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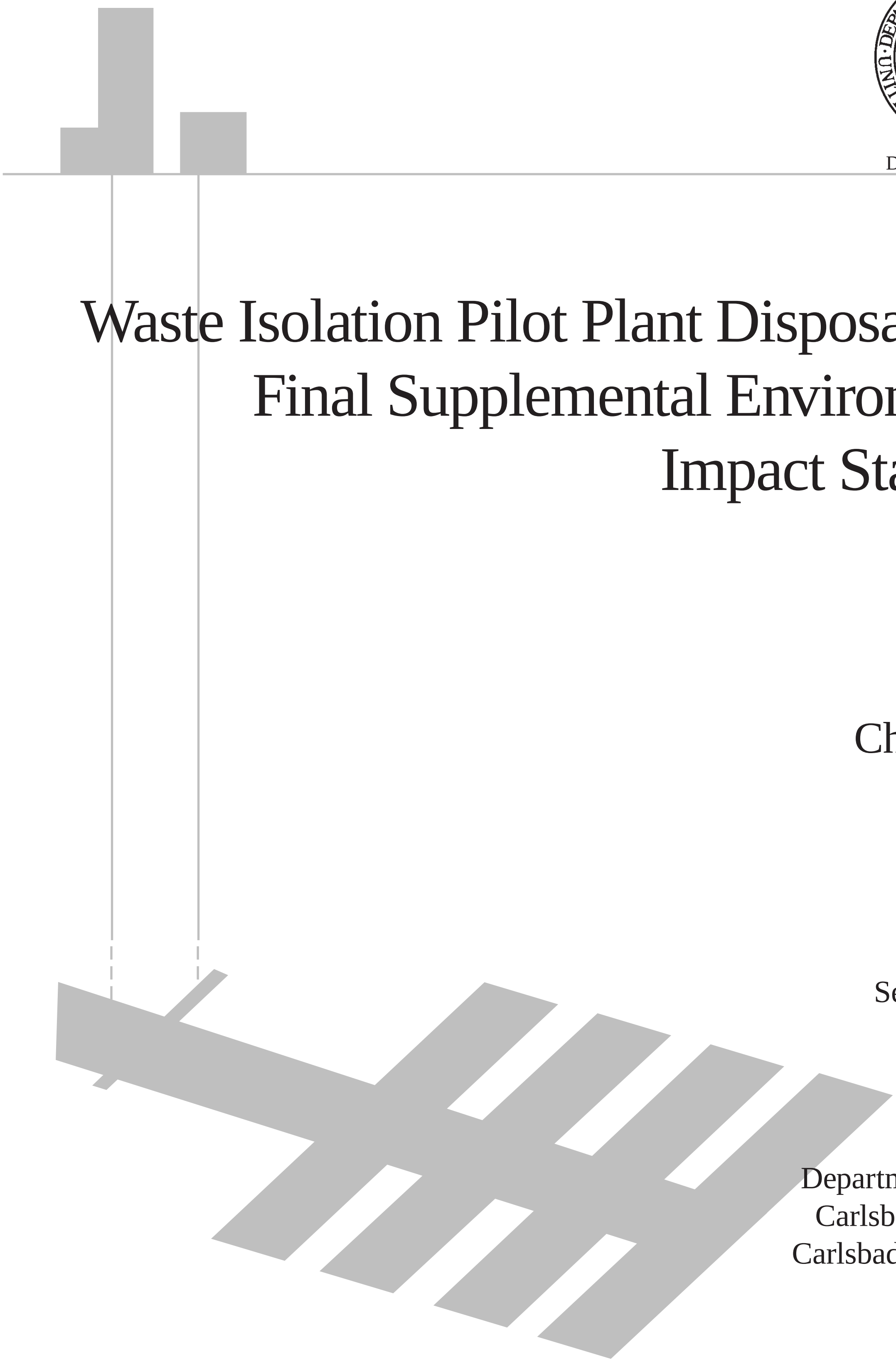

Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement

Volume I
Chapters 1-6

September 1997

Department of Energy
Carlsbad Area Office
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Eddy County, near Carlsbad, New Mexico

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Abstract:

The purpose of *the Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS-II) is to provide information on environmental impacts regarding the Department of Energy's (DOE) proposed disposal operations at WIPP. To that end, SEIS-II has been prepared to assess the potential impacts of continuing the phased development of WIPP as a geologic repository for the safe disposal of transuranic (TRU) waste. SEIS-II evaluates a Proposed Action, three Action Alternatives based on the waste management options presented in the *Final Waste Management Programmatic Environmental Impact Statement*, and two No Action Alternatives. The Proposed Action describes the treatment and disposal of the Basic Inventory of TRU waste over a 35-year period. The Basic Inventory is that waste currently permitted in WIPP based on current laws and agreements. The Action Alternatives propose the treatment of the Basic Inventory and an Additional Inventory as well as the transportation of the treated waste to WIPP for disposal over a 150- to 190-year period. The three Action Alternatives include the treatment of TRU waste at consolidation sites to meet WIPP planning-basis Waste Acceptance Criteria, the thermal treatment of TRU waste to meet Land Disposal Restrictions, and the treatment of TRU waste by a shred and grout process. The No Action Alternatives propose the dismantling and closure of WIPP and storage of the waste. One No Action Alternative proposes treating the waste thermally before placing it in retrievable storage.

SEIS-II evaluates environmental impacts resulting from the various treatment options; the transportation of TRU waste to WIPP using truck, a combination of truck and regular rail service, and a combination of truck and dedicated rail service; and the disposal of this waste in the repository. Evaluated impacts include those to the general environment and to human health. Additional issues associated with the implementation of the alternatives are discussed to provide further understanding of the decisions to be reached and to provide the opportunity for public input on improving DOE's Environmental Management Program.

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GLOSSARY

actinide	An element in the series beginning with element 89 (actinium) and continuing through element 103 (lawrencium). All the transuranic nuclides considered in this document are actinides.
activity	A measure of the rate at which a material emits nuclear radiation, usually given in terms of the number of nuclear disintegrations occurring in a given length of time. The common unit of activity is the curie, which amounts to 37 billion disintegrations per second. The International Standard unit of activity is the becquerel and is equal to one disintegration per second.
aerosolize	The process of converting a solid or a liquid into an airborne suspension of fine particles (an aerosol).
aggregate	The sum total; for purposes of SEIS-II, the accumulated effect or quantity by successive additions, often over time.
air quality	A measure of the quantity of pollutants in the air.
alluvium	Clay, silt, sand, and/or gravel deposits found in a stream channel or in low parts of a stream valley that is subject to flooding. Ancient alluvium deposits frequently occur above the elevation of present-day streams.
alpha particle	A positively charged particle emitted in the radioactive decay of certain nuclides. Made up of two protons and two neutrons bound together, it is identical to the nucleus of a helium atom.
ambient air	The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air in immediate proximity to emission sources.
anhydrite	A mineral consisting of anhydrous calcium sulfate: $CaSO_4$.
aqueous	Related to water.
aquifer	Geologic unit sufficiently permeable to conduct groundwater.
argillaceous rocks	Rocks containing appreciable amounts of clay.
atmosphere	The layer of air surrounding the earth.
atmospheric dispersion	Movement of a contaminant as a result of the cumulative effect of the random motions of the air. Equivalent to eddy diffusion.
atom	Smallest unit of an element that is capable of entering into a chemical reaction and displays the other properties of the element.

backfill	Materials, such as salt or a mixture of salt and other materials, used to reduce void volumes in storage panels or drifts.
background radiation	Radiation from: (1) naturally occurring radioactive materials, as they exist in nature prior to removal, transport, or enhancement or processing by man; (2) cosmic and natural terrestrial radiation; (3) global fallout as it exists in the environment; (4) consumer products containing nominal amounts of radioactive material or emitting nominal levels of radiation; and (5) radon and its progeny in concentrations or levels existing in buildings or the environment that have not been elevated as a result of current or past human activities.
basin	A topographic or structurally low area compared to the immediately adjacent areas.
bedded	Arranged in layers or beds. Usually, but not exclusively, applied to sedimentary deposits.
Bell Canyon Formation	A sequence of rock strata that forms the topmost unit of the Delaware Mountain Group.
berm	An earthen enbankment; a long artificial mound of stone or earth similar to a dike or levee.
bound	To estimate or describe an upper limit on a potential environmental consequence when uncertainty exists.
bounding	That which represents the maximum reasonably foreseeable event or impact. All other reasonably foreseeable events or impacts would have fewer and/or less severe environmental consequences.
°C	Degree Celsius. °C = 5/9 x (°F - 32).
caliche	Calcium carbonate ($CaCO_3$) deposited in the soils of arid or semiarid regions.
cancer	Any malignant new growth of abnormal cells or tissue.
canister	In this document, a container, usually cylindrical, for remotely handled transuranic waste. The waste will remain in this canister during and after emplacement at Waste Isolation Pilot Plant. A canister affords physical containment but not shielding; shielding is provided during shipment by a cask.
carcinogen	An agent capable of producing or inducing cancer.
carcinogenic	Capable of producing or inducing cancer.

cask	A massive shipping container providing shielding for highly radioactive materials and holding one canister.
Castile Formation	A Permian age rock unit of evaporites (interbedded halite and anhydrite) that immediately underlies the Salado Formation, the rock unit in which disposal rooms are excavated.
cloudshine	The pathway of direct external dose from the passing cloud of dispersed radioactive material.
commercial waste	Nuclear waste deriving from commercial sources. These are principally power reactors, but also include research laboratories and medical facilities.
committed dose equivalent	The predicted dose equivalent to a tissue or organ over a 50-year period after an intake of a radionuclide into the body. It does not include dose contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert). (1 rem = 0.01 sievert).
committed effective dose equivalent	The sum of the committed dose equivalents to various organs or tissues in the body from radioactive material taken into the body, each multiplied by the tissue-specific weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).
community	A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values, or exposed to industry that stimulates unwanted noise, odors, industrial traffic, particulate matter, or other nonaesthetic impacts.
concentration	The amount of a substance contained in a unit quantity (mass or volume) of a sample.
conservative	When used with predictions or estimates, leaning on the side of pessimism. A conservative estimate is one in which the uncertain inputs are used in the way that provides a reasonable upper limit of the estimate of an impact.
contact-handled transuranic waste	TRU waste that does not require shielding other than that provided by its container to protect those handling it from radiation exposure. The radiation level at the outer surface of the container is specified as no more than 200 millirem per hour.
containment	Retention of a material or substance within prescribed boundaries.
contamination	The presence of excess radioactive material from a U.S. Department of Energy activity in or on a material or property.

creep	The continuous, usually slow deformation of solid rock resulting from constant strain acting over a long period of time. Salt will creep much faster than limestone, in a manner similar to ice in a glacier.
creep closure	Closure of underground openings, especially openings in salt, by creep flow of the surrounding rock under lithostatic pressure.
criteria pollutants	Six pollutants (ozone, carbon monoxide, total suspended particulates, sulfur dioxide, lead, and nitrogen oxide) known to be hazardous to human health and for which the U.S. Environmental Protection Agency sets National Ambient Air Quality Standards under the Clean Air Act.
critical habitat	The specific areas within the geographical area occupied by a species at the time it is listed as threatened or endangered on which are found those physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection. It also includes specific areas outside the geographical area occupied by the species at the time it is listed if these areas are determined to be essential for the conservation of the species.
criticality	A state in which a self-sustaining nuclear chain reaction is achieved.
Culebra Dolomite	The lower of two geologic units of water-bearing dolomite within the Rustler Formation.
cumulative impacts	Cumulative impacts are those impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
curie	A unit of radioactivity equal to 37 billion (3.7×10^{10}) disintegrations per second.
Darcy's law	A mathematical relationship that describes the flow through porous media.
decommissioning	The removal from active service of a facility.
decontamination	The removal of unwanted material (especially radioactive material) from the surface or from within another material.
defense waste	Nuclear waste deriving from the manufacture of nuclear weapons and the operation of naval reactors. Associated activities, such as the research carried on in the weapons laboratories, also produce defense waste.
degradation	A process of transition. To decompose (a compound) by stages.

Delaware Basin	An area in southeastern New Mexico and the adjacent parts of Texas where the Permian sea deposited a large thickness of evaporites some 220 to 280 million years ago. It is partially surrounded by the Capitan Reef.
design life	The design life of components or systems generally refers to the estimated minimum period of time that the component or system is expected to perform within specifications before the effects of aging result in performance deterioration or a requirement to replace the component or system.
diffusion	Movement of atoms, ions, or molecules of one substance into or through another as a result of thermal or concentration gradients.
diffusion, molecular	Movement of a contaminant as the result of the cumulative effect of the random motions of molecules along a concentration or thermal gradient.
disposal	In this document, permanent disposition of waste in a repository. Use of the word disposal” implies that no need for later retrieval is expected. It also implies a minimal need for surveillance.
Disposal Phase	The period in which the U.S. Department of Energy proposes to permanently emplace transuranic wastes in the Waste Isolation Pilot Plant.
dissolution	The process whereby a material is taken into solution. Selective dissolution of minerals may produce cavities and caves, or enlarged fractures in a rock formation.
dissolution front	The boundary of a geologic region within which rock is dissolving. In this document, the term particularly refers to the wedge-like leading edge of salt dissolution at the interface between the Rustler and Salado Formation.
distribution coefficient	In an aquifer, the ratio of the concentration of a substance absorbed by the rock to the concentration of the substance remaining in solution. A large distribution coefficient implies that the substance moves much more slowly than the groundwater. It is measured in units of cubic centimeters per gram or equivalent.
disturbed rock zone	The disturbed rock zone is a volume of rock adjacent to an underground excavation in which mechanical properties (e.g., elastic modulus) and hydraulic properties (e.g., permeability and degree of saturation) have been changed because of the excavation.
dolomite	A sedimentary rock consisting primarily of the mineral dolomite: $\mathrm{CaMg\ (CO_3)_2}$.
dose (absorbed dose)	The energy imparted to matter per unit mass by ionizing radiation. The unit of absorbed dose is the rad (or gray [Gy]). In SEIS-II, it is used as a general term for dose equivalent, total effective dose equivalent, and committed dose equivalent.

dose conversion factor	A numerical factor used in converting radionuclide intake (curies) in the body to the resultant dose equivalence (rem or person-rem).
dose equivalent	The product of absorbed dose in rad (or gray) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert).
dose rate	The radiation dose delivered per unit time (e.g., rem per hour).
dual porosity	Having fracture porosity as well as interconnected pores (matrix porosity).
ecology	The science dealing with the relationship of all living things with each other and with the environment.
economic sector	A distinctive part of the economy of a geographic region defined by a standard industrial classification scheme. One such scheme defines “major” sectors and divides them into subsectors; for example, the major sector “trade” contains the subsectors “wholesale trade” and “retail trade.” Another classification scheme specifies “primary” and “secondary” sectors; the criterion for including a sector in the primary classification is that its level of activity is generally not controlled by the level of economic activity in the region; a primary industry, in other words, produces goods and services for export from the region.
effective dose equivalent	The sum of the products of the dose equivalent received by specified organs or tissues of the body and a tissue-specific weighting factor. The effective dose equivalent is expressed in units of rem (or sievert).
effluent	Liquid or airborne material released to the environment. In common usage, however, the term “effluent” implies liquid release.
EIS	Environmental impact statement; a document required by the National Environmental Policy Act for proposed major Federal actions involving potentially significant environmental impacts.
E/Q (E over Q)	A measure of atmospheric dispersion for short-term (acute) atmospheric releases using gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the time-integrated air concentration ($Ci \bullet s/m^3$) divided by the total release from the source (Ci). Integrated air concentrations used are usually plume centerline values. E/Qs are typically used for releases lasting no longer than 8 to 24 hours.
element	One of the known chemical substances that cannot be divided into simpler substances by chemical means.
endangered species	Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the Endangered Species Act.

energy	The capacity for doing work.
environment	The sum of all external conditions and influences affecting the life development and, ultimately, the survival of an organism.
environmental monitoring	The act of measuring, either continuously or periodically, some quantity of interest, such as radioactive material in the air.
ephemeral stream	A stream channel that carries water only during part of the year, immediately after periods of rainfall or snowmelt.
equilibrium	A state of rest in a chemical or mechanical system. Chemical: The state of a reaction in which its forward and reverse reactions occur at equal rates so that the concentrations of the reactants do not change with time. Mechanical: Forces in one direction are equal and opposite to those in the opposing direction. Flow of salt to fill the excavated cavity is an attempt by the salt to reattain a state of mechanical equilibrium.
erosion	Removal and transport of materials by wind, ice, or water on the earth's surface.
evaporite	A sedimentary rock composed primarily of minerals produced by partial or total evaporation of sea water.
evapotranspiration	Loss of water from the earth's surface to the atmosphere by a combination of evaporation from the soil, lakes, streams, and transpiration from plants.
exposure	A measure of the ionization produced in air by X or gamma radiation. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of the air in the volume element.
°F	Degree Fahrenheit. °F = (°C x 9)/5 + 32.
fault	A fracture or a zone of fractures along which there has been displacement parallel to the fracture.
fissile	Describes a nuclide that undergoes fission upon absorption of neutrons of any energy.
fission (nuclear)	The splitting of a heavy nucleus typically into two approximately equal parts (infrequently three parts), which are nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or can be induced by nuclear bombardment.
fission product	An element or compound resulting from fission.

formation	A mappable geologic body of rock identified by lithic characteristics and stratigraphic position. Formations may be combined into groups or subdivided into members.
40 CFR Part 191	The U.S. Environmental Protection Agency standard for managing and disposing of spent nuclear fuel and high-level and transuranic wastes. Subpart A deals with managing and storage of wastes, while Subpart B covers long-term isolation and disposal.
fraction	A small part of the total. The particulate fraction is that part of the waste in a particulate form.
gamma	Short-wavelength electromagnetic radiation (high-energy photons) emitted in the radioactive decay of certain nuclides. Gammas are the same as gamma rays or gamma waves.
geology	The science that deals with the earth; the materials, processes, environments, and history of the planet, especially the lithosphere, including the rocks, their formation, and structure.
gross alpha	The total rate of alpha particle emission from a sample, without regard to energy distribution or source nuclides.
gross beta	The total rate of emission of beta particles from a sample, without regard to energy distributions or source nuclides.
groundshine	The pathway of direct external dose from radioactive material that has deposited on the ground after being dispersed from the accident site.
groundwater	All subsurface water, especially that contained in the saturated zone below the water table.
gypsum	A soft mineral consisting of hydrous calcium sulfate: $CaSO_4A2H_20$.
habitat	The part of the physical environment in which a plant or animal lives.
half-life	Time required for a radionuclide to lose 50 percent of its activity by decay. Each radionuclide has a unique half-life; that is, half of a particular radionuclide will decay in a specified amount of time; then half of the remaining portion will decay in the same amount of time, and so on. Half-life can also refer to the length of time that a chemical/radionuclide/biological agent remains in the body. Each material has biologically unique half-lives, depending on the substance, the organ of concern, and its route of elimination.
halite	A mineral composed of sodium chloride, NaCl.

hazard index	An indicator of the potential toxicological hazard from exposure to a particular substance. The hazard index is equal to an individual's estimated exposure divided by the U.S. Environmental Protection Agency's substance-specific reference dose.
hazardous waste	Hazardous constituents regulated by the Resource Conservation and Recovery Act and defined in 40 CFR 261 Subparts C and D.
head	When used in a hydraulic sense, it is understood to mean static head. The static head is the height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point.
headspace	The space between the container lid and the waste inside the container.
high efficiency particulate air filter	This filter is designed to remove 99.9 percent of particles as small as 0.3 micrometer in diameter from a flowing air stream.
high-level waste	The highly radioactive waste material that results from the reprocessing of spent nuclear fuel. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.
historic resources	The sites, districts, structures, and objects associated with historic events, persons, or social or historic movements.
horizon	A particular layer in a sequence of rock units. The waste-emplacement horizon in the Waste Isolation Pilot Plant is a specific level about 655 meters (2,150 feet) below the surface in the Salado Formation at which openings are being excavated for waste disposal.
hot cell	A heavily shielded enclosure for handling and processing (by remote means or automatically) or storing highly radioactive materials.
hydraulic conductivity	A quantity that describes the rate at which water flows through an aquifer. It has units of length/time and is equal to the hydraulic transmissivity divided by the thickness of the aquifer.
hydraulic gradient	A quantity that describes the rate of change of pressure head per unit of distance of flow at a given point and in a given direction.
igneous	A rock or mineral that crystallizes from magma, molten rock.
immediately dangerous to life and health	A term that represents a maximum airborne concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

in situ	In the natural or original position; i.e., in place.
intensity (earthquake)	A measure of the effects of an earthquake on humans and structures at a particular place. It is measured in numerical units on the modified Mercalli scale.
interbed	A bed of one kind of rock occurring between or alternating with beds of another rock type.
ionization	The process that creates ions. Nuclear radiation, X-rays, high temperatures, and electric discharges can cause ionization.
ionizing radiation	Radiation capable of displacing electrons from atoms or molecules to produce ions.
isotope	An atom of a chemical element with a specific atomic number and atomic weight. Isotopes of the same element have the same number of protons but different numbers of neutrons. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus. For example, uranium-235 is an isotope of uranium with 92 protons and 143 neutrons and uranium-238 is an isotope of uranium with 92 protons and 146 neutrons.
karst	A topography characterized by sinkholes, caves, and disappearing streams formed by dissolution in limestone, dolomite, and evaporite bedrock.
kelvin	A unit of temperature, abbreviated K, equal to the degree Celsius expressed as: $°K = °C + 273$.
lag storage	The storage of TRU waste that has been certified to the WAC and is awaiting shipment to the WIPP facility for disposal.
latent cancer fatalities	Deaths resulting from cancer that has become active after a latent period following radiation exposure. Latent cancer fatalities can be calculated for the public by using the risk conversion factor of $5x10^{-4}$ deaths per person-rem and for the worker by using the risk conversion factor of $4x10^{-4}$ deaths per person-rem.
leaching	The process of extracting a soluble component from a solid by the percolation of a solvent, such as water, through the solid.
lineament	A geologic term for straight or gently curved, linear topographic features.
lithostatic pressure	The vertical pressure at a point in the earth's crust equal to the weight of the overlying column of rock.
Los Medaños	The area in southeastern New Mexico surrounding the Waste Isolation Pilot Plant site. In English, it means "dune country."

low-income population	A population where 25 percent or more of the population is identified as living in poverty.
low-level waste	Radioactive waste not classified as high-level waste, transuranic waste, or uranium or thorium mill tailings.
Magenta Dolomite	The upper of the two dolomite layers within the Rustler Formation that are locally water-bearing.
magnitude (earthquake)	A measure of the total energy released by an earthquake. It is commonly measured in numerical units on the Richter scale. Each unit, e.g. 7, is different from an adjacent unit by a factor of 30.
maximally exposed individual (MEI)	A hypothetical member of the public who is exposed to a release of radioactive or chemically hazardous material in such a way (by combination of location, dietary habits, etc.) that the individual will likely receive the maximum dose from such release.
member	A division of a formation differentiated by separate or distinct lithology or complex of lithologies.
migration	The natural travel of a material through the air, soil, or groundwater.
mitigate	To take practicable means to avoid or minimize environmental harm from a selected alternative.
molecular weight	The weight of a molecule of a chemical expressed in atomic mass units.
Nash Draw	A shallow 8-kilometer- (5-mile-) wide valley open to the southwest located to the west of the Waste Isolation Pilot Plant site.
National Environmental Policy Act	This Act was designed to promote inclusion of environmental concerns in Federal decision-making.
National Register of Historic Places	A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national importance.
noninvolved worker	For this document, a worker who is not involved in the operation of a facility when a radioactive release occurs.
NO_x	Oxides of nitrogen, primarily nitrogen oxide and nitrogen dioxide. These are produced primarily by combustion of fossil fuels, and can constitute an air pollution problem.

nuclide	A species of atom, characterized by its number of protons, number of neutrons, and energy state.
order of magnitude	A multiple of ten. When a measurement is made with a result such as 3×10^7, the exponent of 10 (here 7) is the order of magnitude of that measurement. To say that this result is known to within an order of magnitude is to say that the true value lies between (in this example) 3×10^6 and 3×10^8.
organic compounds	Of or designating carbon compounds. (Some simple compounds of carbon, such as carbon dioxide, are frequently classified as inorganic compounds.)
overpack	A container put around another container. In the Waste Isolation Pilot Plant, overpacks would be used on damaged or otherwise contaminated drums, boxes, and canisters that would not be practical to decontaminate.
oxide	A compound consisting of an element combined with oxygen.
ozone	A molecule of oxygen in which three oxygen atoms are chemically attached to each other.
package	In the regulations governing the transportation of radioactive materials, the packaging together with its radioactive contents as presented for transport.
packaging	A shipping container without its contents.
particulates	Solid particles and liquid droplets small enough to become airborne.
PE-Ci	Plutonium-239 equivalent curies are used as a radioactive hazard index factor that relates the radiotoxicity of transuranic radionuclides to that of plutonium-239.
permeability	The capability of a soil or rock to transmit a fluid.
person-rem	A measure of the radiation dose to a given population; the sum of the individual radiation doses received by that population.
pH	A measure of the hydrogen ion concentration in aqueous solution. Pure water has a pH of 7, acidic solutions have a pH less than 7, and alkaline solutions have a pH greater than 7.
physiographic	Geographic regions based on geologic setting.

planning-basis Waste Acceptance Criteria	The U.S. Department of Energy document, currently in revision number 5, that describes the criteria by which unclassified transuranic waste will be accepted for emplacement at the Waste Isolation Pilot Plant and the basis on which these criteria were established. The current planning-basis for waste acceptance criteria is a compendium of the minimal requirements established by law, regulation, and U.S. Department of Energy orders that transuranic waste must meet to be transported to and disposed of at the Waste Isolation Pilot Plant. The treatment selected pursuant to the Supplemental Environmental Impact Statement-II analyses could result in modifications to the waste acceptance criteria.
PM_{10}	Particulate matter with a 10-micron or less aerodynamic diameter.
point source	A source of effluents that is small enough in dimensions that it can be treated as if it were a point. The converse is a diffuse source. A point source can be either a continuous source or a source that emits effluents only in puffs or for a short time.
pollution	The addition of an undesirable agent to the environment in excess of the rate at which natural processes can degrade, assimilate, or disperse it.
polyhalite	A relatively hard and brittle evaporite mineral: $K_2MgCa_2(SO_4)_4\mathbf{A}{\cdot}2H_2O$. In the Delaware Basin, it is often associated with anhydride.
population dose	The sum of the radiation doses received by the individual members of a population.
population-weighted E/Q	A measure of the atmospheric dispersion across an entire populated sector following an acute release. For a given 22.5° compass sector, it is the sum of the product of the E/Q and the population for each of the ten segments comprising the sector, with units of person•s/m^3. (See also E/Q [E over Q].)
porosity	Percentage of void space in a material.
potash	Potash is the common industrial term for potassium in various chemical combinations with sodium, magnesium, chlorine, and sulfate.
potentiometric surface	Surface to which water in an aquifer would rise by hydrostatic pressure. It is usually represented in figures as a contour map, in which each point indicates how high the water would rise in a well tapping that aquifer at that point.
progeny	Stable or radioactive elements formed by the radioactive decay of another nuclide, which is the “parent.”
pyrophoric	Spontaneously igniting in air; producing sparks by friction.

Quality Factor	A modifying factor used to calculate the dose equivalent from absorbed dose. The quality factor can vary by type and energy of the ionizing radiation.
radiation	Ionizing radiation; e.g., alpha particles, beta particles, gamma rays, X-rays, neutrons, protons, and other particles capable of producing ion pairs in matter. As used in this document, radiation does not include nonionizing radiation.
radioactive decay	The spontaneous transformation of one nuclide into a different nuclide or into a different state of the same nuclide. The process results in the emission of nuclear radiation (alpha, beta, or gamma radiation).
radioactive waste	Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which there is no practical use or for which recovery is impractical.
radioactivity	The property or characteristic of radioactive material to undergo spontaneous transformations (“disintegrations” or “decay”) with the emission of energy in the form of radiation. It means the rate of spontaneous transformations of a radionuclide. The unit of radioactivity is the curie (or becquerel). (1 curie = 3.7×10^{10} becquerel).
radionuclide	A nuclide that emits radiation by spontaneous transformation.
radionuclide inventory	A list of the kinds and amounts of radionuclides in a container or a source. Amounts are usually expressed in activity units: curies or curies per unit volume.
recharge	In groundwater hydraulics, the addition of water to the zone of saturation; also, the amount of water added.
Record of Decision	The document, publicly available, by which a Federal department or agency decides on an alternative presented and evaluated through the environmental impact statement process.
reference dose	The reference dose is an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime (subchronic reference dose), or during a lifetime (chronic reference dose).
rem	A common (or special) unit of dose equivalent, effective dose equivalent, or committed dose equivalent.
remote-handled transuranic waste	TRU waste that requires shielding in addition to that provided by the container to protect people nearby from radiation exposure. By definition, the radiation level at the outer surface of the container is greater than 200 millirem per hour and less than 1,000 rem per hour.

repository	A facility for disposal of radioactive waste.
reserves	Mineral resources that can be extracted profitably by existing techniques and under present economic conditions.
Resource Conservation and Recovery Act	This Act was designed to provide “cradle to grave” control of hazardous chemical wastes.
resources	Mineralization that is concentrated enough, in large enough quantity, and in a physical and chemical form such that its extraction may be possible in the future.
retrievable storage	Storage of radioactive waste in a manner designed for recovery without loss of control or release of radioactivity.
RH-72B	A packaging designed to transport remote-handled transuranic waste. The cask is a circular cylinder providing shielding from the radioactive contents. The cask is designed to provide double containment of a vented canister that is 3 meters (10 feet) long by 0.67 meter (2.2 feet) in diameter. The vented canister weighs 1,000 kilograms (2,200 pounds) and has a payload of approximately 2,631 kilograms (5,800 pounds), which is approximately 0.89 cubic meters (31 cubic feet) of waste.
risk	The likelihood of suffering a detrimental effect as a result of exposure to a hazard. In accident analysis, the probability weighted consequence of an accident, defined as the accident frequency per year multiplied by the consequence.
runoff	The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and either infiltrates or eventually returns to streams.
Rustler Formation	The evaporite beds, including mudstones, of Permian age that immediately overlie the Salado Formation in which the Waste Isolation Pilot Plant disposal levels are built.
Salado Formation	The Permian Age evaporite unit within which wastes would be disposed of in the Waste Isolation Pilot Plant repository.
San Simon Swale	A broad depression about 24 kilometers (15 miles) east of the Los Medaños site, open to the southeast.
scenario	A set of conditions presumed for the purpose of estimating doses by analysis.
seismicity	All of the earthquakes that may occur in a region, regardless of magnitude.
shaft	A man-made hole, either vertical or steeply inclined, that connects the surface with an underground excavation.

shield	Material used to reduce the intensity of radiation that would irradiate personnel or equipment.
slurry	A suspension of fine particles in a liquid, in which the solid constituents are easily carried along by the liquid.
solubility	The degree to which a compound in its pure state will dissolve; water is the solvent used for determining aqueous solubility of a compound.
sorption	The binding on a microscopic scale of one substance to another, such as by adsorption or ion exchange.
source term	The kinds and amounts of radionuclides that may lead to an assumed release of radioactive material.
spent fuel or spent nuclear fuel	Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.
storage	Temporary placement of waste in a facility. Storage usually implies the need for continued surveillance.
strata	Layers of rock.
stratigraphy	The study of layered sequences of rocks.
surface water	A creek, stream, river, pond, lake, bay, sea, or other waterway that is directly exposed to the atmosphere.
tectonic activity	Movement of the earth’s crust, produced by internal forces, such as uplift, subsidence, folding, faulting, and seismic activity.
Ten Drum Overpacks	A metal container (73 inches high and 72 inches in outside diameter) similar to the standard waste box, designed to efficiently use the inner containment vessel of the TRUPACT-II. Authorized packaging configurations are as follows: ten 55-gallon drums, one standard waste box, or four 55-gallon drums within a standard waste box.
threatened species	Any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act.
throughput	The number of TRUPACT-IIs and RH-72Bs capable of being processed at the WIPP Waste Handling Building in a given time period (i.e., 50 TRUPACT-IIs and 8 RH-72Bs per week).
total effective dose equivalent	The sum of the effective dose equivalent from radiation sources external to the body during the year plus the committed effective dose equivalent from

	radionuclides taken into the body. A 50-year time interval is assumed for determining committed dose.
TRANSCOM	A satellite-based tracking and communication system established by the U.S. Department of Energy.
transmissivity	A quantity defined in the study of groundwater hydraulics that describes the rate at which water may be transmitted through an aquifer. It has units of length^2/time.
transmutation	Any process in which a nuclide is transformed into a different nuclide, or more specifically, when transformed into a different element by a nuclear reaction.
transuranic mixed waste	Transuranic waste that is commingled with Resource Conservation Recovery Act-regulated hazardous wastes as defined in 40 CFR Part 261, Subparts C and D.
transuranic radionuclide	A nuclide with an atomic number (number of protons) greater than that of uranium (92). All transuranic radionuclides are radioactive.
transuranic waste	Waste materials (excluding high-level waste and certain other waste types) contaminated with alpha-emitting radionuclides that are heavier than uranium with half-lives greater than 20 years and occur in concentrations greater than 100 nanocuries per gram. Transuranic waste results primarily from plutonium reprocessing and fabrication as well as research activities at U.S. Department of Energy defense installations.
TRUPACT	Transuranic Package Transporter.
TRUPACT-II	TRUPACT-II is the package designed to transport contact-handled transuranic waste to the Waste Isolation Pilot Plant site. It is a cylinder with a flat bottom and a domed top that is transported in the upright position. The major components of the TRUPACT-II are an inner, sealed, stainless steel containment vessel within an outer, sealed, stainless steel containment vessel. Each containment vessel is nonvented and capable of withstanding 345 kilopascals (50 pounds per square inch) of pressure. The inner containment vessel cavity is 1.8 meters (6 feet) in diameter and 2 meters (6.75 feet) tall, with a capability of transporting fourteen 0.21-cubic-meter (55-gallon) drums, two standard waste boxes, or one 10-drum overpack.
tuff	Volcanic rock formed of welded or compacted volcanic ash.
void volume	That part of the total volume not occupied by the solid volume. The void volume may contain either liquid or gas.

volatile organic compound	Any compound containing carbon and hydrogen in combination with any other element that has a vapor pressure of 77.6 millimeters of mercury (1.5 pounds per square inch) absolute or greater under actual storage conditions.
volatilization	To evaporate at normal temperatures and pressures.
vug	A cavity, often with a mineral coating of different composition than the surrounding rock.
Waste Acceptance Criteria (WAC)	A set of minimum waste characteristics criteria that the U.S. Department of Energy has established as a planning basis for waste that would be emplaced at the Waste Isolation Pilot Plant. Should disposal operations at the Waste Isolation Pilot Plant be approved, these planning-basis criteria (or some modification of them) would become the WAC. The WAC may change based on decisions in the Record of Decision for SEIS-II that change these minimum requirements.
waste form	The condition of the waste. This phrase is used to emphasize the physical and chemical properties of the waste.
Waste Isolation Pilot Plant	The facility near Carlsbad, New Mexico, that has been designated to be an operational site for evaluating disposal capabilities of bedded salt for U.S. Department of Energy-generated transuranic waste.
waste matrix	The material that surrounds and contains the waste and, to some extent, protects it from being released into the surrounding rock and groundwater. Only material within the canister (or drum or box) that contains the waste is considered part of the waste matrix.
$\overline{X}/Q'$ (chi-bar over Q prime)	A measure of the average atmospheric dispersion for long-term (chronic) atmospheric releases using a gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the average air concentration in Ci/m^3 divided by the release rate (Ci/s). Typically, the concentration used is the average centerline value for individuals and is averaged over a specific sector of a polar grid surrounding the release point for populations. $\overline{X}/Q'$s are used for long-term (chronic) releases, often on the order of months or years.

ACRONYMS AND ABBREVIATIONS

3D	three dimensional
µR/hr	microroentgen per hour
ACGIH	American Conference of Governmental Industrial Hygienists
AEC	U.S. Atomic Energy Commission
AIHA	American Industrial Hygiene Association
AIS	Air Intake Shaft
ALARA	as low as reasonably achievable
Ames	Ames Laboratory-Iowa State University
ANL-E	Argonne National Laboratory-East
ANL-W	Argonne National Laboratory-West
AQCR	Air Quality Control Regulations
ARCO	ARCO Medical Products Company
ATSF	Atchison, Topeka, and Santa Fe Railroad
BBER	Bureau of Business and Economic Research of the University of New Mexico
BCL	Battelle Columbus Laboratories
BEIR-III	1980 report of the Committee on Biological Effects of Ionizing Radiation of the National Academy of Sciences/National Research Council.
BEMR	Baseline Environmental Management Report
Bettis	Bettis Atomic Power Laboratory
BIR-2	Baseline Inventory Report, Revision 2
BIR-3	Baseline Inventory Report, Revision 3
BLM	U.S. Bureau of Land Management
BNL	Brookhaven National Laboratory
Bq	becquerel
BSEP	Brine Sampling and Evaluation Program
°C	degree Celsius
C&C	Agreement for Consultation and Cooperation
CAO	Carlsbad Area Office
CAST	Colorado Allstate Trucking
CCA	Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant
CCDF	Complementary Cumulative Distribution Function
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CH_4	methane
CH-TRU	contact-handled transuranic
Ci	curie
cm^2	square centimeters
CMR	Central Monitoring Room
CO	carbon monoxide
CO_2	carbon dioxide
CoC	contaminant of concern

CR	concentration ratio
CSR	Compliance Status Report
D&D	decontamination and decommissioning
DBE	design-basis earthquake
DCF	dose conversion factor
Department	U.S. Department of Energy
DDREF	Dose and Dose Rate Effectiveness Factor
DF	dose factor
DLR	Dewey Lake Redbeds
DOE	U. S. Department of Energy
DOT	U.S. Department of Transportation
DRZ	disturbed rock zone
EA	Environmental Assessment
EEG	Environmental Evaluation Group
EIS	Environmental Impact Statement
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
E/Q	atmospheric dispersion factor for short-term releases
ER	environmental restoration
ERPG	Emergency Response Planning Guideline
ETEC	Energy Technology Engineering Center
°F	degree Fahrenheit
FEIS	Final Environmental Impact Statement for the Waste Isolation Pilot Plant
FEPs	features, events, and processes
FFCAct	Federal Facility Compliance Act
FGE	fissile-gram equivalent
F.I.R.E.	Fire, Insurance and Real Estate
FONSI	finding of no significant impact
FR	Federal Register
FRA	Federal Railroad Administration
ft^3	cubic feet
FY	fiscal year
GENII	Generation II Code Package
H_2S	hydrogen sulfide
Hanford	Hanford Site
HEPA	high-efficiency particulate air
HI	hazard index
hour/km	hours per kilometer
HQ	DOE Headquarters
HRCQ	highway route-controlled quantities
ICC	Interstate Commerce Commission
ICRP	International Commission on Radiological Protection
IDB	Integrated Data Base
IDLH	immediately dangerous to life or health
IMPLAN	IMpact analysis for PLANing
INEEL	Idaho National Engineering and Environmental Laboratory
IRIS	Integrated Risk Information System
ISC3	Industrial Source Complex computer code
ISCLT3	Industrial Source Complex long-term model

ISCST3	Industrial Source Complex short-term model
kg	kilogram
kg/m^3	kilograms per cubic meter
Knolls	Knolls Atomic Power Laboratory
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LCF	latent cancer fatality
LDR	Land Disposal Restrictions
LET	linear energy transfer
LLNL	Lawrence Livermore National Laboratory
LWA	Waste Isolation Pilot Plant Land Withdrawal Act
m^3	cubic meters
MAP	Mitigation Action Plan
MB	marker bed
MEI	maximally exposed individual
mg	milligram
mg/m^3	milligrams per cubic meter
MgO	magnesium oxide
mg/s	milligrams per second
mi	mile
ml	milliliter
Mound	Mound Plant
MOU	Memorandum of Understanding
mph	miles per hour
MRA	modular risk analysis
mrem	millirem
mrem/hr	millirem per hour
MSHA	Mining Safety and Health Administration
m/s	meters per second
MWIR95	Mixed Waste Inventory Summary Report 1995
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection and Measurements
NEFTRAN	Network Flow and Transport
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NM	New Mexico
NMDG&F	New Mexico Department of Game and Fish
NMDOL	New Mexico Department of Labor
NMED	New Mexico Environment Department
NMEMNR	New Mexico Energy, Minerals, and Natural Resources Department
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOI	Notice of Intent
NO_x	Oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission

NRHP	National Register of Historic Places
NSC	National Safety Council
NTS	Nevada Test Site
NUTS	Nuclide Transport System
O_3	ozone
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
Pa	Pascal
Pantex	Pantex Plant
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie
PE-Ci	plutonium-239 equivalent curies
PEIS	Programmatic Environmental Impact Statement
PEL	permissible exposure limit
PGDP	Paducah Gaseous Diffusion Plant
PIC	Passive Institutional Controls
PM_{10}	particulate matter less than or equal to 10 micrometers in diameter
PNNL	Pacific Northwest National Laboratory
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
ppmv	parts per million volume
PSD	prevention of significant deterioration
RBP	Radiological Baseline Program
RC	retrieval and characterization
RCRA	Resource Conservation and Recovery Act
RfD	reference dose levels
RFETS	Rocky Flats Environmental Technology Site
RH-72B	remote-handled transuranic waste shipping container (proposed)
RH-TRU	remote-handled transuranic
ROD	Record of Decision
ROI	region of influence
RSPA	Research and Special Programs Administration
SAR	Safety Analysis Report
SEIS-I	Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant
SEIS-II	Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement
s/m^3	seconds per cubic meter
s/mg	seconds per milligram
SIC	Standard Industrial Classification
SMC	Salado Mass Concrete
SNL	Sandia National Laboratories
SNL-CA	Sandia National Laboratories, California
SNM	special nuclear material
SO_2	sulfur dioxide

SO_x	oxides of sulfur
SPM	Systems Prioritization Methodology
SRS	Savannah River Site
STEL	short-term exposure limit
SVOC	semivolatile organic compound
SWB	standard waste box
SWIFT II	Sandia Waste Isolation Flow and Transport (computer software)
TBE	Teledyne Brown Engineering
TCC	TRANSCOM Control Center
TCLP	Toxicity Characteristic Leaching Procedure
TDEM	time-domain electromagnetic
TDOP	Ten Drum Overpack
TDS	total dissolved solids
TEDE	total effective dose equivalent
TI	transportation index
TRANSCOM	Transportation Tracking and Communications System
TRC	total recordable case
TRU	transuranic
TRUCON	TRUPACT Content Codes
TRUPACT-II	Transuranic package transporter - II
TSCA	Toxic Substance Control Act
TSP	total suspended particulates
TWA	time-weighted average
UDF	unit dose factor
UEF	unit exposure factor
UIF	unit impact factor
U of Mo	University of Missouri
USAMC	U.S. Army Materiel Command
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
VR	volume ratio
W	watts
WAC	planning-basis Waste Acceptance Criteria
WAC-4	Waste Acceptance Criteria, revision 4
WAC-5	Waste Acceptance Criteria, revision 5
WGA	Western Governors Association
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WM PEIS	Final Waste Management Programmatic Environmental Impact Statement
WVDP	West Valley Demonstration Project
$\overline{X}/Q'$	atmospheric dispersion factor for chronic releases

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MEASUREMENTS AND CONVERSIONS

The following information is provided to assist the reader in understanding certain concepts in this supplemental environmental impact statement (SEIS-II). Definitions of technical terms can be found in the Glossary.

EXPONENTIAL NOTATION

Exponential notation is used in SEIS-II to express very large or very small numbers. For example, the number 1 billion could be written as 1,000,000,000 or, using exponential notation, as 1E+9. Translating from exponential notation to a more traditional number requires moving the decimal point either right (for a positive number after the E) or left (for a negative number after the E). If the value given is 5.0E+2, move the decimal point two places (insert zeros if no numbers are given) to the right of its present location. The result would be 500. If the value given is 5.0E-4, move the decimal point four places to the left of its present location. The result would be .0005.

ROUNDING

Some numbers in SEIS-II have been rounded, therefore sums and products throughout the document may not be consistent. A number was rounded only after all calculations using that number had been made. Numbers that are actual measurements were not rounded.

The waste volumes were rounded in the following manner:

124,756.2	rounded to	125,000
61,423.7	rounded to	61,000
1,476.4	rounded to	1,500
242.4	rounded to	240
16.7	rounded to	17
8.5	rounded to	9
0.3	rounded to	1

The total waste volumes for the proposed action were not rounded because these volumes were established by the Waste Isolation Pilot Plant Land Withdrawal Act.

UNITS OF MEASURMENT

The primary units of measurement used in this report are metric units with English equivalents enclosed in parentheses. DOE Order 5900.2A, “ Use of the Metric System of Measurement,” prescribes the use of this system in DOE documents. Table MC-1 lists the mathematical values or formulas needed for conversion between metric and English units. Table MC-2 summarizes and defines the terms for units of measure and corresponding symbols found throughout this report.

Table MC-1
Metric Conversion Chart

To Convert to Metric			To Convert out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
gallons	0.00378	cubic meters	cubic meters	264.55	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.038	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths then add 32	Fahrenheit
Force					
pounds per square inch	6,895	pascals	pascals	0.000145	pounds per square inch

Table MC-2
Names and Symbols for Units of Measure

Length

Symbol	Name
cm	centimeter
ft	foot
in	inch
km	kilometer
m	meter
mi	mile
mm	millimeter
µm	micrometer

Numerical Relationships

Symbol	Meaning
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to
2σ	two standard deviations

Volumes and Concentrations

Symbol	Name
cm^3	cubic centimeter
ft^3	cubic foot
gal	gallon
in^3	cubic inches
L	liter
m^3	cubic meter
mL	milliliter
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard

Rate

Symbol	Name
m^3/s	cubic meters per second
ft^3/s	cubic feet per second
ft^3/min	cubic feet per minute
gpm	gallons per minute
km/h	kilometers per hour
mi/h	miles per hour

Sound

Symbol	Name
dB	decibel
dBA	A-weighted decibel

Area

Symbol	Name
ac	acre
cm^2	square centimeter
ft^2	square foot
ha	hectare
in^2	square inch
km^2	square kilometer
mi^2	square mile

Mass

Symbol	Name
g	gram
kg	kilogram
mg	milligram
µg	microgram
ng	nanogram
lb	pound
ton	metric ton (1E + 6 g)

Temperature

Symbol	Name
°C	degrees Centigrade
°F	degrees Fahrenheit
°K	degrees Kelvin

Many metric measurements presented include prefixes that denote a multiplication factor that is applied to the base standard (e.g., 1 kilometer = 1,000 meters). Table MC-3 presents these metric prefixes.

Table MC-3
Metric Prefixes

Prefix	Symbol	Multiplication Factor
exa	E	1 000 000 000 000 000 000 = 10^{18}
peta	P	1 000 000 000 000 000 = 10^{15}
tera	T	1 000 000 000 000 = 10^{12}
giga	G	1 000 000 000 = 10^{9}
mega	M	1 000 000 = 10^{6}
kilo	k	1 000 = 10^{3}
hecto	h	100 = 10^{2}
deka	da	10 = 10^{1}
deci	d	0.1 = 10^{-1}
centi	c	0.01 = 10^{-2}
milli	m	0.001 = 10^{-3}
micro	µ	0.000 001 = 10^{-6}
nano	n	0.000 000 001 = 10^{-9}
pico	p	0.000 000 000 001 = 10^{-12}
femto	f	0.000 000 000 000 001 = 10^{-15}
atto	a	0.000 000 000 000 000 001 = 10^{-18}

RADIOACTIVITY UNITS

Sections of SEIS-II deal with levels of radioactivity that might be found in various environmental media. Radioactivity is a property; the amount of a radioactive material is usually expressed as “activity” in curies (Ci) (Table MC-4). The curie is the basic unit used to describe the amount of substance present, and concentrations are generally expressed in terms of curies per unit mass or volume. One curie is equivalent to 37 billion disintegrations per second or is a quantity of any radionuclide that decays at the rate of 37 billion disintegrations per second. Disintegrations generally include emissions of alpha or beta particles, gamma radiation, or combinations of both.

RADIATION DOSE UNITS

The amount of ionizing radiation energy received by a living organism is expressed in terms of radiation dose. Radiation dose in this report is usually written in terms of effective dose equivalent and reported numerically in units of rem (Table MC-5). Rem is a term that relates ionizing radiation and biological effect or risk. A dose of 1 millirem (0.001 rem) has a biological effect similar to the dose received from about a 1-day exposure to natural background radiation. A list of the radionuclides discussed in this document and their half-lives is included in the section entitled Select Radionuclides.

CHEMICAL ELEMENTS

A list of chemical elements, chemical constituents, and their nomenclature is presented in Table MC-6.

Table MC-4
Names and Symbols for Units of Radioactivity

Radioactivity	
Symbol	Name
Ci	curie
cpm	counts per minute
mCi	millicurie (1E-3 Ci)
µCi	microcurie (1E-6 Ci)
nCi	nanocurie (1E-9 Ci)
pCi	picocurie (1E-12 Ci)

Table MC-5
Names and Symbols for Units of Radiation Dose

Radiation Dose	
Symbol	Name
mrad	millirad (1E-3 rad)
mrem	millirem (1E-3 rem)

Table MC-6
Elemental and Chemical Constituent Nomenclature

Symbol	Constituents	Symbol	Constituents
Ag	silver	Pa	protactinium
Al	aluminum	Pb	lead
B	boron	Pu	plutonium
Be	beryllium	SF_6	sulfur hexafluoride
CO	carbon monoxide	Si	silicon
CO_2	carbon dioxide	SO_2	sulfur dioxide
Cu	copper	Ta	tantalum
F^-	fluoride	Th	thorium
Fe	iron	Ti	titanium
MgO	magnesium oxide	U	uranium
N	nitrogen	UO_2	uranium oxide
Ni	nickel	V	vanadium
NO_2-	nitrite	W	tungsten
NO_3-	nitrate	Zn	zinc

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HALF-LIVES OF SELECT RADIONUCLIDES

Symbol	Radionuclide	Half-Life
Ac-225	Actinium-225	10.0 days
Ac-227	Actinium-227	21.8 years
Ac-228	Actinium-228	6.13 hours
Ag-109m	Silver-109m	39.8 seconds
Am-241	Americium-241	432 years
Am-243	Americium-243	7,380 years
At-217	Astatine-217	32 milliseconds
Ba-137m	Barium-137m	2.55 minutes
B-7	Boron-7	53.4 days
Bi-210	Bismuth-210	5.01 days
Bi-212	Bismuth-212	60.6 minutes
Bi-213	Bismuth-213	46 minutes
Bi-214	Bismuth-214	19.8 minutes
Bk-249	Berkelium-249	311 days
C-14	Carbon-14	5,730 years
Cd-109	Cadmium-109	453 days
Ce-144	Cerium-144	284 days
Cf-249	Californium-249	352 years
Cf-252	Californium-252	2.64 years
Cm-242	Curium-242	163 days
Cm-243	Curium-243	28.5 years
Cm-244	Curium-244	18.1 years
Cm-245	Curium-245	8,500 years
Cm-246	Curium-246	4,730 years
Cm-247	Curium-247	1.56E + 7 years
Cm-248	Curium-248	3.39 E + 5 years
Co-60	Cobalt-60	5.27 years
Cs-134	Cesium-134	2.06 years
Cs-137	Cesium-137	30.0 years
Eu-152	Europium-152	13.33 years
Eu-154	Europium-154	8.8 years
Eu-155	Europium-155	4.96 years
Fr-221	Francium-221	4.8 minutes
H-3	Hydrogen-3	12.4 years
I-129	Iodine-129	1.57E + 7 years
Kr-85	Krypton-85	10.7 years
Ni-63	Nickel-63	96 years
Np-237	Neptunium-237	2.14E + 6 years
Np-239	Neptunium-239	2.35 days
Pa-231	Protactinium-231	3.28E + 4 years
Pa-233	Protactinium-233	27.0 days
Pa-234m	Protactinium-234m	1.17 minutes
Pb-209	Lead-209	3.25 hours
Pb-210	Lead-210	22.3 years
Pb-212	Lead-212	10.6 hours
Pb-214	Lead-214	26.8 minutes
Pm-147	Promethium-147	2.62 years
Po-210	Polonium-210	138 days
Po-212	Polonium-212	0.305 microseconds
Po-213	Polonium-213	4.2 microseconds
Po-214	Polonium-214	164 microseconds
Po-216	Polonium-216	0.15 microseconds
Po-218	Polonium-218	3.05 minutes
Pr-144	Praseodymium-144	17.3 minutes
Pu-236	Plutonium-236	2.85 years
Pu-238	Plutonium-238	87.7 years
Pu-239	Plutonium-239	24,065 years
Pu-240	Plutonium-240	6,537 years
Pu-241	Plutonium-241	14.4 years
Pu-242	Plutonium-242	3.76E + 5 years
Pu-244	Plutonium-244	8.26E + 7 years
Ra-223	Radium-223	11.4 days
Ra-226	Radium-226	1,600 years
Ra-228	Radium-228	5.75 years
Rn-220	Radon-220	55.6 seconds
Rn-222	Radon-222	3.82 days
Ru-106	Ruthenium-106	368 days
Sb-125	Antimony-125	2.77 years
Sm-151	Samarium-151	90 years
Sr-90	Strontium-90	29.1years
Tc-99	Technetium-99	2.13E + 5 years
Th-228	Thorium-228	1.91 years
Th-230	Thorium-230	7.7E + 4 years
Th-232	Thorium-232	1.41E + 10 years
U-232	Uranium-232	72 years
U-233	Uranium-233	1.59E + 5 years
U-234	Uranium-234	2.45E + 5 years
U-235	Uranium-235	7.04E + 8 years
U-236	Uranium-236	2.34E + 7 years
U-238	Uranium-238	4.47E + 9 years
Y-90	Yttrium-90	64.0 hours
Zr-95	Zirconium-95	64.0 days

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CHAPTER 1
INTRODUCTION

This chapter presents the underlying purpose and need for action, the National Environmental Policy Act (NEPA) compliance history for the Waste Isolation Pilot Plant (WIPP), the need for the second supplemental environmental impact statement (SEIS-II), the relationship of SEIS-II to other planning documents, and a description of the contents of this document.

1.1 PURPOSE AND NEED FOR ACTION

The U.S. Department of Energy (DOE or the Department) needs to dispose of transuranic (TRU) waste generated by past, present, and future activities in a manner that protects public health and the environment. In previous NEPA documents, the Department examined alternatives to repository disposal at WIPP. In this document, the Department assesses whether and, if so, how to dispose of TRU waste at WIPP.

1.2 OVERVIEW

TRU waste has been generated since the 1940s as part of the nuclear defense research and production activities of the federal government. Several types of operations (current, past, or future) have generated or will generate TRU waste: (1) nuclear weapons development and manufacturing, (2) plutonium recovery, stabilization, and management, (3) research and development, (4) environmental restoration, and decontamination and decommissioning, (5) waste management, and (6) testing at private institutions and universities under DOE contract.

Until about 1970, TRU waste, then classified as low-level waste, was disposed of in shallow trenches without an intent to retrieve it. In 1970, it was determined that TRU waste should be isolated and disposed of in a different manner than low-level waste. Thus, the Atomic Energy Commission, a DOE predecessor agency, adopted a policy

TRANSURANIC WASTE

TRU waste is defined as "waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste, (B) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations" (WIPP Land Withdrawal Act, Public Law 102-579).

TRU elements, each having several isotopes, are radioactive and typically man-made. The half-lives of many are considerably longer than 20 years. For instance, the half-life of one isotope of plutonium is 24,000 years.

TRU waste is further classified as contact-handled (CH) TRU waste or remote-handled (RH) TRU waste. CH-TRU waste has radioactivity levels that are low enough to permit workers to directly handle the containers in which the waste is kept. This level of radioactivity is specified as a dose rate of no more than 200 millirems per hour (mrem/hr) at the outside surface of the container. RH-TRU waste has a surface dose rate greater than 200 mrem/hr, so workers use remote manipulators to handle containers of RH-TRU waste. TRU mixed waste is CH-TRU or RH-TRU waste that also contains hazardous materials, such as lead or organic solvents regulated by the Resource Conservation and Recovery Act (RCRA).

HIGHLIGHTS OF CHANGES SINCE PUBLICATION OF THE DRAFT SEIS-II

In response to stakeholder comments and requests and in an effort to ensure that SEIS-II incorporates the Department's latest planning efforts, changes have been made throughout SEIS-II since its publication in draft form in November 1996. Sidebars are used throughout the document to indicate where changes have been made. No sidebars, though, are used to indicate changes to text boxes, figures, or tables. Below is a list of some notable modifications:

- Two sites have been removed from the tables and the maps presented throughout the document. These two sites, the Pantex Site and Teledyne Brown Engineering, have moved the small amount (less than 1 cubic meter) of TRU waste reported in the Draft SEIS-II to Los Alamos National Laboratory and Rocky Flats Environmental Technology Site, respectively. Since they no longer have TRU waste, the impacts from the waste originating at these two sites are included in the impacts for Los Alamos National Laboratory and Rocky Flats Environmental Technology Site.

- Additional text boxes have been added to Chapter 3 and Chapter 5 that discuss the impacts of waste not disposed of in WIPP under the Proposed Action. Also, additional text has been added to Chapter 3 and Chapter 5 that discusses methods of reducing the period of disposal operations for each Action Alternative to 75 years or less and how impacts would change should DOE choose to use those methods.

- The Proposed Action has been identified as DOE's Preferred Alternative, although rail transportation would continue to be an option for future transportation of TRU waste.

- Additional discussions of current socioeconomic conditions and of WIPP site geology and hydrology have been added to Chapter 4.

- All references to planning documents and to related NEPA documents have been updated. New documents have been reviewed and changes to SEIS-II have been made as needed to ensure consistency with other planning efforts.

- A new appendix (Appendix J) has been added to discuss updated TRU waste inventory estimates and current TRU waste management initiatives.

- The analyses presented in Chapter 5 and in the appendices have been reviewed, redone as necessary, and their presentation revised, based on stakeholder comments on the draft. (See the summary of comments and changes in the Summary text box titled "Issued Raised During the SEIS-II Public Comment Period.")

- Performance assessment analyses have been redone based on stakeholder comments and requests. Two particular changes should be noted. First, new analyses indicate that in this document's most conservative scenarios, radionuclides and heavy metals would reach the Culebra Dolomite should a drilling intrusion occur. Second, the performance assessment results for No Action Alternative 2 have been reduced from 2,325 fatalities to 800 fatalities during 10,000 years. Neither number, though, takes into account potential deaths due to inadvertent intrusion. Chapter 5 now includes estimates of the impacts of intrusion.

- Volume III, the *Comment Response Document*, has been added to SEIS-II. Nearly 4,000 comments were received on the Draft SEIS-II. Those comments are summarized and responses to those comments are presented in the *Comment Response Document*.

requiring that TRU waste be placed in containers and stored in a manner so as to be retrievable from storage within 20 years. The most recent estimates of TRU waste are presented in *The National Transuranic Waste Management Plan* (DOE 1996h). According to *The National Transuranic Waste Management Plan*, approximately 102,025 cubic meters (3.6 million cubic feet) of defense CH-TRU waste and 1,941 cubic meters (69,000 cubic feet) of defense RH-TRU waste are in retrievable storage at waste sites around the country. Defense TRU waste is TRU waste that has been generated due to defense activities.

In addition to the currently stored TRU waste, defense CH-TRU and RH-TRU waste would continue to be generated through the year 2033 from continuing site activities, waste management activities, and decontamination and decommissioning of DOE facilities. The most current estimate for newly generated CH-TRU waste is 38,437 cubic meters (1.4 million cubic feet) and for newly generated RH-TRU waste is 2,816 cubic meters (100,000 cubic feet). These estimates are less than previous estimates, mainly due to changes when decommissioning and decontamination activities may occur. (See Appendix J for additional discussion of *The National Transuranic Waste Management Plan* volumes.)

LAND WITHDRAWAL ACT (LWA) LIMITS

The LWA limits the amount and types of TRU waste that can be emplaced at WIPP. The limits include the following:

- WIPP capacity is limited to 175,600 cubic meters (6.2 million cubic feet) total TRU waste by volume.
- No more than 5 percent by volume of RH-TRU waste may have a surface dose rate in excess of 100 rem per hour.
- No RH-TRU waste may have a surface dose rate in excess of 1,000 rem per hour.
- RH-TRU waste containers shall not exceed 23 curies per liter maximum activity level averaged over the volume of the container.
- The total curies of RH-TRU waste shall not exceed 5,100,000 curies.

In addition the Consultation and Cooperation Agreement (C&C Agreement) with the State of New Mexico limits the volume of RH-TRU waste to 7,080 cubic meters (250,000 cubic feet).

To conservatively estimate potential impacts, analyses in SEIS-II are based on the larger total volumes in the earlier *Transuranic Waste Baseline Inventory Report*, *Revision 3* (BIR-3) (DOE 1996e), which incorporates the waste volumes of its second revision (BIR-2) (DOE 1995j), although analyses based on *The National Transuranic Waste Management Plan* are also included (see Appendix J and Section 5.13). The SEIS-II estimates, based on BIR-3, include 62,000 cubic meters (2.2 million cubic feet) of stored defense CH-TRU waste and 3,600 cubic meters (127,000 cubic feet) of stored defense RH-TRU waste. SEIS-II estimates also include 73,000 cubic meters (2.6 million cubic feet) of newly generated defense CH-TRU waste and 32,000 cubic meters (1.1 million cubic feet) of newly generated defense RH-TRU waste that will be generated through 2033.

DOE estimates that approximately 138,000 cubic meters (4.9 million cubic feet) of CH-TRU waste and 3,100 cubic meters (108,000 cubic feet) of RH-TRU waste was previously disposed of by near surface burial. Disposal of this buried waste at WIPP (if excavated) is also considered under SEIS-II action alternatives. Table 1-1 shows the TRU waste inventory.

Table 1-1
Current and Anticipated DOE TRU Waste (in cubic meters) [a]

Type	CH-TRU Waste	RH-TRU Waste
Stored Through 1995	62,000	3,600
Newly Generated Through 2033 [b]	73,000	32,000
PCB-Commingled	720	0
Commercial/Nondefense	200	450
Previously Disposed of Nondefense	138,000	3,100

[a] The inventory for SEIS-II is based on BIR-3 (DOE 1996e). More recent volumes are presented in Appendix J.
[b] Defense TRU waste.

Continued storage of TRU waste at the generator-storage sites poses potential problems. For example, some of the metal drums used to store TRU waste are showing signs of corrosion, and the contents of these drums eventually will have to be repackaged. Additional storage facilities would be needed at the generator-storage sites. Additional worker exposures to penetrating radiation would occur due to repackaging and inspection of waste containers. New treatment capacity would also be needed because much of the TRU mixed waste (which is about 60 percent of the waste volume discussed above) is subject to Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDR) and cannot be placed in or on the land unless it is treated to satisfy those restrictions. However, recent amendments to the Land Withdrawal Act (LWA) allow WIPP to accept RCRA waste without meeting the restrictions. Also, continued storage at certain sites may require modification of legally binding agreements between DOE, the U.S. Environmental Protection Agency (EPA), and/or the states where the waste is located.

In recognition of the potential problems posed by continued storage of TRU waste, the Congress passed The National Security and Military Applications of Nuclear Energy Act of 1980 (Public Law 96-164) authorizing DOE to develop a research and development facility to demonstrate the safe disposal of radioactive waste that has resulted or will result from defense activities and that is exempted from regulation by the U.S. Nuclear Regulatory Commission (NRC) (i.e., defense TRU waste).

This legislation resulted in the design of a centralized repository for the disposal of TRU waste (after appropriate NEPA review—see below) known as WIPP. The site selected for the repository is located approximately 50 kilometers (30 miles) east of Carlsbad, New Mexico. In 1992, Congress confirmed the need for the disposal of TRU waste by passage of the WIPP Land Withdrawal Act (Public Law 102-579). The LWA reserved the area surrounding the WIPP site for construction, experimentation, operation, repair and maintenance, disposal, shutdown, monitoring, decommissioning, and other activities associated with WIPP. DOE is now proposing to continue the phased development of WIPP by disposing of TRU waste resulting from defense activities and programs.

1.3 WIPP NEPA COMPLIANCE HISTORY

In 1980, DOE prepared the *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) to assess the potential environmental impacts of developing WIPP and of alternatives for disposing of or managing defense TRU waste. The FEIS proposed a two-phased approach to the development of WIPP: (1) a site and preliminary design validation program and (2) full construction (DOE 1980).

The alternatives analyzed in the FEIS included the following:

- *Alternative 1: The No Action Alternative*. A research and development facility to demonstrate the safe disposal of TRU waste would not be developed, and post-1970 TRU waste would continue to be retrievably stored.

- *Alternative 2:* The two-phased approach to developing WIPP at its proposed site in southeastern New Mexico would be implemented.

- *Alternative 3*: TRU waste stored at Idaho National Engineering and Environmental Laboratory (INEEL) would be disposed of in the first available repository for high-level radioactive waste.

- *Alternative 4*: A decision on the site for WIPP would be delayed until at least 1984 to allow for the investigation of alternative sites.

In a Record of Decision (ROD) published by DOE on January 28, 1981 (46 Federal Register [FR] 9162), the Department selected Alternative 2, to proceed with the phased development of WIPP at the site in southeastern New Mexico. DOE designed the facility to accommodate 175,600 cubic meters (6.2 million cubic feet) of CH-TRU waste and 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste. The Department concluded in the ROD that the adverse environmental impacts of the phased development of WIPP would be minor and that there would be minimal risk of any release of radioactivity to the environment.

After construction of most of the WIPP facilities, the Department prepared the *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) (DOE 1990) to update the environmental record established in the FEIS.

SEIS-I evaluated the impacts of the following three alternatives:

- *Proposed Action Alternative:* A phased approach to develop WIPP would continue, as authorized by Public Law 96-164 and as modified by changes proposed in SEIS-I, by beginning an underground WIPP Test Phase.

- *No Action Alternative:* No waste would be emplaced at WIPP. Storage of TRU waste would continue at the generator-storage sites, and new storage facilities would be built.

- *Alternative Action:* Only those tests that could be performed without emplacing waste underground would be conducted until it was determined that WIPP complies with EPA standards and other regulatory requirements for the long-term protection of the environment from the disposal of TRU waste.

The SEIS-I ROD, published by DOE on June 22, 1990 (55 FR 25689), chose the Proposed Action Alternative. The 1990 ROD also committed the Department to prepare SEIS-II before the disposal phase and to provide an analysis of the long-term performance of WIPP in light of new information obtained since 1990. The WIPP Test Phase was to have involved the testing of TRU waste underground at WIPP. In October 1993, DOE decided not to conduct the Test Phase. DOE decided that the experiments could be adequately performed at a lower cost in aboveground laboratories as part of the ongoing experimental program.

The 1990 ROD also stated that a more detailed analysis of the impacts of processing and handling TRU waste at the generator-storage facilities would be conducted. The Department has analyzed TRU waste management activities in the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997b). The WM PEIS analyzes environmental impacts at the potential locations of treatment and storage sites for TRU waste; SEIS-II addresses impacts associated with alternative treatment methods, the disposal of TRU waste at WIPP and alternatives to that disposal, and the transportation to WIPP. (SEIS-II also includes potential transportation between generator sites.) Figure 1-1 shows the locations of facilities that currently store or will generate TRU waste during the 35-year period analyzed in SEIS-II.

