalities, were calculated using the RADTRAN computer code with the projected inventories of fissile materials and their form (nuclide composition), under each alternative considered, and based on nearest routing between sites. Fatalities from potential air pollution were estimated using 1.0×10^{-7} cancer fatalities per urban kilometer. Highway accidents fatalities were estimated from national statistics using 1.5×10^{-8} rural, 3.7×10^{-9} suburban, and 2.1×10^{-9} urban for occupational risks per km, and 5.3×10^{-8} rural, 1.3×10^{-9} suburban, and 7.5×10^{-9} urban for nonoccupational risks per km (SNL 1986a:167). Transportation impacts, in terms of total potential fatalities, were calculated using the RADTRAN computer code with the projected inventories of fissile materials and their form (nuclide composition), under each alternative considered, and based on best direct routing between sites. The transportation accident model in RADTRAN assigns accident probabilities to a set of accident categories. For the truck analysis, the eight accident-severity categories defined in NRC's *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170, December 1977) were used. The least severe accident category (Category I) represents low magnitude of crush force, accident-impact velocity, fire duration, or puncture-impact speed. The most severe category (Category VIII) represents a large crush force, high accident-impact velocity, long fire duration, and high puncture-impact speed, such as 88-km/hr (55-mph) collision into the side of the vehicle, and a 982 °C (1,800 °F) fire lasting 1.5 hr to produce a release of material. The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for the strictly controlled SST shipments and 1.0 for other shipments.

For facilities without a specific site, a bounding risk was established in order to estimate impacts for distances of 1,000 km (621 mi), 2,000 km (1,243 mi), and 4,000 km (2,486 mi), assuming rural, suburban, and urban population distribution of 84, 15, and 1 percent, respectively. For generic representative sites, no specific highway routes were used in the transportation modeling process; the risks for three representative distances are presented for comparison purposes. Under the European MOX fuel fabrication option, the impacts were assessed for transporting Pu materials from DOE origins (that is, from storage, pit disassembly/conversion site, or Pu conversion site) to placement of the material aboard ship. Port handling risks were estimated and ocean transport impacts (global commons) were calculated from the U.S. port to the European port, using RADTRAN. Environmental analyses of overseas port handling, land transport, and handling at the overseas plant would be the responsibility of the European fuel fabrication recipient. The impacts from ocean transport of MOX fuel back to the United States and truck transport from the port to a reactor or storage site were also calculated. The potential health impacts are presented as bounding values equal to the maximum potential risk for both accident and accident-free scenarios.

4.4.2 AFFECTED ENVIRONMENT

4.4.2.1 Transportation Procedures and Practices

Congress has mandated uniform laws for the safe transport of hazardous materials. DOT is the principal Federal agency designated by Congress to implement the regulations, ensure compliance, and provide emergency response guidance.

The Department ships hazardous materials, including radioactive materials, in full compliance with Federal laws specifically covering the transport of these hazardous materials (49 CFR 171-178). These laws are applicable to, and cannot be preempted by, individual states. Although not required by law, DOE has a policy of coordinating the transport of certain hazardous materials, such as Pu and HEU, with State officials. The actual routes are classified; however, they are selected to circumvent populated areas, maximize the use of interstate highways, and avoid bad weather. Exceptional precautions are taken to ensure safe transport. Although DOE has experienced traffic accidents related to the interstate transport of radioactive materials, there has never been a traffic accident involving the release of radioactive material causing injury or death. DOE coordinates emergency preparedness plans and responses with involved states.

The safe, secure transportation of special nuclear materials includes special vehicles and special transportation operational procedures. The design of the vehicles and the transportation operating procedures are classified; however, there has never been a failure of this system to provide safe secure transportation during more than 20 years of operation (DOE 1993ff:1-4).

Special nuclear materials, which include Pu and HEU, require extra measures to ensure physical security and protection of the public from radiation during transportation. DOE's Transportation Safeguards Division (TSD), located in Albuquerque, New Mexico, has the responsibility to provide for the transport of these materials. The TSD was established in 1975 and has accumulated over 110 million km (70 million mi) of over-the-road experience with no accidents causing a fatality or release of radioactive material. DOE's transportation vehicle, the SST, is a specially designed part of an 18-wheel tractor-trailer truck that incorporates various deterrents to prevent unauthorized removal of the cargo. It would be difficult to distinguish these trucks from most other semi-trailer trucks operating on the nation's highways. However, there are significant differences. The SST is designed to protect the cargo in the event of an accident through superior structural characteristics and a highly reliable cargo tie down system similar to that used in aircraft. The thermal characteristics of the SST would allow the trailer to be totally engulfed in a fire without incurring damage to the cargo. The tractor-trailers and their escort vehicles are equipped with communications, radiological monitoring, and other equipment, which further enhance en route safety and security.

Armed nuclear materials couriers, who are Federal officers, accompany each shipment containing special nuclear material. These couriers are hand-picked and highly trained in tractor-trailer driving and electronic and communication systems operation, and are authorized by AEA to carry firearms and make arrests in the performance of their duties. They drive the tractor-trailers and escort vehicles and operate the communications and other convoy equipment. The couriers must meet periodic qualification requirements for firearms, physical fitness, and driving proficiency. They also must pass an annual medical examination and are subject to random drug and alcohol testing.

The Department makes every effort to ensure that its convoys travel at safe speeds and do not travel during inclement weather. Should the convoys encounter adverse weather, provisions exist for them to seek secure shelter at previously identified facilities. A liaison program provides State and local law enforcement officers information on what actions to take to assist one of these vehicles should it be involved in an accident. A DOE control center maintains an emergency contact directory of Federal, State, and local response organizations located throughout the contiguous United States. [Text deleted.]

As further described in Appendix G, the vehicles and transport procedures are specifically designed and tested to prevent a radiological release under all credible accident scenarios. In addition, the packaging is designed and tested to prevent releases. DOE requires the use of highly sophisticated Type B packaging, which is designed to prevent the release of contents under all credible transportation accident conditions, for shipments of Pu and HEU. The testing requirements for these packagings are very demanding. For example, the drop test is equivalent to an impact on a hard surface at 322 km/hr (200 mph) without serious damage to the package or release of its radioactive contents. The containers used for shipping Pu and HEU must pass extremely rigid drop, puncture, thermal, and water immersion testing, and secure approval certification by DOT, NRC, and DOE.

4.4.2.2 Site Transportation Interfaces for Hazardous Materials

The existing transportation modes that serve each DOE site under consideration and the links to those modes for the intersite transport of hazardous materials are summarized in Table 4.4.2.2–1. Although hazardous materials could be transported by rail, truck, air, and barge modes, the materials (including hazardous materials) associated with storage and disposition would be transported only by truck and rail. Pu, including MOX fuel, and HEU would be transported exclusively by SST. Immobilized materials, blendstock for MOX fuel fabrication, TRU waste, and LLW would be transported by certified commercial truck carriers. Pu materials immobilized with highly radioactive isotopes would be transported by rail to a repository. Radioactive CsCl capsules would be shipped by commercial carriers or SST depending on the quantity, in accordance with DOE Order 5633.36. For this analysis, shipment by commercial carrier was assumed. There would be no barge or air shipments and, therefore, there would not be any impacts from transportation by these modes.

Table 4.4.2.2–1. Transportation Modes and Comparison Ratings by Site

Site	Onsite Railroad Service	Nearest Interstate Highway (km)	Distance to Airport for Cargo Shipments (km)	Barge Service	Possible Weather Delays[a]	Overall Level of Transport Service
Hanford	Yes	32	15	Yes	Yes	Good
NTS	No	97	105	No	No	Good
INEL	Yes	74	40	No	Yes	Good
Pantex	Yes	23	11	No	Minimal	Outstanding
ORR	Yes	6	61	Yes	Minimal	Good
SRS	Yes	48	32	Yes	Minimal	Good
RFETS	Yes	16	40	No	Yes	Satisfactory
[Text deleted.]						
LANL	No	66	177	No	Yes	Satisfactory

[a] DOE Transportation Safeguards System shipments.

Source: DOE 1991j; LANL 1992a:1; NTS 1992a:3; RFP 1992b:2.

In the *Nuclear Weapons Complex Reconfiguration Site Evaluation Panel Report,* five sites (Hanford, INEL, ORR, Pantex, and SRS) have been given a comparative rating based on the strengths and weaknesses of their transportation services (DOE 1991j:7). For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel were applied to the remaining DOE sites under consideration. Although DOE has experienced traffic accidents related to the intersite transport of radioactive materials, there has never been a traffic accident involving a release of radioactive material causing injury or death during transportation.

The Department's hazardous material (radioactive and nonradioactive) shipments are small compared to the large shipment volume from non-DOE hazardous material transported within the United States. DOT estimates that approximately 3.6 billion t/yr (4.0 billion tons/yr) of regulated hazardous materials are transported and that approximately 500,000 movements of hazardous materials occur each day (PL 101-615, Section 2[1]). There are approximately 2 million annual shipments of radioactive materials involving about 2.8 million packages, which represents about 2 percent of the annual hazardous materials shipments. Most radioactive shipments involve small or moderate quantities of material in relatively small packages. In comparison, the DOE Nuclear Weapons Complex ships about 6,200 radioactive packages (commercial and classified) annually among its sites. DOE's annual shipments of radioactive packages have represented less than 0.3 percent of all radioactive shipments in the United States. Up to a maximum of 603 shipments per year of radioactive material would be generated for any alternative in this PEIS. This is about 0.03 percent as compared to the total of 2 million shipments, although the size of each shipment may be larger than commercial shipments. Information on each site's historical transportation shipment records is included in Appendix G.

[Text deleted.]

4.4.2.3 Packaging

All Pu, HEU, and MOX fuel to be relocated under this PEIS would be packaged in DOT-approved Type B containers and transported by SST. Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packagings used by the DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations (49 CFR 171-180). For relatively low-level radioactive materials, strong, tight packagings or DOT specification Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. Shipments of more sensitive radioactive materials require use of highly sophisticated Type B packaging, designed and tested to prevent the release of contents under all credible transportation accident conditions. Each Type B packaging must pass four extremely rigid regulatory tests (drop, puncture, thermal, and immersion) that cover essentially 100 percent of the probable and hypothetical accidents involving impact, puncture, fire, and water immersion. It is highly unlikely that all four accident scenarios would occur to the same package, thus the regulatory requirements are conservative.

Special nuclear material (Pu and HEU) and certain other radioactive materials or weapons components require special protection. In addition to meeting the stringent Type B containment and confinement requirements of NRC's 10 CFR 71 and DOT's 49 CFR, packaging for nuclear weapons and components must be certified separately by DOE. The DOE operates the Transportation Safeguards System for the intersite transport of weapons and components, including Pu and HEU. Specially designed SST are utilized to ensure high levels of safety and physical protection. The system for safe secure transport of Pu and HEU is described in Appendix G.

Typical packagings for the materials analyzed in this PEIS are the DOT specification 6M, Type B or equivalent packaging for the shipment of Pu and HEU; the AT-400A or FL, Type B packaging for Pu pits; the Westinghouse model MO-1, Type B packaging for new MOX fuel; the BUSS R-1 cask for CsCl capsules; the TRUPACT for TRU waste; and Type B truck and rail casks for immobilized materials and MOX spent nuclear fuel. Most other radioactive materials would be transported by commercial truck in Type A fissile packagings. As a representation, a typical testing sequence for the 6M, Type B packaging used for the shipment of Pu and HEU is described in Appendix G. Table 4.4.2.3–1 presents a summary of the radioactive materials, packagings, and affected sites analyzed in this PEIS. [Text deleted.]

4.4.2.4 Transportation Routes and Emergency Preparedness Coordination Among Federal, State, and Local Agencies

Federal laws govern the transport of hazardous materials in the United States to ensure the safety of the public and security of the cargo. The DOT is the principal Federal agency designated by Congress to implement the regulations, ensure compliance, and provide emergency response guidance. Transportation of Pu and HEU, MOX fuel, and immobilized Pu radioactive materials covered by this PEIS would be transported through numerous States in full compliance with Federal laws (49 CFR) that are applicable to individual States. The actual routes would be classified; however, they are selected with input from State and local agencies to circumvent populated areas, maximize the use of interstate highways, and avoid adverse weather. The actual routes would not be designated until the time of transport. Exceptional precautions are taken to ensure safe transport. In addition, DOE has a liaison program through which it communicates with law enforcement and public safety agencies throughout the country, making them aware of these shipments and the exceptional precautions being taken to ensure safe transport through their state.

The packaging, vehicles, and transport procedures are specifically designed and tested to prevent a radiological release under all credible accident scenarios. However, if an emergency situation were to occur, Federal, State, and local emergency preparedness officials are trained and prepared to react to such an emergency. The FEMA is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with Federal executive agencies that have emergency response functions in the event of a transportation incident. The FEMA coordinates Federal and State participation in developing emergency response plans and is responsible for the development of the interim *Federal Radiological Emergency Response Plan*. This plan is designed to coordinate Federal support to State and local governments, upon request, during the event of a radiological material transportation incident. FEMA also routinely identifies entities at the State and local levels with whom DOE officials should coordinate to ensure emergency preparedness for specific DOE transportation of Pu or HEU. DOE also has access to transportation coordinators in the Local Emergency Planning Councils and Area Planning Contingency Groups which are required to be formed at the regional and local levels under the *Emergency Planning and Community Right-To-Know Act* of 1986. DOE assists in the training of local emergency preparedness officials in how to respond to such emergencies and how to use certain monitoring equipment. FEMA, which runs the National Fire Academy, also conducts civil defense training of local firefighters. Since firefighters are often the first responders to any type of emergency, the FEMA training includes emergency response to radiological incidents.

4.4.3 Environmental Consequences

Weapons-usable fissile materials analyzed in this PEIS would be either dispositioned or placed into long-term storage. [Text deleted.] This section summarizes the health impacts from the intersite transportation of Pu, HEU, MOX fuel, Cs-137, and other radioactive materials, including waste, based on RADTRAN model results. Impacts are presented based on the movements of the total amount of materials considered under each storage and disposition alternative for the life of the project.

Normal operations associated with the storage and disposition of weapons-usable fissile materials could result in the exposure of transportation workers and the general public to toxic chemicals from vehicular emissions and radiation from the transport of radiological feed materials, products, and wastes generated to accomplish various storage and disposition alternatives. During normal operations (that is accident-free transportation), of radioactive and nonradioactive materials (that is, Pu, HEU, CsCl capsules, canisters of immobilized Pu with radionuclides, MOX fuel, spent nuclear fuel, and wastes), the general population living and traveling along the transport route has a risk of exposure to radioactive and non-radioactive materials (that is, a small amount of

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives

	Long-Term Storage				Disposition—Common Activities							
	Upgrade[a]	Consolidation	Collocation		Pit Disassembly/Conversion				Pu Conversion			
		Input	Input 1	Input 2	Input	Output 1	Output 2	Output 3	Input	Output 1	Output 2	Output 3
Materials	Pu	Pu	Pu	HEU	Pu	Pu	TRU waste	LLW	Pu	Pu	TRU waste	LLW
Form	Pits, metal, oxide	Pits, metal, oxide	Pits, metal, oxide	Canned sub-assemblies, metal or oxide	Pits	Metal or oxide	Solid	Solid	Metal or oxide	Metal or oxide	Solid	Solid
Quantity per year (kg)	27,000	27,000	27,000	15,080	2,000	2,000	15,000	12,000	1,000	661	35,890	308,162
Quantity per package[b] (kg)	4.5	4.5	4.5	5.2	45	4.5	980	2,200	4.5	4.5	980	2,200
Packages per shipment	35	35	35	35	35	35	3	5	35	35	3	5
Shipments per year	172	172	172	83	13	13	6	2	7	5	13	28
Packages (type)	AT-400A (B), FL (B) and 6M (B)	AT-400A (B), FL (B) and 6M (B)	AT-400A (B), FL (B) and 6M (B)	6M (B)	AT-400A (B) and FL (B)	6M (B)	TRUPACT (B)	Metal box (A)	6M (B)	6M (B)	TRUPACT (B)	Metal box (A)
Potential origins	RFETS LANL	Hanford INEL Pantex SRS RFETS LANL	Hanford INEL Pantex SRS RFETS LANL	Y–12 Plant	Pantex SRS RFETS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford INEL Pantex SRS RFETS LANL	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS
Potential destinations	Hanford INEL Pantex SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex ORR SRS	Hanford NTS INEL Pantex SRS	Hanford NTS INEL Pantex ORR SRS	Lag storage or disposition[c]	WIPP or alternative	LLW disposal site	Hanford NTS INEL Pantex ORR SRS	Lag storage or disposition[c]	WIPP or alternative	LLW disposal site
Mode	SST	SST	SST	SST	SST	SST	Truck	Truck	SST	SST	Truck	Truck

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives—Continued

	Immobilization								
	Vitrification			Ceramic Immobilization			Electrometallurgical Treatment		
	Input 1	Input 2	Output	Input 1	Input 2	Output	Input 1	Input 2	Output
Materials	Pu	Cs	Pu/ Cs glass[d]	Pu	Cs	Pu/Cs/Gd/ ceramic[d]	Pu	Cs	Pu/Cs/ TRU/ ceramic
Form	Metal, oxide, borosilicate glass	Salt	Glass	Metal or oxide	Salt	Disks	Metal or oxide	Salt	Glass-bonded zeolite
Quantity per year (kg)	5,000	64	100,800	5,000	64	42,000	5,000	47	104,000
Quantity per package[b] (kg)	4.5	5.72	1,680 (84 kg Pu)	4.5	5.72	656	4.5	4.71	5,200 (260 kg Pu)
Packages per shipment	35	1	1	35	1	1	35	1	1
Shipments per year	32	12	60	32	12	64	32	10	20
Packages (type)	6M (B)	BUSS cask (B)	Cask (B)	6M 114 l drum (B)	BUSS cask (B)	Cask (B)	6M 114 l drum (B)	BUSS cask (B)	Cask (B)
Potential origins	Current or lag storage site[c]	Hanford	New glass vitrification site	Current or lag storage site[c]	Hanford	Immobilization site	Current or lag storage site[c]	Hanford	INEL
Potential destinations	Immobilization site	Immobilization site	HLW repository	Immobilization site	Immobilization site	HLW repository	INEL	INEL	HLW repository
Mode	SST	Truck or SST	Rail	SST	Truck or SST	Rail	SST	Truck or SST	Rail

Table 4.4.2.3–1. Transportation Summary of Radioactive Materials and Packagings for Alternatives—Continued

	MOX Fuel Fabrication for Reactors			Deep Borehole: Direct Disposition	Deep Borehole: Immobilized Disposition	
	Input 1	**Input 2**	**Output**	**Input**	**Input**	**Output**
Materials	Pu	Uranium	MOX fuel	Pu	Pu	Pu-loaded ceramic coated pellets
Form	Oxide powder	Oxide powder	Reactor fuel bundles	Metal or oxide	Metal or oxide	Pellets
Quantity per year (kg)	3,000	129,600	132,600	5,000	5,000	500,000
Quantity per package[b] (kg)	4.5	2,200	382 (23 Pu, 359 UO_2)	4.5	4.5	510
Packages per shipment	35	5	2	35	35	5
Shipments per year	20	12	174	32	32	197
Packages (type)	6M (B)	Metal box (A)	MO-1 cask (B)	6M 114 l drum (B)	6M 114 l drum (B)	208 l drum (B)
Potential origins	Current or lag storage site[c]	Y–12 Plant	MOX fabrication site	Current or lag storage site[c]	Current or lag storage site[c]	Immobilization site
Potential destinations	MOX fabrication site	MOX fabrication site	Reactors	Deep borehole site	Immobilization site	Deep borehole site
Mode	SST	Truck	SST	SST	SST	Truck

[a] All HEU for this project is assumed to be located at the Y–12 Plant.

[b] Bounding values used for analysis purposes only.

[c] Lag storage is temporary storage at a disposition facility.

[Text deleted.]

[d] HLW could be combined with the immobilized Pu for the Vitrification or Ceramic Immobilization Alternatives.

Source: DOE 1996e; DOE 1996f; LANL 1996b; LLNL 1996a; LLNL 1996b; LLNL 1996c; LLNL 1996d; LLNL 1996e; LLNL 1996h; NT DOE 1996a; PX DOE 1996a.

additional vehicular emissions) from the passing shipments. Transportation workers could be similarly exposed to radioactive and non-radioactive materials. These are examples of causes of potential radiological and nonradiological fatalities resulting from normal transportation operations. Traffic accidents could have impacts to drivers, passengers, or pedestrians similar to any local or interstate traffic accident. In addition, there could be damage resulting in the releases from the hazardous cargo being transported. Appendix G describes the tests that the packages must withstand to be certified for transporting special nuclear materials. However, traffic accidents could theoretically cause radiological fatalities if there were a release of radioactive material as a result of the traffic accident, and nonradiological fatalities from the effects of vehicular crashes. Radiological and nonradiological fatalities resulting from traffic accidents could affect both the general population and the transportation workers.

Since the establishment of TSD in 1975, DOE has accumulated over 70 million miles of over-the-road experience transporting DOE owned cargo with no accidents causing a fatality or release of radioactive material. However, since there is a theoretical chance of fatalities, this PEIS modeled the potential fatalities from radiological effects of transportation (both normal operations and accident situation) and nonradiological effects of transportation (both normal operations and accident situation) for the various storage and disposition alternatives. [Text deleted.] The potential transportation risks, although small, are greatest for nonradiological traffic accidents compared to radiological risks for both normal operations and accident situations. Impacts are based on the total amount and types of materials moved, numbers of shipments, and the distances those shipments would travel.

The following sections present for each alternative the potential radiological and nonradiological fatalities to the general population and transportation workers. Transportation workers include both the driving crews and any transportation workers who load and unload the materials. Only total potential fatalities, which include radiological and nonradiological impacts for routine and accident conditions, are discussed in this section. The majority of the total impact is due to nonradiological accidents (traffic accidents), followed by radiological routine exposure, nonradiological routine exposure (air pollution), and radiological accidents. Radiological accidents typically have about 1 percent of the total fatalities.

4.4.3.1 No Action

Existing facilities would be used for continued which is the baseline case to which the transportation impacts for other alternatives is compared. Under No Action, there would be no transportation of materials as part of the proposed long-term storage and disposition alternatives, thus no transportation risks incurred.

As part of ongoing operations at the DOE sites, fissile materials may require movement and offsite transportation. These actions, however, would be addressed in separate site-specific environmental documentation, as appropriate.

[Text deleted.]

4.4.3.2 Long-Term Storage Alternatives

Upgrade Alternative

Preferred Alternative for Storage

For the Preferred Alternative for storage, all Pu would be shipped from RFETS. The Pu pit material would be shipped from RFETS to Pantex; the non-pit Pu material would be shipped from RFETS to SRS. Shipments from RFETS would begin in 1997. Pits at SRS are strategic reserve and would be stored according to the ROD for the Stockpile Stewardship and Management PEIS. For analysis of intersite transportation impacts of the Preferred Alternative, the only contributors to intersite transportation risks would be the requirement to ship Pu pits from RFETS to Pantex and to ship non-pit Pu from RFETS to SRS. Intrasite transportation between Zone 4 and Zone 12 at Pantex would occur for the Preferred Alternative if pits are stored in Zone 4 before the upgrade facility is available. Analysis of this intrasite transportation is discussed in Appendix Q. HEU and non-RFETS Pu would remain at existing locations so there would be no additional contributors to transportation risks. All HEU is assumed at ORR. All nonsurplus HEU and surplus HEU pending disposition would be stored in upgraded facilities at ORR under the Preferred Alternative. Pu material currently at Hanford, INEL, Pantex, SRS, and LANL would remain onsite pending disposition (or lag storage at the disposition facilities). The impacts in terms of potential fatalities are based on risks from normal (accident-free) operations and from accidents, both radiological and nonradiological operations and accidents. The risks are based on quantities and types of Pu material as well as the distance, routes, and number of SST trips required. Potential fatalities from intersite transportation activities for the Preferred Alternative are summarized in Table 4.4.3.2–1. Nonradiological accidents are the dominant risk for the Preferred Alternative.

Table 4.4.3.2–1. Total Potential Fatalities From Intersite Transportation Activities for the Preferred Alternative for Storage[a]

Material	Ship From	Ship To	Total Potential Fatalities
Pu Pits	RFETS	Pantex	0.00636
Non-Pit Pu	RFETS	SRS	0.0602
Total Transportation Risk			0.0666

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Source: RADTRAN model results.

Upgrade Without Rocky Flats Environmental Technology Site Plutonium or Los Alamos National Laboratory Plutonium Subalternative

Under this subalternative, four sites are considered for the upgrade of existing Pu storage facilities: Hanford, INEL, Pantex, and SRS. Pu material from RFETS and LANL included in this PEIS would remain at these two sites. HEU would continue to be stored at ORR. For this subalternative there would be no potential fatalities because intersite transportation would not occur.

Upgrade With Rocky Flats Environmental Technology Site Plutonium and Los Alamos National Laboratory Plutonium Subalternative

Under this subalternative, four sites are considered for the upgrade of existing Pu storage facilities: Hanford, INEL, Pantex, and SRS. Pu material from RFETS and LANL included in this PEIS would be transported to one or more of these four sites. HEU would continue to be stored at ORR. The estimated potential impact from transporting the Pu materials from RFETS and LANL to each potential storage site is presented in Table 4.4.3.2–2. In the case where the RFETS and LANL Pu material would be distributed to more than one site for storage, the resulting number of total potential fatalities would be within the range of values, 0.031 to 0.087, shown in Table 4.4.3.2–2, and fatalities per site would be less than the maximum values shown. [Text deleted.] Nonradiological accidents are the dominant risk for the Upgrade With RFETS Pu and LANL Pu Subalternative.

Consolidation Alternative

Under this alternative, weapons-usable Pu would be transported from existing storage sites to one of five potential consolidated storage facilities located at Hanford, NTS, INEL, Pantex, or SRS (ORR is excluded as a Pu-only storage site). The total potential number of fatalities resulting from transporting Pu to each site under the

Table 4.4.3.2–2. Total Potential Fatalities From the Transportation of Rocky Flats Environmental Technology Site Plutonium and Los Alamos National Laboratory Plutonium for the Upgrade Alternative[a]

Candidate Sites[b]	Total Potential Fatalities[c]
Hanford	0.051
INEL	0.032
Pantex	0.031
SRS	0.087

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Under the Upgrade Alternative, NTS and ORR are not potential storage sites for Pu, and HEU would remain at ORR.

[c] Effect of transporting all Pu from RFETS and LANL covered by this PEIS to one site.

Source: RADTRAN model results.

Consolidation Alternative is shown in Table 4.4.3.2–3. The highest number of potential fatalities, however, would not exceed 0.346, which is based on moving all Pu covered by this PEIS from existing sites to SRS. Nonradiological accidents are the dominant risk for the Consolidation Alternative.

Table 4.4.3.2–3. Total Potential Fatalities From the Transportation of Plutonium for the Consolidation Alternative[a]

Candidate Sites[b]	Potential Fatalities
Hanford	0.272
NTS	0.172
INEL	0.203
Pantex	0.079
SRS	0.346

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Under this alternative, ORR is not a potential Pu storage site.

Source: RADTRAN model results.

Collocation Alternative

Under this alternative, weapons-usable Pu and HEU would be transported from existing storage sites to one of six potential collocation storage sites at Hanford, NTS, INEL, Pantex, ORR, or SRS. The transportation health effects were calculated individually for each fissile material going to each of the candidate sites, and then summed. The highest number of potential fatalities, however, would not exceed 1.070, which is based on moving all material to Hanford. The total potential number of fatalities resulting from transporting Pu and HEU under the Collocation Alternative are summarized in Table 4.4.3.2–4. Nonradiological accidents are the dominant risk for the Collocation Alternative.

For both the Consolidation and Collocation Alternatives, all the weapons-usable Pu stored at RFETS and surplus Pu materials currently stored at LANL are included in the analyses for intersite transportation. [Text deleted.]

Table 4.4.3.2–4. Total Potential Fatalities From the Transportation of Plutonium and Highly Enriched Uranium for the Collocation Alternative[a]

Candidate Sites	Potential Fatalities
Hanford	1.070
NTS	0.829
INEL	0.873
Pantex	0.458
ORR	0.285
SRS	0.495

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Source: RADTRAN model results.

