APPENDIX B
ENVIRONMENTAL IMPACT METHODOLOGIES

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This appendix briefly describes the methods used to assess the potential direct, indirect, and cumulative effects of the alternatives in the *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems (Consolidation EIS)*. Included are impact assessment methodologies for land resources, air quality, noise, geology and soils, water resources, ecological resources, cultural resources, socioeconomics, environmental justice, waste management, cumulative impacts, infrastructure, public and occupational health and safety, and transportation. Each section includes a description of the affected resources, region of influence (ROI), and the impact assessment method. Detailed descriptions of the methods for the evaluation of human health effects of normal operations, facility accidents, and transportation are presented in Appendix C of this environmental impact statement (EIS).

Methods for assessing environmental impacts vary for each resource area. For air quality, for example, pollutant emissions from operations related to production of radioisotope power systems (RPS) were evaluated for their effect on ambient concentrations and their compliance with ambient standards. Comparison with regulatory standards is a commonly used method for benchmarking environmental impacts, and appropriate comparisons have been made in a number of resource analyses to provide perspective on the magnitude of identified impacts. For waste management, waste generation rates were compared with site waste generation rates and with the capacities of waste management facilities. Impacts in all resource areas were analyzed consistently; that is, the impact values were estimated using a consistent set of input variables and computations. Moreover, efforts were made to ensure that calculations in all areas used accepted protocols and up-to-date models.

B.1 Land Resources

B.1.1 Land Use

B.1.1.1 Description of Affected Resources

Land use includes the land on and adjacent to the site, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. The ROI for the *Consolidation EIS* includes the site and areas immediately surrounding the site.

B.1.1.2 Description of Impact Assessment

The amount of land disturbed and conformity with existing land use were considered to evaluate potential impacts (see **Table B–1**). The *Consolidation EIS* evaluates the impacts of alternatives on land use within each facility site location. The analysis focuses on the net land area affected, its relationship to conforming and nonconforming land uses, current growth trends and use designations, proximity to special use areas, and other factors pertaining to land use. Total additional land area requirements considered include those areas to be occupied by the footprint of new facilities that would be required in conjunction with any additional parking areas, graveled areas, or construction laydown areas. These requirements were compared to the total land area of the site.

B.1.2 Visual Resources

B.1.2.1 Description of Affected Resources

Visual resources are the natural and manmade features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape; however, they exert varying degrees of influence. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape. The ROI for visual resources includes the geographic area from which the RPS production facilities and the transfer roadway may be seen. This would generally involve nearby higher elevations and public roadways.

Table B–1 Impact Assessment Protocol for Land Use and Visual Resources

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Land area used	Acreage of site	Facility acreage requirements	Area converted to project use
Compatibility with existing or future land use	Existing land use configurations	Location of facilities on the site; expected modifications of site activities and uses to accommodate the alternatives	Incompatibility with existing or future land use
Visual resources	Current Visual Resource Management classification	Location of facilities on the site; facility dimensions and appearance	Change in Visual Resource Management classification

B.1.2.2 Description of Impact Assessment

Visual resource assessments are based on the Bureau of Land Management's visual resource management method. A qualitative visual resource analysis, adapted from the Bureau of Land Management's visual contrast rating system (DOI 1986), is conducted to determine whether the candidate sites would change as a result of proposed RPS consolidation activities. Classifications of visual contrast settings are provided in **Table B–2**. Classifications were derived from an inventory of scenic qualities, sensitivity levels, and distance zones for particular areas.

Table B–2 Bureau of Land Management Classification of the Visual Resources

Classification	*Visual Settings*
Class I	Very limited management activity; natural ecological change
Class II	Management activities may be seen, but should not attract the attention of the casual observer, such as solitary small buildings or dirt roads
Class III	Management activities may attract attention, but should not dominate the view of the casual observer; natural landscape still dominates buildings, utility lines, and secondary roads
Class IV	Management activities may dominate the view and major focus of viewer attention, such as cluster of two-story buildings, large industrial/office complexes, primary roads, and limited clear cutting for utility lines or ground disturbances

The visual resources analysis focuses on the degree of contrast between the Proposed Action and the surrounding landscape, the location and sensitivity levels of public vantage points, and the visibility of the Proposed Action from the vantage points. The distance from a vantage point to the affected area and atmospheric conditions were also considered, as distance and haze can diminish the degree of contrast and visibility. A qualitative assessment of the degree of contrast between proposed facility construction and operations and the existing visual landscape is presented, as applicable.

Thus, to determine the range of potential visual effects of new facilities, the analysis considered potential impacts of construction and operations in light of the aesthetic quality of surrounding areas, as well as the visibility of proposed activities and facilities from public vantage points.

B.2 Infrastructure

B.2.1 Description of Affected Resources

Site infrastructure includes physical resources encompassing the transportation and utility systems required to support the construction and/or modification and operation of facilities associated with production of RPS. It includes the capacities of onsite road networks, electric power and electrical load capacities, natural gas and liquid fuel (i.e., fuel oil, diesel fuel, and gasoline) capacities, and water supply system capacity.

The ROI is generally limited to the boundaries of each proposed site. However, should infrastructure requirements exceed site capacities, the ROI would be expanded (for analysis) to include the sources of additional supply. For example, if electrical demand (with added facilities) exceeded site availability, then the ROI would be expanded to include the likely source of additional power (i.e., the power pool currently supplying the site).

B.2.2 Description of Impact Assessment

In general, infrastructure impacts were assessed by evaluating the requirements of each alternative, including associated activities and facility demands against site capacities. An impact assessment was made for each resource (road networks, electricity, fuel, and water) for the various alternatives (see **Table B–3**). Local transportation system impacts were addressed qualitatively, as additional transportation infrastructure requirements under the Proposed Action and alternatives. Tables reflecting site availability and infrastructure requirements were developed for each alternative. Data for these tables were obtained from documentation[1] describing the existing infrastructure at the facility site locations and from data reports prepared to support the EIS with regard to production of RPS.

Table B–3 Impact Assessment Protocol for Infrastructure

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Transportation			
Roads (kilometers)	Site/facility area capacity and current usage	Activity and facility requirements	Additional requirement (with added facilities) exceeding facility area/site capacity
Electricity			
Energy consumption (megawatt-hours)	Site/facility area and current usage	Activity and facility requirements	Additional requirement (with added facilities) exceeding facility area/site capacity
Fuel			
Natural gas (cubic meters) Gasoline (million liters) Diesel fuel (million liters)	Site/facility area and current usage	Activity and facility requirements	Additional requirement (with added facilities) exceeding facility area/site capacity
Water (million liters)	Site/facility area and current usage	Activity and facility requirements	Additional requirement (with added facilities) exceeding facility area/site capacity

[1] *For applicable source data, see the documentation referenced in Sections 3.1.2, 3.2.2, and 3.3.2 of the Consolidation EIS.*

Any projected demand for infrastructure resources exceeding site availability can be regarded as an indicator of impact. Whenever projected demand approaches or exceeds capacity, further analysis for that resource is warranted. Often, design changes can mitigate the impact of additional demand for a given resource. For example, substituting fuel oil for natural gas (or vice versa) for heating or industrial processes can be accomplished at little cost during the design of a facility, provided the potential for impact is identified early. Similarly, a dramatic "spike" in peak demand for electricity can sometimes be mitigated by changes to operational procedures or parameters.