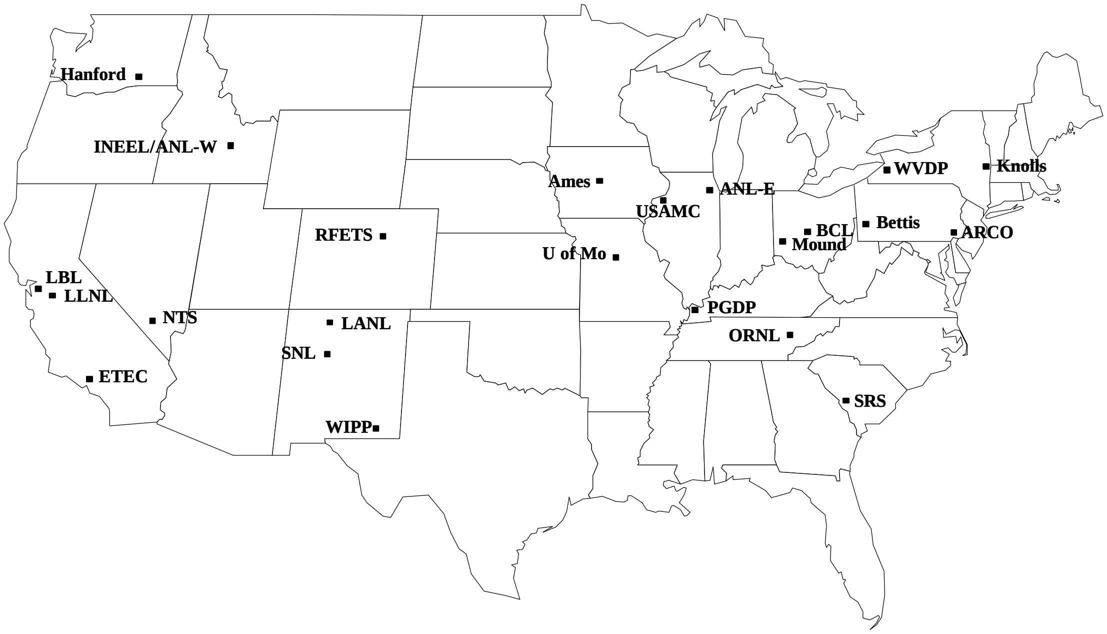

Figure 1-1
Approximate Location of SEIS-II TRU Waste [a]

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

Since SEIS-I, DOE has published three environmental assessments (EA) and two supplement analyses related to WIPP. These documents are summarized in Table 1-2. The Department also published a mitigation action plan (MAP) on July 10, 1991 (DOE 1991) for actions to prevent or reduce the environmental impacts associated with DOE's selected alternative. DOE issues an annual report on the progress made in implementing the MAP and the effectiveness of any mitigation and will continue to do so until the mitigation activity is complete. The report is issued annually on the anniversary date of the MAP. DOE has issued the WIPP Annual Mitigation Reports each year since the MAP was published (DOE 1992, 1993, 1994, 1995c, 1996f, and 1997d).

Table 1-2
WIPP NEPA Documents Since SEIS-I

Document Title	Document Description
Environmental Assessment for the Proposed Actinide Source-Term Test Program at Los Alamos National Laboratory (1995*)* (DOE/EA-0977*)*	This EA examined the site-specific environmental impacts of conducting tests at Los Alamos National Laboratory as part of the WIPP experimental program. A finding of no significant impact (FONSI) was issued on January 23, 1995.
Environmental Assessment for the Construction and Operation of the Carlsbad Environmental Monitoring and Research Center (1995) (DOE/EA-1801)	This EA examined the impacts of construction by New Mexico State University and continued Department funding of the operations of the Carlsbad Environmental Monitoring and Research Center. The center independently monitors environmental impacts for ongoing and future WIPP operations as part of its aim to improve environmental monitoring techniques. A FONSI was issued on October 10, 1995.
Environmental Assessment for the Construction and Operation of the Sand Dunes to Ochoa Powerline Project (1995*)* (DOE/EA-1109)	This EA examined the impacts of constructing a second powerline to supply electricity to WIPP. The Department adopted the Bureau of Land Management's EA and FONSI on May 19, 1995.
Supplement Analysis of Proposed Waste Characterization and Packaging Activities at the Idaho National Engineering Laboratory for the WIPP Test Program (1991) (DOE/EIS-0026-FS/SA1)	This supplement analysis described the environmental impacts of conducting some of the WIPP waste characterization activities at two locations at Idaho National Engineering and Environmental Laboratory, rather than at one location as described in SEIS-I. The activities analyzed included (1) certification and storage of CH-TRU waste at the existing Radioactive Waste Management Complex, (2) characterization and repackaging of these wastes into bins or 55-gallon drums at the existing Hot Fuel Examination Facility, and (3) transportation of wastes along the 26-mile route between the two facilities. The Department determined that these activities did not involve any substantial changes to the SEIS-I Proposed Action or notable new circumstances or information bearing on the environmental impacts, and no further NEPA documentation was required.
Supplement Analysis of Proposed Transportation Routes to the Waste Isolation Pilot Plant and Discovery of Deviated Gas Well at WIPP (1991) (DOE/EIS-0026-FS/SA2)	This supplement analysis described the selection of some TRU waste transportation routes and the discovery of a deviated gas well at WIPP. The analysis also described a directionally drilled or deviated gas well on Section 31 that was drilled in 1982. The Department determined that these activities did not involve substantial changes to the SEIS-I Proposed Action or notable new circumstances or information bearing on the environmental impacts. Therefore, DOE decided that no additional NEPA documentation was required.

1.4 NEED FOR A SECOND SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

In addition to the Department's 1990 ROD commitment to prepare SEIS-II, regulatory and statutory changes and changes in the TRU waste inventory and waste acceptance criteria have occurred since the SEIS-I was issued. Also, new hydrologic and geologic information is available that may affect the performance assessment of WIPP and its ability to isolate waste. SEIS-II, therefore, takes into account all of the changed circumstances since 1990 that might affect the potential environmental impacts from the WIPP disposal and closure phases. Some of these changes are presented below.

- *Identification of Additional TRU Waste Generator Sites*. SEIS-I identified 10 principal generator-storage sites which have over 99 percent of the TRU waste volume that would be sent to WIPP. In the WM PEIS, the Department identified 10 additional sites that generate and store small amounts of TRU waste that may be disposed of at WIPP. Recent waste volume surveys have identified two other sites that store small quantities of TRU waste that were not identified in the WM PEIS.

- *Changes in TRU Waste Volumes and Waste Forms*. Estimates of the volumes of TRU waste and the final waste forms have changed since 1990. The volume changes are due to the reduction of activities associated with the production of nuclear weapons in the United States and better estimates of waste volumes obtained from the generator-storage sites. The changes in expected final waste forms reflect plans of certain generator-storage sites to treat their TRU waste in a manner that would alter its current form.

- *Changes in Compliance Status of Previously Disposed of TRU Waste*. Until about 1970, DOE disposed of TRU waste in shallow trenches. SEIS-I did not consider this waste in its analyses. Since SEIS-I, it has become evident that compliance with RCRA or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) may require excavation of a portion of this previously disposed of TRU waste. If excavated, this waste would be considered newly generated. In SEIS-II, an estimate of the previously disposed of inventory is included and analyzed as part of the action alternatives.

- *Passage of the LWA*. The LWA, which transferred the WIPP site from the U.S. Department of the Interior to DOE, included provisions that might affect the environmental impacts of some WIPP disposal alternatives. As an example, one section of the Act allows no more than 175,600 cubic meters (6.2 million cubic feet) of total TRU waste volume and 5.1 million curies of RH-TRU waste to be disposed of at WIPP. Other parts of the Act require studies of rail and truck transportation, RH-TRU waste, and waste processing and volume reduction technologies. In 1996, Congress passed the National Defense Authorization Act for Fiscal Year 1997 (Public Law 104-201), which amended the LWA. Among other things, Public Law 104-201 provides the RCRA land disposal restrictions do not apply to WIPP.

- *Acquisition of New Data from the Experimental Program*. Since 1990, the Department has continued the experimental program and has acquired additional information about the WIPP site, TRU waste, and the potential interactions that may occur between the two. The results of this continuing program include new data that may more clearly define environmental impacts from WIPP. For example, there are reduced uncertainties about the rate and magnitude of gas generation from TRU waste, which bears on the long-term ability of the repository to isolate waste from the environment.

- *Carlsbad Area Office/Waste Isolation Pilot Plant Waste Minimization and Pollution Prevention Awareness Program Plan* (DOE 1995b). In 1995, DOE published this plan, which calls for a 10 percent reduction in the amount of sanitary waste generated by using source reduction techniques and a further 15 percent reduction by implementing improved recycling activities, a 30 percent reduction in the amount of RCRA-regulated waste, and the conduct of pollution prevention assessments to identify opportunities for further improvements.

- *Publication of the WM PEIS (May 1997).* The Department has prepared a nationwide study examining the environmental impacts of managing five types of DOE radioactive and hazardous waste, including TRU waste. This study provides information on the potential impacts of various siting alternatives, which DOE will use in deciding where to locate treatment, storage, and/or, depending on the type of waste, disposal facilities. For TRU waste, the Department would identify DOE sites for treatment and storage facilities but not the type of treatment to be performed. The WM PEIS presents new information on TRU waste management. There are some differences in the waste inventories and generator-storage sites discussed in the WM PEIS and in SEIS-II. The differences are due in part to the different time periods analyzed in the WM PEIS and SEIS-II. The differences, and the reasons for them, are explained in Appendix B.

- *Changes to the Planning-Basis Waste Acceptance Criteria (WAC).* The Department has revised the allowable activity for CH-TRU waste that could be placed in WIPP. The maximum plutonium-239 equivalent activity (PE-Ci) for untreated CH-TRU waste is 80 PE-Ci for a drum and 130 PE-Ci for a standard waste box. If overpacked in standard waste boxes or ten-drum overpacks, untreated CH-TRU waste in 55-gallon drums may contain up to 1,800 PE-Ci of activity. Drums containing solidified or vitrified CH-TRU waste, though, may contain up to 1,800 PE-Ci of activity per drum without overpacking (DOE 1996c).

- *Changes to the Transportation Routes.* Changes have been made to the planned transportation routes presented in SEIS-I.

- *Changes to the TRUPACT-II Certificate of Compliance (NRC 1989).* NRC has modified the Certificate of Compliance (No. 9218, Revision No. 6). These changes included the addition of tritium-contaminated waste as authorized contents and the revision of generic quality assurance activities. These changes do not affect the ability of the package to meet the requirements of Title 10, Code of Federal Regulations (CFR), Part 71.

- *Changes in the Status of Relevant Regulations.* In 1993, EPA issued the Environmental Standards for Management and Disposal of TRU Waste codified in 40 CFR Part 191 and in 1996 issued criteria to certify and determine WIPP's compliance with these standards to be codified in 40 CFR Part 194 (61 FR 5224, February 9, 1996).

1.5 THE RELATIONSHIP OF SEIS-II TO OTHER DOE PLANNING DOCUMENTS

The NEPA process is a part of DOE's planning process. Council on Environmental Quality (CEQ) regulations encourage integrating environmental impact statements (EIS) "with other planning at the earliest possible time to insure that planning and decisions reflect environmental values" (40 CFR Part 1501.2). SEIS-II has been timed to take advantage of information presented in prior documents and to inform current and future planning efforts. The relationship among major planning and compliance documents and SEIS-II is as follows:

- *Compliance Certification Application (DOE 1996i):* This document, prepared in accordance with 40 CFR Part 194 and submitted to the EPA in October 1996 and accepted by the EPA in May 1997, is required by the LWA to demonstrate compliance with standards for disposal of TRU waste (40 CFR 191, Subparts B and C). Conceptual models and computer codes used for performance assessment calculations in the Compliance

Certification Application (CCA) were used in SEIS-II to assess the long-term ability of WIPP to isolate radioactive waste from the accessible environment.

- *Resource Conservation and Recovery Act Part B Permit Application (DOE 1996a):* This document, submitted April 1996, is the application to operate WIPP as a disposal facility, as defined under RCRA regulations (40 CFR Part 264). The application has been submitted to the New Mexico Environment Department, the state agency responsible for issuing the permit. (The New Mexico Hazardous Waste Act and its implementing regulations are the state analog to RCRA.). The application provides background information regarding the DOE proposals for operating WIPP and is, therefore, one of the foundations on which assumptions in SEIS-II concerning WIPP operations are based.

- *Final No-Migration Variance Petition (DOE 1996d):* This document, submitted to the EPA and published on June 14, 1996, is a petition to receive a variance from the RCRA LDRs on the basis that the migration of hazardous constituents would not exceed health-based levels at the disposal unit boundary. However, such a variance is no longer required pursuant to the National Defense Authorization Act for Fiscal Year 1997, Public Law No. 104-201. The document also provides background information on the long-term ability of WIPP to isolate hazardous waste and has been summarized and incorporated by referenced throughout SEIS-II.

- *Waste Isolation Pilot Plant Safely Analysis Report (SAR), Revision 0 (DOE 1995i):* The intent of this document, published in November 1995, is to examine the hazards associated with the disposal of CH-TRU and RH-TRU waste and to identify where mitigation is needed. The SAR provides accident analyses of CH-TRU and RH-TRU waste. These analyses have been incorporated into SEIS-II where appropriate.

- *Waste Isolation Pilot Plant Safety Analysis Report (SAR), Revision 1, (DOE 1997a):* As with Revision 0, the intent of this document, published in March 1997, is to examine the hazards associated with the disposal of CH-TRU waste and to identify where mitigation is needed. The SAR provides accident analyses of CH-TRU waste (similar analyses for RH-TRU waste are not included). These analyses have been incorporated into SEIS-II, where appropriate.

- *Transuranic Waste Baseline Inventory Report, Revision 2 (BIR-2) (DOE 1995j):* This report, published in December 1995, provides the waste volumes, hazardous constituent inventories, and most of the radionuclide data used by DOE in its regulatory compliance applications. BIR-2 (as well as BIR-3, below) is used as the basis for the SEIS-II waste volumes. SEIS-II supplements the radionuclide inventory with inventory data from the Integrated Data Base (IDB) (DOE 1995e).

- *Transuranic Waste Baseline Inventory Report, Revision 3 (BIR-3) (DOE 1996e):* This report, which DOE used for the WIPP CCA, includes information pertaining to waste that is currently eligible for disposal at WIPP under existing laws. BIR-3 waste volumes and hazardous constituent inventories are unchanged from BIR-2. The radionuclide inventories at some sites are changed. Also, information on complexing agents, nitrates, sulfates, phosphates, and cement was added because these components could potentially affect WIPP's ability to contain TRU waste. The information on complexing agents, nitrates, sulfates, phosphates, and cement was incorporated into the parameters used in the SEIS-II analysis of long-term performance. The adjusted volumes used for SEIS-II analyses are based upon BIR-3 inventories.

- *Remote-Handled Transuranic System Assessment (DOE 1995h):* This report, published in November 1995, discusses the disposal of DOE RH-TRU waste. The report discusses packaging RH-TRU waste at treatment sites in such a way that it could be handled as CH-TRU waste. This would entail placing the RH-TRU waste in shielded payload containers to limit the radiation dose at the outer container surface to not more than 200 mrem/hr. This waste could then be handled and emplaced as CH-TRU waste. All other CH-TRU waste requirements would apply as well. This study also considered several options for RH-TRU waste emplacement, such as putting the waste in repository walls, in vertical boreholes in the floors of the repository, or in trenches mined in the repository floor. These considerations were used to determine the number of repository panels needed under the Proposed Action and the action alternatives in SEIS-II.

- *Remote-Handled Transuranic Waste Study (DOE 1995f):* This study was conducted, as required by the LWA, to evaluate the impacts of RH-TRU waste on the performance assessment of the repository and to determine the effects of RH-TRU waste as a part of the WIPP Total Inventory. Also, this study conducted a comparison of CH-TRU and RH-TRU waste to assess differences and similarities for gas generation, flammability and explosiveness, solubility, and brine and geotechnical interactions. The conclusions and findings of this study were considered when addressing TRU waste handling and performance assessment concerns in SEIS-II.

- *The National Transuranic Waste Management Plan (DOE 1996h):* This plan, published in September 1996, presents a TRU waste management system for the DOE Complex. The system maintains compliance with all binding consent orders, unilateral orders, and regulatory agreements concerning TRU waste and creates a management system in support of the DOE Office of Environmental Management's *Accelerating Cleanup: Focus on 2006* (DOE 1997c). (New TRU waste volume estimates presented in this plan are discussed in Appendix J and Section 5.13.)

Based on these documents, DOE believes it has sufficient information to meaningfully evaluate the environmental impacts of the proposal to dispose of TRU waste at WIPP and of the alternatives to that proposal.

In addition, several DOE NEPA documents that are related to SEIS-II either have been completed since SEIS-I, are being prepared, or have been proposed. As discussed below, DOE is preparing project-level, site-wide, and programmatic NEPA documents that address TRU waste management facilities or potential TRU waste generating activities throughout the DOE complex. These parallel efforts are being undertaken to expedite compliance with site-specific consent orders and settlements and to meet DOE's responsibilities under NEPA. The decisions that may result from these NEPA reviews may change the amount of TRU waste at DOE facilities. The amount of waste used for SEIS-II quantitative analyses does not reflect these possible decisions. The potential volume changes, though, are expected to be small relative to the total amount of waste considered for the SEIS-II calculations.

Final Waste Management Programmatic Environmental Impact Statement (Published in 1997, [DOE 1997b])

The relationship between SEIS-II and the WM PEIS (DOE 1997b) is set forth in Appendix B of this document. SEIS-II uses the WM PEIS to support its analyses in two principal ways. First, it uses the WM PEIS results as a baseline, updates that information, and adjusts the impacts according to differences in the concentration of radionuclides and differences in waste volume from the addition of buried waste. Second, SEIS-II alternatives use the locations of proposed treatment facilities presented in the WM PEIS (DOE 1997b).

The WM PEIS preferred alternative assumes that TRU waste would be treated to planning-basis WAC at the facilities where it is currently stored or would be generated, except that waste at the Pantex Plant and Sandia National Laboratories (SNL) would be shipped to Los Alamos National Laboratory (LANL) for treatment, Rocky Flats Environmental Technology Site (RFETS) would send a portion of its TRU waste to INEEL for treatment, Savannah River Site (SRS) would send its RH-TRU waste to Oak Ridge Reservation for treatment, and the Oak Ridge Reservation would send its CH-TRU waste to SRS for treatment.

Although SEIS-II incorporates by reference and, where appropriate, updates and adjusts information from the WM PEIS, the potential actions analyzed in SEIS-II are not connected to the potential actions analyzed in the WM PEIS. To further explain, the WM PEIS evaluates alternative configurations for managing (treating, storing, or disposing of) five types of waste, including TRU waste, that are at DOE sites or are otherwise under DOE’s control or responsibility. The alternative configurations range from managing the wastes where they are currently located to transporting them to one centralized site for management. The WM PEIS evaluates trends in various impacts as alternative configurations become more or less centralized. The WM PEIS postulates three generic types of treatment for TRU waste, in order to analyze the impacts of treating and storing TRU waste under the various alternative configurations (although the WM PEIS does not address TRU waste disposal, recognizing that a disposal decision would be made on the basis of the WIPP SEIS-II). These generic treatments allow DOE, in the WM PEIS, to compare the relative impacts of centralized, regionalized, and decentralized treatment and storage. To reduce the potential impacts of storing untreated wastes, DOE must decide, pursuant to the WM PEIS, the most cost-effective and environmentally preferable configuration to treat and store TRU waste, regardless of whether the Department decides to dispose of this waste at WIPP.

In addition to TRU waste, the WM PEIS analyzes four other types of waste: high-level waste, low-level waste, low-level mixed waste, and hazardous waste. These wastes would not be disposed of at WIPP, and management of these wastes is unrelated to, and outside the scope and purpose of, SEIS-II.

SEIS-II, in contrast, is the third in a series of staged NEPA reviews that focuses on WIPP disposal of TRU waste. SEIS-II analyzes impacts and alternatives for disposal at WIPP, transportation to WIPP, and associated activities not addressed in, and not within the scope of, the WM PEIS. SEIS-II involves additional and different workers, time frames, transportation modes, alternatives, and affected environments. Decisions associated with whether to dispose of TRU waste at WIPP can and should be made regardless of any decisions made pursuant to the WM PEIS. Furthermore, decisions for TRU waste disposal are far removed from decisions on management of the other types of waste analyzed in the WM PEIS. Decisions concerning WIPP pursuant to SEIS-II will not automatically trigger or prejudice decisions for high-level waste, low-level waste, hazardous waste, and low-level mixed waste that may be made pursuant to the WM PEIS. As such, SEIS-II and the WM PEIS have different purposes, meet different needs, and are independently justified.[1]

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement (Published in 1996, DOE/EIS-0229)

This programmatic environmental impact statement (PEIS) (DOE 1996j) analyzes alternatives for the storage and disposition of weapons-usable fissile materials that originate in the United States. Weapons-usable fissile materials are those that could be used to make nuclear weapons and include various isotopes of plutonium (except plutonium-238, which is used as an energy source for space missions) and uranium highly enriched in uranium-235. Specifically, this PEIS analyzes alternatives for the storage of surplus weapons-usable plutonium and highly enriched uranium until any disposition, the storage of nonsurplus weapons-usable plutonium and highly enriched uranium, and the disposition of surplus plutonium. Storage alternatives for plutonium and uranium include using current storage facilities (no action alternative), upgrading current facilities, consolidating plutonium storage at a new facility, and co-locating plutonium and highly enriched uranium storage at a new facility. Disposition alternatives for plutonium include several alternatives in the following categories: emplacement in a deep borehole; immobilization in glass, ceramic, or metal; and fabrication into mixed oxide fuel with subsequent burning in nuclear reactors. The Department issued its ROD on this PEIS on January 21, 1997. The Department decided to pursue a dual strategy for disposing of excess plutonium that would immobilize some (and potentially all) of the inventory in a glass or ceramic material, and allows the burning of some of the surplus plutonium as mixed oxide fuel in existing reactors, depending upon subsequent decisions. The Department is preparing a *Surplus Plutonium Disposition Environmental Impact Statement* (Notice of Intent, May 22, 1997, 62 FR 28009**)**. The disposition of surplus weapons-usable plutonium (a fissile material) could produce approximately 4,500 cubic meters (158,000 cubic feet) to 7,000 cubic meters (245,000 cubic feet) of TRU waste for disposal at WIPP. (The additional TRU waste is discussed in the Cumulative Impacts section of Chapter 5.)

Los Alamos National Laboratory Site-Wide Environmental Impact Statement (Draft in Preparation)

DOE is preparing a site-wide EIS for LANL that will include an analysis of existing and planned waste management activities, including those for TRU waste, for the next 5 to 10 years (DOE 1995g). The potential environmental consequences that would result from the implementation of existing and anticipated activities, possible mitigation measures, site-specific strategies for TRU waste management, and projects reasonably expected during this period will be addressed.

Final Environmental Impact Statement for the Nevada Test Site and Off-site Locations in the State of Nevada (Published in 1996, DOE/EIS-0243-F)

A site-wide EIS was prepared to help define the future mission of the Nevada Test Site (DOE 1996g). This site-wide EIS evaluated resource management alternatives that would support current and future defense related missions, research and development, waste management,

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[1] DOE believes that the analyses presented in the WM PEIS and SEIS-II are more understandable and useful for decision making and for informing the public than they would be if combined in a single, less focused document.

environmental restoration, infrastructure maintenance, and facility upgrades and alternative uses over the next 5 to 10 years. The Department issued its ROD on this PEIS on December 13, 1996.

With respect to TRU and TRU mixed waste, the Department decided to continue onsite storage pending the development of DOE disposal decisions. The Department also decided to construct a facility for characterizing and certifying TRU waste for offsite disposal**.**

Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site Environmental Impact Statement (Draft in Preparation)

DOE is preparing an EIS (Notice of Intent, 61 FR 58866, November 19, 1996) to decide how and where certain non-weapons-usable plutonium residues and scrub alloy, currently located at the RFETS, would be managed. DOE previously analyzed the stabilization of the approximately 106,000 kilograms (233,690 pounds) of plutonium residues at the RFETS for safe interim storage in the *Solid Residue Treatment, Repackaging, and Storage Environmental Assessment* (DOE 1996b). This EIS will analyze treatment alternatives for approximately 42,000 kilograms (92,594 pounds) of the plutonium residues and all of the scrub alloy in storage at the RFETS.

Site-Wide Environmental Impact Statement for the Rocky Flats Environmental Technology Site (Preparation Suspended)

DOE has issued a Notice of Intent (59 FR 4001, August 5, 1994) to prepare a site-wide EIS for the RFETS. The Notice described the intended scope of the site-wide EIS as providing a basis for selection of a site-wide strategic approach for nuclear materials storage, waste management, cleanup, and economic conversion, as well as project-level decisions for land use, management of nuclear materials, deactivation of RFETS facilities, decontamination and decommissioning of existing facilities, and possible on-site and off-site transportation of radioactive, hazardous, and mixed waste. The scope of the site-wide EIS has been modified so that issues associated with the safe interim storage of plutonium at RFETS will be analyzed in the Plutonium Interim Storage EIS (Notice of Intent, 61 FR 37247, July 17, 1996), and completion of the site-wide EIS has been suspended.

Savannah River Site Waste Management Final Environmental Impact Statement (Published in 1995, DOE/EIS-0217)

DOE issued the *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE 1995d) that evaluates the construction and operation of low-level mixed waste and TRU mixed waste facilities identified in the *Savannah River Site Treatment Plan* developed under the Federal Facility Compliance Act (FFCAct) and the effects of minimizing, treating, storing, and disposing of liquid high-level radioactive, low-level radioactive, hazardous, mixed (radioactive and hazardous), and TRU waste. The EIS is intended to support decisions on the operation of specific treatment, storage, and disposal facilities over the next 10 years and to provide a baseline for analyses of future waste management activities. A ROD (60 FR 55249 [1995]) was issued October 30, 1995, announcing DOE’s intention to implement the moderate treatment configuration alternative for storing, and treating transuranic waste, among others. The ROD also indicated that DOE will issue additional RODs pertaining to the treatment of mixed low-level radioactive and TRU mixed waste following negotiations with the State of South Carolina under the Federal Facility Compliance Act.

Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement (Published in 1995, DOE/EIS-0203-F)

Based upon this programmatic and site-wide EIS (DOE 1995a), DOE issued an ROD on June 1, 1995 (60 FR 28680), which when implemented might result in the acceptance of off-site TRU waste from other DOE sites for treatment (pending negotiations under the FFCAct and decisions to be made based on the WM PEIS). DOE issued an amendment to the ROD on March 8, 1996 (61 FR 9441) incorporating the terms of the settlement agreement and court order in *Public Service Co. v. Batt*. The settlement agreement/court order requires shipment of INEEL TRU waste to WIPP or other such facility by a target date of December 31, 2018.

1.6 CONTENT OF SEIS-II

This SEIS-II is composed of six chapters and twelve appendices, as follows:

- *Chapter 1*, *Introduction:* This chapter defines the purpose and need for agency action. It also presents an overview of the WIPP project, a summary of its NEPA compliance history, and discussions of other DOE NEPA efforts and planning documents.

- *Chapter 2*, *Background Information:* This chapter provides an overview of DOE's TRU waste management throughout its facilities, includes details on the WIPP project and facility, presents a discussion of the TRU waste inventories, and summarizes relevant stakeholder outreach and involvement activities.

- *Chapter 3*, *Description of the Proposed Action and Alternatives:* This chapter is a description of the Proposed Action (Preferred Alternative) and each of the alternatives. The Proposed Action is to proceed with the phased development of WIPP by disposing of retrievably stored and future-generated defense TRU waste after treatment to the planning-basis WAC, up to the limits of the LWA and the DOE—New Mexico Agreement for Consultation and Cooperation. There are three alternatives to the Proposed Action, each involving different TRU waste treatment options and different waste volumes. There are two no action alternatives, one in which TRU waste would remain at various DOE sites in compliance with applicable regulations and another in which TRU waste would be stored at consolidation sites. WIPP would not open if either no action alternative is selected.

- *Chapter 4*, *Description of the Affected Environments:* This chapter summarizes and updates the description of the affected environment contained in the FEIS and SEIS-I and discusses new information regarding the hydrogeology at the WIPP site. It also summarizes the affected environment at the 10 major generator-storage sites.

- *Chapter 5*, *Environmental Impacts:* This chapter presents analyses of postulated radionuclide and hazardous chemical releases and exposures for the Proposed Action and action alternatives, the impacts that would result both from routine transportation and operations and from transportation and operational accidents, and the potential impacts of closing WIPP under the no action alternatives and from long-term repository performance after closure under the Proposed Action and the action alternatives. This chapter also includes discussions of environmental justice, the potential impacts of waste retrieval and recovery, cumulative impacts, and mitigation measures. Additional discussions include unavoidable adverse impacts, i.e., those that may remain following mitigation; short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and irreversible or irretrievable commitment of resources that would result from implementation of the Proposed Action.

- *Chapter 6, Consultations and Permits:* This chapter discusses the agencies and persons consulted and provides the status of compliance with key regulatory requirements.
- *Appendix A, Waste Inventory:* This appendix provides information on the characteristics and quantities of DOE TRU waste.
- *Appendix B, Summary of the Waste Management Programmatic Environmental Impact Statement and Its Use in Determining Human Health Impacts:* This appendix provides an overview of that information in the WM PEIS that is relevant to SEIS-II.
- *Appendix C, Air Quality:* This appendix describes the methods used for analyzing potential impacts to air quality at WIPP for routine emissions of nonradiological air pollutants during normal operations.
- *Appendix D, Life-Cycle Costs and Economic Impacts:* This appendix discusses the technical approach and sources of information used to estimate the life-cycle costs and economic impacts of the SEIS-II alternatives.
- *Appendix E, Transportation:* This appendix forms the basis for transportation impact analysis results and discusses plans for transporting TRU waste.
- *Appendix F, Human Health:* This appendix describes the methods used to estimate human health impacts that result from radioactive material and hazardous chemical exposures and intakes.
- *Appendix G, Facility Accidents:* This appendix describes the methods used to estimate the impacts of facility accidents, both at WIPP and at treatment, consolidation, and storage facilities.
- *Appendix H, Long-Term Consequence Analysis for Proposed Action and Action Alternatives:* This appendix describes the analytical methods, codes, and exposure calculations used to determine the impacts from postulated long-term release scenarios.
- *Appendix I, Long-Term Consequence Analysis for No Action Alternative 2:* This appendix describes the analytical methods, codes, and exposure calculations used to determine the impacts from postulated long-term release scenarios.
- *Appendix J, Changes in the Department of Energy's Transuranic Waste Management Program*: This appendix describes other DOE TRU waste inventories and waste management practices.
- *Appendix K, List of Preparers and Contributors:* This appendix provides the names and credentials of those persons involved in the preparation of SEIS-II.

- *Appendix L*, *Distribution List:* This appendix contains a list of the individuals that received a copy of either the full Draft SEIS-II document and/or the Summary.

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CHAPTER 2
BACKGROUND INFORMATION

This chapter provides an overview of the management of transuranic (TRU) waste throughout U.S. Department of Energy (DOE or the Department) facilities, presents details on the Waste Isolation Pilot Plant (WIPP) and its history, and concludes with a summary of stakeholder outreach and involvement activities relevant to the preparation of this second supplemental environmental impact statement (SEIS-II).

2.1 OVERVIEW OF TRU WASTE IN THE DOE COMPLEX

During the past 50 years, DOE and its predecessor agencies have been responsible for atomic energy and nuclear weapons research and production. The nuclear weapons complex has consisted of major facilities, including those at large reservations in the states of Nevada, Idaho, Washington, and South Carolina. In New Mexico and California, national laboratories have designed weapons, most of which were assembled in Texas, from components fabricated in Colorado, Florida, Missouri, Ohio, Tennessee, and Washington (DOE 1997).

TRU waste results from defense activities and programs of the U.S. government. Several types of operations (current, past, or future) have generated or will generate TRU waste: (1) nuclear weapons development and manufacturing; (2) plutonium recovery, stabilization, and management; (3) research and development; (4) environmental restoration, and decontamination and decommissioning; (5) waste management at various DOE and other government facilities and laboratories; and (6) testing at private institutions and universities under contract to DOE. TRU waste also results from commercial activities subject to regulation by the U.S. Nuclear Regulatory Commission (NRC) and from DOE-sponsored activities that are not considered to be defense activities or programs.

KEY DEFINITIONS

Defense TRU Waste: TRU waste that results from defense activities. Since 1970, this waste has been placed in retrievable storage. It continues to be generated from environmental restoration, decontamination and decommissioning activities, waste management programs, and testing and research.

Nondefense TRU Waste: TRU waste that currently is restricted from disposal in WIPP by the WIPP Land Withdrawal Act (LWA) because it does not result from defense activities.

Commercial TRU Waste: TRU waste produced by commercial facilities licensed by the U.S. Nuclear Regulatory Commission (NRC) and restricted from disposal in WIPP because it does not result from defense activities. DOE is managing some of this waste at the direction of Congress.

Polychlorinated Biphenyl (PCB)-Commingled TRU Waste: TRU waste that contains 50 parts per million or greater of PCBs and is subject to regulation under the Toxic Substances Control Act (TSCA). This waste is currently restricted from disposal in WIPP unless treated in compliance with the TSCA or unless WIPP receives a permit to dispose of TRU waste under the TSCA.

Previously Disposed of Waste: TRU waste that, prior to 1970, was disposed of in shallow burial pits, and that, if excavated, would be considered newly generated waste, potentially eligible for disposal in WIPP.

WASTE ACCEPTANCE CRITERIA (WAC)

The WAC was first developed in 1989 and revised several times, most recently in 1996. These criteria govern the form, packaging, and transport of TRU waste to be disposed of at WIPP, should WIPP disposal be approved. These criteria also address WIPP operations and safety requirements, transportation requirements, waste package requirements, Resource Conservation and Recovery Act (RCRA) requirements, and performance assessment requirements. Overall, they consolidate the minimum requirements of all laws, regulations, and DOE internal requirements that apply to TRU waste transportation and disposal and establish specific minimum waste characteristics which TRU waste must meet before it can be accepted and emplaced at WIPP.

The WAC establish the conditions that govern the physical, radiological, and chemical composition for TRU waste, setting weight, thermal, and radiological limits. Weight limits are established for TRUPACT-II containers, contact-handled (CH) TRU waste drums, and shipments so that shipments will not exceed highway weight limits. Thermal power limits, which define the amount of heat that may be produced by radioactive decay, are established for waste containers to limit the concentration of flammable gas which may be generated within the container. Radiological criteria include the maximum plutonium-239 equivalent activity (PE-Ci) for containers and for stored TRU waste to avoid the potential for nuclear criticality.

For the purposes of SEIS-II analyses, all waste would be packaged at a minimum to the current planning-basis WAC. In addition, the alternatives examine more extensive treatment by a shred and grout or thermal process. Even if treated by a shred and grout or thermal process, though, all waste must necessarily also meet the minimum criteria embodied in the WAC to be disposed of at WIPP. Also, to be transported for consolidation or treatment, TRU waste must meet minimum WAC requirements, which include transportation requirements.

The version of the WAC used for the SEIS-II analyses was Revision 5 (DOE 1996b), the most current planning-basis WAC. As laws and regulation change, and should new waste criteria be developed as a result of SEIS-II, the WAC will be revised to reflect the new requirements.

2.1.1 Introduction

For the purposes of SEIS-II, TRU waste is broadly categorized to include (1) defense waste of the type that was subject to previous WIPP-related National Environmental Policy Act (NEPA) reviews and (2) other defense and nondefense waste for which DOE retains management responsibility. The *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) (DOE 1980) and *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) (DOE 1990) examined the impacts of transporting and disposing of waste that resulted from defense activities and that was placed in retrievable storage pursuant to a 1970 Atomic Energy Commission policy (see Section 1.2) and TRU waste that was reasonably expected to be generated by these ongoing activities and programs. For the purposes of SEIS-II, this defense TRU waste inventory is hereafter referred to as the “Basic Inventory.”

Other defense and nondefense TRU waste not previously included in the waste inventory by the FEIS or SEIS-I include (1) nondefense and commercial TRU waste (comprising 0.2 percent of the total TRU waste volume), (2) defense TRU waste commingled with PCBs, (3) and defense (and perhaps some nondefense) TRU waste disposed of prior to the Atomic Energy Commission policy of 1970. This TRU waste inventory is hereafter referred to as the “Additional Inventory.”

In addition, SEIS-II refers to the "Total Inventory," which is the sum of the Basic and Additional Inventories.

Previously disposed of TRU waste excavated in compliance with RCRA, the Comprehensive Environmental Response, Compensation, and Liability Act, or as a result of DOE's own cleanup initiatives would be considered newly generated waste and as such could become potentially eligible for WIPP disposal.

2.1.2 TRU Waste

TRU waste contains transuranic radionuclides and may also contain other radionuclides. Most TRU radionuclides decay through the emission of alpha radiation. However, transuranic and other radionuclides present in the waste may emit beta, gamma, X-ray, and neutron radiation as well. Alpha (helium nuclei) and beta (electron) radiation are particulate emissions that cannot penetrate the walls of TRU waste containers and present a health hazard only if the particles are inhaled or ingested. Gamma (photon), X-ray (electromagnetic), and neutron (uncharged particle) radiation can penetrate the walls of waste containers and may present an external dose hazard to individuals near the containers. Gamma and X-ray radiation can be shielded to reduce the radiation dose to workers using high density materials such as lead or steel; neutrons must be shielded using materials with high hydrogen content such as water, plastic, or paraffin. Radionuclides americium-241, an X-ray emitter, barium-137m, a gamma-emitter that is a decay product of cesium-137, and cobalt-60, another gamma-emitter, are the main contributors to external dose from TRU waste that would be disposed of at WIPP under the Proposed Action and the action alternatives.

TRU waste is categorized as either CH-TRU or remote-handled (RH) TRU based on the external dose rates at the surface of the waste container. TRU waste is considered CH-TRU waste if the external dose rate at the outer surface of the waste container is 200 millirem per hour or less. TRU

TRU WASTE TRANSPORTATION PACKAGING

The Department plans to use two packagings to transport TRU waste; a third is under consideration.

***TRUPACT-II*:** The TRUPACT-II would be used to transport CH-TRU waste. The NRC has certified these containers. To achieve NRC approval, these containers must endure fire, water immersion, and free drops without leakage. Each container has the capacity to hold fourteen 55-gallon drums, two standard (0.9-meter x 1.4-meter x 1.8-meter [3.1-foot x 4.5-foot x 5.9-foot]) waste boxes, or a 10-drum overpack which fits one standard waste box or ten 55-gallon drums. Each TRUPACT-II has an allowable capacity of 2,835 kilograms (6,250 pounds). Up to three TRUPACT-IIs can be transported on a specially designed trailer, and up to six containers can be carried on a specially adapted rail car.

RH-72B: The RH-72B cask would be used to transport RH-TRU waste. The Department is currently awaiting NRC certification of the RH-72B cask. This package is designed to shield personnel and the environment from penetrating radiation that is produced by RH-TRU waste. The canister within each cask can hold up to 3,630 kilograms (8,000 pounds). One RH-72B cask can be carried on a specially designed trailer, and up to three casks can be carried on a specially adapted rail car.

HALFPACK: The HALFPACK is being developed by the Department and is a shorter, lighter version of the TRUPACT-II. It would allow the shipment of waste containers too heavy to be shipped efficiently in a TRUPACT-II because of U.S. Department of Transportation weight limitation requirements. The HALFPACK would hold half the volume of waste as the TRUPACT-II.

waste with an external dose rate greater than 200 millirem per hour is considered RH-TRU waste; however, RH-TRU waste with an external dose rate greater than 1,000 rem per hour (1,000,000 millirem per hour) at the outer surface of the container cannot be disposed of at WIPP because it is prohibited by the LWA.

DOE has developed a coding system, comprised of waste matrix code groups, to organize waste streams by their physical and chemical properties. Eleven waste matrix code groups for waste having similar physical and chemical properties have been used to categorize CH-TRU waste and RH-TRU waste (DOE 1996c). These code groups are listed in Table 2-1.

TRU mixed waste is defined as any TRU waste that is commingled with a hazardous waste regulated by RCRA, as defined in Title 40, Code of Federal Regulations (CFR) 261, Subparts C and D. TRU waste containing hazardous chemical constituents has physical and radiological characteristics similar to TRU waste that does not contain these constituents. The majority of TRU mixed waste contains relatively small quantities of spent halogenated solvents, which were used in

Table 2-1
Final TRU Waste Form Code Groups and Definitions

Final TRU Waste Form Code Group	Definition
Combustible	Debris that is approximately 95 percent or more, by volume, combustible materials. Examples of combustible debris are materials constructed of plastic, rubber, wood, paper, and cloth.
Filter	Debris that is approximately 50 percent or more, by volume, High Efficiency Particulate Air (HEPA) filters or additional filters constructed of more than one material type (e.g., metal, inorganic nonmetal, and combustibles).
Graphite	Debris that is approximately 95 percent or more, by volume, graphite-based solid materials. Graphite debris includes crucibles, graphite components, and pure graphite.
Heterogeneous	Debris that is at least 50 percent by volume materials that do not meet criteria for assignment into other categories. For example, waste that is a mixture of metal and combustible debris, neither of which comprises 95 percent or more of the waste by volume.
Inorganic nonmetal	Debris that is approximately 95 percent or more, by volume, inorganic nonmetal material. Examples of waste in this group include glass and ceramics.
Lead/cadmium metal	Debris that is approximately 95 percent or more, by volume, metal that contains bulk lead or cadmium as part of the matrix. Examples of this waste include glovebox parts with lead clad in stainless-steel or cadmium sheets.
Uncategorized metal	Debris that is approximately 95 percent or more, by volume, metal but either lacks sufficient information to enable characterization into one of the other categories or contains both lead and cadmium as part of the bulk matrix.
Salt	Debris that is at least 50 percent by volume salts. Stable pyrochemical salt is an example of this group.
Soil	Debris that is approximately 95 percent or more, by volume, soil. This includes sand, silt, and rock/gravel where rock/gravel volumes total less than 50 percent of the matrix.
Solidified inorganic	Debris that is at least 50 percent by volume inorganic process residues. This group includes solidified sludges and small particles.
Solidified organic	Debris that is at least 50 percent by volume organic process residues. These are defined as process residues with a base structure that is primarily organic. The matrix may contain some inorganic solids content such that approximately 20 percent by weight of the waste would remain as residue ash/solids following incineration. Examples include organic resins, organic sludges and solidified organic liquids.

cleaning and degreasing of equipment, glassware, and components. Based on sampling of gases within TRU waste drums, the most common volatile organic hazardous constituents are methylene chloride, carbon tetrachloride, and 1,1,1-trichloroethane (DOE 1996c). TRU mixed waste also contains various RCRA-regulated metals. These metals are usually associated with solid materials, such as lead shielding and chromium-based stainless steel. Lead, chromium, and cadmium are the most prevalent heavy metals in TRU mixed waste. TRU mixed waste is approximately 60 percent of the Department's TRU waste.

For the TRU waste that would be disposed of at WIPP, DOE has created the planning-basis WAC (DOE 1996b). These criteria specify all of the requirements that must be met by each waste generator-storage site before its TRU waste is shipped to WIPP and disposed of and govern the physical, radiological, and chemical composition of the waste, as well as requirements for waste packaging. Criteria have been developed for shipping, packaging, waste form, waste package, data package, and other miscellaneous criterion categories. These criteria address WIPP operations and safety, transportation, waste package requirements, RCRA requirements, and WIPP performance assessment requirements.

For example, some of the criteria under the waste package requirements include the following:

- The maximum gross weight of the TRUPACT-II with payload is 8,730 kilograms (19,250 pounds) and the maximum gross weight of the canister of the RH-72B cask is 3,630 kilograms (8,000 pounds).

- Total gross weight of a transporter including payload is 36,300 kilograms (80,000 pounds).

- The maximum plutonium-239 equivalent activity (expressed as PE-Ci) for untreated TRU waste is 80 PE-Ci for a drum or 130 PE-Ci for a standard waste box. If overpacked in standard waste boxes or 10-drum overpacks, untreated CH-TRU waste in 55-gallon drums may contain up to 1,800 PE-Ci of activity. Drums containing solidified or vitrified CH-TRU waste may contain up to 1,800 PE-Ci of activity per drum. RH-TRU waste canisters may not exceed 1,000 PE-Ci (DOE 1996b).

- Liquid waste cannot exceed 2 liters (0.5 gallons) in a CH-TRU waste drum, 8 liters (2 gallons) in a standard waste box, or 6 liters (1.5 gallons) in a RH-TRU waste canister.

- The maximum removable surface contamination on drums is 50 picocuries (pCi) per 100 square centimeters (16 square inches) for alpha-emitting radionuclides and 450 pCi per 100 square centimeters (16 square inches) for beta and gamma-emitting radionuclides.

- The maximum thermal power must be less than 40 watts for a TRUPACT-II and be less than 300 watts for a RH-TRU waste canister.

Future additions or revisions to the planning-basis WAC may be necessary; for example, additional RCRA requirements may be issued or results of the WIPP performance assessment studies may require changes. Any changes to the planning-basis WAC based on SEIS-II analyses will be identified in the Record of Decision (ROD). Section 2.2.1 and Appendix A discuss planning-basis WAC further.

2.1.3 Waste Management at the Generator-Storage Sites

The locations and volumes of the TRU waste inventory are given in Table 2-2 (for the Basic Inventory) and Table 2-3 (for the Additional Inventory).

The 1990 SEIS-I (DOE 1990) stated that WIPP may eventually dispose of post-1970 defense TRU waste from 10 sites. These sites are identified in Table 2-2. Since 1990, DOE has identified 12 additional sites that either store or are anticipated to generate TRU waste. Eight of these sites store or generate TRU waste considered to be part of the Basic Inventory (Table 2-2). TRU waste

Table 2-2
Basic Inventory TRU Waste Volumes [a, b]

	Stored (1995) (cubic meters)		**Estimated Total through 2022 [c] (cubic meters)**		**Projected Total through 2033 [d] (cubic meters)**	
Site [e]	**CH-TRU**	**RH-TRU**	**CH-TRU**	**RH-TRU**	**CH-TRU**	**RH-TRU**
Hanford Site (Hanford)	12,000	200	46,000	22,000	57,000	29,000
Los Alamos National Laboratory (LANL)	11,000	94	18,000	190	21,000	230
Idaho National Engineering and Environmental Laboratory (INEEL)	28,000	220	28,000	220	28,000	220
Argonne National Laboratory - West (ANL-W)	7	19	750	1,300	1,000	1,700
Argonne National Laboratory - East (ANL-E)	25	---	150	---	200	---
Savannah River Site (SRS)	2,900	---	9,600	---	12,000	---
Rocky Flats Environmental Technology Site (RFETS)	4,900	---	9,300	---	11,000	---
Oak Ridge National Laboratory (ORNL)	1,300	2,500	1,600	2,900	1,700	3,100
Lawrence Livermore National Laboratory (LLNL)	230	---	940	---	1,200	---
Nevada Test Site (NTS)	620	---	630	---	630	---
Mound Plant (Mound)	300	---	300	---	300	---
Bettis Atomic Power Laboratory (Bettis)	---	---	120	7	170	9
Sandia National Laboratories - Albuquerque (SNL)	7	---	14	---	17	---
Paducah Gaseous Diffusion Plant (PGDP)	---	---	6	---	8	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	3	---
Energy Technology Engineering Center (ETEC)	2	6	2	7	2	7
University of Missouri Research Reactor (U of Mo)	1	---	1	---	1	---
Ames Laboratory - Iowa State University (Ames)	---	---	1	---	1	---
Battelle Columbus Laboratories (BCL)	---	580	---	580	---	580
Totals	**62,000**	**3,600**	**116,000**	**27,000**	**135,000**	**35,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. The thermal treatment, though, is not necessarily for PCB-commingled waste. TRU waste containing more than 50 parts per million of PCBs cannot be disposed of at WIPP without applicable permits. The Basic Inventory is waste that resulted from defense activities and that was placed in retrievable storage pursuant to the Atomic Energy Commission policy of 1970 and TRU waste reasonably expected to be generated by these ongoing activities. Volumes have been rounded. Actual totals may differ due to rounding. Projected totals have not been adjusted in anticipation of disposal. A discussion of updated volumes and TRU waste locations presented in the *National Transuranic Waste Management Plan* is presented in Appendix J, throughout SEIS-II, where appropriate, and in the Summary.

[b] Dashes indicate no waste.

[c] Post-1970 defense TRU waste volumes through 2022 are estimated in BIR-2.

[d] The Proposed Action, described in Chapter 3, is based on operation of WIPP for 35 years through 2033. Total includes TRU waste to be generated for 35 years.

[e] Sites in boldface were included in SEIS-I. INEEL and ANL-W are located near each other and are counted as a single site in SEIS-II; however, ANL-W is listed separately to indicate its contribution to the inventory.

Table 2-3
Additional Inventory TRU Waste Volumes [a, b, c]

Site [d]	PCB-Commingled (cubic meters)		Commercial/Nondefense (cubic meters)		Previously Disposed of (cubic meters)		Total (cubic meters)	
	CH-TRU	RH-TRU	CH-TRU	RH-TRU	CH-TRU	RH-TRU	CH-TRU	RH-TRU
Hanford Site (Hanford)	240	--- [e]	---	---	63,000	1,000	63,000	1,000
Los Alamos National Laboratory (LANL)	---	---	---	---	14,000	120	14,000	120
Idaho National Engineering and Environmental Laboratory (INEEL)	460	---	---	---	57,000	440	57,000	440
Savannah River Site (SRS)	---	---	---	---	4,900	---	4,900	---
Oak Ridge National Laboratory (ORNL)	---	---	5	---	61	120	66	120
Mound Plant (Mound)	19	---	---	---	---	---	19	---
Sandia National Laboratories - Albuquerque (SNL)	---	---	---	---	1	---	1	---
ARCO Medical Products Company (ARCO)	---	---	1	---	---	---	1	---
Knolls Atomic Power Laboratory (Knolls)	---	---	---	81	---	---	---	81
Lawrence Berkeley Laboratory (LBL)	---	---	2	---	---	---	2	---
West Valley Demonstration Project (WVDP)	---	---	190	370	---	1,400	190	1,700
Totals	**720**	**---**	**200**	**450**	**138,000**	**3,100**	**139,000**	**3,500**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. The thermal treatment, though, is not necessarily for PCB-commingled waste. The Additional Inventory includes PCB-commingled TRU waste, commercial TRU waste, nondefense TRU waste, and TRU waste disposed of prior to the Atomic Energy Commission policy of 1970. A discussion of updated volumes and TRU waste locations presented in the *National Transuranic Waste Management Plan* is presented in Appendix J, throughout SEIS-II, where appropriate, and in the Summary.

[b] The volume of TRU waste includes the 1995 existing and projected waste through 2033.

[c] Actual totals may differ due to rounding.

[d] Sites in boldface also store post-1970 defense TRU waste, see Table 2-2. The remaining four sites currently have no post-1970 defense TRU waste.

[e] Dashes indicate no waste.

stored at the remaining four sites (ARCO, Knolls, LBL, and WVDP) is part of the Additional Inventory (Table 2-3). Together, TRU waste at these 22 sites account for all waste analyzed as part of SEIS-II (see Figure 2-1).

Additional information about the TRU waste inventory can be found in Appendix A. The waste volumes shown in Tables 2-2 and 2-3 are based on 35 years of future projected generation beginning in 1998, plus the TRU waste in retrievable storage (see Appendix J for updated inventory information). Projections between 1995 and 1998 are included. DOE recognizes that TRU waste may continue to be generated after 2033 but believes that volume projections beyond 2033 are too speculative to be useful for the analyses at this time; however, DOE may include projections beyond 2033 in any future NEPA analyses.[1]

There is uncertainty in the total waste volume figures presented in Tables 2-2 and 2-3. The projections beyond 2022 are extrapolations based on the projected waste generation rates between 1995 and 2022 and provide bounding estimates for use in the analyses. The amount of previously disposed of TRU waste that could be retrieved for eventual storage or disposal is highly uncertain. Decisions on disposition of waste and contaminated media from environmental restoration activities are made on a cleanup-by-cleanup basis, and such decisions have not been made for many of the Department's environmental restoration activities. Also, the Department is in the process of characterizing and developing cleanup strategies for many contaminated sites and, therefore, cannot precisely determine what type or volume of waste might result from cleanup of those sites.

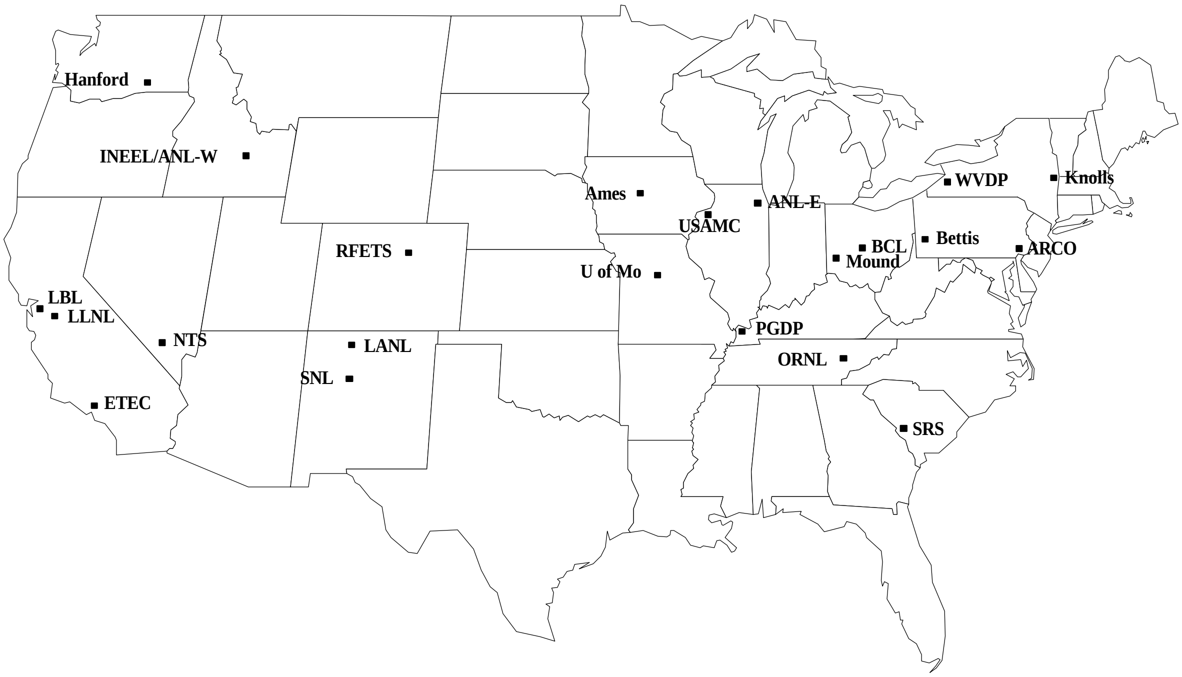

Figure 2-1
Approximate Location of SEIS-II TRU Waste [a]

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

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[1] While SEIS-II provides an analysis of impacts based on 35 years of waste generation, the Department's current RCRA Part B Permit Application (DOE 1996a) is based on 25 years and will be renewed every 5 years.

In addition, the waste volumes used for SEIS-II analyses are estimates of “emplaced waste volumes” (the volumes of the containers that TRU wastes would be emplaced in), not actual waste volumes inside the containers, except as noted. DOE recognizes that virtually all containers would contain some void space and that some containers may be only partially filled (for instance, to meet limits on weight or thermal power for transportation).

The ROD (55 Federal Register [FR] 25689) based on SEIS-I (DOE 1990) stated that SEIS-II would examine in greater detail waste management at the generator-storage sites. Later in 1990, DOE announced its intent to prepare a programmatic environmental impact statement for managing the treatment, storage, and disposal of radioactive and hazardous waste in the DOE Complex, including the treatment and storage of TRU waste (55 FR 42633). Also, in 1992, the U.S. Congress passed the Federal Facility Compliance Act (FFCAct) requiring DOE to prepare plans for developing treatment capacities and technologies for mixed waste. The FFCAct requires the site treatment plans to be submitted to the states or the U.S. Environmental Protection Agency (EPA) for review, and authorizes the states or EPA to issue orders requiring compliance with the plans. The *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997), published in June 1997, was developed in parallel with the FFCAct site treatment plans.

To date, DOE has submitted FFCAct site treatment plans for a majority of its sites, and in most cases orders or settlements have been reached with the states and EPA. Certain orders and settlements also include schedules for transporting treated TRU waste to WIPP. DOE has reached a negotiated settlement with the State of Idaho concerning TRU waste that was entered by the court in the case of *Public Service Co. v Batt*, Civil NO 91-0035-S-EJL (D. ID, October 17, 1995). DOE intends to keep its commitments pursuant to these binding agreements and orders. The Order issued to LANL requires DOE to complete treatment of TRU mixed waste to applicable regulatory standards by December 31, 2010. By September 30, 2023, Oak Ridge National Laboratory (ORNL) must complete shipment of stabilized RH-TRU waste sludges and CH- and RH-TRU solids to WIPP. And at RFETS, newly generated TRU mixed waste cannot be stored for longer than two years once WIPP begins accepting mixed TRU waste from RFETS.

The site treatment plans reflect DOE's strategy for the management of TRU mixed waste. Most of the FFCAct agreements allow the Department to continue to store TRU mixed waste without treating it to meet the RCRA Land Disposal Restrictions (LDR), recognizing that DOE has plans to decide whether to dispose of this waste at WIPP. (Such TRU mixed waste could be disposed of at WIPP without treatment to meet the RCRA LDRs under the recent amendments to the LWA in Public Law 104-201.) The LANL FFCAct agreement is an exception to this general rule, requiring DOE to begin planning for the LDR treatment of LANL TRU mixed waste but allowing renegotiation should WIPP open. Treatment of all the TRU waste to meet the LDRs is still a reasonable alternative and is analyzed in SEIS-II.

LEGALLY BINDING ORDERS AND AGREEMENTS

DOE is subject to a number of legally binding agreements and orders concerning TRU waste. One example of such an order is the negotiated settlement agreement entered by the court in the case of *Public Service Co. v Batt*, Civil No. 91-0035-S-EJL (D. ID, October 17, 1995). DOE intends to keep its commitments pursuant to these binding agreements and orders.

Under any of the alternatives assessed in SEIS-II, the generator-storage sites would maintain the capability to manage TRU waste generated in the future. In general, the facilities would vary by site depending on the waste streams and volumes generated and could have the capability to do the following:

- Safely store TRU waste generated from the various waste streams
- Characterize TRU waste which could involve radioassay and nondestructive testing, headspace sampling, inner-bag gas sampling, drum venting, solids sampling, real-time radiography, and visual sampling
- Treat TRU waste through size reduction, vitrification, or thermal treatment
- Certify TRU waste to meet planning-basis WAC requirements
- Package TRU waste
- Load TRU waste containers

These facilities would provide the generator-storage sites with the capability to prepare TRU waste for shipment to the major treatment sites. Treatment sites would have capabilities similar to those listed above for the generator-storage sites but would generally be sized to handle a greater volume of TRU waste.

Additional information regarding alternatives for the management of TRU waste, as studied in the WM PEIS, may be found in Appendix B.

2.1.4 Waste Isolation Pilot Plant

In 1957, the National Academy of Sciences concluded that the most promising method of disposal of high-level waste seemed to be in bedded salt deposits. Some of the most favorable characteristics of bedded salts included (1) that they were generally found in geologically stable regions that were capable of waste isolation for hundreds of millions of years, (2) that salt beds were essentially dry, with no intergranular liquids, and (3) that salt would creep and encapsulate wastes for long periods of time following disposal.

Following a study of salt beds throughout the Permian Basin, which includes the Delaware Basin in Eastern New Mexico and large areas of Kansas, West Texas, and Oklahoma, the WIPP site was selected during the early 1970s as a research and development facility to demonstrate the safe disposal of radioactive waste resulting from defense-related activities. Eastern New Mexico was specifically selected as the area for the WIPP site in early studies by ORNL (Appendix MASS, CCA [Doe 1996e]) because it best met the following criteria:

Characteristics	Requirement
Depth of Salt	1000 to 2500 feet
Thickness of Salt	at least 200 feet
Lateral Extent of Salt	Sufficient to protect against dissolution
Tectonics	Low historical seismicity, no salt-flow structures nearby

Characteristics (cont'd)	Requirement (cont'd)
Hydrology	Minimal groundwater
Mineral potential	Minimal
Existing Boreholes	Minimal number (No Deep Boreholes within two miles of the site)
Population Density	Low
Land Availability	Federal Land Preferred (Three square miles and a two-mile-wide buffer zone)

DOE's predecessor agency selected a candidate site in bedded salt beds contained within the Salado Formation northeast of the present WIPP site in 1974. However, field investigations conducted to confirm existing site information found unexpected geologic structures such as steeply dipping beds, missing units, and brine containing hydrogen sulfide near the deeper planned repository depths. This early site was deemed unacceptable and a search for a new site was initiated in late 1975 which identified the present site.

The WIPP site is located in southeastern New Mexico (Figure 2-2). The site is approximately 50 kilometers (30 miles) east of Carlsbad, New Mexico, in an area known as Los Medaños, a relatively flat, sparsely inhabited plateau with little surface water (DOE 1990). WIPP consists of the 41-square-kilometer (16-square-mile) area under the jurisdiction of DOE pursuant to LWA. The WIPP site boundary was established to ensure that at least 1.6 kilometers (1 mile) of intact salt exists laterally between the waste disposal area and the accessible environment and to ensure that no permanent residences will be established in close proximity to the facility.

WIPP includes surface and underground facilities that would support waste handling and emplacement. These facilities were discussed in Section 2.2 of SEIS-I (DOE 1990). The principal surface structure at WIPP is the Waste Handling Building (WHB) (Figure 2-3). The primary function of the WHB and its associated systems is to unload TRU waste (from the TRUPACT-II for CH-TRU waste and from the RH-72B cask, if it is NRC certified for RH-TRU waste) and to transfer the containers of TRU waste to the underground disposal area through a waste shaft. The WHB contains four functional areas: the CH-TRU waste handling area, the RH-TRU waste handling area, the WHB support area, and the waste shaft (DOE 1996c). Other surface facilities include the hoist houses, support building, guard and security building, water pump house, TRUPACT-II maintenance building, training building, office trailers, exhaust filter building, warehouse and shops, engineering building, drill core storage building, and the safety and emergency services building.

The WIPP underground facilities are located at the repository horizon 655 meters (2,150 feet) beneath the surface (Figure 2-4). These facilities include the waste disposal area, an experimental region (deactivated in 1995 and 1996), access tunnels, and associated support facilities (DOE 1996c). The underground support facilities include those needed to service and maintain equipment for excavation and disposal operations, monitor for contamination, and allow limited decontamination of personnel and equipment, if necessary. All WIPP facilities currently have protection for potential fire, tornado, lightning, high wind, and other types of natural disasters. All underground facilities also are inspected by both the Occupational Safety and Health Administration and the Mine Safety and Health Administration.