Phaseout

If a site is selected for phaseout, the total potential fatalities impacts of relocating excess Pu or HEU to other DOE sites would be similar to the impacts calculated under the storage and disposition alternatives. [Text deleted.]

Subalternative Not Including Strategic Reserve and Weapons Research and Development Materials

For each of the long-term storage alternatives where the strategic reserve and weapons R&D is not included as part of this program, the transportation health risks associated with the remaining fissile materials has been proportionally estimated from the risks calculated for the entire inventory. Since less material would be moved, the overall result would be potentially fewer fatalities for each alternative. Most of the material is surplus and therefore the reduction would be less than one half of the total fatalities with the strategic reserve.

4.4.3.3 Disposition Alternatives

Alternatives for disposition are intended to permanently prevent certain surplus Pu materials from being used to produce nuclear weapons. The alternative categories are Deep Borehole, Immobilization, and Reactor. Under these disposition alternatives, it is assumed that the surplus fissile materials have been placed in storable forms, suitable for shipment, at the facility of origin.

For the disposition alternatives, the following would apply:

- Almost all surplus Pu pits are located at Pantex, with a limited quantity at RFETS. Pu pits would be transported from existing storage, primarily at Pantex, to potential pit disassembly/conversion sites (unless pit disassembly/conversion is located at the existing storage site). For transportation analysis purposes, pit disassembly/conversion is assumed to be located at one of the following sites: Hanford, NTS, INEL, Pantex, ORR, or SRS, and all pits would be transported from Pantex.

- Non-pit Pu material would be transported from existing storage to a Pu conversion site. For transportation risk analysis purposes, it is assumed that the Pu conversion function would be located at one of six sites: Hanford, NTS, INEL, Pantex, ORR, or SRS. The material would be in a form suitable for shipment in compliance with DOT regulations (49 CFR).

- Surplus Pu at RFETS and at LANL is also being considered for disposition, therefore, is included in the intersite transportation analysis. RFETS and LANL are not being considered for any disposition functions, such as pit disassembly/conversion or immobilization of materials.

- For the disposition actions, the transport of surplus Pu would always originate at either the existing storage sites (Hanford, INEL, Pantex, SRS, RFETS, and LANL) or at the potential pit disassembly/conversion or Pu conversion site (Hanford, NTS, INEL, Pantex, ORR, or SRS).

Table 4.4.3.3–1 presents the total potential health impact from the transportation of Pu from existing storage sites to pit disassembly/conversion or Pu conversion sites. Included in the impact is the effect from the transport of LLW and TRU waste generated. Nonradiological accidents are the dominant risk for both the pit disassembly/conversion and Pu conversion alternatives.

Table 4.4.3.3–1. Total Potential Fatalities From the Transportation of Plutonium From Existing Storage Sites to a Pit Disassembly/Conversion or Plutonium Conversion Site[a]

Sites Analyzed	Pit Disassembly/ Conversion	Pu Conversion
Hanford	0.203	0.455
NTS	0.107	0.211
INEL	0.155	0.340
Pantex	0.033	0.293
ORR	0.155	0.557
SRS	0.190	0.635

[a] Includes effect from the transport of Pu, LLW, and TRU waste from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Source: RADTRAN model results.

[Text deleted.]

The total potential fatalities presented in Table 4.4.3.3–1 are based on transporting 30 t (33.1 tons) of pits to the pit disassembly/conversion site and 20 t (22 tons) of Pu to the Pu conversion site. Should the amount of material be less than these amounts, the risk would be lower than these values.

Deep Borehole

Under the deep borehole category, surplus weapons-usable Pu would be in one of two forms: (1) containers of stabilized Pu would be directly emplaced in a borehole and (2) Pu-loaded, ceramic-coated pellets would be emplaced in a borehole. This category of alternatives requires surplus Pu to be transported from lag storage to the borehole site, or to an immobilization site and then to the borehole site. A specific borehole site has not been selected; therefore, for transportation analysis purposes, generic distances of 1,000, 2,000, and 4,000 km (621, 1,243, and 2,486 mi) were used. The amount of Pu to be transported is estimated to not exceed 5 t (5.5 tons) per year.

Under the Direct Disposition Alternative, Pu material would be packaged in 2.25-kg (5-lb) lots (in metal or oxide form) in metal cans at the pit disassembly/conversion site or Pu conversion site. Two cans of Pu (4.5 kg [10 lb]) would be placed into each DOT-specification 2R inner container, which, in turn, would be placed in DOT specification 6M, Type B packaging and shipped by SST to the borehole site. Each shipment (truckload) would contain 35 packages. There would be a total of 32 shipments per year. The shipping containers would be placed directly into metal emplacement canisters at the borehole site without additional handling of Pu material.

Under the Immobilized Disposition Alternative, Pu material would be packaged in 2.25-kg (5-lb) lots (in metal or oxide form) in metal cans, as described above. Two cans would be placed into each DOT-specification 6M, Type B packaging and shipped to a ceramic immobilization facility. There, the material would be converted into Pu-loaded, ceramic-coated pellets (1-percent Pu). The Pu-loaded, ceramic-coated pellets would be shipped in Type B, 208-l (55-gal) drum packaging by SST or commercial truck to the deep borehole site. An estimated 500 t (551 tons) of Pu-loaded, ceramic-coated pellets would be transported per year. This would consist of transporting 510 kg (1,124 lb) of material per Type B package, five packages per SST or commercial truckload shipment, and 981 packages or 197 shipments per year.

The total potential number of fatalities resulting from the transportation of Pu for each of the deep borehole alternatives are shown in Table 4.4.3.3–2. These risks include: (1) the transport of material directly to a deep borehole site, and (2) the transport of material to an immobilization site and then the transport of ceramic pellets from the immobilization site to a deep borehole site. The impacts in Table 4.4.3.3–2 also include the maximum health effect from transporting Pu from existing storage to a pit disassembly/conversion site or Pu conversion site, as derived from Table 4.4.3.3–1. Nonradiological accidents are the dominant risk for the Deep Borehole Category of Alternatives. To calculate the maximum impacts in Table 4.4.3.3–2, 5 t (5.5 tons) of Pu would be transported annually from the farthest lag storage site.

Table 4.4.3.3–2. Total Potential Fatalities From the Transportation of Plutonium and Immobilized Materials for the Deep Borehole Category of Alternatives[a]

Alternative	Sites Analyzed	Total Potential Fatalities[b]
Direct Disposition	No immobilization	1.18
Immobilized Disposition	Hanford	1.95
	NTS	1.62
	INEL	1.79
	Pantex	1.62
	ORR	2.01
	SRS	2.12

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Based on a distance of 4,000 km to a deep borehole site.

Source: RADTRAN model results.

Immobilization

Under the immobilization category, surplus Pu (in metal or oxide form) would be transported to one of six sites analyzed (Hanford, NTS, INEL, Pantex, ORR, or SRS). Regardless of the site or immobilization technology selected, the amount of Pu to be transported is estimated to not exceed 5 t (5.5 tons) per year.

It is estimated that for 5 t (5.5 tons) of Pu, 35 6M Type B packages would be shipped in each of 32 SST truckloads per year (a total of 1,111 6M packages per year). If the surplus Pu is immobilized with Cs-137, approximately 64 kg (141 lb) of CsCl capsules per year, in approximately 12 BUSS R-1 casks, would require shipment from Hanford to the immobilization site.

The immobilized Pu would be transported in NRC-certified packagings to the HLW repository program in one of two alternative forms; these are:[1]

- **Plutonium, Cesium, and Gadolinium in Vitrified Glass Logs.** Under the Vitrification Alternative, an estimated 101 t (111 tons) of material would be transported per year. This would consist of transporting approximately 1,680 kg (3,704 lb) of material (including 84 kg [185 lb] of Pu and

[1] A variant for both vitrification and ceramic immobilization is to use HLW in place of Cs-137. Use of this material for either alternative would have less total fatalities since HLW would be resident at the site already.

2.1 kg [4.6 lb] of Cs-137) per rail cask, 1 cask per rail shipment, and 60 casks or 60 shipments per year.

- **Plutonium, Cesium, and Gadolinium in Ceramic Disks.** Under the Ceramic Immobilization Alternative, an estimated 42 t (46 tons) of material would be transported per year. This would consist of transporting 656 kg (1,446 lb) of material per rail cask, one cask per rail shipment, and 64 casks or 64 shipments per year.

The total potential fatalities for the transportation of Cs-137 from Hanford to each of the immobilization sites analyzed would range from 0.024 to 0.086. If HLW is used for either the Vitrification or Ceramic Immobilization Alternative there would be 0 total potential fatalities because only HLW onsite where the facility is located would be used. For calculating transportation risks, the representative HLW repository site is assumed at Yucca Mountain, Nevada, for reasons described in Appendix H.

A summary of the maximum health effects from transportation of radiological materials under the immobilization alternative category is presented in Table 4.4.3.3–3. Impacts include the maximum health effects from transporting Pu from existing storage to a pit disassembly/conversion site or Pu conversion site. To calculate the impacts, 5 t (5.5 tons) of Pu would be transported annually from the lag storage[2] site farthest from each of the immobilization sites. Nonradiological accidents are the dominant risk for the Immobilization Category of Alternatives. Under the Preferred Alternative, for analysis purposes, 30 percent of the surplus Pu would be sent to the Pu conversion facility and then either to the vitrification or ceramic immobilization facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in Table 4.4.3.3–3.

Table 4.4.3.3–3. Total Potential Fatalities From the Transportation of Plutonium and Immobilized Materials for the Immobilization Category of Alternatives[a]

	Sites Analyzed					
Alternative	**Hanford**	**NTS**	**INEL**	**Pantex**	**ORR**	**SRS**
Vitrification	0.96	0.49	0.75	0.70	1.25	1.40
Ceramic Immobilization	0.98	0.50	0.77	0.72	1.28	1.43

[a] The analysis assumed that the pit disassembly/conversion and Pu conversion would be collocated at the immobilization site. The analysis includes effect of transporting Cs-137 from Hanford to the immobilization site and the transportation of immobilized materials to a HLW repository site, resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

Note: Under the Preferred Alternative, for analysis purposes, 30 percent of the surplus Pu would be sent to the Pu conversion facility and then either to the vitrification or ceramic immobilization facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in this table.

Source: RADTRAN model results.

Another immobilization alternative analyzed is electrometallurgical treatment. ANL-W has been analyzed as the representative site, although electrometallurgical treatment could be performed at any site and would give different transportation impacts. Under this alternative, using ANL-W as the representative site, all surplus Pu (in metal or oxide form) would be transported from SRS (the bounding site) to ANL-W located at INEL where it would be immobilized with spent nuclear fuel and Cs-137 at an electrometallurgical treatment facility to produce glass-bonded zeolite, vitrified in canisters as waste. Canisters of GBZ would then be shipped to a HLW repository program. The annual amount of Pu feed material for this process would be identical to that required for the other immobilization processes described above. Approximately 5 t (5.5 tons) of Pu (1,111 packages, 35 packages per SST, 32 SST loads) would be required per year. Pu would be shipped to INEL in DOT-approved 6M, Type B packaging (using 2R inner containers) with approximately 4.5 kg (10 lb) of Pu per package. For the

[2] Lag storage is temporary storage at a disposition facility.

transport of Cs-137 feed material from Hanford, approximately 64 kg/yr (141 lb/yr) of Cs-137, consisting of one rail cask per shipment, 10 shipments per year, would be required. To transport an estimated 104,000 kg/yr (229,278 lb/yr) of GBZ to a repository by rail would require approximately 20 shipments per year, each shipment consisting of one cask (20 casks/yr), or approximately 200 shipments (200 casks) over the 10-year life of the project. This assumes a repository is available and the shipments are made during the 10-year glass bonding production period; otherwise, the immobilized material would be stored onsite until the HLW program accepts the material. The total potential fatalities resulting from the transport of radioactive materials under this alternative is 0.923.

Mixed Oxide Fuel for Reactors

Surplus Pu (oxide powder) would be transported from the lag storage sites (after pit disassembly/conversion or Pu conversion) to domestic or foreign MOX fuel fabrication plants for blending into MOX nuclear reactor fuel. It is estimated that the maximum amount of Pu oxide to be transported per year from lag storage to a MOX fuel fabrication plant would not exceed 3 t (3.3 tons). For domestic MOX fuel fabrication, approximately 20 SST truckloads, consisting of 35 DOT-specification 6M, 113.6-l (30-gal) packages per SST, would be expected to move to the MOX fuel fabrication site each year. It is estimated that the maximum amount of UO_2 powder to be transported per year would be 130 t (143 tons). Approximately 12 truckloads, consisting of five DOT-specification Type A metal boxes per truckload, would also be transported to the MOX fuel fabrication site each year. Each metal box would contain about 2,200 kg (4,850 lb) of UO_2 material.

After processing the Pu at a domestic MOX fuel fabrication plant, a maximum of 133 t (147 tons) of MOX fuel (PuO_2 and UO_2), in reactor fuel bundles, would be transported in approximately 174 truckloads per year to a commercial reactor site or an approved DOE interim storage site. Each truckload contains approximately 2 packages. The Westinghouse Electric model MO-1 shipping cask (NRC Certificate 9069) is used for this analysis. Each cask would contain approximately 23 kg (51 lb) of PuO_2 and 359 kg (791 lb) of UO_2 with an average of 6-percent Pu. Based on an estimated 3,272 t (3,607 tons) of MOX fuel for the entire MOX fuel project, an estimated total of 4,283 truckloads would be required.

The final destination for the MOX fuel could be any reactor capable of using this fuel. After processing the oxides of Pu and uranium into MOX fuel, the fuel has not met the Spent Fuel Standard. However, Pu in the form of MOX fuel is less weapons-usable and much less susceptible to dispersion into the environment than Pu in the oxidized form prior to MOX fuel fabrication. MOX fuel is less weapons-usable because it would require some chemical processing to reclaim the Pu metal. Still, security measures must be implemented and similar measures are routinely in place in the U.S. domestic nuclear power industry for manufacturing and transporting uranium-based fuel to reactor sites. DOE would ensure that MOX fuel is protected by comparable security measures for point of fabrication through usage in a reactor. MOX fuel is less susceptible to dispersion in the environment because the Pu is contained in a pellet and the pellets are contained in a fuel rod. The structural integrity of the fuel rods make dispersion of even the pellets, much less the Pu inside the pellets, very unlikely. Because MOX fuel is less weapons-usable and less dispersable, after fabrication the MOX fuel would be transported by SST with appropriate security protection as described in Appendix G. To allow for comparison of the reactor alternatives, an estimated risk to transport MOX fuel from a MOX fabrication site to a reactor site within the United States or to the Canadian Border (hypothetical distance of 1,000, 2,000, or 4,000 km [621, 1,243, or 2,486 mi]) was used.

The total health risk impacts from transporting both Pu by SST and uranium oxide by truck to potential MOX fuel fabrication plants (hypothetically located 1,000, 2,000, or 4,000 km [621, 1,243, or 2,486 mi] from origin) and to an ocean terminal (hypothetically located at Sunny Point, NC, approximately 1,000, 2,000, or 4,000 km [621, 1,243, or 2,485 mi] from origin), are given in Table 4.4.3.3–4. For Pu destined for European MOX fabrication plant, the impacts include: transportation to the U.S. port; port handling at the U.S. port; ocean transport to European ports of Barrow, United Kingdom, and Cherbourg, France; ocean transport of MOX fuel back to the United States; and SST transport of MOX fuel from the port to either an existing (commercial) reactor site or storage site in the United States. In selecting transportation routes, including any ports, the safety of the public and security of the cargo are of primary consideration. To ensure these primary considerations are achieved, DOE would evaluate the ports to be used based on a set of criteria that would include adequacy of harbor and dock characteristics to satisfy the Pu container carrying ship requirements; adequacy of facilities for safe receipt, handling, and transhipment of Pu and MOX fuel; overall port security; availability of safe and secure lag storage; adequacy of overland transportation systems from ports to the reactor and from the Pu site(s); availability of a skilled labor force with routine experience in safe and secure handling of hazardous cargo; emergency preparedness status and response capabilities at the port and the nearby communities; quality of intermodal access for truck or rail shipments to and from the port; proximity to the proposed pit disassembly/conversion and reactor sites; local restrictions or regulations on movement of hazardous cargo; absence of significant environmental restrictions for the port; and the size of human population at the ports and along transportation routes. Port handling and global commons risks associated with the European MOX fuel fabrication option are discussed in Appendix G. [Text deleted.] The maximum risk impacts from the transport of Pu oxide, uranium oxide, and MOX fuel under the reactor alternatives are summarized in Table 4.4.3.3–4. Nonradiological accidents are the dominant risk for the Reactor Category of Alternatives. The highest number of total potential fatalities from the transportation of materials from lag storage (after pit disassembly/conversion or Pu conversion) to fuel fabrication and then to a reactor site is 4.16 for MOX fuel fabrication in the United States and a 4,000-km (2,485-mi) representative distance for each segment. The transportation risk for shipping MOX fuel from a domestic fabricator to an existing LWR is approximately the same as the transportation risk for shipping uranium-based fuel from a domestic fabricator to an existing LWR. Since the MOX fuel replaces the uranium-based fuel, the incremental transportation risk for the Existing LWR Alternative is only the risk of shipping the oxides to the MOX fuel fabrication site. Assuming a 4,000-km (2,485-mi) representative distance for each segment, the total potential facilities is 0.55. As shown in Table 4.4.3.3–4, using MOX fuel fabricated abroad would increase the transportation risk for this alternative. Under the Preferred Alternative, for analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX Fuel Fabrication Facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in Table 4.4.3.3–4.

Reactor facilities are designed to accommodate spent nuclear fuel onsite, as described under waste management. The impacts of the future transport of DOE spent nuclear fuel, including both incident-free and accident conditions, are addressed in the DOE *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). That EIS concluded that the estimated number of fatalities from the operation of DOE spent nuclear fuel management facilities would not exceed 0.065 fatalities per year for transportation. Because the dominant risk in transporting radiological materials is nonradiological accidents, the fatalities from the transportation of spent LEU fuel assemblies will be similar to the transportation of spent MOX fuel assemblies. For analysis purposes in the Storage and Disposition PEIS, a maximum risk of 0.65 fatalities is used for transporting spent nuclear fuel to an HLW repository during the 10-year reactor operations period. This maximum risk for transportation of spent nuclear fuel has been added to each MOX total fatalities in Table 4.4.3.3–4.

Summary of Disposition Alternative Transportation Impacts.

A summary of the highest number of potential fatalities for each of the disposition alternatives is presented in Table 4.4.3.3–5. Based on the sites and environmental settings analyzed, none of the alternatives would exceed these values.

Table 4.4.3.3–4. Total Potential Fatalities From the Transportation of Plutonium Oxide, Uranium Oxide, and Mixed Oxide Fuel for the Reactor Category of Alternatives[a]

Representative Distance (km)	From Lag Storage Site to a U.S. MOX Fuel Fabrication Site	From Lag Storage Site to a European Port[b]	From a U.S. MOX Fuel Fabrication Site to a Reactor Site	From a European Port to a U.S. Reactor or Storage Site[b]
Plutonium Oxide				
1,000	0.102	0.132	NA	NA
2,000	0.188	0.218	NA	NA
4,000	0.359	0.389	NA	NA
Uranium Oxide				
1,000	0.060	0.087	NA	NA
2,000	0.104	0.131	NA	NA
4,000	0.193	0.221	NA	NA
Mixed Oxide Fuel				
1,000	NA	NA	1.07	1.47
2,000	NA	NA	1.91	2.31
4,000	NA	NA	3.61	4.01

[a] Resulting from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions.

[b] Port handling is evaluated separately as a facility risk. For the Preferred Alternative, the total potential facilities would be less. For analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX Fuel Fabrication Facility.

Note: Under the Preferred Alternative, for analysis purposes, 70 percent of the surplus Pu would be sent to the pit disassembly/conversion facility and then to the MOX fuel fabrication facility. Accordingly, the total potential fatalities for the Preferred Alternative would be lower than those shown in this table. NA=not applicable.

Source: RADTRAN model results.

Table 4.4.3.3–5. Highest Number of Potential Fatalities From the Transportation of Materials for Each Disposition Alternative[a]

Alternative	Highest Number of Potential Fatalities
Deep Borehole	
Direct Disposition	1.18
Immobilized Disposition	2.12
Immobilization	
Vitrification[e]	1.40
Ceramic Immobilization[e]	1.43
Electrometallurgical Treatment	0.923
Reactor	
Existing LWR[e]	5.65[b]
Partially Completed LWR	5.65[c]
Evolutionary LWR	5.65[c]
CANDU Reactor	5.00[d] [e]

[a] Highest potential number of fatalities from both radiological and nonradiological risks to the public and workers for the life of the project for both routine and accident conditions. Includes effects from the transport of Pu from existing storage sites to the pit disassembly/conversion site and Pu conversion site.

[b] Represents total fatalities for transportation with MOX fuel fabricated in the United States, shipped to a reactor in the United States, and the spent fuel shipped to a HLW repository. Because an existing LWR already has LEU fuel shipped to the site and would have spent fuel shipped from the site, the net incremental increase is 1.38 fatalities.

[c] Represents total fatalities for transportation with MOX fuel fabricated in the United States, shipped to a reactor in the United States, and the spent fuel shipped to a HLW repository.

[d] Represents total fatalities for transportation with MOX fuel fabricated in the United States and shipped to the Canadian border and does not include transportation impacts in Canada.

[e] Under the Preferred Alternative, for analysis purposes, approximately 30 percent of the total surplus Pu would be immobilized by either vitrification or ceramic immobilization, and the remaining highest surplus Pu would be used as MOX fuel in existing reactors. Accordingly, the highest number of potential fatalities for the Preferred Alternative would be lower than those for all the Reactor Alternatives.

Source: RADTRAN model results.

4.5 ENVIRONMENTAL JUSTICE IN MINORITY AND LOW-INCOME POPULATIONS

Pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,* this section identifies and addresses any disproportionately high and adverse human health or environmental effects on minority and low-income populations from activities described in previous sections of the PEIS. DOE is in the process of finalizing its Environmental Justice guidance. Because DOE is still in the process of developing guidance, the approach taken in this analysis may differ somewhat from whatever final guidance is eventually issued, and from the approach taken in other NEPA documents.

4.5.1 METHODOLOGY

Potential environmental justice impacts are assessed using a phased approach. This approach establishes four thresholds for assessing whether environmental justice issues are likely to arise as a result of proposed DOE activities. As described in DOE's draft guidance on incorporating environmental justice into the NEPA process, the following four questions form the framework and establish the thresholds for the phased approach to environmental justice analysis:

- Are there any potential impacts to human populations?
- Are there any potential impacts to minority populations or low-income populations?
- Are potential impacts to minority populations or low-income populations disproportionately high and adverse?
- Are any potential disproportionately high and adverse impacts "significant?"

Environmental Justice guidance developed by the Council on Environmental Quality (CEQ) defines "minority" as individual(s) who are members of the following population groups: American Indian or Alaskan Native, Asian or Pacific Islander, Black, not of Hispanic origin, or Hispanic (CEQ 1996a). Minority populations are identified when either the minority population of the affected area exceeds 50 percent or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis. Low-income populations are identified using statistical poverty thresholds from the Bureau of Census' Current Population Reports, Series P-60 on Income and Poverty.

Environmental justice impacts become issues of concern if the proposed activities result in disproportionately high adverse human and environmental effects to minority and low-income populations. Disproportionately high and adverse human health effects are identified by assessing these three factors to the extent practicable:

- Whether the health effects, which may be measured in risks or rates, are significant (as employed by NEPA) or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death;
- Whether the risk or rate of exposure by a minority population or low-income population to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and
- Whether health effects occur in a minority population or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

Previous sections in Chapter 3 describe employment and income, population, housing, and community services surrounding each site. Income distribution is presented in this section. Impacts for each ROI from implementation of proposed alternatives are analyzed in Chapter 4. Selected ROI demographic characteristics for racial/ethnic minority groups and low income populations are presented in Tables 4.5.1–1 through 4.5.1–7. [Text deleted.]

Any disproportionately high and adverse human health or environmental effects on minority populations and low-income populations that could result from the storage and disposition alternatives being considered are assessed for an 80-km (50-mi) area surrounding each of the eight DOE sites. [Text deleted.] The shaded areas in Figures 4.5.1–1, 4.5.1–3, 4.5.1–5, 4.5.1–7, 4.5.1–9, 4.5.1–11, 4.5.1–13, and 4.5.1–15 show 1990 Census tracts for each DOE site where racial/ethnic minorities comprise 50 percent or more (simple majority) of the total population, or where minorities comprise less than 50 percent but greater than 25 percent of the total population in the Census tract. Figures 4.5.1–2, 4.5.1–4, 4.5.1–6, 4.5.1–8, 4.5.1–10, 4.5.1–12, 4.5.1–14, and 4.5.1–16 show low-income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two). Data on geographic distribution of low income and minority populations and prevailing wind conditions are used to assess whether toxic/hazardous pollutants and radiological releases from the proposed actions would be emitted disproportionately in the direction of these populations. This assessment is then used to identify whether any of the alternatives would cause disproportionately high and adverse effects to minority or low income populations in the vicinity of the sites.

Potential Impacts on Minority and Low-Income Populations From Subsistence Consumption of Fish and Wildlife

Section 4.4 of Executive Order 12898 directs Federal agencies, "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that federal agencies communicate to the public the risks of these consumption patterns."

The potential environmental impacts of DOE activities on populations engaging in subsistence consumption could vary greatly depending on the precise location of a storage or disposition facility at a particular site, and the technology employed for the treatment or disposal of wastes at such a facility. In a prior NEPA review, incorporated herein by reference, DOE reviewed fish and wildlife consumption at Hanford, NTS, INEL, ORR, and SRS. At these sites, DOE found the potential impacts associated with the consumption of fish and wildlife to be small or to be no different than the potential impacts on the general population (DOE 1995v:5.20-11).

With regard to the impacts analyzed in this PEIS, and in the absence of subsistence consumption data by population sub-groups, DOE used the following criteria and assumptions, weighted in order of importance, to identify groups of sites that may be near minority and low-income populations potentially engaging in subsistence consumption:

- Proximity of Tribal Lands to DOE sites (the presence of Native Americans near DOE sites is assumed to create a greater possibility for subsistence consumption)
- Distance of the DOE site to major surface water bodies (populations nearer water are assumed to have a greater possibility of subsistence consumption of fish)
- Population density in the 80-km (50-mi) ROI around the site (rural residents are assumed to have a greater possibility of engaging in subsistence hunting and fishing)
- Proximity and concentration of minority and low-income populations to DOE sites (higher concentrations of minority and low-income populations are assumed to have a greater potential for subsistence consumption)

The eight DOE sites considered in this PEIS can be loosely categorized into three groups: those with the highest possibility for subsistence consumption, those with intermediate possibilities for subsistence consumption, and those with the lowest possibilities for subsistence consumption. Populations around more rural sites with recognized Native American groups are assumed more likely to engage in subsistence hunting and fishing. These sites include Hanford, INEL, LANL, and SRS. Although the areas around RFETS and NTS are more urban, these sites are of intermediate concern due to the presence of Native American populations or the presence of surface water onsite. ORR and Pantex are considered to have a lower possibility of populations who principally rely on fish and/or wildlife for subsistence, since there are no Federally recognized Native American groups around these two sites.

In order to assemble and disseminate information on subsistence hunting and fishing, DOE began publishing *A Department of Energy Environmental Justice Newsletter: Subsistence and Environmental Health* in the Spring of 1996. The three goals of the newsletter are (1) "to provide useful information about the health implications of consuming contaminated fish, wildlife, livestock products, or vegetation;" (2) "to provide information about projects and programs at DOE and other Federal and State agencies that address the problems associated with consuming contaminated fish, wildlife, livestock products, or vegetation;" and (3) "to receive relevant information from readers." In addition to the Newsletter, DOE has a new project underway to identify what information is being collected on subsistence consumption by other Federal agencies and to serve as a clearinghouse for such information.