B.3 Noise

B.3.1 Description of Affected Resources

Noise, or sound, results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. Propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is undesirable sound that interferes or interacts negatively with the human or natural environment. Noise can disrupt normal activities (e.g., hearing, sleep), damage hearing, or diminish the quality of the environment.

Noise-level measurements used to evaluate the effects of nonimpulsive sound on humans are compensated by an A-weighting scale that accounts for the hearing response characteristics (i.e., frequency) of the human ear. Noise levels are expressed in decibels, or in the case of A-weighted measurements, decibels A-weighted. The U.S. Environmental Protection Agency (EPA) has developed noise-level guidelines for different land use classifications (EPA 1974). The EPA guidelines identify a 24-hour exposure level of 70 decibels as the level of environmental noise that will prevent any measurable hearing loss over a lifetime. Likewise, levels below 55 decibels outdoors and 45 decibels indoors are identified as preventing activity interference and annoyance.

Noise from facility construction or operations and associated traffic could affect human and animal populations. The ROI for each facility includes the site and surrounding areas, including transportation corridors, where proposed activities might increase noise levels. Transportation corridors most likely to experience increased noise levels are those roads within a few kilometers of the site boundary that carry most of the site's employee and shipping traffic.

Noise-level data representative of site environs were obtained from existing reports. The acoustic environment was further described in terms of existing noise sources for the proposed locations and traffic noise levels along access routes.

B.3.2 Description of Impact Assessment

Noise impacts associated with the alternatives could result from construction and operations activities, including increased traffic (see **Table B–4**). Impacts of proposed activities under each alternative were assessed according to the types of noise sources and facility site locations relative to the site boundary and noise-sensitive receptors. Potential noise impacts of traffic were assessed based on the likely increase in traffic volume. Possible impacts on wildlife were evaluated based on the possibility of sudden loud noises occurring during site activities under each alternative.

Table B–4 Impact Assessment Protocol for Noise

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Noise	Identification of sensitive offsite receptors (e.g., nearby residences, nearby threatened and endangered wildlife habitat); description of noise-levels and noise sources in the vicinity of the site	Description of noise sources; shipment and workforce traffic estimates	Increase in day/night average sound level at sensitive receptors

B.4 Air Quality

B.4.1 Description of Affected Resources

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could:

- endanger human health,
- harm living resources and ecosystems,
- damage material property, or
- impair or interfere with the comfortable enjoyment of life and other legitimate uses of the environment.

For the purpose of the *Consolidation EIS*, only outdoor air pollutants were addressed. They could be in the form of solid particles, liquid droplets, gases, or a combination of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants or by reaction with normal atmospheric constituents that may be influenced by sunlight). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Thus, air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location can be described by comparing the concentrations of various pollutants in the atmosphere with the appropriate standards. Ambient air quality standards have been established by Federal and state agencies, allowing an adequate margin of safety for the protection of public health and welfare from the adverse effects of pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy; those below such standards are considered acceptable.

The pollutants of concern are primarily those for which Federal and state ambient air quality standards have been established, including criteria air pollutants, hazardous air pollutants, and other toxic air compounds. Criteria air pollutants are those listed in Title 40 of the *Code of Federal Regulations* (CFR) Part 50 (40 CFR 50), "National Primary and Secondary Ambient Air Quality Standards." Hazardous air pollutants and other toxic compounds are those listed in Title I of the Clean Air Act, as amended (Title 40 of the *United States Code*, Section 7401 *et seq.* [40 U.S.C. 7401 *et seq.*]), those regulated by the National Emissions Standards for Hazardous Air Pollutants (40 CFR 61), and those that have been proposed or adopted for regulation by the applicable state or are listed in state guidelines. States may set ambient standards that are more stringent than the National Ambient Air Quality Standards (NAAQS). The more stringent of the state or Federal standards for each site is shown in this *Consolidation EIS*.

Areas with air quality that meets the NAAQS for criteria air pollutants are designated as being in "attainment," while areas with air quality that does not meet the NAAQS for such pollutants are

designated as "nonattainment." Areas may be designated as "unclassified" when sufficient data for attainment-status designation are lacking. Attainment-status designations are assigned by county, metropolitan statistical area, consolidated metropolitan statistical area, or portions thereof, or air quality control regions. Air quality control regions designated by EPA and attainment-status designations are listed in 40 CFR 81, "Designation of Areas for Air Quality Planning Purposes."

Prevention of Significant Deterioration (PSD) regulations limit pollutant emissions from new or modified sources and establish allowable increments of pollutant concentrations for attainment areas. Three PSD classifications are specified, with the criteria established, in the Clean Air Act. Class I areas include national wilderness areas, memorial parks larger than 2,020 hectares (5,000 acres), national parks larger than 2,430 hectares (6,000 acres), and areas that have been redesignated as Class I. Class II areas are all areas not designated as Class I. No Class III areas have been designated (42 U.S.C. 7472 *et seq.*).

The ROI for air quality encompasses an area surrounding a candidate site that is potentially affected by air pollutant emissions caused by implementation of the alternatives. The air quality impact area normally evaluated is the area in which concentrations of criteria pollutants would increase more than a significant amount in a Class II area (on the basis of averaging period and pollutant: 1 microgram per cubic meter for the annual average for sulfur dioxide, nitrogen dioxide, and PM_{10};[1] 5 micrograms per cubic meter for the 24-hour average for sulfur dioxide and PM_{10}; 500 micrograms per cubic meter for the 8-hour average for carbon monoxide; 25 micrograms per cubic meter for the 3-hour average for sulfur dioxide; and 2,000 micrograms for the 1-hour average for carbon monoxide [40 CFR 51.165]). Generally, this covers a few kilometers downwind from the source. Further, for sources within 100 kilometers (60 miles) of a Class I area, the air quality impact area evaluated would include the Class I area if the increase in concentration of any air pollutants for which there are PSD increments is greater than 1 microgram per cubic meter (24-hour average). The area of the ROI depends on emission source characteristics, pollutant types, emission rates, and meteorological and topographical conditions. For the purpose of this analysis, impacts were evaluated at the site boundary and along roads within the sites to which the public has access, plus any additional areas in which contributions to pollutant concentrations are expected to exceed significant levels.

Baseline air quality is typically described in terms of pollutant concentrations modeled for existing sources at each candidate site and background air pollutant concentrations measured near the sites. For this analysis, emission data from existing sources were obtained from existing EISs and recent site environmental reports. Concentrations from these data were modeled using the Industrial Source Complex Short Term model (EPA 1995, 2000), or were obtained from existing documents.