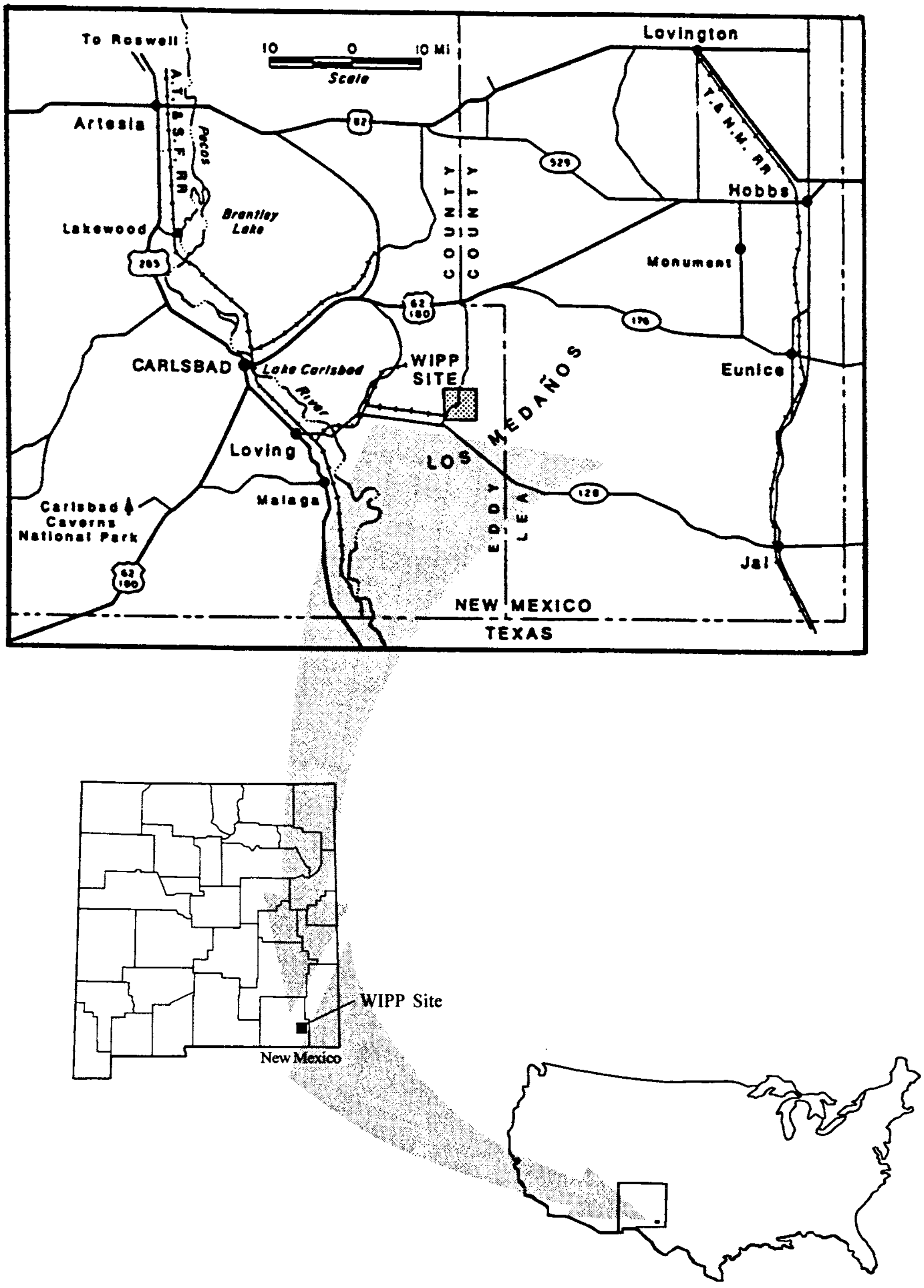
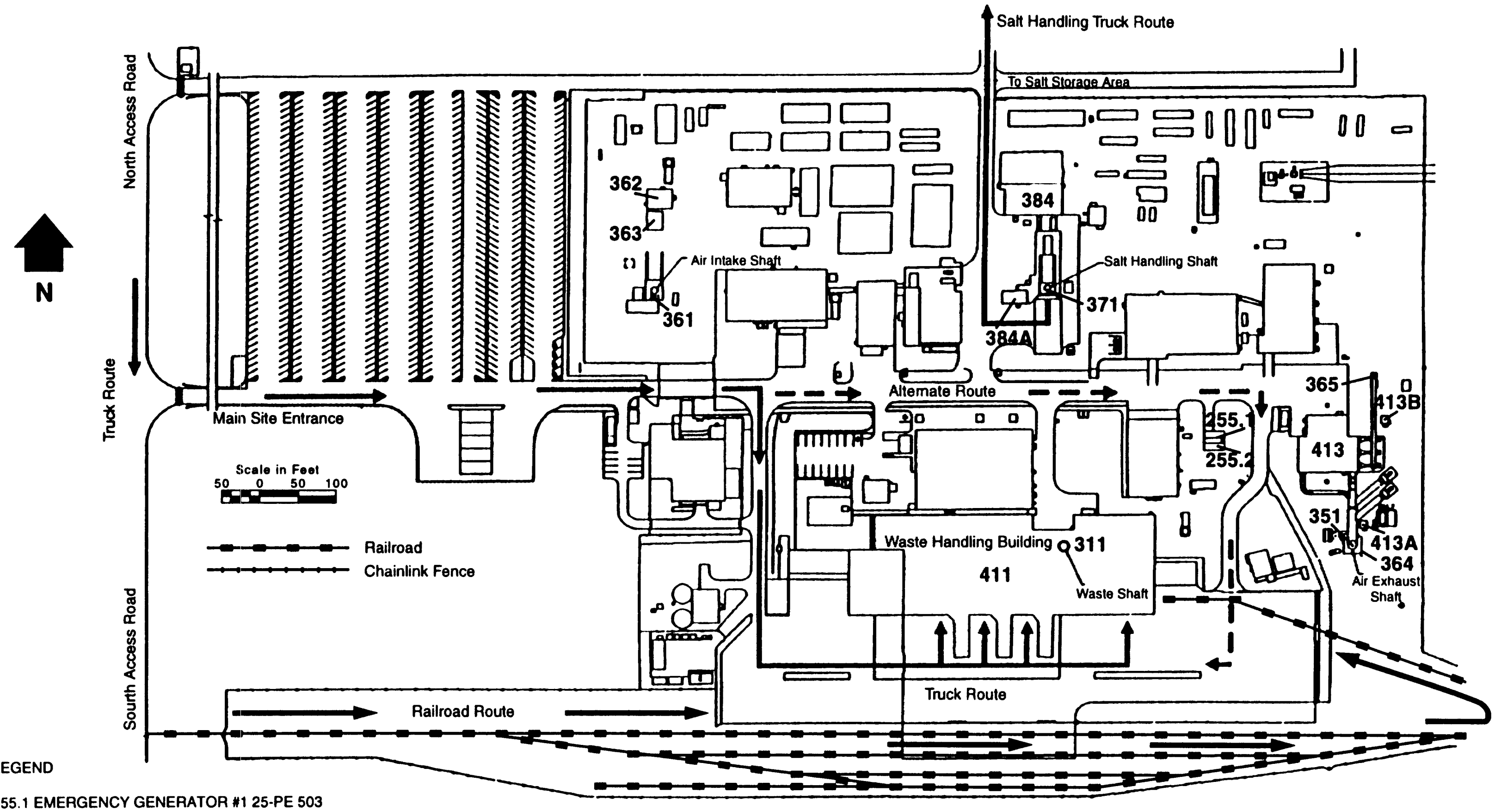


Figure 2-2
The Location of WIPP



LEGEND

255.1 EMERGENCY GENERATOR #1 25-PE 503
255.2 EMERGENCY GENERATOR #2 25-PE 504
311 WASTE SHAFT
351 EXHAUST SHAFT
361 AIR INTAKE SHAFT
362 AIR INTAKE SHAFT/HOIST HOUSE
363 AIR INTAKE SHAFT/WINCH HOUSE
364 EFFLUENT MONITORING INSTRUMENT SHED A
365 EFFLUENT MONITORING INSTRUMENT SHED B
371 SALT HANDLING SHAFT
384 SALT HANDLING SHAFT HOISTHOUSE
384A SALT HOIST OPERATIONS
411 WASTE HANDLING BUILDING
413 EXHAUST-SHAFT FILTER BUILDING
413A MONITORING STATION A
413B MONITORING STATION B

Figure 2-3
WIPP Surface Structures

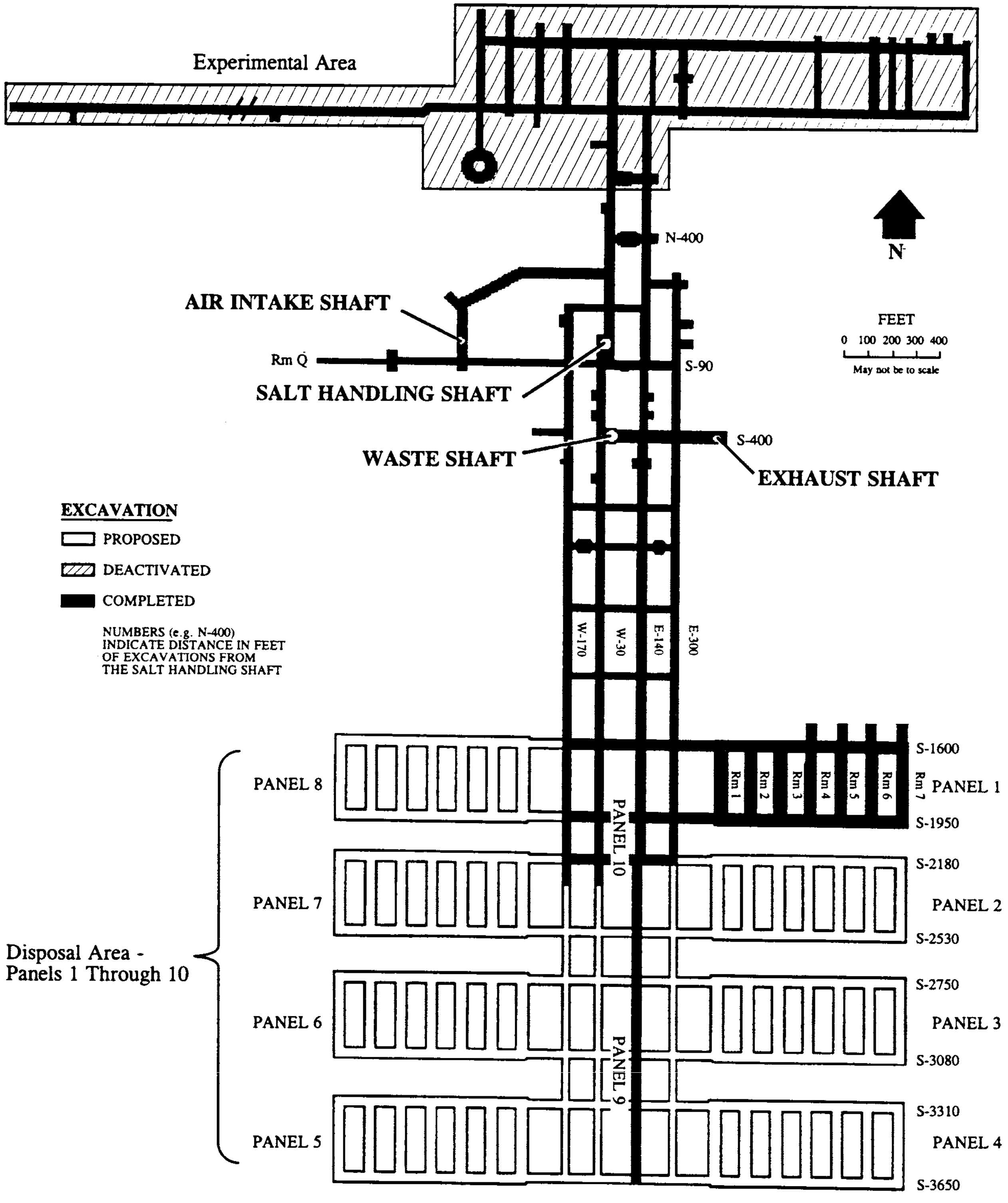


Figure 2-4
Plan View of WIPP Underground Facility
(655 meters [2,150 feet] below ground level)

One underground panel (panel 1) has been excavated. Seven additional panels and the north-south accessways (i.e., panel-equivalents 9 and 10) would be necessary to accommodate the 175,600 cubic meters (6.2 million cubic feet) of TRU waste permissible under LWA. Each panel would consist of seven waste disposal rooms, each about 91 meters (300 feet) long, 10 meters (33 feet) wide, and 4 meters (13 feet) high. Pillars between rooms would be 30 meters (100 feet) wide. Rockbolts or other types of ground control techniques would be used, as necessary, to ensure safe conditions during waste emplacement activities (DOE 1996c).

2.2 TRU WASTE TREATMENT

Although there are many different physical, chemical, and thermal treatment methods that have been previously tested or are in development for TRU waste treatment (DOE 1995c), the three types of treatment in SEIS-II are the same as those considered in the WM PEIS (DOE 1997). To ensure that the full range of potential impacts were considered, SEIS-II examined three types of treatment based on increasing levels of complexity: a minimal level of treatment needed to meet planning-basis WAC, an intermediate level of treatment using a shred and grout process, and a more complex level of thermal treatment sufficient to comply with the RCRA LDRs. DOE maintains that the impacts from these three levels of treatment represent a full range of impacts for available treatment methods.

The Proposed Action and one alternative would treat and package TRU waste only as needed to meet planning-basis WAC. A second alternative would use a shred and grout process, increasing the volume of the TRU waste by encapsulating it in cement. One alternative and one no action alternative would use a thermal treatment process to destroy organic components of the TRU waste and fuse the remainder into a glass or ceramic product, or possibly, into a metal ingot. Both CH-TRU and RH-TRU waste would be treated by the same processes; only the handling of the TRU waste would vary.

These three levels reasonably bound the potential environmental impacts for other types of treatment that might be developed for future TRU waste application. DOE will select the type of treatment necessary to satisfy disposal and storage criteria. The decisions that DOE makes on the basis of SEIS-II may be a combination of the treatment methods analyzed. This means that two or more of the treatment options may be selected for different portions of the waste.

OBJECTIVES OF TRU WASTE TREATMENT

TRU waste needs to be treated in order to put it in a form that would allow it to be safely handled, transported, and disposed of.

Treatment requirements are established to ensure compliance with requirements established by law, regulations, and DOE internal orders that are designed to protect the safety and health of workers. For example, planning-basis WAC prohibit waste containing over 50 parts per million of PCBs because land disposal of that waste would require a permit under TSCA. Other planning-basis WAC limitations, such as limitations on free liquids, are imposed because of the potential impacts of certain waste forms on the ability of WIPP to isolate the radioactive portion of the waste as required by EPA regulations (40 CFR Part 191).

Several RCRA requirements, including the prohibitions on explosives, compressed gases, and corrosive materials, are incorporated into the planning-basis WAC.

2.2.1 Treatment to Meet Planning-Basis WAC

Planning-basis WAC (DOE 1996b) defines the physical, quality assurance, handling, and documentation requirements that must be met for a container of TRU waste to be accepted at WIPP for disposal. The requirements specify TRU waste characteristics and limits and include radionuclide content, activity levels, and permissible shipping container weight. Explosives, compressed gases, and corrosive materials are prohibited by planning-basis WAC. Restrictions are set on amounts of residual liquids, thermal power, and pyrophoric materials. Planning-basis WAC includes WIPP-specific requirements as well as requirements set by various regulatory agencies, including the NRC, EPA, and U.S. Department of Transportation. Stored TRU waste may be WAC-certified or may need treatment to meet planning-basis WAC certification requirements.

Chapter 5 of this document explains how impacts would differ among alternatives if portions of the total waste volume analyzed were treated under each treatment option should the Department decide to combine two or more treatment options.

The baseline process used by treatment sites to ensure that TRU waste meets planning-basis WAC includes:

- TRU waste retrieval from storage
- TRU waste characterization in accordance with the *Transuranic Waste Characterization Quality Assurance Program Plan* (DOE 1995e)
- TRU waste treatment and packaging as needed to allow shipment in the TRUPACT-II or RH-72B packaging. Waste treatment might involve removing or solidifying residual liquids, neutralizing corrosive and deactivating reactive wastes, removing and puncturing compressed gas containers, solidifying particulates, and recementing stored TRU waste sludges. Waste treatment also may require the repackaging of existing TRU waste to fit into the appropriate shipping containers and the removal of items that do not conform with the WAC.
- TRU waste certification to planning-basis WAC

TRU waste characterization is an important step in determining whether the final TRU waste form meets planning-basis WAC. Depending on the TRU waste matrix code groups, characterization would include some or all of the following:

- Nondestructive, nonintrusive assay to identify and quantify the radionuclides in the TRU waste
- Radiographic analyses to determine the physical form of TRU waste in closed containers
- Container headspace gas analysis to detect the presence of hydrogen, methane, or EPA-listed volatile organic compounds
- Solids analyses for the presence of heavy metals such as lead, cadmium, or beryllium
- Visual inspection of an appropriate number of containers to verify quality control

Treatment sites would properly treat TRU waste identified as nonconforming during characterization. Treatment facilities would be designed to protect workers, the public, and the environment from exposure to radioactive and hazardous materials.

Planning-basis WAC uses thermal power limits as a surrogate for the gas generation potential of TRU waste. When TRU waste is in close proximity to organic materials, hydrogen gas can be produced, and hydrogen gas can be an explosion hazard. Thermal power limits vary according to the radiation and the packaging of the TRU waste within a container. For example, the hydrogen concentration for waste transported in a TRUPACT-II is limited to no greater than 5 percent (within the innermost layer of packaging) over a 60-day period. Because packaging CH-TRU waste in plastic bags inhibits the dispersal of the generated gas, the rate of gas dispersion decreases with increasing bag layers. Therefore, the more bag layers present in CH-TRU waste packaging, the greater the amount of gas present, the lower the allowed thermal power (DOE 1994) and thus, a smaller volume of CH-TRU waste would be allowed per waste container to limit gas generation. For the purposes of analyses in SEIS-II, it was assumed that no bags were used (bagless posting), thereby maximizing the volume of waste in a container and the concentration of waste that would be emplaced at WIPP. This assumption also would reduce the number of waste shipments.

2.2.2 Shred and Grout Treatment

In a shred and grout treatment process, TRU waste would be shredded to achieve a relatively uniform size and then mixed with grout. Small particles and free liquids would be immobilized with this process and any pyrophoric or corrosive characteristics of the TRU waste would be eliminated. Shred and grout treatment may also reduce the gas generation potential of TRU waste forms that already meet WAC. The gas generation potential in this case refers to the production of methane and other gases by rusting metals and decomposing materials.

An optimum shred and grout process for TRU waste treatment has not yet been selected by DOE. Site-specific NEPA review would be prepared by the Department if this type of treatment were selected for use at the treatment sites. The process selected may be modeled after commercially available technology.

Shredding TRU waste would be accomplished through a mechanical device that cuts, tears, or breaks the TRU waste into small uniform pieces. Most commercially available shredders feed the material between counter-rotating drums with intermeshing knives or teeth. For example, RFETS purchased a shredder that is designed to reduce graphite molds, HEPA filters, and process filters to pieces no larger than 2.5 x 5 x 5 centimeters (1 x 2 x 2 inches). The WIPP *Engineered Alternatives Cost/Benefit Study Final Report* (DOE 1995b) describes a shredding process that would result in pieces with a maximum dimension of 10 centimeters (4 inches).

Both organic and inorganic solid TRU waste would be suitable for treatment by shred and grout. Shredding generally reduces the TRU waste volume by allowing more efficient packing of smaller pieces; however, adding grout tends to increase the overall volume by about 20 percent.

Portland cement, sand, and fresh water are typically used to make grout. An alternate formulation has a cement base, salt for aggregate rather than sand, and simulated WIPP brine in place of fresh water. Additives would be used to control the long-term behavior of the grout. In addition, the formulation and application of the grout could be optimized for various TRU waste streams. For example, one process would combine the TRU waste and the grout before placing the mix in drums; another would add TRU waste and grout in alternating layers and then vibrate the drums; a third process would add grout to drums filled with TRU waste and then vibrate the drums.

TRU waste treatment facilities would check waste drums for radioactive contamination, decontaminate as necessary, then weigh, label, and temporarily seal the drums. After letting the grout mixture cure for several days, waste drums would undergo an inspection, and permanent lids would be installed. Finally, waste drums would undergo inspection to certify that they meet planning-basis WAC.

Much of the shred and grout treatment would be conducted using remote handling techniques, even for CH-TRU waste, because of the potential for airborne contaminant release during the shredding process. Facilities and processes would be designed to protect workers, the public, and the environment from exposure to radioactive and hazardous materials.

2.2.3 Thermal Treatment

Thermal treatment of TRU mixed waste would be designed to meet the LDRs as well as similar requirements of the TSCA. Such treatment would destroy or immobilize the hazardous substances that RCRA and TSCA regulate. (Although thermal treatment to meet RCRA LDRs would otherwise be necessary for about 60 percent of the TRU waste that DOE owns or is responsible for, the recent amendments to the LWA in Public Law 104-201 exempts WIPP disposal from such RCRA requirements.) DOE is currently pursuing plans to use a thermal treatment process at Idaho National Engineering and Environmental Laboratory to treat both TRU mixed waste and TRU waste commingled with PCBs. Existing or future NEPA documentation has or would be prepared by the Department for these treatment facilities.

Thermal treatment involves exposing TRU waste to temperatures in excess of 3,000 degrees Celsius (°C) (5,400 degrees Fahrenheit [°F]). Nearly all TRU mixed waste streams in the DOE complex could be treated thermally, including solid combustibles and heterogeneous debris. The high temperatures would destroy organic materials and convert inorganic components to either a glassy slag, a metal phase, or a consolidated waste form. These phases could be separated out and offer the potential for recycling. Such high temperature treatment processes might also include a secondary, fuel-fired combustion chamber for treating off-gases to ensure a high efficiency in destroying all organic materials, regardless of the initial properties of the TRU waste.

Most of the alpha-emitting radionuclides and heavy metals would be bound as oxides in the slag, which would be expected to pass the EPA toxicity characteristics leach procedure. Thermal treatment may offer improved waste isolation because radionuclides and heavy metals in the slag would be less soluble in the brine and, in the event of human intrusion by drilling, less waste would be drawn to the surface in the drilling muds. The gas generation potential of thermally treated waste would also be less than that of untreated TRU waste.

The thermal process would produce aqueous liquids that would need to be neutralized and wet solids, debris, and residues that would need to be disposed of as low-level waste (DOE 1997). DOE would consider the impacts of these waste streams in future NEPA studies when selecting a specific thermal treatment process (i.e., vitrification, plasma hearth, etc.) and a specific site for a treatment facility.

Potential thermal treatment processes are discussed in a 1995 DOE publication entitled *Alternatives to Incineration Technical Area Status Report* (DOE 1995a). Summaries of three of these processes follow:

Plasma Torch and Electric Arc Technologies

Both the plasma torch and electric arc technologies involve a high-voltage discharge in a gas to form a plasma. They differ in that the plasma torch process involves plasma discharge in a flowing gas that stabilizes the arc and provides the thermal source. In contrast, the electric arc process involves plasma discharge in a nonflowing gas medium that provides the primary energy for heating and melting the TRU waste. The two plasma technologies can accept a variety of TRU wastes and TRU waste matrices. Depending on the system design, TRU waste liquids, soils and sludges, and even entire containers may be melted to form a molten slag.

A reducing environment is typically used to thermally treat volatile organic constituents. Process byproducts are synthetic off-gases and organics, which are combusted in an afterburner. Because very small gas volumes are used in these systems, only small volumes of off-gas are produced. Molten solid material can be continuously removed by overflow or poured by batch to form a leach-resistant, vitrified (glassy) TRU waste form.

Vitrification

Vitrification is the process of converting materials into a glass or glass-like substance. Temperatures used in this process are typically between 1,000°C to 1,600°C (1,800°F to 2,900°F). Thermal vitrification processes destroy organic constituents by pyrolysis or combustion. These processes also immobilize inorganics by incorporating them in the glass product. Various types of electric melters could be used to vitrify TRU waste, including vertical and horizontal joule, induction, microwave, and plasma and electric arc melters.

In the joule, induction, and microwave melters, molten glass is heated internally to form a pool of molten glass in a refractory lined or “cold wall” steel vessel. In many of these melters, a cold cap, or crust, is formed on the top of the melt from the feed as it is introduced to the top of the melter. This cap would act as the interface between incoming TRU waste and the molten glass. The bottom of the cap forms an interface where the feed material melts as it enters the glass matrix. The cold cap also serves to filter particulates and to condense and retain volatilized radionuclides and heavy metals for possible reincorporation into the melt. Water and organics volatilize from the cap and enter the plenum, a pressurized enclosure where the organics may be oxidized or reformed with the steam. Organic destruction may also occur through pyrolysis in the melt or in a secondary combustion chamber.

Molten Salt

The molten salt oxidation process consists of a bath of molten salts maintained at 700°C to 950°C (1,300°F to 1,700°F) to oxidize organic components of TRU mixed waste and to retain radionuclides, metals, and acid gases in a salt residue. During operation, a mixture of liquid or solid particulate TRU waste and air is injected into the bottom of the melt which is contained in a ceramic-lined vessel. The high temperature and intimate contact with the molten salt causes the rapid reaction of the organic material with the oxygen in the air to produce conventional combustion products.

The final products of this process would be a glass or ceramic slag, a metal ingot (depending on the original TRU waste form), and treated off-gas. This treatment process would reduce the original TRU waste volume by about 35 percent or less. The glass or ceramic slag product would contain all or most of the TRU waste. The metal ingot product could be sufficiently free of radionuclides that it would be suitable for disposal as low-level waste or recycled material. In either case, the slag and potentially the metal ingot would be characterized for certification to meet the planning-basis WAC. Most materials recovered from the off-gases would be cycled to ensure their incorporation into the slag. The treated off-gas would meet facility-specific release limits, as dictated by facility permits.

2.3 STAKEHOLDER OUTREACH AND INVOLVEMENT ACTIVITIES

DOE conducted several activities prior to the SEIS-II public scoping period to inform the public of the Department's intent to prepare SEIS-II. Letters were sent to SEIS-II stakeholders, including private citizens, elected officials, tribal leaders, and public affairs officers, announcing the Department's plan to prepare SEIS-II. A Fact Sheet and the DOE Carlsbad Area Office Monthly Stakeholder Calendar for August 1995 were also distributed to stakeholders to notify the public of the upcoming SEIS-II scoping activities. In addition, an informal telephone survey was conducted to gather stakeholder suggestions about the structure of the SEIS-II scoping meetings.

SEIS-II public scoping activities included the following:

- A Notice of Intent (NOI) published in the Federal Register on August 23, 1995 (60 FR 43779), and a notice reopening the comment period published in the Federal Register on October 13, 1995
- A public comment period from August 23, 1995, to October 16, 1995
- Public scoping meetings held in Carlsbad, New Mexico, on September 7, 1995; Albuquerque, New Mexico, on September 12, 1995; Santa Fe, New Mexico, on September 14, 1995; Denver, Colorado, on September 19, 1995; Boise, Idaho, on September 20, 1995; and a second meeting in Denver, Colorado, on October 11, 1995

The NOI listed the times and locations of the public scoping meetings and the length of the public scoping period.

The Department issued the Implementation Plan for SEIS-II in May 1996. The Implementation Plan provides background information on WIPP, describes the Department's purpose and need for the WIPP project, and describes the SEIS-II work plan. It also describes the scoping process, major issues identified during the scoping process, and contains a brief discussion of how major scoping issues will be addressed in SEIS-II. Copies of the Implementation Plan were distributed to state, tribal and local governments, U.S. Congressional delegates from states with an interest in the WIPP project, all parties who provided scoping comments, and other interested parties.

Fact Sheets were prepared by the Department to provide stakeholders with additional information on topics related to SEIS-II. Two Fact Sheets, one on prescoping activities and the other on postscoping activities, have been distributed to parties on the SEIS-II mailing list. Fact Sheets were also distributed at the public scoping meetings. These sheets provided information on the NEPA process, the WIPP project, the DOE reading rooms, the role of public participation in the decision process, and other topics relevant to SEIS-II. The Department also will distribute Fact Sheets upon completion of the Final SEIS-II and publication of the ROD to all parties on the SEIS-II mailing list.

DOE published the Draft SEIS-II Notice of Availability (NOA) in the FR on November 29, 1996 (61 FR 60690). The NOA provided information on how the public could obtain copies and provide comments on the Draft SEIS-II, and the locations, dates, and times of the Draft SEIS-II hearings.

More than 900 copies of the Draft SEIS-II and 1,200 copies of the Draft SEIS-II Summary were distributed to federal, state, local, Tribal officials, and the general public. Three fact sheets were distributed along with the Draft SEIS-II and the Summary: an overview of how the public could provide comments on the Draft SEIS-II and the public hearing schedule; a list of the SEIS-II reading rooms (which has been reprinted as Table 2-4); and a list of the alternatives analyzed in the Draft SEIS-II.

DOE had initially established a 60-day public comment period that included the public hearing process. In response to public requests for more time to study the Draft SEIS-II, DOE subsequently extended the public comment period to 90 days (62 FR 4989). The public was also provided the opportunity to comment at a series of public hearings held in the following locations: Albuquerque, New Mexico on January 6 and 7, 1997; Santa Fe, New Mexico on January 8, 9, 10, 1997; Carlsbad, New Mexico and Denver, Colorado on January 13, 1997; Richland, Washington and Boise, Idaho on January 15, 1997; Oak Ridge, Tennessee on January 21, 1997; and North Augusta, South Carolina on January 23, 1997.

More than 700 individuals attended the hearings and more than 300 individuals provided oral testimony. The SEIS-II public hearings were scheduled after the holiday season to afford more people the opportunity to attend them. In addition, DOE staff attended meetings in New Mexico, Oregon, and Idaho to give presentations on SEIS-II. Recognizing that not every individual, organization, or agency could or would attend a public hearing, DOE invited comments on the Draft SEIS-II by mail, facsimile, and the Internet and received more than 150 letters.

Table 2-4
List of WIPP Reading Rooms

NAME	ADDRESS
U.S. Department of Energy Headquarters [a] Public Reading Room	Room 1E-190/Forrestal Building Freedom of Information Reading Room 1000 Independence Ave. S.W. Washington, DC 20585
Defense Nuclear Facilities Safety Board [a]	625 Indiana Ave. N.W., Suite 700 Washington, DC 20004
Scientific and Technical Information Center U.S. Department of Energy Reading Room [a]	P.O. Box 62 Oak Ridge, TN 37831
Thomas Branigan Memorial Library	200 East Picacho Las Cruces, NM 88001
New Mexico State Library [a]	325 Don Gaspar Santa Fe, NM 87503
Pannell Library New Mexico Junior College	5317 Lovington Highway Hobbs, NM 88240
Carlsbad Public Library [a] Public Document Room	101 South Halagueno Carlsbad, NM 88220
Zimmerman Library University of New Mexico [a] Government Publications	Roma Ave. and Yale Blvd. Albuquerque, NM 87131-1466
Martin Speare Memorial Library	New Mexico Institute of Mining and Technology Leroy and Bullock Campus Station Socorro, NM 87801
U.S. Department of Energy FOIA Public Reading Room	Technical-Vocational Institute Montoya Campus Library 4700 Morris NE Albuquerque, NM 87111
Raton Public Library	244 Cook Ave. Raton, NM 87740
New Mexico State University Library	P.O. Box 30001 Las Cruces, NM 88003
U.S. Department of Energy Public Reading Room [a]	1776 Science Center Dr. Idaho Falls, ID 83702
INEEL Boise Office	816 West Bannock Suite 306 Boise, ID 83702
Shoshone-Bannock Library HRDC Building	Bannock and Pima Fort Hall, ID 83203
University of Idaho Library University of Idaho	Rayburn St. Moscow, ID 83202
Moscow Environmental Restoration Information Office	530 South Ashbury Suite 2 Moscow, ID 83842
Pocatello Public Library	113 South Garfield Pocatello, ID 83201
Idaho State University Library	741 South 7th Ave., Box 8089 Pocatello, ID 83209
Twin Falls Public Library	434 2nd St. East Twin Falls, ID 83301
Standley Lake Library	8485 Kipling St. Arvada, CO 80005
Superfund Records Center U.S. Environmental Protection Agency	999 18th St. 5th Floor Denver, CO 80202
U.S. Department of Energy Public Reading Room Rocky Flats Operations [a]	Front Range Community College Library 3645 West 112th Ave. Level B, Center of the Building Westminster, CO 80030
Citizens Advisory Board	9035 N. Wadsworth Pkwy Suite 2250 Westminster, CO 80021

[a] Reference documents are available at these locations

Table 2-4
List of WIPP Reading Rooms — Continued

NAME	ADDRESS
U.S. Department of Energy Public Reading Room Richland Operations Office	Washington State University Tri-Cities 100 Sprout Rd. Room 130 West Richland, WA 99352
U.S. Department of Energy Public Reading Room	9800 South Cass Ave. Building 201 Argonne, IL 60439
U.S. Department of Energy Public Reading Room Nevada Operations Office	2621 Losee Rd. North Las Vegas, NV 89030-4129
U.S. Department of Energy Public Reading Room Oakland Operations Office	1301 Clay St. Room 700 N Oakland, CA 94612
U.S. Department of Energy Public Reading Room	Miamisburg Senior Adult Center 305 Central Ave. Miamisburg, OH 45342
Texas State Library Information Services Division	1201 Brazos St. Austin, TX 78701
Wyoming State Library Government Documents	Supreme Court Building 2301 Capitol Ave. Cheyenne, WY 82002
Idaho National Engineering and Environmental Laboratory Pocatello Office	1651 AT Ricken Dr. Pocatello, ID 83201
Idaho National Engineering and Environmental Laboratory Twin Falls Office	233 2nd St. North Suite B Twin Falls, ID 83301
Information Center Colorado Department of Public Health and Environment	4300 Cherry Creek Dr. South Building A Denver, CO 80222-1530
U.S. Department of Energy Public Reading Room	55 Jefferson Cir. Oak Ridge, TN 37830
Community Reading Room	Los Alamos National Laboratory P.O. Box 1663, MS A-117 Los Alamos, NM 87545
Mobile Public Library Federal Document Collection	701 Government St. Mobile, AL 36602-1499
Arkansas State Library Federal Document Collection	One Capitol Mall Little Rock, AR 72201
Flagstaff City-Coconino County Public Library	300 West Aspen Flagstaff, AZ 86001
Atlanta-Fulton Public Library Federal Document Collection	One Margaret Mitchell Square, N.W. Atlanta, GA 30303-1089
Indiana State Library Federal Document Collection	140 North Senate Ave. Indianapolis, IN 46204-2296
Kansas State Library Federal Document Collection	State Capitol Building Topeka, KS 66612
Mississippi State Law Library Federal Document Collection	450 High St. Jackson, MS 39215-1040
Missouri State Library Federal Document Collection	600 West Main Jefferson City, MO 65102
Oregon State Library Federal Document Collection	State Library Building 250 Winter Street, N.E. Salem, OR 97310-0640
The Navajo Nation U.S. Environmental Protection Agency	c/o Levon Benally, Jr. P.O. Box 339 Window Rock, AZ 86515
State Library Louisiana	760 North Third St. Baton Rouge, LA 70802
The Oklahoma Department of Libraries	200 N.E. 18th St. Oklahoma City, OK 73105

[a] Reference documents are available at these locations

2.4 REFERENCES CITED IN CHAPTER 2

DOE (U.S. Department of Energy), 1980, *Final Environmental Impact Statement for the Waste Isolation Pilot Plant*, DOE/EIS-0026, October, Washington, D.C.

DOE (U.S. Department of Energy), 1990, *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant*, DOE/EIS-0026-FS, January, Washington, D.C.

DOE (U.S. Department of Energy), 1994, *TRUPACT-II Content Codes (TRUCON)*, DOE/WIPP 89-004, Revision 8, WIPP Project Office, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1995a, *Alternatives to Incineration Technical Area Status Report*, DOE/MWIP-26, April, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 1995b, *Engineered Alternatives Cost/Benefit Study Final Report*, WIPP/WID 95-2135, September, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1995c, *Radioactive Waste Processing and Volume Reduction Technology Study*, DOE/CAO-95-3102, October, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1995d, *Transuranic Waste Baseline Inventory Report*, DOE/CAO-95-1121, Revision 2, December, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1995e, *Transuranic Waste Characterization Quality Assurance Program Plan*, DOE/CAO-94-1010, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1996a, *Comment Responses and Revisions to the Resource Conservation and Recovery Act Part B Permit Application*, DOE/WIPP 91-005, Revision 5.2, January, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1996b, *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, DOE/WIPP-069, Revision 5, April, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1996c, *Final No-Migration Variance Petition*, DOE/CAO-96-2160, June, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1996d, *Transuranic Waste Baseline Inventory Report*, DOE/CAO-95-1121, Revision 3, June, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1996e, *Title 40 CFR 191 Combliance Certification Application for the Waste Isolation Pilot Plant*, DOE/CAO-2184, October, Carlsbad, New Mexico.

DOE (U.S. Department of Energy), 1997, *Final Waste Management Programmatic Environmental Impact Statement*, DOE/EIS-0200-F, May, Washington, D.C.

CHAPTER 3
DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

The following sections provide descriptions of the Proposed Action, three action alternatives, and two no action alternatives. Section 3.4 presents a summary table of the Proposed Action and alternatives. The chapter closes with a discussion of the alternatives that are not analyzed in detail in this second supplemental environmental impact statement (SEIS-II), a summary of impacts, and a detailed discussion of the preferred alternative.

In the Notice of Intent that initiated the public scoping process for SEIS-II, the Department of Energy (DOE or the Department) preliminarily identified a Proposed Action, two action alternatives, and a no action alternative. Comments received during the scoping process identified the need for an additional action alternative and another no action alternative.

The Proposed Action, three action alternatives, and two no action alternatives presented in this chapter, therefore, comprise a wide range of options from which the Department can make decisions. Among the decisions that can be supported by these options are the following:

- Whether to open the Waste Isolation Pilot Plant (WIPP) for disposal of transuranic (TRU) waste or continue to maintain the waste in storage. The two no action alternatives examine the impacts of not opening WIPP.

- Which portions of contact-handled (CH) TRU and remote-handled (RH) TRU waste inventory (identified in Chapter 2 as the Total Inventory consisting of the Basic Inventory and Additional Inventory) should be disposed of at WIPP or continued in storage. Analyses of the alternatives include the impacts of both inventories.

- Which minimal level of waste treatment should be required in the Waste Acceptance Criteria (WAC) to meet disposal performance standards or storage requirements prior to the disposal of or storage of waste.[1] The three action alternatives differ in the treatment proposed, as do the two no action alternatives.

- Whether to transport TRU waste primarily by truck or by rail. Three transportation options (truck, commercial rail, and dedicated rail) are assessed for all alternatives except the Proposed Action, where transportation by truck is the only option considered, and No Action Alternative 2, where there is no transportation.

FURTHER NEPA ANALYSIS

The Department would conduct site-specific National Environmental Policy Act (NEPA) analyses to assess the impacts of siting and operating individual waste treatment facilities before making final decisions concerning whether to construct and operate those facilities.

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[1] DOE may decide, for site-specific reasons, to treat TRU waste to levels beyond the minimal level ultimately required in the WAC. Such a decision would be based on further site-specific NEPA review.

Decisions based on SEIS-II may be a combination of the options presented within the alternatives analyzed. This means that portions of two or more of the alternatives analyzed in SEIS-II may be combined and used by the Department for the management or disposal of TRU waste.

The Preferred Alternative is the Proposed Action, reserving the possibility of using rail transportation in the future following appropriate NEPA review. Additional detail on the Preferred Alternative is presented at the end of this chapter.

The following sections describe the Proposed Action; Action Alternatives 1, 2, and 3; and No Action Alternatives 1 and 2.

3.1 PROPOSED ACTION: BASIC INVENTORY, TREAT TO WAC, DISPOSE OF AT WIPP (PREFERRED ALTERNATIVE RESERVING RAIL TRANSPORTATION FOR FUTURE CONSIDERATION)

The Department's Proposed Action is to continue with the phased development of WIPP by disposing of TRU waste at the facility, as authorized by Public Laws 96-164, 102-579, and 104-201. For the purposes of analyses in this document, WIPP disposal is assumed to begin in 1998. Under the Proposed Action, DOE would dispose of defense TRU waste that has been placed in retrievable storage and that would continue to be generated from plutonium stabilization and management, environmental restoration, decommissioning activities, waste management programs, and testing and research during the 35-year period from 1998 to 2033 (i.e, waste included in the Basic Inventory). Table 3-1 presents the volume of TRU waste included in this Basic Inventory.

However, SEIS-II analyses assumed disposal of 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste, much less than the RH-TRU waste Basic Inventory. This volume was analyzed because it is the volume allowed by the Consultation and Cooperation (C&C) Agreement with the State of New Mexico. For CH-TRU waste, SEIS-II analyses were performed using a disposal volume of 168,500 cubic meters (5,950,000 cubic feet), which is greater than the CH-TRU waste Basic Inventory. This volume was analyzed because when added to the RH-TRU waste volume above, the total disposal volume was that allowable under the Land Withdrawal Act (LWA).

(More recent waste volume estimates presented in Appendix J show a decrease in the volume of RH-TRU waste, to a volume that could be completely disposed of at WIPP. As explained in Chapter 2, the SEIS-II analyses are based on a more conservative inventory.)

Management at WIPP of the Additional Inventory described in Chapter 2 is not analyzed as part of the Proposed Action. Alternatives for management of the Additional Inventory are presented in Action Alternatives 1, 2, 3, and No Action Alternative 1, discussed later in this chapter. Existing RH-TRU waste in the Basic Inventory that exceeds the amount allowable by current laws and agreements is identified as "excess waste." It was assumed, for the purposes of analyses, that the excess RH-TRU waste, which amounts to approximately 43,000 cubic meters (1,500,000 cubic feet), would be located at the Hanford Site (Hanford) and Oak Ridge National Laboratory (ORNL) and would remain in storage at these sites for an indefinite number of years following treatment.[1]

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[1] For the purposes of analyses in SEIS-II, it was assumed that waste would be shipped from all four RH-TRU waste consolidation sites at similar rates so that the entire projected INEEL and LANL RH-TRU waste volumes would be accepted, and the remaining capacity for RH-TRU waste disposal would be filled proportionally with waste from ORNL and Hanford. New waste estimates presented in Appendix J indicate that all waste may be disposed of.

Table 3-1
TRU Waste Volumes (Basic Inventory) for the Proposed Action [a]

Site [c]	Site Volume Through 2033 (cubic meters)		Pretreatment Consolidated Volume [b] (cubic meters)		Post-Treatment Disposal Volume (cubic meters)	
	CH-TRU	**RH-TRU**	**CH-TRU**	**RH-TRU**	**CH-TRU** [d]	**RH-TRU** [e]
Hanford Site (Hanford)	57,000	29,000	57,000	29,000	57,000	42,000
Los Alamos National Laboratory (LANL)	21,000	230	21,000	230	21,000	330
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	28,000	220	29,000	2,000	30,000	2,800
Argonne National Laboratory - West (ANL-W)	1,000	1,700	--- [g]	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	---	200	---
Savannah River Site (SRS)	12,000	---	12,000	---	12,000	---
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	---	17,000	---
Oak Ridge National Laboratory (ORNL)	1,700	3,100	1,800	3,700	1,900	5,300
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	1,200	---
Nevada Test Site (NTS)	630	---	630	---	630	---
Mound Plant (Mound)	300	---	300	---	340	---
Bettis Atomic Power Laboratory (Bettis)	170	9	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	---	---	---	---
Energy Technology Engineering Center (ETEC)	2	7	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	---	---	---	---
Ames Laboratory – Iowa State University (Ames)	1	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	---	580	---	---	---	---
Total	**135,000**	**35,000**	**135,000**	**35,000**	**143,000** [h]	**50,000** [i]
Disposal Volume Allowed by LWA and the C&C Agreement	**---**	**---**	**---**	**---**	**168,500** [h]	**7,080** [i, j]

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 parts per million (ppm) of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Volumes have been rounded. Actual totals may differ due to rounding. The site volumes through 2033 match the final columns on Table 2-2.

[b] Volumes include consolidation of waste as indicated on Figure 3-1.

[c] Sites in boldface were included in SEIS-I.

[d] Post-treatment volumes have been adjusted to meet packaging and transportation requirements to meet planning-basis WAC.

[e] Values represent WIPP emplacement volumes, except for Hanford and ORNL which may not be able to emplace all of their RH-TRU waste at WIPP. (New volume estimates, as presented in Appendix J, indicate all waste could be emplaced.)

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, are counted as one site in SEIS-II.

[g] Dashes indicate no waste.

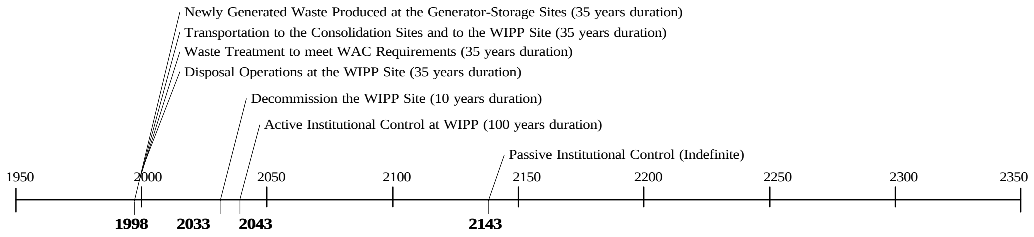
[h] Though 143,000 cubic meters of CH-TRU waste are part of the Basic Inventory, additional CH-TRU waste may become a part of that inventory should RCRA or CERCLA action lead to retrieval of previously disposed of waste. Therefore, SEIS-II assesses the impact of the entire disposal volume allowed, 168,500 cubic meters.

[i] All LANL and INEEL RH-TRU waste is assumed to be disposed of; RH-TRU waste disposed of for Hanford would be approximately 2,800 cubic meters; that for ORNL would be 1,100 cubic meters (after consolidation).

[j] The LWA limits the total RH-TRU waste curie content of WIPP to 5.1 million. Under the Proposed Action, the total curie content associated with the 7,080 cubic meters would be less than 1 million curies.

Current data and projections indicate that 18 sites would generate Basic Inventory waste or currently have it in storage. TRU waste would first be treated at the 18 sites as necessary to meet planning-basis WAC. Consolidation under the Proposed Action would occur in the manner described in the ROD to be issued for the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997). Such consolidation could be at the 10 largest generator-storage sites (see Figure 3-1) as in the WM PEIS Decentralized Alternative or at fewer sites as in the WM PEIS (DOE 1997) preferred alternative. For purposes of analysis, SEIS-II assumed consolidation at the 10 largest generator-storage sites; not consolidating the waste and consolidating it in a manner similar to the WM PEIS preferred alternative are also discussed in the text.[1]

The timeline below presents the approximate schedule for waste disposal activities under the Proposed Action. The disposal of TRU waste at WIPP would begin in 1998 and continue for 35 years, through the year 2033, at which time the facility would be closed. Decommissioning activities of WIPP would take up to 10 years (2043) and would be followed by an active institutional control period assumed for analyses to last 100 years, ending in 2143.



Timeline for the Implementation of the Proposed Action

3.1.1 Activities at the Generator-Storage Sites

This section describes WIPP-related activities that would occur under the Proposed Action at various generator-storage sites throughout the DOE complex. The WM PEIS and Chapter 4 of SEIS-II contain information on the sites themselves.

The 18 generator-storage sites would consolidate CH-TRU waste at 10 consolidation sites for subsequent shipment to WIPP. Of the seven RH-TRU waste sites, three sites would ship their RH-TRU waste for consolidation prior to shipment to WIPP. The flow of waste described here is assumed for analysis of potential environmental impacts, but the Department may adjust the configuration later in the WM PEIS Record of Decision.

The type of treatment performed would depend on whether the waste is already certified as meeting WAC. Some waste may require treatment and packaging to meet WAC. For purposes of analysis, all waste has been assumed to be treated and packaged to

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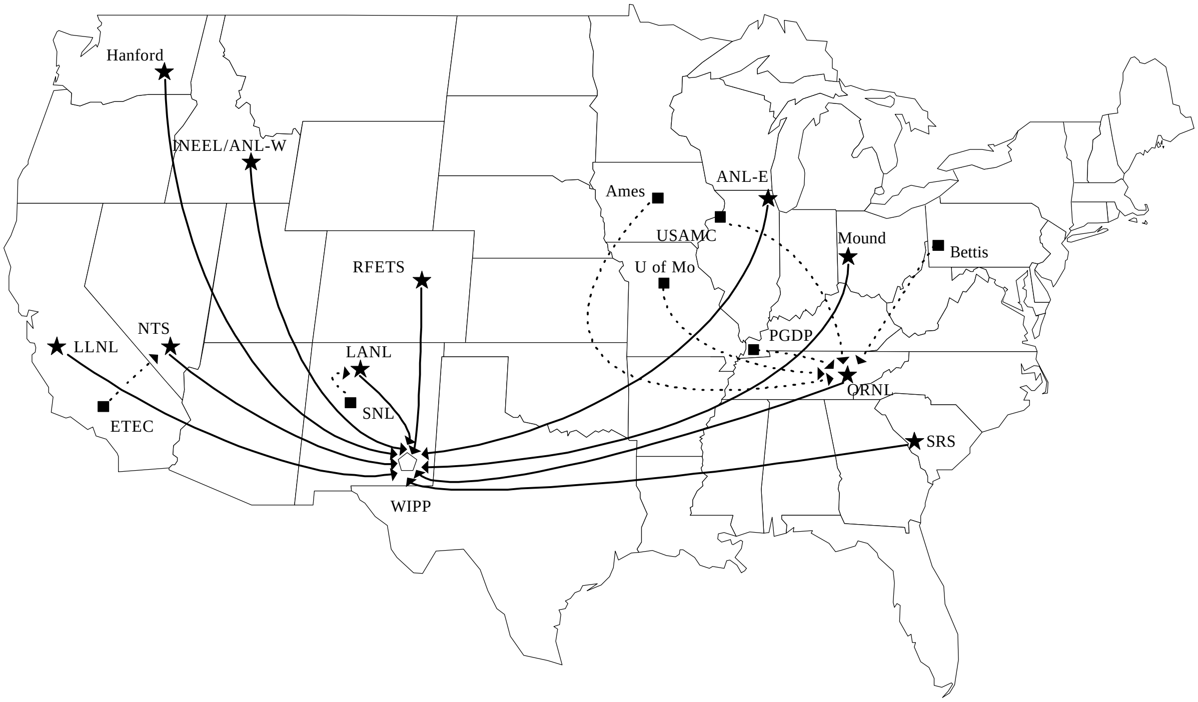
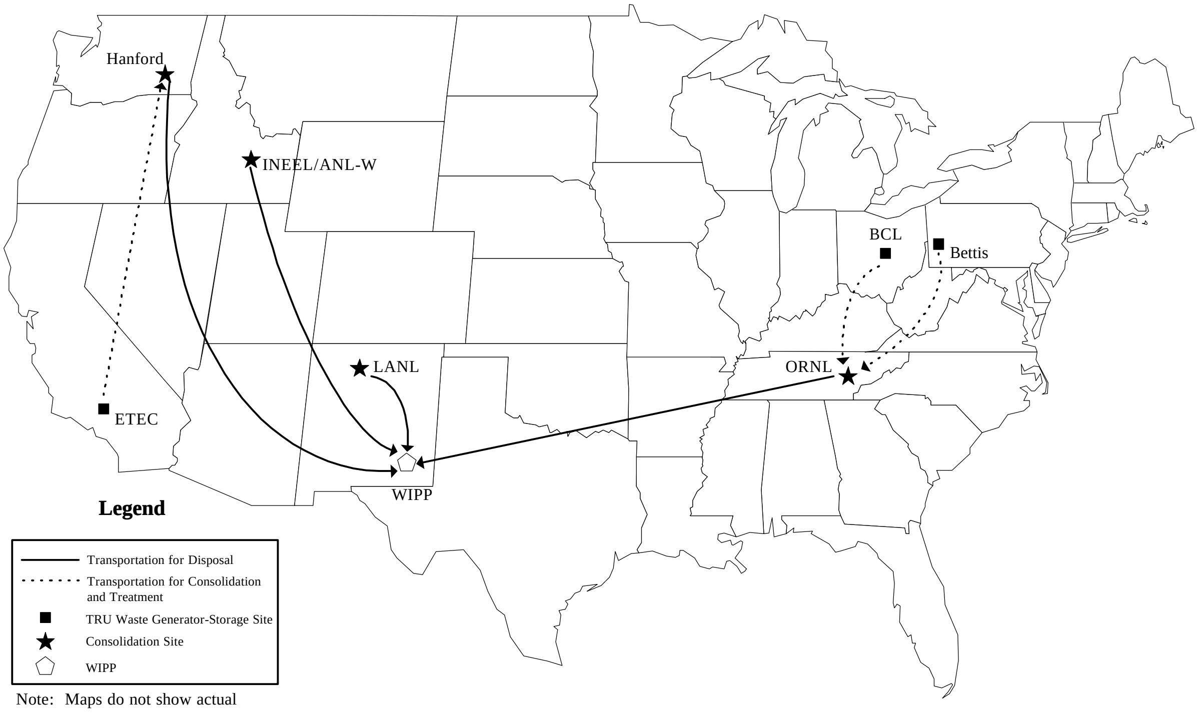
[1] The consolidation scheme presented in SEIS-II is intended for the purpose of analyzing the impacts and may not reflect the actual movement of waste that will occur.

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-1
Movement of Waste for the Proposed Action [a]
(For complete names of facilities and waste volumes, see Table 3-1)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

planning-basis WAC (using mobile treatment units where appropriate).[1] This could include, for example, reducing size and packaging, adding absorbents to eliminate free liquids, packaging, and assaying and sampling to ensure that packaging and transportation certification criteria have been met.

One aspect of the WAC addresses the generation of hydrogen gas in the TRUPACT-II during shipment. The assumption has been made that all CH-TRU waste will be packaged using bagless posting (i.e., no plastic bag liners will be used in waste containers). Bagless posting offers a lower gas generation rate than using one or more layers of plastic bagging materials and therefore results in fewer shipments (see Appendix A).

Each site preparing to ship TRU waste to WIPP would coordinate with WIPP personnel for scheduling purposes. Together, site and WIPP personnel would arrange for shipment from the site to WIPP using either the TRUPACT-II or the RH-72B cask.

3.1.2 Transportation Activities

Under the Proposed Action, trucks transporting TRU waste in U.S. Nuclear Regulatory Commission (NRC)-certified transportation containers (certified under 10 CFR Part 71) and traveling over U.S. Department of Transportation (DOT) and state-designated routes would transport the TRU waste between the generator-storage sites and from the consolidation sites to WIPP. Trucks would transport CH-TRU waste in TRUPACT-IIs and RH-TRU waste in RH-72B casks. The rate at which both CH-TRU waste and RH-TRU waste would arrive at WIPP for disposal would be based on the WIPP waste handling throughput rate and the storage area. On average, WIPP facilities would handle about 50 TRUPACT-IIs of CH-TRU waste and about eight RH-72B casks of RH-TRU waste per week. WIPP currently has no permits to store backlogged shipments, although it may obtain a permit to store small amounts of waste in its Waste Handling Building. DOE proposes to obtain the Resource Conservation and Recovery Act (RCRA) permits for limited nonroutine storage capacity in the Waste Handling Building (see Figure 2-3), but the time that incoming waste can spend in the staging area is limited. The Safety Analysis Report for Packaging attached to Certificate of Compliance No. 9218 (NRC 1997) limits the time a TRUPACT-II can remain sealed (with waste inside) to a maximum of 60 days, due to the potential for hydrogen gas accumulation within the TRUPACT-II. WIPP operations managers would meet these requirements through continuous coordination with the treatment sites to control the time and rate at which CH-TRU and RH-TRU waste arrives at WIPP for disposal.

Currently, the Department is proposing the use of trucks to transport waste. The Department has investigated and continues to investigate the possibility of using rail transportation but considers it less reasonable at this time. The primary factors that make rail carriage less reasonable are the following: (1) limited interest of the rail carriers in handling the shipments, (2) higher cost of dedicated rail transportation as compared to truck transportation, (3) the initial cost of acquiring additional TRUPACT-IIs needed for rail transportation (because three times as many TRUPACT-IIs would be needed for each shipment) and of acquiring or modifying rail cars for transport, and (4) DOE’s inability to obtain rail carrier assurance that TRUPACT-II transit will

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[1] At the smaller sites, use of mobile characterization and/or treatment units was assumed. Any emissions from these mobile units would be HEPA (High Efficiency Particulate Air) filtered. The characterization, packaging, and treatment performed by the mobile units would be on such a small volume of waste that there would be virtually no additional waste, and virtually no radiological or hazardous chemical impacts to workers or the public would be expected.

TRANSCOM SYSTEM

DOE has developed a transportation tracking and communications system that is used to track truck and rail shipments. This satellite-based system, the Transportation Tracking and Communications (TRANSCOM) system, has been in operation since 1989. Since its inception, the TRANSCOM System has tracked over 500 shipments for DOE. The use of TRANSCOM is mandated by DOE Order 460.2, *Departmental Materials Transportation and Packaging Management*.

The mission of the TRANSCOM system is to provide tracking and communications for shipments of radioactive materials, hazardous materials, and other high-visibility shipping campaigns, as specified by DOE. The TRANSCOM system is managed and operated at the TRANSCOM Control Center (TCC) in Oak Ridge, Tennessee, for DOE.

The TRANSCOM system provides the TCC staff, shippers, carriers, receivers, and state, Tribal, and federal users with the ability to view information about shipments and communicate with each other during shipment tracking. Information about shipment contents, points of contact, routes, status, locations, and emergency response information is available to local emergency response teams and each user. The information is displayed in tabular and graphical form using a series of national, state, and county maps. The vehicle location can be determined to within a few meters, with position updates as frequently as every 60 seconds. Drivers are alerted to adverse weather or road conditions.

enable DOE to unseal the TRUPACT-II within 60 days, as required by NRC. Regular rail transportation, because of its lower cost and accident risk, is still considered a desirable option for some waste transportation in the future, provided the factors that make it currently less reasonable can be mitigated. Though rail transportation was not analyzed under the Proposed Action, use of rail transportation is reserved for future consideration under the Preferred Alternative; if rail transportation were used, impacts are expected to be lower than impacts from truck transportation.

3.1.2.1 Shipping Procedures

The DOE *Transuranic Materials Transportation Guide* (DOE 1996b) establishes the procedures to be followed for shipping TRU waste; essentially, these are the same procedures planned earlier and reported in the *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) (DOE 1990). DOE personnel, the generator-storage sites, and the carriers would comply with all applicable rules, regulations, and orders pertaining to the packaging, marking, labeling, inspection, and transportation of TRU waste as issued by the DOT, DOE, the U.S. Environmental Protection Agency (EPA), and NRC.

Each generator-storage site would ensure that the TRU waste to be shipped meets WAC, that the waste is properly loaded into the TRUPACT-II or RH-72B cask, that all DOE procedures have been followed, that labels and placards are in compliance with DOT regulations, and that bills of lading are entered correctly into the TRANSCOM system. The generator-storage sites will follow the requirements for Type A packages described in Title 49, CFR Part 173. The Department would be prepared to provide emergency response support in the event of an accident.

A contract carrier would provide dedicated drivers and tractor-trailer trucks to transport TRU waste to WIPP. The trailers and packagings are owned by DOE. Specific responsibilities of the carrier would include providing drivers who are qualified according to DOT requirements (49 CFR Part 391) and ensuring that vehicles are operated in a safe manner. The carrier would ensure that both the tractor and the trailer are in operating condition prior to leaving the shipper’s premises and

CONSERVATISM OF TRU WASTE VOLUME ESTIMATES

TRU waste inventory estimates, as used throughout SEIS-II, embody many conservative assumptions to ensure bounding analyses of maximum, reasonably foreseeable impacts. The following reflect some of the conservative assumptions.

- The BIR-3 estimates of TRU waste volumes include projections that may overestimate TRU waste volumes. For instance, in both the Basic Inventory and the Additional Inventory, volume estimates include projections of waste yet to be generated. Though the Department's TRU waste generation due to defense activities has decreased because of a change in the nation's nuclear weapons needs, the projections of future waste also include waste anticipated by activities such as decontamination and decommissioning. These activities, which would include cleaning and disassembling facilities, can generate a great deal of TRU waste, but whether that waste will actually be generated and whether it will be CH-TRU or RH-TRU waste is uncertain. For the purposes of analyses, SEIS-II has used the estimates included in BIR-3.

- The Additional Inventory includes estimates of TRU waste produced prior to 1970 and believed to have been disposed of in trenches at some of the sites. Since DOE's definition of TRU waste has changed and some of the buried waste would probably be classified as low-level waste under current definitions, the amount that is actually TRU waste is unknown. For the purposes of analyses, all of this waste, as estimated in BIR-3, is considered part of the Additional Inventory and the effects of its disposal at WIPP are assessed in the SEIS-II action alternatives. SEIS-II analyzes 141,000 cubic meters (5 million cubic feet) of TRU waste that has been previously disposed of. Currently, though, DOE estimates that only 80,000 cubic meters (2.8 million cubic feet) of this waste would be excavated.

- The C&C Agreement between the State of New Mexico and DOE limits the amount of RH-TRU waste allowable at WIPP to 7,080 cubic meters (250,000 cubic feet). The Department's Proposed Action proposes disposing of this amount of RH-TRU waste, although the actual amount may be as low as 4,300 cubic meters (150,000 cubic feet). The lower figure reflects the current plans for disposing of this waste in the walls of WIPP panel rooms before emplacement of CH-TRU waste in the rooms. At startup, delays in preparing the RH-TRU waste for shipment are anticipated, which would result in the emplacement of some CH-TRU waste before RH-TRU waste is ready for WIPP. To ensure that SEIS-II disposal analyses are conservative, the analyses for the Proposed Action were conducted as if the full 7,080 cubic meters of RH-TRU waste would be emplaced.

- Application of the LWA and the C&C Agreement would limit the amount of CH-TRU waste allowable under the Proposed Action to 168,500 cubic meters (5,950,000 cubic feet), but only 143,000 cubic meters (5,050,000 cubic feet) is estimated to be in the Basic Inventory. Still, because of the potential for excavation of previously disposed of waste (which would then be classified as newly generated) and the potential for treatment of alpha-emitting, low-level waste that could convert currently non-TRU waste forms into TRU waste by concentrating transuranic radionuclides (as discussed in the cumulative impacts analysis), and repackaging of RH-TRU waste to meet the criteria of CH-TRU waste, SEIS-II analyses consider the effects of filling WIPP to its allowable capacity.

- While the LWA and C&C Agreement include limits on the volume of TRU waste that can be emplaced, there is considerable uncertainty concerning how much of a container's volume is made up of TRU waste and how much is void space. Many of the containers would include a great deal of void space, particularly for RH-TRU waste; the actual volume of waste in a drum or cask, therefore, may be much less than the volume of the drum or cask. For the purposes of analyses in SEIS-II, the volume of the drum or cask is used, as if the drum or cask were full without void space.

While volume changes to the TRU waste inventory could reduce or increase the effects calculated in SEIS-II, the best estimates available have been used and conservative assumptions have been incorporated to ensure that the results would actually be less than those presented. A text box entitled "Factors to Consider in Combining Alternatives" (presented in Chapter 5) explains in more detail how the results would change as inventory volumes change.

during the trip. Drivers would be required to make routine visual safety inspections of the tractor, trailer, and containers either every 160 kilometers (100 miles) or every two hours, in addition to routine inspections required by DOE, DOT, and affected states. The carrier or any other person operating a motor vehicle that contains a Class 7 (radioactive) material for which placarding is required must comply with routing and training requirements in 49 CFR Part 397, Subpart D. Carriers would keep current copies of their maintenance certificates in their vehicles at all times.

In the event of an accident, the carrier driver would notify emergency first-responders via cellular phone and would notify the Central Monitoring Room (CMR) at WIPP via TRANSCOM. A senior DOE official or the DOE Carlsbad Area Office (CAO) Incident/Accident Team Leader would assist those in charge at the accident. DOE resources would be made available to local authorities, as appropriate, to support the mitigation of the accident, including, but not limited to, package recovery and site cleanup. In the event of an accident involving a fire, breach, release, or suspected radioactive contamination, the carrier would follow established procedures to obtain any needed federal, state, or local assistance or technical advice. Drivers would carry instructions for actions to be taken in the event of an accident and would be trained in package recovery procedures (see Appendix E). Any carrier accident, no matter how minor, would be reported to the CAO Transportation Manager, the WIPP Traffic Manager, the CMR operator, and DOE Headquarters Emergency Operations Center via the DOE Albuquerque Operations Office. If not already notified by the carrier, the shipper would be notified by the CMR operator.

Delays in scheduled arrival may occur from time to time due to weather conditions, maintenance checks, and other factors at the treatment sites. All schedule delays of two or more hours from the shipping, receiving, or transit time would be reported immediately to the CMR, which would notify the shipper or receiver, as appropriate. If a shipment were delayed, a new scheduled time of arrival would be arranged. There would be no “deadlines” for a shipment to be received at WIPP.

The carrier’s management plan provides guidance from the Western Governors Association and DOE on the selection of suitable safe parking areas. As instructed, carriers would use designated DOE or Department of Defense sites, or an area designated by the affected state as a safe parking area, in the event of a shipping layover. If no DOE, Department of Defense, or state-designated site were available, the driver would select a site based on criteria related to the nearby population size, proximity, and security and would notify the nearest state police district office.

3.1.2.2 Shipping Routes

Under the Proposed Action, transportation could include shipments between the generator-storage sites and from the 10 largest generator-storage sites to WIPP. The states through which the trucks would pass would designate shipment routes in consultation with DOE. Figures in Appendix E show the currently designated routes. These routes, as well as any chosen in the future, would comply with DOT requirements, use the Interstate Highway System or other state-designated roads, and use the shortest routes to access the interstate highways. The routes also would bypass urban areas if this could be done safely and efficiently. The requirements for state-routing designation are provided in 49 CFR Part 397, Subpart 103, and the procedures by which highway routing can be preempted are prescribed in 49 CFR Part 397, Subpart E.

3.1.3 Activities at WIPP

At the time of SEIS-I (DOE 1990), all surface facilities, shafts, and hoist facilities had been constructed. Underground, an initial waste disposal panel (Panel 1) had been excavated and was ready to accommodate the Test Phase activities (see Section 2.1.4). These physical facilities, which are described in SEIS-I, are essentially unchanged.

3.1.3.1 Excavation Operations

Under the Proposed Action, a total of ten panel-equivalents (in the panels and access tunnels) would be needed to dispose of the waste. DOE has excavated the first panel, which consists of seven disposal rooms and, from an engineering viewpoint, could receive waste now. The Department would excavate the additional disposal panels as needed. The Department estimates that it would require up to three years to excavate a panel.

The massive salt beds at a depth of 655 meters (2,150 feet) creep slowly in response to pressure from the overlying rock and would eventually cause the excavated openings within the salt beds to close. This is the reason why “just-in-time excavation” would be used. Just-in-time excavation is based on the concept that when additional room is needed for waste disposal, a new panel would be excavated and ready for use “just in time.” This means that each panel would be excavated, filled, and closed in a time frame that would minimize the potential for hazardous conditions such as roof falls.

The Department would maintain each excavation (e.g., panel room) until it is filled. Personnel working underground would conduct a monitoring and excavation maintenance program in compliance with a long-term ground control plan (WID 1995). In addition to regular visual inspections, geotechnical instrumentation would provide continuous information about rock mass movement and deformation. Every underground worker would have the responsibility and authority to close a suspect area to entry until it has been inspected by excavation safety personnel. Unsafe or potentially unsafe areas would be remediated by bringing down loose rock or installing control measures such as wire mesh and roof bolts. The facilities would be inspected a minimum of four times a year by the Mine Safety and Health Administration, as required by Section 11 of the Land Withdrawal Act.

Salt that results from the excavation of the panels would be stored aboveground in the existing salt pile, which would be 12 hectares (30 acres) in size. Management of the salt pile may include selling or disposing of unneeded salt under the Materials Act of 1947. The salt pile would stabilize naturally, and a drainage pond would contain runoff. Salt would be retained at the site for potential use in permanent shaft seals and markers upon closure of WIPP.

3.1.3.2 TRU Waste Handling Operations at the Surface

CH-TRU waste would arrive at WIPP on tractor-trailer trucks, each of which can carry up to three TRUPACT-IIs. Thus, each truck shipment could deliver up to forty-two 55-gallon drums, six standard waste boxes of CH-TRU waste, or three Ten Drum Overpacks. RH-TRU waste would also arrive by truck. Each truck could carry one RH-72B cask. Each cask contains a canister holding up to three 55-gallon drums of RH-TRU waste or up to 0.89 cubic meters (31 cubic feet) if drums are not used inside the canister.

For CH-TRU waste, the Department has developed detailed procedures for unloading the trucks, opening the TRUPACT-IIs, inspecting the packages, preparing packages to be moved underground, and then moving them to the underground. Conceptually, the process is as follows: When a truck arrives at the Waste Handling Building, it would be inspected for load integrity and the presence of radioactive contamination. The truck would be unloaded, and the TRUPACT-IIs moved to a specially designed platform with equipment and testing facilities. Each time another barrier surface of the container assembly was uncovered, the waste packages would be checked for surface radiation levels and contamination. The packages then would be placed on pallets for transport to underground emplacement.

CH-TRU waste shipping packages or waste containers with surface contamination less than or equal to 20 disintegrations per minute alpha or 200 disintegration per minute beta/gamma would not need to be decontaminated prior to handling. If surface contamination on the exterior of the shipping package or waste container is detected in amounts less than 2,000 disintegrations per minute alpha or 20,000 disintegrations per minute beta/gamma over an area less than or equal to 0.56 square meters (6 square feet), the shipping package or waste container would be decontaminated prior to any further steps in the waste handling process (DOE 1996a). If surface contamination in excess of these levels was detected, the canister or drums would be put into an outer sleeve and a lid would be welded on using remote handling equipment. The shipping package or waste container would either be returned to the treatment site, shipped to a different DOE site if the original shipper does not have suitable facilities, or shipped to a non-DOE site for decontamination. In all cases, the waste would be packaged and certified prior to return shipment to WIPP. In the unlikely event that the external surface contamination is too great to allow safe return and transportation to a shipping site, DOE would take necessary isolation, safety, and decontamination measures. DOE could potentially dispose of any such packages or containers in WIPP, upon appropriate RCRA Part B Permit modification.

The Department proposes to use backfill material, with components added that would minimize the mobility of radionuclides during the repository's post-closure phase, to aid in complying with the requirements of 40 CFR Part 191.13. The mobility of radionuclides, which is determined in part by their solubility in brine, is dependent on the physical and chemical conditions present in the repository, particularly those anticipated as a result of gas generation from the degradation of waste. The purpose of the added component (magnesium oxide) is to react with the brine in such a way that radionuclide solubility and, therefore, the mobility are lowered. Details on the theory behind the current plans for this backfill are described in Appendix D22 of the WIPP RCRA Part B Permit Application (DOE 1996a).