In a recent article reviewing the literature on subsistence consumption, ANL found that (1) "the majority of the studies that have been conducted to date are focused on site- or region-specific exposure concerns...At present, it is unclear whether the findings of these studies are representative of consumption and exposure levels among minority populations at a national level;" (2) a large number of risk assessment studies focusing on fish and wildlife consumption examined whole populations without distinguishing between consumption and exposure patterns of specific ethnic (or other) subpopulations;" (3) "the vast majority of studies have focused on fish consumption as an exposure pathway. Few examined wildlife consumption and contamination, and even in such cases the studies were not motivated by minority exposure concerns;" and (4) "the majority populations to be significantly higher than for the population as a whole" (ANL 1994a:1).

Table 4.5.1–1. Selected Demographic Characteristics for the Hanford Site Region of Influence

Characteristics/Area	Benton County (number)	Franklin County (number)	Yakima County (number)	Total Region of Influence	
				(number)	(percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	99,778	23,784	132,147	255,709	75.5
Hispanic	8,624	11,316	45,114	65,054	19.2
Non-Hispanic, American Indian	792	217	7,695	8,704	2.6
Non-Hispanic, Black	1,054	1,251	1,785	4,090	1.2
Non-Hispanic, Asian/Pacific Islander	2,196	805	1,667	4,668	1.4
Non-Hispanic, Other	116	100	415	631	0.2
Total 1990 Population	112,560	37,473	188,823	338,856	
1989 Low Income					
Persons below poverty					
Number	12,402	8,491	37,486	58,379	
Percent[a]	11.1	23.0	20.2		17.4

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–2. Selected Demographic Characteristics for the Nevada Test Site Region of Influence

Characteristics/Area	Clark County (number)	Nye County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity				
Non-Hispanic, White	558,875	15,635	574,510	75.7
Hispanic	82,904	1,237	84,141	11.1
Non-Hispanic, American Indian	5,514	475	5,989	0.8
Non-Hispanic, Black	68,858	274	69,132	9.1
Non-Hispanic, Asian/Pacific Islander	24,483	148	24,631	3.2
Non-Hispanic, Other	825	12	837	0.1
Total 1990 Population	741,459	17,781	759,240	
1989 Low Income				
Persons below poverty				
Number	76,737	1,840	78,577	
Percent[a]	10.5	10.5		10.5

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–3. Selected Demographic Characteristics for the Idaho National Engineering Laboratory Region of Influence

Characteristics/Area	Bannock County (number)	Bingham County (number)	Bonneville County (number)	Butte County (number)	Jefferson County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity							
Non-Hispanic, White	60,626	31,412	67,879	2,791	15,219	177,927	91.1
Hispanic	2,740	3,614	3,010	101	1,155	10,620	5.4
Non-Hispanic, American Indian	1,509	2,209	343	21	109	4,191	2.1
Non-Hispanic, Black	415	31	286	0	3	735	0.4
Non-Hispanic, Asian/Pacific Islander	697	284	663	5	40	1689	0.9
Non-Hispanic, Other	39	33	26	0	17	115	0.1
Total 1990 Population	66,026	37,583	72,207	2,918	16,543	195,277	
1989 Low Income							
Persons below poverty							
Number	8,944	5,804	7,056	392	2,353	25,449	
Percent[a]	13.8	15.6	9.9	13.5	14.3		13.2

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–4. Selected Demographic Characteristics for the Pantex Plant Region of Influence

Characteristics/Area	Armstrong County (number)	Carson County (number)	Potter County (number)	Randall County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	1,951	6,158	66,877	81,364	156,350	79.7
Hispanic	55	354	19,246	6,144	25,799	13.1
Non-Hispanic, American Indian	9	41	709	414	1,173	0.6
Non-Hispanic, Black	0	11	8,460	1,082	9,553	4.9
Non-Hispanic, Asian/Pacific Islander	5	9	2,431	626	3,071	1.6
Non-Hispanic, Other	1	3	151	43	198	0.1
Total 1990 Population	2,021	6,576	97,874	89,673	196,144	
1989 Low Income						
Persons below poverty						
Number	232	583	21,619	7,819	30,253	
Percent[a]	11.8	9.0	22.5	8.9		15.7

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–5. Selected Demographic Characteristics for the Oak Ridge Reservation Region of Influence

Characteristics/Area	Anderson County (number)	Knox County (number)	Loudon County (number)	Roane County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	64,320	300,040	30,668	45,274	440,302	91.3
Hispanic	381	2,067	83	212	2,743	0.6
Non-Hispanic, American Indian	236	775	52	95	1,158	0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092	7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035	0.8
Non-Hispanic, Other	23	121	3	4	151	0.0
Total 1990 Population	68,250	335,749	31,255	47,227	482,481	
1989 Low Income						
Persons below poverty						
Number	9,664	45,608	4,192	7,467	66,931	
Percent[a]	14.3	14.1	13.6	16.0		14.8

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–6. *Selected Demographic Characteristics for the Savannah River Site Region of Influence*

Characteristics/Area	South Carolina				Georgia		Total Region of Influence	
	Aiken County (number)	Allendale County (number)	Bamberg County (number)	Barnwell County (number)	Columbia County (number)	Richmond County (number)	(number)	(percent)
Persons by Race/Ethnicity								
Non-Hispanic, White	90,130	3,598	6,428	11,421	56,141	103,009	270,727	63.6
Hispanic	867	161	75	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	11	22	31	150	491	918	0.2
Non-Hispanic, Black	29,176	7,939	10,356	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	7	20	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	6	1	1	21	105	160	0.0
Total 1990 Population	120,940	11,722	16,902	20,293	66,031	189,719	425,607	
1989 Low Income								
Persons below poverty								
Number	16,671	3,837	4,547	4,367	4,255	32,590	66,267	
Percent[a]	14.0	35.8	28.2	21.8	6.6	18.2		16.2

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

Table 4.5.1–7. Selected Demographic Characteristics for the Rocky Flats Environmental Technology Site Region of Influence

Characteristics/Area	Adams County (number)	Arapahoe County (number)	Boulder County (number)	Denver County (number)	Jefferson County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity							
Non-Hispanic, White	198,710	334,225	201,617	287,162	394,946	1,416,660	79.2
Hispanic	49,179	21,743	15,195	107,382	30,791	224,290	12.5
Non-Hispanic, American Indian	1,824	1,790	1,092	3,761	2,019	10,486	0.6
Non-Hispanic, Black	8,445	22,653	1,879	57,793	3,014	93,784	5.2
Non-Hispanic, Asian/Pacific Islander	6,482	10,796	5,359	10,159	7,365	40,161	2.2
Non-Hispanic, Other	398	304	197	1,353	295	2,547	0.1
Total 1990 Population	265,038	391,511	225,339	467,610	438,430	1,787,928	
1989 Low Income							
Persons below poverty							
Number	27,267	22,973	23,738	78,515	24,926	177,419	
Percent[a]	10.4	5.9	11.0	17.1	5.8		10.1

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.

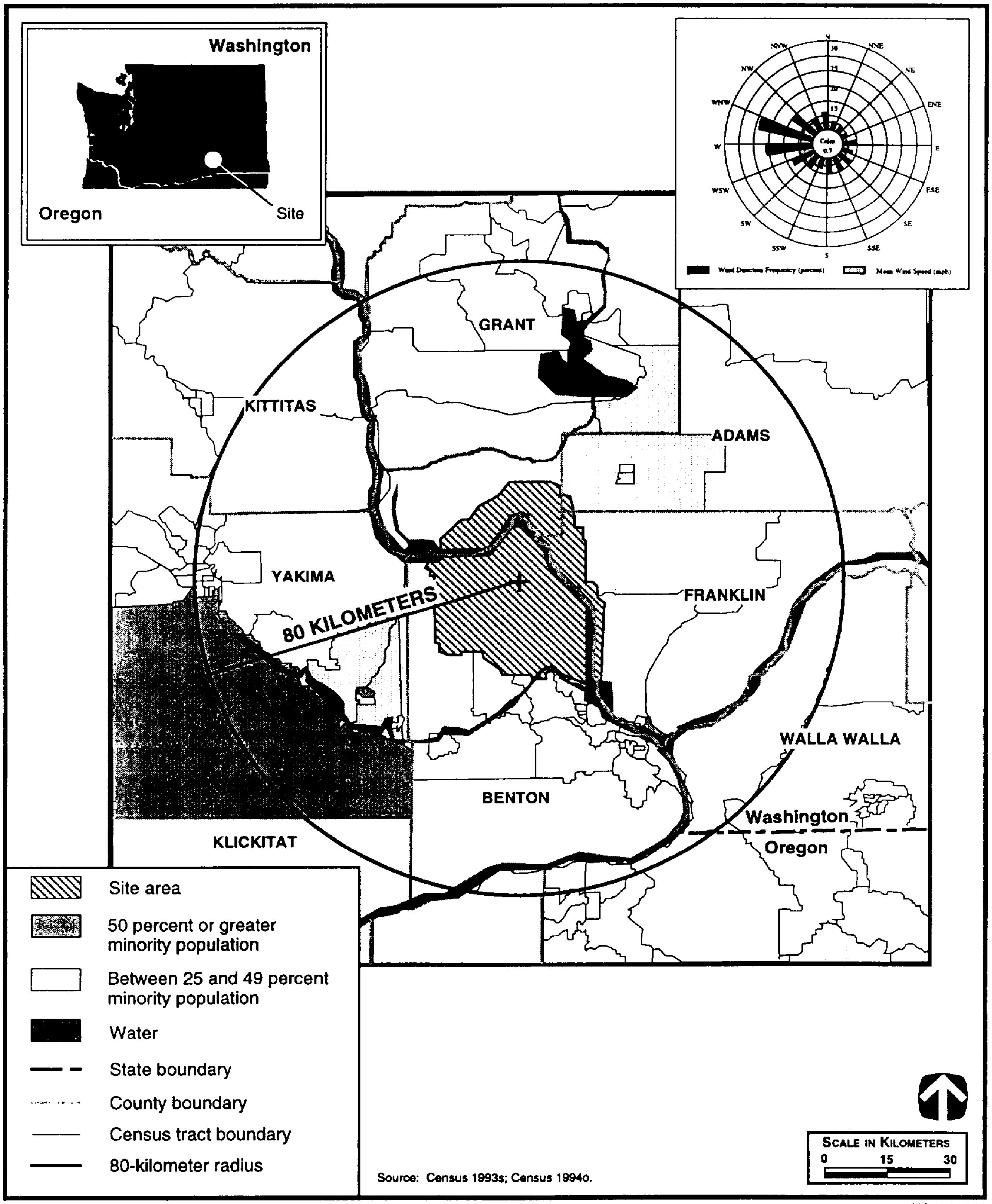
Table 4.5.1–8. Selected Demographic Characteristics for the Los Alamos National Laboratory Region of Influence

Characteristics/Area	Los Alamos County (number)	Rio Arriba County (number)	Santa Fe County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	15,467	4,375	46,450	66,292	43.8
Hispanic	2,008	24,955	48,939	75,902	50.1
Non-Hispanic, American Indian	112	4,830	2,284	7,226	4.8
Non-Hispanic, Black	88	117	505	710	0.5
Non-Hispanic, Asian/Pacific Islander	421	40	439	900	0.6
Non-Hispanic, Other	18,115	34,365	98,928	151,408	100
Total 1990 Population					
1989 Low Income					
Persons below poverty					
Number	433	9,372	12,564	22,369	
Percent[a]	2.4	27.5	13	15.0	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population, including inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Note: May not total 100 percent due to rounding.

Source: Census 1993s; Census 1994o.



2992-HAN/S&D

Figure 4.5.1–1. Minority Population Distribution for Hanford Site and Surrounding Area.

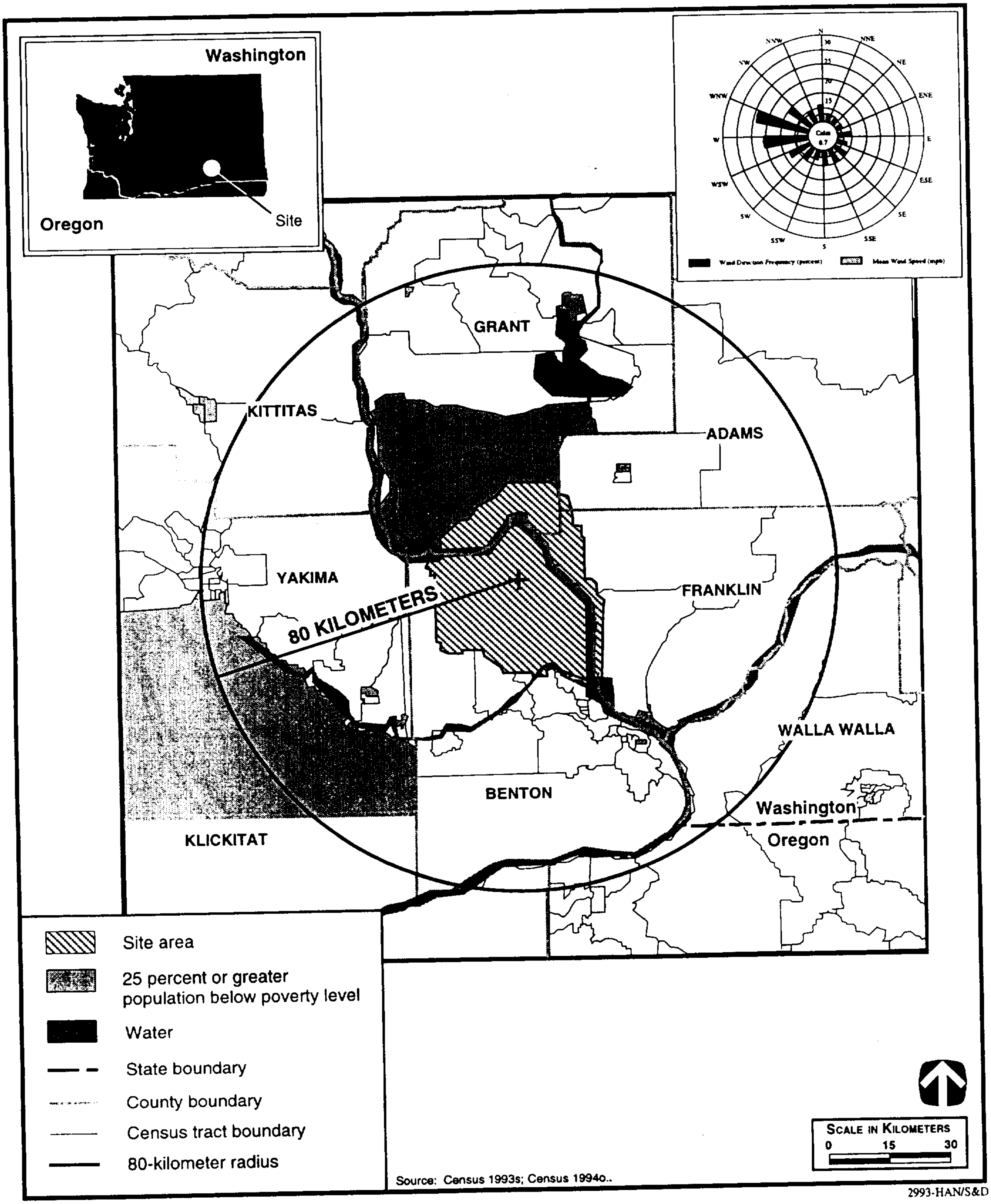


Figure 4.5.1–2. Low-Income Distribution by Poverty Status for Hanford Site and Surrounding Area.

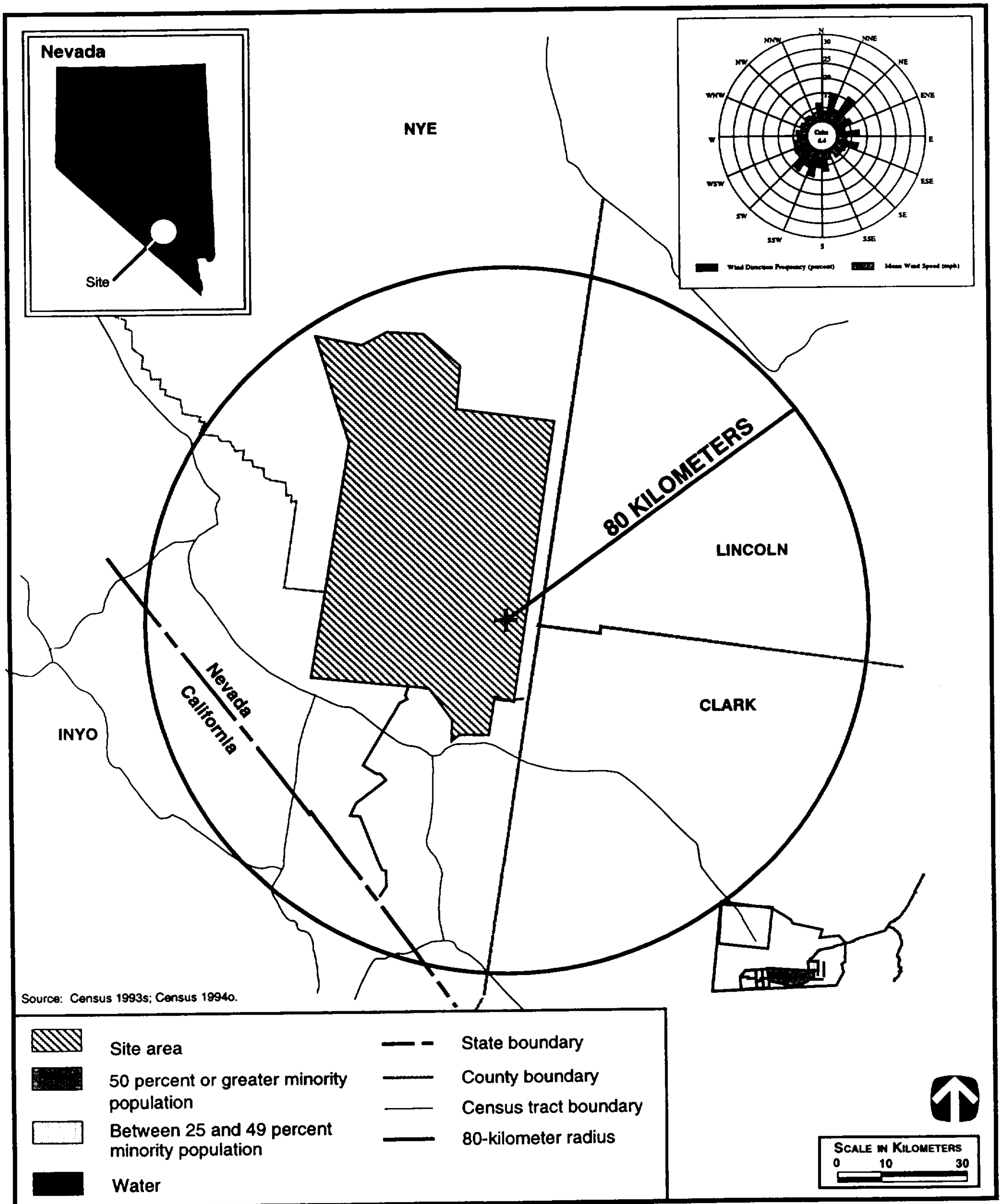


Figure 4.5.1–3. Minority Population Distribution for Nevada Test Site and Surrounding Area.

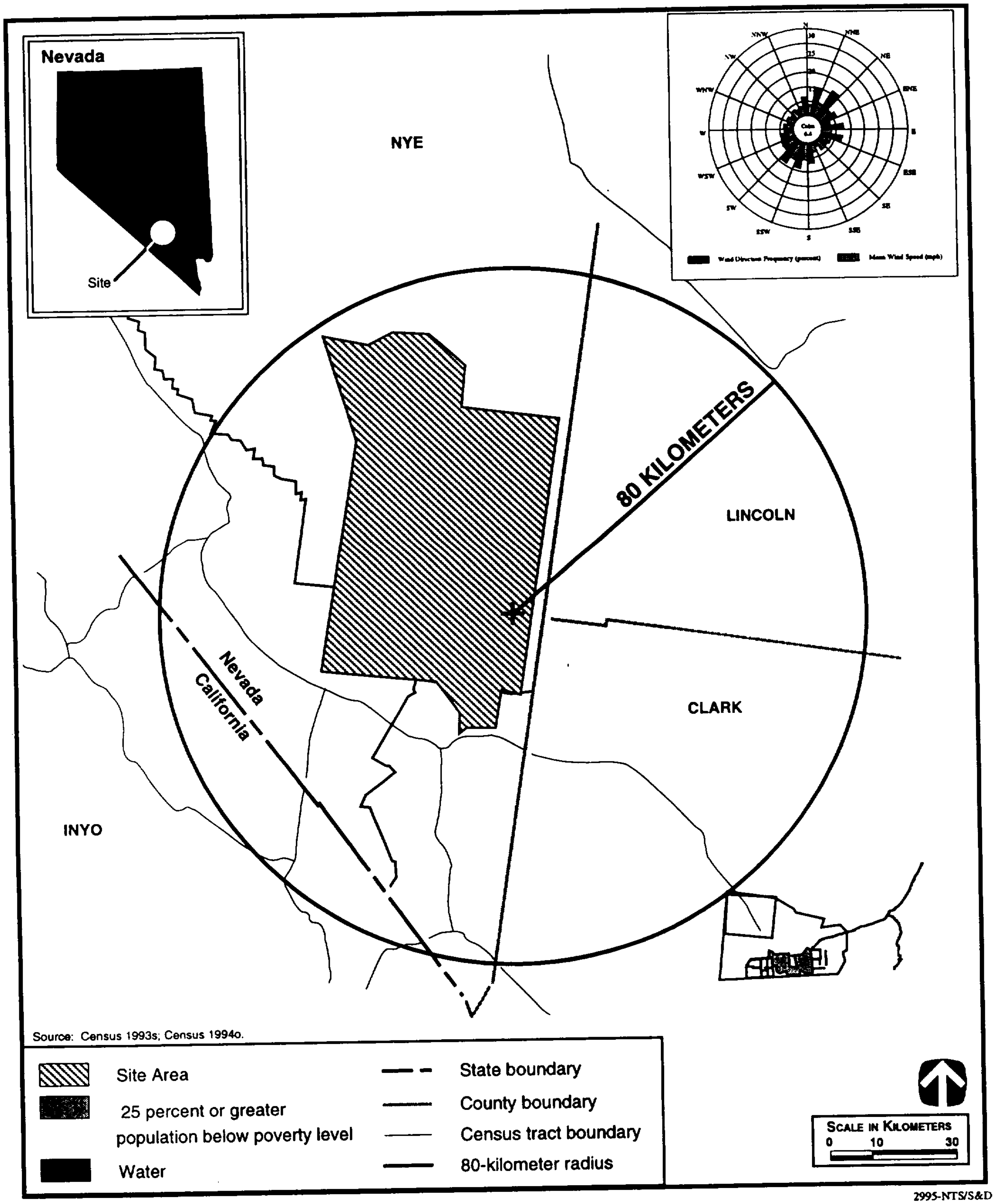
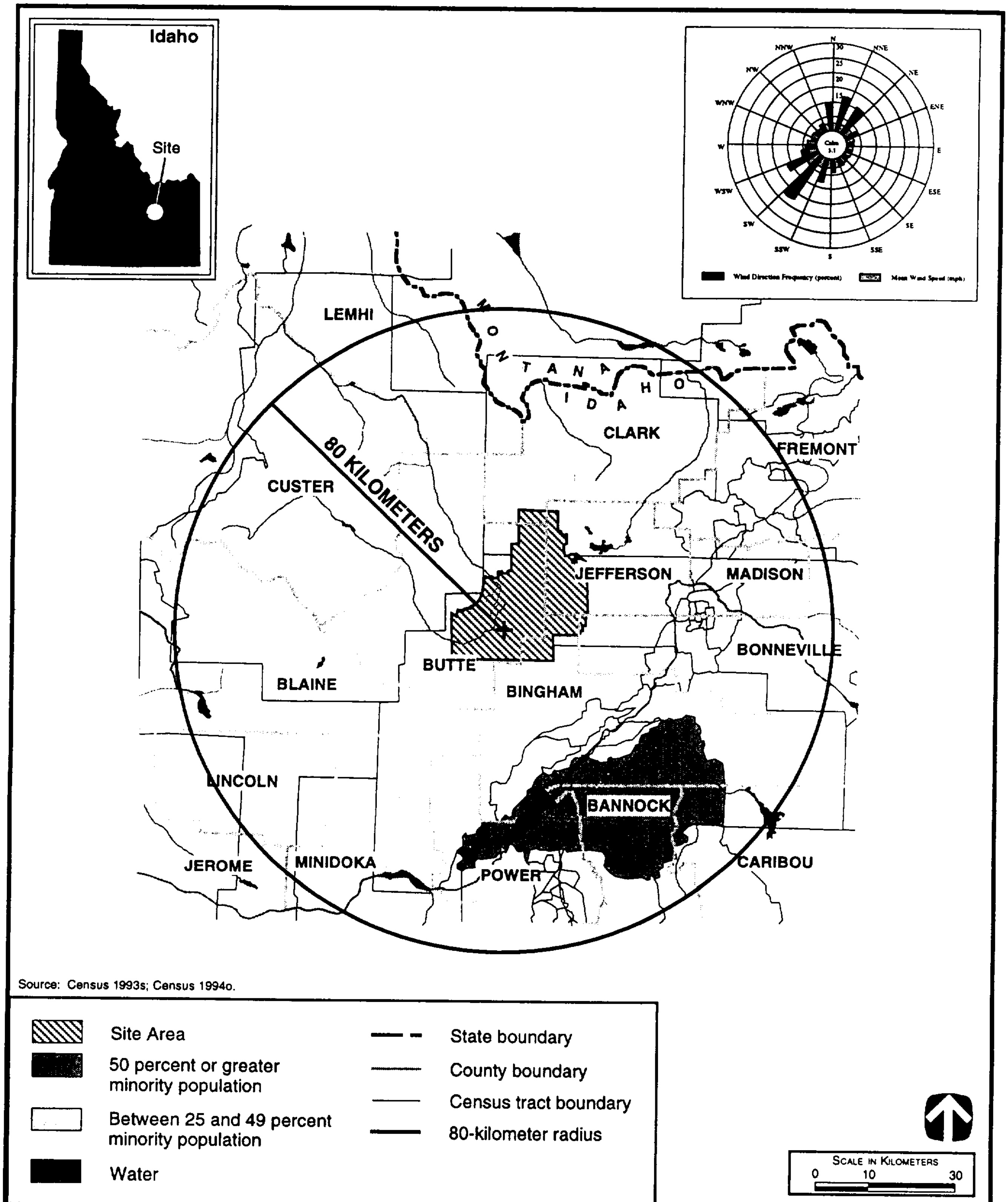


Figure 4.5.1–4. Low-Income Distribution by Poverty Status for Nevada Test Site and Surrounding Area.



2996-INEL/S&D

Figure 4.5.1–5. Minority Population Distribution for Idaho National Engineering Laboratory and Surrounding Area.