B.4.2 Description of Impact Assessment

Potential air quality impacts of pollutant emissions from construction, normal operations, and deactivation were evaluated for each alternative. This assessment included a comparison of pollutant concentrations under each alternative with applicable Federal and state ambient air quality standards (see **Table B–5**). If both Federal and state standards exist for a given pollutant and averaging period, compliance was evaluated using the more stringent standard. Operational air pollutant emissions data for each alternative were based on conservative engineering analyses.

For each alternative, contributions to offsite air pollutant concentrations were modeled on the basis of guidance presented in EPA's "Guideline on Air Quality Models" (40 CFR 51, Appendix W). The EPA screening model, SCREEN 3, was selected as an appropriate model. The modeling analysis incorporated conservative assumptions, which tend to overestimate pollutant concentrations. The maximum modeled

[1] *Particulate matter with an aerodynamic diameter less than or equal to 10 microns (10 microns = .00001 meters or .0004 inches).*

concentration was estimated for each pollutant and averaging time and compared with the applicable standard. The concentrations evaluated were the maximum occurring at or beyond the site boundary and at a public access road or other publicly accessible area within the site.

Table B–5 Impact Assessment Protocol for Air Quality

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Criteria air pollutants and other regulated pollutants [a]	Measured and modeled ambient concentrations (micrograms per cubic meter) from existing sources at site	Emission rate (kilograms per year) of air pollutants from facility; source characteristics (stack height and diameter, exit temperature and velocity)	Concentration of alternative and total site concentration of each pollutant at or beyond site boundary or within boundary on public road compared to applicable standard
Toxic and hazardous air pollutants [b]	Measured and modeled ambient concentrations (micrograms per cubic meter) from existing sources at site	Emission rate (kilograms per year) of air pollutants from facility; source characteristics (stack height and diameter, exit temperature and velocity)	Concentration of alternative of each pollutant at or beyond site boundary or within boundary on public road and compared to acceptable source impact level

[a] Carbon monoxide, hydrogen fluoride, lead, nitrogen oxides, ozone, PM_{10}, sulfur dioxide, total suspended particulates.
[b] Clean Air Act, Section 112, hazardous air pollutants: pollutants regulated under the National Emissions Standards for Hazardous Air Pollutants and other state-regulated pollutants.

B.5 Geology and Soils

B.5.1 Description of Affected Resources

Geologic resources include consolidated and unconsolidated earth materials, including rock and mineral assets such as ore and aggregate materials (e.g., sand, gravel) and fossil fuels such as coal, oil, and natural gas. Geologic conditions include hazards such as earthquakes, faults, volcanoes, landslides, sinkholes, and other conditions leading to land subsidence and unstable soils. Soil resources include the loose surface materials of the Earth in which plants grow, usually consisting of mineral particles from disintegrating rock, organic matter, and soluble salts. Certain soils are important farmlands, which are designated by the U.S. Department of Agriculture Natural Resources Conservation Service. Important farmlands include prime farmland, unique farmland, and other farmland of statewide or local importance as defined in 7 CFR 657.5 and could be subject to the Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*).

Geology and soils were considered with respect to those attributes and geologic and soil resources that could be affected by the alternatives, as well as those geologic conditions that could affect each alternative, including associated facilities. The ROI for geology and soils includes the site and nearby offsite areas subject to disturbance by construction, and/or modification, and operation of facilities for production of RPS and those areas beneath existing or new facilities that would remain inaccessible for the life of the facilities. Conditions that could affect the integrity and safety of existing, modified, or new facilities over the timeframe associated with each alternative include large-scale geologic hazards (e.g., earthquakes, volcanic activity, landslides, and land subsidence) and local hazards associated with the site-specific attributes of the soil and bedrock beneath site facilities. Thus, the area within which these geologic conditions exist is also used to define the ROI for this resource area.

B.5.2 Description of Impact Assessment

Construction, modification, and operation activities under each of the alternatives were considered from the perspective of direct impacts on specific geologic resources and soil attributes to encompass the

consumption of geologic resources. Construction activities were the focus of the impact assessment for geologic and soil resources; hence, the land area to be disturbed and geologic resources consumed to support the alternatives considered, the depth and extent of required excavation work, land areas occupied during operations, and the identification of unstable geologic strata (such as soils or sediments prone to subsidence, liquefaction, shrink-swell, or erosion) were key factors in the analysis (see **Table B–6**).

Table B–6 Impact Assessment Protocol for Geology and Soils

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Geologic hazards	Presence of geologic hazards within the region of influence	Location of facilities	Potential for damage to facilities
Mineral and energy resources	Presence of any rare and/or valuable mineral or energy resources on the site and availability of geologic resources within the region of influence	Location of facilities and project activity demands	Potential to consume, destroy, or render resources inaccessible
Important farmland soils	Presence of prime farmland soils near the facility site locations	Location of facilities	Conversion of important farmland soils to nonagricultural use

The geology and soils impact analysis also considered risks to the facilities (existing, new, or modified) from large-scale geologic hazards such as faulting and earthquakes, lava extrusions and other volcanic activity, landslides, and sinkholes (i.e., conditions that tend to affect broad expanses of land). In general, the facility hazard assessment was based on the presence of any identified hazard and the distance of the facilities from it. This element of the assessment included collection of site-specific information on the potential for impacts on site facilities from local and large-scale geologic conditions. Historical seismicity within a given radius of the site was reviewed, and potential earthquake source areas were identified as a means of assessing the potential for future earthquake activity. Earthquakes are described in the *Consolidation EIS* in terms of several parameters, as presented in **Table B–7**. Probabilistic earthquake ground motion data, to include peak ground acceleration and response spectral acceleration, were evaluated for each site to provide a comparative assessment of seismic hazard. Peak ground acceleration is indicative of what an object on the ground would experience during an earthquake and approximates what a short structure would be subjected to in terms of horizontal force. It does not account for the range of energies experienced by a building during an earthquake, particularly taller buildings. Measures of spectral acceleration account for the natural period of vibration of structures (i.e., short buildings have short natural periods [up to 0.6 seconds], and taller buildings have longer periods [0.7 seconds or longer]) (USGS 2004a). Both parameters are used by the U.S. Geological Survey National Seismic Mapping Project. The U.S. Geological Survey's latest National Earthquake Hazards Reduction Program (NEHRP) maps are based on spectral acceleration and depict maximum considered earthquake ground motion of 0.2- and 1.0-second spectral acceleration, respectively, based on a 2 percent probability of exceedance in 50 years (i.e., corresponding to an annual probability of occurrence of about 1 in 2,500). The NEHRP maps have been adapted for use in the seismic design portions of the *International Building Code* (ICC 2003, USGS 2004b).