The backfill, in mini sacks of polyethylene or other suitable material, would be manually emplaced in the external voids of each seven-pack unit (a collection of seven drums) just before the seven-pack is positioned on the waste stack. A similar process would be used for standard waste boxes, except that the mini sacks would be hung from the lift clips on the boxes.

For RH-TRU waste to be shipped in the RH-72B cask, the Department would not finalize the waste handling operations procedures until the NRC certifies the RH-72B transportation cask. In general, the procedures would be similar to the sequence described for the CH-TRU waste and the TRUPACT-II. One difference would be that RH-TRU waste would be handled in canisters made of quarter-inch steel with welded lids. Using remote manipulators, the RH-TRU waste canisters would be removed from the RH-72B casks and placed in a room specially designed for shielding radiation. Subsequent testing operations would be conducted in this room until the canisters would be sent down the waste handling shaft.

3.1.3.3 Emplacement Operations for CH-TRU Waste

At the repository horizon station of the waste handling shaft, specially designed transporters would take the CH-TRU waste pallets from the shaft to the disposal room. Forklifts with a specially designed handling mechanism would then remove the waste from the transport pallets and stack the waste packages three high, leaving up to 1.2 meters (4 feet) of room for ceiling clearance. Each disposal panel would accommodate approximately 81,000 55-gallon drum equivalents (both drums and waste boxes will be used for disposal) equivalent to 16,700 cubic meters (590,000 cubic feet) of CH-TRU waste. DOE would coordinate filling the disposal rooms with RH-TRU waste because the RH-TRU waste would be placed in the walls before filling each room with CH-TRU waste.

In addition, supersacks containing magnesium oxide backfill would be handled and placed with the same technique as used for normal waste handling operations. Once each row of waste units is in place, a layer of six supersacks would be placed on top of them. Finally, magnesium oxide minisacks would be manually stacked on the floor in the space between the waste stack and the panel wall and placed horizontally or vertically. Backfill placed in this manner would remain protected until exposed when sacks are broken during creep closure of the room and compaction of the backfill and waste.

After each panel has been filled, it would be closed using the panel closure system. For the purposes of analyses, the system would be considered passive and consist of either a standard rectangular concrete barrier or an enlarged, tapered concrete barrier. The barrier would be emplaced in both the panel air-intake and air-exhaust tunnels and contact-grouted at the interface between the barrier and the tunnel walls. Contact-grouting involves filling the void spaces. The panel closure system has been designed to add a margin of assurance to limit the migration of hazardous constituents during the 35-year operational and facility closure period and to withstand a potential methane explosion from the accumulation of gas in the panel (see Appendix I of the RCRA Part B Permit Application).

3.1.3.4 Emplacement Operations for RH-TRU Waste

For shielding purposes, the RH-TRU waste canisters would be placed into horizontal boreholes in the walls of the disposal rooms and access tunnels. The horizontal emplacement holes, about 0.9 meters (3 feet) in diameter, would be drilled on 2.4-meter (8-foot) centers to a depth of 4.9 meters (16 feet). Additional holes would be placed in the access tunnels at each end of the disposal rooms. Specially designed insertion equipment would be used to place the RH-TRU waste canisters at the back of the horizontal drill holes and then plug the holes with a massive carbon-steel plug. Once the RH-TRU waste emplacement holes in a disposal room were all used and closed, emplacement of CH-TRU waste would begin (DOE 1995a).

For purposes of analysis, it has been assumed that each RH-TRU waste canister contains three 55-gallon drums containing a total of 0.624 cubic meters (22 cubic feet) of waste. The emplacement volume - which includes the drums of waste, spacers between the drums, and the canister itself - would occupy 0.89 cubic meters (31 cubic feet).

Each disposal panel would accommodate about 730 canisters, equivalent to an emplacement volume of 650 cubic meters (22,950 cubic feet). The SEIS-II analyses are based on the assumption that 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste would be disposed of. The greater volume of RH-TRU waste in SEIS-II than that used for the RCRA Part B Permit Application (DOE 1996a) would be disposed of in the access tunnels, Panels 9 and 10. To account for this difference, these tunnels would each need to be modified to accommodate 1,060 canisters, equivalent to 944 cubic meters (33,000 cubic feet) of waste.

3.1.3.5 Closure and Decommissioning

Under the Proposed Action, WIPP would receive and dispose of TRU waste for 35 years through the year 2033. This is 10 years longer than anticipated in SEIS-I because the Department now has more complete information on the TRU waste inventory and revised estimates of the time needed to treat the waste to meet planning-basis WAC.

DOE would close the repository when WIPP achieves a capacity of 175,600 cubic meters (6.2 million cubic feet) of TRU waste. Final facility closure would include the placement of a

THE PROPOSED ACTION AND THE ADDITIONAL INVENTORY

During the public comment period that followed publication of the Draft SEIS-II in November 1996, stakeholders requested that the Department discuss, as part of the Proposed Action, the impacts of leaving in place or treating and storing the Additional Inventory. The Additional Inventory, as shown in Table 2-3, largely comprises TRU waste disposed of prior to 1970 by burying the waste near the surface. The Department currently has no plans to excavate, treat, and store all of this waste. Such a decision would be made on a site-by-site basis, following RCRA and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) investigations, and probably following additional NEPA review. The Additional Inventory, therefore, is not a part of the Proposed Action. Nevertheless, in response to stakeholders' requests, Chapter 5 now includes text boxes like this one that present an assessment of human health impacts based on analyses done for the action alternatives and no action alternatives described in Chapter 3 of SEIS-II. The scenarios on which these impacts are based include the following:

- All Additional Inventory would be left as currently stored or buried. The impacts for this scenario would be similar to the Additional Inventory impacts of No Action Alternative 2.

- All Additional Inventory would be excavated, treated to planning-basis WAC, and stored at current locations for approximately 70 years. During the 70 years, the Department would look for a disposal solution. The impacts for this scenario would be very similar to the Additional Inventory treatment and storage impacts presented for Action Alternative 1.

- All Additional Inventory would be excavated, shipped to six thermal treatment facilities, treated, and then stored for approximately 70 years. During the 70 years, the Department would look for a disposal solution. The impacts for this scenario would be very similar to the Additional Inventory treatment and storage impacts presented for Action Alternative 2A.

- All Additional Inventory would be excavated, shipped to four thermal treatment facilities, treated, and then stored for 70 years. The impacts for this scenario would be very similar to the Additional Inventory treatment and storage impacts presented for Action Alternative 2B.

repository sealing system. As explained in more detail in the RCRA Part B Permit Application (DOE 1996a), the planned repository sealing system would consist of natural and engineered barriers within the WIPP repository that would prevent water from entering it and impede gases or brines from migrating out.

Current plans for the shaft sealing system propose completely filling the shaft with engineered materials possessing high density and low permeability. Shaft seal components for that portion of the shaft that is within the Salado Formation would provide the primary barrier by limiting fluid transport along the shaft during and beyond the 10,000-year period. Shaft seal components within the Rustler Formation would limit commingling between brine-bearing members, as required by state regulations. Shaft seal components from the Rustler to the surface would fill the shaft with common materials of high density, consistent with good engineering practice. A synopsis of each component is given below:

- Shaft Station Monolith. At the bottom of each shaft, a salt-saturated concrete monolith would support the local roof. A salt-saturated concrete, called Salado Mass Concrete (SMC), is currently specified and would be placed using a conventional slickline construction procedure where the concrete would be batched at the surface. SMC has been tailored to match site conditions.

- Clay Columns. A sodium bentonite would be used for three compacted clay components in the Salado and Rustler Formations. Although alternative construction specifications are viable, labor-intensive placement of compressed blocks is currently planned because of proven performance. Clay columns would effectively limit brine movement from the time they are placed to beyond the 10,000 year regulatory period.

- Concrete-Asphalt Waterstop Components. Concrete-asphalt waterstop components would be comprised of three elements: an upper concrete plug, a central asphalt waterstop, and a lower concrete plug. Three such components are located within the Salado Formation. These concrete-asphalt waterstop components would provide independent shaft cross-section and disturbed rock zone (DRZ) seals that limit fluid transport, either downward or upward.

- Compacted Salt Column. Each shaft seal would include a column of compacted WIPP salt with 1.5 percent weight water added to the natural material. Construction demonstrations have shown that mine-run WIPP salt could be dynamically compacted to a density equivalent to approximately 90 percent of the average density of intact Salado salt. The remaining void space would be removed through consolidation caused by creep closure.

- Asphalt Column: An asphalt-aggregate mixture currently is specified for the asphalt column, which would bridge the Rustler/Salado contact.

- Concrete Plugs. A concrete plug would be located just above the asphalt column and would be keyed into the surrounding rock.

- Earthen Fill. The upper shaft would be filled with locally available earthen fill. Most of the fill would be dynamically compacted (the same method used to construct the salt column) to a density approximating the surrounding lithologies.

The Department would decommission the site in a manner that would allow for safe, permanent disposition of surface and underground facilities, which would be consistent with the then-applicable regulations. Little or no contamination of facilities would be expected. Equipment and facilities would be decontaminated as necessary. Useable equipment would be removed and surface facilities dismantled. A berm would be constructed around the perimeter of the closure area, which would include 70 hectares (175 acres). The area above the 10 panel equivalents would be 50 hectares (125 acres), the area of the salt pile would be 12 hectares (30 acres), and the area of the surface facilities would be 8 hectares (20 acres). The height of the berm would be sufficient to identify the closure area and impede access. DOE would restore the areas occupied by the salt pile and surface facilities and, if necessary, any of the area overlying the disposal panel area, although surface disturbance of this area would be minimal. This decommissioning period is anticipated to take up to 10 years. Any salt remaining after WIPP closure and construction of the berm would be sold or disposed of in accordance with the Materials Act of 1947.

There are no changes since SEIS-I to the anticipated long-term controls for the WIPP site after the Department closes it, which would include active controls, monitoring, and passive controls. The 100-year active institutional control period would extend through the year 2143, during which the Department would use a fence and an unpaved roadway along the perimeter of the repository surface footprint area (the waste disposal area projected to the surface) to control access. The fence line would be posted with signs that warn of the danger and that state that access by unauthorized persons is prohibited. Routine, periodic patrols and surveillances of the protected area would be conducted as well as periodic inspection and necessary corrective maintenance of the fence, signs, and roadway. In addition, the Department would prohibit drilling within the LWA to preclude inadvertent intrusion into the repository.

The Department would place a number of permanent markers to inform and warn subsequent generations that radioactive waste is buried there. This permanent marker system would be designed to minimize the likelihood of human intrusion. Current plans include markers that would do the following:

- Identify the site
- Relay warning messages
- Use multiple methods for marking the site
- Use multiple means of communications (e.g., language, pictographs, scientific diagrams)
- Use multiple levels of complexity within individual messages on individual marker system elements
- Be constructed of materials with little intrinsic value

Other actions under consideration by DOE are the following:

- Construction of an “information center,” located in the middle of the area, with more information on the type of waste disposed of at WIPP, why the waste is dangerous, and why TRU waste should not be disturbed
- Placement of additional warning messages approximately 6 meters (20 feet) beneath the surface, within the perimeter

- Placement of large permanent magnetic materials and radar reflectors within the berm so that the site could be remotely detected
- Creation of off-site archival records at several local, state, and federal organizations

3.2 ALTERNATIVES

SEIS-II analyzes a total of five alternatives to the Proposed Action, including two no action alternatives. The following sections describe these alternatives. A summary table is presented at the end of this section.

3.2.1 Action and No Action Alternatives

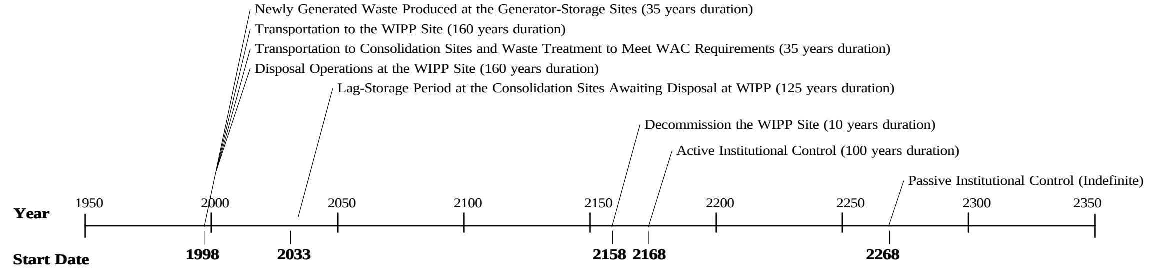
DOE identified the alternatives to the Proposed Action for analyses according to CEQ guidance (46 Federal Register 18026), which indicates that an agency should consider alternatives that are practical or feasible from the technical and economic standpoint and using common sense. Using this guidance and considering the prior LWA requirement that the Department make recommendations for the disposal of all DOE-owned or controlled TRU waste, it is reasonable to examine alternatives that include disposing of all DOE-owned or controlled TRU waste at WIPP. In addition, the CEQ regulations implementing NEPA require a No Action Alternative (40 CFR Part 1502.14 (d)). DOE recognizes that these alternatives may, at least in part, require amendment of existing laws or agreements negotiated with EPA and/or involved states. Nevertheless, under NEPA, DOE is required to consider reasonable alternatives even if they are in conflict with existing law. The fact that DOE is considering these alternatives for the NEPA process should not be construed as meaning that the Department intends to implement any action that would violate the law or violate legally binding agreements negotiated pursuant to law.

The number of disposal panels required for each alternative is influenced by the 10,000-watt-per-surface-acre design limit on heat load for waste disposed of at WIPP. Consistent with the RCRA Part B Permit Application, an average heat load of 60 watts per RH-TRU waste canister is assumed for the Proposed Action and the alternatives (the actual heat load has been calculated at about 1 watt per canister). Additional mining would be necessary under the action alternatives to distribute the RH-TRU waste as required by the surface acre thermal power limitations. The operational time periods for the action alternatives are driven by current maximum RH-TRU waste emplacement and/or mining rates, which are used only to make the alternatives easily comparable to each other and the Proposed Action. If any of the action alternatives were chosen, waste handling and mining operations could be modified to allow shorter operational time periods, and actual RH-TRU waste heat loads would probably require less mining than that assumed for the alternatives.

3.2.2 Action Alternative 1: Total Inventory (Except PCB-Commingled TRU Waste), Treat to WAC, Dispose of at WIPP

For this alternative, WIPP would accept nearly all TRU waste for disposal. The waste would include the Basic Inventory (with the potential excess RH-TRU waste) plus the Additional Inventory. Only TRU waste commingled with polychlorinated biphenyls (PCB) would not be disposed of at WIPP. The waste would be treated to planning-basis WAC and then shipped to the 10 sites with the largest volumes of waste for consolidation. PCB-commingled waste would continue to be managed at the generator sites. Table 3-2 presents the CH-TRU waste volumes, and Table 3-3 presents the RH-TRU waste volumes for Action Alternative 1. These tables list the site volume, pretreatment consolidated volume, and post-treatment volume for the Basic Inventory, Additional Inventory, and the combined total (Total Inventory) for each treatment site. DOE could not dispose of some of these additional waste types at WIPP under the current laws and agreements that regulate WIPP. Figure 3-2 shows the flow of TRU waste between sites and shipment to WIPP for Action Alternative 1.

The timeline below presents the approximate schedule for waste disposal activities under Action Alternative 1. Sites would generate waste for 35 years, beginning in 1998. The disposal of TRU waste at WIPP would begin in 1998 and continue for approximately 160 years, ending in 2158. The duration of disposal operations for Action Alternative 1 is based on the time needed to emplace the total volume of RH-TRU waste, assuming a maximum emplacement rate of 356 cubic meters (12,570 cubic feet) per year, a throughput rate of eight RH-72B canisters per week (DOE 1996b), and an operating time of 50 weeks per year. (Section 3.2.2.4 discusses how operations times could be reduced for this alternative.) Decommissioning activities would last for up to 10 years and would be followed by an active institutional control period assumed for analyses to last 100 years, ending in 2268.



Timeline for the Implementation of Action Alternative 1

3.2.2.1 Activities at the Generator-Storage Sites

The activities at the generator-storage sites would be the same as those described for the Proposed Action, except that they would involve approximately twice as much waste based on BIR-3 estimates. The volumes shown in Tables 3-2 and 3-3 reflect the currently stored and projected volumes and the volumes after any packaging and treatment necessary to meet planning-basis WAC. The generator-storage sites would consolidate all CH-TRU waste at 10 treatment sites after treating the waste to meet WAC for subsequent shipment to WIPP. The generator-storage sites would ship RH-TRU waste to four treatment sites for subsequent shipment to WIPP. Waste treatment would occur over 35 years, through the year 2033.

Although all of the TRU waste could be treated and packaged by 2033, much of the waste would be placed in lag storage at the treatment sites awaiting shipment to WIPP. The lag storage would continue for some waste for 125 years. During that period, storage facilities would be constructed and replaced every 50 years. CH-TRU waste awaiting transportation to WIPP would be packaged every 20 years. RH-TRU waste would be stored in canisters made of quarter-inch steel.

Table 3-2
CH-TRU Waste Volumes for Action Alternative 1 [a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
Site [d]	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	57,000	63,000	120,000	57,000	63,000	120,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	21,000	14,000	35,000	21,000	14,000	35,000
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	28,000	57,000	85,000	30,000	57,000	86,000	30,000	57,000	87,000
Argonne National Laboratory - West (ANL-W)	1,000	--- [g]	1,000	---	---	---	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	200	---	200	200	---	200
Savannah River Site (SRS)	12,000	4,900	17,000	12,000	4,900	17,000	12,000	4,900	17,000
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	11,000	---	11,000	17,000	---	17,000
Oak Ridge National Laboratory (ORNL)	1,700	56	1,700	1,800	260	2,100	1,800	260	2,100
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	1,200	---	1,200	1,200	---	1,200
Nevada Test Site (NTS)	630	---	630	630	---	630	630	---	630
Mound Plant (Mound)	300	---	300	300	---	300	340	---	340
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**139,000**	**273,000**	**135,000**	**138,000**	**273,000**	**143,000**	**138,000**	**281,000**

[a] The inventory for SEIS-II is based on BIR-3,which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-2.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is not included.

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[g] Dashes indicate no waste.

Table 3-3
RH-TRU Waste Volumes for Action Alternative 1 [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory
Hanford Site (Hanford)	29,000	1,000	30,000	29,000	1,000	30,000	42,000	1,500	43,000
Los Alamos National Laboratory (LANL)	230	120	350	230	120	350	330	170	490
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	220	440	660	2,000	440	2,400	2,800	630	3,400
Argonne National Laboratory - West (ANL-W)	1,700	--- [g]	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	2,000	5,600	5,200	2,700	8,000
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	80	80	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**50,000**	**5,000**	**55,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-2.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is not included.

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[g] Dashes indicate no waste.

3.2.2.2 Transportation Activities

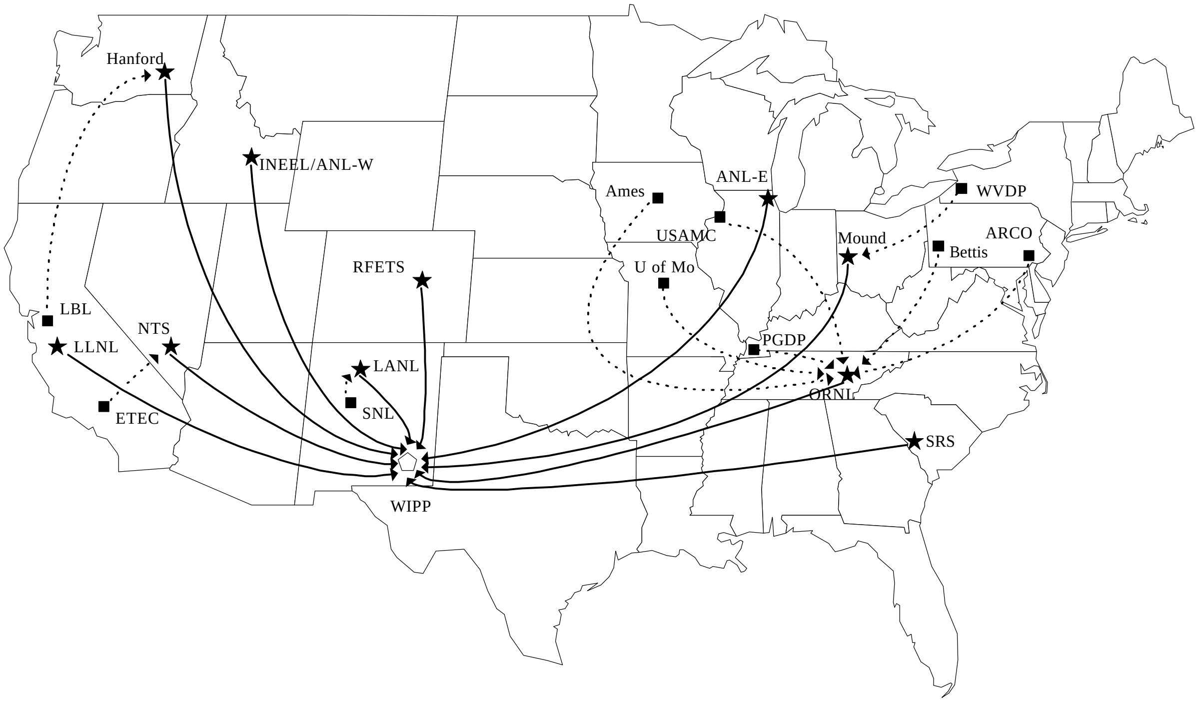
Transportation activities under this alternative would differ from those described for the Proposed Action in the following ways:

- Almost three times as many shipments would be required to ship the CH-TRU and RH-TRU waste to WIPP, due mainly to the additional RH-TRU waste to be shipped to WIPP under Action Alternative 1 (almost eight times more).

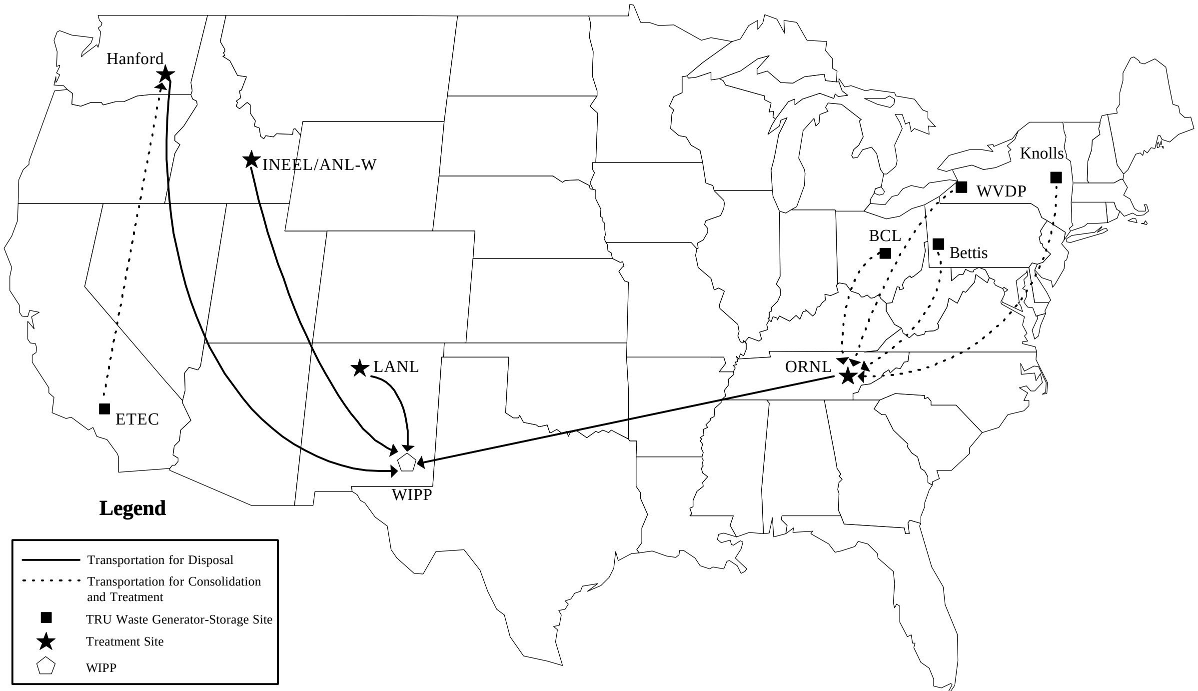
- The period of shipping to WIPP would extend for 160 years, through the year 2158.

- TRU waste may be shipped by truck and by commercial and dedicated rail from the 10 major treatment sites to WIPP. SEIS-II analyses for this alternative include three transportation scenarios. The first scenario uses trucks only, as described under the Proposed Action. The other two scenarios use a mix of commercial rail and truck transportation or dedicated rail and truck transportation. Rail transportation would be used to the maximum extent practicable, and thus the term “maximum rail” is used to indicate

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-2
Movement of Waste for Action Alternative 1 [a]
(For complete names of facilities and waste volumes, see Tables 3-2 and 3-3)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

the emphasis on rail use. Trucks would be used instead of rail from Los Alamos National Laboratory (LANL) and the Nevada Test Site (NTS) because railroads do not currently exist from those sites. DOE would not build new rail lines. WIPP already has a rail spur leading to the facility.

3.2.2.3 Activities at WIPP

Under Action Alternative 1, excavation operations, TRU waste handling operations at the surface, CH-TRU waste emplacement operations, closure, and decommissioning would be the same as those for the Proposed Action. This alternative would extend the operations time frame to as late as the year 2158, and WIPP would accept a larger total volume of TRU waste. A total of 68 panels would be excavated to accommodate the additional waste, with 17 panels to accommodate CH-TRU and RH-TRU waste and 51 panels for RH-TRU waste only (due to a 10,000 watt-per-acre limit). Any expansion of WIPP capacity beyond current limits would require changes to the LWA and the C&C Agreement, as well as permits to operate WIPP.

As with the Proposed Action, RH-TRU waste canisters would be emplaced in horizontal boreholes in panel walls. Other RH-TRU waste disposal options may be considered, including vertical boreholes or trenches in the floors of disposal rooms. In addition, waste currently considered to be RH-TRU waste at the generator-storage sites may be packaged there to meet CH-TRU waste requirements, not exceeding a dose rate of 200 millirem per hour at the container surface. This waste would then be emplaced as CH-TRU waste at WIPP.

Closure and institutional controls would be the same as those for the Proposed Action, except that due to the additional years of operation, decommissioning and the active institutional control period would extend through the year 2268. A berm would be constructed around the perimeter of the site that is 360 hectares (890 acres), 340 hectares (840 acres) of which lies above the 68 panel-equivalents, 12 hectares (30 acres) of which would be for the salt pile, 8 hectares (20 acres) of which would be for surface facilities. DOE would restore the areas occupied by the salt pile and surface facilities and, if necessary, any of the area overlying the disposal panel equivalents, although surface disturbance of this area would be minimal.

3.2.2.4 Reducing Operation Time

During the public comment period following publication of the Draft SEIS-II, stakeholders stated that the 160-year operations period for Action Alternative 1 was too long and requested that the Department reduce the operations period in some manner. Several commenters requested that the Final SEIS-II include greater detail on how reducing the operation’s period would change the impacts presented in Chapter 5 of this document.

DOE has included in Chapter 5 of this document an assessment of impacts should the operation’s period be reduced from 160 years to 60 years by constructing additional facilities at the WIPP site and by employing additional excavation and emplacement crews. The assumptions and description of operations presented above would apply, except for the following modifications:

- During the first seven years of the 60-year period, waste would be emplaced in WIPP as described above. In addition, during those seven years, planning and construction of an additional RH-TRU waste handling building would be completed. This new building would include two RH-TRU waste handling areas. In addition, four new shafts would be constructed, including one waste handling shaft, one salt handling shaft, an air intake shaft, and exhaust shaft. Further NEPA review may need to be conducted, as appropriate, before any new facilities would be built.

- For the final 53 years, all current facilities plus the new facility would be in operation. Two additional excavation crews would be employed, enabling the reduction in operations time from 160 to 60 years. During these 53 years, the emplacement rate would increase from 8 canisters a week to 24 a week. Excavation of new panels would increase from one every two years to three every two years. The same number of panels would be needed.

- In all, an additional 90 people would be employed to operate the new building, its RH-TRU waste operations, and additional excavation and emplacement crews.

- New capital costs would be about $80 million; operating costs would increase by 10 percent.

- All transportation to WIPP would occur over a 60-year period.

3.2.3 Action Alternative 2: Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Dispose of at WIPP

For Action Alternative 2, DOE would treat waste with a thermal process designed to meet the Land Disposal Restrictions (LDR) for TRU mixed waste. The analysis performed for this alternative assumes a 65 percent reduction in the volume of waste due to thermal treatment. WIPP would accept all TRU waste for disposal, which would include the Basic Inventory (including the excess RH-TRU waste) plus the Additional Inventory. For this alternative, the Additional Inventory also includes TRU waste commingled with PCBs. DOE could not dispose of some of the waste types included in the Additional Inventory at WIPP under the current laws and agreements that regulate WIPP.

Three different consolidation and treatment subalternatives are considered under Action Alternative 2. These subalternatives are referred to as Action Alternative 2A, 2B, or 2C and vary only in the location of the treatment sites.

- Under Action Alternative 2A, CH-TRU waste would be treated at Hanford, Savannah River Site (SRS), Rocky Flats Environmental Technology Site (RFETS), LANL, and Idaho National Engineering and Environmental Laboratory (INEEL)/Argonne National Laboratory-West (ANL-W). RH-TRU waste would be treated at Hanford and ORNL.

- Under Action Alternative 2B, CH-TRU waste would be treated at Hanford, SRS, and INEEL/ANL-W. RH-TRU waste would be treated at Hanford and ORNL.

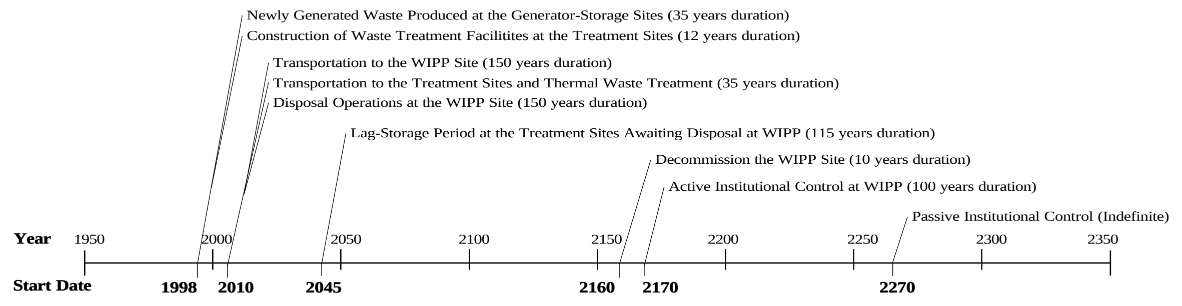
- Under Action Alternative 2C, CH-TRU waste would be treated at WIPP. RH-TRU waste would be treated at Hanford and ORNL.

Table 3-4 presents the CH-TRU waste volumes and Table 3-5 presents the RH-TRU waste volumes for Action Alternative 2A. These tables list the volume by site, pretreatment consolidated volume, and post-treatment volume for the Basic Inventory, Additional Inventory, and Total Inventory. Figure 3-3 shows the flow of TRU waste between sites and shipment to WIPP.

Table 3-6 presents the CH-TRU waste volumes and Table 3-7 presents the RH-TRU waste volumes for Action Alternative 2B. Figure 3-4 shows the flow of TRU waste between sites and shipment to WIPP.

Table 3-8 presents the CH-TRU waste volumes and Table 3-9 presents the RH-TRU waste volumes for Action Alternative 2C. Figure 3-5 shows consolidation of TRU waste and shipment to WIPP. DOE would consolidate and treat CH-TRU waste at WIPP and RH-TRU waste at Hanford and ORNL.

A timeline below presents the approximate schedule for disposal activities under the Action Alternative 2 subalternatives. Sites would generate waste for 35 years, beginning in 1998. It would take 12 years to design and construct the treatment facilities for Action Alternatives 2A, 2B, and 2C. The disposal of TRU waste would begin in 2010 and continue for 150 years, ending in 2160. The disposal operations duration is based on the time needed to excavate the panels and emplace the total volume of RH-TRU waste, assuming a maximum emplacement rate of 356 cubic meters (12,570 cubic feet) per year, a throughput rate of eight RH-72B canisters per week (DOE 1996b), and an operating time of 50 weeks per year. Decommissioning activities would last for up to 10 years and would be followed by an active institutional control period assumed for analyses to last 100 years, ending in 2270. (See Section 3.2.3.4 for discussion of how time periods could be reduced for this alternative.)



Timeline for the Implementation of Action Alternative 2

3.2.3.1 Activities at the Generator-Storage Sites

Under this alternative, the generator-storage sites would prepare twice as much waste as under the Proposed Action, and the waste would be treated by a thermal process to meet the RCRA LDRs. Thermal treatment may involve a vitrification process. The process would vaporize organic matter, thereby reducing the total volume of waste. A vitrification process would add silicon-based materials that would result in a glass-like product. The volumes shown in Tables 3-4 through 3-9 reflect the currently stored or projected volumes and the treatment method. To be conservative, it has been assumed that all waste treatment facilities would be designed and constructed over a period of 12 years and would be ready for operation in the year 2010. (Some sites may be able to

Table 3-4
CH-TRU Waste Volumes for Action Alternative 2A [a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
Site [d]	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	59,000	63,000	122,000	21,000	22,000	43,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	21,000	14,000	35,000	7,400	4,900	12,000
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	28,000	57,000	85,000	30,000	57,000	87,000	10,000	31,000	41,000
Argonne National Laboratory - West (ANL-W)	1,000	--- [g]	1,000	---	---	---	---	---	---
Argonne National Laboratory-East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	14,000	5,000	20,000	5,000	1,800	6,800
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	11,000	---	11,000	3,800	---	3,800
Oak Ridge National Laboratory (ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	20	320	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**139,000**	**274,000**	**135,000**	**139,000**	**274,000**	**47,000**	**60,000**	**107,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-3.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[g] Dashes indicate no waste.

Table 3-5
RH-TRU Waste Volumes for Action Alternative 2A [a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
Site [d]	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	16,000	920	17,000
Los Alamos National Laboratory (LANL)	230	120	350	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory - West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	1,800	960	2,800
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**18,000**	**1,900**	**19,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-3.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] Dashes indicate no waste.

[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

procure such services earlier.) Waste treatment would occur over 35 years, through the year 2045, and lag storage of the TRU waste awaiting shipment (under Action Alternatives 2A and 2B) would occur for 115 years, also through the year 2160. Under these alternatives, lag storage would be required due to the rate at which the panels could be excavated. The lag storage would be similar to that described in Section 3.2.2.1.

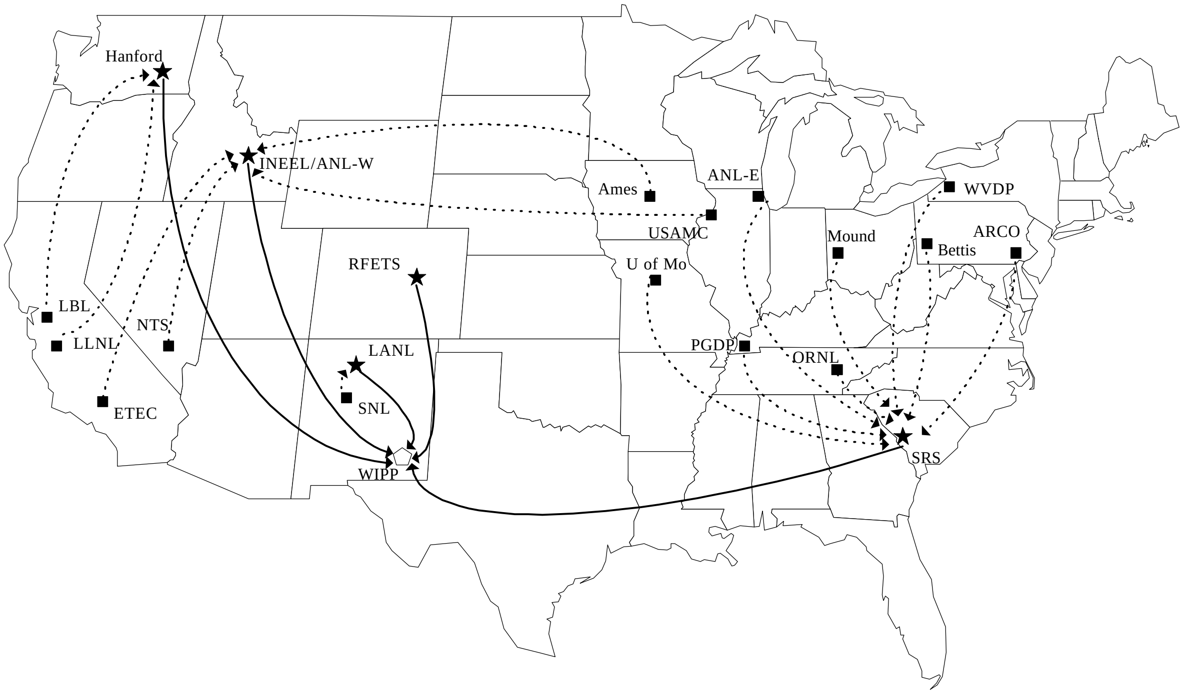
3.2.3.2 Transportation Activities

Transportation activities under this alternative would differ from those described for the Proposed Action in the following ways:

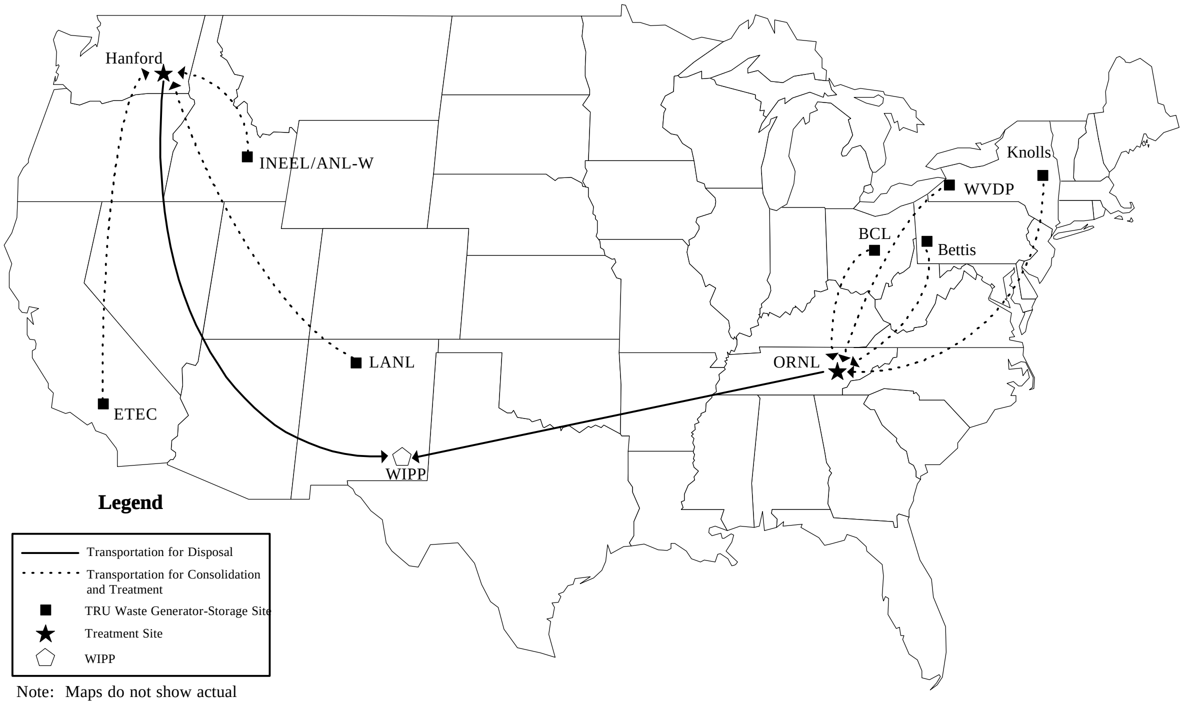
- The period of shipping to WIPP would continue for 150 years, through the year 2160 (compared to 35 years under the Proposed Action).

- SEIS-II analyses for this alternative include three transportation scenarios. The first scenario uses only trucks, as described under the Proposed Action. The other two use a

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-3
Movement of Waste for Action Alternative 2A [a]
(For complete names of facilities and waste volumes, see Tables 3-4 and 3-5)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

Table 3-6

CH-TRU Waste Volumes for Action Alternative 2B [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
	Basic Inventory	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	59,000	63,000	122,000	21,000	22,000	43,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	28,000	57,000	85,000	62,000	71,000	133,000	22,000	36,000	57,000
Argonne National Laboratory-West (ANL-W)	1,000	---	1,000	---	---	---	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	14,000	5,200	20,000	5,000	1,800	6,800
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	19	320	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**139,000**	**274,000**	**135,000**	**139,000**	**274,000**	**47,000**	**60,000**	**107,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-4.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] Dashes indicate no waste.

[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

Table 3-7
RH-TRU Waste Volumes for Action Alternative 2B [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	16,000	920	17,000
Los Alamos National Laboratory (LANL)	230	120	350	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory-West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	1,800	960	2,800
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**18,000**	**1,900**	**19,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-4.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] Dashes indicate no waste.

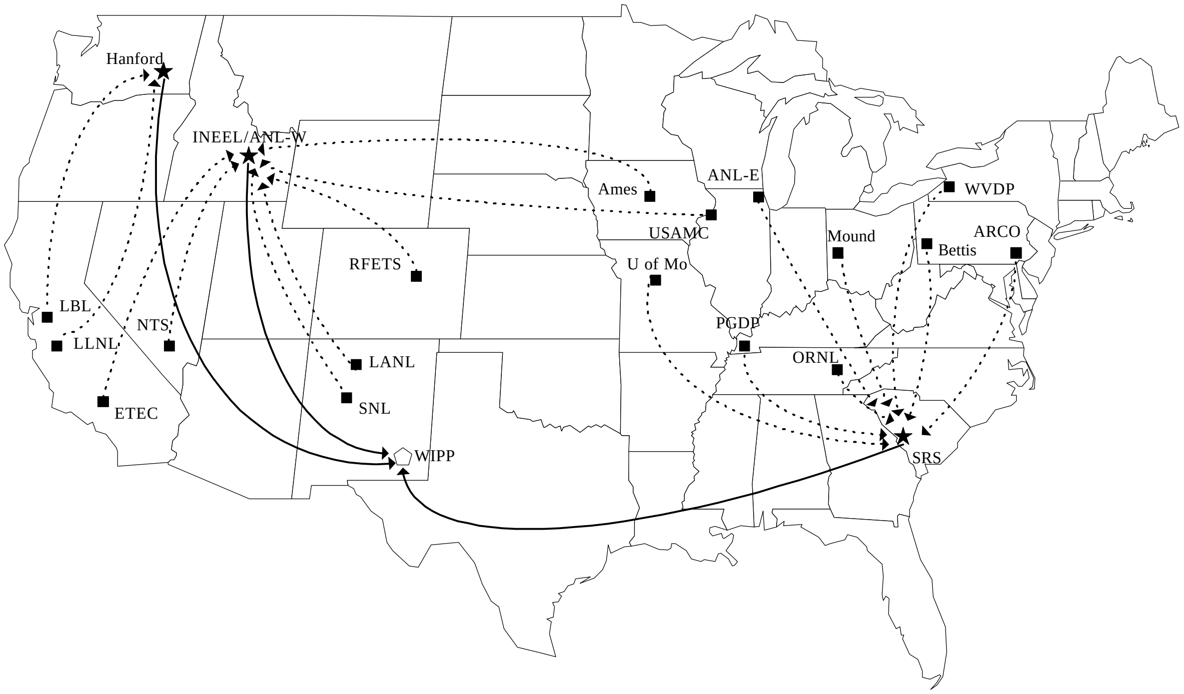
[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

mix of maximum commercial rail and truck transportation or maximum dedicated rail and truck transportation, as described in Section 3.2.2.2. WIPP already has a rail spur leading to the facility. Because little storage is permitted at WIPP, all of the transportation scenarios would be spread over the 150-year shipping period.

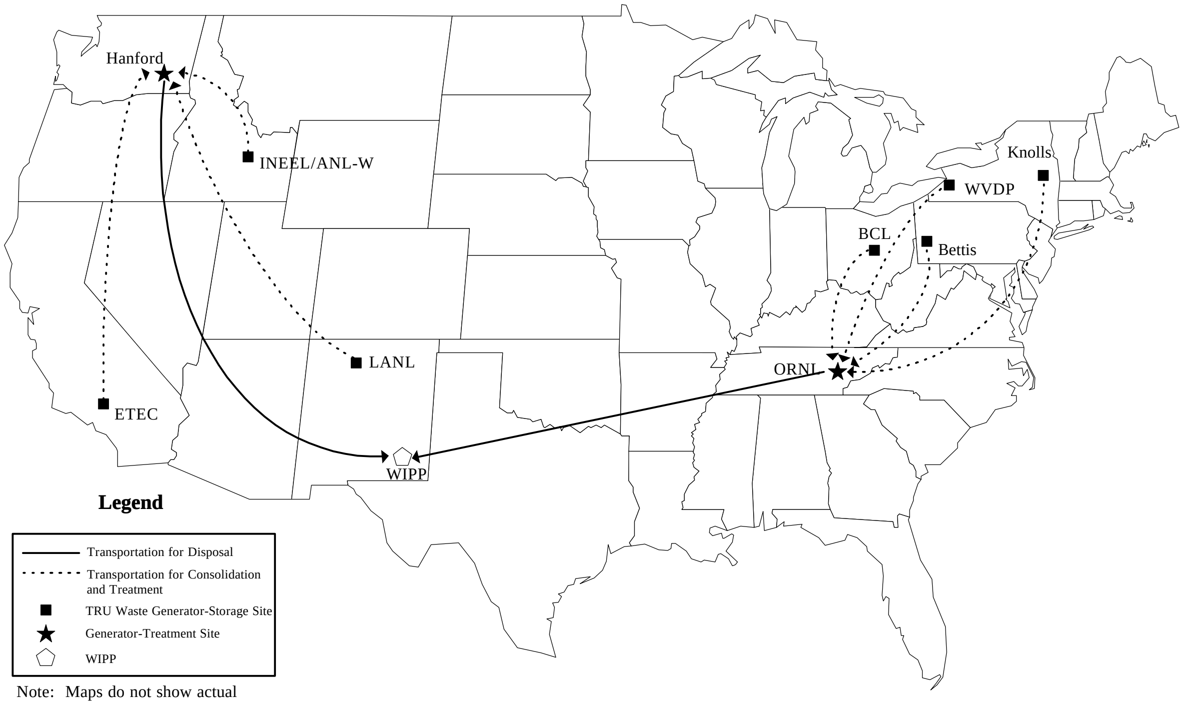
3.2.3.3 Activities at WIPP

Under Action Alternative 2, excavation operations, TRU waste handling operations at the surface, CH-TRU waste emplacement operations, closure, and decommissioning would be similar to the Proposed Action. However, this alternative would extend the operations time frame to as late as the year 2160 even though the overall emplaced waste volume would be smaller than that under all of the other alternatives. As noted above, thermal treatment results in an overall volume reduction of 65 percent. The same quantity of radionuclides would now be present in 35 percent of the original volume; therefore, radionuclide concentration and thermal power generation would increase by a factor of approximately three. Because of the increased thermal power output, CH-TRU waste and RH-TRU waste would be placed in separate panels to meet the WIPP design specifications for thermal power. About 12 panels would be required for CH-TRU waste disposal

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-4
Movement of Waste for Action Alternative 2B [a]
(For complete names of facilities and waste volumes, see Tables 3-6 and 3-7)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

Table 3-8
CH-TRU Waste Volumes for Action Alternative 2C [a]

	Site Volume Through 2033 (cubic meters)			**Pretreatment Consolidated Volume (cubic meters)**			**Post-Treatment Disposal Volume (cubic meters)**		
Site [b]	**Basic Inventory**	**Additional Inventory [c]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [c]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [c]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	--- [d]	---	---	---	---	---
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	---	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [e]	28,000	57,000	85,000	---	---	---	---	---	---
Argonne National Laboratory-West (ANL-W)	1,000	---	1,000	---	---	---	---	---	---
Argonne National Laboratory-East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	---	---	---	---	---	---
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	---	---	---	---	---	---
Oak Ridge National Laboratory(ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	19	320	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
WIPP [f]	---	---	---	135,000	139,000	274,000	47,000	60,000	107,000
Total	**135,000**	**139,000**	**274,000**	**135,000**	**139,000**	**274,000**	**47,000**	**60,000**	**107,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Sites in boldface were included in SEIS-I.

[c] TRU waste commingled with PCBs is included.

[d] Dashes indicate no waste.

[e] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[f] TRU waste is consolidated and treated at WIPP.

Table 3-9
RH-TRU Waste Volumes for Action Alternative 2C [a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
Site [d]	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	16,000	920	17,000
Los Alamos National Laboratory (LANL)	230	120	350	---[f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory-West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	1,800	960	2,800
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**18,000**	**1,900**	**19,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-5.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-II.

[e] TRU waste commingled with PCBs is included.

[f] Dashes indicate no waste.

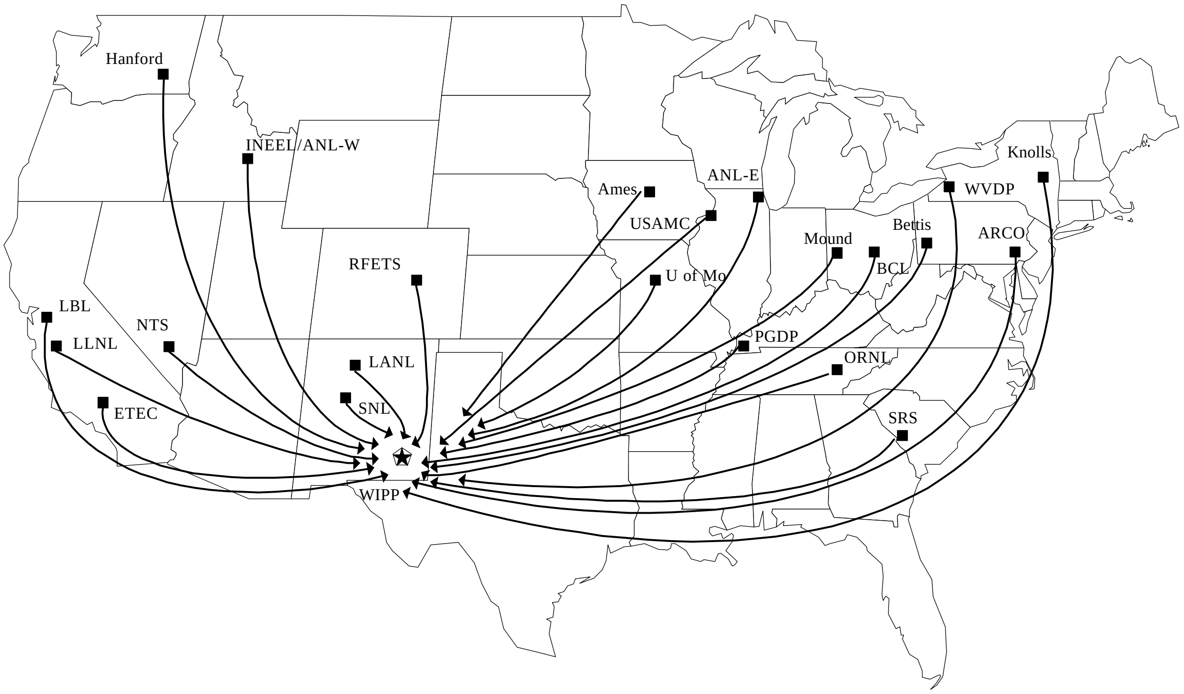
[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

and about 63 panels would be required for RH-TRU waste disposal, 75 panels total. The time required for excavation of 75 panels, at a rate of two years per panel, is the basis for the 150-year operation period. Any expansion of WIPP capacity would require changes to the LWA and the C&C Agreement.

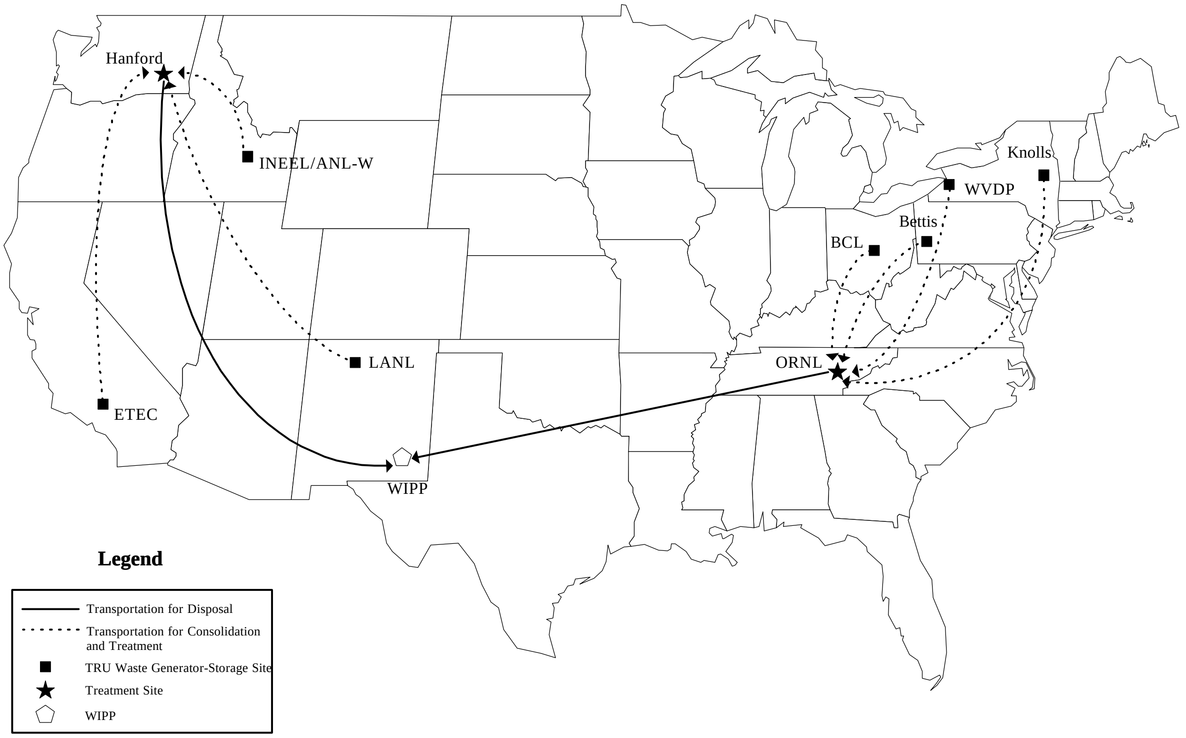
As in the Proposed Action, RH-TRU waste canisters would be emplaced in horizontal boreholes in the walls of the panels. Because of the increased volume of RH-TRU waste, other RH-TRU waste disposal options may be considered, including horizontal boreholes that could accommodate two canisters and vertical boreholes or trenches in the floors of disposal rooms.

Closure and institutional controls would be the same as those for the Proposed Action except that due to the additional years of operation, the decommissioning and active institutional control period would extend through the year 2270. A berm would be constructed around the perimeter of the site, which would include 395 hectares (976 acres), 375 hectares (927 acres) of which lies above the 75 panel equivalents, 12 hectares (30 acres) of which is for the salt pile, and 8 hectares

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-5
Movement of Waste for Action Alternative 2C [a]
(For complete names of facilities and waste volumes, see Tables 3-8 and 3-9)

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[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

(20 acres) of which is for surface facilities. DOE would restore the areas occupied by the salt pile and surface facilities, and, if necessary, any of the area overlying the disposal panel equivalents, although surface disturbance of this area would be minimal.

3.2.3.4 Reducing Operation Time

The overall operation period – including 12 years of construction for offsite thermal treatment facilities (at Hanford, SRS, RFETS, LANL, INEEL, or ORNL) - would be 150 years for all Action Alternative 2 subalternatives. Largely, though, the long operation period is due to the number of panels needed to meet the thermal limit per acre for the RH-TRU waste and an assumption that only one panel would be excavated every two years. This assumption was made to enable all of the SEIS-II alternatives to be easily comparable.

As with Action Alternative 1, stakeholders requested a more detailed understanding of how impacts would change should the Department attempt to shorten the operation time. In response, Chapter 5 of this document includes an assessment of how impacts would change if the excavation of panels were increased to reduce the total operation period to 70 years. For the purposes of the assessment, the discussion of assumptions and description of operations presented above for all of the Action Alternative 2 subalternatives would apply, with the following exceptions:

- WIPP would remain as currently operated for 12 years while thermal treatment facilities were designed and constructed. The 12 years were conservatively estimated; some facilities may begin treatment sooner. No new buildings would be constructed at WIPP because the volume of waste would be reduced by the thermal treatment, but during the first 12 years three additional shafts would be constructed to enable faster excavation and emplacement in the repository. These shafts would be an additional salt handling shaft, an additional air intake shaft, and an exhaust shaft. Further NEPA review may need to be conducted, as appropriate, before any new facilities would be built.

- Two additional excavation crews would be employed during emplacement operations. These two crews would result in approximately 10 additional WIPP employees. The two crews would enable DOE to increase the excavation rate to three panels every two years and increase the emplacement rate from 8 canisters a week to 24 canisters a week. Overall, the two crews would reduce the period of disposal operations at WIPP from 150 years to 58 years.

- Transportation to WIPP would occur during 58 years.

- Capital construction costs for the three shafts would total $24 million; annual operating costs would remain essentially the same.

3.2.4 Action Alternative 3: Total Inventory (Except PCB-Commingled Waste), Treat by Shred and Grout, Dispose of at WIPP

Action Alternative 3 would involve treating the waste with a shred and grout process. This process would increase the volume by 20 percent. For this alternative, WIPP would accept for disposal all TRU waste, which would include the Basic Inventory and the Additional Inventory without PCB-commingled waste. DOE could not dispose of some of the Additional Inventory waste types at WIPP under the current laws and agreements that regulate WIPP. Table 3-10 presents the

Table 3-10
CH-TRU Waste Volumes for Action Alternative 3 [a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
Site [d]	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	59,000	63,000	121,000	70,000	75,000	146,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	21,000	14,000	35,000	25,000	17,000	42,000
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	28,000	57,000	85,000	30,000	57,000	86,000	37,000	68,000	105,000
Argonne National Laboratory - West (ANL-W)	1,000	--- [g]	1,000	---	---	---	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	14,000	5,000	20,000	17,000	6,200	23,000
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	11,000	---	11,000	19,000	---	19,000
Oak Ridge National Laboratory (ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	---	300	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**138,000**	**273,000**	**135,000**	**138,000**	**273,000**	**168,000**	**166,000**	**334,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-6.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is not included.

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[g] Dashes indicate no waste.

CH-TRU waste volumes and Table 3-11 presents the RH-TRU waste volumes for Action Alternative 3. Figure 3-6 shows the flow of TRU waste between sites and shipment to WIPP. DOE would consolidate and treat CH-TRU waste at Hanford, INEEL, LANL, and SRS (RFETS would treat only its own waste). RH-TRU waste would be consolidated and treated at Hanford and ORNL.

Table 3-11
RH-TRU Waste Volumes for Action Alternative 3 [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Disposal Volume [c] (cubic meters)		
	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory	Basic Inventory	Additional Inventory [e]	Total Inventory
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	54,000	2,700	57,000
Los Alamos National Laboratory. (LANL)	230	120	350	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory - West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	6,300	3,300	10,000
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**60,000**	**6,000**	**66,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-6.

[c] Post-treatment volumes have been adjusted to meet packaging and transportation criteria.

[d] Sites in boldface were included in SEIS-I.

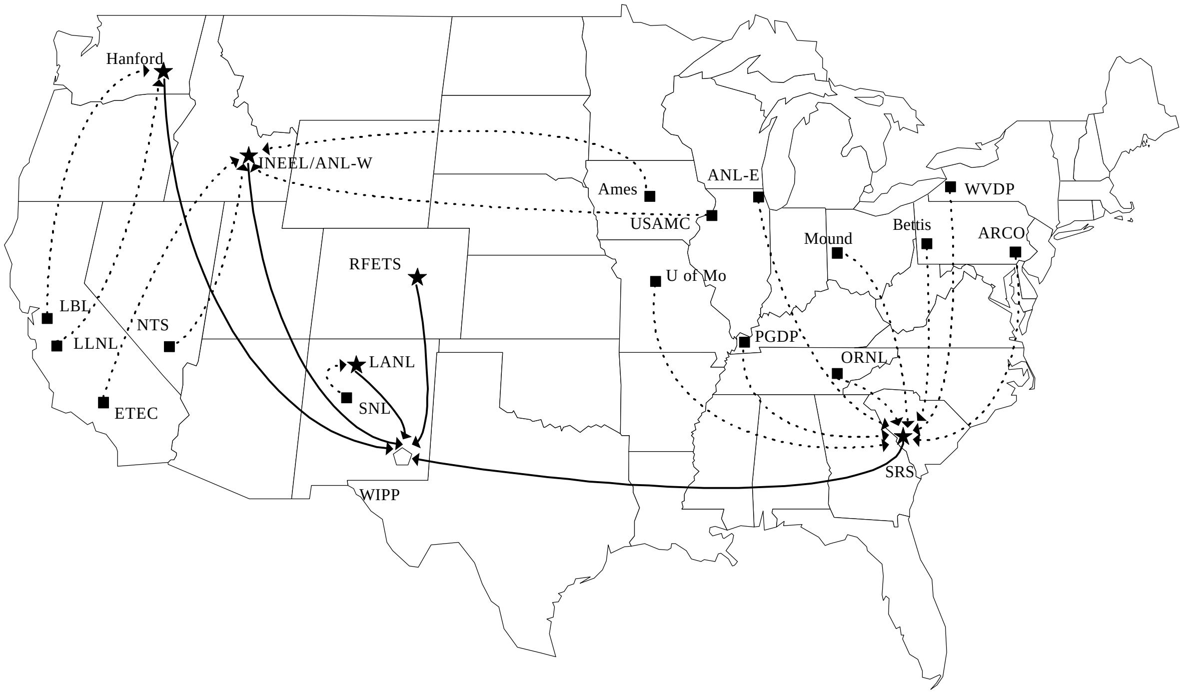
[e] TRU waste commingled with PCBs is not included.

[f] Dashes indicate no waste.

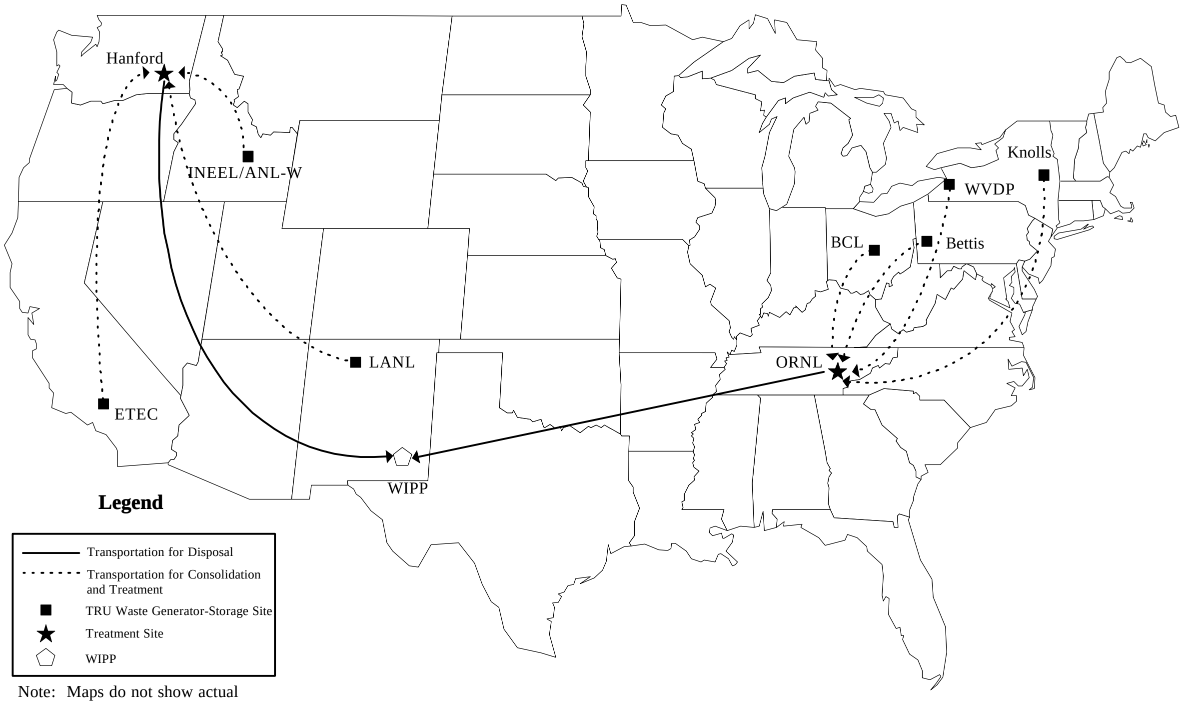
[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

The timeline below presents the approximate schedule for disposal activities under Action Alternative 3. Sites would generate waste for 35 years, beginning in 1998. It would take 12 years to design and construct the treatment facilities for Action Alternative 3. The disposal of TRU waste would begin in 2010 and would continue for 190 years, ending in 2200. The disposal operations duration is based on the time needed to emplace the total volume of RH-TRU waste, assuming a maximum emplacement rate of 356 cubic meters (12,570 cubic feet) per year, a throughput rate of eight RH-72B canisters per week (DOE 1996b), and an operating time of 50 weeks per year. Decommissioning activities would last for up to 10 years and would be

CH-TRU Waste



RH-TRU Waste

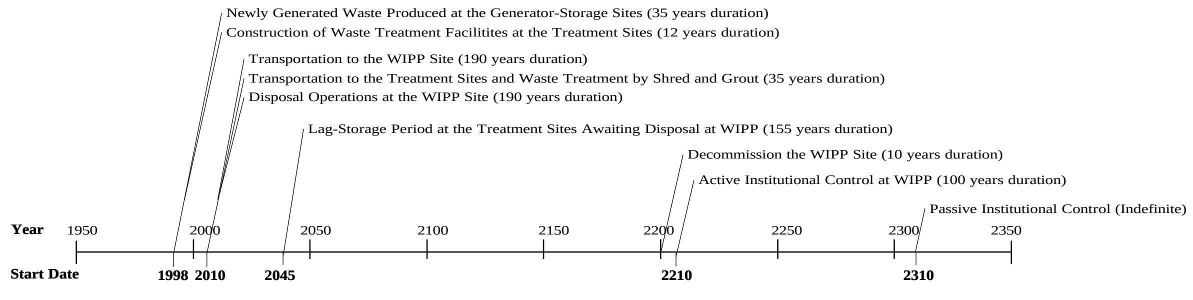


Note: Maps do not show actual transportation routes.

Figure 3-6
Movement of Waste for Action Alternative 3 [a]
(For complete names of facilities and waste volumes, see Tables 3-10 and 3-11)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

followed by an active institutional control period assumed for analyses to last 100 years, ending in 2310. (Section 3.2.4.4 discusses methods that could be used to reduce operations time for this alternative.)