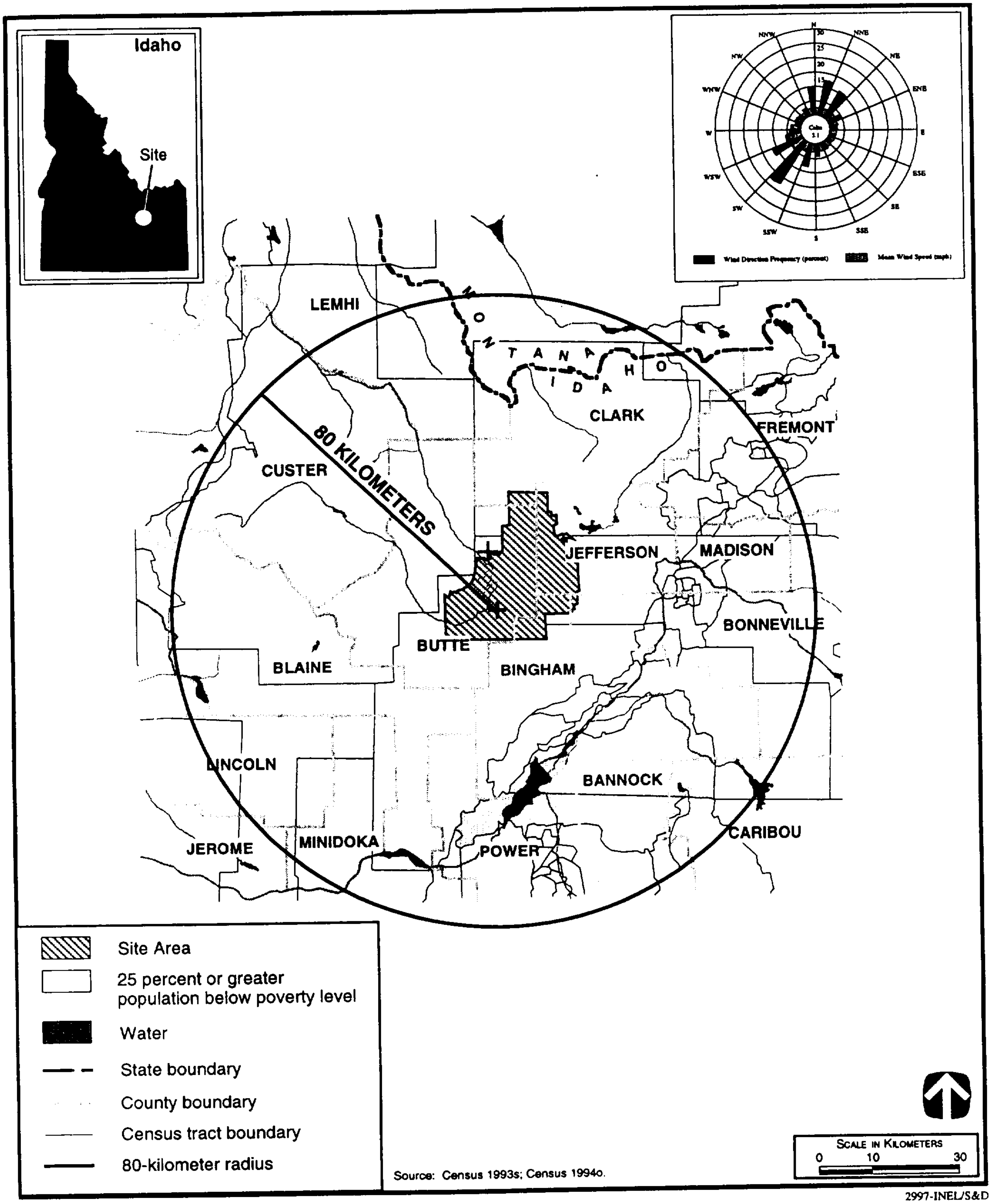


Figure 4.5.1–6. Low-Income Distribution by Poverty Status for Idaho National Engineering Laboratory and Surrounding Area.

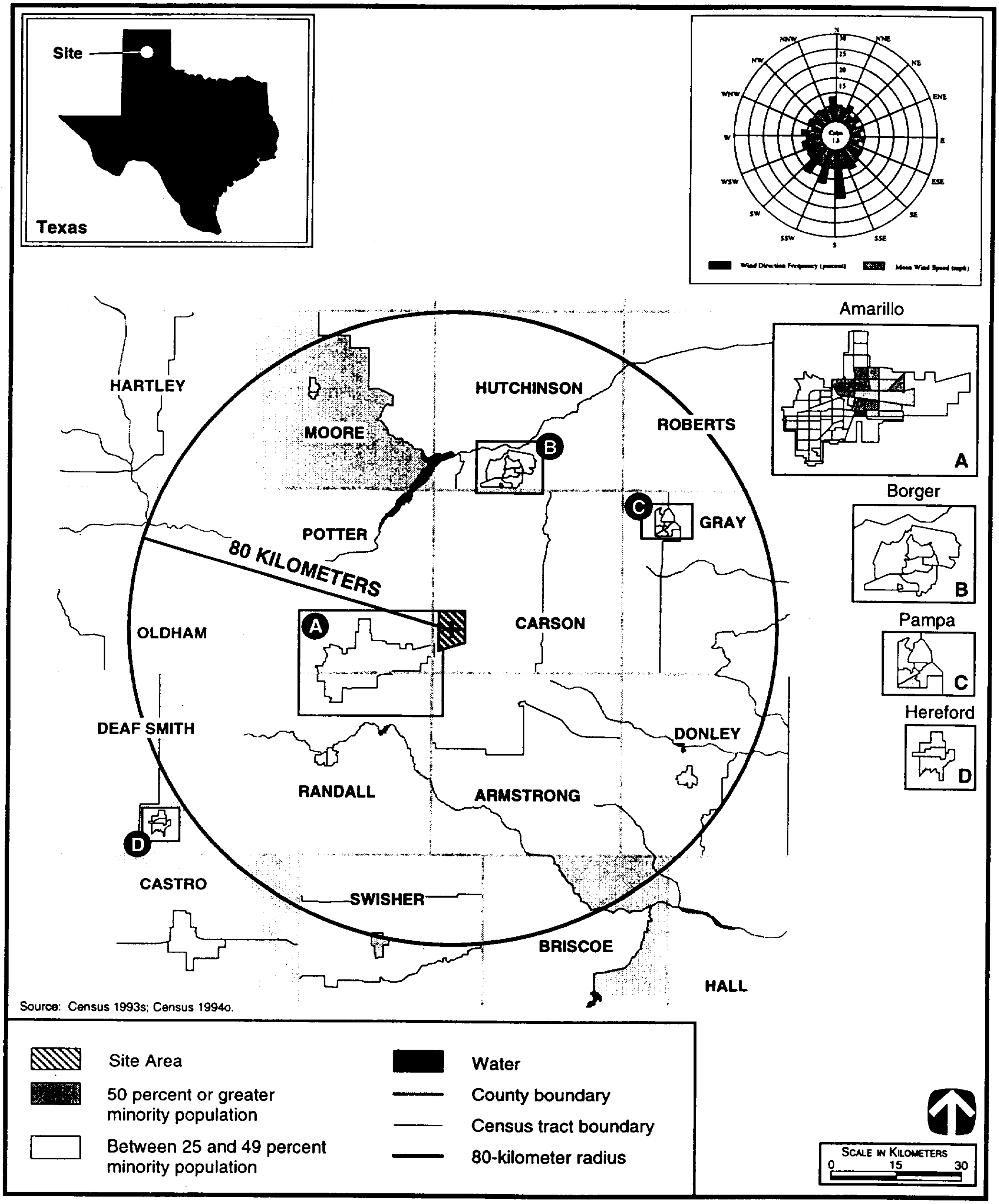


Figure 4.5.1–7. Minority Population Distribution for Pantex Plant and Surrounding Area.

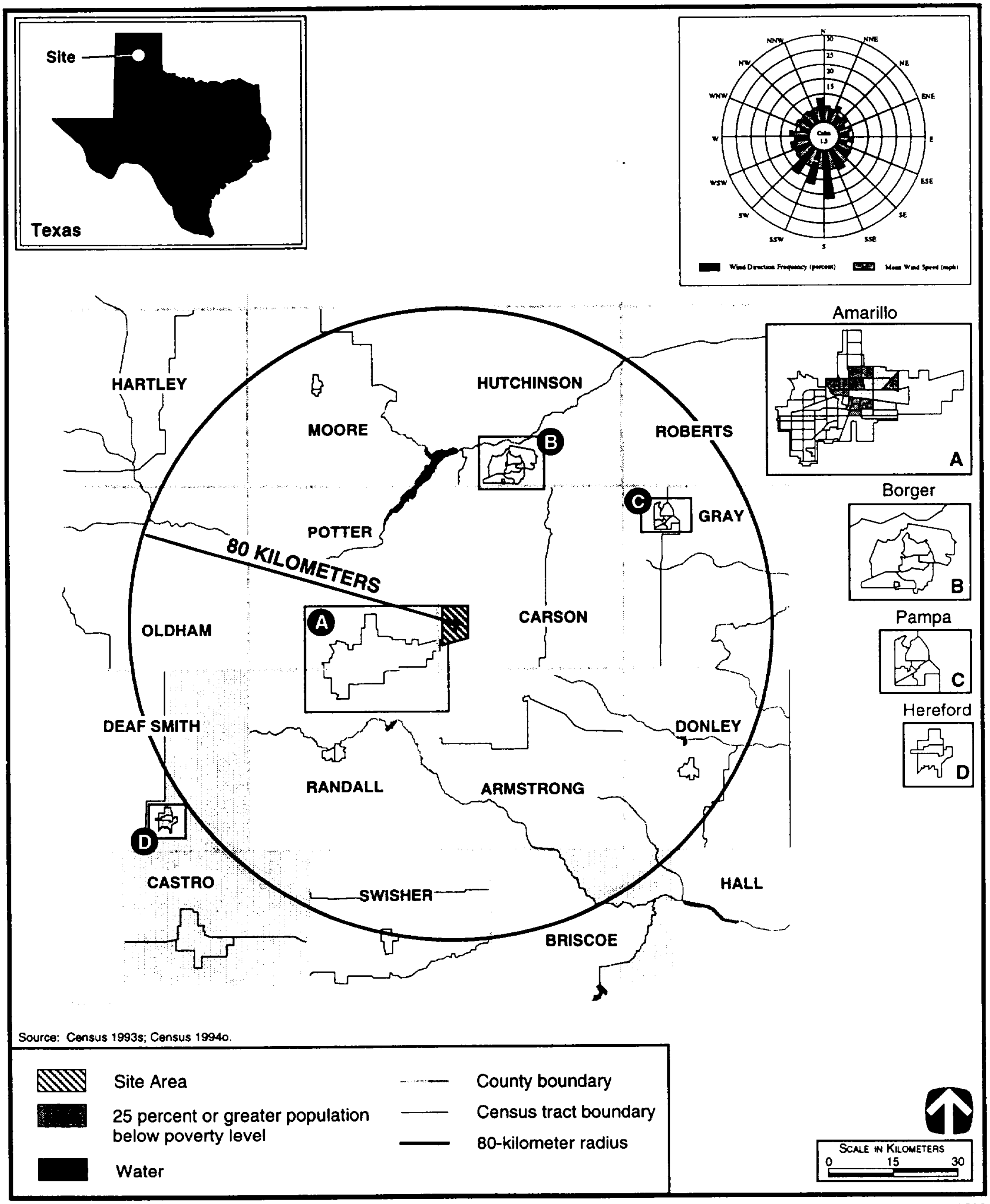


Figure 4.5.1–8. Low-Income Distribution by Poverty Status for Pantex Plant and Surrounding Area.

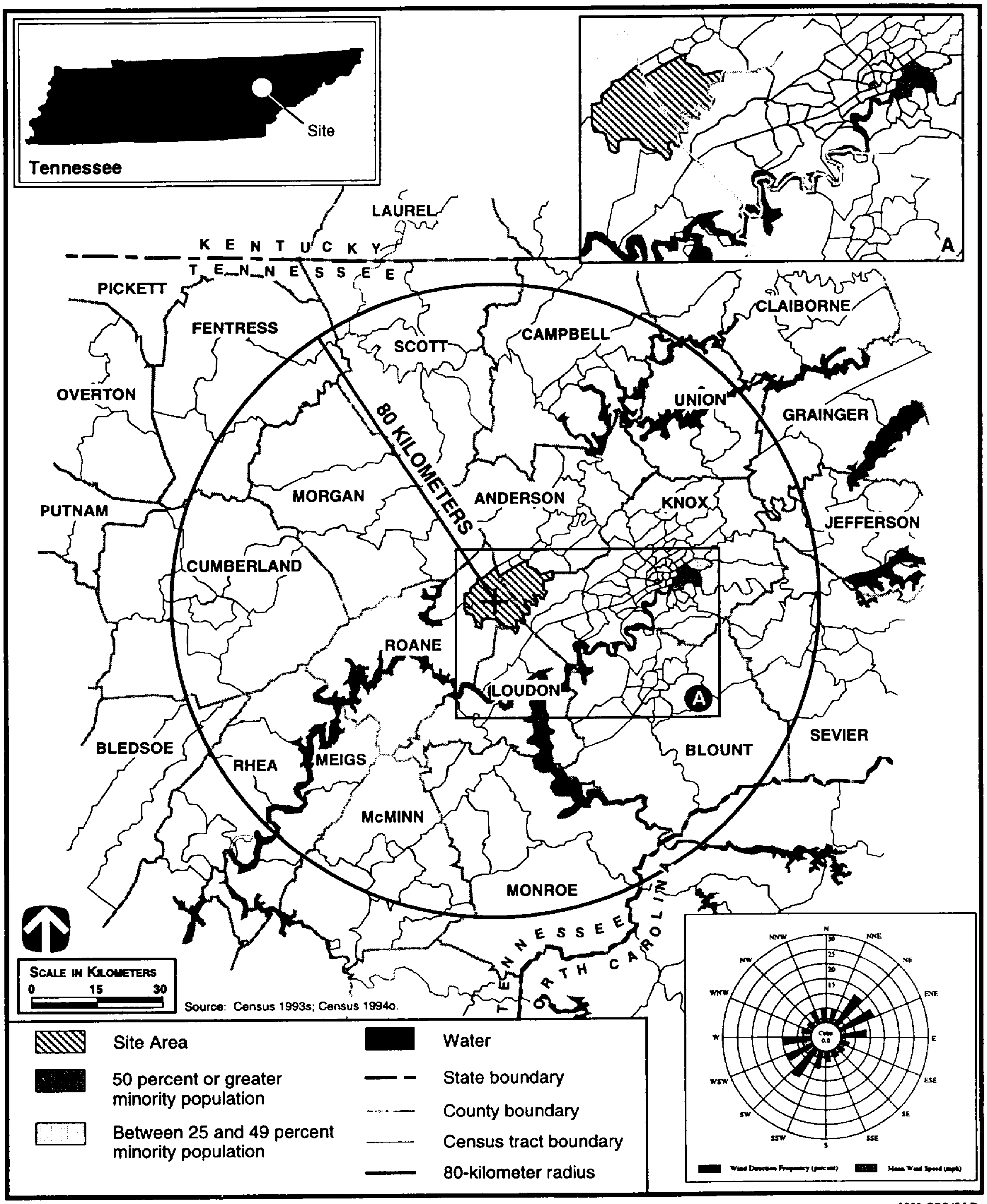


Figure 4.5.1–9. Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.

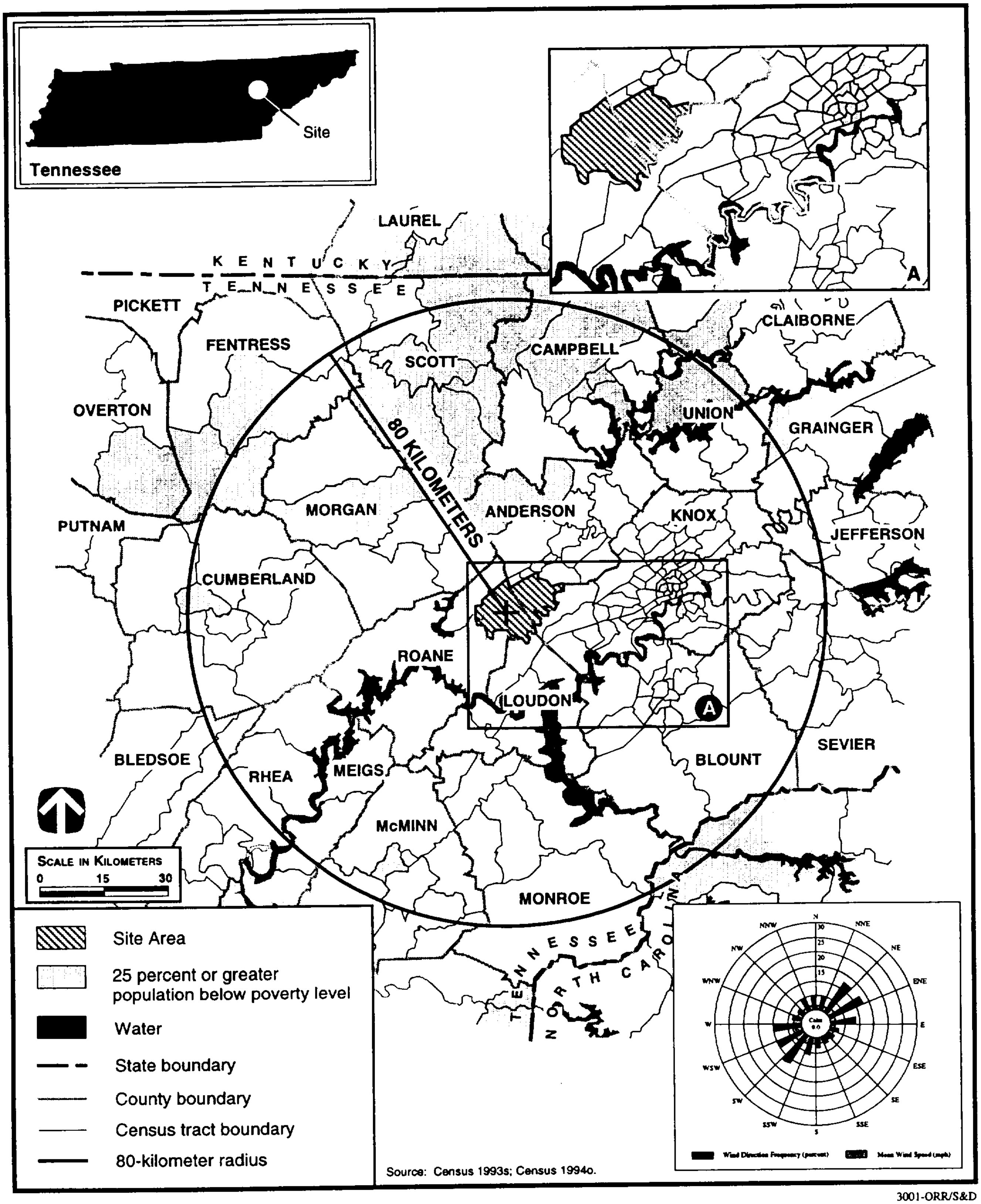


Figure 4.5.1–10. Low-Income Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.

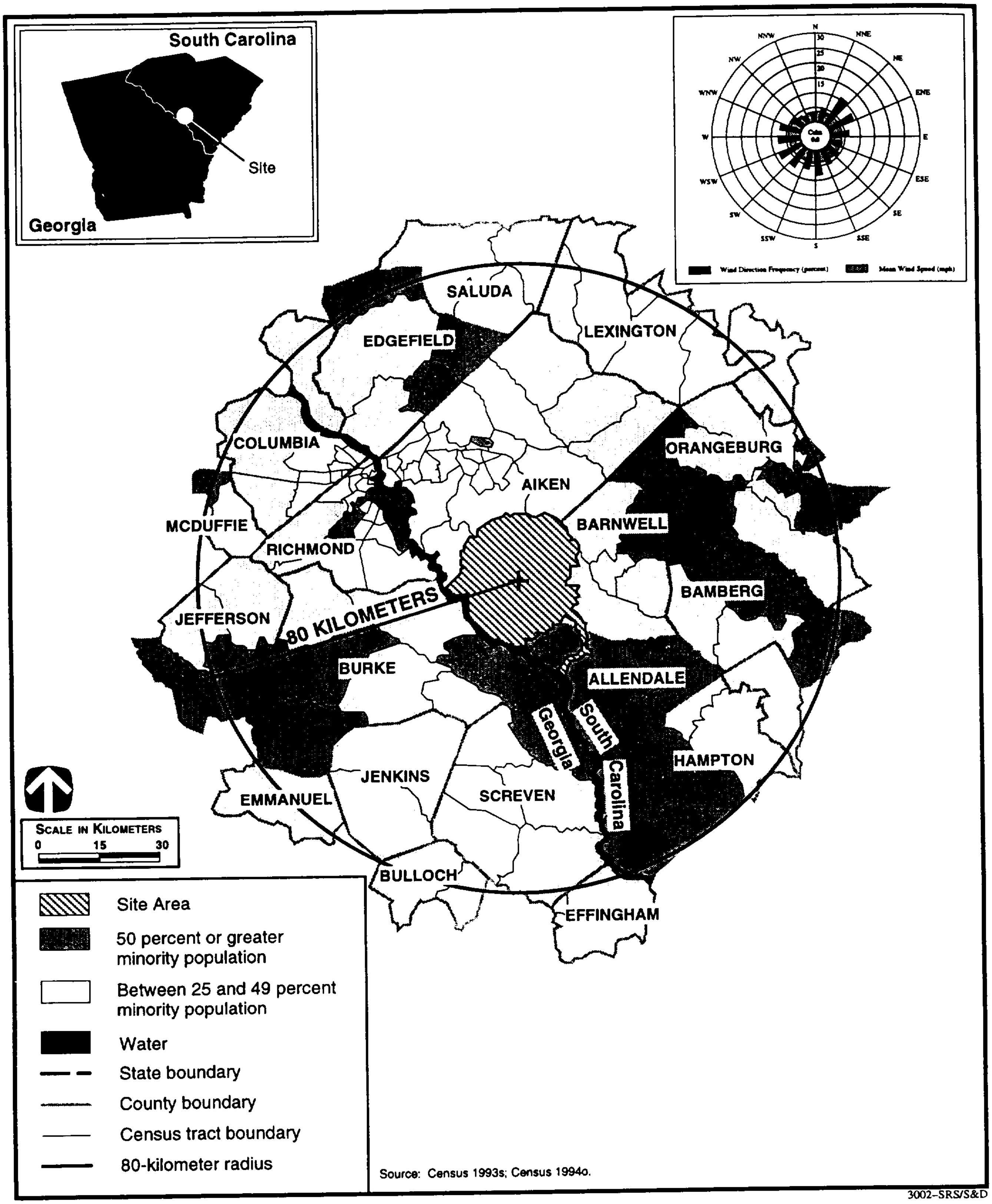


Figure 4.5.1–11. Minority Population Distribution for Savannah River Site and Surrounding Area.

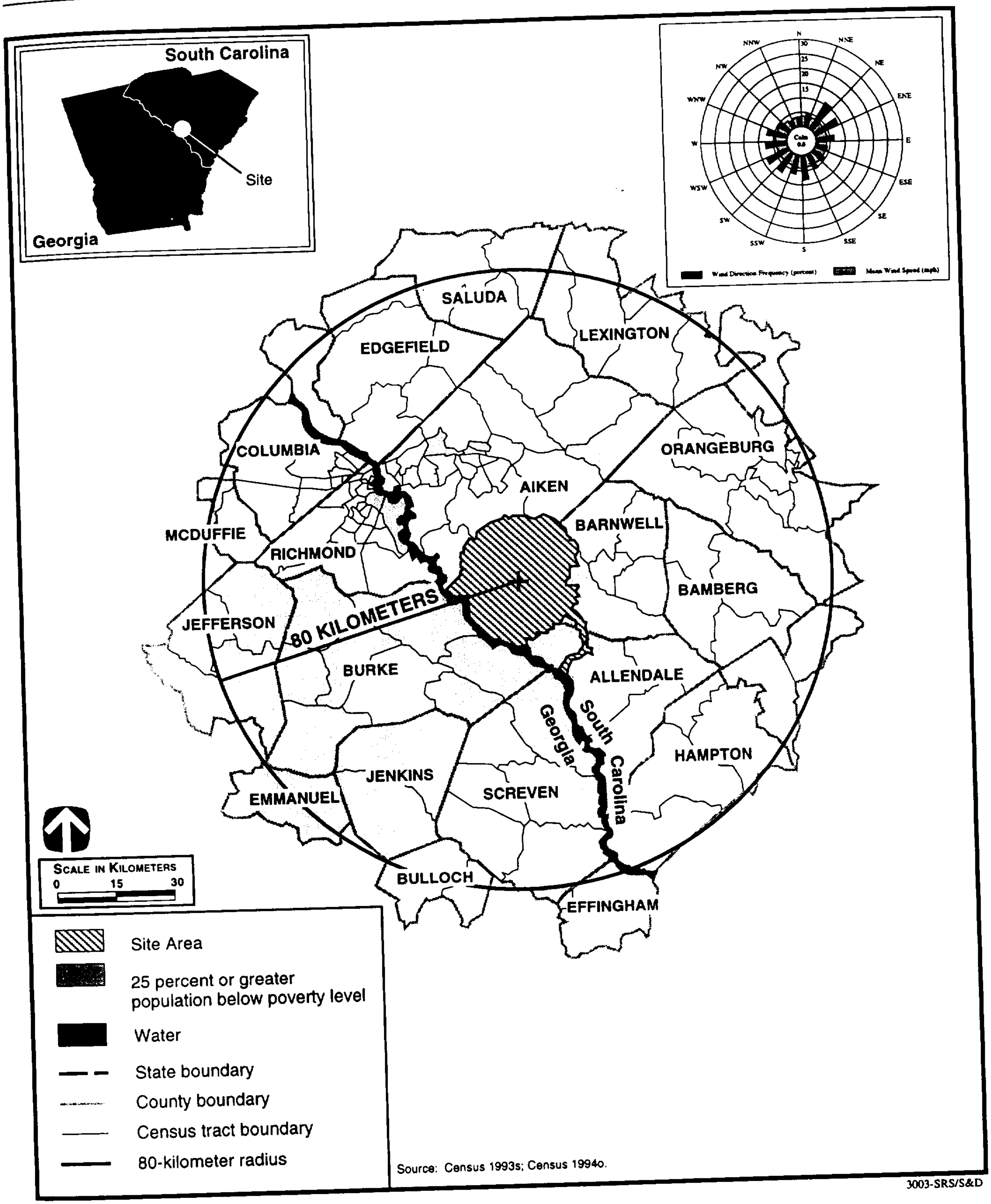


Figure 4.5.1–12. Low-Income Distribution by Poverty Status for Savannah River Site and Surrounding Area.

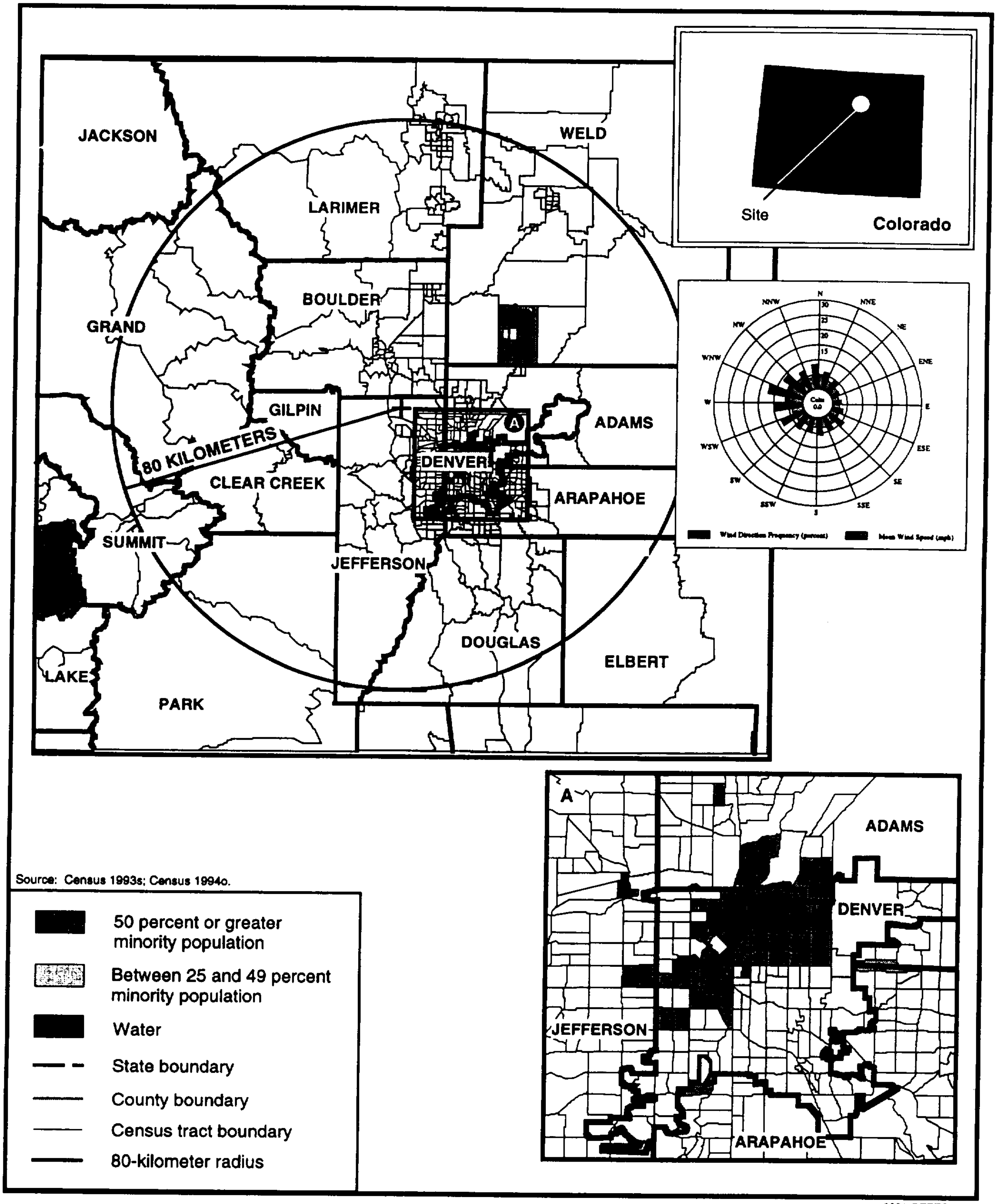


Figure 4.5.1–13. Minority Population Distribution for Rocky Flats Environmental Technology Site and Surrounding Area.