The NEHRP maps were developed based on the recommendations of the Building Seismic Safety Council's Seismic Design Procedures Group (BSSC 2004a, 2004b). The Seismic Design Procedures Group-recommended maps, the maximum considered earthquake ground motion maps, are derived from the U.S. Geological Survey's probabilistic hazard maps with additional modifications that incorporate deterministic ground motions in selected areas and the application of engineering judgment (USGS 2004b). Note that the maximum considered earthquake maps are based on a reference site condition (firm rock) and are suitable for determining estimates of maximum considered earthquake ground shaking for design purposes at most sites. For sites with nonreference conditions and for design

of buildings requiring a higher degree of seismic safety, site-specific design procedures must be used (BSSC 2004b).

Table B–7 The Modified Mercalli Intensity Scale of 1931, with Generalized Correlations to Magnitude, Earthquake Classification, and Peak Ground Acceleration

Modified Mercalli Intensity [a]	*Observed Effects of Earthquake*	*Approximate Magnitude* [b]	*Class*	*Peak Ground Acceleration (g)* [c]
I	Usually not felt except by a very few under very favorable conditions.	Less than 3	Micro	Less than 0.0017
II	Felt only by a few persons at rest, especially on the upper floors of buildings.	3 to 3.9	Minor	0.0017 to 0.014
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibrations similar to the passing of a truck.			
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy object striking building. Standing motorcars rock noticeably.	4 to 4.9	Light	0.014 to 0.039
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	4 to 4.9	Light	0.039 to 0.092
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5 to 5.9	Moderate	0.092 to 0.18
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	6 to 6.9	Strong	0.18 to 0.34
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned.	7 to 7.9	Major	0.34 to 0.65
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	7 to 7.9	Major	0.65 to 1.24
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	7 to 7.9	Major	1.24 and higher
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.	8 and higher	Great	1.24 and higher
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.	8 and higher	Great	1.24 and higher

[a] Intensity is a unitless expression of observed effects of earthquake-produced ground shaking. Effects may vary greatly between locations based on earthquake magnitude, distance from the earthquake, and local subsurface geology. The descriptions given are abbreviated from the Modified Mercalli Intensity Scale of 1931.

[b] Magnitude is a logarithmic measure of the strength (size) of an earthquake related to the strain energy released by it. There are several magnitude "scales" (mathematical formulas) in common use, including local "Richter" magnitude, body wave magnitude, and surface wave magnitude. Each has applicability for measuring particular aspects of seismic signals and may be considered equivalent within each scale's respective range of validity. For very large earthquakes, the moment magnitude scale provides the best overall measurement of earthquake size.

[c] Acceleration is expressed as a percent relative to the Earth's gravitational acceleration (g) (i.e., [g] is equal to 980 centimeters per second squared). Given values are correlated to Modified Mercalli Intensity based on measurements of California earthquakes only (Wald et al. 1999).

Sources: Compiled from USGS 2004c, 2004d; Wald et al. 1999.

An evaluation was also performed to determine if estimated requirements for rock, aggregate, soil, and products derived from rock and mineral resources to support construction and operations activities under each of the alternatives could exceed available resource reserves or stockpiles in the affected regions of influence. Specifically included in this analysis was the provision of borrow materials from onsite quarries and borrow pits to support construction activities. This was accomplished by comparing projections of resource demands for construction and operations with analyses of resource availability at each site and in the affected region. In addition, the analysis of impacts on geologic resources included a determination of whether the construction and operations activities at a specific site could destroy, or preclude the use of, valuable rock, mineral, or energy resources at affected sites.

Pursuant to the Farmland Protection Policy Act of 1981 (7 U.S.C. 4201 *et seq.*) and its implementing regulations, the presence of important farmland soils, including prime farmland, was also evaluated. This act requires agencies to make Farmland Protection Policy Act evaluations part of the National Environmental Policy Act (NEPA) process, the main purpose being to reduce the conversion of farmland to nonagricultural uses by Federal projects and programs. However, otherwise qualifying farmlands in or already committed to urban development, land acquired for a project on or prior to August 4, 1984, and lands acquired or used by a Federal agency for national defense purposes are exempt from the Act's provisions (7 CFR 658.2 and 658.3).

B.6 Water Resources

B.6.1 Description of Affected Resources

Water resources are the surface and subsurface waters that are suitable for human consumption, aquatic or wildlife use, agricultural purposes, irrigation, recreation, or industrial/commercial purposes. The ROI used for water resources encompasses those surface water and groundwater systems that could be impacted by water withdrawals, effluent discharges, and spills or stormwater runoff associated with facility construction, and/or modification, and operations activities under the alternatives. As such, the assessment methodologies described in the following subsections relate to the analysis of those project activities that would generally result in short-term impacts (i.e., limited to the timeframe during which the activity is being performed).

B.6.2 Description of Impact Assessment

Determination of the impacts of the alternatives on water resources consisted of a comparison of project activity data and professional estimates regarding water use and effluent discharges with applicable regulatory standards, design parameters and standards commonly used in the water and wastewater engineering fields, and recognized measures of environmental impact. Certain assumptions were made to facilitate the impact assessment: (1) all water supply production and treatment and effluent treatment facilities would be available and upgraded as necessary in accordance with the timeframe considered under each alternative; (2) the effluent treatment facilities would meet the effluent limitations imposed by the respective National Pollutant Discharge Elimination System permits and/or state-issued discharge permits; and (3) any stormwater runoff from construction and operations activities would be handled in accordance with the regulations of the appropriate permitting authority. It was also assumed that, during construction and other land-disturbing activities, sediment fencing or other erosion control devices would be used to mitigate short-term adverse impacts of sedimentation and that, as appropriate, stormwater holding ponds would be constructed to lessen the impacts of runoff on surface water quality.

B.6.2.1 Water Use and Availability

Impacts on water use and availability were generally assessed by determining changes in the volume of current water usage and effluent discharges as a result of the proposed activities (see **Table B–8**).

Table B–8 Impact Assessment Protocol for Water Use and Availability

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Surface water availability	Surface waters near the facilities, including average flow, low flow, and current usage	Volume of withdrawals from, and discharges to, surface waters	Changes in availability to local/downstream users of water for human consumption, irrigation, or animal feeding
Groundwater availability	Groundwater near the facilities, including existing water rights for major water users and current usage	Volume of withdrawals from, and discharges to, groundwater	Changes in availability of groundwater for human consumption, irrigation, or animal feeding

B.6.2.2 Water Quality

The water quality impact assessment for the *Consolidation EIS* analyzed how routine effluent discharges and nonroutine releases (e.g., spills, containment failure) to surface water, as well as discharges reaching groundwater, from facilities that would be required under each alternative could potentially affect current water quality over the short term. The impacts of the alternatives were assessed as summarized in **Table B–9** and included a comparison of the projected effluent quality with relevant regulatory standards and implementing regulations such as the Clean Water Act (33 U.S.C. 1251 *et seq.*), Safe Drinking Water Act (42 U.S.C. 300(f) *et seq.*), state laws, and existing site permit conditions. The impact analyses evaluated the potential for contaminants to affect receiving water quality as a result of spills and other releases under the alternatives. Separate analyses were conducted for surface water and groundwater impacts.