Timeline for the Implementation of Action Alternative 3

3.2.4.1 Activities at the Generator-Storage Sites

The activities at the generator-storage sites are the same as those described for the Proposed Action, with the exceptions that there would be approximately twice as much waste and that treatment sites would use a shred and grout process to treat the waste. It was assumed that all waste treatment facilities would be constructed over a period of 12 years and would be ready for operation in the year 2010. Waste treatment would occur over 35 years, through the year 2045, and lag storage of the TRU waste awaiting shipment would occur for 155 years, through the year 2200. Lag storage would be necessary due to the rate of emplacement of RH-TRU waste. The lag storage would be similar to that described in Section 3.2.2.1. Engineering details of the shred and grout process that would be used have not been finalized. Nevertheless, such a process would consist of shredding the TRU waste to fragments smaller than some limiting size, perhaps 15 centimeters (6 inches); combining the fragments with a cement-based grout; and placing the mixture in disposal drums. Additional information on the TRU waste treatment processes is presented in Chapter 2.

3.2.4.2 Transportation Activities

Transportation activities under this alternative would differ from those described for the Proposed Action in the following ways:

- More than twice as many shipments as needed for the Proposed Action (based on BIR-3) would be required to transport the Basic Inventory and Additional Inventory to WIPP due to a larger pretreatment waste volume and the volume increase resulting from treatment.

- The period of shipping to WIPP would occur for 190 years, through the year 2200.

- SEIS-II analyses for this alternative include three transportation scenarios. The first scenario uses only trucks, as described under the Proposed Action. The other two use a mix of maximum commercial rail and truck transportation or maximum dedicated rail and truck transportation, as described in Section 3.2.2.2. DOE would not build new rail lines. WIPP already has a rail spur leading to the facility.

3.2.4.3 Activities at WIPP

Under Action Alternative 3, excavation operations, TRU waste handling operations at the surface, CH-TRU waste emplacement operations, closure, and decommissioning would be the same as for the Proposed Action. This alternative would extend the operations time frame to as late as the year 2200 and would accept a larger total volume of TRU waste at WIPP. Seventy-one panels would be excavated to accommodate the additional waste, with 20 panels to accommodate CH-TRU and RH-TRU waste and 51 panels for RH-TRU waste only. Any expansion of WIPP capacity would require changes to the LWA, the C&C Agreement, and various permits to operate WIPP.

As in the Proposed Action, RH-TRU waste canisters would be emplaced in horizontal boreholes in the walls of the panels. Because of the increased volume of RH-TRU waste, other RH-TRU waste disposal options may be considered, including horizontal boreholes that could accommodate two canisters and vertical boreholes or trenches in the floors of disposal rooms.

Closure and institutional controls would be the same as those for the Proposed Action, except that decommissioning and assumed active institutional control period would extend through the year 2310 because of the additional years of operation. A berm would be constructed around the perimeter of the site. This berm would include 375 hectares (927 acres), 355 hectares (877 acres) of which would lie above the 71 panel equivalents, 12 hectares (30 acres) of which would be for the salt pile, and 8 hectares (20 acres) of which would be for surface facilities. DOE would restore the areas occupied by the salt pile and surface facilities, and, if necessary, any of the area overlying the disposal panels.

3.2.4.4 Reducing Operation Time

The 190 years of total operation time for treatment and emplacement of TRU waste under Action Alternative 3 is due to the large volume of RH-TRU waste to be emplaced, the increase in that volume due to treatment, and the assumptions that only one excavation shift will be used and that only 8 RH-TRU waste canisters will be emplaced per week. These assumptions were made to ensure all of the alternatives were comparable to the Proposed Action and to each other. During the public comment period, though, stakeholders stated that the operation time was too long and that DOE should consider methods of reducing it. Stakeholders also asked that the Final SEIS-II include greater detail on how the impacts would change if the operation time were reduced.

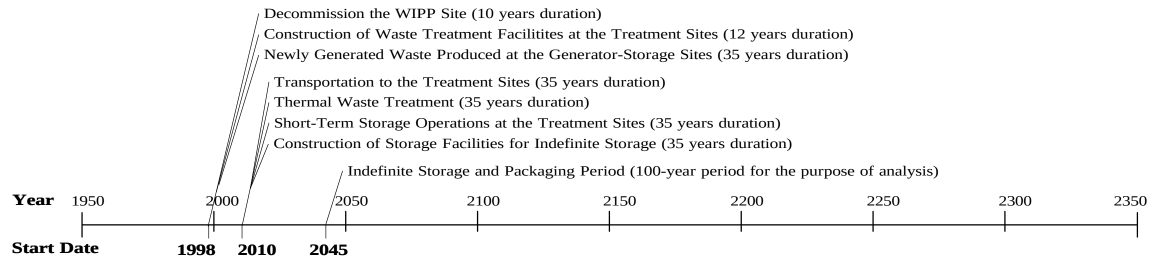
In response, this document includes analyses of impacts should the period of total operation be reduced from 162 years to 75 years by constructing new RH-TRU waste handling facilities and increasing the number of excavation crews. The 75 years would include 12 years to plan, design, and construct treatment facilities and 63 years for emplacement operations. The assumptions and description of operations presented for Action Alternative 3 above would apply, except for the following modifications:

- During the 12 years when treatment facilities would be planned, designed, and constructed, a new RH-TRU waste handling facility would be constructed at WIPP. The additional facility would include two RH-TRU waste handling areas and four new shafts into the facility. The four shafts would include a waste emplacement shaft, a salt removal shaft, an air intake shaft, and a ventilation shaft. Further NEPA review may need to be conducted, as appropriate, before any new facilities would be built.
- Two additional excavation crews would be used to excavate panels for the waste, increasing the excavation rate to three panels every two years. In all, an additional 90 WIPP employees would be hired.
- All transportation to WIPP would be completed in 63 years, following the 12-year period for construction of the treatment facilities.
- The capital cost of the new facility would be about $80 million; annual operating costs would increase by 10 percent.

3.2.5 No Action Alternative 1: Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Store Indefinitely, Dismantle WIPP

Under No Action Alternative 1, no waste would be shipped to WIPP. DOE would consolidate and thermally treat its inventory and would manage the treated waste indefinitely in newly engineered and constructed monitored storage facilities at the consolidation sites. A 65 percent reduction in volume was assumed due to the thermal treatment. The Department would dismantle the existing facilities at WIPP, salvage the equipment for other uses, and close the repository. Agreements and orders between DOE and various states, such as those under the Federal Facility Compliance Act, could require modification because of the extended time frame for storage.

Two waste treatment subalternatives were assumed for No Action Alternative 1. These two subalternatives are referred to as No Action Alternative 1A and 1B, respectively. Table 3-12 presents the CH-TRU waste volumes and Table 3-13 presents the RH-TRU waste volumes for No Action Alternative 1A. Figure 3-7 shows the flow of TRU waste between the sites. DOE would consolidate and treat CH-TRU waste at five sites (Hanford, INEEL, LANL, SRS, and RFETS) and RH-TRU waste at two sites (Hanford and ORNL). Table 3-14 presents the CH-TRU waste volumes and Table 3-15 presents the RH-TRU waste volumes for No Action Alternative 1B. Figure 3-8 shows the flow of TRU waste between sites. DOE would consolidate and treat CH-TRU waste at three sites (Hanford, INEEL, and SRS) and would treat RH-TRU waste at two sites (Hanford and ORNL). The timeline below presents the approximate schedule for No Action Alternatives 1A and 1B. Sites would generate waste for 35 years, beginning in 1998.



Timeline for the Implementation of No Action Alternatives 1A and 1B

Table 3-12
CH-TRU Waste Volumes for No Action Alternative 1A [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Volume [c] (cubic meters)		
	Basic Inventory	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	59,000	63,000	122,000	21,000	22,000	43,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	21,000	14,000	35,000	7,400	4,900	12,000
Idaho National Engineering and Environmental Laboratory (INEEL) [f]	28,000	57,000	85,000	30,000	57,000	87,000	10,000	31,000	41,000
Argonne National Laboratory - West (ANL-W)	1,000	--- [g]	1,000	---	---	---	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	14,000	5,200	20,000	5,000	1,800	6,800
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	11,000	---	11,000	3,800	---	3,800
Oak Ridge National Laboratory (ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	19	320	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Material Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**139,000**	**274,000**	**135,000**	**139,000**	**274,000**	**47,000**	**60,000**	**107,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-7.

[c] Post-treatment volumes have been adjusted to meet safe packaging criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[g] Dashes indicate no waste.

It would take 12 years to design and construct the treatment facilities for No Action Alternatives 1A and 1B. The waste would be treated for 35 years and stored indefinitely. The treated TRU waste would be placed in and maintained at newly constructed storage facilities. WIPP would be decommissioned immediately. Decommissioning would last 10 years.

Table 3-13
RH-TRU Waste Volumes for No Action Alternative 1A [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Volume [c] (cubic meters)		
	Basic Inventory	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	16,000	920	17,000
Los Alamos National Laboratory (LANL)	230	120	350	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory - West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	1,800	960	2,800
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,500**	**39,000**	**18,000**	**1,900**	**19,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-7.

[c] Post-treatment volumes have been adjusted to meet safe packaging criteria.

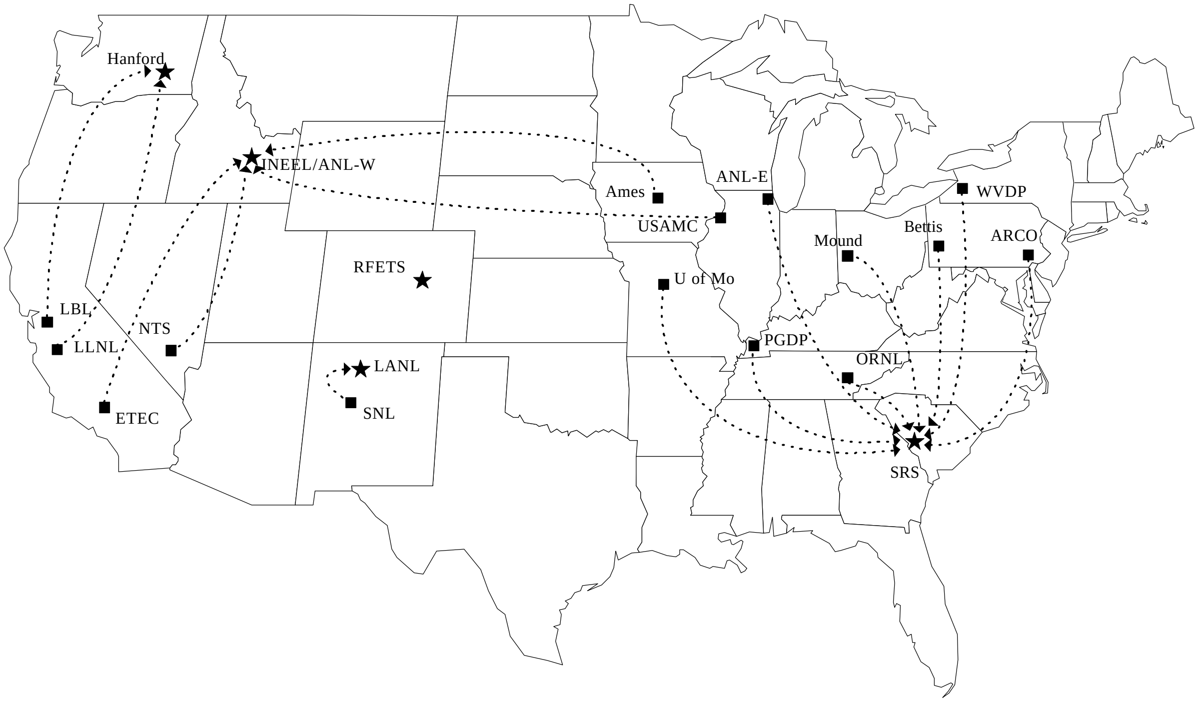
[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

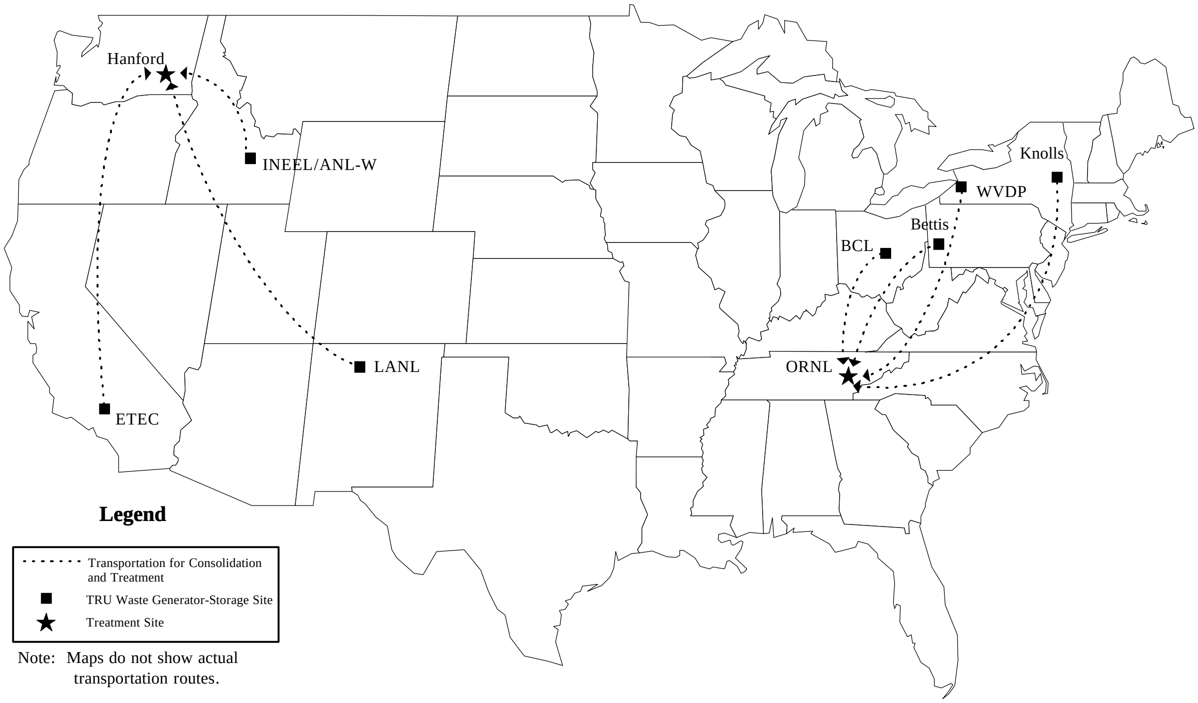
[f] Dashes indicate no waste.

[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-7
Movement of Waste for No Action Alternative 1A [a]
(For complete names of facilities and waste volumes, see Tables 3-12 and 3-13)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

Table 3-14
CH-TRU Waste Volumes for No Action Alternative 1B[a]

	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume[b] (cubic meters)			Post-Treatment Volume[c] (cubic meters)		
Site[d]	**Basic Inventory**	**Additional Inventory[e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory[e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory[e]**	**Total Inventory**
Hanford Site (Hanford)	57,000	63,000	120,000	59,000	63,000	122,000	21,000	22,000	43,000
Los Alamos National Laboratory (LANL)	21,000	14,000	35,000	---[f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL)[g]	28,000	57,000	85,000	62,000	71,000	133,000	22,000	36,000	57,000
Argonne National Laboratory - West (ANL-W)	1,000	---	1,000	---	---	---	---	---	---
Argonne National Laboratory - East (ANL-E)	200	---	200	---	---	---	---	---	---
Savannah River Site (SRS)	12,000	4,900	17,000	14,000	5,200	20,000	5,000	1,800	6,800
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	11,000	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	1,700	66	1,700	---	---	---	---	---	---
Lawrence Livermore National Laboratory (LLNL)	1,200	---	1,200	---	---	---	---	---	---
Nevada Test Site (NTS)	630	---	630	---	---	---	---	---	---
Mound Plant (Mound)	300	19	320	---	---	---	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	---	170	---	---	---	---	---	---
Sandia National Laboratories - Albuquerque (SNL)	17	1	18	---	---	---	---	---	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	8	---	---	---	---	---	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	2	---	2	---	---	---	---	---	---
University of Missouri Research Reactor (U of Mo)	1	---	1	---	---	---	---	---	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	---	---	---	---	---
ARCO Medical Products Company (ARCO)	---	1	1	---	---	---	---	---	---
Lawrence Berkeley Laboratory (LBL)	---	2	2	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	190	190	---	---	---	---	---	---
Total	**135,000**	**139,000**	**274,000**	**135,000**	**139,000**	**274,000**	**47,000**	**60,000**	**107,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-8.

[c] Post-treatment volumes have been adjusted to meet safe packaging criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

[f] Dashes indicate no waste.

[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

Table 3-15
RH-TRU Waste Volumes for No Action Alternative 1B [a]

Site [d]	Site Volume Through 2033 (cubic meters)			Pretreatment Consolidated Volume [b] (cubic meters)			Post-Treatment Volume [c] (cubic meters)		
	Basic Inventory	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**	**Basic Inventory**	**Additional Inventory [e]**	**Total Inventory**
Hanford Site (Hanford)	29,000	1,000	30,000	32,000	1,600	33,000	16,000	920	17,000
Los Alamos National Laboratory (LANL)	230	120	350	--- [f]	---	---	---	---	---
Idaho National Engineering and Environmental Laboratory (INEEL) [g]	220	440	660	---	---	---	---	---	---
Argonne National Laboratory - West (ANL-W)	1,700	---	1,700	---	---	---	---	---	---
Oak Ridge National Laboratory (ORNL)	3,100	120	3,200	3,700	1,900	5,600	1,800	960	2,800
Bettis Atomic Power Laboratory (Bettis)	9	---	9	---	---	---	---	---	---
Energy Technical Engineering Center (ETEC)	7	---	7	---	---	---	---	---	---
Battelle Columbus Laboratories (BCL)	580	---	580	---	---	---	---	---	---
Knolls Atomic Power Laboratory (Knolls)	---	81	81	---	---	---	---	---	---
West Valley Demonstration Project (WVDP)	---	1,700	1,700	---	---	---	---	---	---
Total	**35,000**	**3,500**	**39,000**	**35,000**	**3,600**	**39,000**	**18,000**	**1,900**	**19,000**

[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Volumes include consolidation of waste as indicated on Figure 3-8.

[c] Post-treatment volumes have been adjusted to meet safe packaging criteria.

[d] Sites in boldface were included in SEIS-I.

[e] TRU waste commingled with PCBs is included.

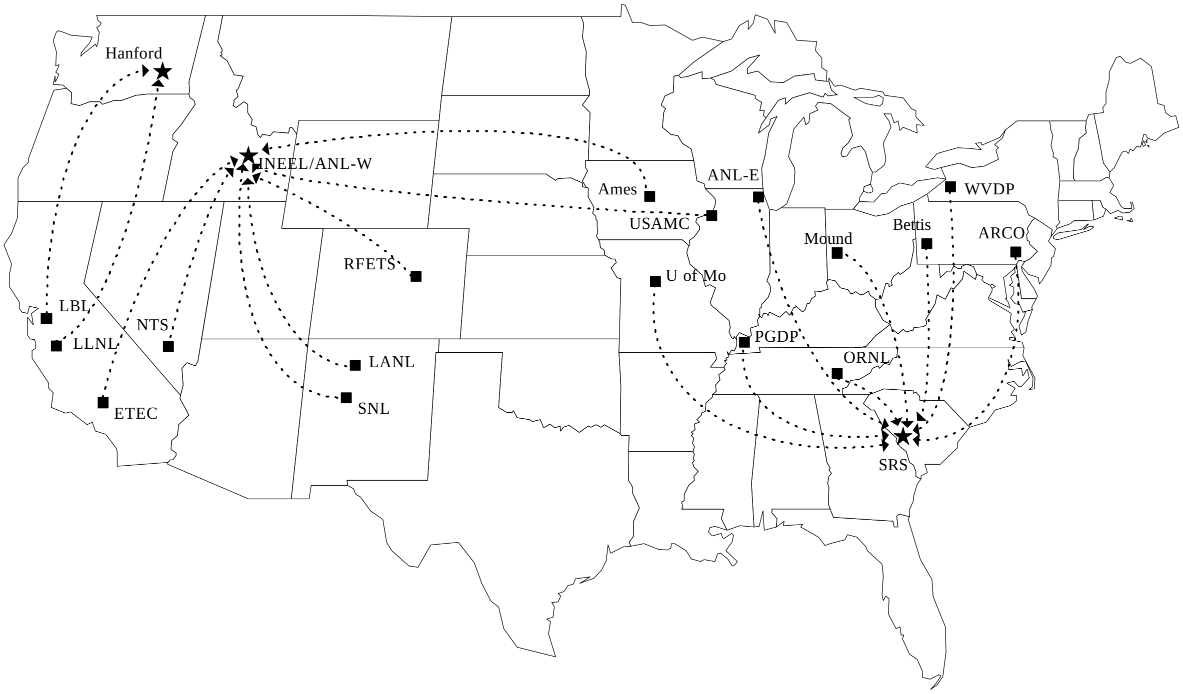
[f] Dashes indicate no waste.

[g] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

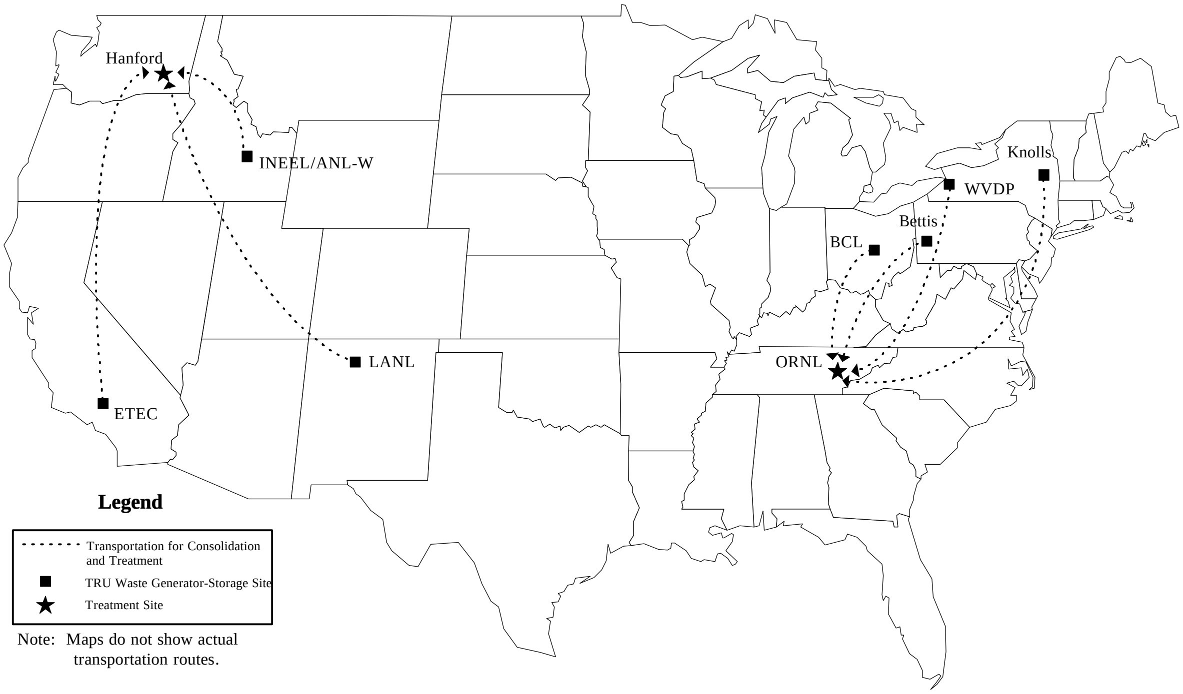
3.2.5.1 Activities at the Generator-Storage Sites

Consolidation sites would use a thermal treatment process that may involve vitrification. This process would destroy organic matter, thereby reducing the total volume of thermally treated waste. A vitrification process would add silica-based materials that would result in a glass-like product. The volumes shown in Tables 3-12 through 3-15 reflect the currently stored and projected volumes and any thermal treatment. Waste treatment facilities would be constructed over a period of 12 years and would be ready for operation in the year 2010. The treated waste would be managed for an indefinite period of time at the consolidation sites in newly engineered, monitored storage facilities. Though the Department would investigate designing packages with longer minimal shelf-lives than those currently used, to bound the impacts it was assumed for the SEIS-II analyses that CH-TRU waste packaging would be performed every 20 years. Currently used drums and waste boxes have a relatively short design life and would degrade over time due to corrosion. It was further assumed, for purposes of analysis, that the storage facilities themselves would be refurbished or replaced at least every 50 years, although the Department may attempt to design facilities with a longer lifetime under this alternative.

CH-TRU Waste



RH-TRU Waste



Note: Maps do not show actual transportation routes.

Figure 3-8
Movement of Waste for No Action Alternative 1B [a]
(For complete names of facilities and waste volumes, see Tables 3-14 and 3-15)

[a] Although Pantex currently has no TRU waste, future decisions by the Department may result in TRU waste generation at Pantex.

3.2.5.2 Transportation Activities

Transportation activities under this alternative would differ from those described for the Proposed Action in the following ways:

- No waste would be shipped to WIPP.
- The period of shipping to consolidation sites would begin in the year 2010.
- SEIS-II analyses for this alternative include three transportation scenarios. The first scenario uses only trucks, as described under the Proposed Action. The other two scenarios use a mix of maximum commercial rail and truck transportation and maximum dedicated rail and truck transportation, as described in Section 3.2.2.2.

3.2.5.3 Activities at WIPP

There would be no disposal activities at WIPP; the Department would terminate its WIPP mission. DOE would fill the shafts with salt from the storage pile and then seal the excavation. The aboveground site would be restored and perhaps returned to the U.S. Bureau of Land Management (BLM). DOE would salvage all usable equipment and dismantle and remove the surface facilities.

3.2.6 No Action Alternative 2: Basic Inventory, Treat Newly Generated TRU Waste to WAC, Store at Generator Sites, Dismantle WIPP

Activities associated with No Action Alternative 2 are discussed below. There would be no treatment of stored waste, although newly generated waste would be treated to the requirements of WAC for safe storage. There would be no transportation of any of the waste from the generator-storage sites, unless future agreements require such movement.

3.2.6.1 Activities at the Generator-Storage Sites

Under No Action Alternative 2, no waste would be shipped to WIPP. Current TRU waste management practices would continue at all sites, except where DOE has entered into agreements to have waste removed from small quantity sites to facilitate safe long-term storage. In such cases, shipment of TRU waste from a small quantity site to a consolidation site would be by truck. Newly generated TRU waste would be treated to WAC for safe storage. Existing TRU waste in storage would not be treated but would continue to be managed under current practices. Newly generated waste would constitute about 73,000 cubic meters (2,600,000 cubic feet) of the 135,000 cubic meters (4,800,000 cubic feet) of CH-TRU waste and 32,000 cubic meters (1,100,000 cubic feet) of the 35,000 cubic meters (1,200,000 cubic feet) of RH-TRU waste in the Basic Inventory. Table 3-16 presents TRU waste volumes for No Action Alternative 2.

Table 3-16
TRU Waste Volumes for No Action Alternative 2 [a]

Site [b]	Site Volume Through 2033 (cubic meters)		Stored Volume (1995) (cubic meters)		Newly Generated Post-Treatment Volume (cubic meters)	
	CH-TRU	RH-TRU	CH-TRU	RH-TRU	CH-TRU	RH-TRU
Hanford Site (Hanford)	57,000	29,000	12,000	200	45,000	29,000
Los Alamos National Laboratory (LANL)	21,000	230	11,000	90	10,000	130
Idaho National Engineering and Environmental Laboratory (INEEL) [c]	28,000	220	28,000	220	---	---
Argonne National Laboratory - West (ANL-W)	1,000	1,700	7	20	1,000	1,700
Argonne National Laboratory - East (ANL-E)	200	--- [d]	25	---	180	---
Savannah River Site (SRS)	12,000	---	2,900	---	9,200	---
Rocky Flats Environmental Technology Site (RFETS)	11,000	---	4,900	---	6,000	---
Oak Ridge National Laboratory (ORNL)	1,700	3,100	1,300	2,500	350	600
Lawrence Livermore National Laboratory (LLNL)	1,200	---	230	---	960	---
Nevada Test Site (NTS)	630	---	620	---	10	---
Mound Plant (Mound)	300	---	300	---	---	---
Bettis Atomic Power Laboratory (Bettis)	170	9	---	---	170	9
Sandia National Laboratories - Albuquerque (SNL)	17	---	7	---	10	---
Paducah Gaseous Diffusion Plant (PGDP)	8	---	---	---	8	---
U.S. Army Materiel Command (USAMC)	3	---	3	---	---	---
Energy Technology Engineering Center (ETEC)	2	7	2	6	---	1
University of Missouri Research Reactor (U of Mo)	1	---	1	---	1	---
Ames Laboratory - Iowa State University (Ames)	1	---	1	---	1	---
Battelle Columbus Laboratories (BCL)	---	580	---	580	---	---
Total	**135,000**	**35,000**	**62,000**	**3,600**	**73,000**	**32,000**

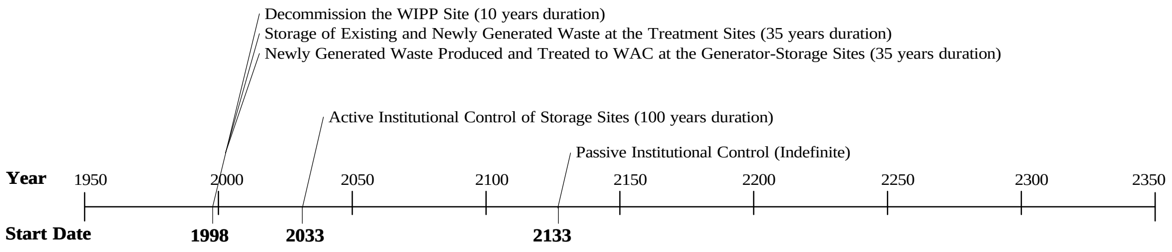
[a] The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites. Waste exceeding 50 ppm of PCBs cannot be disposed of in WIPP unless treated to remove the PCBs first. Site volumes through 2033 are the sum of similar columns on Tables 2-2 and 2-3. Volumes have been rounded. Actual totals may differ due to rounding.

[b] Sites in boldface were included in SEIS-I.

[c] INEEL and ANL-W are considered as one site in the WM PEIS and, therefore, counted as one site in SEIS-II.

[d] Dashes indicate no waste.

A timeline below presents the approximate schedule under No Action Alternative 2. Sites would continue to generate waste for 35 years and would store the waste. WIPP would be decommissioned beginning immediately.



Timeline for the Implementation of No Action Alternative 2

3.2.6.2 Transportation Activities

The generator-storage sites would only ship waste to the consolidation sites if it were to facilitate safe storage or requirements of future agreements. No waste would be shipped to WIPP.

3.2.6.3 Activities at WIPP

There would be no disposal activities at WIPP; the Department would terminate its WIPP mission. DOE would fill the shafts with salt and then seal the excavation. DOE would restore the aboveground site and perhaps return it to the BLM. DOE would salvage all usable equipment and dismantle and remove the surface facilities according to the WIPP Land Management Plan (DOE 1993).

3.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

SEIS-II does not include detailed analyses of several alternatives discussed during the scoping process. These alternatives were not analyzed in detail because — depending on the alternative — they are not technically viable, would not adequately or economically meet DOE's need to safely dispose of TRU waste in a timely manner, involve additional environmental and policy concerns that would need to be accommodated, or are otherwise unreasonable in the present context. The following alternatives are not analyzed in detail.

Transmutation. An accelerator or a reactor could possibly be used to transmute long-lived radionuclides into short-lived or stable nuclides; however, the transmutation process has not been demonstrated for TRU waste. Also, transmutation is a technology that has not yet been proven for production-size facilities. The transmutation process, as well as reactor operations, would result in fission products that would have to be disposed of as radioactive waste by some other method. This alternative was considered and rejected for the same reasons in the 1980 *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) (DOE 1980). DOE is not aware of any proven physical or chemical techniques that will neutralize or change the fundamental physical process of radioactive decay. The National Academy of Sciences (NAS) (1996) published a report that evaluated the relative effects, costs, and feasibility of employing separations and transmutation technologies in DOE programs. (These technologies would be used for managing spent nuclear fuel for civilian power reactors and radioactive wastes in tanks at selected existing defense production reactor sites. To DOE's knowledge there has been no similar detailed, independent study with respect to TRU waste.) Based on this research, DOE does not believe that transmutation represents a technically achievable, cost-effective, near-term alternative for the elimination or disposal of TRU waste.

Coprocess with high level waste and vitrify[1]. TRU and high level waste could be combined and mixed with molten glass. This vitrification would produce highly radioactive glass "logs" that would have to be stored in interim storage and eventually buried in a geologic repository (NAS 1994). While the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (DOE 1996c) considered this process to be a reasonable alternative for analysis, it is a much less reasonable alternative for TRU waste. The technical difficulties of thermal loading in a high-level waste repository, the operational difficulties

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[1] Vitrification of TRU waste not mixed with high-level waste is considered in SEIS-II.

SEIS-II AND THE WM PEIS ALTERNATIVES

Each SEIS-II alternative reflects an alternative in the WM PEIS in the way consolidation of waste is assumed.

The SEIS-II Proposed Action assumes, for the purposes of analyses, consolidation similar to the WM PEIS Decentralized Alternative, which was the basis for the WM PEIS preferred alternative. As in the WM PEIS Decentralized Alternative, the Proposed Action assumes that TRU waste would be treated to WAC at the facility where it currently is stored or would be generated. The waste would then be consolidated at the 10 facilities with the largest volume of waste to await disposal at WIPP. Those 10 sites are Hanford, LANL, INEEL, ANL-East, SRS, RFETS, ORNL, Lawrence Livermore National Laboratory (LLNL), NTS, and the Mound Plant (Mound). The SEIS-II inventory includes small quantities of TRU waste from several sites that were not considered for the WM PEIS. Waste from these sites would be consolidated at the closest site with larger volumes, if necessary.

The SEIS-II Action Alternative 1 also assumes, for analysis purposes, consolidation similar to the WM PEIS Decentralized Alternative. TRU waste would be treated to WAC at the facility where it currently is stored or would be generated. The waste would then be consolidated at the same 10 facilities as assumed for the Proposed Action. (The major difference between the SEIS-II Proposed Action and the SEIS-II Action Alternative 1 is the amount of waste to be disposed of.)

The three SEIS-II Action Alternative 2 subalternatives assume, for analysis purposes, consolidation similar to the WM PEIS Regionalized 2, Regionalized 3, and Centralized Alternatives. In each, the TRU waste would be consolidated at treatment sites where it would be treated by a thermal process to meet the RCRA LDRs. The three different consolidation options considered under Action Alternative 2 are:

- **Action Alternative 2A:** Assumes for analysis that CH-TRU waste would be treated at Hanford, SRS, RFETS, LANL, and INEEL/ANL-W. Assumes that RH-TRU waste would be treated at Hanford and ORNL. The consolidation used for analysis is similar to the WM PEIS Regionalized 2 Alternative.

- **Action Alternative 2B:** Assumes for analysis that CH-TRU waste would be treated at Hanford, SRS, and INEEL/ANL-W. Assumes that RH-TRU waste would be treated at Hanford and ORNL. The consolidation used for analysis is similar to the WM PEIS Regionalized 3 Alternative.

- **Action Alternative 2C:** Assumes for analysis that CH-TRU waste would be treated at WIPP. Assumes that RH-TRU waste would be treated at Hanford and ORNL. The consolidation used for analysis is similar to the WM PEIS Centralized Alternative.

The SEIS-II Action Alternative 3 is similar to the WM PEIS Regionalized 1 Alternative. For both alternatives, TRU waste would be consolidated at regional sites throughout the country and treated by a shred and grout process before shipping the TRU waste to WIPP. CH-TRU waste would be treated at Hanford, LANL, RFETS, SRS, and INEEL/ANL-W. RH-TRU waste would be treated at Hanford and ORNL.

The two SEIS-II No Action Alternative 1 subalternatives are similar to the WM PEIS Regionalized 2 and Regionalized 3 Alternatives. The waste would be treated at the same sites described above for the SEIS-II Action Alternatives 2A, 2B, and 2C. SEIS-II No Action Alternative 1A is similar to the WM PEIS Regionalized 2 Alternative; SEIS-II No Action Alternative 1B is similar to the WM PEIS Regionalized 3 Alternative.

The SEIS-II No Action Alternative 2 is similar to both the WM PEIS Decentralized and No Action Alternatives. The currently stored waste would be left untreated. Newly generated waste would be treated to WAC. All waste would be stored at the sites where it is currently stored or would be generated.

that a large additional volume of TRU waste would cause, and potential legislative clarification or Nuclear Regulatory Commission certification by rule, make this alternative unreasonable.

Disposal in space. This alternative was considered and rejected in the FEIS. The disposal of TRU waste in a low earth orbit would not be sufficient because material in such an orbit would fall back to earth over a time span that is short as compared to the necessary disposal time and decay time of the TRU waste. Therefore, the waste would have to be launched into an orbit around the sun that is unlikely to encounter the earth or be put on a path to fall into the sun or escape the solar system entirely. The type and number of rockets needed for this type of launch would be very expensive, and the rockets would have to be very reliable. Research shows that even with reliable rockets the possibility of a rocket failure exists, and such a failure could result in the waste reentering from space (NAS 1994).

Underground detonation. Such detonations would produce a large amount of hazardous fission products. Research shows that the waste form resulting from a detonation would be somewhat unpredictable and it would be embedded in an underground location not selected for, or designed as, a long-term repository (NAS 1994). Because of the volume of waste to be disposed of, a large number of detonations would be required. Also, the geologic environment around the detonation points would be greatly disturbed. The manufacture of the explosive devices used in the detonations would generate more waste. This alternative would present additional environmental and policy concerns that would have to be addressed.

Subseabed disposal. This alternative was considered and rejected in the FEIS. Subseabed disposal of TRU waste would involve implanting canisters of TRU waste tens of meters into deep ocean sediments by free-fall penetration or other techniques (DOE 1980). In addition, subseabed disposal is prohibited by international treaties, and further development would be required. The U.S. program studying subseabed disposal was canceled in 1986, and no other country is currently pursuing such research.

Deep borehole disposal. This alternative involves drilling or sinking very deep boreholes or shafts (3,000-meters [9,840-feet] or more) and placing TRU waste canisters into these holes. This method relies on the surrounding rock to contain the waste and on the great depths to delay the release and reentry of radioactive material into the biosphere. This disposal method was reviewed in the FEIS (DOE 1980) and was ruled out because of substantial technical challenges in characterizing the geological conditions at the depth of interest, severe engineering problems in excavating deep holes and emplacing waste canisters, and the large number of boreholes (800 to 1,300) estimated to be required. Deep borehole disposal was evaluated as a candidate technology for possible disposal of surplus fissile materials (DOE 1996c). However, the technology may be more practicable for disposal of surplus fissile materials than for disposal of TRU waste because the volume of fissile materials potentially requiring disposal is many times smaller than the volume of TRU waste. Also, because many years of investigation and development would be needed before this method might be available for the disposal of TRU waste, selection of this technology would considerably delay the disposal of TRU waste.

Greater confinement (shallow borehole). This disposal method involves burial of waste in containers engineered to provide multiple barriers in shallow boreholes at a depth of about 100 feet. At many DOE sites, waste buried at this depth would likely interact with groundwater and could eventually pose an environmental and human health hazard. Greater confinement disposal is being used for some waste types at the NTS, which has a deep water table, and greater confinement disposal of small quantities of TRU waste in this manner might be feasible. The degree of isolation that could be provided by greater confinement disposal over the 10,000-year-plus period WIPP would be expected to isolate waste is unknown, but this relatively shallow burial method offers no apparent advantage over disposal at WIPP. The need to evaluate the ability of any anticipated greater confinement disposal site to isolate waste would further delay disposal of TRU waste by several years. For the volume of waste that DOE proposes to dispose of in WIPP, greater confinement disposal would be a less cost-effective method of disposal.

Geologic repositories at sites other than WIPP. Three general classes of geologic media have been considered in the past for the disposal of radioactive waste (DOE 1980). These geologic media are salt, igneous rocks (granite, basalt, and tuff), and argillaceous rocks (shale). Salt is a favorable disposal media because of its thermal and physical properties and because its very survival for hundreds of millions of years has demonstrated its isolation from circulating groundwater and the stability of the geologic formations in which it is located (DOE 1980).

Alternative Engineered Barriers. Regulations within 40 CFR Part 194 suggest that alternative engineered barriers, including some not specifically examined here (e.g., supercompaction, improved waste canisters, grout and bentonite backfill) should be considered. The Department examined these as alternatives and determined based on the evaluation conducted in the *Engineered Alternatives Cost/Benefit Study Final Report* (DOE 1995b) that they were less effective than the engineered barriers examined in SEIS-II.

Other Suggestions. Zircon technology and changing the state of atoms to “supercold” in order to slow down radionuclide activity were technologies suggested for TRU waste treatment methods during the public scoping process. None of these technologies are currently technically or economically feasible, and their use as treatment or disposal alternatives would require additional research.

3.4 COMPARISON OF THE PROPOSED ACTION AND ALTERNATIVES

Table 3-17 gives a tabular comparison of the major features of the Proposed Action and the alternatives. This table is meant to help the reader understand the differences and similarities among the different courses of action described in SEIS-II. Figures 3-9 and 3-10 provide graphical comparisons of the CH-TRU and RH-TRU post-treatment waste volumes that would be disposed of according to alternative.

Over the life of the campaign, routine operation under the Proposed Action could result in five estimated worker fatalities at waste treatment sites and three worker fatalities at WIPP. Truck transportation under the Proposed Action could result in an estimated additional eight deaths among members of the public and crew. Although highly unlikely, the most severe accident, a severe truck accident with a maximum radionuclide inventory having a frequency of less than 7.5 x 10^{-7} per accident, could result in an additional 16 deaths. The waste disposed of at WIPP under the Proposed Action would be isolated from the environment for more than 10,000 years unless an intrusion by drilling occurred. If an intrusion occurred, radionuclides could reach the Culebra Dolomite, but impacts would be negligible. Health impacts due to any released waste at the storage sites could vary depending on the population density in the vicinity at the time the waste was released. The Proposed Action would be the least expensive of the action alternatives ($19.03 billion in 1994 dollars, $10.13 billion when the costs are discounted).

Table 3-17
Summary of WIPP SEIS-II Alternatives

Comparison Parameters	*Proposed Action (Preferred Alternative):* **Basic Inventory, Treat to WAC, Dispose of at WIPP**	*Action Alternative 1:* **Total Inventory (Except PCB-Commingled TRU Waste), Treat to WAC, Dispose of at WIPP**	*Action Alternative 2:* **Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Dispose of at WIPP**	*Action Alternative 3:* **Total Inventory (Except PCB-Commingled TRU Waste), Treat by Shred and Grout, Dispose of at WIPP**	*No Action Alternative 1:* **Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Store Indefinitely, Dismantle WIPP**	*No Action Alternative 2:* **Basic Inventory, Treat Newly Generated TRU Waste to WAC, Store at Generator Sites, Dismantle WIPP [a]**
Waste Type	Defense-related, post-1970 TRU waste in retrievable storage and newly generated through the year 2033 (Basic Inventory).	Basic Inventory plus other DOE-owned or controlled waste including non-defense, commercial, previously disposed of waste, and excluding PCB-commingled waste (Additional Inventory).	Basic Inventory plus Additional Inventory (including PCB-commingled waste).	Basic Inventory plus Additional Inventory (excluding PCB-commingled waste).	Basic Inventory plus Additional Inventory (including PCB-commingled waste).	Same as Proposed Action.
Post-Treatment Volume[b] to be Disposed of at WIPP, or Stored	CH-TRU: 168,500 m^3 (5,950,000 ft^3) RH-TRU: 7,080 m^3 (250,000 ft^3) Excess Waste[c] RH-TRU 43,000 m^3 (1,500,000 ft^3)	CH-TRU: 281,000 m^3 (9,900,000 ft^3) RH-TRU: 55,000 m^3 (2,000,000 ft^3)	CH-TRU: 107,000 m^3 (3,800,000 ft^3) RH-TRU: 19,000 m^3 (690,000 ft^3)	CH-TRU: 334,000 m^3 (11,800,000 ft^3) RH-TRU: 66,000 m^3 (2,300,000 ft^3)	CH-TRU: 107,000 m^3 (3,800,000 ft^3) RH-TRU: 19,000 m^3 (690,000 ft^3)	CH-TRU: 135,000 m^3 (4,800,000 ft^3) RH-TRU: 35,000 m^3 (1,200,000 ft^3)
Waste Consolidation Locations (assumed for purposes of analyses; actual consolidation would be in accordance with the ROD for the WM PEIS)	18 sites total - WAC treatment of CH-TRU at the largest sites and store at 10 largest sites[d]. Ship to WIPP. - WAC treatment of RH-TRU at Hanford, INEEL/ANL-W, ORNL, and LANL. Ship to WIPP.	22 sites total - Same as Proposed Action except two other sites (LBL, WVDP) consolidate and treat CH-TRU at Mound and Hanford.	22 sites total Action Alternative 2A - LDR treatment of CH-TRU at Hanford, INEEL, LANL, SRS, and RFETS. - LDR treatment of RH-TRU at Hanford and ORNL. Action Alternative 2B - LDR treatment of CH-TRU at Hanford, INEEL, and SRS. - LDR treatment of RH-TRU at Hanford and ORNL. Action Alternative 2C - LDR treatment of CH-TRU at WIPP. - LDR treatment of RH-TRU at Hanford and ORNL.	22 sites total - Shred and grout treatment of CH-TRU at Hanford, INEEL, LANL, SRS, and RFETS. - Shred and grout RH-TRU at Hanford and ORNL.	22 sites total No Action Alternative 1A - LDR treatment of CH-TRU at Hanford, INEEL, LANL, SRS, and RFETS. - LDR treatment of RH-TRU at Hanford and ORNL. No Action Alternative 1B - LDR treatment of CH-TRU at Hanford, INEEL, and SRS. - LDR treatment of RH-TRU at Hanford and ORNL.	Minimal consolidation to ensure safe storage; however, no sites would ship to WIPP.
Waste Treatment	Treat to meet WAC.	Treat to meet WAC.	Thermal treatment to meet the LDRs (including PCB-commingled waste).	Treatment by shred and grout.	Thermal treatment to meet the LDRs (including PCB-commingled waste). Package every 20 years indefinitely.	Newly generated waste treated to WAC.

Table 3-17
Summary of WIPP SEIS-II Alternatives — Continued

Comparison Parameters	*Proposed Action (Preferred Alternative):* **Basic Inventory, Treat to WAC, Dispose of at WIPP**	*Action Alternative 1:* **Total Inventory (Except PCB-Commingled TRU Waste), Treat to WAC, Dispose of at WIPP**	*Action Alternative 2:* **Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Dispose of at WIPP**	*Action Alternative 3:* **Total Inventory (Except PCB-Commingled TRU Waste), Treat by Shred and Grout, Dispose of at WIPP**	*No Action Alternative 1:* **Total Inventory (Including PCB-Commingled TRU Waste), Treat Thermally to Meet LDRs, Store Indefinitely, Dismantle WIPP**	*No Action Alternative 2:* **Basic Inventory, Treat Newly Generated TRU Waste to WAC, Store at Generator Sites, Dismantle WIPP [a]**
Transportation Mode	Truck. The Preferred Alternative reserves the option of rail transportation.	Three options: - Truck only - Maximum[e] commercial rail - Maximum dedicated rail	Three options: - Truck only - Maximum[e] commercial rail - Maximum dedicated rail	Three options: - Truck only - Maximum[e] commercial rail - Maximum dedicated rail	Three options: - Truck only - Maximum[e] commercial rail - Maximum dedicated rail	Truck only.
Disposal Operations	CH-TRU stacked in disposal rooms. RH-TRU placed in horizontal boreholes. RH-TRU disposal would start 6 years after CH-TRU and 7,080 m^3 (250,000 ft^3) of RH-TRU can be disposed of. 10 panel equivalents required at WIPP.[f]	CH-TRU stacked in disposal rooms. RH-TRU would be placed in either of horizontal and vertical boreholes, and/or provided extra shielding to CH-TRU levels. 68 panel equivalents required at WIPP.	CH-TRU stacked in disposal rooms. RH-TRU would be placed in either of horizontal and vertical boreholes, and/or provided extra shielding to CH-TRU levels. 75 panel equivalents required at WIPP.	CH-TRU stacked in disposal rooms. RH-TRU would be placed in either of horizontal and vertical boreholes, and/or provided extra shielding to CH-TRU levels. 71 panel equivalents required at WIPP.	No disposal. CH-TRU and RH-TRU would be in newly engineered, monitored storage at treatment sites.	No disposal. CH-TRU and RH-TRU continue to use existing storage.
WIPP Operations Time Frame [g]	Receive and emplace waste beginning 1998 for 35 years. Decommissioning for 10 years and active institutional control for 100 years, ending in 2143.	Same as Proposed Action, lag storage for 125 years and disposal would be for 160 years, until 2158; active institutional control ending in 2268.	Waste disposal and thermal treatment to meet the LDRs would begin in 2010 after treatment facility construction. Lag storage for 115 years. Disposal would be for 150 years, until 2160. Decommissioning and active institutional control would be the same as the Proposed Action, ending in 2270.	Waste disposal and shred and grout treatment would begin in 2010 after treatment facility construction Lag storage for 155 years. Disposal would be for 190 years, until 2200. Decommissioning and active institutional control would be the same as the Proposed Action, ending in 2310.	Dismantle and close WIPP in 10 years. Thermal treatment to meet the LDRs would begin in 2010 after treatment facility construction. Package and manage indefinitely at treatment sites.	Dismantle and close WIPP. Sites generate waste for 35 years beginning in 1998. Storage at the generator-storage sites evaluated for 35 years, ending in 2033. Active institutional control at generator-storage sites until 2133.
WIPP Institutional Control Site Area	70 hectares (175 acres)	360 hectares (890 acres)	395 hectares (976 acres)	375 hectares (927 acres)	20 hectares (50 acres) (Only for 10 years during decommissioning)	20 hectares (50 acres) (Only for 10 years during decommissioning)

[a] New facilities may be constructed in the future pursuant to future NEPA review.

[b] These values correspond to the Post-Treatment Consolidated Volume and Post-Treatment Disposal Volume data in Tables 3-1 through 3-16; differences in the numbers are due to rounding. The inventory for SEIS-II is based on BIR-3, which takes into account potential thermal treatment at some sites.

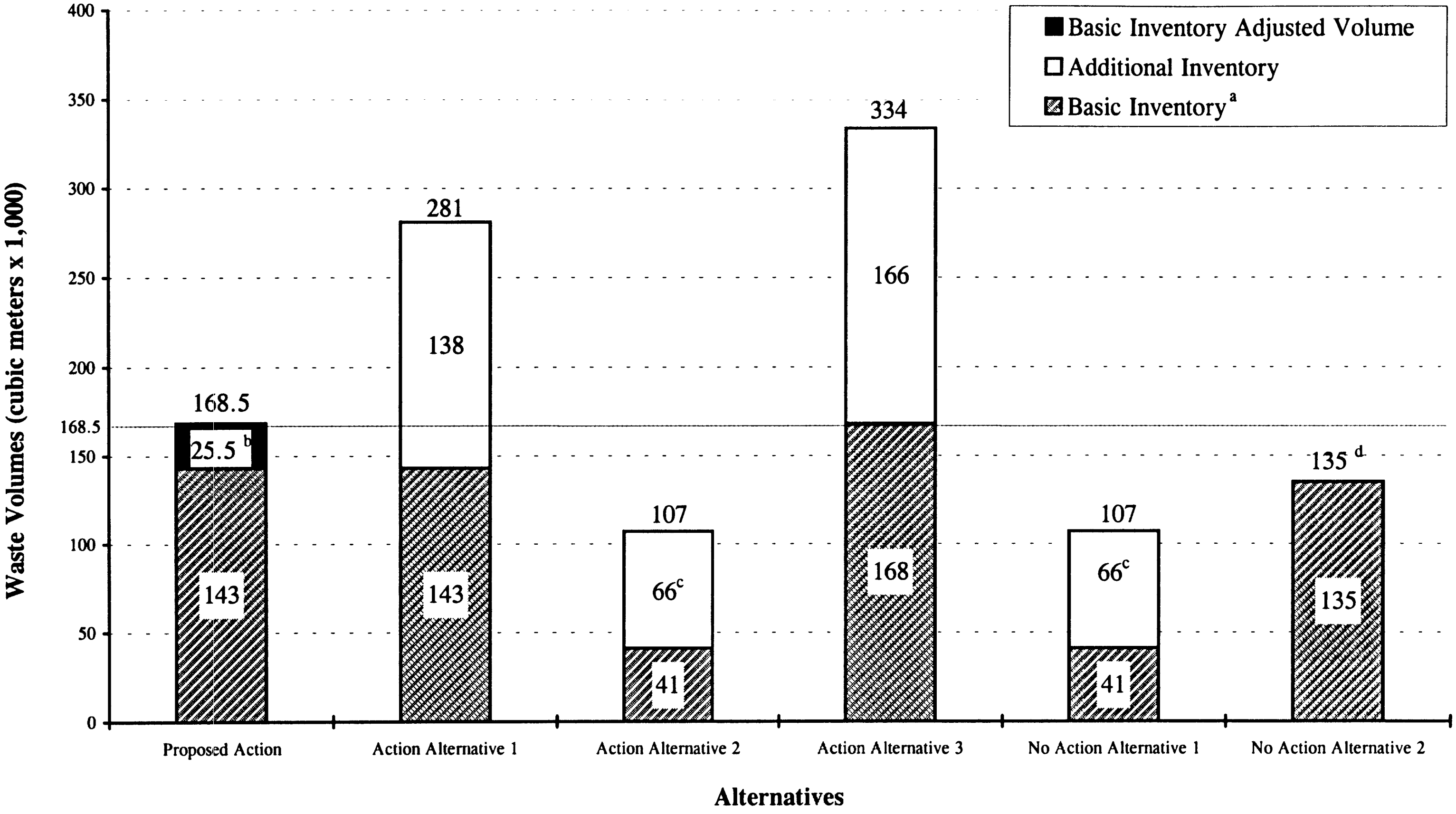
[c] Recent estimates in the *National Transuranic Waste Management Plan* indicate there would be no excess RH-TRU waste; see Appendix J.

[d] The 10 largest generator-storage sites are ANL-E, Hanford, INEEL/ANL-W, LANL, LLNL, Mound, NTS, ORNL, RFETS, and SRS.

[e] Maximum rail is used to denote that 18 of the 22 sites have rail facilities nearby; the remaining sites would ship by truck. Areas and volumes have been rounded.

[f] Under the Proposed Action, the consequence analysis for RH-TRU waste is based on 7,080 cubic meters (250,000 cubic feet), the maximum disposal volume of RH-TRU waste that is allowable at WIPP under the Consultation and Cooperation Agreement. The disposal strategy is to emplace RH-TRU waste canisters in the panel room walls prior to stacking CH-TRU waste in the rooms. At startup, however, a lag in RH-TRU waste availability is anticipated that would result in only CH-TRU waste initially being disposed of. The actual amount of RH-TRU waste disposed of, therefore, may be as low as 4,300 cubic meters.

[g] These time frames are those presented in the Draft SEIS-II. For reduced time frames, see Sections 3.2.2.4, 3.2.3.4, and 3.2.4.4.



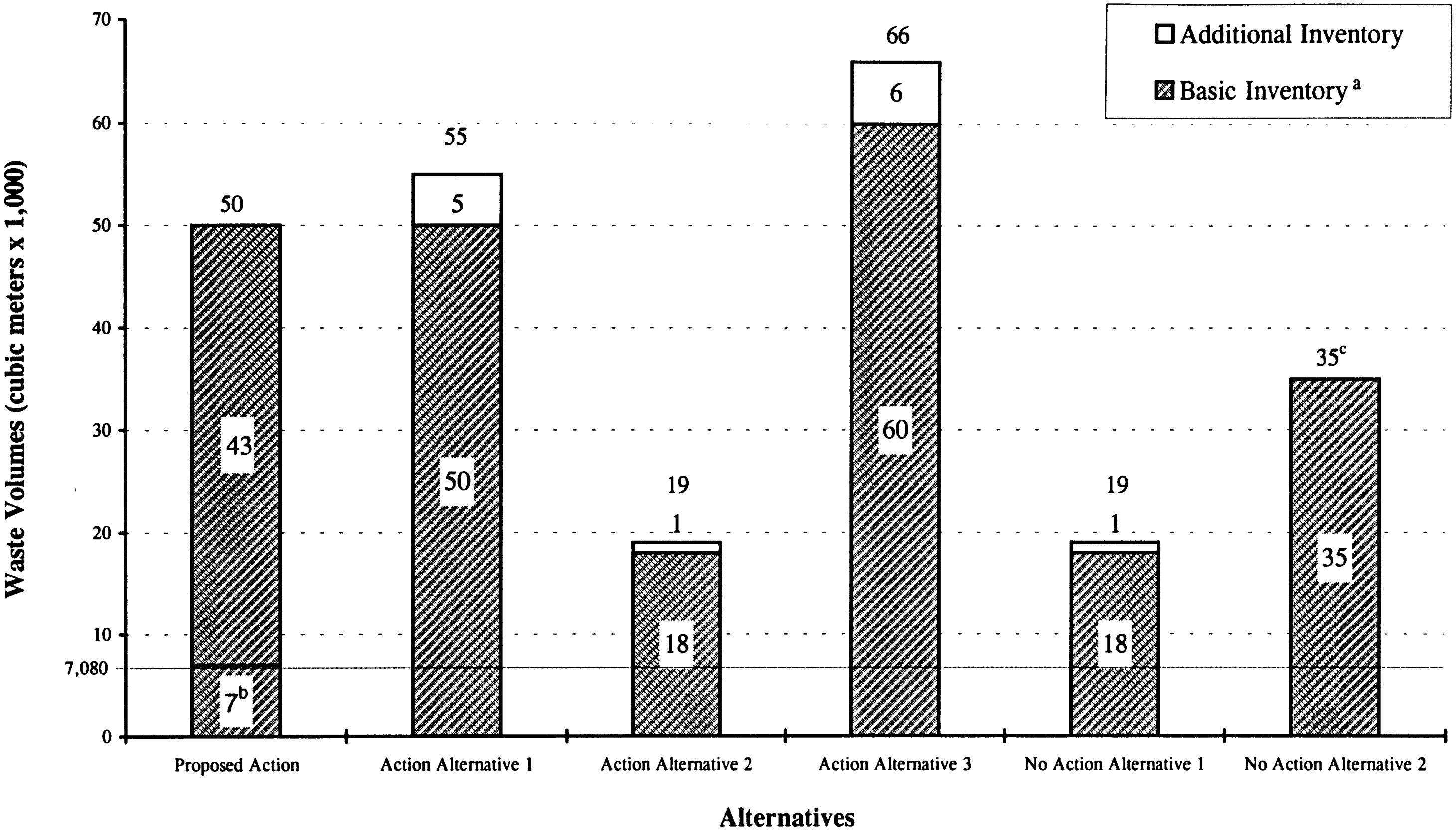
[a] The Basic Inventory consists of post-1970 and newly generated defense waste. The Basic Inventory for all alternatives has the same radionuclide inventory.

[b] The CH-TRU waste Basic Inventory is adjusted from approximatesly 143,000 cubic meters to 168,500 cubic meters in order to evaluate the total volume of CH-TRU waste allowable at WIPP under current laws and agreements.

[c] Includes TRU waste commingled with PCBs.

[d] Only 73,000 cubic meters of newly generated defense waste would be treated. Existing stored waste would not be treated. Therefore, the post-treatment waste volume of the Basic Inventory is not the same as for the Proposed Action and Action Alternative 1.

Figure 3-9
CH-TRU Post-Treatment Waste Volumes by Alternative



[a] The Basic Inventory consists of post-1970 and newly generated defense waste. The Basic Inventory for all alternatives has the same radionuclide inventory.

[b] Only 7,080 cubic meters of the Basic Inventory (14 percent of the Basic RH-TRU inventory) was evaluated for WIPP disposal under the Proposed Action because of the WIPP disposal limit established under the C&C Agreement with the State of New Mexico. The excess RH-TRU waste would be treated to WAC and stored at non-WIPP treatment sites.

[c] Only 32,000 cubic meters of newly generated defense waste would be treated. Existing stored waste would not be treated. Therefore, the post-treatment waste volume of the Basic Inventory is not the same as for the Proposed Action and Action Alternative 1.

Figure 3-10
RH-TRU Post-Treatment Waste Volumes by Alternative

Action Alternative 1 could result in an estimated six worker fatalities at the waste treatment sites and seven worker fatalities at WIPP. Truck transportation under Action Alternative 1 could result in an estimated additional 29 deaths (28 among members of the public). The most severe accident under this alternative would be the destruction of a storage facility as a result of a beyond-design-basis earthquake (with an annual frequency of 1×10^{-5} or less) and could result in an additional 300 deaths. The waste disposed of at WIPP under Action Alternative 1 would be isolated from the environment for more than 10,000 years, and Action Alternative 1 would effectively isolate all DOE TRU waste generated and expected to be generated over 35 years (except for a small quantity of PCB-commingled waste). Action Alternative 1 costs would be $50.95 billion in 1994 dollars ($16.32 billion when discounted), assuming truck transportation (to be comparable to the Proposed Action).

Action Alternative 2 could result in an estimated seven to twelve worker fatalities at the waste treatment sites and one to two fatalities to the populations in the vicinity of the treatment sites (with subalternatives 2A and 2B having higher impacts than subalternative 2C). An estimated six worker fatalities would result from disposal operations at WIPP under all subalternatives. Truck transportation under Action Alternative 2 could result in an estimated additional 17 to 20 deaths (16 to 19 among members of the public, with Action Alternative 2C having higher transportation impacts than Action Alternatives 2A or 2B). The most severe accident under this alternative would be the destruction of a storage facility as a result of a beyond-design-basis earthquake (with an annual frequency of 1×10^{-5} or less) and could result in an additional 480 deaths. The waste disposed of at WIPP under Action Alternative 2 would be isolated from the environment for more than 10,000 years, and Action Alternative 2 would effectively isolate all DOE TRU waste generated and expected to be generated over 35 years. Action Alternative 2 costs would range from $54.01 billion to $57.18 billion in 1994 dollars ($19.56 billion to $21.19 billion when discounted), depending on the subalternative and assuming truck transportation (to be comparable to the Proposed Action).

Action Alternative 3 could result in an estimated seven worker fatalities at the waste treatment sites and seven worker fatalities at WIPP. Truck transportation under Action Alternative 3 could result in an estimated additional 39 deaths (38 among members of the public). The most severe accident under this alternative would be the failure of the WIPP waste hoist (with an annual frequency of 4.5×10^{-7} or less) and could result in an additional 29 deaths. The waste disposed of at WIPP under Action Alternative 3 would be isolated from the environment for more than 10,000 years, and Action Alternative 3 would effectively isolate all DOE TRU waste generated and expected to be generated over 35 years (except for a small quantity of PCB-commingled waste). Action Alternative 3 costs would be $59.67 billion in 1994 dollars ($18.03 billion when discounted), assuming truck transportation (to be comparable to the Proposed Action).

No Action Alternative 1 could result in an estimated 10 to 11 worker fatalities at the waste treatment sites and 2 fatalities to the populations in the vicinity of the treatment sites (depending on the subalternative). No worker deaths would be estimated to result from closure activities at WIPP. Truck transportation under No Action Alternative 1 could result in an estimated zero deaths to workers and one death to members of the public. The most severe accident under this alternative would be the destruction of a storage facility as a result of a beyond-design-basis earthquake (with an annual frequency of 1×10^{-5} or less) and could result in an additional 480 deaths. No Action Alternative 1 would restrict access for 100 years to all DOE TRU waste generated and expected to be generated over 35 years, at which time the waste would either have to be disposed of or a decision would have to be made to continue storage. If the waste were released, either by loss of institutional control or by natural disaster, the thermally treated waste form would restrict migration of the waste initially, but the waste would eventually become more mobile as the vitrified waste form eroded. If the waste were released, deaths to the public over 10,000 years would depend in part on population densities and distributions, but no deaths would be expected based on current densities and distributions. Future increases in population densities near TRU waste storage sites could increase the number of estimated deaths that could result from releases of TRU waste. No Action Alternative 1 costs would range from $30.28 to $32.85 billion in 1994 dollars ($17.09 to $18.54 billion when discounted), assuming truck transportation (to be comparable to the Proposed Action).

No Action Alternative 2 could result in an estimated two worker fatalities at the waste storage sites and no worker deaths from closure activities at the WIPP site. No transportation is assumed under No Action Alternative 2, and no deaths would result. The most severe accident under this alternative would be the destruction of a storage facility as a result of a beyond-design-basis earthquake (with an annual frequency of 1×10^{-5} or less) and could result in an additional 300 deaths. No Action Alternative 2 would restrict access to the currently stored and newly generated portion of DOE TRU waste for 100 years, at which time the waste would either have to be disposed of or a decision would have to be made to continue storage. If the waste were released, either by loss of institutional control or by natural disaster, estimated deaths would total 800 for the Total Inventory over 10,000 years given current population densities and distributions. Future increases in population densities near TRU waste storage sites could increase the number of estimated deaths that could result from releases of TRU waste. No Action Alternative 2 costs would be $2.49 billion in 1994 dollars ($1.68 billion when discounted).

Table 3-18 is a summary table that compares the more notable impacts from within the Proposed Action and the alternatives.

3.5 PREFERRED ALTERNATIVE

The Department’s Preferred Alternative is to proceed with WIPP disposal of defense TRU waste treated to planning-basis WAC under the Proposed Action (see Section 3.1). Under the Preferred Alternative, the Department would initially transport waste by truck and would continue to explore the availability of safe and cost-effective commercial rail transportation.

The Department has identified the Proposed Action (reserving the option of future rail transportation) as its Preferred Alternative for a number of reasons, including the following: the Proposed Action would provide long-term isolation of TRU waste from the accessible environment, and the Proposed Action is consistent with DOE’s obligations under agreements and court orders and with the LWA.

In contrast, the action alternatives would require amendments to the LWA and/or the C&C Agreement with New Mexico. The no action alternatives would not meet the Department’s purpose and need for action, would not meet court orders and treatment plans, and would result in long-term impacts that would be avoided under the Proposed Action.