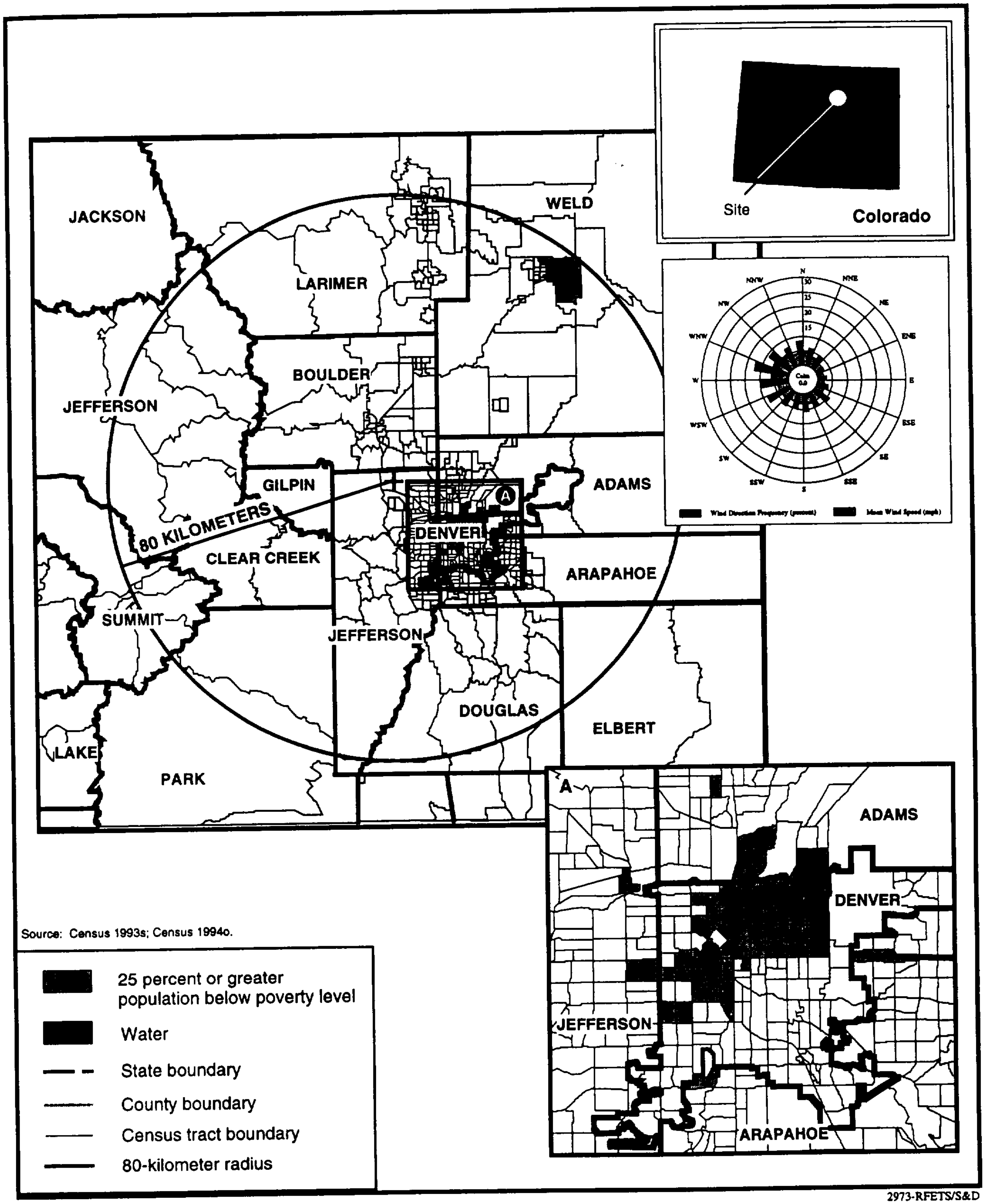


Figure 4.5.1–14. Low-Income Distribution by Poverty Status for Rocky Flats Environmental Technology Site and Suronding Area.

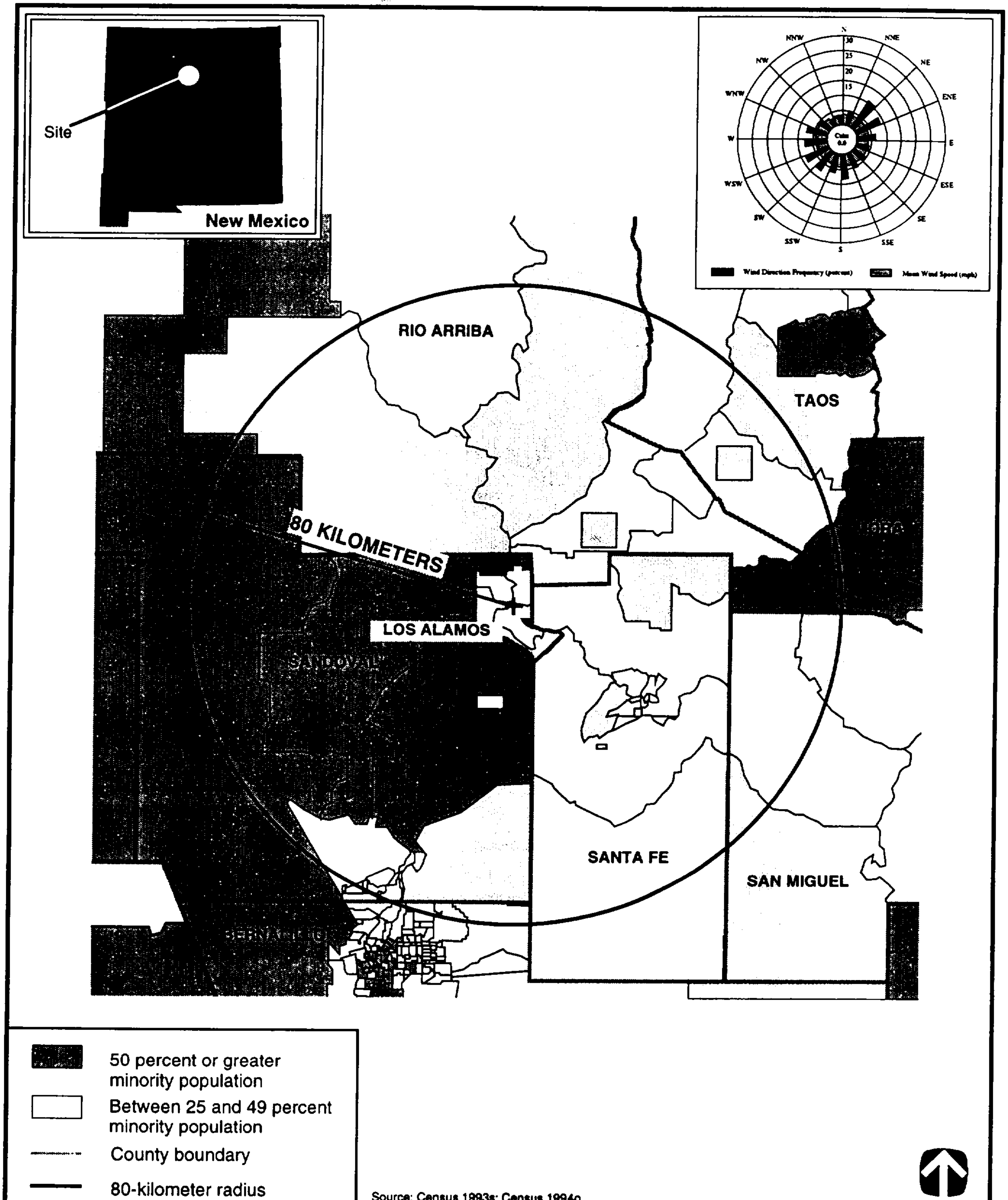


Figure 4.5.1–15. Minority Population Distribution for Los Alamos National Laboratory and Surrounding Area.

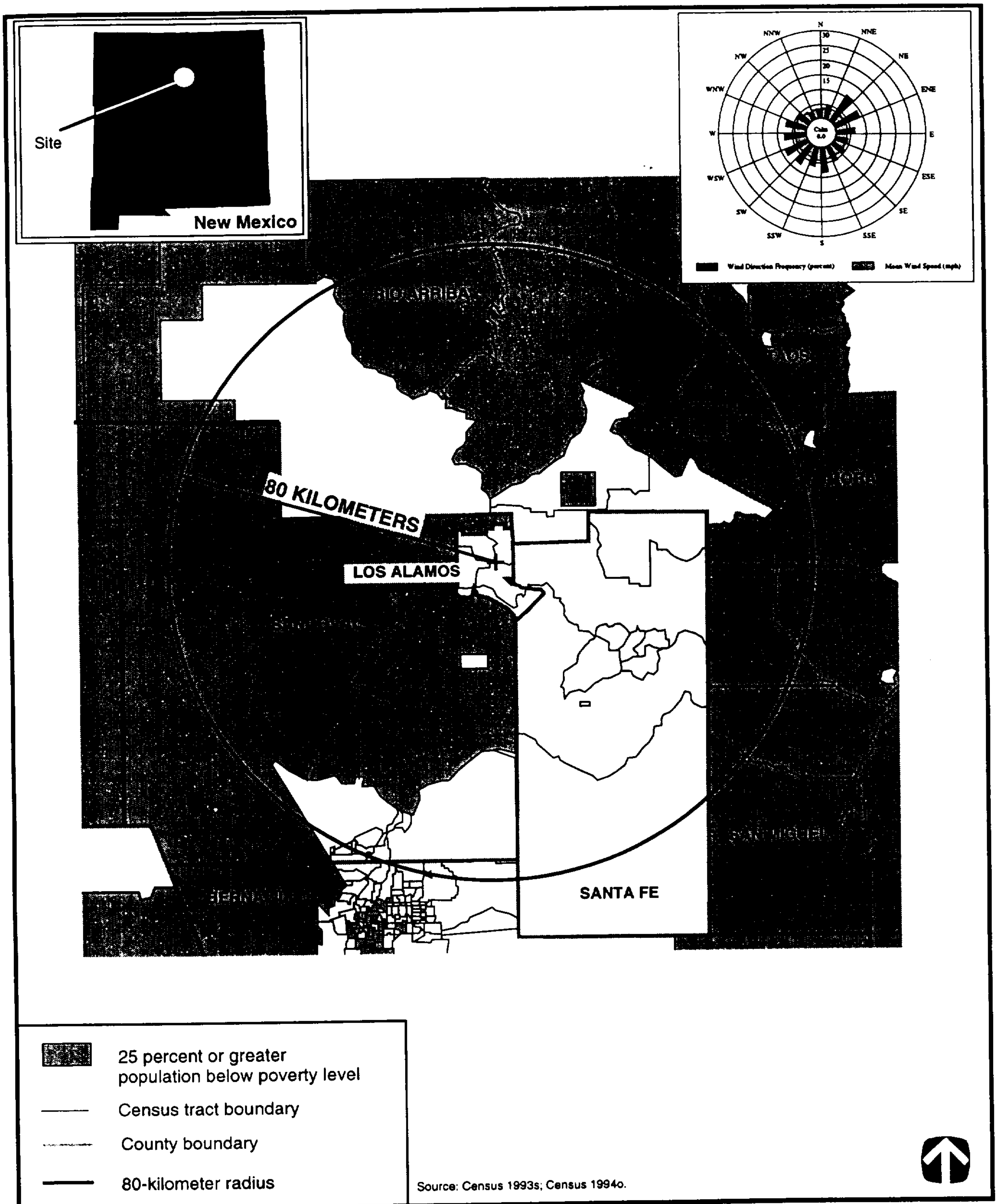


Figure 4.5.1–16. Low-Income Distribution by Poverty Status for Los Alamos National Laboratory and Surrounding Area.

4.5.2 ENVIRONMENTAL CONSEQUENCES

As seen in Figures 4.5.1–1 through 4.5.1–16, minority populations and low-income populations reside within 80 km (50 mi) of each of the DOE sites. The density and distribution of these populations vary from site to site with SRS and LANL having relatively large low-income populations and minority populations and NTS with relatively small low-income populations and minority populations within an 80-km (50-mi) radius of the site. Tables 4.5.1–1 through 4.5.1–8 provide demographic statistics for the ROIs used in the socioeconomic analysis.

For environmental justice impacts to occur, there must be high and adverse human health or environmental impacts that disproportionately affect minority populations or low-income populations. The public health and safety analysis shows that air emissions and hazardous chemical and radiological releases from normal operations for all storage and disposition alternatives would be within regulatory limits and that no latent cancer fatalities would result.

The public health and safety analyses also indicate that radiological releases from accidents would not result in significant adverse human health or environmental impacts. Therefore, such accidents would not have disproportionately high and adverse impacts on minority or low-income populations. For the Preferred Alternative, for accidents associated with existing reactors using MOX fuel, the maximum risk (which includes accident probability) of latent cancer fatalities to the public within 80 km (50 mi) would be 0.10 for the 11-year Pu disposition campaign. It is unlikely that there would be disproportionately high and adverse impacts to minority populations or low-income populations surrounding the existing reactors.

The Preferred Alternative would potentially combine different technologies and facilities at a number of sites. As discussed in Section 4.6, there would be no high or adverse impacts from routine operations or accidents, for such a combination of activities, that would disproportionately affect minority or low-income nonworker populations.

The environmental justice analysis also takes into account potential impacts to subsistence populations. However, DOE is unaware of any identified subsistence populations residing on or near any of the alternative sites.

The Department also notes that because none of the alternatives would lead to radiological releases to water that exceed Federal and State regulations, there would be no incremental impacts to fish or other edible aquatic life in the areas surrounding the alternative sites. All chemical releases would be regulated by NPDES permits and would be in compliance with Federal and State regulations. Furthermore, this PEIS evaluates doses to the surrounding population through air and liquid exposures for all alternatives, including No Action.

The analyses indicates that socioeconomic changes resulting from implementing any of the proposed alternatives would not lead to environmental justice impacts. Most alternatives would provide economic benefits through generating additional employment and income in the affected regions. At some sites there would be increased traffic congestion during facility construction or modification, however this impact would be temporary and would not disproportionately affect minority or low income communities. [Text deleted.] Regional income and employment would never decrease by more than one percent during phaseout, and at INEL, LANL, and Pantex, phaseout would have virtually no impact on either site or regional employment levels.

Transportation accidents are random occurrences that could potentially affect the population around the accident site. However, the random nature of these accidents precludes any disproportionate impact to minority or low income populations.

4.6 SUMMARY OF IMPACTS

The reasonable action alternatives analyzed in the PEIS are this Preferred Alternative, three long-term storage alternatives, and nine disposition alternatives (3 categories). The long-term storage alternatives, the disposition by immobilization alternative, and the Preferred Alternative all have suboptions or variants. In addition to these alternatives, the No Action Alternative has been analyzed for storage and disposition. The potential environmental impacts described in the following sections represent the impacts resulting from each alternative. Detailed explanations and the supporting data for the statements made and conclusions drawn are contained in Sections 4.1 through 4.5.

4.6.1 PREFERRED ALTERNATIVE IMPACTS

The Department's Preferred Alternative for storage and disposition is shown in Table 4.6.1–1. For long-term storage, DOE's Preferred Alternative is a combination of No Action, upgrade, and phaseout for the various DOE sites. For disposition of surplus Pu, the Preferred Alternative is a combination of reactor and immobilization alternatives.

Table 4.6.1–1. Storage and Disposition Actions at Department of Energy Sites Proposed by the Preferred Alternative

Action	Hanford	NTS	INEL	Pantex	ORR	SRS	RFETS	LANL
Storage								
No Action	X[a]	X[b]	X[a]					X[a]
Upgrade				X[c]	X[d]	X[e]		
Phaseout							X	
Disposition[f]								
Pit disassembly/conversion	X		X	X		X		
MOX fuel fabrication	X		X	X		X		
Pu conversion	X					X		
Immobilization	X					X		

[a] Pending subsequent tiered NEPA analysis for disposition of surplus Pu at these sites.
[b] NTS does not currently store either Pu or HEU.
[c] For storage of those pits currently at Pantex, pits from RFETS, and strategic reserve pits only.
[d] For storage of HEU only.
[e] For storage of only those Pu materials currently at SRS and non-pit Pu materials from RFETS.
[f] "X" denotes potential sites for locating the disposition facilities pending subsequent tiered NEPA decisions. Only one of each facility is needed for accomplishing the disposition mission.

Impacts from Storage Actions Under the Preferred Alternative

The Department's Preferred Alternative for the long-term storage of surplus Pu is a combination of No Action, upgrade, and phaseout for the various DOE sites. Table 4.6.1–2 shows the incremental operation requirements, public health risk, and waste generation that would result from the storage actions under the Preferred Alternative.

Land Resources. The implementation of the storage actions under the Preferred Alternative would have no additional impact to land resources and visual resources at all sites except Pantex. The upgrade actions at Pantex would require 0.1 ha (0.25 acre) of land. The amount of land required is a very small portion of the land available for development at the site. The proposed upgrade would be consistent with current and future land-use plans for the site.

Table 4.6.1–2. Incremental Impact Indicators Over No Action From the Annual Operation of the Storage Actions Under the Preferred Alternative

	Hanford No Action	NTS No Action	INEL No Action	Pantex Upgrade[a]	ORR Upgrade	SRS Upgrade[b]	RFETS Phaseout	LANL No Action
Land area used (ha)	0	0	0	0.1	0	0	0	0
Water usage (MLY)	0	0	0	27.5	3	7.1	0	0
Maximum direct employment	0	0	0	90	111	130	-2179	0
Risk of fatal cancer for MEI from lifetime operation	0	0	0	$4.5x10^{-13}$	$5.5x10^{-13}$	$2.1x10^{-10}$	0	0
Solid TRU waste (m^3/yr)	0	0	0	0.8	0	0	0	0
Solid low-level waste (m^3/yr)	0	0	0	138	3	0	0	0
Solid hazardous waste (m^3/yr)	0	0	0	1.5	0.8[c]	0.8	0	0

[a] With RFETS pits.
[b] With RFETS non-pit materials.
[c] Data includes mixed LLW.

Site Infrastructure. The infrastructure at Pantex, ORR, and SRS would be capable of supporting the storage actions under the Preferred Alternative without major modifications. Any minor infrastructure modifications would have negligible impacts at these sites because they would most likely follow existing infrastructure base and rights-of-way.

Air Quality and Noise. Implementing the Preferred Alternative storage action at Pantex, ORR, and SRS would result in short-term air quality impacts during construction and negligible air quality impacts during operation. Modeled air emissions concentrations within applicable Federal, State, and local air quality standards and guidelines. Noise impacts would be negligible at all sites during construction and operation.

Water Resources. At Pantex, all water requirements for the upgrade would be supplied from existing onsite groundwater production wells. The construction and operation of the Upgrade Alternative would contribute to the continued depletion of the Ogallala Aquifer. Surface and groundwater resources at ORR and SRS are adequate to meet the additional requirements of the Preferred Alternative. Water resource impacts at ORR and SRS would be negligible.

Geology and Soils. The construction and operation of the storage actions under the Preferred Alternative would involve some ground disturbing activities with potential for soil erosion at Pantex and SRS. Using standard construction and erosion control measures soil impacts would be negligible. No other apparent direct or indirect effects on geologic resources are anticipated at any of the other DOE sites.

Biological Resources. Construction and operation of the storage actions under the Preferred Alternative would cause minimal disturbance to biological resources at Pantex, ORR, and SRS. All construction and operation activities would take place within an area that was previously disturbed. Minimal impacts to biological resources are expected at any of the other DOE sites as a result of the Preferred Alternative.

Cultural and Paleontological Resources. At Pantex, determinations of NRHP-eligible Cold War Era structures have not yet been completed, but none of the structures that would be modified under the Upgrade Alternative are currently considered NRHP eligible. At ORR, four buildings that are part of the proposed Y–12 Plant

National Register Historic District would be modified under the Preferred Alternative. The Preferred Alternative would not be expected to impact cultural and Paleontological resources at the rest of the DOE sites.

Socioeconomics. At Pantex and SRS, the upgrade would require a small number of additional workers for construction and operation. The small increase in employment would have negligible impact to the regional economy. At RFETS, phaseout of Pu storage would result in the loss of 2,197 direct jobs. Compared to the total employment in the area, the loss of these jobs and the impacts to the regional economy would not be severe. Minimal socioeconomic impacts are expected at the other DOE sites as a result of the Preferred Alternative.

Public and Occupational Health and Safety. The Upgrade Alternative under the Preferred Alternative would increase the amount of Pu stored at Pantex and SRS; increased doses to the public would be negligible. At ORR, doses to the public from upgraded storage would be virtually the same as for storage under No Action. At RFETS, the phaseout of Pu storage would reduce the impacts from radiological and chemical releases and exposure to levels slightly below the No Action levels for normal operations. Stabilization and packaging activities at RFETS would have short-term minor increases in exposure to workers associated with the transport of the Pu. The potential worker exposures would not exceed applicable health and safety regulatory standards. No impacts are expected at the other DOE sites as a result of the Preferred Alternative.

Waste Management. The construction and operation of the storage actions under the Preferred Alternative at Pantex, ORR, and SRS would have an impact on existing waste management activities. Additional wastewater and nonhazardous and hazardous solid waste would be generated at these sites. Hazardous waste would be shipped offsite to a commercial RCRA-permitted treatment and disposal facility. Existing waste handling practices would be used for additional nonhazardous wastes from the new facilities. No waste management impacts are expected at the other DOE sites as a result of the storage action under the Preferred Alternative.

Environmental Justice. The air emissions and hazardous chemical and radiological emissions from normal operations of the storage actions under the Preferred Alternative would be within regulatory limits at all sites. Therefore, there would be no disproportionate impacts to any low income or minority populations at any of the site's due to normal operations. The public health and safety analyses show that air emissions and hazardous chemical and radiological releases from normal operations for the Preferred Alternative storage facilities would be within regulatory limits and that no latent cancer fatalities would result. Because no populations within 80 km (50 mi) of the proposed site would experience high or adverse health or environmental impacts, neither minority populations nor low-income populations would experience disproportionate high and adverse human health or environmental impacts.

The public health and safety analyses also indicate that radiological releases from accidents would not result in significant adverse human health or environmental impacts. Therefore, such accidents would not have disproportionately high and adverse impacts on minority or low-income populations. Potential transportation accidents would be random events along the transportation corridors, therefore, such accidents would not disproportionately impact minority or low income populations.

Intersite Transportation. Potential intersite transportation impacts could occur for transportation of RFETS material to Pantex and because of the small increased risk of traffic accident fatalities. Intersite transportation impacts would primarily be the result of nonradiological impacts such as fatalities from nonradiological highway accidents. The total potential fatalities from the transportation of material under the Preferred Alternative would be 0.006 for Pantex and 0.06 for SRS.

Impacts from Storage and Disposition Actions Under the Preferred Alternative

This section identifies the maximum site impacts that would result at Hanford, INEL, Pantex, and SRS from combining the Preferred Alternative for storage with the Preferred Alternative for disposition at each site. Total site impacts associated with No Action for NTS and LANL, and with phaseout at RFETS, are described in

Section 4.2. The impacts from operating most of the existing reactors would not affect DOE sites and are described in Section 4.3.5. To the extent practical, DOE would use existing buildings and facilities for portions of the disposition activities. The use of existing buildings would reduce the impacts identified in this section. DOE would analyze and compare existing and new buildings for the technologies chosen as part of the Preferred Alternative in subsequent, tiered NEPA reviews.

The preferred strategy for disposition is a combination of reactor and immobilization alternatives. For purposes of analysis, approximately 70 percent of the surplus Pu, which is high purity material, would be converted into MOX fuel for use in nuclear reactors. The Preferred Alternative identifies the use of existing reactors. The Department would retain using MOX fuel in Canadian CANDU reactors in the event of a multilateral agreement among Russia, Canada, and the United States. Low purity Pu would be immobilized in glass or ceramic forms (approximately 30 percent for analysis purposes only). Disposition by use in reactors would require the construction of a MOX fuel fabrication facility and a pit disassembly/conversion facility at a DOE site. Disposition by immobilization would require the construction of a Pu conversion facility and an immobilization facility (either ceramic immobilization or vitrification) at a DOE site. DOE has identified four DOE sites in Table 4.6.1–1 as potential locations for MOX fuel fabrication and pit disassembly/conversion facilities, and two sites for the Pu conversion and immobilization facilities.

The following sections describe the total impacts that would result from the implementation of the Storage and Disposition Program Preferred Alternative at the four DOE sites identified for potential placement of the disposition facilities. The analysis conservatively assumed a maximum impact scenario where two or four disposition facilities could be placed at the same DOE site as shown in Table 4.6.1–1. For immobilization, the analysis conservatively uses impacts from the ceramic immobilization facility since they are generally larger than the impacts from the vitrification facility.

Land Resources. The land-use requirements associated with construction and operation of the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS are shown in Table 4.6.1–3. The requirements shown in Table 4.6.1–3 are the maximum impacts if multiple disposition facilities were located at the same site. Collocating the disposition facilities at a site would likely reduce the amount of land-use impacts due to the sharing of land resources. In addition, optimal use of existing buildings and facilities would occur where possible. All four sites would have adequate land area to accommodate the facilities. Most disposition facilities would be sited in a 1.6-km (1-mi) buffer zone contained within the site boundary. This section describes the impacts to land resources from constructing and operating the Preferred Alternative storage and disposition facilities for each site.

For all four DOE sites, construction and operation would not affect other onsite or offsite land uses. No prime farmlands exist onsite. Construction and operation would be compatible with State and local land-use plans, policies, and controls. Hanford provides information to local jurisdictions for use in their efforts to comply with the GMA.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area, pending decisions on their disposition. No impacts to land-use or visual resources are expected. The pit disassembly/ conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. Construction and operation of the facilities would conform to existing and future land use as described in the *Hanford Site Development Plan* and with ongoing discussions in the comprehensive land-use planning process. According to the *Hanford Site Development Plan*, 200 Area land use is identified as waste operations, which includes radioactive material management, processing, and storage.

Construction and operation would be consistent with the industrialized landscape character of the 200 Area and with the current VRM Class 5 designation. A potential source of visual impacts during operation of the ceramic immobilization facility or MOX facility would be the stack plumes that could be visible from public viewpoints

Table 4.6.1–3. Land-Use Requirements From the Preferred Alternative

Action	Area of Disturbance (ha)			
	Hanford	INEL	Pantex	SRS
Construction				
Storage	0.0	0.0	0.18	0.0
Pit disassembly/conversion	14	14	14	14
Pu conversion	36	NA	NA	36
MOX fuel fabrication	121	121	121	121
Ceramic immobilization	20	NA	NA	20
Total (Maximum Impact)	191	135	135.18	191
Operation				
Storage	0.0	0.0	0.1	0.0
Pit disassembly/conversion	12	12	12	12
Pu conversion	28	NA	NA	28
MOX fuel fabrication	81	81	81	81
Ceramic immobilization	12	NA	NA	12
Total (Maximum Impact)	133	93	93.1	133

Note: NA=not applicable.
Source: Section 4.2.1.1; Section 4.2.3.1; Section 4.3.4.1; Section 4.2.6.1; Section 4.3.1.1; Section 4.3.2.1; Section 4.3.4.2.1; Section 4.3.5.1.1.

with high sensitivity levels, including State Highways 24 and 240 and the city of Richland; however, the proposal would be compatible with the existing industrial character of the area.