Table B–9 Impact Assessment Protocol for Water Quality

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Surface water quality	Surface waters near the facility locations in terms of stream classifications and changes in water quality	Expected contaminants and contaminant concentrations in discharges to surface waters	Exceedance of relevant surface water quality criteria or standards under the Clean Water Act or state regulations and existing permits
Groundwater quality	Groundwater near the facility locations in terms of classification, presence of designated sole-source aquifers, and changes in quality of groundwater	Expected contaminants and contaminant concentrations in discharges that could reach groundwater	Contaminant concentrations in groundwater exceeding relevant standards or criteria established in accordance with the Safe Drinking Water Act or state regulations and/or existing permits

B.6.2.2.1 Surface Water Quality

The evaluation of surface water quality impacts focused on the quality and quantity of any effluents (including stormwater) to be discharged as a result of facility construction, and/or modification, and operations, and the quality of the receiving stream upstream and downstream from the discharges. The evaluation of effluent quality featured review of the expected parameters, such as the expected average

and maximum flows, as well as the nature and parameter concentrations in expected effluents. Parameters of concern include total suspended solids, heavy metals, radionuclides, organic and inorganic chemicals, and any other constituents that could affect the local environment. Factors that currently degrade water quality were also identified.

Surface waters could be affected by site runoff and silting during facility construction or related activities that result in ground disturbance. Such impacts relate to the amount of land disturbed, the type of soil at the site, the topography, and weather conditions. Applications of standard management practices for stormwater and erosion control (e.g., sediment fences, covering disturbed areas) could minimize the impact.

During operations, surface waters could be affected by increased runoff from impervious surfaces (e.g., buildings) or cleared areas. Stormwater from these areas could be contaminated with materials deposited by airborne pollutants, automobile exhaust and residues, materials-handling releases (such as spills), and process effluents. Impacts of stormwater discharges could be highly variable and site specific, and mitigation would depend on management practices, the design of holding facilities (if any), the topography, and adjacent land use. Information from existing water quality data sources were compared with expected discharges from the facilities to determine the potential for and the relative impacts on surface waters.

B.6.2.2.2 Groundwater Quality

Potential short-term groundwater quality impacts associated with effluent discharges and other contaminant releases associated with new facility construction, and/or modification, and operations were examined. Available engineering estimates of contaminant concentrations were weighed against applicable Federal and state groundwater quality standards, effluent limitations, and drinking water standards to determine the impacts of each alternative. The consequences of groundwater use, including dewatering, and effluent discharges on other site groundwater conditions were also evaluated.

B.6.2.3 Waterways and Floodplains

The locations of waterways (e.g., ponds, lakes, streams) and delineated floodplains or zones were identified from maps and other existing documents to assess the potential for impacts of proposed new facility construction and operations, including direct effects on hydrologic characteristics. No construction activities within the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL) would take place within a floodplain. Construction of a new road for the transfer of unirradiated and irradiated targets could occur within the floodplain of the Big Lost River under one route being considered. Therefore, a preliminary floodplain/wetland assessment has been prepared pursuant to 10 CFR 1022 and Executive Order 11988, "Floodplain Management" (see Appendix F of this EIS).

B.7 Ecological Resources

B.7.1 Description of Affected Resources

Ecological resources include terrestrial and aquatic resources, wetlands, and threatened and endangered species. The ROI evaluated for ecological impacts encompassed those areas within the site potentially disturbed by facility construction and operations. To determine whether important ecological resources were present, previous surveys of the site were reviewed.

Terrestrial resources are defined as those plant and animal species and communities that are most closely associated with the land; for aquatic resources, a water environment. Wetlands are defined by the U.S. Army Corps of Engineers and EPA as "… those areas that are inundated or saturated by surface or

groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3).

Endangered species are defined under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*) as those in danger of extinction throughout all or a large portion of their range. Threatened species are defined as those species likely to become endangered within the foreseeable future. The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service propose species to be added to the lists of threatened and endangered species. They also maintain a list of "candidate" species for which they have evidence that listing may be warranted, but for which listing is currently precluded by the need to list species more in need of Endangered Species Act protection. Candidate species do not receive legal protection under the Endangered Species Act, but should be considered in project planning in case they are listed in the future. Critical habitat for threatened and endangered species is designated by the USFWS or the National Marine Fisheries Service. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management consideration or protection. Most states also maintain lists of rare and endangered species as well as other special status species.

B.7.2 Description of Impact Assessment

Impacts on ecological resources could occur as a result of land disturbance, water use, human activity, and noise from the construction and operation of facilities associated with RPS production, including the proposed new road (see **Table B–10**). Night lighting could also impact site ecology. Each of these factors was considered when evaluating potential impacts of the proposed activities. Terrestrial resources could be directly affected through the loss of habitat, which could lead to the direct loss of nests and young animals. Habitat loss, as well as human intrusion and noise, could also result in the movement of more mobile wildlife to adjacent areas with similar habitat. If these areas were below the carrying capacity for the species involved, the animals would be expected to survive. However, displaced animals could be lost if the areas to which they moved were already heavily populated. Thus, the analysis of impacts on terrestrial wildlife was based largely on the extent of plant community loss or modification. Indirect impacts of factors such as human disturbance, noise, and night lighting were evaluated qualitatively.

Impacts on threatened and endangered species, state-protected species, and their habitats during construction of facilities were determined in a manner similar to that for other terrestrial and aquatic resources. A list of sensitive species that could be present at the site was compiled. Informal consultations were initiated with the appropriate USFWS offices and the state as part of the impact assessment for sensitive species.

B.8 Cultural Resources

B.8.1 Description of Affected Resources

Cultural resources are the indications of human occupation and use of property as defined and protected by a series of Federal laws, regulations, and guidelines. For the *Consolidation EIS*, potential impacts were assessed separately for each of the cultural resource categories: prehistoric, historic, and American Indian. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geologic age and could be sources of information on ancient environments and the evolutionary development of plants and animals. Although not governed by the same historic preservation laws as cultural resources, they could be affected by the Proposed Action in much the same manner.

Table B–10 Impact Assessment Protocol for Ecological Resources

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Terrestrial resources	Vegetation and wildlife within the vicinity of facilities	Area disturbed by facility site activities, air and water emissions, and noise	Loss or disturbance to terrestrial habitat; emissions and noise values above levels shown to cause impacts on terrestrial resources
Aquatic resources	Aquatic resources within the vicinity of facilities	Facility area air and water emissions, water source and quantity, and wastewater discharge location and quantity	Discharges above levels shown to cause impacts on aquatic resources
Wetlands	Wetlands within the vicinity of facilities	Area disturbed by facility site activities, air and water emissions, and wastewater discharge location and quantity	Loss or disturbance to wetlands
Threatened and endangered species	Threatened and endangered species within the vicinity of facilities	Area disturbed by facility site activities, air and water emissions, noise, water source and quantity, and wastewater discharge location and quantity	Determination that site activities could disturb threatened and endangered species and their habitats

Prehistoric resources are the physical remains of human activities that predate written records. They generally consist of artifacts that alone or collectively can yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records. In the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with World War II or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The ROI for cultural resource analysis encompasses those areas within the site that would potentially be disturbed by facility construction and occupied during operations.