Table 3-18
Summary of SEIS-II Environmental Impacts

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Land Use and Management									
Treatment Facility Sites	No substantial impacts identified beyond the treatment facilities. Treatment facilities would require no more than 11 hectares, less than 1% of land available at each site for each alternative. Treatment facilities, therefore, could be located in developed areas or areas appropriate for development. Sensitive areas, including wetlands, flood plains, sensitive habitats, and cultural resource areas would be avoided.								No substantial impacts. Only newly generated waste would be treated.
WIPP (during operations)	DOE would occupy the land transferred by the LWA and lease some other land. WIPP would continue to limit drilling and mining activities, and grazing and public access to the site and may acquire oil and gas leases. No other impacts would occur to local land use beyond the site.						Impacts would be minimal because no waste would be emplaced.		
WIPP (area impacted by closure)	70 hectares	360 hectares	395 hectares	395 hectares	395 hectares	375 hectares	20 hectares	20 hectares	20 hectares
Air Quality									
Treatment Facility Sites (As a percentage of the most stringent applicable regulatory standard. Emissions for sites and pollutants not specifically noted would be less than 10% of the most stringent applicable regulatory standard).	RFETS, CO, 17%.		LANL, radionuclides, 134%. RFETS, CO, 24%. INEEL, PM_{10} 10%.	INEEL, radionuclides, 10%. INEEL, PM_{10}, 10%.	WIPP, radionuclides, 137%. WIPP, SO_2, 12%. WIPP, PM_{10}, 25%.	RFETS, CO, 20%.	LANL, radionuclides, 134%. RFETS, CO, 24%, INEEL, PM_{10}, 10%.	INEEL, radionuclides, 10%. SRS, radionuclides, 48%. INEEL, PM_{10}, 10%.	RFETS, CO, 17%.
WIPP Operations (percent of applicable EPA or state standard)	Annual average: negligible increases of O_3 and lead; less than 2% increases in PM_{10}, NO_2, and SO_2. Short-term (24-hour) emission limits: PM_{10} - 57%, NO_2 - 65%, SO_2 - 7%, CO - 3% of standards, releases of lead and ozone would be minimal.						WIPP would not be operated. WIPP would be dismantled.		
Biological Resources									
Treatment Facility Sites	Threatened and endangered species appear at many of the proposed treatment sites and could potentially be impacted. Such species and their critical habitats would be avoided through appropriate consultation, site selection, monitoring, and mitigation measures. Because the treatment sites would require less than 1% of the land available at any site, critical habitats could be avoided at most sites.								No impacts because only minimal treatment would occur.
WIPP (disturbed land area)	Federally- or state-listed or protected, threatened, endangered, and proposed species occur in Eddy County and potentially at the WIPP site, although there have been no threatened, endangered, or proposed species or critical habitats recently observed at the WIPP site by DOE during completion of its recent biennial environmental compliance reports. DOE recently conducted biological surveys at the WIPP site and identified no endangered or threatened species. No impacts to biodiversity or ecosystem balance would be expected. Impacts to other plant and animal species may occur during closure and construction of a berm around the WIPP site. The affected area would differ based on the areas listed above under land use.						Minimal impacts during closure of current facility.		

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Cultural Resources									
Treatment Facility Sites	Although cultural resources are present at many sites, specific treatment facility locations are unknown. Acreage need at any one site is 11 hectares or less. Potential impacts will be avoided or mitigated based on site-specific cultural resource surveys.								No impacts. Treatment would be minimal.
WIPP Resource Sites Potentially Impacted (during operations)	None.						No impacts. WIPP would not be operated.		
WIPP Resource Sites Potentially Impacted (during closure)	Two. Potential impacts would be avoided or mitigated in accordance with the Joint Powers Agreement.	Eleven due to larger surface closure area. Potential impacts would be avoided or mitigated in accordance with the Joint Powers Agreement.					No impacts for the no action alternatives. Closure would only involve the 20 acres on which current facilities have been built.		
Noise									
Treatment Sites	Negligible increase in noise due to waste transportation or treatment facility operation because treatment facilities would probably be placed at industrial-type sites along high-traffic volume corridors. Project-specific impacts to sensitive receptors could occur. Assessment of potential impacts would be conducted in site-wide or project-specific NEPA documentation.								No impacts because transportation would not occur and treatment would be minimal.
WIPP	Negligible increase in noise due to additional daily truck or train traffic. Only 8 trucks per day would travel to WIPP if trucks are used; only 13 to 16 rail cars per week if trains are used.						Not applicable to the no action alternatives. No transportation to WIPP would occur and WIPP would not be operated.		
Water Resources and Infrastructure									
Treatment Sites 1. Water 2. Power 3. Wastewater 4. On-site Transportation	3. Hanford - 5.9% 4. Hanford, INEEL, and LANL - minor impacts		2. INEEL - 6.6% 3. Hanford - 7.8% 4. Hanford, INEEL, and LANL - minor impacts	2. INEEL - 6.6% 3. Hanford - 7.8% 4. Hanford, and INEEL - minor impacts	2. INEEL - 6.6%; WIPP - 50% 3. WIPP - 80% 4. WIPP - 162%; Hanford - minor impacts	2. INEEL - 6.4% 3. Hanford - 7% 4. Hanford, INEEL, and LANL - minor impacts	2. INEEL - 6.6% 3. Hanford - 7.8% 4. Hanford, INEEL, and LANL - minor impacts	2. INEEL - 6.6% 3. Hanford - 7.8% 4. Hanford, and INEEL - minor impacts	No impacts.
Disposal Operations at WIPP	Annual incremental infrastructure impacts at WIPP would be negligible and within capacity for disposal operations.						Decreasing use of resources, none after decommissioning of WIPP.		

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Socioeconomics									
Treatment/Storage Sites									
Life-Cycle Costs (millions of 1994 dollars)	12,140	21,390	27,690	30,550	28,700	24,340	29,360	31,760	1,640
Annual Employment (supported jobs)	11,900	22,500	28,000	28,500	7,200	24,900	29,300	29,800	2,300
Disposal Operations at WIPP									
Life-Cycle Costs (millions of 1994 dollars)	5,300	24,650	23,330	23,330	23,330	28,490	850	850	850
Annual Goods & Services (millions of 1994 dollars)	317	317	317	317	616	317	-317	-317	-317
Annual Employment (supported jobs)	3,538	3,538	3,538	3,538	6,876	3,538	-3,538	-3,538	-3,538
Annual Labor Income (millions of 1994 dollars)	126	126	126	126	245	126	-126	-126	-126
Total Life-Cycle Cost by Mode of Transportation (millions of 1994 dollars); discounted totals using a 4.1 percent annual inflation rate are presented in parentheses									
Total Life-Cycle Costs--Truck	19,030 (10,130)	50,950 (16,320)	54,010 (19,560)	57,180 (21,190)	54,940 (20,100)	59,670 (18,030)	30,280 (17,090)	32,850 (18,520)	No shipments of TRU waste would occur under this alternative. Total life-cycle cost without transportation is 2,490 (1,680).
Total Life-Cycle Costs--Regular Rail	No rail transportation analyzed under Propsed Action; rail transportation reserved under Preferred Alternative.	47,680 (15,800)	52,030 (19,220)	55,020 (20,830)	52,940 (19,760)	55,170 (17,420)	30,240 (17,070)	32,770 (18,470)	
Total Life-Cycle Costs--Dedicated Rail		57,360 (17,330)	57,880 (20,210)	61,360 (21,900)	58,570 (20,720)	68,520 (19,210)	30,460 (17,190)	33,790 (19,040)	
Transportation									
Truck									
Number of Truck Shipments to Consolidation Sites and WIPP	CH - 29,793 RH - 8,915	CH - 41,056 RH - 66,012	CH - 43,313 RH - 30,149	CH - 51,240 RH - 30,149	CH - 41,151 RH - 30,149	CH - 67,844 RH - 82,860	CH - 538 RH - 8,254	CH - 8,466 RH - 8,254	No shipments of TRU waste would occur under this alternative.
Nonradiological Truck Impacts									
Truck Accidents	56	171	109	123	105	239	5	13	
Truck Injuries	39	119	76	86	74	165	4	12	
Truck Fatalities	5	16	10	11	11	22	0.3	1	
Truck Pollution Fatalities	0.1	0.5	0.4	0.5	0.4	0.7	0.03	0.07	

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Radiological Truck Impacts									No shipments of TRU waste would occur under this alternative.
Accident-Free Population Impacts to Crews (LCFs)	0.3	0.7	0.5	0.7	0.5	1.0	0.02	0.07	
Accident-Free Population Impacts to the Public (LCFs)	3.0	11	6	7	6	15	0.4	0.9	
Highest Lifetime Accident-Free Impact to MEIs (probability of an LCF)	8.5E-3	8.6E-3	4.6E-3	4.9E-3	4.5E-3	9.9E-3	Not Analyzed.	Not Analyzed.	
Rail									
Nonradiological Rail Impacts	Transportation by rail not anaylzed under the Proposed Action; rail transportation is reserved under the Preferred Alternative.								
Fatalities Using Regular Rail Service		8	5	6	6	11	0.2	0.5	
Fatalities Using Dedicated Rail Service		112	70	84	84	154	2.8	7	
Radiological Rail Impacts									
Accident-Free Population Impacts to Crews (Regular and Dedicated) (LCFs)		0.03	0.03	0.03	0.03	0.05	8.6E-4	3.7E-3	
Accident-Free Population Impacts to the Public (Regular and Dedicated) (LCFs)		1.5	0.9	1	0.9	2.0	0.07	0.1	
Accidents									
Transportation Accidents (Truck)									
Population Impacts with Conservative Inventory (LCFs)	CH - 16 RH - 16	CH - 16 RH - 16	CH - <1 RH - <1	CH - <1 RH - <1	CH - 16 RH - <1	CH - 16 RH - 16	CH - 16 RH - 16	CH - 16 RH - 16	
Population Impacts with Average Inventory (LCFs)	CH - 3 RH - 0.04	CH - 3 RH - 0.04	CH - <1 RH - <1	CH - <1 RH - <1	CH - 3 RH - <1	CH - 3 RH - 0.04	CH - 3 RH - 0.04	CH - 3 RH - 0.04	
MEI Impact with Conservative Inventory (probability of an LCF)	CH - 0.06 RH - 0.06	CH - 0.06 RH - 0.06	CH - 3E-4 RH - 3E-4	CH - 3E-4 RH - 3E-4	CH - 0.06 RH - 3E-4	CH - 0.06 RH - 0.06	CH - 0.06 RH - 0.06	CH - 0.06 RH - 0.06	
MEI Impact with Average Inventory (probability of an LCF)	CH - 0.04 RH - 7E-4	CH - 0.04 RH - 7E-4	CH - 2E-4 RH - 4E-6	CH - 2E-4 RH - 4E-6	CH - 0.04 RH - 4E-6	CH - 0.04 RH - 7E-4	CH - 0.04 RH - 7E-4	CH - 0.04 RH - 7E-4	
Aggregate Potential Truck Accident Impacts to Populations Along All Transportation Routes (LCFs)	0.4	0.8	0.7	0.7	0.7	1.2	6.8E-3	0.02	

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Transportation Accidents (Rail)									No shipments of TRU waste would occur under this alternative.
Population Impacts with Conservative Inventory (LCFs)	No rail transportation is proposed under the Proposed Action; rail transportation is reserved under the Preferred Alternative.	CH - 32 RH - 32	CH - <1 RH - <1	CH - <1 RH - <1	CH - 32 RH - <1	CH - 32 RH - 32	CH - 32 RH - 32	CH - 32 RH - 32	
Population Impacts with Average Inventory (LCFs)		CH - 6 RH - 0.08	CH - <1 RH - <1	CH - <1 RH - <1	CH - 6 RH - <1	CH - 6 RH - 0.08	CH - 6 RH - 0.08	CH - 6 RH - 0.08	
MEI Impact with Conservative Inventory (probability of an LCF)		CH - 0.12 RH - 0.12	CH - 3E-4 RH - 3E-4	CH - 3E-4 RH - 3E-4	CH - 0.12 RH - 3E-4	CH - 0.12 RH - 0.12	CH - 0.12 RH - 0.12	CH - 0.12 RH - 0.12	
MEI Impact with Average Inventory (probability of an LCF)		CH - 0.08 RH - 1E-4	CH - 2E-4 RH - 4E-6	CH - 2E-4 RH - 4E-6	CH - 0.08 RH - 4E-6	CH - 0.08 RH - 1E-4	CH - 0.08 RH - 1E-4	CH - 0.08 RH - 1E-4	
Aggregate Potential Rail Accident Impacts (LCFs) to Populations Along All Rail Routes		0.8	0.7	0.7	0.7	1.2	6.8E-3	0.02	
Human Health									
Routine Radiological Impacts (LCFs) [a]									
Treatment									
Involved Worker Population	0.8	1.5	1.7	1.3	0.6	1.5	1.7	1.3	0.4
Noninvolved Worker Population	7E-6	8E-6	0.1	0.1	0.06	7E-4	0.1	0.1	8E-5
Maximum Exposed Noninvolved Worker	3E-9	8E-9	5E-5	2E-4	2E-4	2E-7	5E-5	2E-4	4E-8
Public Population	2E-4	2E-4	2.4	2.3	0.9	4E-3	2.4	2.3	1E-3
MEI	9E-9	1E-9	3E-5	5E-5	2E-4	4E-7	3E-5	5E-5	8E-8
WIPP Operations [b] **(LCFs)** [a]							**Storage Impacts at Treatment Sites Only - No WIPP Operations**		
Involved Worker Population	≤1	≤1	<0.4	<0.4	<0.4	0.3	≤1.1	≤1.1	≤3
Noninvolved Worker Population	4E-4	5E-4	2E-4	2E-4	2E-4	5E-4	0.06	0.06	0.1
Maximum Exposed Noninvolved Worker	4E-7	4E-7	2E-7	2E-7	2E-7	3E-7	1E-6	1E-6	4E-5
Public Population	3E-4	4E-4	5E-5	5E-5	5E-5	3E-4	3E-3	2E-3	0.03
MEI	3E-7	5E-7	1E-7	1E-7	1E-7	3E-7	2E-7	2E-9	2E-6
Lag Storage[c] Public Population Impacts	No lag storage for the Proposed Action.	1E-2	1E-3	8E-4	3E-4	3E-3	No lag storage for the no action alternatives.		
Lag Storage Noninvolved Worker Population		0.05	2E-2	2E-2	1E-3	0.07			
Excess RH-TRU Waste Storage Public Population Impacts[d]	2E-5	No excess RH-TRU waste is considered in these alternatives; such RH-TRU waste is reflected in the inventory/waste volumes for these alternatives.							
Excess RH-TRU Waste Storage Noninvolved Worker Population[d]	4E-5								

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Routine Hazardous Chemical Impacts (Cancer Incidence)									
Treatment at Treatment Sites									
Involved Worker Population	2E-5	3E-5	6E-5	9E-5	8E-5	4E-5	6E-5	9E-5	8E-6
Noninvolved Worker Population	1E-7	2E-7	1E-7	1E-7	1E-7	2E-7	1E-7	1E-7	1E-7
Maximum Exposed Noninvolved Worker	1E-10	2E-10	1E-10	1E-10	1E-10	1E-10	1E-10	1E-10	1E-10
Public Population	4E-7	6E-7	3E-7	3E-7	3E-7	4E-7	3E-7	3E-7	4E-7
Maximum Exposed Individual	2E-11	3E-11	2E-11	2E-11	2E-11	2E-11	2E-11	2E-11	2E-11
WIPP Operations [a]							**Storage Impacts at Treatment Sites Only - No WIPP Operations**		
Involved Worker Population	0.01	0.04	No impacts because the TRU waste would be thermally treated.			≤0.01	None because TRU waste would be thermally treated.		≤0.1
Noninvolved Worker Population	1E-4	1E-4				9E-5			6E-3
Maximum Exposed Noninvolved Worker	1E-7	9E-8				5E-8			2E-7
Public Population	2E-5	3E-5				2E-5			6E-3
Maximum Exposed Individual	3E-8	2E-8				1E-8			4E-8
Lag Storage[c] Public Population	No lag storage for the Proposed Action.	5E-3				4E-3	None because there is no lag storage for the no action alternatives.		
Lag Storage Noninvolved Worker Population		0.01				0.02			
Excess RH-TRU Waste Storage Public Population Impacts[d]	3E-4	No excess RH-TRU waste is considered in these alternatives; such RH-TRU waste is reflected in the inventory/waste volumes for these alternatives.							
Excess RH-TRU Waste Storage Noninvolved Worker Population[d]	6E-4								
Selected Facility Accidents [a]									
Treatment Facility Sites (Earthquake) LCFs									
Maximally Exposed Noninvolved Worker	0.01	0.01	1	1	1	0.02	1	1	0.01
Maximally Exposed Individual	2E-3	2E-3	1	1	1	5E-3	1	1	2E-3
Public Population	3	3	480	480	28	6	480	480	3
Storage Facility Sites (Earthquake) LCFs									
Maximally Exposed Noninvolved Worker	3E-3	1.0	0.05	0.05	0.1	0.04	0.02	0.02	0.7
Maximally Exposed Individual	5E-4	0.1	5E-3	5E-3	0.08	5E-3	0.08	0.08	0.1
Public Population	0.9	300	10	9	2	10	10	10	300
WIPP Disposal (Hoist Failure, frequency of 4.5E-7) LCFs									
Maximally Exposed Noninvolved Worker	0.06	0.06	0.5	0.5	0.5	0.5	No impacts because disposal does not occur under the no action alternatives.		
Maximally Exposed Individual	0.08	0.08	0.6	0.6	0.6	0.6			
Public Population	5	5	29	29	29	29			

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
Industrial Safety									
Waste Treatment (fatalities)	4	4	9	7	6	5	9	7	0.7
Construction and Operations (fatalities)	2	6	6	6	6	7	0.8	0.8	0.6
Performance Assessment of Treatment Sites and WIPP									
Treatment Sites - Human Intrusion [e]									
Radiological Impacts (probability of an LCF)									
Driller	4E-4 [f]	Does not apply to these alternatives because there is no waste at the treatment sites under the action alternatives, and TRU waste is managed indefinitely under No Action Alternatives 1A and 1B.							1E-6 to 3E-5
Gardener	3E-3 [f]								4E-3 to 0.06
Scavenger	0.01 [f]								6E-4 to 0.02
Family Farm	1 [f]								0.2 to 1
Treatment Sites - Environmental Release									
Radiological Impacts (probability of an LCF)									
MEI (probability of an LCF)	5E-5 [f]	Does not apply to these alternatives because there is no waste at the treatment sites under the Proposed Action and the action alternatives. For No Action Alternatives 1A and 1B, it was assumed the waste would be managed indefinitely.							3E-6 to 4E-3
Population (LCFs)	3E-4 [f]								4E-5 to 7
Aggregate Population Impacts over 10,000 years	4E-3 [f]	Does not apply to these alternatives because there is no waste at the treatment sites.					8E-4	3E-4	807
Hazardous Chemical Impacts (Cancer Incidence)									
MEI	9E-7 [f]	Does not apply to these alternatives because there is no waste at the treatment sites under the action alternatives, and TRU waste is managed indefinitely under No Action Alternative 1.							1E-7 to 5E-3
Population	5E-6 [f]								5E-7 to 3E-4
WIPP - Human Intrusion (based on the intrusion in the repository scenario)									
Maximum Radiological Impacts Drilling Crew Member (probability of an LCF; dashes indicate no analyses were performed because scenarios are inapplicable)									
CH-TRU Waste Panel	---	4E-4	1E-4	1E-4	1E-4	3E-4	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
RH-TRU Waste Panel	---	1E-5	2E-6	2E-6	2E-6	1E-5			
Mixed CH-TRU and RH-TRU Panel	4E-4	4E-4	---	---	---	3E-4			
Maximum Radiological Impacts Site Geologist (probability of an LCF)									
CH-TRU Waste Panel	3E-9	3E-9	7E-9	7E-9	7E-9	2E-9	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
RH-TRU Waste Panel	3E-9	5E-9	1E-8	1E-8	1E-8	4E-9			
Environmental Justice									
Treatment sites and WIPP	Although possible, disproportionately high and adverse effects on minority or low-income populations are not expected.				Impacts are possible at WIPP during treatment.	Although possible, disproportionately high and adverse effects on minority or low-income populations are not expected.			

Table 3-18
Summary of SEIS-II Environmental Impacts — Continued

Consequence Category	Proposed Action/ Preferred Alternative	Action Alternative 1	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C	Action Alternative 3	No Action Alternative 1A	No Action Alternative 1B	No Action Alternative 2
TRU Waste Retrieval (of one panel of waste before repository closure)									
Population Exposures (LCFs)									
Involved Worker Population	0.03	0.03	0.03	0.03	0.03	0.03	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
Noninvolved Worker Population	4E-5	4E-5	4E-5	4E-5	4E-5	4E-5			
Public Population	3E-5	3E-5	3E-5	3E-5	3E-5	3E-5			
Transportation									
Accident-Free Population Impacts to Crews (LCFs)	0.03	0.03	0.03	0.03	0.03	0.03	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
Accident-Free Population Impacts to the Public (LCFs)	0.3	0.3	0.3	0.3	0.3	0.3			
Traffic-Related Fatalities	0.5	0.5	0.5	0.5	0.5	0.5			
TRU Waste Recovery (of all waste after repository closure)									
Population Exposures (LCFs)									
Involved Worker Population	8	8	8	8	8	8	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
Noninvolved Worker Population	0.3	0.3	0.3	0.3	0.3	0.3			
Public Population	0.2	0.2	0.2	0.2	0.2	0.2			
Transportation									
Accident-Free Population Impacts to Crews (LCFs)	1	1	1	1	1	1	Does not apply to these alternatives. No waste would be disposed of at WIPP.		
Accident-Free Population Impacts to the Public (LCFs)	15	15	15	15	15	15			
Vehicle Emission Effects Fatalities	7	7	7	7	7	7			
Traffic-Related Fatalities	185	185	185	185	185	185			

[a] The probability of an LCF occurring to the MEI or maximum exposed noninvolved worker, and the number of LCFs to the populations.

[b] Under the no action alternatives, this category represents impacts from storage.

[c] Lag storage is storage pending shipment to WIPP. Lag storage does not include long-term storage of waste (such as any excess RH-TRU waste under the Proposed Action) that will not be shipped to WIPP.

[d] Recent estimates in the *National Transuranic Waste Management Plan* indicate there would be no excess RH TRU waste; see Appendix J.

[e] People who might intrude upon the stored waste could receive radiation doses that would greatly exceed current regulatory limits.

[f] Impacts from any excess RH-TRU waste. Scaled from No Action Alternative 2.

Note: For details on impacts due to the Additional Inventory (for the Proposed Action) see the text box "The Additional Inventory and the Proposed Action." For information on how impacts would change should WIPP's operations period be reduced to 175 years or less, see the text box "Reducing Operations Periods."

3.6 REFERENCES CITED IN CHAPTER 3

DOE (U.S. Department of Energy), 1980, *Final Environmental Impact Statement for the Waste Isolation Pilot Plant*, DOE/EIS-0026, October, Washington D.C.

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NRC (U.S. Nuclear Regulatory Commission), 1989, *Safety Evaluation Report, TRUPACT-II Shipping Container, Certificate of Compliance No. 9218*, Rev. 0, Washington, D.C.

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CHAPTER 4
DESCRIPTION OF THE AFFECTED ENVIRONMENTS

This chapter describes the affected environments at the Waste Isolation Pilot Plant (WIPP) site and at the ten major generator-storage sites. The WIPP site is discussed in detail with emphasis on the changes that have occurred and new information that has been determined since the publication of the *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) in 1990 (DOE 1990).

4.1 EXISTING ENVIRONMENT AT THE WIPP

The passage of the WIPP Land Withdrawal Act (LWA), results of recent environmental studies, and changes to various aspects of the existing environment have generated new information concerning the environment at the WIPP site. The following sections update Sections 4.1.1 through 4.3.5 of SEIS-I (DOE 1990).

4.1.1 Land Use and Management

The U.S. Department of Energy (DOE or the Department) defines the region of influence (ROI) for land use impacts as WIPP plus ". . . the site and the area immediately adjacent to the site" (DOE 1997b).[1] Thus, for WIPP, the area of consideration for land use includes privately owned ranches and Bureau of Land Management (BLM) lands, including some leased as mineral and grazing lands immediately adjacent to the WIPP site. The *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) (DOE 1980) states that almost 7,700 hectares (19,000 acres) of land surrounding WIPP were committed to the WIPP project. It notes that the dominant use of the land within 16 kilometers (10 miles) of the site is grazing, with lesser amounts used for oil and gas extraction and potash mining. BLM owns most of this land. Two ranches are located within 16 kilometers (10 miles)

CHANGES IN SITE LAND USE AND MANAGEMENT

Since publication of SEIS-I, DOE has made the following changes in land use. These changes are largely due to the planning-basis WIPP Waste Acceptance Criteria (WAC) and the Land Management Plan.

- *Wildlife Management* - DOE initiated a multi-year research effort to document the population and ecology of several species, and additional seeding of reclamation sites was undertaken.
- *Cultural Resources Management* - DOE created a comprehensive WIPP archeological database.
- *Vegetation Management* - DOE now monitors vegetation for evidence of stress induced by climate and salt tailings.
- *Rights-of-Way* - In 1994, DOE requested and was granted permission by BLM to construct a short access road.
- *Emergency and Facility Security* - DOE has published three plans on emergency and facility security.
- *Groundwater Surveillance* - DOE has installed seven new wells to monitor water quality.

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[1] Currently this ROI includes only two working ranches. No towns are included.

of the WIPP site while the closest town, Loving, New Mexico, is 29 kilometers (18 miles) away. The federal government or the State of New Mexico owns most of the land within 50 kilometers (30 miles) of the WIPP site. Within 80 kilometers (50 miles) of the site, there is dryland farming, irrigated farming along the Pecos River, and some forest, wetland, and urban land (see Figure 4-1).

SEIS-I (DOE 1990) notes the release of approximately 4,450 hectares (11,000 acres) of previously restricted land for unrestricted use, allowing exploration for and development of mineral resources and permanent habitation. It describes a land withdrawal boundary, which defines the WIPP site, as encompassing 16 sections (4,146 hectares [10,240 acres]) of federal land in Township 22 South, Range 31 East (Figure 4-2). This boundary was delineated so as to extend at least 1.6 kilometers (1 mile) beyond any WIPP underground development.

The type of land use surrounding WIPP has not changed substantially since the preparation of SEIS-I, although the level of development has increased. The site has been divided into four areas under DOE control (Figure 4-2). A chain-link fence surrounds the innermost "Property Protection Area," which includes the surface facilities. Surrounding this inner area is the "Exclusive Use Area," set off by a barbed-wire fence. Enclosing these areas is the "Off-Limits Area," which is unfenced to allow livestock grazing but, like the other two, is patrolled and posted against trespass or other land uses. Beyond the "Off-Limits Area," but within the 16-section WIPP site, the land is managed under the traditional public land use concept of multiple use. Mining and drilling for purposes other than support of the WIPP project, however, are restricted (DOE 1995d).

On October 30, 1992, the President signed into law the LWA (Public Law 102-579). This Act transferred responsibility for management of the WIPP withdrawal area from the Secretary of the Interior to the Secretary of Energy. The land is permanently withdrawn from all forms of entry, appropriation, and disposal under the public land laws and is reserved for uses associated with the purposes of WIPP. LWA establishes certain rights and responsibilities, one of which was the preparation of a Land Management Plan published in 1993 (DOE 1993a).

DOE's WIPP Land Management Plan incorporates the restrictions of the LWA and the DOE Memorandum of Understanding (MOU) with the BLM. The Land Management Plan establishes management objectives and planned actions for the use of the withdrawn land until the end of the decommissioning phase. The plan promotes the concept of multiple-use management for the surface area of the withdrawn land and establishes a goal of minimizing land use restrictions where possible. The plan also provides opportunity for participation in the land use planning process by the public, and local, state, and federal agencies.

The Land Management Plan lists 13 areas of concern: wildlife, cultural resources, grazing management, recreation, mining and oil and gas production, rights-of-way, access, emergency and facility security, fire management, water service, groundwater surveillance, salt tailings, and reclamation. The following is a summary of the progress made toward implementing this plan. Details of these actions can be found in the *Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 1994* (DOE 1995d).

Recent efforts in the area of wildlife management include initiating a multi-year research investigation into the ecology and life history of resident raptor populations, with emphasis on the Harris hawk (*Parabuteo unicinctus*); appraisals of populations of small nocturnal mammals; and the additional seeding of reclamation sites to increase soil stabilization.

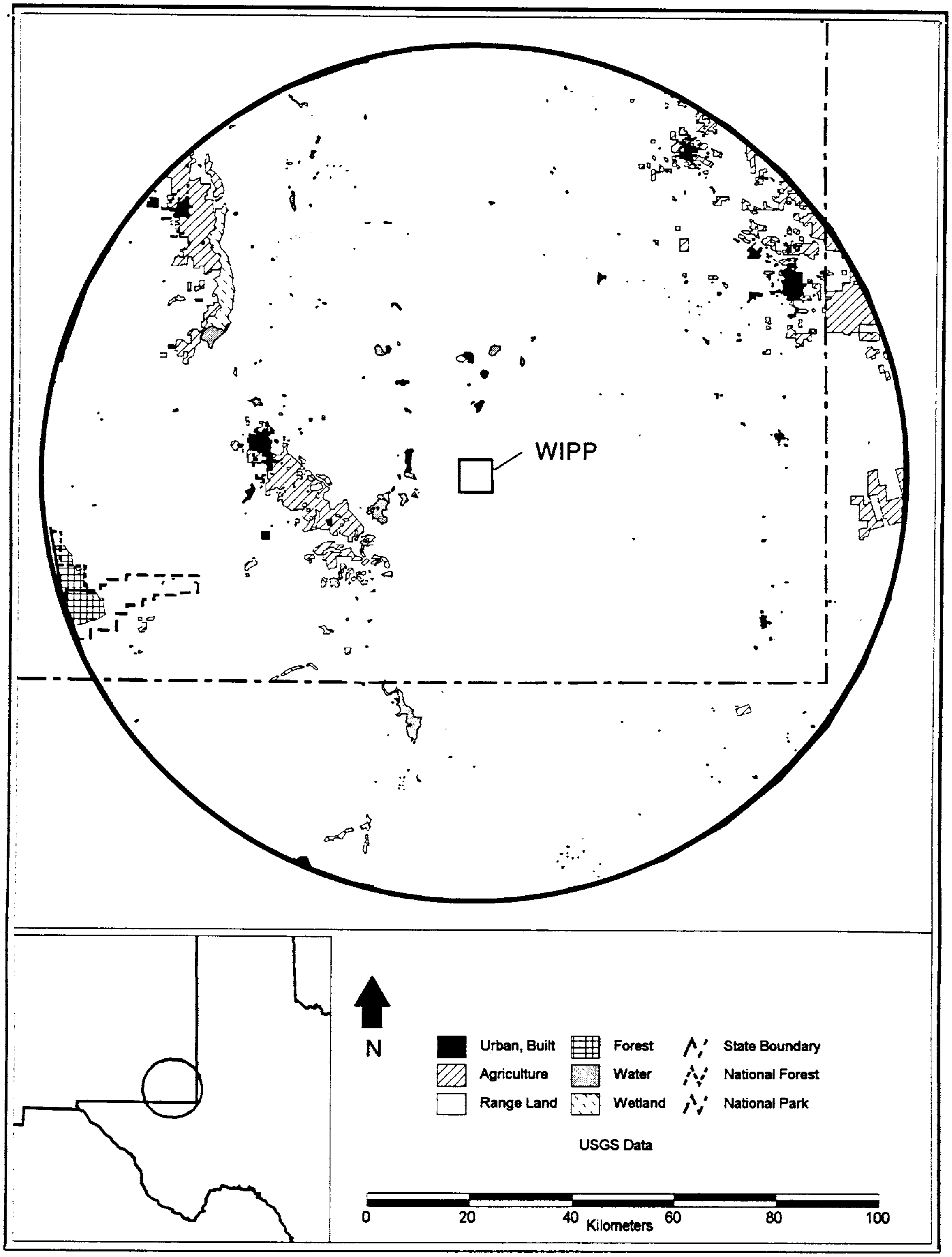


Figure 4-1
Land Use Within 80 Kilometers (50 Miles) of WIPP

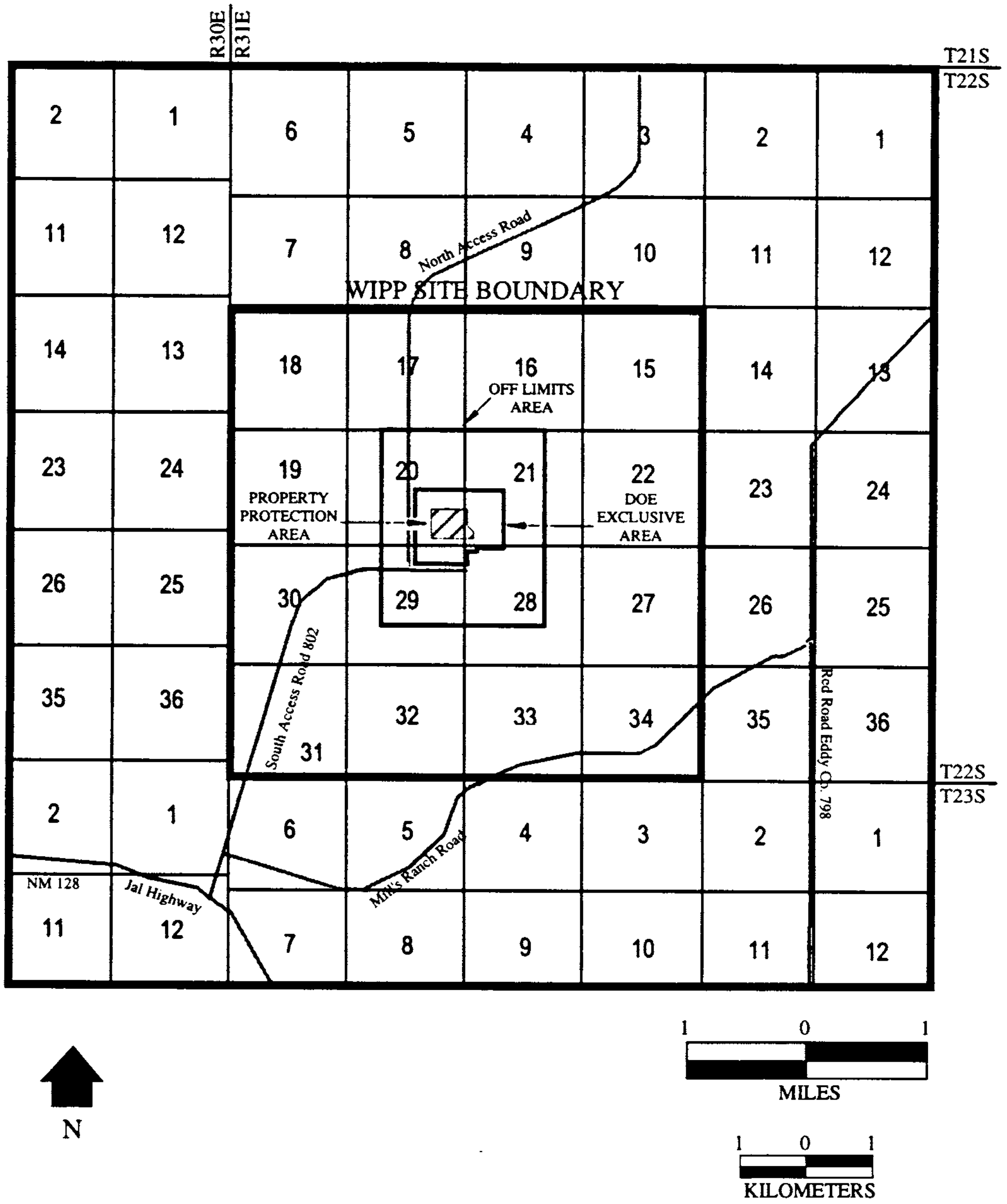


Figure 4-2
WIPP Areas

DOE also recently entered into a Joint Powers Agreement with the State of New Mexico (signed by the State Historic Preservation Officer), pursuant to Sections 106 and 110 of the National Historic Preservation Act and other statutes.

DOE’s intent concerning grazing management is to continue current management practices unless a need develops to modify them. To that end, planned actions include continuing vegetative monitoring in the withdrawal area, continuing the management of grazing allotments under the principles of multiple-use management and sustained yield, and continuing range management practices in accordance with appropriate acts and regulations.

DOE intends to maintain recreation resource values and to continue to provide opportunities for individuals to participate in recreational activities within designated parts of the withdrawal area. Planned actions include environmental monitoring of the withdrawal area, regulating off-road vehicle use, and determining the potential effect of anticipated projects or other activities on the visual quality of the landscape. DOE would also allow hunting and trapping in accordance with applicable regulations.

The Land Management Plan incorporates the restrictions of the LWA. The subsurface of the withdrawal area is reserved for exclusive use of WIPP. No surface or subsurface mining unrelated to the WIPP project, including slant drilling from outside the boundary area, is permitted. The exception is two tracts of land within the withdrawal area that are leased from BLM for oil and gas development below 1,829 meters (6,000 feet). In instances where operators seek permits to drill or mine at a location close to the withdrawal boundary, DOE will request drilling information to detect any potential for subsurface encroachment into the WIPP repository. Should there be potential for encroachment, the operator will be required to modify the drilling activity in accordance with existing memorandums of understanding or similar agreements. Two active mining and drilling leases within the Land Withdrawal Area may be purchased by DOE.

BLM administers rights-of-way in coordination with DOE. The objective is to ensure safe and adequate access to WIPP while protecting the security of personnel and facilities. Consideration is also being given to closing parts of some access roads to protect the health and safety of the public. In 1994, DOE requested and was granted permission to construct short access roads from main roadways to the sites of wells.

Changes concerning emergency and facility security preparedness include implementing plans to minimize impacts during emergencies. These plans include the WIPP Emergency Plan (WP 12-9), the WIPP Resource Conservation and Recovery Act (RCRA) Contingency Plan (WP 02-12), and the WIPP Security Plan.

Fire management is concerned with wildfires in the withdrawal area. The Land Management Plan provides for immediate notification of the BLM Carlsbad Fire Control Officer upon detection of a wildfire. WIPP personnel may call upon help from various sources or may opt to have BLM fight a wildfire, if conditions warrant that choice.

Water service for WIPP is provided by a DOE-constructed water line from Carlsbad’s system to the WIPP site and is made possible by a contract between DOE and the City of Carlsbad.

The groundwater surveillance program adjusts surveillance activities, if necessary, and plugs and seals wells when they are no longer necessary. In support of this program, seven new wells were installed for water quality sampling.

The Land Management Plan provides for the management of the salt pile in an environmentally sound manner until such time as a determination is made on its disposition. Salt backfill is not required for subsidence control or repository performance but may be placed into the repository for final disposition. Management of the salt pile may include monitoring vegetation for evidence of stress from salt; selling or disposing of unneeded salt under the Materials Act of 1947; ripping, leveling, and adding topsoil to the salt stockpile base; and reseeding with seed mixes reflecting indigenous plant species.

Recent activities in the area of land reclamation have included decommissioning numerous fenced areas, removing rebar from study areas to alleviate safety hazards to personnel and livestock, and carrying out additional reclamation measures in selected problem areas such as drainages and eroded slopes.

4.1.2 Air Quality, Climate, and Noise

The Environmental Protection Agency (EPA) has classified Eddy County, New Mexico, where WIPP is located, as an attainment area for all six of the criteria pollutants under the National Ambient Air Quality Standards (NAAQS). WIPP is also in a Class II Prevention of Significant Deterioration (PSD) area, and any new sources of emissions would have to adhere to the standards for such an area (META/Berger 1995). The Class I PSD areas nearest to WIPP are: Carlsbad Caverns National Park, which is approximately 61 kilometers (38 miles) southwest of WIPP, and Guadalupe Mountains National Park, which is approximately 100 kilometers (62 miles) southwest of WIPP.

The measurement of selected air pollutants at WIPP began in 1976 and was reported in FEIS (DOE 1980). SEIS-I (DOE 1990) stated that seven classes of EPA-regulated atmospheric gases had been monitored since August 27, 1986. These gases are carbon monoxide (CO), hydrogen sulfide (H_2S), ozone (O_3) precursors, oxides of nitrogen (NO_x), and sulfur dioxide (SO_2). Total suspended particulates (TSP) were also monitored in conjunction with the air monitoring programs of EPA's Regulatory and Environmental Surveillance Programs. As reported in SEIS-I, the results of this monitoring program indicated that air quality in the area of WIPP usually met state and federal standards. SEIS-I indicated that, during periods of high wind and blowing sands, the TSP standards were occasionally exceeded, but the ambient air quality standard for sulfur dioxide had been infrequently exceeded.

CHANGES IN AIR QUALITY MONITORING

Since publication of SEIS-I, the following changes have occurred:

- *Monitoring of Pollutant Gases* - On October 30, 1994, after DOE notified EPA, monitoring of criteria air pollutants at the WIPP Ambient Air Monitoring Station was discontinued because it was no longer required by regulation.
- *Volatile Organic Compound (VOC) Monitoring Program* - The VOC monitoring program was established at WIPP in 1991 after the EPA determined that air migration of VOC target compounds would be a potential concern during both testing and operations at the facility.

Air quality monitoring data collected since 1990 are summarized in annual WIPP site environmental reports (DOE 1992, 1993b, 1994a, 1995d, and 1996d). WIPP has completed inventories of potential pollutants and emissions in accordance with EPA and New Mexico Air Quality Control Regulations (AQCR). Based on these inventories, WIPP has no permitting or reporting requirements at this time except for those applying to two primary backup diesel generators. An AQCR operating permit was issued for the two diesel generators in 1993 (DOE 1995d). These diesel generators are assumed to emit four pollutants (nitrogen dioxide (NO_2), SO_2, CO and particulate matter less than or equal to 10 micrometers in diameter [PM_{10}]) and have strict limits on emissions for these pollutants (see Section C.3.2). On October 30, 1994, DOE, after notifying EPA, ceased to monitor criteria air pollutants at the WIPP Ambient Air Monitoring Station because there was no longer a regulatory requirement to do so. TSP monitoring continues weekly at off-site locations.

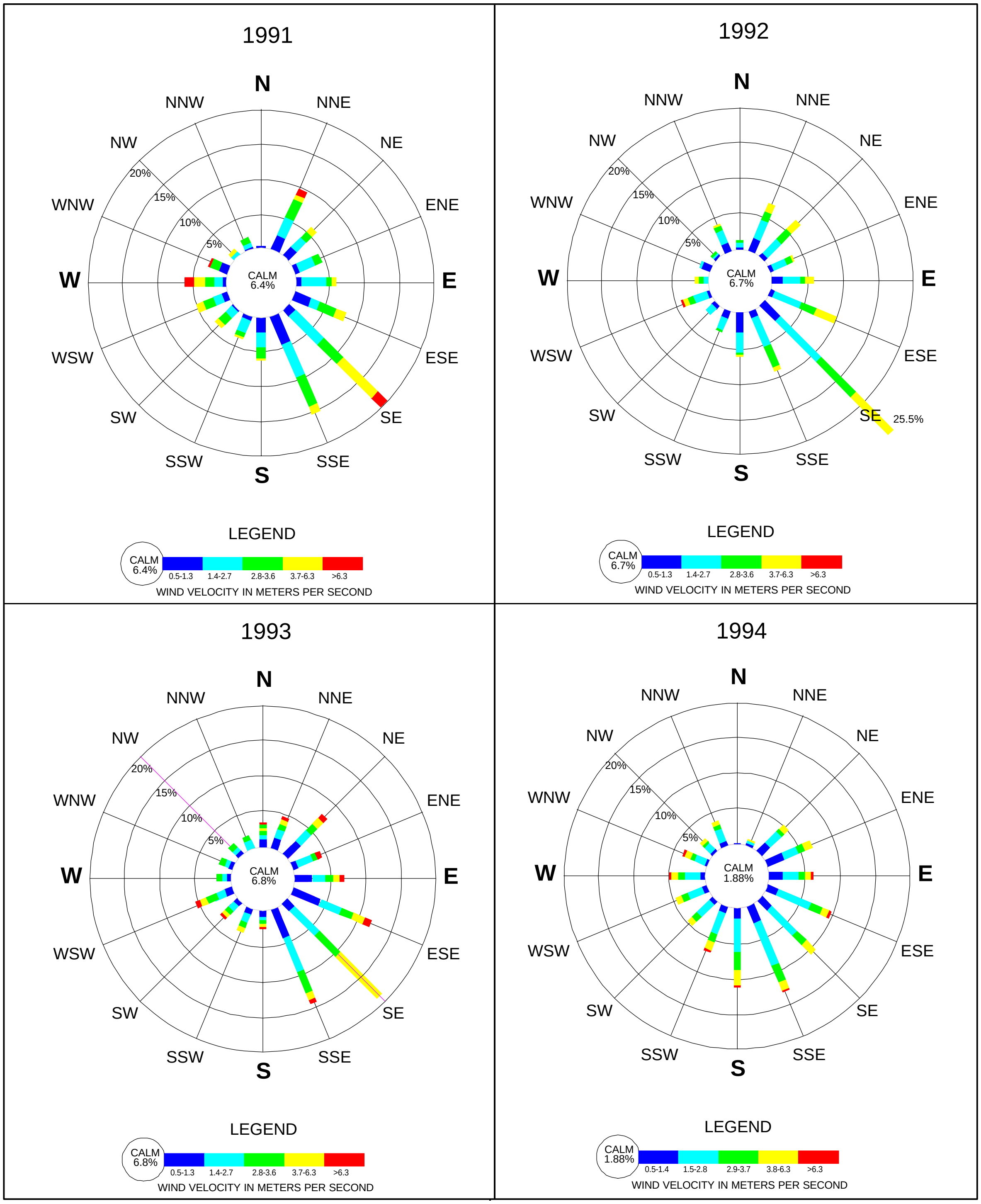
In 1991, after the EPA determined that air migration of VOCs would be a potential concern during testing at the facility, the VOC monitoring program was established at WIPP, and five VOC sampling stations were installed. The VOC monitoring program consisted of monitoring the air pulled from the exhaust shaft for any VOCs released from the test wastes. Samples were regularly analyzed for five target VOCs (carbon tetrachloride, methylene chloride, trichloroethylene, trichloroethane, and freon-113), and for other organics that might be detected.

Background monitoring of target VOCs will continue at three of the five locations. One location will measure the target compounds in the exhaust stream near the top of the exhaust shaft, another will sample the ambient air drawn into the underground facility, and the third will measure the background concentration. By measuring VOCs at the three locations it will be possible to define the variability in VOC concentration due to WIPP operations.

The regional climate is semiarid, with low precipitation and humidity and a high rate of evaporation. Precipitation is unevenly distributed throughout the year, with most occurring during summer thunderstorms. Winds are mostly from the southeast and moderate. In late winter and spring, there are strong west winds and dust storms. Thunderstorms are frequent from June through September, and are often accompanied by hail. Rains are brief but occasionally intense and can result in flash flooding in arroyos and along floodplains. Tornadoes are common throughout the region. From 1955 through 1967, 15 tornadoes were reported in the WIPP site area covered by one degree of latitude and longitude (DOE 1980).

The Carlsbad Air Terminal is the closest meteorological monitoring station and is located approximately 50 kilometers (30 miles) west of WIPP. Because of the relatively flat terrain, meteorological measurements at the airport are considered to be representative of the region. The mean annual temperature is 16 degrees Celsius (60 degrees Fahrenheit), and the mean annual precipitation is about 33 centimeters (13 inches). Drought conditions occurred during 1994. Precipitation for the 1994 calendar year was 31 percent less than that of the 1993 calendar year and 74 percent less than that of the 1992 calendar year.

The predominant wind direction at WIPP during calendar years 1991 through 1993 was from the southeast. However, during the 1994 calendar year, winds during late spring were primarily from the west. Wind speeds categorized as calm (less than 0.5 meters [1.6 feet] per second) usually occur about 7 percent of the time. Wind speeds of 1.4 through 2.7 meters (4.6 through 8.9 feet) per second were the most prevalent in the 1994 calendar year, occurring 25.5 percent of the time. Figure 4-3 displays the 1991 through 1994 wind roses (DOE 1992, 1993b, 1994a, and 1995d).



Source: DOE 1992, 1993b, 1994a, and 1995d

Figure 4-3
Windroses for 1991-1994

These conditions are consistent with long-term averages for the region. For a comprehensive discussion of climatology at the WIPP site, see Section 7.1.1 of the FEIS (DOE 1980). The WIPP site annual environmental reports (DOE 1991, 1992, 1993b, 1994a, 1995d, and 1996d) provide monthly and annual temperatures, precipitation, and wind conditions.

The ambient noise level in the WIPP area prior to construction was 26 to 28 decibels (DOE 1980). DOE requires its facilities to comply with Occupation Safety and Health Administration standards as promulgated in Title 29, of the Code of Federal Regulations (CFR), Section 1910.95. Any WIPP noise sources with the potential to exceed these standards have been mitigated (for example, noise dampers have been installed in the underground air exhausts) and are now in compliance with 29 CFR Section 1910.95.

4.1.3 Geology and Hydrology

The first part of this section summarizes the geological and hydrological features of the WIPP site as well as key factors relevant to the repository's ability to isolate waste (repository performance). The remainder provides a discussion of what has been learned since SEIS-I. For the interested reader, there are several WIPP documents containing detailed, comprehensive, and technical descriptions of WIPP geology and hydrology. These documents have been incorporated by reference. Among them are FEIS (DOE 1980), SEIS-I (DOE 1990), the *Preliminary Performance Assessment for the Waste Isolation Pilot Plant* done by Sandia National Laboratories (SNL) (SNL 1992), the *Final No-Migration Variance Petition* (DOE 1996a), the *Waste Isolation Pilot Plant Safety Analysis Report* (DOE 1997a), and the *Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (DOE 1996c). These references are cited throughout this section.

KEY ELEMENTS CONCERNING GEOLOGY AND HYDROLOGY

Since publication of SEIS-I, additional studies and analyses have provided new information regarding geology and hydrology. These studies have improved the understanding of processes considered in evaluating long-term performance. Several examples are listed below:

- Extensive testing of the Salado Formation's salt beds and interbeds has resulted in confirmation of the Salado's extremely low permeability.
- Recent test data have enabled improved predictions of pressures at which Salado interbeds will likely fracture and relieve elevated gas pressures within the repository.
- Refined modeling of gas generation suggests that elevated gas pressure may slow down or stop brine inflow, thereby slowing gas-generating processes.
- Three-dimensional modeling of groundwater flow in the Rustler Formation suggests a very small amount of vertical flow and a preponderance of horizontal flow within the Culebra Dolomite.
- Recent tests on the Culebra Dolomite have provided new data on contaminant transport in the Culebra and on the Culebra's potential to retard radionuclides.

The geophysical, geochemical, and hydrological behavior of various strata believed to be important to WIPP performance has been investigated during almost 20 years as a part of the WIPP program. Since SEIS-I, most of the research performed has centered on improving understanding of groundwater flow and transport processes. This research has primarily dealt with: (1) hydraulic testing of the Salado Formation and characterization of brine flow within the Salado; (2) modeling of the interactions among gas generation, brine flow into the repository, and contaminated brine flow out of the repository; (3) modeling of regional groundwater flow in units above and below the Salado, particularly the Rustler Formation, which overlies the Salado and includes the Culebra

Dolomite; (4) hydraulic testing and tracer testing within the Culebra Dolomite; (5) characterization and modeling of hydrologic and geochemical characteristics of the Culebra; and (6) geophysical characterization of the pressurized brine occurrences in the Castile Formation that underlies the Salado. The following section summarizes results of investigations of WIPP geology and hydrology published since SEIS-I.

4.1.3.1 Geology

No substantive changes have occurred in the understanding of the site and regional geology since SEIS-I. A brief description of surface and subsurface geology and seismicity, both at the WIPP site and the region immediately surrounding the WIPP repository, is presented here. For detailed descriptions, see the references listed above.

Regional Setting and Surface Geology

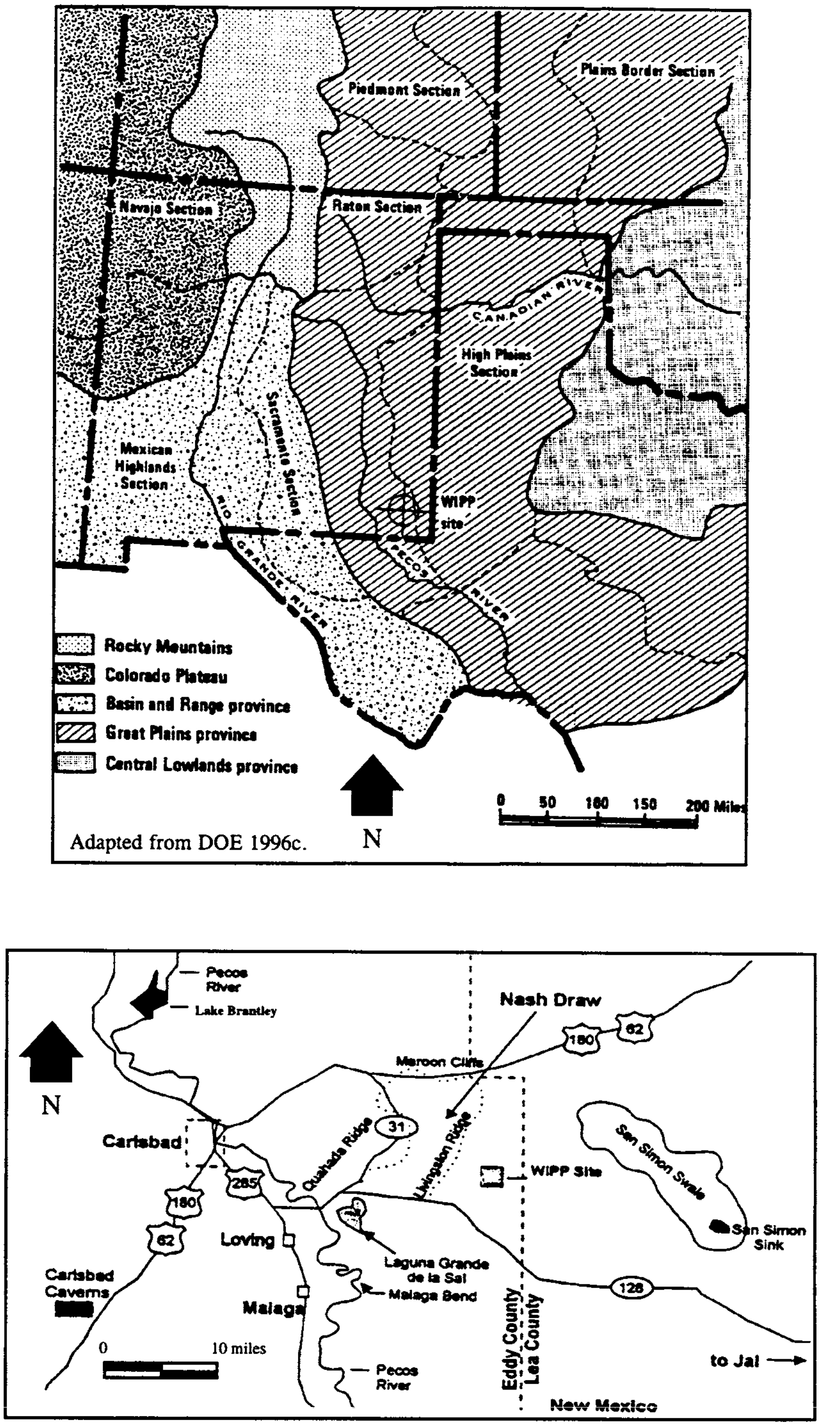
WIPP is located in southeastern New Mexico, in the Pecos Valley Section of the Great Plains Physiographic Province. The terrain throughout the province varies from plains and lowlands to rugged canyons. In the immediate vicinity of WIPP, numerous small mounds formed by wind-blown sand characterize the land surface. A layer enriched in calcium carbonate material, the Mescalero caliche, is typically present beneath the surface layer of sand. This caliche ranges in age from about 510,000 years at the base of the layer to about 410,000 years in the upper part, based on samples within the layer (DOE 1996c, Section 2.1). The caliche layer overlies a 600,000-year old volcanic ash layer (DOE 1996c, Section 2.1). The Mescalero caliche can be found over large portions of the Pecos River drainage area and is generally considered to be an indicator of surface stability (DOE 1980). The site slopes gently from east to west, from an elevation of 1,088 meters (3,570 feet) above sea level at its eastern boundary to 990 meters (3,250 feet) above sea level along its western boundary.

A high plains desert environment characterizes the area. Due to the seasonal nature of the rainfall, most surface drainage is intermittent. The Pecos River, 20 kilometers (12 miles) southwest of the WIPP boundary, is a perennial river and the master drainage for the region. A natural divide lies between the Pecos River and WIPP. As a result, the Pecos drainage system does not currently affect the site. Local physiographic features include Nash Draw and the San Simon Swale (see Figure 4-4).

Subsurface Geology

WIPP is located in the northern portion of the Delaware Basin, a structural basin underlying present-day southeastern New Mexico and western Texas and containing a thick sequence of sandstones, shales, carbonates, and evaporites. The references listed above describe basic characteristics of the stratigraphy (sequence of rock units) of the Delaware Basin.

The WIPP repository is located at a depth of approximately 655 meters (2,150 feet) in rocks of Permian age. The sediments accumulated during the Permian period represent the thickest portion of the sequence in the northern Delaware Basin and are divided into four series. From oldest to youngest, these series are: the Wolfcampian, Leonardian, Guadalupian, and Ochoan. As shown in Figure 4-5, the Ochoan series is divided into four formations. From oldest to youngest, these formations are: Castile, Salado (the lower part of which contains the WIPP repository), Rustler, and Dewey Lake.



Adapted from DOE 1996c.

Figure 4-4
WIPP Site Location in Southeastern New Mexico

SYSTEM	SERIES	GROUP	FORMATION	MEMBER	DEPTH AT WIPP WASTE SHAFT meters (feet)
RECENT	RECENT		SURFICIAL DEPOSITS		
QUATERNARY	PLEISTOCENE		MESCALERO CALICHE		
			GATUNA		
TRIASSIC		DOCKUM	SANTA ROSA		30 (97)
PERMIAN	OCHOAN		DEWEY LAKE		164 (538)
			RUSTLER	Forty-niner	182 (596)
				Magenta Dolomite	189 (621)
				Tamarisk	215 (707)
				Culebra Dolomite	222 (729)
				lower unnamed	257 (844)
			SALADO	upper	409 (1,343)
				McNutt Potash	526 (1,727)
				lower WIPP	655 (2,150) ~810 (2,650)
			CASTILE		~1,200 (4,000)
	GUADALUPIAN	DELAWARE MOUNTAIN	BELL CANYON		~1,550 (5,100)
			CHERRY CANYON		~1,900 (6,200)
			BRUSHY CANYON		

Figure 4-5
Regional Geologic Column

The discussion below presents the geologic formations important to understanding the long-term performance of WIPP, including: the host rock for the WIPP repository (the Salado Formation), the formations below the Salado (the Castile and Bell Canyon Formations), and the formations above the Salado (the Rustler and Dewey Lake Formations).

Salado Formation

The Salado Formation is a massive bedded salt formation, predominantly halite (sodium chloride), and is thick and laterally extensive. DOE selected the Salado Formation as the site of the WIPP repository for several geologic reasons (DOE 1980, 1990): (1) the Salado halite units have very low permeability to fluid flow, which impedes groundwater flow into and out of the repository; (2) the Salado is regionally widespread; (3) the Salado includes continuous halite beds without complicated structure; (4) the Salado is deep with little potential for dissolution; (5) the Salado is near enough to the surface that access is reasonable; and (6) the Salado is largely free of mobile groundwater, as compared to existing mines and other potential repository sites.

The Salado Formation is approximately 530 to 610 meters (1,740 to 2,000 feet) thick in the WIPP site area, and the repository is located in the thickest part. The Salado is comprised of three members. From oldest to youngest, these are: the Lower Member, the McNutt Potash Member, and the Upper Member. The WIPP repository is located in the Lower Member. The Salado contains many distinctive and laterally continuous layers composed mostly of anhydrite (a calcium sulfate mineral) and polyhalite (a potassium-magnesium-calcium sulfate mineral). These layers are so continuous that they have been used by geologists as “marker beds” (MB) and numbered to designate vertical position within the Salado Formation. The WIPP repository is located between MB 139 and MB 138.

Castile Formation

The Castile Formation directly underlies the Salado Formation and comprises the base of the Ochoan Series (see Figure 4-5). It is found 244 meters (800 feet) below the level of the repository. The Castile Formation near WIPP typically contains three relatively thick anhydrite/carbonate units and two thick halite units. The thickness of the Castile varies regionally as well as locally beneath WIPP, and there is considerable evidence from borehole data and geophysical surveys that the units of the Castile are deformed. The more brittle anhydrite units of the Castile are probably fractured, and the fracture zones are relatively permeable and act as zones for accumulation of brine originating in the Castile (DOE 1997a). The Castile is exposed at the surface over a considerable area along the western side of the Delaware Basin. In the eastern part of the basin, it is approximately 430 to 460 meters (1,400 to 1,500 feet) thick. At the northern boundary of WIPP, the Castile’s thickness has been measured at 301 meters (989 feet).

Bell Canyon Formation

The Bell Canyon Formation underlies the Castile Formation and is the uppermost formation of the Guadalupian Series (see Figure 4-5). Near WIPP, the Bell Canyon is comprised of a layered sequence of sandstones, shales, siltstones, and limestones approximately 300 meters (1,000 feet) or more in thickness. It is the uppermost target of hydrocarbon exploration in the local area and is known from outcrops on the west side of the Delaware Basin and from oil and gas exploration boreholes (DOE 1996c, Section 2.1).

Rustler Formation

The Rustler Formation directly overlies the Salado Formation and contains five members (see Figure 4-5). From the base of the Rustler, these members are: the Unnamed lower member, the Culebra Dolomite, the Tamarisk, the Magenta Dolomite, and the Forty-niner. The Culebra and Magenta Dolomites are gypsum-bearing dolomites containing numerous cavities (vugs), fractures, and silty zones. The other three members contain various amounts of anhydrite, siltstone, claystone, and halite. The Rustler is the youngest (uppermost) formation in the Delaware Basin and primarily contains evaporite deposits. In the WIPP region, the Rustler can be 152 meters (500 feet) thick, although it ranges from 91 to 107 meters (300 to 350 feet) thick within the WIPP boundary.

Dewey Lake Formation

The Dewey Lake Formation overlies the Rustler Formation at WIPP (see Figure 4-5). Consisting largely of reddish-brown siltstones and claystones with lesser amounts of sandstone, the Dewey Lake Formation is about 30 to 170 meters (100 to 560 feet) thick in the vicinity of WIPP.

Santa Rosa Formation

The Santa Rosa Formation, also called the Dockum Group, overlies the Dewey Lake Formation. Characterized by light reddish-brown sandstones and conglomerates, the Santa Rosa Formation is thin to absent within the WIPP site boundaries, but is thicker (78 meters [255 feet] or greater) to the east (DOE 1996c, Section 2.1).

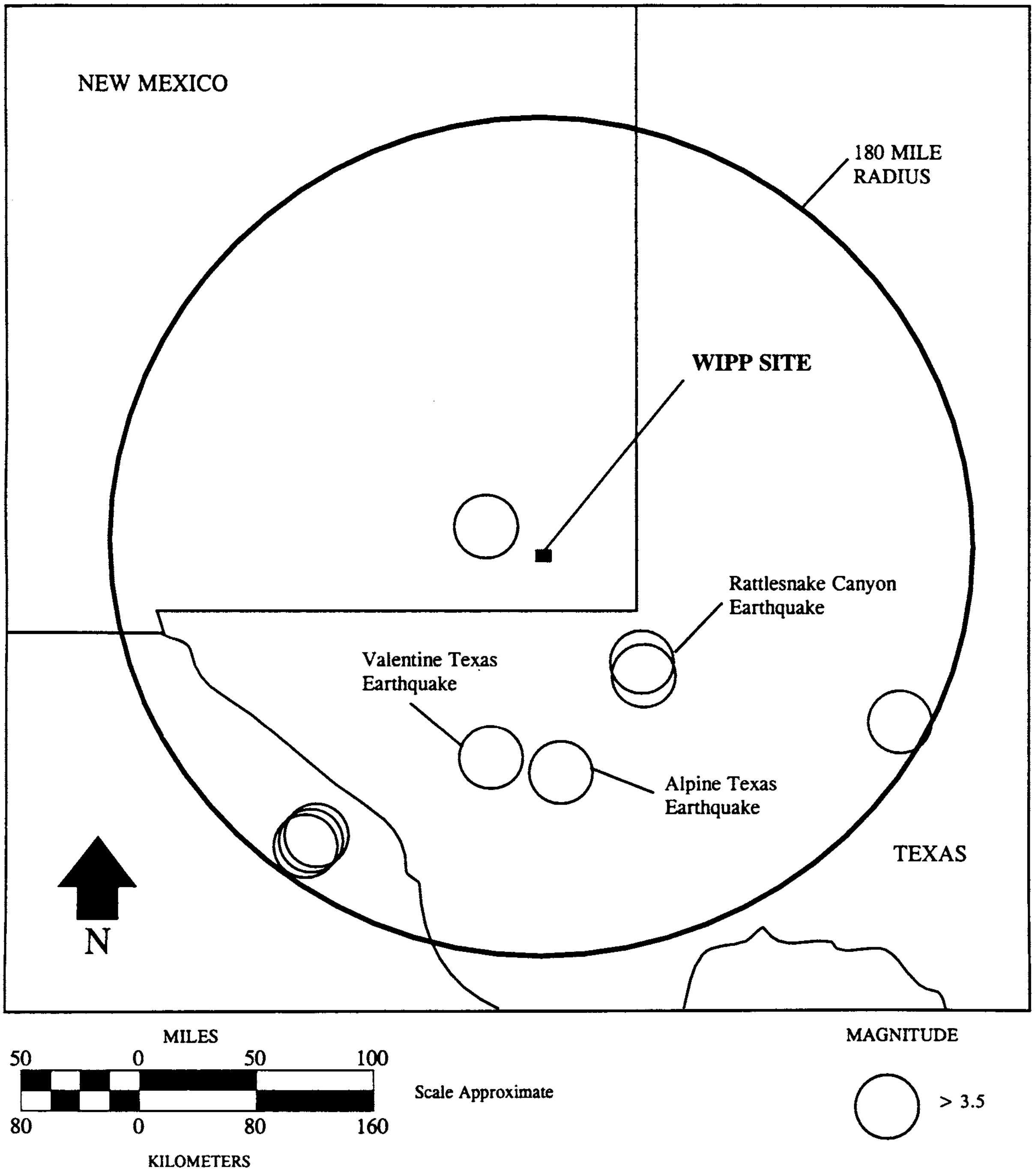
Gatuña Formation

The Gatuña Formation overlies the Santa Rosa Formation and is somewhat similar in lithology and color, although the Gatuña is characterized by a wide range of lithologies (coarse conglomerates to gypsum-bearing claystones). The Gatuña is Pleistocene in age, based on the 600,000-year old volcanic ash layer in the Upper Gatuña (DOE 1996c, Section 2.1). This is the same ash layer used to determine the upper age limit of the Mescalero Caliche that overlies the Gatuña Formation.

Faulting and Seismicity

Understanding of the regional seismicity has changed little since SEIS-I. No surface displacement or faulting younger than early Permian (Wolfcampian) has been reported, indicating that tectonic movement since then, if any, has not been noteworthy. No mapped Quaternary (last 1.9 million years) or Holocene (last 10,000 years) faults exist closer to the site than the western escarpment of the Guadalupe Mountains, about 100 kilometers (60 miles) west-southwest (DOE 1997a).

The strongest earthquake on record within 290 kilometers (180 miles) of the site was the Valentine, Texas, earthquake of August 16, 1931 (DOE 1997a), with an estimated Richter magnitude of 6.4. A Modified Mercalli Intensity V was estimated for this earthquake's groundshaking at WIPP. At Intensity V, groundshaking is felt by nearly everyone, a few instances of cracked plaster occur, and unstable objects are overturned. This is the strongest groundshaking intensity known for the WIPP site. This and other regional earthquakes are shown on Figure 4-6.