Idaho National Engineering Laboratory. Pu materials would continue to be stored at the ICPP and at ANL-W in the ZPPR and FMF vaults, pending decisions on their disposition. No impacts to land-use or visual resources are expected. The pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. Construction and operation would be consistent with the *Idaho National Engineering Laboratory Site Development Plan*, which designates the ICPP as situated within the central core area/Prime Development Zone at INEL.

Construction and operation would be consistent with the industrialized landscape character of the ICPP and with the current VRM Class 5 designation. A potential source of visual impact during operation of the MOX facility would be from the stack plumes that could be visible; however, the proposal would be compatible with the existing industrial character of the area.

Pantex Plant. Buildings 12-66 and 12-82 in Zone 12 South would be modified to accommodate the long-term storage of Pantex Pu material and RFETS pit Pu material for the storage Preferred Alternative. Construction and operation would conform with the *Pantex Site Development Plan*, which includes as part of its master plan the Fissile Material Storage Facility in Zone 12. Zone 12 is also the potential location for the pit disassembly/conversion facility. Construction and operation would conform with the *Pantex Site Development Plan*, which designates Zone 12 for weapon assembly/disassembly. The MOX fuel fabrication facility would be located on undeveloped land in Zone 11, which is designated for applied technology. However, Pantex could revise the site development plan. If this change were approved, the proposed MOX facility would be in compliance, resulting in no impact.

The proposed visual environment of Zone 12 would be compatible with the existing industrialized landscape character and the current VRM Class 5 designation would remain. A potential source of visual impacts during operation of the MOX facility in Zone 11 would be the stack plumes that could be visible; however, the proposal would be compatible with the existing industrial character of the area.

Savannah River Site. The APSF in F-Area would be modified to accommodate the long-term storage of SRS non-pit Pu material and RFETS non-pit Pu material for the Preferred Alternative. Vacant land in the F-Area would be used for the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities. Construction and operation would conform with existing and future land use as designated by the *Savannah River Site Development Plan*. According to the Plan, current F-Area land use is designated industrial operations, while the future land-use category is primary industrial mission. The MOX fuel fabrication facility would be located on undeveloped land approximately 1.6 km (1 mi) north of the P-Reactor Area on the east side of SRS Route F. Construction and operation would conform with future land use as designated by the *Savannah River Site Development Plan*. According to the Plan, the future land-use category for the proposed development site is primary industrial mission. Although the proposal would convert undeveloped land, forested land, and a very small portion of NERP lands, due to conformance of the proposed MOX fuel fabrication facility would conform with site land-use plans.

Construction and operation of the upgrade storage, pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities would be consistent with the industrial landscape character and current VRM Class 5 designation of the F-Area. Construction and operation of the MOX facility would change the current VRM Class 4 designation of the site north of the P-Reactor Area to Class 5. Potential visual impacts could occur during operation of the ceramic immobilization and MOX facilities from additional stack plumes; however, because of hilly terrain, visual effects to public access roads with high sensitivity levels would not occur.

Site Infrastructure. The resource requirements for the construction of the proposed facilities are not expected to exceed site capabilities. Operational requirements from the Preferred Alternative at all sites analyzed are shown in Table 4.6.1–4. The planned facilities use natural gas as the primary utility fuel, and the total requirement for natural gas would be larger than currently available at Hanford, INEL, and SRS. Since INEL and SRS use fuel oil as the primary utility fuel, use of natural gas in lieu of fuel oil would require additional infrastructure. Final designs for facilities under the Preferred Alternative at INEL and SRS would be adapted to use fuel oil. Additional oil and natural gas requirements could be procured through normal contractual means at all sites. Locating the Preferred Alternative disposition actions at any of the analyzed sites would require the construction of additional roads and rail.

Air Quality and Noise. Construction and operation of the proposed facilities under the Preferred Alternative would generate criteria and toxic/hazardous air pollutants. To evaluate potential air quality impacts at Hanford, INEL, Pantex, and SRS, potential concentrations from the facilities have been compared to Federal and State guidelines in Table 4.6.1–5.

Concentrations of PM_{10} and TSP are expected to increase during construction of the facilities. Simultaneous construction of the facilities could result in elevated levels of these pollutants. However, appropriate control measures would be used to control fugitive emissions. It is expected that the sites would typically comply with applicable Federal and State ambient air quality standards during construction.

The PSD regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modification to existing sources. Based on emission rates presented in Appendix F, PSD permits may be required at all of the sites under consideration for the preferred alternative facilities. PSD permits may require inclusion of "offsets" (reductions of existing emissions) for any additional or new emission source.

During operation, concentrations of criteria and toxic/hazardous air pollutants are expected to be in compliance with Federal, State, and local air quality regulations and guidelines at all of the sites analyzed. The estimated pollutant concentrations for the preferred alternative facilities, plus the No Action concentrations, are presented in Table 4.6.1–5.

Noise sources associated with the preferred alternative facilities may include construction equipment, increased traffic, ventilation equipment, cooling systems, and emergency diesel generators. The contribution to offsite

Table 4.6.1–4. Site Infrastructure Requirements From the Preferred Alternative

	Electrical		Fuel		
Action	Energy (MWh/yr)	Peak Load (MWe)	Oil (l/yr)	Natural Gas (m^3/yr)	Coal (t/yr)
Hanford Site					
Site availability	1,678,700	281	14,775,000	21,039,531	91,708
Projected usage (No Action)	345,500	58	9,334,800	21,039,531	0
Projected usage (with Preferred Alternative maximum impact)	424,500	76	9,612,550	34,648,531	0
Storage—No Action[a]	0	0	0	0	0
Pit disassembly/conversion	20,000	5	28,000	3,398,000	0
Pu conversion	21,000	5	39,750	4,361,000	0
MOX fuel fabrication	13,000	5	20,000	2,350,000	0
Ceramic immobilization	25,000	3	190,000	3,500,000	0
Amount required in excess to site availability	0	0	0	13,609,000	0
Idaho National Engineering Laboratory					
Site availability	394,200	124	16,000,000	0	11,340
Projected usage (No Action)	232,500	42	5,820,000	0	11,340
Projected usage (with Preferred Alternative maximum impact)	265,500	52	5,868,000	5,748,000	11,340
Storage—No Action[a]	0	0	0	0	0
Pit disassembly/conversion	20,000	5	28,000	3,398,000	0
MOX fuel fabrication	13,000	5	20,000	2,350,000	0
Amount required in excess to site availability	0	0	0	5,748,000	0
Pantex Plant					
Site availability	201,480	23	1,775,720	289,000,000	0
Projected usage (No Action)	46,266	10	795,166	7,200,000	0
Projected usage (with Preferred Alternative maximum impact)	80,641	20.3	856,414	13,112,000	0
Storage—upgrade (pits from RFETS)[b]	1,375	0.3	13,248	164,000	0
Pit disassembly/conversion	20,000	5	28,000	3,398,000	0
MOX fuel fabrication	13,000	5	20,000	2,350,000	0
Amount required in excess to site availability	0	0	0	0	0
Savannah River Site					
Site availability	1,672,000	330	28,390,500	0	244,000
Projected usage (No Action)	794,000	116	28,390,500	0	221,352
Projected usage (with Preferred Alternative maximum impact)	876,600	134	28,668,250	13,609,000	221,642
Storage—upgrade (non-pits from RFETS)[b]	3,600	0	0	0	290
Pit disassembly/conversion	20,000	5	28,000	3,398,000	0
Pu conversion	21,000	5	39,750	4,361,000	0
MOX fuel fabrication	13,000	5	20,000	2,350,000	0
Ceramic immobilization	25,000	3	190,000	3,500,000	0
Amount required in excess to site availability	0	0	277,750	13,609,000	0

[a] Zeros represent no change for values versus site availability.
[b] Assumes impacts for storage without RFETS and LANL material.
Source: Table C.2.1.1–2; Table C.2.1.2–1; Table C.2.1.2–2; Table C.2.1.2–3; Table C.2.1.3–5.

Table 4.6.1–5. Estimated Operational Concentrations of Pollutants From the Preferred Alternative, Including No Action

Pollutant	Averaging Time	No Action (μg/m³)	Preferred Alternative Actions: Storage Alternative (μg/m³)	Preferred Alternative Actions: Pit Disassembly/ Conversion[a] (μg/m³)	Preferred Alternative Actions: Pu Conversion (μg/m³)	Preferred Alternative Actions: MOX Fuel Fabrication[a] (μg/m³)	Preferred Alternative Actions: Ceramic Immobilization (μg/m³)	Most Stringent Regulation or Guideline[b] (μg/m³)	Total Impact (μg/m³)
Hanford Site[c]									
Criteria Pollutants									
Carbon monoxide	8-hour	0.08	0.08	0.08	0.71	0.08	39.68	10,000	40.31
	1-hour	0.3	0.3	0.3	5.23	0.3	314.95	40,000	319.88
Lead	Calendar Quarter	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5	<0.06
	24-hour	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	<0.06
Nitrogen dioxide	Annual	0.03	0.03	0.03	0.06	0.03	3.75	100	3.78
Particulate matter less than or equal to 10 microns in diameter	Annual	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	50	<0.06
	24-hour	0.02	0.02	0.02	0.02	0.02	0.06	150	0.06
Sulfur dioxide	Annual	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	52	<0.06
	24-hour	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	260	<0.06
	3-hour	0.01	0.01	0.01	0.01	0.01	0.04	1,300	0.04
	1-hour	0.02	0.02	0.02	0.02	0.02	0.11	1,018	0.11
	1-hour	0.02	0.02	0.02	0.02	0.02	0.11	655	0.11
Mandated by the State of Washington									
Gaseous fluoride (as HF)	30-day	[d]	[d]	[d]	<0.01[e]	[d]	[d]	0.8	<0.01[e]
	7-day	[d]	[d]	[d]	<0.01[e]	[d]	[d]	1.6	<0.01[e]
	24-hour	[d]	[d]	[d]	<0.01[e]	[d]	[d]	2.9	<0.01[e]
	12-hour	[d]	[d]	[d]	<0.01[e]	[d]	[d]	3.7	<0.01[e]
Total suspended particulates	Annual	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	60	<0.06
	24-hour	0.02	0.02	0.02	0.02	0.02	0.06	150	0.06

Table 4.6.1–5. Estimated Operational Concentrations of Pollutants From the Preferred Alternative, Including No Action—Continued

Pollutant	Averaging Time	No Action (μg/m³)	Preferred Alternative Actions: Storage Alternative (μg/m³)	Pit Disassembly/ Conversion[a] (μg/m³)	Pu Conversion (μg/m³)	MOX Fuel Fabrication[a] (μg/m³)	Ceramic Immobilization (μg/m³)	Most Stringent Regulation or Guideline[b] (μg/m³)	Total Impact (μg/m³)
Idaho National Engineering Laboratory[f]									
Criteria Pollutants									
Carbon monoxide	8-hour	284	284	284	NA	284	NA	10,000	284
	1-hour	614	614	614	NA	614	NA	40,000	614
Lead	Calendar Quarter	0.001	0.001	0.001	NA	0.001	NA	1.5	0.001
Nitrogen dioxide	Annual	4	4	4	NA	4	NA	100	4
Particulate matter less than or equal to 10 microns in diameter	Annual	5	5	5	NA	5	NA	50	5
	24-hour	80	80	80	NA	80	NA	150	80
Sulfur dioxide	Annual	6	6	6	NA	6	NA	52	6
	24-hour	135	135	135	NA	135	NA	260	135
	3-hour	579	579	579	NA	579	NA	1,300	579
Mandated by the State of Idaho									
Total suspended particulates	Annual	5	5	5	NA	5	NA	60	5
	24-hour	80	80	80	NA	80	NA	150	80
Pantex Plant[g]									
Criteria Pollutants									
Carbon monoxide	8-hour	602	602	602	NA	602	NA	10,000	602
	1-hour	2,900	2,900	2,900	NA	2,900	NA	40,000	2,900
Lead	Calendar Quarter	0.09	0.09	0.09	NA	0.09	NA	1.5	0.09
Nitrogen dioxide	Annual	2.15	2.15	2.15	NA	2.15	NA	100	2.15
Particulate matter less than or equal to 10 microns in diameter	Annual	8.73	8.73	8.73	NA	8.73	NA	50	8.73
	24-hour	88.5	88.5	88.5	NA	88.5	NA	150	88.5

Table 4.6.1–5. Estimated Operational Concentrations of Pollutants From the Preferred Alternative, Including No Action—Continued

Pollutant	Averaging Time	No Action (μg/m³)	Preferred Alternative Actions: Storage Alternative (μg/m³)	Preferred Alternative Actions: Pit Disassembly/ Conversion[a] (μg/m³)	Preferred Alternative Actions: Pu Conversion (μg/m³)	Preferred Alternative Actions: MOX Fuel Fabrication[a] (μg/m³)	Preferred Alternative Actions: Ceramic Immobilization (μg/m³)	Most Stringent Regulation or Guideline[b] (μg/m³)	Total Impact (μg/m³)
Pantex Plant (continued)									
Sulfur dioxide	Annual	<0.01	<0.01	<0.01	NA	<0.01	NA	52	<0.01
	24-hour	<0.01	<0.01	<0.01	NA	<0.01	NA	260	<0.01
	3-hour	<0.01	<0.01	<0.01	NA	<0.01	NA	1,300	<0.01
	30-minute	<0.01	<0.01	<0.01	NA	<0.01	NA	1,045	<0.01
Mandated by the State of Texas									
Gaseous fluoride (as HF)	30-day	<0.75	<0.75	<0.75	NA	<0.75	NA	0.8	<0.75
	7-day	<0.75	<0.75	<0.75	NA	<0.75	NA	1.6	<0.75
	24-hour	0.75	0.75	0.75	NA	0.75	NA	2.9	0.75
	12-hour	1.05	1.05	1.05	NA	1.05	NA	3.7	1.05
	3-hour	4.21	4.21	4.21	NA	4.21	NA	4.9	4.21
Total suspended particulates	3-hour	[d]	[d]	<0.01[e]	NA	<0.01[e]	NA	200	<0.02[e]
	1-hour	[d]	[d]	<0.01[e]	NA	<0.01[e]	NA	400	<0.02[e]
Savannah River Site[h]									
Criteria Pollutants									
Carbon monoxide	8-hour	22	22.17	22	27.42	22	360.7	10,000	366.29
	1-hour	171	171.78	171	196.51	171	1,765	40,000	1,791.29
Lead	Calendar Quarter	0.0004	0.0004	0.0004	<0.01	<0.01	<0.01	1.5	<0.03
Nitrogen dioxide	Annual	5.7	5.8	5.7	5.81	5.7	21.91	100	22.12
Particulate matter less than or equal to 10 microns in diameter	Annual	3	3.01	3	3	3	3.02	50	3.03
	24-hour	50.6	50.75	50.6	50.61	50.6	50.97	150	51.13
Sulfur dioxide	Annual	14.5	14.79	14.5	14.5	14.5	14.5	80	14.79

Table 4.6.1–5. *Estimated Operational Concentrations of Pollutants From the Preferred Alternative, Including No Action—Continued*

Pollutant	Averaging Time	No Action (µg/m³)	Storage Alternative (µg/m³)	Pit Disassembly/ Conversion[a] (µg/m³)	Pu Conversion (µg/m³)	MOX Fuel Fabrication[a] (µg/m³)	Ceramic Immobilization (µg/m³)	Most Stringent Regulation or Guideline[b] (µg/m³)	Total Impact (µg/m³)
		Preferred Alternative Actions							
Savannah River Site (continued)	24-hour	196	201.65	196	196	196	196.03	365	201.68
	3-hour	823	859.65	823	823.03	823	823.21	1,300	859.89
Mandated by the State of South Carolina									
Gaseous fluoride (as HF)	30-day	0.09	0.09	0.09	0.09	0.09	0.09	0.8	0.09
	7-day	0.39	0.39	0.39	0.39	0.39	0.39	1.6	0.39
	24-hour	1.04	1.04	1.04	1.04	1.04	1.04	2.9	1.04
	12-hour	1.99	1.99	1.99	1.99	1.99	1.99	3.7	1.99
Total suspended particulates	Annual	12.6	12.61	12.6	12.6	12.6	12.62	75	12.63

[a] Emissions estimates for the facilities are based on data from similar processes at existing facilities. Because of the processing technology (which does not emit some of the criteria pollutants), the defense-in-depth for Pu processing systems and the extensive HEPA filtration (which removes the remaining criteria pollutants), emissions from criteria pollutants other than VOCs are expected to be below detection limits.

[b] The more stringent of the Federal and State standards is presented for the averaging time.

[c] No Action is the preferred alternative at Hanford for the storage of Pu.

[d] No sources of this pollutant have been identified.

[e] Data does not include No Action.

[f] No Action is the preferred alternative at INEL for the storage of Pu.

[g] Upgrade is the preferred alternative at Pantex for the long-term storage of Pu (pit material only).

[h] Upgrade is the preferred alternative at SRS for the long-term storage of Pu (non-pit material only).

Note: NA=not applicable.

Source: Table 4.2.1.3–1; Table 4.2.3.3–1; Table 4.2.4.3–1; Table 4.2.6.3–1; Table 4.3.1.3–1; Table 4.3.2.3–1; Table 4.3.4.2.3–1; Table 4.3.5.1.3–1.

noise levels would continue to be small at all of the sites because the facilities associated with the Preferred Alternative would be a sufficient distance away from the site boundary and sensitive receptors. Due to the size of the sites, noise emissions from construction and operation activities would not be expected to cause annoyance to the public. Some noise sources may result in the disturbance of wildlife.

Water Resources. The construction and operation of the proposed facilities under the Preferred Alternative would affect water resources. Table 4.6.1–6 shows the estimated water usage and wastewater generation from the Preferred Alternative at Hanford, INEL, Pantex, and SRS. All facilities would be constructed outside of the 100-year, 500-year, and probable maximum floodplain; although, where the 500-year floodplain is not completely mapped at SRS, the facility would likely be located outside of the 500-year floodplain. Flooding from dam failures and flooding from a landslide resulting in river blockage are not expected to occur where applicable. The wastewater discharges are expected to continue to meet NPDES limits and reporting requirements at all sites.

Hanford Site. Surface water obtained from the Columbia River would be used as the water source for operation of the proposed facilities. The total water requirement for the Preferred Alternative at Hanford would be less than 1 percent of the Columbia River's average annual flow (3,360 m^3/s [118,642 ft^3/s]). The withdrawals are minor in comparison with the average flow of the river and would not noticeably affect the local or regional water supply.

Table 4.6.1–6. Potential Changes to Water Resources Resulting From the Preferred Alternative

Affected Resource Indicator	Hanford	INEL	Pantex	SRS
Water Source	Surface	Ground	Ground	Ground
No Action water requirement (million l/yr)	13,511	7,570	249	13,247
No Action wastewater discharges (million l/yr)	246	540	141	700
Construction				
Water availability and use				
Total water requirement (million l/yr)	44.2	3.8	3.86	47.2
Storage alternative (million l/yr)	0[a]	0[a]	0.06[b]	3[c]
Pit disassembly/conversion facility (million l/yr)	1.9	1.9	1.9	1.9
Plutonium conversion facility (million l/yr)	2.4	NA	NA	2.4
MOX fuel fabrication facility (million l/yr)	1.9	1.9	1.9	1.9
Ceramic immobilization alternative (million l/yr)	38	NA	NA	38
Percent increase in projected water use[d]	0.33	0.05	1.55	0.36
Water quality				
Total wastewater discharge (million l/yr)	35	3.8	6.9	37.4
Storage alternative (million l/yr)	0[a]	0[a]	3.1[b]	2.4[c]
Pit disassembly/conversion facility (million l/yr)	1.9	1.9	1.9	1.9
Plutonium conversion facility (million l/yr)	2.4	NA	NA	2.4
MOX fuel fabrication facility (million l/yr)	1.9	1.9	1.9	1.9
Ceramic immobilization alternative (million l/yr)	28.8	NA	NA	28.8
Percent increase in wastewater discharge[e]	14.23	0.70	4.89	5.34
Percent increase in stream flow	neg	NA	NA	0.74[f]
Operation				
Water availability and use				
Total water requirement (million l/yr)	481.9	151.4	178.9	489
Storage alternative (million l/yr)	0[a]	0[a]	27.5[b]	7.1[c]
Pit disassembly/conversion facility (million l/yr)	94.6	94.6	94.6	94.6
Plutonium conversion facility (million l/yr)	80.5	NA	NA	80.5
MOX fuel fabrication facility (million l/yr)	56.8	56.8	56.8	56.8
Ceramic immobilization alternative (million l/yr)	250	NA	NA	250

Table 4.6.1–6. Potential Changes to Water Resources Resulting From the Preferred Alternative—Continued

Affected Resource Indicator	Hanford	INEL	Pantex	SRS
Percent increase in projected water use[g]	3.57	2.00	71.85	3.69
Water quality				
Total wastewater discharge (million l/yr)	241.7	128.7	141.6	243.5
Storage alternative (million l/yr)	0[a]	0[a]	12.9[b]	1.8[c]
Pit disassembly/conversion facility (million l/yr)	85.2	85.2	85.2	85.2
Plutonium conversion facility (million l/yr)	15	NA	NA	15
MOX fuel fabrication facility (million l/yr)	43.5	43.5	43.5	43.5
Ceramic immobilization alternative (million l/yr)	98	NA	NA	98
Percent increase in wastewater discharge[h]	98.25	23.83	100.4	34.79
Percent increase in stream flow	neg	NA	NA	4.83[f]
Floodplain				
Is action in 100-year floodplain?	No	No	No	No
Is critical action in 500-year floodplain?	No	No	No	Unlikely

[a] Zero values indicate No Action Alternative for storage at Hanford and INEL.
[b] Value represents upgrade without RFETS and LANL material.
[c] Value represents a conservative assumption for SRS to receive all RFETS and LANL Pu material as opposed to non-pit Pu material only.
[d] Percent increases in water requirements during construction of the proposed facilities are calculated by dividing water requirements for the facility by No Action water requirements at each analyzed site.
[e] Percent increases in wastewater discharged during construction of the proposed facilities are calculated by dividing wastewater discharges for the facility by No Action discharge at each analyzed site.
[f] Percent change in stream flow from wastewater discharges is calculated from the minimum flow of the Fourmile Branch (0.16 m^3/s).
[g] Percent increases in water requirements during operation of the proposed facilities are calculated by dividing water requirements for the facilities by No Action water requirements at each analyzed site.
[h] Percent increases in wastewater discharged during operation of the proposed facilities are calculated by dividing wastewater discharges for the facilities by No Action discharge at each analyzed site.

Note: NA=not applicable; neg=negligible. Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: Table 4.2.4.4–1; Table 4.2.6.4–1; Table 4.3.1.4–1; Table 4.3.2.4–1; Table 4.3.4.2.4–1; Table 4.3.5.1.4–1.

The wastewater would be disposed to newly constructed sanitary, utility, and process wastewater treatment systems. The wastewater discharge would account for a 98-percent increase over the No Action Alternative projected discharge.

Idaho National Engineering Laboratory. Water requirements for the operation of the Preferred Alternative at INEL would be obtained from groundwater sources. The water requirements for the site over the projected No Action water usage would be a 2-percent increase for operations (approximately 9.6 percent of the groundwater allotment) and less than a 0.05-percent increase for construction (approximately 0.24 percent of the groundwater allotment).

The wastewater discharged during operations would be a 24-percent increase over the No Action projected discharge. Existing INEL treatment facilities could accommodate all the new Preferred Alternative processes and wastewater streams. However, if necessary, new sanitary, utility, and process wastewater treatment systems would be constructed.

Pantex Plant. Water requirements for the operation of the Preferred Alternative at Pantex would be obtained from groundwater resources or, if feasible, from the City of Amarillo Hollywood Road Wastewater Treatment Plant. Should only groundwater be used, the total annual site groundwater withdrawal, including the Preferred Alternative in the year 2005 (the No Action base year), would be 428 million l/yr (112 million gal/yr). This represents a 72-percent increase in the projected No Action usage. However, because the projected No Action usage reflects reductions in water use due to planned downsizing over the next few years, this quantity (No Action plus the Preferred Alternative) is considerably less than what is currently being withdrawn at Pantex (836 million l/yr [221 million gal/yr]). Although Pantex's groundwater usage is expected to decline in the future, the site will still contribute to the declining water levels of the Ogallala Aquifer.

Total estimated wastewater discharge for the Preferred Alternative (283 million l/yr [74.7 million gal/yr]) at Pantex would result in a 100-percent increase in the No Action projected discharge. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed.

Savannah River Site. Water requirements during operation of the Preferred Alternative would be obtained from existing or new well fields at SRS. The Preferred Alternative water requirements for the site would be a 3.7-percent increase over projected No Action groundwater usage. Suitable groundwater from the deep aquifers at the site is abundant, and aquifer depletion is not a problem.

The Preferred Alternative wastewater discharge to the river would be less than 5 percent of the minimum flow of Fourmile Branch (0.16 m^3/s [5.7 ft^3/s]), and less than 0.003 percent of the Savannah River average flow (282 m^3/s [9,960 ft^3/s]). SRS treatment facilities could accommodate all the new processes and wastewater streams if a new facility is built for tritium supply and recycling operations as planned. However, if necessary, new sanitary, utility, and process wastewater treatment systems would be constructed.

Geology and Soils. The construction of the proposed facilities under the Preferred Alternative would involve some ground disturbing activities at Hanford, INEL, Pantex, and SRS. Ground disturbance increases the potential for soil erosion. The key factors affecting the erosion potential of a site are the amount of disturbed land and the amount of annual precipitation. The amount of land disturbed as a result of the Preferred Alternative facilities is shown in Table 4.6.1–3. The potential for soil erosion at Hanford, INEL, and Pantex is slight because of low precipitation. Since SRS receives more precipitation, the potential for erosion is considered moderate. The amount of soil loss would depend on the frequency and severity of precipitation events, wind velocities, and the size, location, and duration of soil disturbance.

During operation, improvements (buildings, roads, and landscaping) would considerably reduce the erosion potential. Erosion from stormwater runoff and wind could occasionally occur during operation of the facilities. Beyond increased erosion potential, no direct or indirect effects on geologic resources are anticipated. The construction and operation of the facilities and the site infrastructure improvements would not restrict access to potential geologic resources.

Biological Resources.

Hanford Site. Pu materials would continue to be stored at the PFP in the 200 West Area. There would be no impacts on biological resources anticipated. The pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be constructed on vacant land in the 200 Area adjacent to 200 East. Construction of the four disposition facilities would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. If the area to which they moved were below its carrying capacity, these animals would be expected to survive. However, if the area were already supporting the maximum number of individuals, the additional animals would compete for limited resources, which could lead to habitat degradation and eventual loss of excess population. Nests and young animals living within the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Construction and operation of the four disposition facilities would not affect wetlands or aquatic resources since no wetlands or surface water bodies exist near the assumed facilities locations. During both construction and operation, water would be withdrawn from the Columbia River through an existing intake structure, and wastewater would be discharged to evaporation/infiltration ponds. Wetlands or aquatic resources bordering the river would not be affected because the volume of water included represents a small percentage of the flow of the river.

It is unlikely that federally listed threatened and endangered species would be affected by construction and operation of the four disposition facilities, but sagebrush habitat would be disturbed. The sagebrush community is an important nesting/breeding and foraging habitat for several State-listed and candidate species, such as the ferruginous hawk, loggerhead shrike, western burrowing owl, pygmy rabbit, western sage grouse, and sage thrasher. Pre-activity surveys would be conducted as appropriate before construction to determine the occurrence of plant species or animal species and habitat in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes, as appropriate.