B.8.2 Description of Impact Assessment

The analysis of impacts on cultural resources addressed potential direct and indirect impacts at each site (see **Table B–11**). To determine whether cultural resources were present, previous surveys of facility locations were examined.

Potential indirect impacts include those associated with reduced access to a resource site, as well as impacts associated with increased traffic and visitation to sensitive areas. Direct impacts include those resulting from ground-disturbing activities associated with construction and operations. Consultations to comply with Section 106 of the National Historic Preservation Act are being conducted with the State Historic Preservation Officer. Correspondence offering consultation was sent to American Indian tribes.

Table B–11 Impact Assessment Protocol for Cultural Resources

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Prehistoric and historic resources	Prehistoric and historic resources within the vicinity of facilities	Location of facilities on the site and facility acreage requirements	Potential for loss, isolation, or alteration of the character of prehistoric and historic resources; introduction of visual, audible, or atmospheric elements out of character; neglect of resources listed or eligible for listing on the National Register of Historic Places
American Indian resources	American Indian resources within the vicinity of facilities	Location of facilities on the site and facility acreage requirements	Potential for loss, isolation, or alteration of the character of American Indian resources; introduction of visual, audible, or atmospheric elements out of character
Paleontological resources	Paleontological resources within the vicinity of facilities	Location of facilities on the site and facility acreage requirements	Potential for loss, isolation, or alteration of paleontological resources

B.9 Public and Occupational Health and Safety

B.9.1 Description of Affected Resources

The assessment of public and occupational safety and health includes determining the potential adverse effects on human health of exposure to ionizing radiation and hazardous chemicals. Health effects are determined by identifying the type and quantities of additional material (radioactive and chemical) to which one might be exposed, estimating chemical concentrations and radiological doses, and then calculating the resultant health effects (latent cancer fatalities [LCFs]). The impacts of various releases during normal activities and postulated accidents on human health of workers and the public residing within 80 kilometers (50 miles) of each site were assessed. This assessment used site-specific factors such as meteorology, population distribution, and nearest public resident. More detailed information on analysis approach, modeling, the types and quantities of materials released during normal operation and accident conditions is provided in Appendix C of this EIS.

B.9.2 Description of Impact Assessment

Health effects, in terms of incremental doses and related risks (LCFs), were assessed based on the types and quantities of material released. Models were used to project the impacts on the health of workers and the public of releases during normal, or incident-free, operations. The models included:

- GENII (PNL 1988) for all radioactive material released during normal operations,
- MACCS2 (SNL 1997) for all radioactive material released during accident conditions, and
- ALOHA (EPA 1999b) for hazardous chemicals released during accident conditions

Detailed discussions of application of these models are provided in Appendix C of this EIS.

B.10 Transportation

B.10.1 Description of Affected Resources

Transportation of any commodity involves a risk to both transportation crewmembers and members of the public. This risk results directly from transportation-related accidents and indirectly from the increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the Proposed Action and alternatives, the human health risks associated with the transportation of radioactive materials on public highways and railroads were assessed.

Transportation impacts consist of two parts: the impacts of incident-free, or routine, transportation and the impacts of transportation accidents. Incident-free transportation impacts include radiological impacts on the public and the workers from the radiation field surrounding the transportation package. Nonradiological impacts of potential transportation accidents include traffic accident fatalities.

Transportation-related risks are calculated and presented separately for workers (truck drivers or railroad engineers) and members of the general public (residing or in vehicles along the routes and those at rest and refueling stops). For the incident-free operation, the affected population includes individuals living within 800 meters (0.5 miles) of each side of the road or rail line. For accident conditions, the affected population includes individuals residing within 80 kilometers (50 miles) of the accident, and the maximally exposed individual, who would be an individual located 100 meters (330 feet) directly downwind from the accident. The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternatives being considered. As such, the impact on the affected population is used as the primary means of comparing various alternatives. In addition, the nonradiological risk associated with traffic accident fatalities is another comparison parameter among the alternatives.

B.10.2 Description of Impact Assessment

The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing the individual risks from all reasonably conceivable accidents. Only as a result of a severe fire and/or a powerful collision, which are of extremely low probability, could a transportation package of the type used to transport radioactive material be damaged to the extent that there could be a release of radioactivity to the environment with significant consequences. In addition to calculating the radiological risks that would result from all reasonably conceivable accidents during transportation of radioactive material, the consequences of maximum reasonably foreseeable accidents, events with a probability greater than 1×10^{-7} (1 chance in 10 million) per year, were also assessed. The latter consequences are determined for atmospheric conditions likely to prevail during accidents. The analysis used the RISKIND computer code to estimate doses to individuals and populations (Yuan et al. 1995).

The risks of incident-free effects are expressed in additional LCFs. The risks of radiological accidents are expressed as additional LCFs and, for nonradiological accidents, as additional immediate (traffic) fatalities.

In determining the transportation risks, per shipment risk factors are calculated for the incident-free and accident conditions using the RADTRAN 5 computer program (SNL 2003) in conjunction with the Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson

and Michelhaugh 2003) to choose representative routes in accordance with U.S. Department of Transportation regulations. The TRAGIS program provides population estimates along the representative routes for determining the population radiological risk factors. Details on analysis approach, modeling, and parameter selections are provided in Appendix D of this EIS.

B.11 Socioeconomics

B.11.1 Description of Affected Resources

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the Proposed Action could affect regional employment, income, and expenditures. Job creation is generally characterized by two types: (1) construction-related jobs, that are transient in nature and short in duration, and thus less likely to have a longer term socioeconomic impact; and (2) operations-related jobs in support of facility operations, required for a longer period of time, that have the greater potential for permanent socioeconomic impacts in the ROI.

The socioeconomic environment is generally made up of regional economic indicators and demographic characteristics of the area. Economic indicators include employment, the civilian labor force, and unemployment rates. Demographic characteristics include population, housing, education, health and local transportation information.

B.11.2 Description of Impact Assessment

For each county in the ROI, data were compiled on current socioeconomic conditions, including employment, the civilian labor force, and unemployment. Census data were compiled for population, housing, and community services. U.S. Bureau of the Census population estimates for the regions of influence were combined with overall projected workforce requirements for each alternative to determine the extent of impacts on regional economic and demographic (population) characteristics, including levels of demand for housing and community services, and local transportation impacts (see **Table B–12**).