NOTES:

LOCATIONS OF SELECTED EARTHQUAKES WITHIN 300 KILOMETERS (180 MILES) OF THE WIPP SITE. FOR DRAFTING CLARITY NO EARTHQUAKE WITH A MAGNITUDE LESS THAN 3.5 IS SHOWN.

Figure 4-6
Regional Earthquake Epicenters Occurring after 1962

Since 1990, at least two seismic events have occurred that were recorded at WIPP. The Rattlesnake Canyon Earthquake occurred approximately 100 kilometers (60 miles) east-southeast of WIPP in January 1992. This event was assigned a Richter magnitude of 5.0 and occurred at a depth of approximately 12 kilometers (7.4 miles). This event had no effect on any of the structures at WIPP, as documented by post-event inspections by WIPP staff and the New Mexico Environment Department (DOE 1997a).

The most recent earthquake recorded at the WIPP site occurred on April 14, 1995, and was located 32 kilometers (20 miles) east-southeast of Alpine, Texas (approximately 240 kilometers [150 miles] south of the site). It was assigned a magnitude of 5.3 and is the largest event within 300 kilometers (185 miles) of the site since the Valentine, Texas, earthquake (Sanford et al. 1995). This event also had no effect on any structures at WIPP.

Based on a probabilistic seismic risk analysis and the region's historic seismicity, the strongest earthquake acceleration expected at WIPP would be 0.075 gravity (7.5 percent of acceleration due to gravity) with an average return period of 1,000 years. The design-basis earthquake (DBE) is conservatively assumed to be 0.1 gravity. Mine experience and studies on earthquake damage to underground facilities show that tunnels, mines, and wells are not damaged at sites having peak surface accelerations below 0.2 gravity (DOE 1997a).

Natural Resource Exploration and Development

Hydrocarbons

Prior to 1970, most commercially related drilling in the WIPP area targeted shallow oil (1,200 to 1,400 meters [4,000 to 4,500 feet] in depth) in the Bell Canyon Formation. Most of the exploratory wells from this period were plugged and abandoned. From 1970 to the mid-1980s, most drilling near WIPP focused on gas exploration in the deeper Morrow and Atoka Formations (approximately 4,000 meters [13,000 feet]). Most drilling for deep gas occurred northeast of WIPP. After parts of the Potash Area were opened to oil and gas exploration in the 1990s, exploration for deep gas in the Morrow and Atoka Formations occurred along the western boundary of the WIPP land withdrawal area (Broadhead et al. 1995).

According to Broadhead et al. (1995), estimates of probable oil and condensate resources within the WIPP Land Withdrawal Area include 12.3 million barrels of oil and gas condensate recoverable by primary production methods and an additional 6.4 million barrels of oil potentially recoverable by secondary recovery and waterfloods. Probable gas resources could total 5.3 billion cubic meters (186 billion cubic feet), 89 percent of which will be produced from the Atoka and Morrow Reservoirs. The remainder of the gas could be produced from shallow reservoirs in the Delaware Mountain Group. Probable resources within an additional 1.6-kilometer-wide (1-mile-wide) study area surrounding the withdrawn acreage include 22.9 million barrels of oil and gas condensate that could be recoverable by primary production methods and an additional 13.8 million barrels of oil that could be recoverable through waterflooding. Probable gas resources in this area could total 4.7 billion cubic meters (168 billion cubic feet), 79 percent of which could be produced from the deep Strawn, Atoka, and Morrow Reservoirs.

Broadhead et al. (1995) also state that possibly significant additional resources of oil, gas, and gas condensate exist beneath the WIPP site and the additional 1.6-kilometer-wide (1-mile-wide) area in untapped sandstones of the Delaware Mountain Group, in largely unexplored and unevaluated sandstones and carbonates of the Bone Spring Formation, and in carbonate reservoirs in the Wolfcamp and Strawn Group. During the late 1980s and early 1990s, commercial oil was discovered in the Cherry Canyon and Brushy Canyon Formations of the Delaware Mountain Group adjacent to the eastern and northeastern boundary of WIPP, at a depth of approximately 2,100 to 2,400 meters (7,000 to 8,000 feet). These formations are currently the primary exploration and development targets in the Permian Basin, one of the most actively explored areas in the United States (Broadhead et al. 1995).

According to a study of comprehensive well records for nine townships around the WIPP site (Broadhead et al. 1995), 532 wells had been drilled in search of oil and gas by the end of 1993 (Figure 4-7). Few wells had been drilled in the area prior to 1960. Between 1960 and 1989, drilling activity increased but was sporadic and never exceeded 20 wells per year. Since 1990, however, drilling has increased markedly, with annual totals increasing to a maximum of 140 wells in 1993 (Figure 4-8). This increase has been partially attributable to the opening of previously restricted areas of the Potash Area to drilling. Most of these wells were drilled into the Brushy Canyon Formation of the Delaware Mountain Group.

Three commercial wells have been drilled for oil and gas within the boundaries of the WIPP Land Withdrawal Area (see Figure 4-7). Two vertical wells were drilled within the area during the 1970s; neither one became a producing well. A third well was drilled in 1982 from a location outside of the WIPP Land Withdrawal Area. The well was drilled at an angle underneath the area to intercept gas in the Atoka Formation and is currently commercially productive (Broadhead et al. 1995).

Potash

Bedded potash was discovered in Eddy County, New Mexico, in 1925. By 1944, New Mexico was the largest domestic potash producer, representing 85 percent of consumption. Development continued through the 1950s and 1960s, reversed in the 1970s and, for several reasons has declined since (Barker and Austin 1995).

The Carlsbad Potash District, located in southeastern New Mexico near the northeastern border of the Delaware Basin, contains the largest domestic potash reserves. Sylvinite, a mixture of sylvite and halite, is the typical potash ore mined in the Carlsbad Potash District. The only potash mines in the state are located in Eddy and Lea Counties within the soluble potash zone. The WIPP Land Withdrawal Area occupies approximately 41 square kilometers (16 square miles) on the southeastern edge of the Known Potash Leasing Area (or Potash Enclave, administered by BLM) (see Figure 4-9). During the last decade or so, commercial potash mining has continued and the mining front is much closer to the WIPP site, having approached the site boundary on the southwestern side. Future mining is likely to occur there or on the north side of the site (Barker and Austin 1995).

Within the Known Potash Leasing Area, the majority of actively mined and potential resources of potash ore are found in the 37-meter-thick (120-foot-thick) McNutt Member of the Salado Formation, which is the host for 11 ore zones. Horizon Number 1 is at the base of the McNutt Member and Number 11, which is not mined, is at the top. In the vicinity of the withdrawal area, the McNutt Member is found at depths ranging from 400 to 525 meters (1,312 to 1,722 feet) above the repository horizon. An additional ore zone is found in the Upper Member of the Salado.

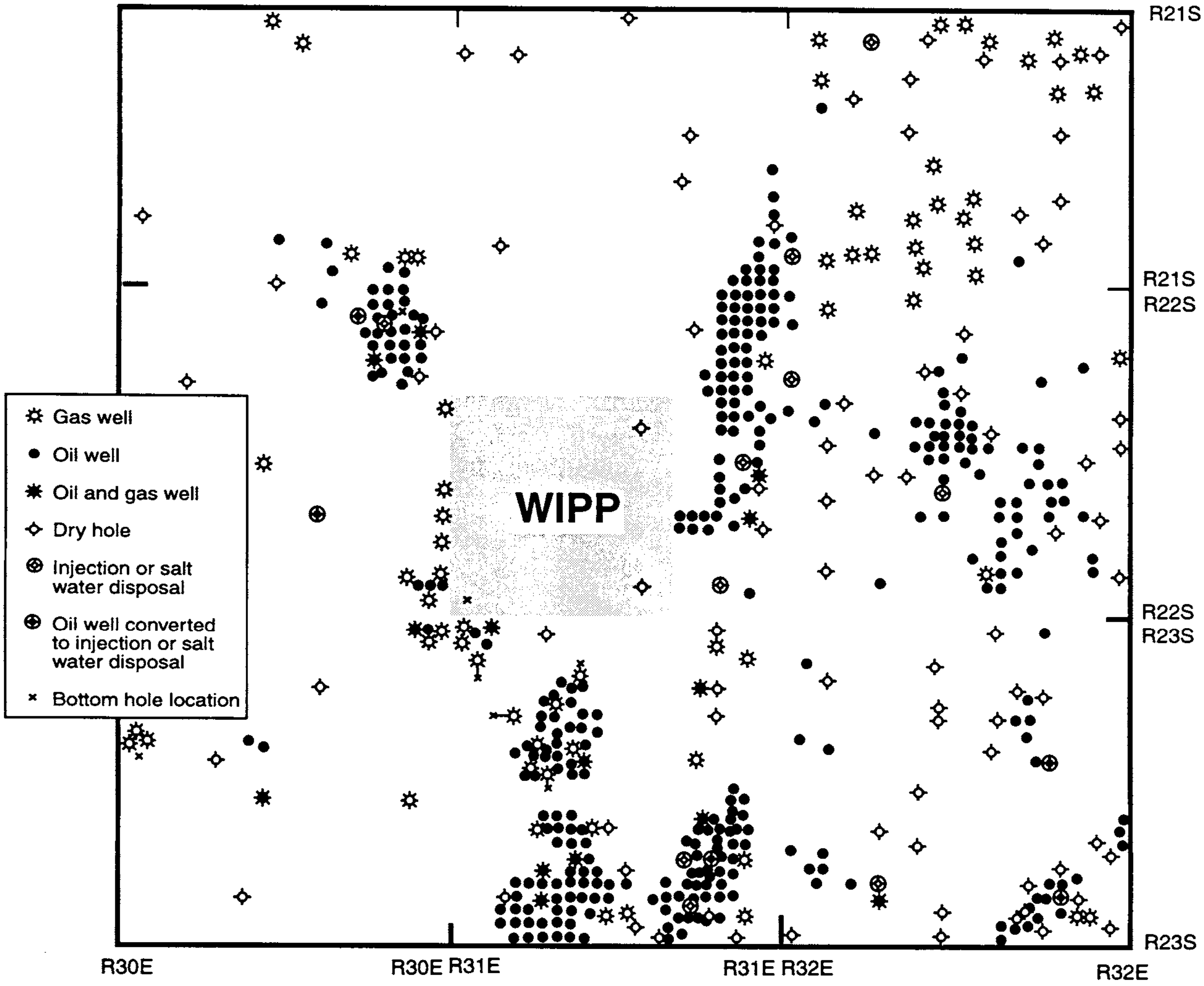


Figure 4-7
Oil, Gas, and Injection Wells in the Nine-Township Area Centered on the WIPP Site

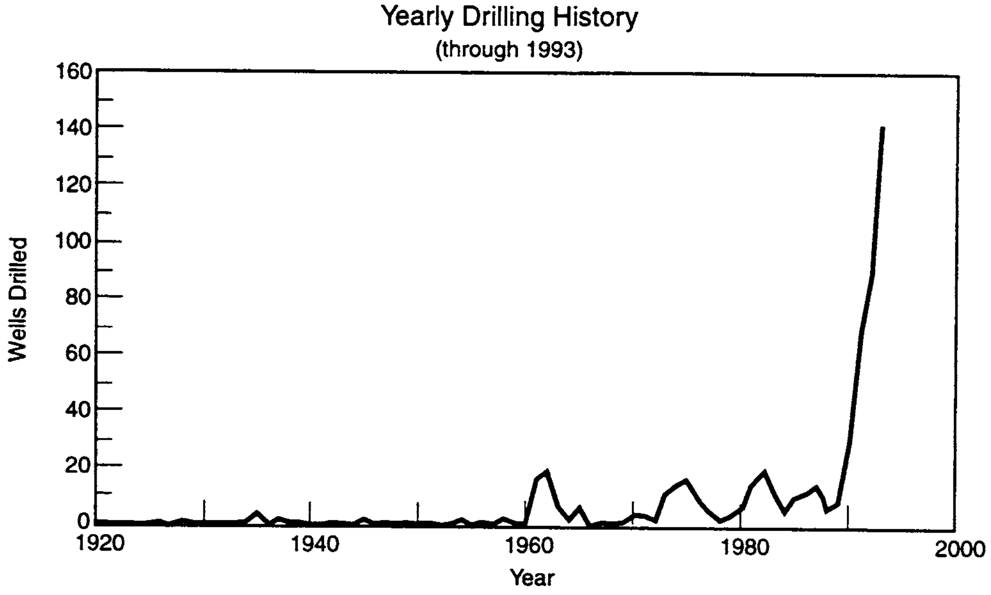


Figure 4-8
Annual Number of Oil and Gas Wells Completed
in the Nine-Township Area Centered on the WIPP Site

Potash ore zones are 1 to 3 meters (3 to 10 feet) thick and are laterally consistent except where interrupted by salt horses, collapse features, and igneous dikes (Barker and Austin 1995). Continuous mining equipment that has been adapted from coal mining is used to extract most of the potash ore, although blasting is also used. All mines in the Carlsbad Potash District consist of at least two shafts for safety and ventilation, and older mines may have three or more shafts because working faces are now 5 to 8 kilometers (3 to 5 miles) from the main shafts.

A summary of the current knowledge and estimates of potash mining reserves, based on recent work performed by the New Mexico Bureau of Mines and Mineral Resources in the vicinity of the WIPP site, is provided in Attachment 15-5 of Appendix MASS of the *Title 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (CCA) (DOE 1996c). A summary of current leases indicates that all are held by eight holding companies, five of which are actively mining in the area. No active potash mining leases currently exist within the WIPP controlled area.

4.1.3.2 Hydrology

This section provides a summary of the surface hydrology of the WIPP region, followed by the hydraulic and hydrogeologic characteristics of the geologic formations relevant to WIPP.

Surface Water Hydrology

Understanding of the surface water hydrology in the WIPP vicinity has changed little since SEIS-I. WIPP is located east of the Pecos River and within the Pecos River basin (which represents about one-half of the drainage area of the Rio Grande Water Resources Region). The drainage area of

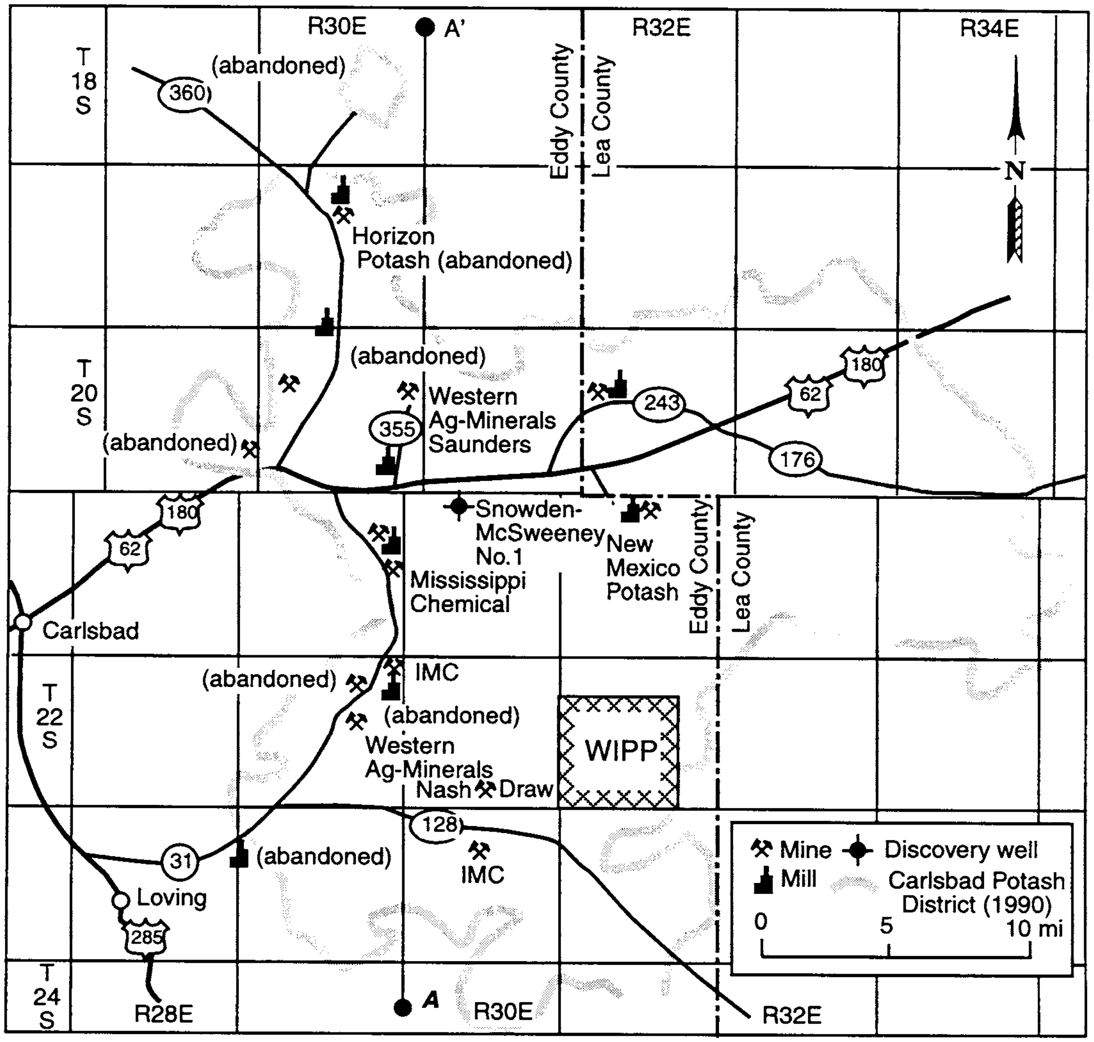


Figure 4-9
Active, Inactive, and Abandoned Potash Facilities in Eddy and Lea Counties, Southeastern New Mexico, Within the Carlsbad Potash District

the Pecos River at this location is 49,200 square kilometers (19,000 square miles). The WIPP site has a few small intermittent creeks, the only westward-flowing tributaries of the Pecos River within 32 kilometers (20 miles) north or south of the site.

The Pecos River is the main surface water resource in the WIPP vicinity. Due to inflow from brine springs (from the Rustler Formation) and slight exceedence of water quality levels of certain heavy metals (DOE 1996a), river water is not used for human consumption. Irrigation and livestock watering are the primary uses of the water from the Pecos.

More than 90 percent of the mean annual precipitation at the site is lost by evapotranspiration. On a mean monthly basis, evapotranspiration at the site greatly exceeds the available rainfall; however, intense local thunderstorms produce runoff and percolation. The maximum recorded flood on the Pecos River occurred on August 23, 1966, near Malaga, about 25 kilometers (15 miles) from WIPP. The maximum elevation of the flood was 90 meters (300 feet) below the elevation of the WIPP surface facility.

Groundwater Hydrology

The WIPP repository is situated in the thick, relatively impermeable Salado Formation salt beds 655 meters (2,150 feet) below the ground surface. The hydrologic and mechanical properties of the salt beds surrounding WIPP are better understood than the regional hydrology. Generally, however, groundwater in the Rustler and Dewey Lake Formations and the units overlying them are essentially isolated from the hydrology of the Salado Formation.

The Rustler Formation includes the Culebra and Magenta Dolomites, two units containing water of low quality (brine to brackish) (DOE 1996c, Section 2.2.1). The Culebra Dolomite, which is the first notable water-bearing unit above the Salado Formation, has been investigated for its potential to transport radionuclides released from the repository resulting from a borehole intrusion. Groundwater flow in the units overlying the Salado Formation has been assumed to occur primarily in the Culebra Dolomite, although it is recognized that regional flow in the Rustler Formation is three-dimensional and occurs to some degree in all Rustler units (DOE 1996c, Section 2.2.1). Flow in the Culebra is generally from north to south. The Dewey Lake Formation overlies the Rustler Formation and in some areas is relatively transmissive, particularly in the south central and southwestern part of the WIPP site (DOE 1996c, Section 2.2.1). The location of the water table is generally considered to be the Dewey Lake.

Only a few locations of groundwater recharge and discharge to and from the Rustler Formation are known. The only documented areas of naturally occurring groundwater discharge in the vicinity of WIPP are the Pecos River near Malaga Bend (Hunter 1985) and, to a lesser extent, the saline lakes in Nash Draw. This local flow associated with Nash Draw is unrelated to groundwater flow at WIPP. The only documented area of groundwater recharge is also near Malaga Bend (Hunter 1985). This location is hydraulically downgradient from the repository, and recharge here has little relevance to flow near WIPP. Recent regional groundwater modeling by Corbet and Knupp (1996) has suggested that groundwater in the Culebra, Magenta, and Dewey Lake and Triassic units originates in areas that are north and northeast of the WIPP site (DOE 1996c).

The following sections discuss the hydraulic and hydrogeologic characteristics of the geologic formations enclosing, underlying, and overlying the WIPP underground facility.

Salado Formation Hydrology

As described above, the Salado Formation has several characteristics which make it a favorable host medium for a repository, including its low permeability to fluids and its relatively low water content. Hydraulic tests from which permeabilities have been derived indicate that the Salado halite has either extremely low or no permeability (no measurable flow occurred during some of the tests). Tests in pure halite indicate permeabilities of less than 1×10^{-23} square meters (1×10^{-22} square feet); permeabilities measured in impure halite range from 1×10^{-23} to 4×10^{-18} square meters (1×10^{-22} to 4×10^{-17} square feet) (DOE 1996c, Section 2.2.1).

There is also indirect evidence of the Salado's low permeability. Measurements in the Salado in the WIPP site region have shown that there are areas of anomalously high and low fluid pressures. If the Salado were relatively permeable, these pressures would likely have equalized relatively quickly; conversely, if the Salado were relatively impermeable, these pressures would probably not equalize, or would do so only over a very long time. Since these pressure differences do exist, it is likely that these areas of anomalous pressures have remained constant over long periods of time because of the relative lack of permeability of the salt (Lappin et al. 1989).

Inflow of brine into the repository excavation has been observed in boreholes and from "weeps," which are localized brine seeps issuing from cracks in the disturbed surfaces of the repository walls, floors, and roofs. The volumes of brine observed from these occurrences have been small, and flow into the repository has ceased within three years of initial observation (DOE 1996c, Appendix MASS). Brine migrates along clay-rich layers and cracks developed in the "disturbed rock zone" (DRZ). Eventually the DRZ heals, thereby cutting off fracture-controlled flow paths into the repository. Nevertheless, for the long-term, it is reasonable and conservative to consider that there may be brine near the repository that would flow toward and into the repository, albeit at a low rate.

Models are available to estimate the amount of brine that would flow into the excavation over time. DOE (1996c) discussed three mechanisms of brine inflow: (1) far-field flow, which is flow from outside the influence of the repository along naturally interconnected pore spaces; (2) redistribution, which is flow within the interconnected fractures of the DRZ; and (3) clay consolidation, which is the squeezing of water out of clay layers which intersect the repository. Of these mechanisms, only the first two are considered crucial (DOE 1996c, Appendix MASS); together, they are capable of contributing approximately 50 to 160 cubic meters (1,785 to 5,712 cubic feet) of brine per disposal room, which has an approximate volume of 3,675 cubic meters (128,700 cubic feet) (DOE 1996c, Appendix MASS).

Brine inflow is a concern in that the brine would provide necessary moisture for the degradation of certain waste material components and gas generation. This could occur from a combination of processes such as microbial activity, canister corrosion, corrosion of metal waste, and radiolysis of brine. If a sufficient supply of brine exists and gas accumulates faster than it can dissipate, it is conceivable that gas pressure could build up to the point that it exceeds lithostatic pressure (approximately 15 million pascals). In this event, fractures would form in the repository walls and provide pathways for contaminants away from the repository.

According to the CCA (DOE 1996c), the total volume of gas that may be generated by corrosion and microbial degradation may be sufficient to result in repository pressures that approach lithostatic levels. Sustained pressures above lithostatic levels are not physically reasonable within the disposal system, and fracturing of the more brittle anhydrite layers is expected to occur if sufficient gas is present. The permeability and porosity of the anhydrite marker beds (MB 138 and MB 139) will increase rapidly as pore pressure approaches and exceeds lithostatic levels. Pressure-dependent fracturing approximates the hydraulic effect of pressure-induced fracturing and will likely allow gas and brine to move more freely within the marker beds at higher pressures. The interbeds may be expected to serve as conduits for brine flow between the impure halite and the repository. Conceptually, brine flows laterally along higher permeability interbeds toward or away from the repository and vertically between the interbeds and the lower permeability halite. Because the interbeds have a very large contact area with adjacent halite-rich rock, even a very small flux from the halite into the interbeds (for brine inflow) or to the halite from the interbeds (for brine outflow) can accumulate into a significant quantity of brine. In this manner, halite serves as a source or sink for brine in the repository. It is expected that, because of density differences between gas and brine and their stratification within the repository, brine outflow will be dominantly in MB 139, and gas outflow will occur in anhydrite a and b or MB 138.

Interbeds also contain natural fractures that may be partially healed. If high pressure is developed in an interbed, its preexisting fractures may dilate or new fractures may form, altering its porosity and permeability. Pressure-dependent changes in permeability are supported by experiments conducted in the WIPP underground and in the laboratory (Beauheim et al. 1993). To the extent that it occurs, dilation or fracturing of interbeds is expected to increase the transmissivity of interbed intervals. The threshold pressure of dilated or fractured interbeds is expected to be low because apertures of the fractures increase; thus, fluid is expected to be able to flow outward readily if adequate pressure is available to dilate the interbeds.

The Salado salt has such a low permeability that it is difficult to measure with existing technology. Studies of the Salado indicate that the impure halite (greater than 0.5 percent impurities) may exhibit brine flow through pore spaces and along grain boundaries, but measurements on continuous layers of pure halite indicate zero or near-zero permeabilities. The interpretation of flow mechanism is inconclusive. The presence of the pure halite layers suggests that vertical flow through the Salado does not occur (DOE 1996c, Section 2.2.1).

Castile Formation Hydrology

The Castile Formation is dominated by anhydrite and halite zones of low permeability (DOE 1996c, Section 2.2.1.2); however, fracturing in the anhydrite zone of the upper portion of the Castile has generated isolated regions with much greater permeability than the surrounding intact anhydrite. These regions, referred to as brine reservoirs, contain brine at greater than hydrostatic pressure.

Castile brine reservoirs in the northern Delaware Basin contain widely spaced, highly-angled fractures; therefore, a borehole which penetrated through a brine reservoir would be unlikely to intersect a fracture and release brine. Appreciable volumes of brine have been produced from several reservoirs in the Delaware Basin, but there is little direct information on the areal extent of the reservoirs or the interconnection between them (DOE 1996c, Section 2.2.1.2).

Borehole ERDA-6, located 5 kilometers (3 miles) northeast of the WIPP site, and borehole WIPP-12, 1.6 kilometers (1 mile) north of the site center, encountered a zone of pressurized brine within the Castile Formation (DOE 1996c, Section 2.2.1.2). The fluid pressure measured in 1983 in the WIPP-12 borehole was 12.7 megapascals, greater than the nominal hydrostatic pressure of 11.1 megapascals for a column of equivalent brine at that depth. Results of hydraulic tests performed in the ERDA-6 and WIPP-12 boreholes suggest that the extent of the highly permeable portions of the Castile is limited. The vast majority of brine is thought to be stored in low-permeability microfractures, with about 5 percent of the overall brine volume stored in large, open fractures. The volumes of the ERDA-6 and WIPP-12 brine reservoirs were estimated in 1983 to be 100,000 cubic meters (3.5×10^6 cubic feet) and 2.7 million cubic meters (9.5×10^7 cubic feet), respectively.

A geophysical survey using time-domain electromagnetic (TDEM) methods was completed over the WIPP-12 brine reservoir and the waste disposal panels (DOE 1996c, Section 2.2.1.2). The TDEM measurements detected a conductor thought to be the WIPP-12 brine reservoir and also indicated that similar brine reservoirs may be present within the Castile under a portion of the waste disposal panels. In a recent geostatistical analysis, 354 drill holes and 27 Castile brine occurrences were used to establish that there is an 8 percent probability that a hole drilled into the waste panel region would encounter brine in the Castile. This analysis is included in the CCA as Attachment 18-6 in Appendix MASS (DOE 1996c).

The origin of brine in the Castile has been investigated geochemically and reported in the CCA in Section 2.1.6.2 (DOE 1996c). Based on the ratios of major and minor element concentrations in the brine, the report concluded that these fluids originated from ancient seawater and that no evidence exists for fluid contribution from present meteoric waters. The Castile brine chemistries from the ERDA-6 and WIPP-12 reservoirs are distinctly different from each other and from local groundwater samples. The geochemical data indicate that the brine in reservoirs has not mixed to any significant extent with other bodies of water and has not circulated. The brine is saturated, or nearly so, with respect to halite and, consequently, has little potential to dissolve halite.

Bell Canyon Formation Hydrology

The Bell Canyon Formation is considered to form a single hydrostratigraphic unit about 300 meters (1,000 feet) thick. The low-permeability of the Castile Formation that overlies it effectively isolates the fluid flow in the Bell Canyon. In the WIPP vicinity, the brines in the Bell Canyon flow northeasterly and discharge into the Capitan aquifer (DOE 1996c, Section 2.2.1.2).

Rustler Formation Hydrology

The Rustler Formation is the most significant hydrogeologic unit above WIPP because it contains the Culebra Dolomite, the first laterally continuous hydrologic unit above the Salado Formation. In addition to the Culebra, the Rustler Formation also contains four other units: 1) the Unnamed Lower Member, 2) the Tamarisk Member, 3) the Magenta Dolomite Member, and 4) the Forty-Niner Member. The following summary of the most current understanding of all these units draws mainly from discussions in the CCA (DOE 1996c, Section 2.2.1.4).

Unnamed Lower Member

The Unnamed Lower Member makes up a single hydrostratigraphic unit in WIPP models of the Rustler Formation, although its composition varies somewhat (DOE 1996c, Section 2.2.1.4). Overall, it acts as a confining layer: the basal interval of the Unnamed Lower Member, approximately 19.5 meters (64 feet) thick, is composed of siltstone, mudstone, and claystone, and contains the water-producing zones of the lowermost Rustler. Transmissivity values of 2.9 x 10^{-10} square meters (3.12 x 10^{-9} square feet) per second and 2.4 x 10^{-10} square meters (2.58 x 10^{-9} square feet) per second were reported from tests at well H-16, corresponding to hydraulic conductivities of 1.5 x 10^{-11} meters (4.95 x 10^{-11} feet) per second and 1.2 x 10^{-11} meters (3.96 x 10^{-11} feet) per second. Hydraulic conductivity in the lower portion of the Unnamed Lower Member is believed by DOE to increase to the west in and near Nash Draw, where dissolution at the underlying Rustler-Salado contact has caused subsidence and fracturing of the sandstone and siltstone. The porosity of the Unnamed Lower Member was measured in 1995 as part of the H-19 hydropad testing. Two claystone samples had effective porosities of 26.8 and 27.3 percent, and one anhydrite sample had an effective porosity of 0.2 percent.

The remainder of the Unnamed Lower Member contains mudstones, anhydrite, and variable amounts of halite. The hydraulic conductivity of these lithologies is extremely low; tests of mudstones and claystones in the waste handling shaft gave hydraulic conductivity values varying from 6 x 10^{-15} meters (1.98 x 10^{-14} feet) per second to 1 x 10^{-13} meters (3.28 x 10^{-13} feet) per second (DOE 1996c, Section 2.2.1.4).

Culebra Member

The Culebra Member, also referred to as the Culebra Dolomite, has been the most investigated hydrogeologic unit in the Rustler Formation during the past decade since it is the most transmissive unit at the WIPP site. Because of its hydraulic characteristics, the Culebra is considered the most likely pathway for radionuclide releases from the repository to the accessible environment.

According to the CCA, Culebra flow patterns have been recognized as moving predominantly north to south on the WIPP site and strongly affected by a high transmissivity zone in the southeastern portion of the site. Contours of these water levels suggest that the flow above the WIPP repository is to the south, flow in Nash Draw is to the southwest, and flow south of WIPP is possibly toward the west.

In the past trends in water chemistry along the inferred southerly flow have been an issue in interpretations of local flow conditions in the Culebra Dolomite. Using generally accepted interpretations of flow and chemistry, total dissolved solids would be expected to decrease and the general character of groundwater would be expected to change in the principal direction of groundwater flow. A number of past interpretations of groundwater flow paths and solute chemistry of the Culebra were based on the concept that groundwater flow in the Culebra was a confined system and that rock interactions along the flow path from WIPP must transform the groundwater from a more saline sodium chloride-type water to a more dilute calcium sulfate-type water.

In a recent interpretation by Corbet (1997), the Department has suggested that changes in groundwater chemistry that would be expected for a confined system are complicated by contributions of vertical leakage and regional groundwater recharge that interact with distinctive rock types originating in different areas surrounding the WIPP site. Corbet (1997) concludes that the distributions of solute chemistry observed in the Culebra are consistent with inferred groundwater flow conditions and reflect with a mixing of distinctly different groundwater originating in recharge areas to the east (slowly moving saline groundwater originating from dissolution of the Rustler and/or Salado and moving to the west), southwest (groundwater reacting with anhydrites of the Rustler and flowing southeast), and north and northeast (meteoric recharge water reacting with Rustler anhydrites and moving south through the WIPP site).

Over the years, both hydraulic and tracer tests have been used to characterize the flow and transport characteristics of the Culebra. The Culebra is a fractured dolomite layer with properties that vary horizontally and vertically. Examination of core and shaft exposures has revealed that there are multiple scales of porosity within the Culebra, including fractures ranging from microscale to potentially large, vuggy (cavity-filled) zones, and interparticle and intercystalline porosity. Measurements of core samples indicate porosities ranging from 0.03 to 0.30 (DOE 1996c, Section 2.2.1.4); this large range in porosity for small samples is expected, given the variety of porosity types within the Culebra. The core measurements indicate that the Culebra has a significant number of porosity connections leading to a limited amount of fluid movement, particularly within interparticle cavities where the porosity and permeability is high, such as in chalky lenses.

The majority of fluid movement in the Culebra occurs within fractures and within vugs connected by fractures (DOE 1996c, Section 2.2.1.4). In some regions, the permeability of the fractures is inferred to be significantly higher than the permeability of the other porosity types; in other regions, there appear to be no fractures of high permeability, which may be due to a lack of large fractures or the result of gypsum fillings in portions of the Culebra.

The hydraulic tests have been designed to yield pressure data that can be used in the interpretation of Culebra transmissivity, permeability, and storativity. The most detailed hydraulic data have been collected from tests at the WIPP hydropads, which generally comprise a network of three or more wells located within close proximity of each other. Long-term pumping tests yielding pressure data over a large area have been conducted at hydropads H-3, H-11, and H-19, and at well WIPP-13. In addition, slug tests and short-term pumping tests conducted at individual wells have provided pressure data that can be used to interpret the transmissivity at those locations. Detailed cross-hole hydraulic tests that yielded data on hydraulic properties have recently been conducted at the H-19 hydropad. The pressure data from long-term pumping tests and the interpreted transmissivity values for individual wells are used to generate the transmissivity fields of the Culebra that were used in performance assessment flow modeling (see DOE 1996c, Appendix TFIELD).

In order to evaluate the transport properties of the Culebra Dolomite, a series of tracer tests was conducted at the H-2, H-3, H-4, H-6, H-11, and H-19 hydropads near the WIPP site. Tests at the first five locations consisted of two-well dipole tests and/or multi-well convergent flow tests and are described in detail in Jones et al. (1992). More recent tracer tests at the H-19 hydropad and additional tracer tests performed at the H-11 hydropad consisted of single-well injection-withdrawal tests and multi-well convergent flow tests and are described in the CCA (DOE 1996c, Section 2.2.1.4). The recent tracer tests were specifically designed to evaluate the importance of horizontal and vertical heterogeneity and diffusion on transport processes.

Tamarisk Member

The Tamarisk Member functions as a confining layer. Attempts were made in two wells, H-14 and H-16, to test a 2.4-meter (7.9-foot) sequence of the Tamarisk that consists of layers of claystone, mudstone, and siltstone sandwiched between layers of anhydrite. The permeability was too low to measure in either well within the time allowed for testing; consequently, the transmissivity of the claystone sequence was estimated to be less than approximately 2.7 x 10^{-11} square meters (2.9 x 10^{-10} square feet) per second, one or more orders of magnitude less than that of the tested interval in the Unnamed Lower Member. The porosity of the Tamarisk was measured in 1995 as part of testing at the H-19 hydropad. Two claystone samples had an effective porosity of 21.3 to 21.7 percent, and five anhydrite samples had effective porosities of 0.2 to 1.0 percent (DOE 1996c, Section 2.2.1.4).

Magenta Member

The Magenta Member is a conductive, hydrostratigraphic unit about 7.9 meters (26 feet) thick at WIPP. The Magenta is saturated except near outcrops along Nash Draw, and hydraulic data are available from 15 wells. Transmissivity ranges over five orders of magnitude from 1 x 10^{-9} to 4 x 10^{-4} square meters (1.08 x 10^{-8} to 4.30 x 10^{-3} square feet) per second. The porosity of the Magenta was measured in 1995 as part of testing at the H-19 hydropad. Four samples had effective porosities ranging from 2.7 to 25.2 percent (DOE 1996c, Appendix HYDRO).

The hydraulic transmissivities of the Magenta, based on sparse data, show a decrease in conductivity from west to east, with slight indentations of the contours north and south of WIPP that correspond to the topographic expression of Nash Draw. In most locations, the hydraulic conductivity of the Magenta is one to two orders of magnitude less than that of the Culebra. The Magenta does not have hydraulically significant fractures in the vicinity of WIPP. The hydraulic gradient across the site varies from 3 to 4 meters per kilometer (16 to 20 feet per mile) on the eastern side, steepening to about 6 meters per kilometer (32 feet per mile) along the western side near Nash Draw (DOE 1996c, Figure 2-32).

Inferences about vertical flow directions in the Magenta have been made from well data collected by DOE, which reported a downward flow out of the Magenta over the WIPP site, consistent with results of groundwater basin modeling. However, DOE concluded that flow between the Forty-Niner and Magenta would be upward in H-3, H-14, and H-16, three boreholes which yielded reliable pressure data for the Forty-Niner. This conclusion is not consistent with the results of groundwater modeling, and this inconsistency may be the result of local heterogeneity in rock properties that affect flow on a scale that cannot be duplicated in regional modeling. Like the Culebra, groundwater elevations in the Magenta have changed over the period of observation; in fact, the pattern of changes is similar to that observed for the Culebra and is attributed to the same causes (see Section 2.2.1.4 of the CCA, DOE 1996c).

Forty-Niner Member

The Forty-Niner Member is described as a confining hydrostratigraphic layer and consists of low-permeability anhydrite and siltstone about 20 meters (66 feet) thick throughout the WIPP area (DOE 1996c, Section 2.2.1.4). Tests reported in DOE (1996c) for H-14 and H-16 yielded transmissivities of about 3 x 10^{-8} to 8 x 10^{-8} square meters (3.23 x 10^{-7} to 8.61 x 10^{-7} square feet) per second and 3 x 10^{-9} to 6 x 10^{-9} square meters (3.23 x 10^{-8} to 6.46 x 10^{-8} square feet) per second, respectively. The porosity of the Forty-Niner was measured as part of the H-19 hydropad testing. Three claystone samples had effective porosities ranging from 9.1 to 24.0 percent, and four anhydrite samples had effective porosities ranging from 0.0 to 0.4 percent.

Rustler-Salado Contact Zone

The contact between the Rustler and Salado Formations in the vicinity of Nash Draw (see Figure 4-4) is of interest, because it provides evidence of earlier dissolution. It is an unstructured residuum of gypsum, clay, and sandstone created by the dissolution of halite and has been known as the brine aquifer or residuum. The residuum is absent under the WIPP site (DOE 1996c, Section 2.2.1.4).

Robinson and Lang (1938) suggested that the structural conditions that caused the development of Nash Draw might control the occurrence of the brine; thus, the brine aquifer boundary may coincide with the topographic surface expression of Nash Draw. Their studies show brine concentrated along a strip from 3.3 to 13 kilometers (2 to 8 miles) wide and about 43 kilometers (26 miles) long. Data from test holes indicate that the residuum containing the brine ranges in thickness from 3 to 18 meters (10.5 to 60 feet) and averages about 7 meters (24 feet).

Hydraulic properties for the area between Malaga Bend on the Pecos River and Laguna Grande de la Sal were estimated by Hale et al. (1954), who calculated a transmissivity value of 8.6×10^{-3} square meters (9.25×10^{-2} square feet) per second and estimated the potentiometric gradient to be 0.27 meter per kilometer (1.4 feet per mile). The coincident fluctuation of water levels in the area's test holes with pumping rates in irrigation wells along the Pecos River suggest the Rustler-Salado residuum to be part of a continuous hydrologic system.

In the northern half of Nash Draw, the approximate outline of the brine aquifer as described by Robinson and Lang (1938) has been supported by drilling associated with the WIPP hydrogeologic studies. These studies also indicate that the main differences in the aquifer's areal extent occur along the eastern side of Nash Draw where the boundary is very irregular and, in places (test holes P-14 and H-07), extends farther east than previously indicated. The recent studies also found a variability in thickness of residuum present in test holes WIPP-25 through WIPP-29, ranging from 3.3 meters (11 feet) in WIPP-25 to 33 meters (108 feet) in WIPP-29 in Nash Draw, as compared to 2.4 meters (8 feet) in test hole P-14 east of Nash Draw. The specific geohydrologic mechanism that has caused dissolution to be greater in one area than in another is not apparent, although a general increase in chloride concentration in water from the north to the south may indicate the effects of movement down the natural hydraulic gradient in Nash Draw.

The average hydraulic gradient within the residuum in Nash Draw is about 1.9 meters per kilometer (10 feet per mile). In contrast, the average gradient at the WIPP site is 7.4 meters per kilometer (39 feet per mile). This difference reflects the changes in transmissivity, which are as much as five orders of magnitude greater in Nash Draw. The transmissivity determined from aquifer tests in test holes completed in the Rustler-Salado contact residuum of Nash Draw ranges from 2.1×10^{-10} square meters (2.26×10^{-9} square feet) per second at WIPP-27 to 8.6×10^{-6} square meters (9.25×10^{-5} square feet) per second at WIPP-29. This is in contrast to the WIPP site proper, where transmissivities range from 3.2×10^{-11} square meters (3.44×10^{-10} square feet) per second at test holes P-18 and H-5c to 5.4×10^{-8} square meters (5.81×10^{-7} square feet) per second at test hole P-14 (DOE 1996c, Appendix HYDRO). Locations and estimated hydraulic heads of these wells are illustrated in the CCA (DOE 1996c, Figure 2-35).

Hale et al. (1954) believed the residuum discharges to the alluvium near Malaga Bend on the Pecos River. Because the confining beds in this area are probably fractured due to dissolution and collapse of the evaporites, the brine (under artesian head) moves up through these fractures into the overlying alluvium and then discharges into the Pecos River.

Water in the Rustler-Salado contact residuum in Nash Draw contains the largest concentrations of dissolved solids in the WIPP area, ranging from 41,500 milligrams per liter (5.63 ounces per gallon) in borehole H-1 to 412,000 milligrams per liter (55.9 ounces per gallon) in borehole H-5c (DOE 1996c, Appendix HYDRO). These waters are classified as brines. The dissolved mineral constituents in the brine consist mostly of sulfates and chlorides of calcium, magnesium, sodium, and potassium; the major cations and anions are sodium and chloride. Concentrations of the other major ions vary according to the areal location of the sample, are probably directly related to the interaction of the brine and the host rocks, and reflect residence time within the rocks. Residence time of the brine depends upon the transmissivity of the rock, that is, the presence of large concentrations of potassium and magnesium in water is correlated with minimal permeability and a relatively undeveloped flow system.

Dewey Lake and the Santa Rosa Formation Hydrology

The Dewey Lake and Santa Rosa Formations and surficial soils overlie the Rustler Formation and are the uppermost hydrostratigraphic units considered by DOE (DOE 1996c). A brief description of the main features of these units is provided below.

Dewey Lake Formation

The Dewey Lake Formation, also referred to as the Dewey Lake Redbeds, contains a productive zone of saturation, probably under water table conditions, in the southwestern to south-central portion of the WIPP site and south of the site. Several wells operated by the J.C. Mills Ranch south of the WIPP site produce sufficient quantities of water from the Dewey Lake to supply livestock. Short-term production rates of 5.7 to 6.8 cubic meters (1,500 to 1,800 gallons) per hour were observed in boreholes P-9, WQSP-6, and WQSP-6a (DOE 1996c, Appendix USDW). The saturated zone is typically found in the middle of the Dewey Lake, 55 to 81 meters (180 to 265 feet) below the surface and appears to derive much of its transmissivity from open fractures. The saturated zone may be perched or simply underlain by less transmissive rock. Fractures below the saturated zone tend to be completely filled with gypsum. Open fractures and/or moist (but not fully saturated) conditions have been observed at similar depths north of the saturation zone, at the H-1, H-2, and H-3 boreholes (DOE 1996c, Appendix HYDRO).

DOE estimated the position of the water table in the southern half of the WIPP site from an analysis of drillers' logs from three potash exploration boreholes and five hydraulic test holes. Using log records of the elevation of the first moist cuttings recovered during drilling, the elevation of the water table over the WIPP waste panels was estimated to be about 980 meters (3,215 feet) above sea level. In comparison, the repository lies 385 meters (1,260 feet) above sea level.

Santa Rosa Formation

The Santa Rosa Formation is absent over the western portion of the WIPP site and crops out northeast of Nash Draw. It is present over the eastern half of the WIPP site, where it reaches a thickness of 91 meters (300 feet). Near the WIPP site, the Santa Rosa may have a saturated thickness of limited extent. Its porosity is estimated at about 13 percent, and it has a specific capacity ranging from 0.029 to 0.041 liters per second per meter (2.3×10^{-3} to 3.3×10^{-3} gallons per second per foot) (DOE 1996c, Appendix HYDRO).

Potential Impacts of Karst and Dissolution Processes

The current understanding of the extent, timing, and features related to dissolution (including a brief history of past project studies related to karst) in the area surrounding WIPP is described in Section 2.1.6.2 of the CCA (DOE 1996c**)**. In summary, these studies and investigations show that the geomorphology of the region, particularly near Nash Draw and to a lesser extent near WIPP, has been influenced by shallow dissolution. Groundwater flow in the Culebra and other units of the Rustler is primarily controlled by fractures that have been affected by shallow dissolution processes. A significant proportion of the fractures within the Culebra are filled with secondary gypsum east of the WIPP; to the west of the site most fractures are open.

Groundwater basin modeling performed in the CCA suggests that the Culebra becomes progressively more confined toward the east, corresponding to an increase in the overburden towards the east. This is also thought to coincide with a decrease in the fracturing associated with dissolution at the Rustler-Salado boundary. Percolating groundwater has caused the lateral dissolution of halite at the top of the Salado, causing collapse of the overlying Rustler with consequent changes in hydrogeological properties. The most prominent lateral dissolution feature in the region is seen at Nash Draw, some 5 miles (8 kilometers) to the west of the WIPP site. Average rates calculated in previous investigations of karst indicate that dissolution at the top of the Salado at the edge of the WIPP site would not take place for some 225,000 years, and an additional 2 to 3 million years would be required for dissolution to reach the repository horizon.

Deep dissolution of salt or other evaporite minerals in formations near the WIPP site is distinguished from shallow and lateral dissolution not only by depth but also by the origin of the water. Groundwater originating from deep brine-bearing zones can lead to the formation of cavities at depths that could potentially cause the collapse of overlying beds. These processes could lead to the formation of collapse breccias if the overlying rocks are brittle or to deformation that causes fracturing if the overlying rocks are ductile. These pipes may reach the surface or pass upwards into fractures and then into cracks that do not extend to the surface. Breccia pipes may also form through the downward percolation of meteoric waters or accelerate contaminant transport from the repository by creating enhanced pathways of vertical flow that bypass low-permeability units in the Rustler. If dissolution occurred within or beneath the waste panels themselves, there could be increased circulation of groundwater through the waste and a breach of the Salado host rock.

Past investigations in the region have identified these types of deep dissolution features within the Delaware Basin; however, their occurrences have been limited to areas along the margins of the basin that are underlain by Capitan Reef. Because of these observations, deep dissolution is not expected to occur sufficiently close to WIPP nor to affect groundwater flow in the immediate region of WIPP during the period of regulatory concern.

Within Nash Draw, extensive fracturing of the Rustler allows more groundwater flow and, therefore, dissolution of the Rustler. East of Livingstone Ridge, there is less fracturing and dissolution in the Rustler. In the CCA, the Department has concluded that the extent of dissolution at the top of the Salado will not reach the controlled area until long after 10,000 years. Thus, shallow and deep dissolution at the WIPP site were not considered in the CCA performance assessment calculations.

Potential Hydrologic Effects of Natural Resource Exploration and Development Activities

The wide range of natural resource-related activities, which historically have been and will continue to be important in the region, have implications for future site impacts. The following is a brief description of the potential impacts of hydrocarbon exploration and development and potash mining.

Potential Impacts from Oil and Gas Development

Just outside of the WIPP site, oil and gas reserves are accessed by drilling through the Salado Formation and into the underlying oil- and gas-bearing formations. In the early 1990s, the Delaware Basin in the vicinity of the WIPP site experienced a significant increase in oil and gas exploration and development (Broadhead et al. 1995). Current restrictions do not allow any drilling activities within the WIPP controlled area, therefore, no direct impact from drilling activities is expected.

Hydrocarbon exploration and development, as a normal part of operations, also involves the injection of brine into boreholes that are used for brine disposal and enhanced oil recovery. The production of oil and gas is often accompanied by the production of large volumes of reservoir brine. Typically, the unwanted brine is injected back into the subsurface in an approved zone or zones through the use of salt water disposal wells. As oil, gas, and reservoir brine are produced in primary oil production, the natural reservoir energy will be expended and secondary methods such as water flooding are used to enhance crude oil recovery. A successful water flooding operation injects pressurized water through a well borehole into the oil bearing zone, to force additional oil to flow towards the producing well. Without proper management, both primary and secondary recovery methods can have significant hydraulic impact on surrounding geologic media.

In 1988, sudden water level changes were observed in wells completed in the Culebra Dolomite south of the WIPP site. Changes were first observed in Well H-9, about 10 kilometers (6 miles) south of the WIPP site (Figure 4-10). From 1988 through mid-1993, water levels steadily rose almost 5.5 meters (18 feet) before dropping abruptly. Water levels continued to drop until the end of 1995; currently, water levels are on the rise.

Analysis of the water level changes in H-9 and a number of other observation wells in areas north and south of WIPP and in the vicinity of WIPP have suggested that the changes in wells to the south are the result of possible hydraulic impacts of water flooding activities south of the WIPP site. Although there is no direct evidence to conclude which water flooding operation or what specific hydraulic condition is creating the specific water level changes observed near the WIPP site, casing leaks are the most logical pathway for introduction of fluid into the Rustler Formation.

The problem of injected water migrating out of the zone also occurs at other oil fields underlying the Salado Formation in the region.

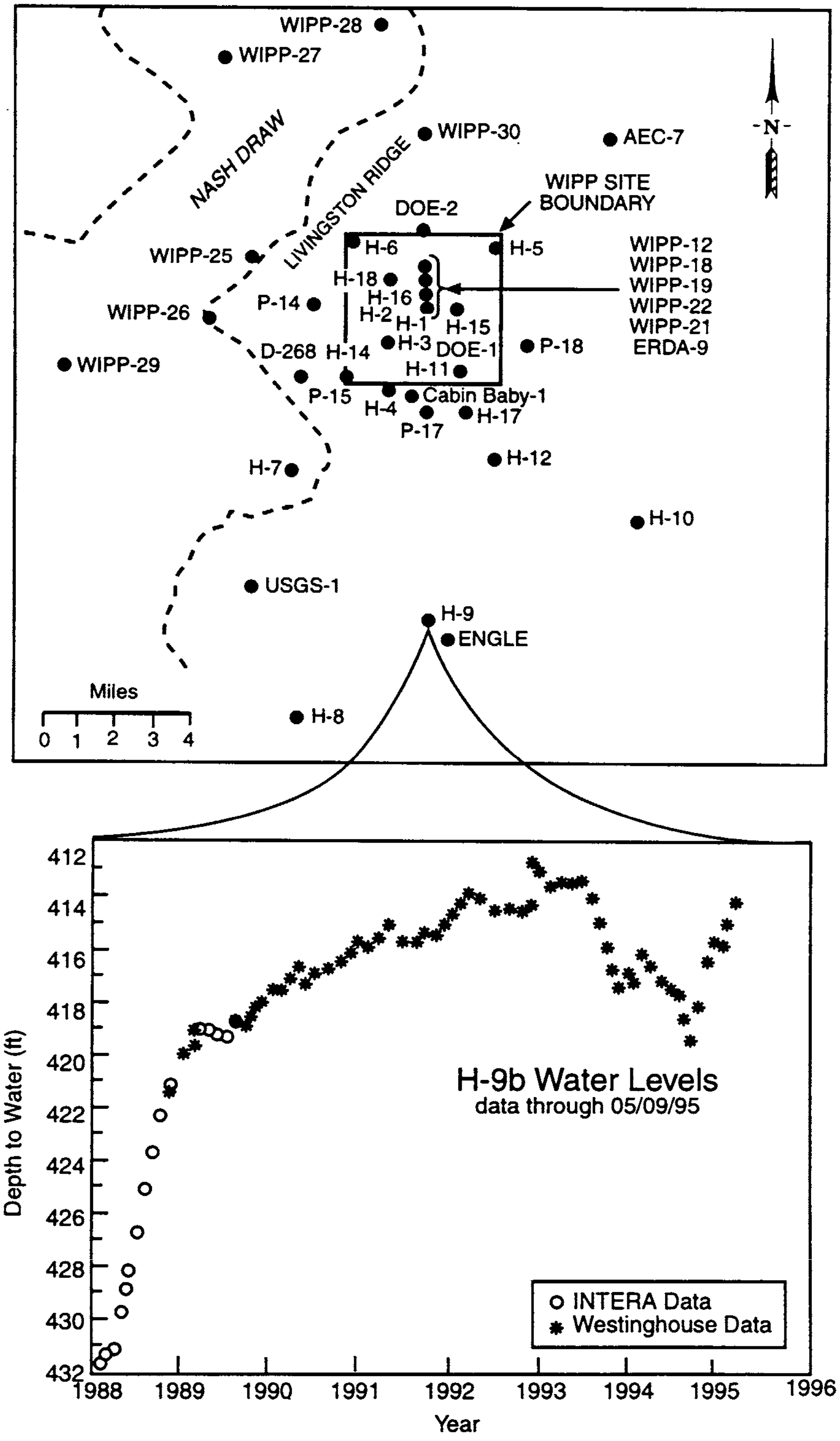


Figure 4-10
Locations of Wells Completed in the Culebra Dolomite in the Vicinity of the WIPP Site and Water-Level Changes in Observation Well H-9b between 1988 and 1996

Another example of potential hydrologic impacts from injection of large volumes of brine occurred in January, 1991 at a site located about 12 kilometers (8 miles) southeast of the WIPP site. In this incident, a borehole was in the process of being drilled through the Salado Formation when a salt water blowout, encountered at depths between 683 and 695 meters (2,240 and 2,280 feet), flowed uncontrollably for five days. In a lawsuit that followed, a claim was made that a nearby water flooding operation allowed large quantities of injected brine to escape out of an approved injection zone (which entered in the overlying Salado Formation) and migrate into the borehole. Evidence presented in the case substantiated the claim that brine injected to depths of about 915 meters (3,000 feet) had migrated out of the injection zone to the Salado Formation. The wells used in the water flooding operation were drilled and completed in the 1940s so the possibility of faulty well completion or failed well casing are potential causes of the out-of-injection zone migration. The potential for this type of incident to occur at WIPP was evaluated by DOE and was viewed as highly unlikely because of differences in geology between the WIPP site and the nearby site, changes in oil-well completion practices since the 1940s, and improved reservoir management practices.

The two examples of impacts noted above and other examples of the potential impacts of brine disposal and water flooding are described in more detail in Silva (1996).

Potential Impacts of Potash Mining

Potash mining has the potential to impact the hydrology of the area near the WIPP site in two ways. One impact involves the potential for mining operations and the development of room and pillar mines to cause weakening and collapse of overlying strata and subsequent subsidence. This may result in the propagation of fractures through both overlying water-bearing unit and potential contaminant pathways (e.g., the Culebra Dolomite), thereby increasing their hydraulic conductivity and potentially damaging petroleum well casings and uncased wells (Neill et al. 1996).

The other potential impact comes from the need of potash mining operations to dispose of brine generated during mining operations. As in the case of oil and gas drilling operations, potash mining requires the use of salt water disposal wells, and the potential exists that out-of-zone migration of brine injected through improperly sealed wells and deteriorating casing could have a potential impact on hydrologic conditions near the WIPP site.

Active and Passive Controls

The Department believes that planned active controls (see DOE 1996c, Chapter 7) will ensure that the prohibition on the drilling of hydrocarbon wells and on potash mining is enforced during the active institutional control period. For the purpose of this analysis, this period of active institutional control is assumed to be 100 years after the disposal operations period and site closure although it is the Department’s intention to maintain active institutional control well beyond this period. Beyond the active institutional period, DOE intends to implement a set of passive institutional controls (DOE 1996c, Section 7.3.4) that are expected to significantly deter the possibility of human intrusion for 700 years. Beyond that time, the effectiveness of passive controls is expected to degrade, and the potential exists for drilling or mining activities to encroach into the area of the WIPP site, leading to an intrusion from one or more exploratory boreholes or from mines into the repository and/or underlying possible pressurized brine reservoir. This potential impact was evaluated in the long-term performance assessment analysis described in Chapter 5 and Appendix H.

4.1.4 Biological Resources

SEIS-I (DOE 1990) describes the WIPP site area as characterized by sand dunes. Further, it describes the vegetation as dominated by shinnery oak (*Quercus havardii*), mesquite *(Prosopis grandulosa*), sand sage (*Artemisia filifolia*), dune yucca (*Yucca campestris*), smallhead snakeweed (*Gutierrezia microcephala*), three-awn (*Aristida* spp.), and numerous species of forbs and perennial grasses. The most conspicuous mammals at the site are the black-tailed jack rabbit (*Lepus californicus*) and the desert cottontail (*Sylvilagus auduboni*); other common small mammals include Ord's kangaroo rat (*Dipodomys ordii*), plains pocket mouse (*Perognathus flavescens*), and northern grasshopper mouse (*Onychomys leucogaster*). Large mammals include mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and coyote (*Canis latrans*). Loggerhead shrike (*Lanis ludovicianus*), Pyrrhuloxia (*Cardinalis sinuata*), and black-throated sparrow (*Amphispiza bilineata*) are common resident birds. The Harris hawk (*Parabuteo unicinctus*) is a resident raptor. Aquatic habitats near WIPP, which include stock watering ponds and tanks, may be frequented by yellow mud turtles (*Kinosternon flarescens*) and tiger salamanders (*Ambystoma tigrinum*) (DOE 1992, 1993b, 1994a, 1995d).

Since SEIS-I, ecological monitoring at WIPP has continued. Changes noted in vegetation distribution include an increase in shrub cover and a decrease in grasses such as black grama grass (*Bouteloua eriopoda)* near the salt tailings (due to the colonization of these habitats by salt-tolerant shrub species). No effects from salt-induced physiological stress were seen on the general vegetation of the area. Changes in cover and density during the last few years have been attributed to variations in annual rainfall (DOE 1993b, 1994a, and 1995d).

Wildlife monitoring has indicated increases in some species of birds at the site. This is primarily due to changes in surface conditions such as water availability (DOE 1992) and to increases in oilfield activities in areas surrounding the site which may have disturbed some populations and caused their relocation within the site (DOE 1994a). Surveys taken from 1984 through 1993 have documented 98 species of birds which inhabit or migrate through the area (DOE 1994a).

Mammal populations have fluctuated as a result of changes in natural conditions such as rainfall, temperature, and disease. No differences in mammal population numbers have occurred as a result of WIPP activities (DOE 1995d).

In consultation with the USFWS, the Department concluded in SEIS-I that the following threatened or endangered species occur or have the potential to occur on lands within or outlying the WIPP site: Lee's pincushion cactus (*Coryphantha sneedi* var. *leei*), American peregrine falcon, bald eagle (*Haliaeetus leucocephalus*), and Pecos gambusia (*Notropis simus pecosensis*). DOE stated that it believed the actions described in SEIS-I would have no impacts on any threatened or endangered species because those activities did

CHANGES IN RARE, THREATENED, AND ENDANGERED SPECIES

The threatened, endangered, and candidate species present in Eddy County, New Mexico, have changed since SEIS-I. In 1995, DOE consulted with the U.S. Fish and Wildlife Service (USFWS), the New Mexico Department of Game and Fish (NMDG&F), and the New Mexico Energy, Minerals and Natural Resources Department (NMEMNR) regarding the presence of federally threatened, endangered, and proposed species, state-listed rare and endangered animals, and state-listed rare and endangered plant species, respectively, in Eddy County, New Mexico. Since SEIS-I, more than 60 new state and federal species have been added to these county-wide lists, although no new species have been found at the WIPP site.

not involve any ground disturbance that was not already evaluated in the FEIS (DOE 1980). NMDG&F agreed with the Department that the anticipated WIPP activities would probably not have appreciable impacts on state-listed endangered species in the area. The Department concluded in SEIS-I that there is no critical habitat for terrestrial species identified as endangered by either the USFWS or the NMDG&F at the site (DOE 1990).

In September 1995, DOE contacted the USFWS to determine the occurrence of threatened, endangered, and proposed species at WIPP. The USFWS listed eight endangered, six threatened, and 37 proposed species for Eddy County, New Mexico (USFWS 1995) (see Table 4-1). At that time, DOE also contacted the NMDG&F and NMEMNR regarding the occurrence of state-listed rare, threatened, and endangered plant and animal species in Eddy County. The NMDG&F currently lists 22 threatened and 7 endangered animal species (NMDG&F 1995), and the NMEMNR lists 7 state-endangered and 17 state-sensitive plant species (Sivinski and Lightfoot 1995) (see Table 4-1). There is no designated critical habitat for such species at the WIPP site (NMDG&F 1995, USFWS 1995).

In 1996, DOE conducted another survey on the WIPP Land Withdrawal Area and associated lands to investigate the potential for impact to rare, threatened, endangered, or sensitive plant or animal species as a result of the potential actions presented in SEIS-II. The 1996 survey included an assessment of suitable habitats for these species. No threatened, endangered, or state-listed species were found on the WIPP Land Withdrawal Area during the survey. The data reported in the survey, which support the conclusions of other studies, suggest that dense and permanent populations of these species are not presently established on WIPP lands.

4.1.5 Cultural Resources

This section provides a brief evaluation of recent activities concerning the prehistoric and historic cultural resources at WIPP. FEIS (DOE 1980) summarized background discussions and data, followed by an update in SEIS-I (DOE 1990). More recent summaries of the WIPP cultural resources information are found in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1993a) and the *Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 1994* (DOE 1995d).

Cultural resources investigations at WIPP began in 1976 and have continued to the present. A review of the bibliography of existent WIPP cultural resources reports indicates that at least 24 separate investigations have been conducted. SEIS-I summarized two archeological investigations that provide further insight into the life of the hunter-gatherers who occupied the area of the WIPP site.

CHANGES IN CULTURAL RESOURCES MANAGEMENT

Memorandum of Understanding - In 1994, a memorandum of understanding between DOE and the Department of the Interior transferred management responsibility for cultural resources in the Land Withdrawal Area to DOE.

The first investigation excavated three sites that had been identified in FEIS that were in areas which could have been disturbed during construction activities. Two of the sites were plant-collecting and processing sites, and one was a base camp used between 1,000 B.C. and 1,400 A.D. The second investigation covered Control Zones III and IV and areas identified for

Table 4-1
Species of Special Concern in Eddy and Lea Counties, New Mexico [a]

Name	FE [b]	FT [c]	FC [d]	SE [e]	ST [f]	SR [g]
Mammals						
Arizona black-tailed prairie dog (*Cynomys ludovicianus arizonensis*)			X			
Big free-tailed bat (*Nyctinomops macrotis*)			X			
Black-footed ferret (*Mustela nigripes*)	X					
Cave myotis (*Myotis velifer*)			X			
Fringed myotis (*Myotis thysanodes*)			X			
Gray-footed chipmunk (*Tamias canipes*)			X			
Guadalupe southern pocket gopher (*Thomomys umbrinus guadalupensis*)			X			
Long-legged myotis (*Myotis volans*)			X			
Occult little brown bat (*Myotis lucifugus occultus*)			X			
Pale Townsend's big-eared bat (*Plecotus townsendii pallescens*)			X			
Pecos river muskrat (*Ondatra zibethicus ripensis*)			X			
Small-footed myotis (*Myotis ciliolabrum*)			X			
Swift fox (*Vulpes velox*)			X			
Yuma myotis (*Myotis yumanensis*)			X			
Birds						
American peregrine falcon (*Falco peregrinus anatum*)	X			X		
Arctic peregrine falcon (*Falco peregrinus tundrius*)		X				
Baird's sparrow (*Ammodramus bairdii*)			X		X	
Bald eagle (*Haliaeetus leucocephalus*)		X			X	
Bell's vireo (*Vireo bellii arizonae*)					X	
Black tern (*Chlidonias niger*)			X			
Broad-billed hummingbird (*Cynanthus latirostris*)					X	
Brown pelican (*Pelecanus occidentalis*)	X			X		
Common ground-dove (*Columbina passerina*)				X		
Ferruginous hawk (*Buteo regalis*)			X			
Gray vireo (*Vireo vicinior*)					X	
Interior least tern (*Sterna antillarum*)	X			X		
Loggerhead shrike (*Lanius ludovicianus*)			X			
Mexican spotted owl (*Strix occidentalis lucida*)		X				
Neotropical cormorant (*Phalacrocorax brasilianus*)					X	
Northern aplomado falcon (*Falco femoralis septentrionalis*)	X			X		
Northern goshawk (*Accipiter gentilis*)			X			
Southwestern willow flycatcher (*Empidonax traillii extimus*)	X				X	
Varied bunting (*Passerina versicolor*)					X	
Western burrowing owl (*Athene cunicularia hypugea*)			X			
White-faced ibis (*Plegadis chihi*)			X			
Reptiles						
Arid land ribbon snake (*Thamnophis proximus*)					X	
Blotched water snake (*Nerodia erythrogaster*)					X	
Dunes sagebrush lizard (*Sceloporus arenicolus*)			X		X	
Mottled rock rattlesnake (*Crotalus lepidus lepidus*)					X	
Texas horned lizard (*Phrynosoma cornutum*)			X			
Western river cooter (*Pseudemys gorzugi*)					X	

[a] Includes federal-endangered, -threatened, and -candidate species, state-endangered and -threatened species, and state-rare and -sensitive species. None of these species have been found during surveys at the WIPP sites. Due to revisions in the lists of endangered and threatened species, only two of the identified federal candidate species (the swift fox and Pecos pupfish) are still listed.