Idaho National Engineering Laboratory. Pu materials would continue to be stored at the ICPP and at ANL-W in the ZPPR and FMF vaults. There would be no impacts on biological resources anticipated. The pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The ICPP area falls within the big sagebrush/thickspike wheatgrass/needle-and-thread grass community. Construction of the two disposition facilities would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. If the area to which they moved were below its carrying capacity, these animals would be expected to survive. However, if the area were already supporting the maximum number of individuals, the additional animals would compete for limited resources, which could lead to habitat degradation and eventual loss of excess population. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Wetlands and aquatic resources associated with the nearest surface water body, the Big Lost River, are located 1.6 km (1 mi) from the facility location, so impacts are not expected there. Due to the lack of wetlands or aquatic resources at the assumed facility locations, these resources would not be affected by construction or operation of the two facilities.

It is unlikely that federally threatened or endangered species would be affected by construction of the two disposition facilities, but several State-listed species may be affected. Burrows and foraging habitat for the pygmy rabbit would be lost. Bat species such as the Townsend's western big-eared bat may roost in caves and forage through the assumed site. One State-listed sensitive plant species could potentially be affected by construction of the facility. The plant species, tree-like oxytheca, has been collected at eight sites on INEL and at only two other sites in Idaho. If present, individual plants of this species could be destroyed during land clearing activities. Preactivity surveys would be conducted as appropriate before construction to determine the occurrence of these species in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes, as appropriate. No impacts to threatened and endangered species are expected due to facility operation.

Pantex Plant. Buildings 12-66 and 12-82 in Zone 12 South would be modified to accommodate the long-term storage of Pantex Pu material and RFETS pit Pu material. Upgrading the existing storage Pu storage facility at Pantex would cause minimal disturbance to biological resources because all activities, including some new construction, would take place within the developed area. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the developed area have already adapted to its presence. Impacts to wetlands and aquatic resources would not occur since these resources are not found in the upgrade area. Since the upgrade would take place within a developed area, impacts to threatened and endangered species would not be expected.

Zone 12 is also the potential location for the pit disassembly/conversion facility. The MOX fuel fabrication facility would be located on undeveloped land in Zone 11, which lacks natural vegetation. Disturbance to wildlife would be limited due to the disturbed nature of the assumed locations; however, small mammals and some birds and reptiles could be displaced by construction. Since the area around both locations does not contain any wetlands or aquatic resources, these resources would not be affected by construction of the facility. During operation, wastewater would be discharged to site playas through NPDES-regulated outfalls. The additional wastewater could lead to minor increases in open water near the outfalls, as well as changes in plant species composition. It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of the facilities. Although the assumed sites have been disturbed, it is possible that the State-listed Texas horned lizard could be present. Before construction, preactivity surveys would be conducted, as appropriate, to determine the presence of any special status species and habitat on the proposed site. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes, as appropriate.

Savannah River Site. The APSF in F-Area would be modified to accommodate the storage of RFETS non-pit Pu material in addition to SRS non-pit Pu material. There would be minimal additional impacts on biological resources anticipated with modifying the APSF in F-Area.

Vacant land in the F-Area would be used for the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities. Impacts to terrestrial resources would be minimal because the F-Area is one of the highly developed industrial areas of the SRS. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the F-Area have already adapted to similar disturbances. There would be no direct impacts to wetlands or aquatic resources from construction of the facility. Secondary impacts from stormwater runoff would be controlled by implementation of a soil erosion and sediment control plan. Operational impacts to wetlands and aquatic resources would be minimal since there would be relatively small increases in treated wastewater and stormwater that would be discharged via NPDES permitted outflows. Impacts from construction and operation of the three disposition facilities would not be expected to affect threatened and endangered species due to the developed nature of the assumed facility locations. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by these facilities. Before committing construction resources, DOE would consult with Federal and State agencies pursuant to the ESA and other statutes, as appropriate.

The MOX fuel fabrication facility would be located on undeveloped land approximately 1.6 km (1 mi) north of the P-Reactor Area on the east side of SRS Route F. Construction of the MOX facility would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. If the area to which they moved were below its carrying capacity, these animals would be expected to survive. However, if the area were already supporting the maximum number of individuals, the additional animals would compete for limited resources which could lead to habitat degradation and eventual loss of excess population. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Since the majority of the assumed MOX fuel fabrication facility site is upland, the facility could be located to avoid direct impacts to wetlands. It would not be necessary to disturb wetlands along the site streams. Wastewater discharge from construction and operation would be minimal and would not be expected to affect wetlands associated with the receiving stream. Stormwater runoff during construction could cause temporary water quality changes in local tributaries to Par Pond. During operation, nonhazardous wastewater would be discharged to local drainage channels. Flow increases are not expected to impact stream hydrology or aquatic resources. All discharges would be required to meet NPDES permit regulations.

It is unlikely that federally listed threatened or endangered species are expected to be affected by construction or operation of a MOX fuel fabrication facility. Although bald eagles have been sighted in the vicinity of the assumed facility location, it is highly unlikely that construction and operation of the MOX fuel fabrication facility would affect this species. Although suitable foraging habitat for the red cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by the MOX facility, Before construction, preactivity surveys would be conducted as appropriate to determine the presence of any special status species and habitat on the proposed site. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes, as appropriate.

Cultural and Paleontological Resources. The potential impacts to cultural and paleontological resources are closely related to the amount of land disturbed. The land-use requirements associated with construction and operation of the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS are shown in Table 4.6.1–3. Collocating the disposition facilities at a site would likely reduce the amount of land disturbed during construction and reduce the impacts to cultural and paleontological resources. In addition, optimal use of existing buildings and facilities would occur where possible. Because most of the locations proposed have been previously disturbed (except at SRS), it is unlikely that they would contain subsurface prehistoric or historic archaeological deposits. Some paleontological remains may be encountered during construction. Operations would not have additional impacts on historic, prehistoric, or paleontological resources, but there may be visual or auditory intrusions to Native American resources at some site. This section describes the impacts to cultural and paleontological resources of constructing and operating the storage and disposition facilities for each Preferred Alternative site.

Hanford Site. Pu materials would continue to be stored at the PFP in the 200 West Area. For the storage Preferred Alternative, there would be no anticipated impacts to cultural or paleontological resources. The pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. Although no archeological resources have been identified during surveys conducted in the adjacent 200 Areas, some may exist in the facility locations. Any such sites would be identified through compliance with Sections 106 and 110 of the NHPA. Any identified sites may be affected by facility construction. Operation would not result in additional impacts.

Although all of Hanford is considered sacred land by some Native American groups, no areas of great cultural significance have been identified close to the 200 Area. Resources may be identified through facility-specific consultation. Impacts from construction and operation may include reduced access to traditional use areas or visual or auditory intrusion into sacred or ceremonial space.

Pliocene and Pleistocene fossil remains have been discovered at Hanford. Although none have been recorded in the facility locations, they may exist. These resources may be affected by ground disturbing construction. Operations would not have additional impacts on paleontological resources.

Idaho National Engineering Laboratory. Pu materials would continue to be stored at the ICPP and the ZPPR and FMF vaults in ANL-W. For the storage Preferred Alternative, there would be no anticipated impacts to cultural or paleontological resources. The pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The pit disassembly/conversion facility would be sited in a location previously approved for the construction of the Special Isotope Separation Project. A surface survey of this area identified no prehistoric or historic sites. Although it is possible, the ICPP is unlikely to contain intact subsurface cultural deposits, due to prior ground disturbance and environmental setting. INEL has a contingency plan in place should any archeological remains be discovered during construction. Two historic sites occur adjacent to the ICPP—one historic can scatter across the Big Lost River to the northeast, and one abandoned homestead to the east. The can scatter is not considered eligible for NRHP listing, and the homestead has been fenced off for protection. Construction and operation are not expected to affect either site.

Native American resources may be affected by the proposed facilities. Facility construction and operation may have visual or auditory impacts on traditional use areas or sacred sites. Resources may be identified through consultation with the interested tribes.

Some paleontological remains may be encountered during construction. The ICPP lies on alluvial gravels associated with the Big Lost River floodplain, which have produced fossilized remains. Operation would not have an effect on paleontological resources.

Pantex Plant. Buildings 12-66 and 12-82 in Zone 12 South would be modified to accommodate the long-term storage of Pantex Pu material and RFETS pit Pu material for the storage Preferred Alternative. These buildings are not considered NRHP eligible based on an evaluation of World War II Era structures at Pantex. However determinations of NRHP-eligible Cold War Era structures have not been completed, and some structures in Zone 12 may be determined eligible on that basis. Zone 12 is also the potential location for the pit disassembly/ conversion facility. Because Zone 12 South is developed, disturbed, and removed from water sources, it is unlikely to contain subsurface prehistoric or historic archeological deposits, even on lands used for equipment laydown or construction parking. No impacts to prehistoric or historic resources are expected to result from the construction or operation of these facilities.

The MOX fuel fabrication facility would be located on undeveloped land in Zone 11. Areas that would be disturbed in Zone 11 have not been systemically surveyed for archaeological or paleontological resources. Before construction, additional survey work may be necessary under Section 106 of the NHPA. Because Zone 11 is disturbed, it is unlikely to contain subsurface prehistoric or historic archeological deposits. Should any subsurface remains be discovered during construction, appropriate mitigation, documentation, and/or preservation measures would be conducted as necessary. Operations would not have additional impacts to archeological resources as it does not result in additional ground disturbance. Facility construction may have an impact on historic structures at Pantex. The original buildings in Zone 11 were constructed between 1942 and 1945 to produce general purpose bombs. Zone 11 contains buildings, ramps, and landscape features that clearly illustrate the historic layout of a World War II bomb manufacturing line. Only two buildings within Zone 11 have been determined ineligible for listing on the NRHP. Construction may obscure the spatial relationship between these buildings, thereby compromising their historic significance. Operation of the facility is not expected to affect historic structures.

The Department has recently initiated consultation with Native American groups that have expressed interest in Pantex lands. To date, no Native American resources have been identified within Zones 11 and 12. Resources may be identified through additional consultation. Although no mortuary remains have been discovered at Pantex to date, it is possible that some exist within land to be disturbed by development. Burials are considered important Native American resources. Construction and operation could affect traditionally used plant and animal species.

The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains, this formation has produced Late Pleistocene vertebrate remains including woolly mammoth, bison, and camel, sometimes in context with archaeological remains. The land to be disturbed during construction may contain some fossilized remains. Operation would not have an affect on paleontological resources.

Savannah River Site. The APSF in F-Area would be modified to accommodate the storage of SRS non-pit Pu material and RFETS non-pit Pu material for the storage Preferred Alternative. Vacant land in the F-Area would be used for the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities. Portions of the F-Area have been surveyed and contain sites potentially eligible for the NRHP. Additional surveys would be conducted in any unsurveyed areas to be disturbed by construction to comply with NHPA Sections 106 and 110. Site types known to occur at SRS include remains of prehistoric base camps, quarries, and workshops. Historic resources include remains of farmsteads, cemeteries, churches, and schools. Resources such as these may be affected by new facility construction, but not operation.

The MOX fuel fabrication facility would be located on undeveloped land approximately 1.6 km (1 mi) north of the P-Reactor Area on the east side of SRS Route F. To date, seven prehistoric sites have been located within 0.5 km (0.3 mi) of this area, so the potential for archaeological sites is moderate to high, and some NRHP-eligible resources may occur within the acreages that would be disturbed by construction. Prehistoric site types that may occur at SRS include villages, base camps, limited activity sites, quarries, and workshops. Historic site types that may occur at SRS include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, cattle pens, dams, towns, churches, cemeteries, trash scatters, and roads.

Some Native American resources may be affected by construction and operation of the facilities. Resources such as prehistoric sites, cemeteries, isolated burials, and traditional plants could be affected by construction. Facility operation could result in reduced access to traditional use areas or sacred space. Visual or auditory intrusions to the areas may also result from the proposed facilities. These resources would be identified through consultation with the potentially affected tribes.

Some paleontological remains may occur on this acreage, but impacts during construction would be considered negligible because fossil assemblages known to occur at SRS are of low research value. No additional impacts are expected to paleontological resources during operation since no additional ground disturbance is expected.

Socioeconomics. The socioeconomic impact indicators associated with construction and operation of the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS are shown in Table 4.6.1–7. The maximum impacts that could result from the operating of multiple storage and disposition facilities at one site are shown in the table. Although collocating multiple disposition facilities would likely lead to economies of scale, the ensuing analysis assumes that there would be no sharing of labor resources among the different operations. At all four sites the primary impact of the Preferred Alternative would be to increase regional employment and income. There would be some increase in demand for community services and housing at each of the sites as a result of in-migrating population. However, the available housing and existing community infrastructure would be able to accommodate these small population increases. Construction and operation of the proposed facilities would increase traffic flow and cause a potential decline in the level of service on some road segments at all sites except Hanford.

Table 4.6.1–7. Changes to Economic and Demographic Indicators for the Preferred Alternative (Full Operation)

Indicator	Hanford	INEL	Pantex	SRS
Change in ROI population	5,095	2,125	4,298	6,153
Percent change in ROI population	1.1	0.9	2.0	1.2
Change in REA employment	10,370	5,998	6,404	9,482
Percent change in REA employment	2.8	3.8	2.9	3.3
Change in REA per capita income	$464	$266	$94	$326
Percent change in REA per capita income	2.0	1.4	0.5	1.6

Source: Socio 1996a.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area, and there would be no impact on the site workforce. However, under the Preferred Alternative, pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would also be located at Hanford. Construction of the various facilities would continue through the year 2013, and there would be sufficient available labor within the region to fulfill construction workforce requirements. Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total REA employment would increase by 2,001 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be fully operational, generating an additional 7,467 jobs in the REA.

In 2003, the pit disassembly/conversion and MOX facilities would be the first disposition alternative facilities to become fully operational. Pu conversion would begin in 2006, and the ceramic immobilization operations would begin in 2013. The operational workforce would increase beginning in 2003 and peak in 2013 when all of the disposition facilities would become fully operational. Total direct employment would reach 3,073 in 2013. Total REA employment would increase by 10,370, and unemployment would decrease from 9.1 percent to 7.1 percent. The per capita income would increase by 2 percent. In-migration to fulfill specialized direct job requirements would lead to a population increase of about 1 percent in the ROI.

The additional population would increase the demand for community services by approximately 1 percent. A total of about 50 new teachers would be needed by 2013. Because the increase in demand would occur over a 10-year period and would be distributed over several school districts, there would be no significant impact on any single district. Thirteen additional police officers and seven firefighters would be needed to maintain No Action service levels. Six more doctors would be needed to maintain the projected No Action doctor-to-population ratio. In each case, the increase would be 1 percent or less over the No Action Alternative. Demand for housing would also increase, but the impact on the local markets would be minimal.

Construction and operation workers at Hanford would generate 1,920 and 5,900 additional vehicle trips per day on local roads, respectively. The level of service would not change due to the additional traffic generated during construction. Operations would cause a drop in level of service from B to C on Washington State Route 240 from Washington State Route 24 to Washington State Route 224.

Idaho National Engineering Laboratory. Plutonium material would continue to be stored at ICPP and ZPPR, and in FMF vaults at ANL-W. No additional workforce would be required for continuation of the storage mission at INEL. However, under the Preferred Alternatives, pit disassembly/conversion and MOX facilities would also be located at INEL. Construction of the two facilities would take place concurrently and continue through 2003. Some in-migration would take place both during construction and operation to fill specialized job requirements. Direct employment during peak construction would reach 660 in 1999 and total 1,330 during the first year of full operation in 2003. Total REA employment would increase by 1,192 during construction and by 5,998 during operations. Unemployment would decrease from 5.4 percent to 4.8 percent during peak construction and fall further to 2.4 percent during operation. The per capita income would increase by less than 0.4 percent during construction and by about 1.4 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of less than 1 percent in the ROI. The additional population would increase demand for community services by less than 1 percent during both construction and operations. A total of approximately 7 new teachers would be needed by 1999, and 29 by 2003. Because the increase in demand would occur over a multiyear period and would be distributed over several school districts, there would be no significant impact on any single district. One additional police officer and no firefighters would be needed during the construction phase to maintain the No Action service levels. During operations, five police officers and four firefighters would be needed. While one additional doctor would be required during construction, two doctors would be needed to maintain the No Action doctor-to-population ratio during full operation. In each case, the increase would be less than 1 percent over the No Action Alternative. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at INEL would generate 1,267 and 2,554 additional vehicle trips per day on local roads, respectively. The level of service would not change due to the additional traffic generated during construction. Operations would cause a drop in level of service from D to E on US 20 from US 26/91 at Idaho

Falls to US 26 East. Operations would also cause a drop in level of service from B to C on US 20/26 from US 26 East to Idaho State Route 22/33.

Pantex Plant. Buildings 12-66 and 12-82 would be modified to accommodate the long-term storage of Pantex Pu material and RFETS pit Pu material for the storage Preferred Alternative. Additional workers would be required for construction and operation of the modified storage facilities. The Preferred Alternative would also involve locating pit disassembly/conversion and MOX fabrication facilities at Pantex. Construction of these two facilities would take place concurrently and continue through 2003, when full operations would commence. Because the construction of the disposition facilities would require a larger workforce than would modification of the storage facilities, peak construction impacts would occur in 1999. Peak operation impacts would occur in 2005, when all three facilities would be fully operational. Total direct construction employment during peak construction would reach 660 in 1999, and direct operation employment would reach 1,420 in 2005, when all three facilities would be fully operational. Total REA employment would increase by 1,192 during peak construction and by 6,404 during operations. Unemployment would decrease from 4.8 percent to 4.3 percent during peak construction and fall further to 3.0 percent during operations. The per capita income would increase about 0.3 percent during construction and by 0.5 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of 0.1 percent during construction and about 2 percent during operation. The increase in demand for community services during construction would be minimal. One additional teacher would be needed to maintain the No Action level of service. However, no additional police officers, firefighters, or doctors would be required during the construction phase. During operation, an additional 48 teachers would be required to maintain the No Action student-to-teacher ratio. Because the increased demand would occur over a multiyear period and would be distributed over several school districts, there would be no significant impact on any single district. Seven additional police officers and 10 firefighters would be needed to maintain No Action service levels. In addition, seven more doctors would be needed to maintain the No Action doctor-to-population ratio. These increases would average about 2 percent over the No Action Alternative. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at Pantex would generate 1,267 and 2,726 additional vehicle trips per day on local roads, respectively. The level of service would not change due to the additional traffic generated during construction. Operations would cause a drop in level of service from A to B on Farm-to-Market 683 from U.S. 60 to Farm-to-Market 293 and on Farm-to-Market 2373 from I-40 to U.S. 60.

Savannah River Site. Under the Preferred Alternative, the Actinide Packaging and Storage Facility in the F-area would be modified to accommodate the long-term storage of the SRS non-pit Pu material and RFETS non-pit Pu material. The modification activities would employ workers from the current workforce, while operation of the expanded storage facility would require some additional workers. Under this alternative, pit disassembly/ conversion, Pu conversion, MOX fuel fabrication, and the ceramic immobilization facilities would also be located at SRS. Construction of the various facilities would continue until 2013, when all of the facilities would become operational. There would be sufficient available labor in the region to fulfill the construction workforce requirements.

Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total REA employment would increase by 1,793 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be operating and generating an additional 6,936 jobs in the REA.

Peak economic impacts would occur in 2013, when all of the storage and disposition facilities would be fully operational. Total employment in the region would increase by 9,482, and unemployment would decrease to 4.5 percent. Regional per capita income would increase by about 1.6 percent.

Because of the demand for in-migrating workers to fill specialized employment requirements, the ROI population would increase by 0.9 percent. Demand for community services would also increase. To maintain the No Action student-to-teacher ratio, a total of 65 new teachers would have to be added to the ROI school districts, an increase of about 1 percent. Because the increase in demand for teachers would take place over a several years and affect several school districts, there would be minimal impact on any single school district.

The population increase would also result in the need for 18 police officers and 18 firefighters to maintain No Action service levels. In addition, 10 doctors would be required to maintain the No Action doctor-to-population ratio. In each case the increase would be about 1 percent or less. The increase in demand for housing would be too small to affect the market.

Construction and operation workers at SRS would generate 1,920 and 6,150 additional vehicle trips per day on local roads, respectively. Construction would cause a drop in level of service from E to F on South Carolina State Route 19 from U.S. 1/78 at Aiken to U.S. 278. Operations would not significantly impact local roads.

Public and Occupational Health and Safety. Tables 4.6.1–8 through 4.6.1–11 present the potential human health impacts from the radiological and hazardous chemical releases during facility normal operations and potential accidents associated with the combination of storage and disposition Preferred Alternative actions at each of the DOE sites.

Normal Operations. The human health impacts from the radiological and hazardous chemical releases during facility normal operations associated with the storage and disposition Preferred Alternative actions were analyzed at each of the DOE sites. The impact of the Preferred Alternative actions were then combined to obtain the "total impact." Total impact for each receptor/impact parameter is the summation of each facility, action, process, or technology for each of the operational campaigns (the number of years required to complete Pu disposition). Under normal radiological operations, the annual incremental dose to the MEI ranges from 2.7×10^{-4} mrem/yr at INEL to 4.1×10^{-3} mrem/yr at SRS. All doses, when added to No Action, are within the radiological limits specified in NESHAPS (40 CFR 61, Subpart H) and DOE Order 5400.5. The annual incremental dose to the population within 80 km (50 mi) from the Preferred Alternative ranges from 4.2×10^{-3} person-rem/yr at INEL to 0.22 person-rem/yr at SRS. For DOE activities, proposed 10 CFR 834 (See 58 FR 1628) would generally limit the potential annual population dose to 100 person-rem from all pathways combined, and would require an ALARA Program. When the contribution from the Preferred Alternative is combined with the No Action population dose for each of the sites, the total dose is well within the proposed 10 CFR 834. The dose assessments of the involved worker for storage and disposition facilities are within DOE radiological limits and administrative control levels. The incremental latent cancer fatalities to the involved workforce statistically estimated from these doses attributed to the Preferred Alternative range from 0.48 at INEL to 1.32 at SRS for the entire campaign (estimates based on the *1990 Recommendations of the International Commission of Radiological Protection*).

Facility Accidents. A set of potential accidents was postulated for each component of the Preferred Alternative. For each DOE site subject to multiple storage and disposition actions (Hanford, INEL, Pantex, and SRS), this includes a set of accidents for the storage option coupled with the combination of preferred disposition technologies assumed for the analysis. For the Existing LWR Alternative, a PRA approach was applied to determine the effects of operating an existing LWR with a MOX core. The incremental effects are described below.

One measure of impact calculated from modeled accident scenarios is expected risk, the summation of risk (the product of accident occurrence probability and consequence) for the accident spectrum modeled for each component of the Preferred Alternative. These expected risks were aggregated for the Preferred Alternative for the following impact receptors: a worker located 1,000 m (3,280 ft) from the accident release point; the maximum offsite individual located at the site boundary; and the population located within 80 km (50 mi) of the accident release point. Aggregated expected risk estimates of cancer fatality(s) for each assumed campaign under the Preferred Alternative range from: 1.3×10^{-6} at INEL to 1.5×10^{-5} at Pantex; 1.4×10^{-8} at INEL to

Table 4.6.1–8. Potential Human Health Impacts to the Public and Workers Under Normal Operation and Potential Accidents for the Preferred Alternative at Hanford Site

Receptor/Impact Parameter	Site No Action/ Reference Baseline (per 50 years of operation)[a,b]	Disposition Facility: Pit Disassembly/ Conversion (per 10-year campaign)[b]	Disposition Facility: Pu Conversion (per 10-year campaign)[b]	Disposition Facility: MOX Fuel Fabrication (per 11-year campaign)[b]	Disposition Facility: Immobilization (per 3.5-year campaign)[b]	Total Incremental Impact
Normal Operations						
Radiological Impacts						
MEI						
Annual dose (mrem/yr)	5.3×10^{-3}	2.9×10^{-4}	1.8×10^{-4}	1.4×10^{-4}	2.3×10^{-7}	6.1×10^{-4}
Health effects (LCF risk)	1.3×10^{-7}	1.4×10^{-9}	9.0×10^{-10}	7.8×10^{-10}	4.2×10^{-13}	3.1×10^{-9}
Public Within 80 km						
Annual dose (person-rem/yr)	1.6	0.016	8.4×10^{-3}	6.2×10^{-3}	3.9×10^{-5}	0.031
Health effects (LCFs)	0.039	8.0×10^{-5}	4.2×10^{-5}	5.3×10^{-5}	7.0×10^{-8}	1.6×10^{-4}
Total Involved Workforce						
Health effects (LCFs)	5.1	0.34	0.53	0.14	0.16	1.17
Hazardous Chemical Impacts						
MEI						
Hazard index	6.2×10^{-5}	2.7×10^{-5}	2.9×10^{-5}	3.3×10^{-5}	2.6×10^{-3}	0.003
Cancer risk	0	0	3.2×10^{-8}	0	0	3.2×10^{-8}
Worker Onsite						
Hazard index	4.0×10^{-3}	5.0×10^{-4}	1.6×10^{-3}	1.6×10^{-3}	1.6×10^{-1}	0.164
Cancer risk	0	0	1.4×10^{-5}	0	0	1.4×10^{-5}
Facility Accidents						
MEI (LCF risk)	c	2.6×10^{-8}	2.0×10^{-8}	2.9×10^{-8}	1.7×10^{-11}	7.5×10^{-8}
Public within 80 km (LCF risk)	c	4.7×10^{-5}	3.6×10^{-5}	5.2×10^{-4}	2.4×10^{-8}	6.0×10^{-4}
Worker at 1,000 m (LCF risk)	c	6.5×10^{-7}	4.9×10^{-7}	7.1×10^{-7}	2.0×10^{-9}	1.9×10^{-6}

[a] The contribution from existing Pu storage is included in the site No Action total. A more detailed description of No Action impacts can be found in Section 4.2.1.9.

[b] Applies to health effects calculations for normal operations and facility accident risks.

[c] The safety to workers and the public from accidents at existing facilities is controlled by Technical Safety Requirements specified in a SAR or a Basis for Interim Operations document.

Note: LCF=latent cancer fatality; MEI=maximally exposed individual member of the public.

Source: Section 4.2.1.9; Section 4.3.1.9; Section 4.3.2.9; Section 4.3.4.1.9; Section 4.3.5.1.9.

Table 4.6.1–9. Potential Human Health Impacts to the Public and Workers Under Normal Operation and Potential Accidents for the Preferred Alternative at Idaho National Engineering Laboratory

Receptor/Impact Parameter	Site No Action/ Reference Baseline (per 50 years of operation)[a,b]	Disposition Facility: Pit Disassembly/ Conversion (per 10-year campaign)[b]	Disposition Facility: MOX Fuel Fabrication (per 11-year campaign)[b]	Total Incremental Impact
Normal Operations				
Radiological Impacts				
MEI				
Annual dose (mrem/yr)	0.018	1.8×10^{-4}	8.8×10^{-5}	2.7×10^{-4}
Health effects (LCF risk)	4.4×10^{-7}	9.0×10^{-10}	4.9×10^{-10}	1.4×10^{-9}
Public Within 80 km				
Annual dose (person-rem/yr)	2.4	3.2×10^{-3}	9.7×10^{-4}	4.2×10^{-3}
Health effects (LCFs)	0.061	1.5×10^{-5}	5.4×10^{-6}	2.0×10^{-5}
Total Involved Workforce				
Health effects (LCFs)	4.4	0.34	0.14	0.48
Hazardous Chemical Impacts				
MEI				
Hazard index	1.5×10^{-2}	5.8×10^{-5}	7.1×10^{-5}	1.3×10^{-4}
Cancer risk	3.6×10^{-6}	0	0	0
Worker Onsite				
Hazard index	2.2×10^{-1}	5.1×10^{-4}	1.6×10^{-3}	2.1×10^{-3}
Cancer risk	7.7×10^{-4}	0	0	0
Facility Accidents				
MEI (LCF risk)	c	6.6×10^{-9}	7.1×10^{-9}	1.4×10^{-8}
Public within 80 km (LCF risk)	c	1.4×10^{-5}	1.6×10^{-5}	3.0×10^{-5}
Worker at 1,000 m (LCF risk)	c	6.1×10^{-7}	6.5×10^{-7}	1.3×10^{-6}

[a] The contribution from existing Pu storage is included in the site No Action total. A more detailed description of No Action impacts can be found in Section 4.2.3.9.

[b] Applies to health effects calculations for normal operations and facility accident risks.

[c] The safety to workers and the public from accidents at existing facilities is controlled by Technical Safety Requirements specified in a SAR or a Basis for Interim Operations document.