B.12 Waste Management

B.12.1 Description of Affected Resources

Depending on the alternative, construction and operation of facilities associated with production of RPS would generate several types of waste. Such wastes could include the following:

- Mixed transuranic waste: Radioactive waste not classified as high-level radioactive waste and containing more than 100 nanocuries per gram of alpha-emitting transuranic isotopes with half-lives greater than 20 years that also contains hazardous components regulated under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 *et seq.*).

- Low-level radioactive waste: Waste that contains radioactivity and is not classified as high-level radioactive waste, transuranic waste, or spent nuclear fuel, or the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the transuranic concentration is less than 100 nanocuries per gram of waste.

Table B–12 Impact Assessment Protocol for Socioeconomics

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Regional Economic Characteristics			
Workforce requirements	Site workforce projections	Estimated construction and operations staffing requirements and timeframes	Workforce requirements added to sites' workforce projections
Region of influence – civilian labor force	Labor force estimates from the Census Bureau	Estimated construction and operations staffing requirements and timeframes	Workforce requirements as a percentage of the civilian labor force
Employment rate	Latest available employment data in counties surrounding the site from the Census Bureau	Estimated construction and operations staffing requirements and timeframes	Potential change in unemployment
Demographic Characteristics			
Population and demographics of race, ethnicity, and income	Latest available estimates by county from the Census Bureau	Estimated effect on population	Potential effects on population
Housing and Community Services			
Housing – percent of occupied housing units (houses and apartments)	Latest available ratios from the Census Bureau	Estimated housing unit requirements	Potential change in housing unit availability
Education - Total enrollment - Teacher-to-student ratio	Latest available information for local school districts or state and county estimates	Estimated effect on enrollment and teacher-to-student ratio	Projected change in teacher-to-student ratio
Health care – number of hospital beds and physicians per 1,000 residents	Latest available rates from the Census Bureau	Estimated effect on health care services	Potential change in the availability of hospital beds/ physicians
Local Transportation			
Traffic – number of vehicles	Latest available information on traffic conditions affecting site access roads, intrasite road, and local regional transportation networks	Estimated number of commuter and truck vehicle trips to and from the site	Projected change in traffic conditions

- Mixed low-level radioactive waste: low-level radioactive waste that also contains hazardous components regulated under RCRA (42 U.S.C. 6901 *et seq.*).

- Hazardous waste: Under RCRA, a solid waste that, because of its characteristics, may: (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes appear on special EPA lists or possess at least one of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. This category does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act (42 U.S.C. 2011 *et seq.*).

- Nonhazardous solid waste: Discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and

from community activities. This category does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act (42 U.S.C. 2011 *et seq.*).

The alternatives could have an impact on existing U.S. Department of Energy (DOE) facilities devoted to the treatment, storage, and disposal of these categories of waste.

B.12.2 Description of Impact Assessment

As shown in **Table B–13**, impacts were assessed by comparing the projected wastestream volumes generated from the proposed activities under each alternative with the site's waste management capacities and generation rates. Only the impacts relative to the capacities of waste management facilities were considered; other environmental impacts of waste management facility operations (human health effects) are evaluated in other facility-specific or sitewide NEPA documents.

Table B–13 Impact Assessment Protocol for Waste Management

Resource	*Required Data*		*Measure of Impact*
	Affected Environment	*Alternative*	
Waste management capacity - Mixed transuranic waste - Low-level radioactive waste - Mixed low-level radioactive waste - Hazardous waste - Nonhazardous waste	Site generation rates (cubic meters per year) for each waste type Site management capacities (cubic meters) or rates (cubic meters per year) for potentially affected treatment, storage, and disposal facilities for each waste type	Generation rates (cubic meters per year) for each waste type	Combination of facility waste generation volumes and other site generation volumes in comparison to the capacities of applicable waste management facilities

B.13 Cumulative Impacts

This section describes the methodology used to estimate cumulative impacts. The methodology includes subsections describing: (1) regulations and guidance, (2) approach to cumulative impacts, (3) uncertainties, (4) selection of resource areas for analysis, (5) spatial and temporal considerations, and (6) description of impact assessment.

B.13.1 Regulations and Guidance

Cumulative impacts analysis in DOE NEPA documents is governed by the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (CEQ regulations) (40 CFR 1500-1508) and the DOE NEPA Implementing Procedures (10 CFR 1021). Because specific requirements are not incorporated in the CEQ and DOE regulations, one must look to *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997), and *Consideration of Cumulative Impacts in EPA Review of National Environmental Policy Act Documents* (EPA 1999a) for guidance on how to conduct cumulative impact analyses.

The CEQ regulations (40 CFR 1500-1508) define cumulative effects as impacts on the environment that result from the Proposed Action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR 1508.7). Thus, the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource, no matter what entity (Federal, non-Federal, or private) is taking the action (EPA 1999a).

Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. Cumulative effects can also result from spatial (geographic) and/or temporal (time) crowding of environmental perturbations. Said another way, the effects of human activities will accumulate when a second perturbation occurs at a site before the system can fully rebound from the effect of the first perturbation.

While there is no universally accepted framework for cumulative effects analysis, eight general principles identified in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) have gained acceptance. These eight principles are based on the premise that resources, ecosystems, and the human community each can experience effects. For each of these there are thresholds, or levels, of stress beyond which their desired condition degrades.

Following is a summary of the CEQ's eight principles of cumulative effects analysis:

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions. This includes any other actions that affect the same resources.

2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, or human community of all actions taken, no matter who (Federal, non-Federal, or private) has taken the actions. Effects of individual activities may interact to cause additional effects not apparent when looking at individual effects one at a time.

3. Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, or human community being affected, as opposed to from the perspective of the Proposed Action. Analyzing cumulative effects involves developing an understanding of how the resources are susceptible to effects.

4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those effects that are truly meaningful. The boundaries for evaluating cumulative effects should be expanded to the point at which the resource is no longer affected significantly or the effects are no longer of interest to affected parties.

5. Cumulative effects on a given resource, ecosystem, or human community are rarely aligned with political or administration boundaries. Cumulative effects analysis on natural systems must use natural ecological boundaries; analysis of human communities must use actual sociocultural boundaries to ensure including all effects.

6. Cumulative effects may result from accumulation of similar effects, or from the synergistic interaction of different effects. In some cases, the net adverse cumulative effect is less than the sum of the individual effects; in other cases, the net adverse cumulative effect is greater.

7. Cumulative effects may last for many years beyond the life of the action that caused the effects. An example is radioactive contamination. Cumulative effects analysis needs to apply the best science and forecasting techniques.

8. Each affected resource, ecosystem, or human community must be analyzed in terms of its capacity to accommodate additional effects, based on its own time and space parameters. The most effective cumulative effects analysis focuses on what is needed to ensure long-term productivity or sustainability of the resource.

The methodology used in the *Consolidation EIS* incorporates these eight principles.

B.13.2 Approach to Cumulative Impacts

Region of Influence (ROI):

A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur.