Note: LCF=latent cancer fatality; MEI=maximally exposed individual member of the public.

Source: Section 4.2.3.9; Section 4.3.1.9; Section 4.3.2.9; Section 4.3.4.1.9; Section 4.3.5.1.9.

6.0×10^{-6} at Pantex; and 3.0×10^{-5} at INEL to 9.1×10^{-4} at Pantex; respectively for these impact receptors. The Y–12 upgrade at ORR under the Preferred Alternative could reduce the expected risk of cancer fatalities for the design basis accidents analyzed in the Y–12 EA to 5.1×10^{-7}, 7.4×10^{-6}, and 5.7×10^{-8} per year for the 80-km (50-mi) offsite population, MEI, and noninvolved worker, respectively by meeting the performance goal for a moderate hazard facility of Performance Category 3 as prescribed in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*.

The evaluated accident scenario with the highest risk to the public at the DOE sites under the Preferred Alternative (a fire on the loading dock of the MOX fuel fabrication facility) would result in an estimated risk of 5.2×10^{-5}, 1.6×10^{-5}, 1.8×10^{-5}, and 5.2×10^{-5} cancer fatalities over the assumed MOX fuel fabrication campaign at Hanford, INEL, Pantex, and SRS, respectively.

Table 4.6.1–10. Potential Human Health Impacts to the Public and Workers Under Normal Operation and Potential Accidents for the Preferred Alternative at Pantex Plant

Receptor/Impact Parameter	No Action/ Reference Baseline (per 50 years of operation)[a]	Pantex Pu Storage Upgrade (per 50 years of operation)[a,b]	Disposition Facility: Pit Disassembly/ Conversion (per 10-year campaign)[a]	Disposition Facility: MOX Fuel Fabrication (per 11-year campaign)[a]	Total Incremental Impact
Normal Operations					
Radiological Impacts					
MEI					
Annual dose (mrem/yr)	$6.1x10^{-5}$	$1.8x10^{-8}$	$1.1x10^{-3}$	$5.2x10^{-4}$	$1.6x10^{-3}$
Health effects (LCF risk)	$1.5x10^{-9}$	$4.5x10^{-13}$	$5.5x10^{-9}$	$2.9x10^{-9}$	$8.4x10^{-9}$
Public Within 80 km					
Annual dose (person-rem/yr)	$2.8x10^{-4}$	$6.3x10^{-6}$	$6.4x10^{-3}$	$2.8x10^{-3}$	$9.2x10^{-3}$
Health effects (LCFs)	$7.0x10^{-6}$	$1.6x10^{-7}$	$3.3x10^{-5}$	$1.6x10^{-5}$	$5.0x10^{-5}$
Total Involved Workforce					
Health effects (LCFs)	0.68	0.12	0.34	0.14	0.6
Hazardous Chemical Impacts					
MEI					
Hazard index	$5.7x10^{-3}$	0	$1.5x10^{-4}$	$1.9x10^{-4}$	$3.4x10^{-4}$
Cancer risk	$1.1x10^{-8}$	0	0	0	0
Worker Onsite					
Hazard index	$6.1x10^{-3}$	0	$2.6x10^{-4}$	$8.0x10^{-4}$	$1.0x10^{-3}$
Cancer risk	$4.5x10^{-7}$	0	0	0	0
Facility Accidents					
MEI (LCF risk)	c	$5.8x10^{-6}$	$1.0x10^{-7}$	$1.2x10^{-7}$	$6.0x10^{-6}$
Public within 80 km (LCF risk)	c	$8.8x10^{-4}$	$1.6x10^{-5}$	$1.8x10^{-5}$	$9.1x10^{-4}$
Worker at 1,000 m (LCF risk)	c	$1.4x10^{-5}$	$2.6x10^{-7}$	$2.9x10^{-7}$	$1.5x10^{-5}$

[a] Applies to health effects calculations for normal operations and facility accident risks.
[b] The committed effective dose equivalent for the storage facility is calculated based upon analysis of measured dose.
[c] The safety to workers and the public from accidents at existing facilities is controlled by Technical Safety Requirements specified in a SAR or a Basis for Interim Operations document.
Note: LCF=latent cancer fatality; MEI=maximally exposed individual member of the public.
Source: Section 4.2.4.9; Section 4.3.1.9; Section 4.3.2.9; Section 4.3.4.1.9; Section 4.3.5.1.9.

Under the Preferred Alternative, the use of LWRs is being pursued for the disposition of surplus plutonium through the use of MOX fuel in place of UO_2. An important question is whether the use of MOX fuel changes the safety envelope of UO_2 fueled reactors documented in SARs, PRAs, and NUREG-1150 (*Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*). Related reactor safety issues are addressed in a recent report by the NAS (*Management and Disposition of Excess Weapons Plutonium Reactor-Related Options*). The report indicates that the potential influences on safety of the use of MOX fuel in LWRs has been extensively studied in the United States in the 1970s (*Final Generic Environmental Impact Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors*, NUREG-0002). These influences have also been extensively studied in Europe, Japan and Russia. Regarding effects of MOX on accident probabilities, the National Academy of Sciences report states, "... no important overall adverse impact of MOX use on the accident probabilities of the LWRs involved will occur; if there are adequate reactivity and thermal margins in the fuel, as licensing review should ensure, the main remaining determinants of accident probabilities will involve factors not related to fuel composition and hence unaffected by the use of MOX rather

Table 4.6.1–11. Potential Human Health Impacts to the Public and Workers Under Normal Operation and Potential Accidents for the Preferred Alternative at Savannah River Site

Receptor/Impact Parameter	Site No Action/ Reference Baseline (per 50 years of operation)[a]	Upgrade of Actinide Packaging and Storage Facility (per 50 years of operation)[a,b]	Disposition Facility: Pit Disassembly/ Conversion (per 10-year campaign)[a]	Disposition Facility: Pu Conversion (per 10-year campaign)[a]	Disposition Facility: MOX Fuel Fabrication (per 11-year campaign)[a]	Disposition Facility: Immobilization (per 3.5-year campaign)[a]	Total Incremental Impact
Normal Operations							
Radiological Impacts							
MEI							
Annual dose (mrem/yr)	0.79	$7.6x10^{-6}$	$1.6x10^{-3}$	$1.0x10^{-3}$	$1.5x10^{-3}$	$1.3x10^{-6}$	$4.1x10^{-3}$
Health effects (LCF risk)	$2.0x10^{-5}$	$2.1x10^{-10}$	$8.0x10^{-9}$	$5.0x10^{-9}$	$8.4x10^{-9}$	$2.3x10^{-12}$	$2.2x10^{-8}$
Public Within 80 km							
Annual dose (person-rem/yr)	44	$3.5x10^{-4}$	0.11	0.066	0.044	$6.7x10^{-5}$	0.22
Health effects (LCFs)	1.1	$8.8x10^{-6}$	$5.6x10^{-4}$	$3.3x10^{-4}$	$2.4x10^{-4}$	$1.2x10^{-7}$	$1.1x10^{-3}$
Total Involved Workforce							
Health effects (LCFs)	5.2	0.15	0.34	0.53	0.14	0.16	1.32
Hazardous Chemical Impacts							
MEI							
Hazard index	$5.2x10^{-3}$	$1.6x10^{-6}$	$7.3x10^{-6}$	$7.9x10^{-6}$	$9.0x10^{-6}$	$7.1x10^{-4}$	$7.4x10^{-4}$
Cancer risk	$1.3x10^{-7}$	0	0	$8.7x10^{-9}$	0	0	$8.7x10^{-9}$
Worker Onsite							
Hazard index	1.2	$2.2x10^{-4}$	$4.5x10^{-4}$	$1.4x10^{-3}$	$1.4x10^{-3}$	0.14	1.3
Cancer risk	$1.9x10^{-4}$	0	0	$1.3x10^{-5}$	0	0	$1.3x10^{-5}$
Facility Accidents							
MEI (LCF risk)	c	$7.2x10^{-8}$	$1.0x10^{-8}$	$7.9x10^{-9}$	$1.6x10^{-8}$	$2.9x10^{-11}$	$1.1x10^{-7}$
Public within 80 km (LCF risk)	c	$3.5x10^{-4}$	$5.1x10^{-5}$	$3.8x10^{-5}$	$5.8x10^{-5}$	$3.0x10^{-8}$	$5.0x10^{-4}$
Worker at 1,000 m (LCF risk)	c	$3.0x10^{-6}$	$4.3x10^{-7}$	$3.2x10^{-7}$	$4.7x10^{-7}$	$1.3x10^{-9}$	$4.2x10^{-6}$

[a] Applies to health effects calculations for normal operations and facility accident risks.

[b] The dose results are taken from the APSF which is based on 5,000 storage positions. The SRS Upgrade With RFETS Pu and LANL Pu Subalternative contains 4,100 storage positions for the additional material at the upgraded APSF. A more detailed description of No Action and APSF upgrade impacts can be found in Section 4.2.6.9.

[c] The safety to workers and the public from accidents at existing facilities is controlled by Technical Safety Requirements specified in a SAR or a Basis for Interim Operations document.

Note: LCF=latent cancer fatality; MEI=maximally exposed individual member of the public.

Source: Section 4.2.6.9; Section 4.3.1.9; Section 4.3.2.9; Section 4.3.4.1.9; Section 4.3.5.1.9.

than LEU fuel." Regarding the effects of MOX on accident consequences, the report states, "... it seems unlikely that the switch from uranium-based fuel could worsen the consequences of a postulated (and very improbable) severe accident in a LWR by more than 10 to 20 percent. The influence on the consequences of less severe accidents, which probably dominate the spectrum value of population exposure per reactor-year of operation would be even smaller, because less severe accidents are unlikely to mobilize any significant quantity of plutonium at all."

The incremental effects of utilizing MOX fuel in a commercial reactor in place of UO_2 were derived from a quantitative analysis of several typical severe accident scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers highly unlikely severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic offsite population located within 80 km (50 mi) of the severe accident release point would range from -2.0×10^{-4} to 3.0×10^{-5} per year for the accident release scenarios analyzed. Accidents severe enough to cause a release of Pu or uranium include combinations of events that are highly unlikely. Estimates and analyses presented in chapter 4 and summarized in Table 2.5–3 indicate a range of latent cancer fatalities and risk per year from 5.9×10^3/0.15 to 7.3×10^3/0.16. These preliminary results would be reexamined for licensing purposes and subsequent NEPA review. More detailed safety analyses would be performed using both up-to-date calculations of radionuclide inventories for different fuel compositions and irradiation histories, and population-exposure models for sensitivity changes in those inventories resulting from the use of weapons-grade Pu in the fuel.

Natural Phenomena. Under the Preferred Alternative, HEU would continue to be stored at Y–12 at ORR in existing facilities that would be upgraded. The majority of the HEU would be housed in upgraded facilities currently used for HEU storage. The remaining HEU would be stored in facilities that were formerly used for material processing but are currently being modified and converted into storage areas. Modifications to existing buildings would make the facilities suitable for long-term storage and consist primarily of those upgrades required to meet natural phenomena requirements (including earthquakes and tornadoes) as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). The Y–12 storage buildings would be upgraded to meet the performance goal for a moderate hazard facility of Performance Category 3 in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*. In a Performance Category 3 facility, radioactive or toxic materials are present in significant quantities. Design considerations for this category are to limit facility damage so that hazardous materials can be controlled and confined, occupants can be protected, and functions of the facility can continue without interruption. A performance goal for Performance Category 3 is a hazard exceedance frequency of 1.0×10^{-4} per year (DOE Order 5480.28). Meeting this performance goal would reduce the expected risk for the design basis accidents analyzed in the Y–12 EA (for example, Building 9212) by approximately 80 percent, resulting in a latent cancer fatality risk of 5.1×10^{-7} to the MEI and 5.7×10^{-8} to a noninvolved worker, and potential latent cancer fatalities of 7.4×10^{-6} for the 80-km (50-mi) offsite population.

At SRS, F-Canyon facilities could be used for the immobilization of surplus Pu using the can-in-canister variant under the Preferred Alternative. The earthquake accident analysis in the *Environmental Impact Statement, Interim Management of Nuclear Materials* (IMNM EIS) determined that the F-Canyon facilities are structurally sound. Since that time, DOE has prepared a *Supplemental Analysis of Seismic Activity on F-Canyon* (August 1996). Based on the evaluation, an earthquake that could occur about once every 8,000 years could cause a level of structural damage to F-Canyon similar to the level of damage attributed to the earthquake considered in the IMNM EIS. Thus, the capability of F-Canyon to survive an earthquake more severe than that evaluated in the EIS, in combination with the fact that the likelihood of this level of damage was less than assumed in the EIS (1 per 8,000 years compared to 1 per 5,000 years), indicates that F-Canyon is seismically safe, or safer, than indicated in the IMNM EIS.

Waste Management. There is no spent nuclear fuel or HLW associated with construction or operation of Preferred Alternative facilities, but the ceramic immobilization facility would generate as its product output a stabilized ceramic form spiked with Cs radionuclides. (For immobilization using vitrification a stable glass form of Pu and HLW would be generated.) Storage of this immobilized product would be provided until disposal in a geologic repository pursuant to the NWPA. Pursuant to the NWPA, DOE is currently characterizing the Yucca Mountain Site as a potential repository for spent nuclear fuel and HLW. Legislative clarification, or a determination by the NRC that the immobilized Pu should be isolated as HLW, may be required before the material could be placed in Yucca Mountain should DOE and the President recommend, and Congress approve its operation. No radionuclides, which are RCRA wastes, would be used for immobilization so the immobilized product would be consistent with the repository's WAC. Each of the facilities under the Preferred Alternative has as part of its conceptual design waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with the regulatory requirements of RCRA, and other applicable statutes. Under the Preferred Alternative, the waste management infrastructure of the individual facilities would be integrated into a single waste management infrastructure to include maximum use of existing and planned site waste management facilities. Depending in part on decisions in the waste-type-specific RODs for the Waste Management PEIS, wastes could be treated, and (depending on the type of waste) disposed of onsite or at regionalized or centralized DOE sites. The treatment level and potential disposal of TRU and mixed-TRU waste at WIPP will depend on decisions in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*. For the purposes of analyses only, this PEIS assumes that TRU and mixed-TRU waste would be treated onsite to the current planning-basis WIPP WAC, and shipped to WIPP for disposal. This PEIS also assumes that hazardous waste LLW and mixed LLW would be treated and disposed of in accordance with current site practice.

Construction and operation of the proposed facilities would affect existing waste management activities at each of the sites analyzed, increasing the generation of TRU, low-level, mixed, hazardous, and nonhazardous wastes as shown in Table 4.6.1–12. Wastes generated during construction would consist of wastewater and hazardous and solid nonhazardous wastes. Wastewater and solid nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be treated onsite or shipped offsite, to a commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of offsite in a commercial RCRA-permitted disposal facility. No radioactive or hazardous soil contamination is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all applicable Federal and State regulations.

Hanford Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment, and packaging to meet the current planning-basis WIPP WAC or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the Hanford Tri-Party Agreement to meet the WIPP WAC or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase,* 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,590 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the WAC of the 200-Area LLW Burial Grounds. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 3,400 m^3/ha (1,800 yd^3/acre), this would require 0.6 ha/yr (1.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (320 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the Hanford Tri-Party Agreement. The 46 m^3 (12,150 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated onsite or offsite, and shipped in Department of

Table 4.6.1–12. *Estimated Annual Generated Waste Volumes for the Preferred Alternative*

Category	No Action (m^3)	Storage Alternative (m^3)	Pit Disassembly/ Conversion (m^3)	Pu Conversion (m^3)	MOX Fuel Fabrication (m^3)	Ceramic Immobilization (m^3)	Total Impact (m^3)
Hanford Site[a]							
Transuranic							
Liquid	None	0	None	3.2[b]	None	75[b]	78.2
Solid	271	0	67	278	306	99	1,021
Mixed transuranic							
Liquid	None	0	None	0	None	None	0
Solid	98	0	4[b]	191	4	0.7	297.7
Low-level							
Liquid	None	0	4	56[b]	4[b]	7[b]	71
Solid	3,390	0	102	1,743	153	14	5,402
Mixed low-level							
Liquid	3,760	0	0.4	0.04	0.8	None	3,761.24
Solid	1,505	0	1.7	191	38	0.15	1,735.85
Hazardous							
Liquid	Included in solid	0	2	2	4	38	46
Solid	560	0	0.7	11	153	19	743.7
Nonhazardous (sanitary)							
Liquid	414,000	0	85,200	15,000	43,300	34,000	591,500
Solid	5,107	0	100	2,060	76	920	8,263
Nonhazardous (other)							
Liquid	Included in sanitary	0	Included in sanitary	56	227	170,000	170,283
Solid	Included in sanitary	0	3[c]	0	84[c]	15[c]	102
Idaho National Engineering Laboratory[d]							
Transuranic							
Liquid	None	0	None	NA	None	NA	0
Solid	3.5	0	67	NA	306	NA	376.5

Table 4.6.1–12. Estimated Annual Generated Waste Volumes for the Preferred Alternative—Continued

Category	No Action (m^3)	Storage Alternative (m^3)	Pit Disassembly/ Conversion (m^3)	Pu Conversion (m^3)	MOX Fuel Fabrication (m^3)	Ceramic Immobilization (m^3)	Total Impact (m^3)
Mixed transuranic							
Liquid	None	0	None	NA	None	NA	0
Solid	Included in TRU	0	4	NA	4	NA	8
Low-level							
Liquid	None	0	4[b]	NA	4[b]	NA	8
Solid	7,200	0	102	NA	153	NA	7,455
Mixed low-level							
Liquid	4	0	0.4	NA	0.8	NA	5.2
Solid	170	0	1.7	NA	38	NA	209.7
Hazardous							
Liquid	Included in solid	0	2	NA	4	NA	6
Solid	1,200	0	0.7	NA	153	NA	1,353.7
Nonhazardous (sanitary)							
Liquid	Included in solid	0	85,200	NA	43,300	NA	128,500
Solid	52,000	0	100	NA	76	NA	52,176
Nonhazardous (other)							
Liquid	None	0	Included in sanitary	NA	227	NA	227
Solid	Included in sanitary	0	3[c]	NA	84[c]	NA	87
Pantex Plant[e]							
Transuranic							
Liquid	None	0	None	NA	None	NA	0
Solid	None	0.8	67	NA	306	NA	373.8
Mixed transuranic							
Liquid	None	0	None	NA	None	NA	0
Solid	None	0	4	NA	4	NA	8
Low-level						NA	
Liquid	8	0.08[b]	4[b]	NA	4[b]	NA	16.08
Solid	32	138	102	NA	153	NA	425

Table 4.6.1–12. Estimated Annual Generated Waste Volumes for the Preferred Alternative—Continued

Category	No Action (m³)	Storage Alternative (m³)	Pit Disassembly/ Conversion (m³)	Pu Conversion (m³)	MOX Fuel Fabrication (m³)	Ceramic Immobilization (m³)	Total Impact (m³)
Mixed low-level							
Liquid	4	0.2	0.4	NA	0.8	NA	5.4
Solid	46	8	1.7	NA	38.1	NA	93.7
Hazardous							
Liquid	2	1	2	NA	4	NA	9
Solid	31	1.5	0.7	NA	153	NA	186.2
Nonhazardous (sanitary)							
Liquid	141,000	12,900	85,200	NA	43,300	NA	282,400
Solid	339	275	100	NA	76	NA	790
Nonhazardous (other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	NA	227	NA	227
Solid	Included in sanitary	344[c]	3[c]	NA	84[c]	NA	431
Savannah River Site[f]							
Transuranic							
Liquid	None	0	None	3.2[b]	None	75[b]	78.2
Solid	338	0	67	278	306	99	1,088
Mixed transuranic							
Liquid	None	0	None	0	None	None	0
Solid	Included in TRU	0	4	191	4	0.7	199.7
Low-level							
Liquid	74,000	0	4[b]	56[b]	4[b]	7[b]	74,071
Solid	16,400	0	102	1,743	153	14	18,412
Mixed low-level							
Liquid	1,330	0	0.4	0.04	0.8	None	1,331.24
Solid	7,700	0	1.7	191	38	0.15	7,930.85
Hazardous							
Liquid	1,260	0	2	2	4	38	1,306
Solid	15,100	0.8	0.7	11	153	19	15,284.5

Table 4.6.1–12. Estimated Annual Generated Waste Volumes for the Preferred Alternative—Continued

Category	No Action (m^3)	Storage Alternative (m^3)	Pit Disassembly/ Conversion (m^3)	Pu Conversion (m^3)	MOX Fuel Fabrication (m^3)	Ceramic Immobilization (m^3)	Total Impact (m^3)
Nonhazardous (sanitary)							
Liquid	703,000	1,806	85,200	15,000	43,300	34,000	882,306
Solid	61,200	18	100	2,060	76	920	64,374
Nonhazardous (other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	56	227	170,000	170,283
Solid	Included in sanitary	18[c]	3[c]	0	84[c]	15[c]	120

[a] No Action is the Preferred Alternative for storage of surplus Pu at Hanford.
[b] Liquid TRU and low-level waste would be treated and solidified before disposal.
[c] Includes recyclable waste.
[d] No Action is the Preferred Alternative for storage of surplus Pu at INEL.
[e] Upgrade is the Preferred Alternative at Pantex for the long-term storage of surplus Pu pit material only.
[f] Upgrade is the Preferred Alternative at SRS for the long-term storage of surplus Pu non-pit material only.
Note: NA=not applicable.
Source: Table 4.2.1.10–1; Table 4.2.3.10–1; Table 4.2.4.10–1; Table 4.2.6.10–1; Table 4.3.1.10–1; Table 4.3.2.10–1; Table 4.3.4.2.10–1; Table 4.3.5.1.10–1.

Transportation (DOT)-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of offsite in commercial RCRA-permitted disposal facilities.

Approximately 177,000 m^3 (46.8 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45.0 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 3,240 m^3 (4,240 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Richland landfill per current site practice.

Idaho National Engineering Laboratory. Under the Preferred Alternative approximately 373 m^3 (488 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP WAC or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the INEL Site Treatment Plan to meet the current planning-basis WIPP WAC or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase,* 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,000 gal) of liquid and 255 m^3 (333 yd^3) of solid LLW would require treatment, processing, and packaging to meet the WAC of the RWMC. Assuming a land usage of factor of 6,200 m^3/ha (3,300 yd^3/acre), the disposal of LLW would require 0.04 ha/yr (0.1 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.1 m^3 (290 gal) of liquid and 40 m^3 (52 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the INEL Site Treatment Plan. The 6 m^3 (1,500 gal) of liquid and 154 m^3 (201 yd^3) of solid hazardous wastes would be collected, treated onsite or offsite, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of offsite in commercial RCRA-permitted disposal facilities.

Approximately 129,000 m^3 (34.0 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 253 m^3 (331 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the onsite landfill per current site practice.

Pantex Plant. Under the Preferred Alternative approximately 374 m^3 (489 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP WAC or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan* to meet the WIPP WAC or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase,* 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,100 gal) of liquid and 392 m^3 (513 yd^3) of solid LLW would require treatment, processing, and packaging to meet the WAC of the NTS Area 5 RWMS WAC. After treatment and volume reduction, 324 m^3 (424 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 6,000 m^3/ha (3,200 yd^3/acre), the disposal of LLW would require 0.05 ha/yr (0.13 acres/yr) of LLW disposal area at NTS. Assuming 16.6 m^3 (21.7 yd^3) of LLW per shipment, 20 additional LLW shipments per year from Pantex to NTS would be required. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.3 m^3 (350 gal) of liquid and 48 m^3 (63 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan*. The 7 m^3 (1,760 gal) of liquid and 155 m^3 (203 yd^3) of solid hazardous wastes would be collected, treated onsite or offsite, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of offsite in commercial RCRA-permitted disposal facilities.

Approximately 141,000 m^3 (37.2 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The existing sanitary wastewater treatment system has adequate excess capacity to treat the additional quantity of sanitary wastewater. The 391 m^3 (511 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Amarillo landfill under current site practice.

Savannah River Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP WAC or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the SRS Treatment Plan to meet the current planning-basis WIPP WAC or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase,* 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,600 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the WAC of the SRS E-Area Low-Level Radioactive Disposal Facility. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 8,600 m^3/ha (4,600 yd^3/acre), this would require 0.2 ha/yr (0.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (311 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the SRS Site Treatment Plan. The 46 m^3 (12,070 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated onsite or offsite, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of offsite in commercial RCRA-permitted disposal facilities.

Approximately 179,000 m^3 (47.3 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The centralized sanitary wastewater treatment system is adequate to treat the sanitary portion. The 3,250 m^3 (4,250 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to an offsite landfill per current site practice.

Intersite Transportation. A summary of the estimated health effects from transportation of radiological materials for the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS if all the applicable Preferred Alternative disposition facilities were located at a single site is shown in Table 4.6.1–13. If the disposition facilities are at multiple sites then the health effects would be larger, as described below. For the storage Preferred Alternative, there would be no additional transportation of Pu to Hanford and INEL and therefore, no potential fatalities at those sites. Pits from RFETS would be transported to Pantex, and non-pit Pu material from RFETS would be transported to SRS. Pits to be transferred would be packaged in FL (Type B) containers at RFETS before shipment and, upon receipt at Pantex, would be repackaged into AL-R8 containers in Zone 12 South and placed into storage in Zone 4 West pending availability of AT-400A containers and relocation to

Table 4.6.1–13. Total Potential Fatalities[a] From the Transportation of Materials for the Preferred Alternative

Activity	Hanford	INEL	Pantex	SRS
Storage	0.0	0.0	0.006	0.060
Pit disassembly/conversion	0.209	0.161	0.0	0.184
Pu conversion	b	NA	NA	b
MOX fuel fabrication	0.193	0.193	0.193	0.193
Ceramic immobilization	0.98	NA	NA	1.43
Total if disposition activities are one site	1.382	0.354	0.199	1.867

[a] Resulting from both radiological and nonradiological risks for the life of the project.
[b] The analysis assumed that the Pu conversion facility would be located at the immobilization site.
Note: NA = not analyzed for the Preferred Alternative.
Source: Table 4.4.3.2-1; Table 4.4.3.3-1; Table 4.4.3.3-3; Table 4.4.3.3-4.

upgraded storage facilities in Zone 12 South. The transportation of pits between Zone 4 and Zone 12 and the repackaging of the pits from AL-R8 to AT-400A containers is analyzed in the Pantex EIS.

For the disposition alternative, the transportation analysis was based upon the assumption that the storage Preferred Alternative had been implemented prior to the start disposition transportation.

Further, the reactor portion of the disposition Preferred Alternative assumed that the pit disassembly/conversion facility and the MOX facility could be sited at one location or sited at different locations. The total potential fatalities could range from 0.193 (the pit disassembly/conversion and MOX facilities at Pantex) to 0.761 (the pit disassembly/conversion and MOX facilities at different sites). In addition to the DOE sites, there would be transportation of the MOX fuel from the DOE site to existing reactors. The destination of the MOX fuel could be either the eastern or western United States. Assuming 4,000 km (2,484 mi), there would be an additional 3.61 potential fatalities.

For the immobilization portion of the disposition Preferred Alternative, the analysis assumed that the Pu conversion and ceramic immobilization facility would be at the same location. The total potential fatalities could range from 0.98 (both facilities at Hanford) to 1.43 (both facilities at SRS). The analysis includes the effect of transporting Cs-137 to the immobilization site and the transportation of immobilized materials to a HLW repository site. The ceramic immobilization facility was selected for this analysis because the transportation impacts were slightly greater that the vitrification facility.

Environmental Justice. The public health and safety analyses show that air emissions and hazardous chemical and radiological releases from normal operations for all of the storage alternatives would be within regulatory limits and that no latent cancer fatalities would result. Because no populations within 80 km (58 mi) of the proposed site would experience high or adverse health or environmental impacts, neither minority populations nor low-income populations would experience disproportionate high and adverse human health or environmental impacts.

The public health and safety analyses also indicate that radiological releases from accidents would not result in significant adverse human health or environmental impacts. Therefore, such accidents would not have disproportionately high and adverse impacts on minority or low-income populations. Potential transportation accidents would be random events along the transportation corridors, therefore, such accidents would not disproportionately impact minority or low income populations.