In general, the following approach was used:

- The ROI for impacts associated with projects analyzed in this EIS was defined.
- The affected environment and baseline conditions were identified.
- Past, present, and reasonably foreseeable actions and the effects of those actions were identified.
- Aggregate (additive) effects of past, present, and reasonably foreseeable actions were assessed.

B.13.3 Uncertainties

As described above, cumulative impacts were assessed by combining the smallest and largest potential effects of *Consolidation EIS* alternative activities with the effects of other past, present, and reasonably foreseeable actions in the ROI. Many of these actions occur at different times and locations, and may not be truly additive. For example, the set of actions that impact air quality occurs at different times and locations across the ROI, and, therefore, it is unlikely that the impacts are completely additive. The effects were combined irrespective of the time and location of the impact, even though they do not necessarily occur in the same timeframe, to envelope any uncertainties in the projected activities and their effects. This approach produces a maximum estimation of cumulative impacts for the activities considered.

B.13.4 Selection of Resource Areas for Analysis

As shown in **Table B–14**, the following resource areas were selected for cumulative impact analysis: land resources; site infrastructure (i.e., employment, electricity, and water use); geology and soils; air quality; ecological resources; cultural resources; public health and safety; occupational health and safety; transportation; and waste management.

Table B–14 Selection of Resource Areas for Cumulative Impact Analysis

Resource Area	*Evaluated in Recent EIS* [a]	*Historically Important* [b]	*Appreciable Impact in this Consolidation EIS* [c]
Land resources	X	X	X
Site infrastructure	X		
Geology and soils	X		X
Air quality	X		
Ecological resources	X	X	X
Cultural resources	X	X	X
Public health and safety	X	X	
Occupational health and safety	X	X	X
Transportation	X	X	X
Waste Management	X	X	X

EIS = environmental impact statement.
[a] From Table B–14.
[b] From Chapter 3, *Consolidation EIS*.
[c] From Chapter 4, *Consolidation EIS*.

These resource areas were selected based on examination of previous INL NEPA documents, an examination of resource areas in the region with historically appreciable effects, and the potential for appreciable environmental effects of implementing the *Consolidation EIS* alternatives. This is consistent with CEQ cumulative effects analysis principles No. 3: *"Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, or human community being affected…"* and No. 4: *"…the list of environmental effects must focus on those effects that are truly meaningful"* (CEQ 1997). The resource areas selected are those most likely to have potential for meaningful cumulative impacts.

B.13.5 Spatial and Temporal Considerations

The environmental impacts of an action have limits in both space (geographically) and time (temporally). Cumulative impacts of past, present, and reasonably foreseeable future actions have similar limits.

Spatial considerations determine the geographic area to be evaluated. The geographic area (ROI) to be evaluated is specific to each resource area and includes the area that may be affected by cumulative impacts. The ROIs used in the cumulative impact analysis are summarized in **Table B–15**. Many of these are the same as those described in the introduction to Chapter 3 of this EIS.

Table B–15 Regions of Influence for Resource Areas Evaluated in the Cumulative Impact Analysis

Resource Area	*Region of Influence*
Land resources	Includes the site, and nearby offsite land areas within local planning jurisdictions
Site infrastructure	Includes the site, and areas immediately adjacent to the site that supply the majority of resources (i.e., land, workers, electricity, and water)
Geology and soils	Includes the site, and nearby offsite areas
Air quality	Includes the site, and nearby offsite areas within local air quality control regions
Ecological resources	Includes the site, and nearby offsite plants, animals, and habitat that could be affected
Cultural resources	Includes the site, and nearby offsite cultural resources that could be affected
Public health and safety	Includes the site, offsite areas within 80 kilometers (50 miles) of the site, and transportation corridors
Occupational health and safety	Includes the site, and transportation corridors; limited to workers
Transportation	Includes the site, and local offsite transportation corridors
Waste management	Includes site waste management facilities and other offsite areas in the region where wastes are managed

This *Consolidation EIS* evaluates impacts for a 35-year timeframe for the No Action Alternative. The Consolidation Alternative evaluates impacts for a 2-year construction period, a 1-year startup/testing period, and a 35-year operating period. The Consolidation with Bridge Alternative spans the period from 2007 to 2047 and includes a 5-year bridge period, and a 35-year operating period. The impacts of other present and future actions within this timeframe were considered. In addition, actions that have impacts that remain even after the activity is completed (residual impacts) were also considered.

B.13.6 Description of Impact Assessment

Based on examination of the potential environmental effects of implementing *Consolidation EIS* alternatives, DOE and other agency actions in the region, and private actions, DOE selected a suite of resource areas that were likely to have potential for cumulative impacts and need to be analyzed. The selected indicators of cumulative impacts are shown in **Table B–16**.

Table B–16 Indicators of Cumulative Impacts

Category	*Indicator*
Land resources	- Land disturbed compared with local land availability
Site infrastructure	- Electricity use compared with local capacity - Water use compared with local capacity - Peak site employment
Geology and soils	- Geologic materials needed compared to amounts available
Air quality	- Criteria pollutant concentrations compared with standards or guidelines
Ecological resources	- Exposure of plants and animals to contaminant emissions
Cultural resources	- Disturbance of cultural resources
Public health and safety	- Offsite population dose and latent cancer fatalities - Maximally exposed individual dose - Comparison with dose limits and background dose
Occupational health and safety	- Total dose and latent cancer fatalities - Comparison with dose limits and background dose
Transportation	- Public Total dose and latent cancer fatalities Maximally exposed individual dose - Transportation workers Total dose and latent cancer fatalities Maximally exposed individual dose - Traffic fatalities
Waste management	- Transuranic waste generation rate compared with existing management capacities and generation rate - Low-level radioactive waste generation rate compared with existing management capacities and generation rate - Mixed low-level radioactive waste generation rate compared with existing management capacities and generation rate - Hazardous waste generation rate compared with existing management capacities and generation rate - Nonhazardous waste generation rate compared with existing management capacities and generation rate

B.14 Environmental Justice

B.14.1 Description of Affected Resources

Environmental justice assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from implementation of the alternatives in the *Consolidation EIS*. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used:

- Minority individuals: Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races.

- Minority populations: Minority populations are identified where either: (1) the minority population of the affected area exceeds 50 percent, or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

- Low-income population: Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's *Current Population Reports*, Series PB60, on Income and Poverty.

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as those minority and low-income populations that reside within an 80-kilometer (50-mile) radius centered on the candidate facilities at the site for production of RPS.

B.14.2 Description of Impact Assessment

Adverse health effects are measured in risks and rates that could result in LCFs as well as other fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. The minority and low-income populations are subsets of the general public residing around the site, and all are exposed to the same hazards generated from various operations at the site. Therefore, estimates for environmental justice impacts are determined using either the human health risks results or similar methods provided in Appendix C of this EIS.

B.15 References

BSSC (Building Seismic Safety Council), 2004a, 2003 Edition *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, Part 1: Provisions* (FEMA 450), Washington, DC, Available at http://www.bssconline.org/.

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