[b] FE = federal-endangered species (USFWS 1995)

[c] FT = federal-threatened species (USFWS 1995)

[d] FC = federal-candidate species (USFWS 1995)

[e] SE = state-endangered species (NMDG&F 1995, Sivinski and Lightfoot 1995)

[f] ST = state-threatened species (NMDG&F 1995)

[g] SR = state-rare and -sensitive species (Sivinski and Lightfoot 1995)

Table 4-1

Species of Special Concern in Eddy and Lea Counties, New Mexico — Continued [a]

Name	FE [b]	FT [c]	FC [d]	SE [e]	ST [f]	SR [g]
Fish						
Bigscale logperch (*Percina macrolepida*)					X	
Blue sucker (*Cycleptus elongatus*)			X	X		
Gray redhorse (*Moxostoma congestum*)					X	
Greenthroat darter (*Etheostoma lepidum*)					X	
Headwater catfish (*Ictalurus lupus*)			X			
Mexican tetra (*Astyanax mexicanus*)					X	
Pecos bluntnose shiner (*Notropis simus pecosensis*)		X			X	
Pecos gambusia (*Gambusia nobilis*)	X				X	
Pecos pupfish (*Cyprinodon pecosensis)*			X		X	
Plains minnow (*Hybognathus placitus*)			X			
Rio Grande shiner (*Notropis jemezanus*)			X			
Invertebrates						
Ovate vertigo (*Vertigo ovata*)			X		X	
Pecos springsnail (*Fontelicella pecosensis*)			X		X	
Texas hornshell (*Popenaias popei*)			X	X		
Plants						
Catchfly gentian (*Eustoma exaltatum*)						X
Chapline's columbine (*Aquilegia chrysantha chaplinei*)						X
Desert parsley (*Pseudocymopterus longiradiatus*)						X
Dune unicorn plant (*Proboscidea sabulosa*)						X
Few-flowered jewelflower (*Streptanthus sparsifloras*)			X			X
Gray sibara (*Sibara grisea*)						X
Guadalupe cliff daisy (*Chaetopappa hersheyi*)			X			X
Guadalupe mescal bean (*Sophora gypsophila guadalupensis*)						X
Guadalupe milkwort (*Polygala rimulicola rimulicola*)						X
Guadalupe penstemon (*Penstemon cardinalis regalis*)						X
Guadalupe rabbitbrush (*Chrysothamnus nauseosus texemsis*)			X			X
Guadalupe smooth aster (*Aster laevis guadalupensis*)			X			
Gypsum milkvetch (*Astragalus gypsodes*)						X
Gypsum wild buckwheat (*Erigonum gypsophilum*)		X		X		
Hitchcock's mockorange (*Philadelphus hitchcockianus*)						X
Kuenzler's hedgehog cactus (*Echinocereus fendleri kuenzleri*)				X		
Lee's pincushion cactus (*Coryphantha sneedii leei*)		X		X		
Lloyd's hedgehog cactus (*Echinocereus lloydii*)	X			X		
McKittrick pennyroyal (*Hedeoma apiculata*)						X
Scheer's pincushion cactus (*Coryphantha scheeri scheeri*)				X		
Shining coral root (*Hexalectris nitida*)			X	X		
Texas tobacco root (*Valeriana texana*)						X
Tharp's bluestar (*Amsonia tharpii*)			X	X		
Waterfall milkvetch (*Astragalus waterfallii*)						X
Wright's water-willow (*Justicia wrightii*)			X			X

[a] Includes federal-endangered, -threatened, and -candidate species, state-endangered and -threatened species, and state-rare and -sensitive species. None of these species have been found during surveys at the WIPP sites. Due to revisions in the lists of endangered and threatened species, only two of the identified federal candidate species (the swift fox and Pecos pupfish) are still listed.

[b] FE = federal-endangered species (USFWS 1995)

[c] FT = federal-threatened species (USFWS 1995)

[d] FC = federal-candidate species (USFWS 1995)

[e] SE = state-endangered species (NMDG&F 1995, Sivinski and Lightfoot 1995)

[f] ST = state-threatened species (NMDG&F 1995)

[g] SR = state-rare and -sensitive species (Sivinski and Lightfoot 1995)

possible land exchange. Sites encountered in the second investigation tended to lack evident or intact features. No definitive structures were identified. Of the 40 new sites identified, 14 were considered eligible for inclusion in the National Register of Historic Places (NRHP). The sites that are eligible or potentially eligible for the NRHP were mapped, and DOE activities have avoided disturbance of these sites. As a result of this past work, about 37 percent of the WIPP withdrawal area (1,551 hectares [3,830 acres]) has been inventoried for cultural resources.

To date, 60 archeological sites have been recorded in the withdrawal area, including 91 isolated occurrences (single or few artifacts, or isolated features). Sites and isolates are almost exclusively prehistoric in origin, and only one site with both prehistoric and historic components has been recorded. Based on the inventory data, and assuming environmental homogeneity and a fairly even distribution of archeological sites, DOE estimates that the WIPP site may contain about 99 archeological sites and 153 locations where isolated artifacts may be found (1993a).

There are no known Native American sacred sites or burials in the Land Withdrawal Area. Prior to the passage of the LWA in 1992, BLM managed the cultural resources on WIPP. In 1994, a memorandum of understanding between DOE and the Department of the Interior transferred management responsibility for cultural resources to DOE. Cultural resources are currently managed according to guidelines set forth in the WIPP Land Management Plan (DOE 1993a). DOE and the State of New Mexico have signed a Joint Powers Agreement that includes provisions specifying how DOE will satisfy its obligations regarding cultural resources under Sections 106 and 110 of the National Historic Preservation Act.

4.1.6 Socioeconomic Environment

The socioeconomic ROI for WIPP, as defined in FEIS (DOE 1980) and SEIS-I (DOE 1990), is Eddy and Lea counties in southeast New Mexico.[1] Any major changes in future activities undertaken at the WIPP site would have their most immediate socioeconomic effects in the two-county ROI. Principal centers of economic activity in the ROI include Artesia, Carlsbad, Hobbs, and Lovington. The oil and gas extraction and refining industries anchor the economies in both Eddy and Lea counties. Oil and gas mining services, mineral mining, tourism, and business services are the other significant industries of the ROI. The Carlsbad area also is known as a gateway to the Carlsbad Caverns-Guadalupe Mountains National Park complex. Economic impacts associated with WIPP primarily affect the Carlsbad portion of the ROI. Very few WIPP-related expenditures occur outside of the Carlsbad area, and very few direct WIPP employees reside elsewhere within the ROI. Most of the income spent by WIPP employees for local goods and services is spent in the Carlsbad area.

CHANGES IN SOCIOECONOMICS

Since publication in 1990 of SEIS-I, the following changes have occurred:

- *Census Information* - Demographic characteristics in SEIS-II are based on 1990 U.S. Bureau of the Census information as well as more recent data.
- *Economic Characteristics* - SEIS-II uses economic characteristics involving employment and wages covered by unemployment insurance from 1980 through 1990, based on 1994 information provided by the New Mexico Department of Labor and the University of New Mexico Bureau of Business and Economic Research.

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[1] Towns in this ROI include Artesia, Atoka, Black River village, Carlsbad, El Paso Gap, Hope, Lakewood, Loco Hills, Loving, Malaga, Riverside, Seven Rivers, and Whites City in Eddy County. It also includes Caprock, Crossroads, Eunice, Hillburn City, Hobbs, Humble City, Jal, Lovington, Maljamar, McDonald, Monument, Nadine, Oil Center, and Tatum in Lea County.

Previous analyses of the socioeconomic impacts of WIPP on southeastern New Mexico occurred in Fiscal Year (FY) 1982 (Adcock et al. 1983), FY 1987 (Lansford et al. 1988), and most recently FY 1988 (Adcock et al. 1989). Socioeconomic analyses were also conducted for SEIS-I (DOE 1990). Employment and wage characteristics for 1994 are based on information provided by the New Mexico Department of Labor (NMDOL 1995) and the Bureau of Business and Economic Research of the University of New Mexico (BBER 1995). Other social and demographic characteristics reported for 1990 are based on 1990 Census information and more recent data compiled by the U.S. Bureau of the Census (1994). Lansford et al. (1994, 1995, 1996) also provide summary economic data relating to WIPP.

4.1.6.1 Background Characteristics

The construction of WIPP had some notable socioeconomic impacts in the ROI from 1981 through 1986. Subsequently, WIPP has had a relatively smaller impact on the socioeconomic characteristics in the ROI relative to changes from the extraction of oil and natural gas, the major industry of Eddy and Lea counties. This industry experienced a loss of almost one-third of its 1980 work force over the decade, substantially dampening the population growth in the ROI (BBER 1995). Correspondingly, WIPP-related activities tended to have a stabilizing effect on the local economy, particularly in Eddy County.

Table 4-2 shows that in 1990, four years after the major WIPP construction effort, the total population in the ROI was 104,370. This population is comprised of approximately 81.9 percent White, 32.4 percent Hispanic (both White and non-White), and 0.5 percent Native American. The ROI has smaller portions of Hispanic and Native American populations when compared to New Mexico as a whole, where the two groups comprise 38.2 percent and 8.9 percent, respectively. About 56 percent of the total ROI population is between the ages of 18 and 65. Overall, 65.4 percent of the ROI population has completed high school, with 11.2 percent attaining a baccalaureate degree or higher.

The ROI experienced slight advances in personal income in spite of the general downturn in oil and natural gas extraction during the 1980s. The median household and per capita income levels shown in Table 4-3 for the ROI were $23,305 and $10,241, respectively. Table 4-3 also shows that 17.4 percent of all families in the ROI were below the national poverty threshold. Poverty thresholds vary by family size and number of related children under 18 years of age. For example, the U.S. Bureau of the Census (1994) defined the national poverty threshold for a family of five persons in 1989 to be $14,900. New additions to the housing stock during 1990 through 1992 were relatively small across the ROI, while vacancy rates for rental units suggested ample availability of rental housing for under $350 per month.

4.1.6.2 Role of WIPP in the Economic Base

Table 4-4 lists recent information on local employment and wage earnings for the ROI. During 1994, a total of 38,094 employees earned $858 million in covered wages (wages covered by unemployment insurance) (NMDOL 1995). The most influential economic sectors in the ROI involved the extractive industries, the trade and service sectors, and government activities.

Given the stability of WIPP funding over the 1990s, the economic base of the ROI has been relatively less sensitive to changes in WIPP activities than to other large-scale enterprises such as the oil and gas industry. Declines in that industry in the 1980s resulted in lower employment and

Table 4-2
1990 Population and Community Characteristics by County in ROI [a]

Characteristic	Eddy	Lea	ROI Total [b]
Total population	48,605	55,765	104,370
Population by Race and Ethnicity			
White (percent)	81.5	82.2	81.9
Black (percent)	1.7	4.7	3.3
Native American (percent)	0.5	0.6	0.5
Asian (percent)	0.4	0.4	0.4
Other or Non-Reporting (percent)	15.9	12.1	13.9
Hispanic [c] (percent)	35.3	29.8	32.4
Population by Age and Education			
Percentage under 18	30.2	33.2	31.8
Percentage 65 and over	15.2	10.6	12.7
Percentage high school	67.3	63.8	65.4
Percentage bachelor degree	10.9	11.5	11.2
Total School Enrollment	13,489	16,457	29,946
College	2,010	2,765	4,775
Elementary or high schools	10,790	12,859	23,649
Community hospitals	2	2	4
Number of beds	156	278	434
Number of physicians	54	40	94

[a] ROI as defined for the socioeconomic environment constitutes a two-county aggregation based on 1990 census information.
[b] ROI percent totals are calculated on the total class level divided by the total ROI population.
[c] Hispanic is an ethnic characterization and consequently persons of Hispanic origin can be of any race.

Source: U.S. Bureau of the Census 1994.

Table 4-3
Income, Poverty, and Housing Characteristics (1989-1992) by County in ROI

Characteristic	Eddy	Lea	ROI Total
Median household income (dollars)	23,418	23,352	23,305
Per capita income (dollars)	10,490	10,025	10,241
Families below poverty line	2,162	2,806	4,968
Percentage of families below poverty line	16.2	18.5	17.4
Persons below poverty line	9,755	12,309	22,064
Percentage of persons below poverty line	20.4	22.4	21.1
Total housing units	20,134	23,333	43,467
Median value of owner-occupied units (dollars)	44,800	39,600	42,200
Median gross rent (dollars)	304	312	308
Vacancy rate	13.2	17.3	15.41
New building permits (1990-1992) as percentage of 1990 housing stock	< 1	< 1	< 1

Source: U.S. Bureau of the Census 1994.

Table 4-4
1994 ROI County Employment and Covered Wages (in Millions of 1994 Dollars)

	Eddy		Lea		ROI Total	
Sector	**Employees**	**Wage**	**Employees**	**Wage**	**Employees**	**Wage**
Agriculture	513	6.9	232	3.0	745	9.9
Mining	2,985	103.1	4,297	132.4	7,282	235.5
Construction	1,006	19.0	1,188	24.6	2,194	43.6
Manufacturing	921	31.0	529	9.8	1,450	40.8
Transportation and Utilities	1,628	52.2	1,487	51.7	3,115	103.9
Trade	3,798	51.4	4,891	77.9	8,689	129.3
F.I.R.E. [a]	614	13.7	529	12.1	1,143	25.8
Services [b]	3,753	62.9	3,668	65.9	7,421	128.8
Government						
Federal	425	15.7	123	4.2	548	19.9
State	420	8.9	238	5.6	658	14.5
Local	2,162	49.2	2,687	56.8	4,849	106
Totals	18,225	414	19,869	444	38,094	858
Unemployed percent	6.8		5.5		6.1	

[a] Finance, Insurance, and Real Estate

[b] The New Mexico Department of Labor classifies WIPP employees under the service sector industry, SIC 87.

Source: NMDOL 1995 and U.S. Bureau of the Census 1994.

wage earnings, while upturns in the 1990s have resulted in higher employment and wage earnings. Future growth and diversification of the economic base in the ROI would tend to diminish the economic impact of future changes in WIPP activities. WIPP, however, continues to play a role in the economic diversification of the Carlsbad economy, and several private ventures related to WIPP science and technology have started operations in Carlsbad. Depending on the extent to which they are reliant on the WIPP budget for their revenue, such businesses will be directly affected by alternatives considered in SEIS-II. Therefore, the more independent of WIPP these businesses become, the less they will be affected by federal actions at WIPP.

The direct economic impact of the anticipated WIPP operations reflects the levels of wage and salary payments to WIPP employees and the size of business and government procurement associated with WIPP construction and operations activities. At the time of the FY 1988 study, $24.3 million was paid in direct WIPP wages and salaries to 661 site personnel, while nonsalary expenditures were estimated to be $95.3 million (Adcock et al. 1989). By 1994, WIPP-related employment and annual wages had risen to 1,005 jobs and $44.56 million, respectively. This accounted for 2.6 percent of the total employment and approximately 5.2 percent of covered wage earnings in Eddy and Lea counties in 1994 (Landsford et al. 1995). In 1995, WIPP-related employment and covered wages dropped slightly to 952 jobs and annual wages of approximately $43.48 million (Landsford et al. 1996).

Nonsalary expenditures are mainly for regional support services, materials, capital equipment, and construction. However, WIPP outlays are also used to pay for business and government expenditures, including grants, community assistance, and out of region expenditures made through or by the local WIPP project office (DOE 1990).

The indirect economic impact of the anticipated WIPP operations is reflected by the subsequent spending and creation of new jobs that follow initial WIPP outlays in any given year. To assess the economic impacts of changes in the funding at the WIPP site, Adcock et al. (1989) estimated an economic activity multiplier value of 2.19 for FY 1988. That is, for every $1.00 spent by WIPP on materials, labor, benefits, equipment and services, another $1.19 worth of goods and services was generated in the ROI for a total impact of $2.19.

Relative to the $24.3 million of direct salaries and wages paid in FY 1988, an estimated additional $26.2 million of indirect wages and salaries were paid in the ROI in FY 1988 in support of 1,153 indirect jobs (Lansford et al. 1988). Meanwhile, the direct nonsalary expenditures of $95.3 million were estimated to generate an additional $113.6 million of indirect nonsalary expenditures in the local economy.

4.1.6.3 Environmental Justice

Environmental justice in the context of this document refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities at WIPP under the various SEIS-II alternatives. The environmental justice ROI covers all populations within an 80-kilometer (50-mile) radius of the reservation boundary of WIPP.[1] This region includes parts of three counties in New Mexico (Chaves, Eddy, and Lea) and parts of seven counties in Texas (Andrews, Culberson, Gaines, Loving, Reeves, Ward, and Winkler). Seventy-five percent of the ROI lies within New Mexico, and the remaining 25 percent lies within Texas.

The following population data are derived from the 1990 Census of Population and Housing (U.S. Bureau of the Census 1994). Within the Environmental Justice ROI, the total population of 101,129 persons includes 4.1 percent non-White, 32.6 percent Hispanic, and 36.8 percent minority (all except White non-Hispanic persons). In addition, 21.5 percent of the total population had 1989 incomes below the poverty level, as defined by the U.S. Bureau of the Census. There are no Native American reservations in the ROI. Figures 4-11and 4-12 display maps of the distribution of minority and low-income populations according to the percentage of the block group population in the environmental justice ROI. Block grouping is a division of territory, the size of which varies according to population density, that has approximately 400 households.

The proportion of Hispanic, minority, and low-income persons in the ROI are all greater than in the United States as a whole. Also, the proportion of low-income persons in the ROI is greater than in both New Mexico and Texas. Finally, the proportion of Hispanic persons in the ROI is smaller than in New Mexico but greater than in Texas.

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[1] Towns in this ROI include Artesia, Atoka, Black River village, Carlsbad, El Paso Gap, Hope, Lakewood, Loco Hills, Loving, Malaga, Riverside, Seven Rivers, and Whites City in Eddy County, New Mexico and Eunice, Hobbs, Humble City, Jal, Lovington, Maljamar, Monument, Nadine, and Oil Center in Lea County, New Mexico. This ROI also includes Mentone in Loving County, Texas, and both Arno and Orla in Reeves County, Texas. The other counties in New Mexico and Texas that are part of this ROI have no communities within the 80-kilometer radius.

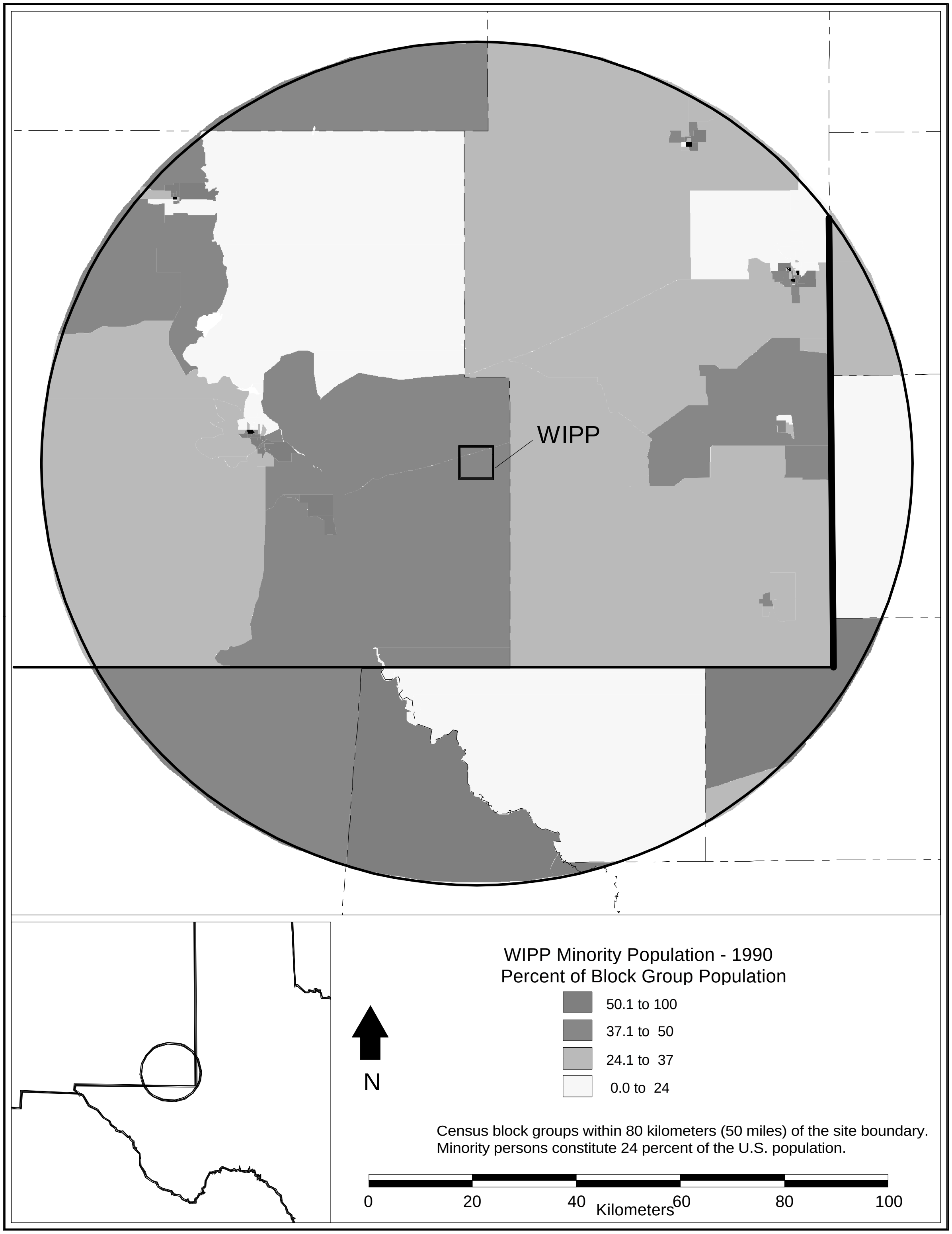

Figure 4-11
Minority Population

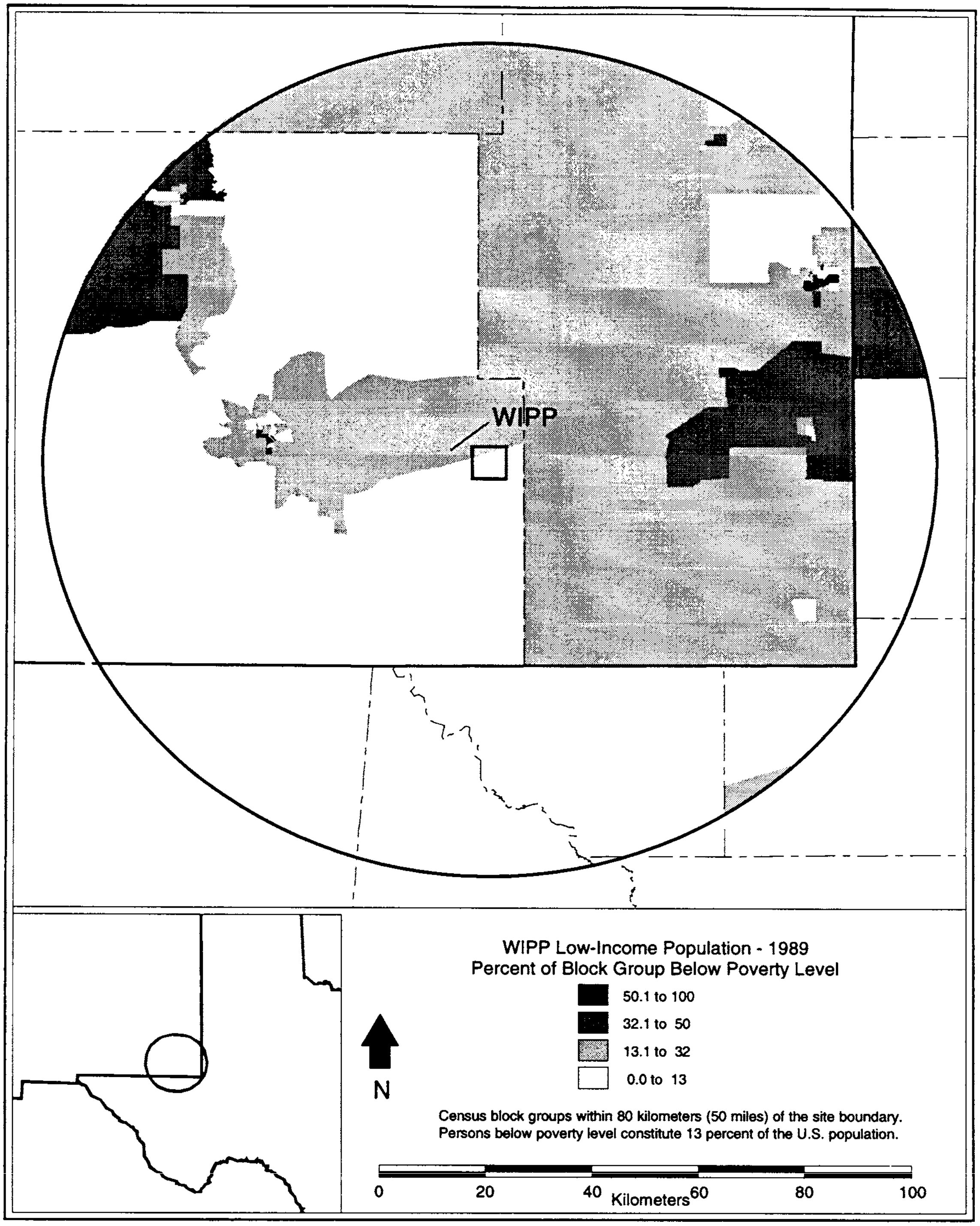

Figure 4-12
Low-Income Population

4.1.7 Transportation

SEIS-I briefly describes the transportation routes leading to WIPP. The site can be reached by rail or highway. DOE has constructed a rail spur to the site from the Burlington Northern and Santa Fe Railroad 10 kilometers (6 miles) west of the site. The site can also be reached from the north and south access roads constructed for the WIPP project. The north access road intersects U.S. Highway 62/180 (U.S. 62/180) 21 kilometers (13 miles) north of WIPP. The south access road intersects New Mexico Highway 128 6.5 kilometers (4 miles) to the southwest of WIPP. Transportation routes from principal DOE sites and facilities are shown in Appendix E, which also presents additional information on transportation methods and routes.

4.1.8 Background Radiation

The background radiation conditions in the vicinity of WIPP are influenced by natural sources of radiation, fallout from nuclear tests, and Project Gnome, a local research project (DOE 1990).

DOE established long-term radiological monitoring programs in southeastern New Mexico prior to the WIPP project, to determine the widespread impacts of nuclear tests at the Nevada Test Site (NTS) and to evaluate the effects of Project Gnome. The background radiation levels measured at WIPP from 1976 to 1979 are discussed in FEIS (DOE 1980).

The WIPP Radiological Baseline Program (RBP) was initiated in 1985 to describe background levels of radiation and radionuclides in the WIPP environment prior to the underground emplacement of radioactive waste (DOE 1990). The RBP consists of five subprograms: (1) atmospheric baseline, (2) ambient radiation (gamma radiation), (3) terrestrial baseline (soils), (4) hydrologic baseline (surface water, bottom sediments, and groundwater), and (5) biotic baseline (radiological parameters in key organisms along potential radionuclide-migration pathways). Mean gross alpha activity in airborne particulates has shown little variation and is within the range of 1 to 3 x 10^{-15} microcuries per milliliter. Mean gross beta activity in airborne particulates fluctuates but is typically within the range of 1 to 4 x 10^{-15} and 1 to 4 x 10^{-14} microcuries per milliliter. The average level of gamma radiation in the environment is approximately 66 millirem per year. On average, a person in the United States receives an effective dose equivalent of about 350-360 millirem per year from all sources of radiation (DOE 1997b, 1995g). Radionuclide concentrations in soil, surface water, sediment samples, and key organisms fall within expected ranges and do not indicate any unexpected environmental concentrations (DOE 1990).

In 1994, atmospheric particulates, ambient radiation, soil, surface water and sediment, groundwater, and biota (vegetation, fish, rabbit, and deer) samples were collected throughout the year from a number of locations and analyzed radiologically. Table 4-5 highlights the radionuclides sampled in the WIPP vicinity. An estimated annual dose of approximately 65 millirem was determined, indicating that no unusual levels of environmental radioactivity exist at WIPP (DOE 1995d).

RADIOLOGICAL ENVIRONMENT

Background Radiation - Since publication of SEIS-I, the WIPP Radiological Baseline Program (RBP) has shown that there has been little variation in mean gross alpha, beta, and gamma levels in airborne particulates. Radionuclide concentrations in soil, surface water, sediment samples, and key organisms have fallen within the expected ranges and have not indicated any excessively high environmental concentrations.

Table 4-5
Radionuclides Sampled in the Vicinity of WIPP

Name	Symbol	Particulate	Soil	Surface-water/ Sediment	Groundwater	Biota
Actinium-228	^{228}Ac			X		X
Beryllium-7	^{7}Be	X				
Potassium-40	^{40}K	X	X	X	X	X
Cobalt-60	^{60}Co	X	X	X	X	X
Strontium-90	^{90}Sr	X	X	X	X	X
Cesium-137	^{137}Cs	X	X	X	X	X
Radium-226/228	$^{226/228}Ra$	X	X	X	X	X
Thorium-228/230/232	$^{228/230/232}Th$	X	X	X	X	X
Uranium-233/234/235/238	$^{233/234/235/238}U$	X	X	X	X	X
Plutonium-238/239/240/241	$^{238/239/240/241}Pu$	X	X	X	X	X
Americium-241	^{241}Am	X	X	X	X	X
Lead-210	^{210}Pb	X	X	X	X	X
Polonium-210	^{210}Po	X	X	X	X	X

As discussed in FEIS (DOE 1980) and SEIS-I (DOE 1990), Project Gnome resulted in a nuclear device being detonated underground approximately 14 kilometers (9 miles) south-southwest of the WIPP site in 1961 as part of the Plowshare Program sponsored by the Atomic Energy Commission. In 1972, the EPA established a program to monitor radionuclide levels in surface water and groundwater in areas potentially affected by Project Gnome. EPA (1989) published the results in its "Off-Site Environmental Monitoring Report: Radiation Monitoring Around United States Test Areas, Calendar Year 1988." In June 1995, the Environmental Evaluation Group (EEG) conducted a limited radiological survey of the Project Gnome area (EEG 1995) as well as a radiochemical analyses with a commercial laboratory. The results indicated that there were elevated levels of plutonium-238 (Pu-238), plutonium-239 (Pu-239), plutonium-240 (Pu-240), and americium-241 (Am-241) in localized surface soils at the Gnome site. Although the results indicated measurable transuranic (TRU) contamination at the Gnome site, EEG reported that the levels did not appear to present any immediate health and safety concern.

4.2 EXISTING ENVIRONMENT AT THE TEN MAJOR GENERATOR-STORAGE SITES

The following sections briefly summarize the existing environments at the 10 major generator-storage sites listed in Chapter 1. Maps showing the locations of the sites can be found in Chapter 3.

4.2.1 Argonne National Laboratory-East (ANL-E)

ANL-E occupies 690 hectares (1,700 acres) in northeast Illinois, in DuPage County, approximately 35 kilometers (22 miles) southwest of downtown Chicago, Illinois. The site is north of the Des Plaines River valley, south of Interstate-55, and west of Illinois Highway 83. Comprised of several buildings, ANL-E is a multi-program laboratory that conducts basic and applied research in the areas of reactor development, physical sciences, and life and environmental sciences. Technology commercialization and science education are also ANL-E missions (META/Berger 1995).

Regional land use surrounding ANL-E is characterized by high concentrations of urban development, including commercial, industrial, public, and residential usage. Several large forest preserves are east and southeast of the site. The site itself is in a suburban area. ANL-E uses only 80 hectares (200 acres) of the site for DOE activities, devoting the rest to forest and landscape areas (META/Berger 1995).

Four on-site wells provide the water supply for ANL-E. An average of 3,000 to 3,400 cubic meters (800,000 to 900,000 gallons) of water is pumped from the wells each day. ANL-E is now in the process of converting from local groundwater supplies to a municipal supply obtained from Lake Michigan (Holdren et al. 1995). The current site load for electricity is 23 megawatts (META/Berger 1995).

The ANL-E is located in a Class II designated PSD air quality area. The nearest Class I designated PSD area is the Seney National Wildlife Refuge located approximately 525 kilometers (325 miles) north of the site in Seney, Michigan. The EPA classifies the site and the surrounding counties as severe nonattainment areas for the criteria pollutant ozone. All other surrounding counties and areas are in attainment of the remaining NAAQS criteria pollutants except for Lyons Township in southeast Chicago, which is listed as a moderate nonattainment area for PM_{10} (META/Berger 1995).

There are no known active tectonic features within 100 kilometers (62 miles) of the site. Several areas of considerable seismic activity are present at moderate distances from ANL-E, including the New Madrid fault zone in southeastern Missouri (a fault zone along the southern Illinois-Indiana border) and one in western Ohio. Horizontal accelerations greater than 0.1 gravity are estimated to occur on the site approximately once in 600 years (META/Berger 1995).

ANL-E is on the northern margin of the Des Plaines River valley. The largest on-site stream is Sawmill Creek, which originates north of the site and enters the Des Plaines River about 2 kilometers (1.25 miles) southeast from the center of the site. ANL-E is located approximately 46 meters (150 feet) above the Des Plaines River and thus is not subject to major flooding (META/Berger 1995). Sawmill Creek is currently the receiving body for effluent from ANL-E treatment facilities. The quality of waters in both Sawmill Creek and the Des Plaines River is poor. The Des Plaines River is used for neither agricultural nor domestic supplies for more than 100 kilometers (62 miles) downstream of ANL-E (Holdren et al. 1995).

ANL-E uses two principal aquifers for its water supply. The upper aquifer is about 60 meters (200 feet) thick and supplies potable water. The other aquifer is below the first, lying between 150 and 460 meters (500 and 1,500 feet) beneath the surface. The two aquifers are not directly connected and pumpage from the upper aquifer does not appear to affect the lower aquifer. No aquifers in the ROI are considered sole source aquifers under Safe Drinking Water Act regulations (META/Berger 1995).

Federal-listed threatened or endangered species are not known to reside on the ANL-E site. The site is known to contain one state-listed endangered bird. Six federally- or state-threatened or endangered species reside in the area and may possibly reside on the site (META/Berger 1995).

As of 1994, a complete survey of ANL-E revealed 43 prehistoric and 6 historic archeological properties, but no sites listed with the NRHP or designated as National Historic Landmarks. Three sites are potentially eligible for the NRHP, 20 sites are not considered eligible, and 26 sites have not been evaluated. The potential of ANL-E to contain traditional cultural resources of interest to Native American groups has also not been evaluated (META/Berger 1995).

The counties of DuPage, Cook, Kane, and Will, in Illinois comprise the economic ROI in which 95.4 percent of all ANL-E's employees reside. About 4,500 persons were employed at ANL-E. The ROI total population in 1992 was 6,568,800, of which approximately 98 percent was urban. Within the ROI, Whites comprise approximately 68.5 percent of the population, Blacks comprise 21.2 percent, and Hispanics comprise 12.1 percent. In 1989, about 9 percent of all families were below the poverty level. The dominant industries in the ROI include manufacturing, finance, insurance, real estate, and government (META/Berger 1995).

The ANL-E ROI is served by Interstate Highways 55, 80, 294, and 355. In addition, U.S. Routes 34 and 45/20 and Illinois Route 83 provide local access. The Chicago metropolitan area has a number of rail lines which can be accessed by truck from ANL-E. The nearest major airport is Chicago's O'Hare International Airport (META/Berger 1995).

Radionuclide sampling at ANL-E is carried out for soil, water, and air. The 1990 data indicated no substantial difference between on-site and off-site radionuclide concentrations in soil samples. In 1993, measurable levels of several radionuclides were detected in Sawmill Creek downstream from the wastewater treatment plant outfall. The concentrations of all these radionuclides were only a small fraction of the DOE-derived concentration guides for water. In 1993, elevated levels of Am-241, cesium-137 (Cs-137), cobalt-60 (Co-60), and Pu-239 were found in sediments below the outfall and are attributed to past releases. Radionuclides found in groundwater include Cs-137, strontium-90 (Sr-90), and tritium (H-3). In 1993, all radionuclide monitoring results were less than the limits established by the Safe Drinking Water Act. Airborne particulates and other airborne sources added to the background radiation in the ANL-E area.

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 3×10^{-3} latent cancer fatalities (LCFs). The population within this area was 7,900,000. The annual dose from airborne radionuclides to the maximally exposed individual (MEI) during 1994 would result in a 8×10^{-9} probability of an LCF. The corresponding dose is below the National Emission Standard for Hazardous Air Pollutants (NESHAP) limit.

4.2.2 Hanford Site (Hanford)

Hanford covers about 1,450 square kilometers (560 square miles) of the southeastern part of the state of Washington in parts of Benton, Grant, and Franklin Counties. The nearest city, Richland, Washington, borders the site on its southeast corner. The site is bounded on the east by the Columbia River, on the west by the Rattlesnake Hills, and on the north by Saddle Mountain. The site has a number of facilities including retired plutonium production reactors, operating reactors, waste management and spent nuclear fuel processing facilities, and nuclear research and development laboratories (DOE 1995a).

Land on the Hanford site is used primarily by DOE. However, there are also areas used as a wildlife refuge and for game management. The land adjacent to the site is either urban, commercial, or agricultural. Agricultural areas include irrigated and dry-land farming and grazing. The Columbia River adjacent to the site is heavily used for recreation (DOE 1995a).

The Columbia River is the principal source of water for Hanford. In 1992, the site consumed approximately 15 million cubic meters (4 billion gallons) of water. The Bonneville Power Administration provides electricity. In 1992, electricity consumption at the site was approximately 340,000 megawatt-hours, with a power demand of 57 megawatts (DOE 1995a).

Air quality in the Hanford region is well within the State of Washington and EPA standards for criteria pollutants, except that short-term particulate concentrations occasionally exceed the PM_{10} standard (DOE 1995a). Hanford is in a Class II air quality area (META/Berger 1995). The Class I areas nearest to the site are Goat Rocks Wilderness Area and Mount Rainier National Park, both about 145 kilometers (90 miles) away. Two other Class I areas are within 175 kilometers (110 miles) of the site (DOE 1995a).

The climate of the area is semiarid, with hot, dry summers and cool winters. Temperatures range from an average high of 2 degrees Celsius (36 degrees Fahrenheit) in January to an average high of 35 degrees Celsius (95 degrees Fahrenheit) in July (DOE 1995a). On average, thunderstorms occur 11 days per year, mostly in summer. The annual average precipitation is 16 centimeters (6.3 inches). The prevailing wind is from the west and the monthly average wind speeds range from 3 meters per second (7 miles per hour) in the winter to 4 meters per second (9 miles per hour) in the summer (META/Berger 1995). Tornadoes are extremely rare, occurring within 160 kilometers (100 miles) of the site about once every three years. The estimated probability of a tornado striking a point on the site is 9.6×10^{-6} per year.

Hanford is on a low-lying, modified plain of the Columbia River. Recent alluvial or windblown sands comprise the surface of the plain, with basaltic lava flows and various layers of gravel, silts, and clays underneath (DOE 1995a).

Earthquake activity in the area of Hanford has historically been low-to-moderate. The site is in a Uniform Building Code Seismic Risk Zone 2B. The largest shock recorded near the site was approximately 4.5 to 5.0 on the Richter scale (Modified Mercalli Intensity of V) in Corfu, 35 kilometers (22 miles) north of the site, in 1918. Another Modified Mercalli Intensity V quake occurred in the area in 1973. The site often experiences low intensity earthquakes occurring in clusters over a short period of time. Volcanic hazards are low as the site is located approximately 160 kilometers (100 miles) east of the Cascade Range, which includes several volcanic vents. Foreseeable volcanic effects at the site are limited to windborne volcanic ash (DOE 1995a).

The Columbia River passes through the northern part of Hanford and forms part of the eastern boundary. The Yakima River is located near the southern portion of the site. There are also two intermittent creeks. Upstream dams control potential flooding from the Columbia River. Minor flooding away from on-site facilities occurs from the other watercourses. The water quality of the Columbia River is high, and the river contributes to the water supply for the site and for nearby cities. Radiological monitoring shows low levels of radionuclides in the river, considerably below concentration guidelines established by EPA drinking water standards. Wastewaters are discharged to several ponds on the site and the Columbia River. Nonradiological contaminant concentrations are within Washington State Water Quality Standards (DOE 1995a).

There are unconfined aquifers located beneath Hanford (DOE 1995a). No aquifers are considered sole-source aquifers (META/Berger 1995). In 1993, several radionuclides and nonradioactive chemicals were detected at levels exceeding EPA drinking water standards and/or DOE derived concentration guides (DOE 1995a). Preliminary investigations have identified four major groundwater contaminant plumes that have been found to enter the Columbia River in at least three locations (META/Berger 1995). Groundwater beneath the site is not used for human consumption or food production, except for one well used for drinking at one of the facilities. Above-background levels of radionuclides have been detected in this well; however, the levels are considerably below EPA drinking water standards (DOE 1995a).

Hanford, a shrub-steppe environment dominated by cheatgrass and sagebrush, includes 10 different types of plant communities. Deer and elk are the major large animals, and coyotes are the main large predators (DOE 1995a). Wetlands existing along the Columbia River and other streams and seeps support extensive stands of various types of vegetation as well as the waterfowl that use them for nesting. The river supports 44 species of fish, including salmon and trout, which use it as a spawning area (META/Berger 1995). A 310-square-kilometer (120-square-mile) area of the site set aside for ecological studies, a wildlife refuge, and a game management area comprises the Arid Land Ecology Reserve.

The entire Hanford site has been designated a National Environmental Research Park (NERP) (DOE 1995a). There are six federal- or state-threatened or endangered species of birds on the Hanford site. One state-endangered mammal and four state-threatened or endangered plant species are also found. In addition, there are 12 other species of animals which are federal- or state-classified as species of concern (META/Berger 1995).

As of 1992, 248 prehistoric archeological sites were recorded, 48 of which are on the NRHP (DOE 1995a). In addition, 11 historic archeological sites and 11 other properties are also listed on the NRHP (META/Berger 1995). Archeological sites include the remains of villages, campsites, cemeteries, monuments, hunting sites, and quarries. Several Native American groups retain traditional secular and religious ties to the region. Some native plant and animal foods used in religious ceremonies can be found on the Hanford site (DOE 1995a).

The primary socioeconomic impact area includes the tri-cities (Richland, Kennewick, and Pasco) and the counties of Franklin and Benton in Washington state. The estimated population for this area in 1992 was about 160,000. The larger economic ROI includes eight other counties in both Washington and Oregon. The estimated population for this ROI in 1992 was about 550,000. The primary economies of the economic ROI, each employing about 40,000 to 50,000 people, include agriculture/fishing/lumbering, manufacturing, trade, services, and government (DOE 1995a). The environmental justice ROI, which is the area within an 80-kilometer (50-mile) radius from the site, contains about 380,000 people. This ROI population includes 20 percent minority, 18 percent low-income (DOE 1995a), and 19 percent Hispanic (META/Berger 1995). The site employs about 14,200 people, accounting for almost 25 percent of the nonagricultural employment in Benton and Franklin Counties. These two counties also account for approximately 93 percent of site employees (META/Berger 1995).

DOE has entered into agreements with the tribal governments representing the Yakama Indian Nation, Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation. These agreements pertain to the core environmental programs and the emergency preparedness and response program.

U.S. Highways 12 and 395, Interstate-82, and State Route 240 run through the Hanford site. Two railroads also connect the area with much of the rest of the nation.

High-level radioactive waste has been accumulating at Hanford since 1944. Before 1970, TRU waste was disposed of on-site in unlined trenches; since 1970, however, Hanford has stored TRU waste in aboveground storage facilities. Besides high-level radioactive waste, the site also has low-level waste, mixed waste, and hazardous waste stored in large amounts. Hanford is included on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List.

In 1993, radiation workers at the site were monitored and found to have average annual doses resulting in an 8×10^{-6} probability of an LCF per individual (DOE 1995a). The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 2×10^{-4} LCFs. The population within this area was 380,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 3×10^{-9} probability of an LCF. The corresponding dose is below the NESHAP limit. About 50 cancer deaths could be projected by the total public radiation dose from Hanford activities since 1944. Essentially all of these would have been the result of radiation exposures received during 1945 (DOE 1995a).

4.2.3 Idaho National Engineering and Environmental Laboratory (INEEL)

INEEL encompasses 230,000 hectares (568,000 acres) within five counties in southeastern Idaho. The site is located 44 kilometers (27 miles) west of Idaho Falls, Idaho, on the Eastern Snake River Plain in the Basin and Range Province of North America. The site is bordered by mountain ranges and volcanic buttes (DOE 1995a).

Land at INEEL is used for DOE operations, recreation, grazing, and environmental research. About 2 percent of the total INEEL site area (4,600 hectares [11,400 acres]) is used for facilities and operations. Recreational uses include public tours of general facility areas and controlled hunting. Between 121,000 and 142,000 hectares (300,000 and 350,000 acres) are used for cattle and sheep grazing. BLM does not allow grazing within 3 kilometers (2 miles) of any nuclear facility, and, to avoid the possibility of milk contamination by long-lived radionuclides, does not permit dairy cattle anywhere on the site. BLM also manages some of the undeveloped areas for wildlife habitat. No mineral exploration or development is allowed on INEEL land (DOE 1995a).

Site activities at INEEL withdraw an average of 7.4 million cubic meters (1.9 billion gallons) of groundwater per year. The peak demand on the INEEL electric system from 1990 to 1993 was about 40 megawatts, and the average usage was approximately 200,000 megawatt-hours per year (DOE 1995a).

The Craters of the Moon National Monument is 25 kilometers (15 miles) southwest of INEEL's western boundary and is in a designated Wilderness Area for which Class I air quality standards must be maintained. Concentrations of criteria pollutants at the site are below the NAAQS, state, and PSD standards and limits. The estimated on-site concentrations of most toxic air pollutants are well below levels established for protection of workers. The maximum short-term benzene concentration slightly exceeds the standard at the highest predicted location. For off-site conditions, all toxic air pollutant levels are below reference levels (DOE 1995a).

INEEL has an arid climate, with low relative humidity, wide daily temperature fluctuations, and large variations in annual precipitation. Thunderstorms occur 2-3 days per month during the summer; otherwise, severe weather is uncommon. No tornadoes were reported on-site from 1950 to 1988. The mean annual temperature is 5.6 degrees Celsius (42 degrees Fahrenheit) and the mean annual precipitation is 22 centimeters (8.7 inches) (DOE 1995a). Notable variations in wind direction and speed are characteristic of the INEEL site. The prevailing wind direction ranges from west-southwest to north, and the average wind speed is about 3.2 meters per second (7.2 miles per hour) (Holdren et al. 1995).

The surface at the INEEL site is comprised primarily of basaltic lava flows ranging in age from about 2,000 years to over 1 million years. The site also contains wind-blown loess and sand and floodplain sediments. Volcanic hazards at INEEL can come from sources inside or outside the boundary of the site. Regional major volcanic activity has occurred at Craters of the Moon National Monument as recently as 2,100 years ago and at Yellowstone National Park (160 kilometers [100 miles] away) three times within the past 2 million years. The probability that volcanism would affect an INEEL site facility is less than 2.5×10^{-5} per year (DOE 1995a).

There are volcanic rift zones lying across INEEL, and the surrounding basin and range landscape also has frequent earthquakes (DOE 1995a). Two major earthquakes, of magnitude 7.3 and 7.5, have occurred within 100 miles of the site during the last 35 years (DOE 1996b). However, based on the seismic history and geologic conditions, earthquakes greater than magnitude 5.5 are unlikely within the site, though moderate to strong ground shaking from earthquakes within the nearby basin and range areas can affect the site (DOE 1995a).

The INEEL site is covered with wind-blown sediments generally less than 2.1 meters (7 feet) deep (DOE 1995a). These soils have a low-to-moderate water erosion hazard and a moderate-to-high wind erodibility (DOE 1995g).

INEEL is located in the Mud Lake-Lost River Basin, a closed drainage basin that includes three main tributaries (the Big and Little Lost Rivers and Birch Creek) which together drain approximately 753,000 hectares (1,860,000 acres). The Big Lost River crosses the site to an area of playas, or sinks, where water is discharged during an unusually wet year. However, surface water from this river, as well as the Little Lost River, does not usually reach the site. Water from Birch Creek flows into the site during the winter and infiltrates into channel gravels, where it recharges a local aquifer (DOE 1995a). During most years, all surface waters in the Little Lost River and Birch Creek are diverted to irrigation before entering the site (Holdren et al. 1995). Local flooding can occur at the site when the ground is frozen and runoff from melting snow is combined with heavy spring rains (DOE 1995a).

Chemical and radioactive parameters measured in the three rivers have not exceeded applicable drinking water quality standards. INEEL site activities do not directly affect the quality of surface water outside the site because surface water does not flow directly off-site. Discharges from facilities are made to manmade seepages and evaporation basins, rather than natural surface water bodies (DOE 1995a).

INEEL overlies the Snake River Plain Aquifer, the largest in Idaho, designated as a sole-source aquifer. This aquifer is also the source of all water used at INEEL. The depth to groundwater from the surface ranges from approximately 60 meters (200 feet) to over 270 meters (900 feet). Groundwater quality is affected by natural water chemistry and contaminants originating at INEEL facilities. Concentrations of radionuclides in the aquifer have decreased over time, primarily due to reduced discharges, adsorption, radioactive decay, and improved waste management practices.

Inside the site boundary, several radionuclide concentrations have exceeded the EPA maximum contaminant levels for drinking water. Outside the site boundary, all contaminant levels measured have been below the EPA levels (DOE 1995a). INEEL is included on the CERCLA National Priorities List.

INEEL site vegetation includes saltbrush deserts, juniper woodlands, native grasslands, big and low sagebrush, and riparian communities. Big sagebrush is dominant, covering approximately 80 percent of INEEL (DOE 1996b). The USFWS National Wetlands Inventory maps show over 130 potential wetlands, most found near the rivers and associated playas. As of December 1994, at least one area at the Big Lost River sinks was found to meet the criteria for jurisdictional wetland delineation by the United States Army Corps of Engineers (DOE 1995a). In 1975, DOE designated most of INEEL as a NERP (DOE 1995g).

Several migratory species use the INEEL site for part of the year. Two federal-endangered and nine federal species of concern were identified as potentially occurring on the site. Two state-protected and ten state species of special concern also potentially occur on the site. No federal- or state-listed plant species were identified as potentially occurring. Eight plant species considered sensitive, rare, or unique are known to occur (DOE 1995a).

INEEL contains paleontological fossil sites and numerous prehistoric archeological sites. As of June 1994, more than 100 cultural resource surveys have been conducted, and over 1,500 archeological resources have been identified. Over 700 of these resources are considered to be potentially eligible for NRHP. The Experimental Breeder Reactor-I is a national historic landmark. INEEL contains many resources culturally important to the Shoshone-Bannock Tribes. These include not only cultural sites but also features of the natural landscape. In accordance with federal laws and in consideration of DOE’s Native American policy, DOE has committed to additional interaction and exchange of information with the Shoshone-Bannock Tribes of the nearby Fort Hall Indian Reservation and is developing procedures for consultation and coordination at INEEL (DOE 1995a).

The socioeconomic ROI is a 7-county area where over 95 percent of INEEL’s approximate 6,400 employees reside (DOE 1996b). The ROI labor force was 104,654 in 1991, and the 1990 population was 219,713 (DOE 1995a). About 2.5 percent of this population was Native American, and 5.5 percent was Hispanic (META/Berger 1995). The population within an 80-kilometer (50-mile) circle centered at Argonne National Laboratory-West (on the INEEL site) contains 7 percent minority and 14 percent low-income. Retail trade and educational services are the two largest employment sectors in the ROI, accounting for 17.6 percent and 11.4 percent of employment, respectively (DOE 1995a). In 1990, the per capita income for the ROI was $14,622 (META/Berger 1995).

DOE has entered into an agreement with the tribal governments representing the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation. This agreement is designed to enhance Tribal technical and scientific capability in the areas of environmental restoration, emergency preparedness and response, and management of cultural resources.

About 144 kilometers (90 miles) of paved public highway run through the INEEL site. Railroads also serve the area, and a rail line into INEEL connects the towns of Arco and Blackfoot.

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 2 x 10^{-4} LCFs. The population within this area was 120,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 2 x 10^{-9} probability of an LCF. The corresponding dose is below the NESHAP limit. In addition, DOE estimates no adverse health effects from any noncarcinogenic chemical contaminants (DOE 1995a).

4.2.4 Lawrence Livermore National Laboratory (LLNL)

LLNL includes the Livermore site, the adjoining Sandia National Laboratories, California site (SNL-CA), and the LLNL experimental test site (Site 300). The Livermore site is approximately 64 kilometers (40 miles) east of San Francisco, California, and about 5 kilometers (3 miles) east of Livermore, California. The SNL-CA site is located next to and south of the Livermore site. Site 300 is about 24 kilometers (15 miles) southeast of Livermore in the sparsely populated hills of the Diablo Range. Today, the major programs at LLNL include defense and related programs, laser fusion, laser isotope separation, biomedical and environmental research, and environmental restoration and waste management (META/Berger 1995).

The Livermore and SNL-CA sites are at the southeast end of Livermore Valley in southern Alameda County. Site 300 is in a mostly rural area of San Joaquin County. Land adjacent to LLNL is predominantly private and consists of agricultural, residential, and light/industrial lands, with a smaller portion of public lands (META/Berger 1995).

The water supply for LLNL is provided by San Francisco's Hetch Hetchy water system. The current site load for water is 2,714,000 liters (717,000 gallons) per day and the maximum capacity is 9.54 million liters (2.52 million gallons) per day. The Pacific Gas and Electric Company and the Western Area Power Administration supply power to LLNL. The current site load is 61 megawatts. The maximum capacity is 100 megawatts (META/Berger 1995).

The Livermore site is in the San Francisco Bay Area Interstate Air Quality Control Region. This region has been classified as a nonattainment area for two criteria pollutants: CO and O_3. The Livermore site is in a Class II area, and any new sources of emissions must adhere to the increment standards for a Class II area (META/Berger 1995). Site 300 is located within the San Joaquin Valley Unified Air Pollution Control District. This area is classified as a nonattainment area for O_3 and PM_{10}. Several PSD Class I areas have been designated in the vicinity of LLNL, including Point Reyes National Wilderness Area, approximately 89 kilometers (55 miles) northwest of the Livermore site; Desolation National Wilderness Area; Mokelumne National Wilderness Area; Emigrant National Wilderness Area; Hoover National Wilderness Area; and Yosemite National Park. Since the promulgation of the PSD regulations in 1977, no PSD permits have been required for any emission source at the Livermore site (DOE 1996b).

The climate at LLNL and the surrounding region is classic Mediterranean with hot dry summers and cold wet winters. The average annual temperature is 12.5 degrees Celsius (54.5 degrees Fahrenheit). The temperature range at Site 300 is more extreme than at the Livermore site because of the higher elevation and pronounced relief (DOE 1996b). Annual precipitation at the SNL-CA ranges from 30 to 38 centimeters (12 to 15 inches) (META/Berger 1995).

All three sites lie within Seismic Zone 4 (DOE 1996b). The San Andreas fault system, the Sur-Nacimiento fault system, and the Coast Range thrust fault system are the major fault systems in the area. Along with local faults, these major regional faults are potential sources of ground motion at LLNL. In January 1980, an earthquake sequence on a local fault produced two earthquakes of magnitudes 5.5 and 5.6. These earthquakes caused structural damage at the Livermore and SNL-CA sites. Larger earthquakes on more distant faults, such as the San Andreas, do not substantially affect the hazard estimation for LLNL. The potential for surface faulting within the Livermore site is very low. Surface faulting at Site 300 in areas adjacent to the active Carnegie fault is possible (META/Berger 1995).

The main surface water features at the Livermore site are the Arroyo Las Positas and Arroyo Seco. Both stream channels are dry for most of the year. Two areas on the Livermore site are within the 100-year floodplains of these two streams; however, no existing on-site structures are within the 100-year floodplain. There are no perennial streams at or near Site 300. The canyons that dissect the hills and ridges at Site 300 drain into intermittent streams. The majority of these on-site streams drain to the south into Corral Hollow Creek, also intermittent, which flows east along the southern boundary of Site 300 in San Joaquin Valley. In addition to these streams, 24 springs and 2 vernal pools exist on-site. Some surface water discharge occurs from cooling towers and other process runoff areas (DOE 1996b).

Groundwater in the vicinity of the Livermore site is generally suitable as a domestic, municipal, agricultural, and industrial supply, with the exception of groundwater less than 90 meters (300 feet) deep. This groundwater is routinely monitored for radioactive and nonradioactive parameters. In 1993, the maximum concentrations of gross alpha, nitrate/nitrite, trichloroethylene, and tritium were above their water quality criteria or standard. The maximum concentrations found for tritium are in one local on-site well and pose no threat to water supplies. VOCs have also been detected in the on-site groundwater and in the area around the Livermore site. All site practices known to contribute VOCs to groundwater have been discontinued. LLNL is working with EPA and the State of California to identify appropriate remedial measures (DOE 1996b).

Two regional aquifers have been identified at Site 300. These are an upper water table aquifer of the Neroly Formation and a deeper confined aquifer also in the Neroly Formation (META/Berger 1995). At Site 300, groundwater is sampled quarterly from inactive and active water supply wells and monitoring wells, and analyzed for radioactive and nonradioactive parameters. Maximum concentrations of arsenic, gross alpha, nitrate/nitrite, trichloroethylene, tritium, and uranium were above their water quality criteria or standard at least once in 1993. LLNL is included on the CERCLA National Priorities List. LLNL is investigating and identifying characteristics of groundwater contamination at Site 300. Several plumes of VOCs and tritium have been identified in shallow and deeper bedrock aquifers in this area and several adjacent off-site areas. LLNL is working with the EPA and the State of California to remediate these plumes (DOE 1996b).

Fifty-nine federal- and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of the Livermore site. Ten of these species have been observed on the site, including the federal-listed bald eagle (*Haliaeetus leucocephalus*). Thirty federal- and state-listed threatened, endangered, and other special status species have been observed on Site 300, and an additional 32 may be found on and in the vicinity of the site. These species include the federal-listed San Joaquin kit fox (*Vulpes macrotis mutica*), American peregrine falcon (*Falco peregrinus anatum*), large-flowered fiddleneck (*Amsinckia grandiflora*) and bald eagle; and the federal-proposed Alameda whipsnake (*Masticophis lateralis euryxanthus*) and California red-legged frog (*Rana aurora draytoni*). Although suitable habitats for several of the other listed species exist on-site at LLNL, potential occurrence of most of the other species is minimal due to the lack of suitable habitat (DOE 1996b). No critical habitat for threatened or endangered species exists at LLNL (META/Berger 1995).

Since 1974, several archeological investigations have taken place at the Livermore site and Site 300. No prehistoric sites have ever been located at the Livermore site. A preliminary investigation at the Livermore site in 1992 explored the historic significance of World War II-era buildings and developed a potential context for initial consideration of the distinguished technical and scientific resources of LLNL. Cultural resource investigations at Site 300 have resulted in the discovery of 7 prehistoric sites, 21 historic sites, and 1 with elements of each. Of these, 24 are officially recorded, but no evaluations to determine site significance have been performed. Sacred and important Native American resources that might be found in the vicinity of LLNL include burials, cremations, vision quest sites, and traditional-use areas. Initial consultation with Native American groups to determine important resources has begun (DOE 1996b).

Four counties comprise the ROI in which 97.2 percent of the approximately 7,850 Livermore site and Site 300 employees reside. In 1990, the population in the ROI was 2,952,000. The population in the ROI is predominantly White (69 percent), and approximately 8.4 percent of the families were living below the poverty level in 1989. In 1991, the unemployment rate for the ROI was 9.3 percent. The 1990 per capita income in the ROI was $21,099. The dominant industries in the ROI include services, government, manufacturing, and retail, which account for 68.8 percent of total earnings (META/Berger 1995).

LLNL is serviced by Interstate-580, Interstate-5, and Interstate-680. South Vasco Road and Greenville Road, both of which are accessed from Interstate-580, service the Livermore site from the north. Patterson Avenue and East Avenue provide access to the Livermore site from the east and west. The Southern Pacific Railroad and the Western Pacific Railroad are the primary providers of rail service to the LLNL region (META/Berger 1995).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 4×10^{-4} LCFs. The population within this area was 6,300,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 3×10^{-8} probability of an LCF. The corresponding dose is below the NESHAP limit. The impact to the LLNL worker population from operations in 1994 was estimated to be 7.3×10^{-3} LCF (DOE 1996b).

4.2.5 Los Alamos National Laboratory (LANL)

LANL is located in north-central New Mexico, 97 kilometers (60 miles) north-northeast of Albuquerque, New Mexico, and 40 kilometers (25 miles) northwest of Santa Fe, New Mexico. The 11,300-hectare (28,000-acre) LANL site and adjacent communities are situated on the Pajarito Plateau (DOE 1995e). Since its inception in 1943, LANL’s primary mission has been nuclear weapons research and development and related projects (META/Berger 1995). The land surrounding LANL is largely undeveloped, and large tracts of federal land surrounding the site are managed by the United States Forest Service, BLM, National Park Service, and Los Alamos County.

Three DOE-operated well fields provide an average of 15.5 million liters (4.1 million gallons) per day for LANL. Electricity usage in 1993 was 68 megawatts (META/Berger 1995).

LANL and its surrounding counties are considered attainment areas with respect to applicable NAAQS. The criteria pollutants make up approximately 79 percent of the stationary source emissions at LANL. Toxic and other hazardous pollutants represent the remaining 21 percent of the stationary source emissions. One PSD Class I area, Bandelier National Monument's Wilderness Study Area, borders LANL to the south. Since promulgation of regulations, no PSD permits have been required for any emissions source at LANL (DOE 1996b).

Los Alamos has a semiarid, temperate mountain climate. The annual average temperature at LANL is 8.9 degrees Celsius (48.1 degrees Fahrenheit) (META/Berger 1995). The average annual precipitation is 48 centimeters (18.7 inches) but is quite variable from year to year. Approximately 36 percent of the annual precipitation normally occurs from thunderstorms during July and August (DOE 1995e).

LANL is located on the Pajarito Plateau, which lies between the Jemez Mountains on the west and the Rio Grande on the east. Deep southeast-trending canyons, separated by long, narrow mesas, dissect the surface of the plateau (DOE 1995e). Studies have determined that the area has three active faults. The strongest earthquake in the past 100 years within a 80-kilometer (50-mile) radius had an estimated magnitude of 5.5 to 6 measured on the Richter scale and a Modified Mercalli Intensity of VII (META/Berger 1995). The site lies within Seismic Zone 2 (DOE 1996b), as established by the Uniform Building Codes.

All groundwater and surface water drainages from the Pajarito Plateau flow toward the Rio Grande. On-site tributaries to the Rio Grande include 14 drainage areas that pass through or start at LANL. Three of the canyons receive treated industrial or sanitary effluent. Surface water in these canyons is principally ephemeral and is not a source of municipal, industrial, or agricultural water supply. Regional, perimeter, and on-site surface waters are monitored to provide routine surveillance on the effect of LANL operations on water quality (META/Berger 1995). Surface water in the Los Alamos area principally occurs as short-lived or intermittent reaches of streams. The overall flood risk to LANL is low because nearly all the structures are located on the mesa tops, from which runoff drains rapidly into the deep canyons (DOE 1996b).

Groundwater in the LANL area occurs in four modes: shallow alluvium in canyons, perched water, the unsaturated zone between the surface and the main aquifer, and the main aquifer (DOE 1995e). Nearly all groundwater used at LANL originates from deep wells that produce water from the main aquifer. Under LANL are Class II aquifers, which provide current sources of drinking water and have other beneficial uses. Most of the wells in the Pajarito Plateau yield fresh water (total dissolved solids less than 500 milligrams per liter), although some wells east of the site have a higher total dissolved solids content (1,000 milligrams per liter or more). The primary, secondary, and radiochemical groundwater quality, as measured from wells and springs in the main aquifer, are below the DOE derived concentration guides or the New Mexico standards applicable to a DOE drinking water system. LANL and the nearby communities are entirely dependent on groundwater for their water supply (DOE 1996b).

The predominant vegetative communities at LANL are ponderosa pine, piñon-juniper, and juniper-grassland. LANL was designated a NERP in 1976 (META/Berger 1995). Most LANL wetlands occur in canyons. Wetlands have developed in the vicinity of some outfalls serving

LANL facilities. Thirty-four federal- or state-listed threatened, endangered, and other special status species may be found in the vicinity of LANL. Five of these species have been observed at LANL, but only one has been found to nest there and occupy the site year-round. Critical habitat for the Mexican spotted owl (*Strix occidentalis lucida*), a federally threatened species, exists at LANL and in areas bordering the northern and western boundaries of LANL (DOE 1996b).

Approximately 75 percent of LANL has been inventoried for cultural resources. More than 1,000 prehistoric sites have been recorded, and approximately 95 percent of these sites are considered eligible or potentially eligible for inclusion in the NRHP. Two areas in the vicinity of LANL have been established as NRHP sites or districts: Bandelier National Monument and Puye Cliffs Historical Ruins. Many of these cultural resources are of special importance to Native Americans in the area. Consultations with local Native Americans to identify any such cultural resources have been conducted in the past and are ongoing. More than 40 historic resources have been recorded at LANL, and about 90 percent of the resources are considered eligible or potentially eligible for the NRHP, based on their association with the broad historic theme of the Manhattan Project and initial nuclear production (DOE 1996b).

Three counties comprise the economic ROI in which 94.7 percent of LANL's 9,700 employees reside. In 1990, the population in the ROI was 152,300. The population in the ROI is predominantly White (79.8 percent) and 12.1 percent of the families are below the poverty level (META/Berger 1995). The 1994 unemployment rate in the ROI was 6.2 percent, and the per capita income in 1993 was $17,689. The service sector accounts for 31 percent of the nonfarm private sector employment in the ROI (DOE 1996b).

DOE has entered into an agreement with Tribal governments representing the Pueblos of Santa Clara, Cochiti, Jemez, and San Ildefonso. The purpose of this agreement is to build Tribal technical and scientific capability in environmental restoration and waste management and to assist the Tribes in participating in DOE decision making.

LANL is served by U.S. 84 and U.S. 285, which link Los Alamos to Santa Fe, New Mexico. U.S. 502, which can be accessed by U.S. 285 from Santa Fe, also services LANL. The nearest railway access is south of Santa Fe in Lamy, New Mexico (META/Berger 1995).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 2×10^{-3} LCFs. The population within this area was 220,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 4×10^{-6} probability of an LCF. The corresponding dose is below the NESHAP limit. Two epidemiological studies have recently been conducted in the LANL area. The most recent study presented an increased incidence of thyroid cancer in residents of Los Alamos county compared to the rest of New Mexico (DOE 1996b).

4.2.6 Mound Plant (Mound)

Mound is located in west-central Ohio, in Montgomery County, within the city limits of Miamisburg, Ohio, about 16 kilometers (10 miles) south-southwest of Dayton, Ohio (Holdren et al. 1995). Mound occupies about 124 hectares (306 acres) (DOE 1979) and is situated on the highlands overlooking the Great Miami River. Until December 1991, Mound manufactured nonnuclear components and tritium-containing components for nuclear weapons. Mound's current mission is environmental restoration and economic development (DOE 1994b). Land use and cover within the vicinity of the Mound site is primarily residential and woodland, and on the site itself there are heavily wooded areas (Holdren et al. 1995).

The Air Quality Control Region comprising the facility has been classified as attainment of the NAAQS for NO_2, SO_2, and lead. However, EPA lists Montgomery County as nonattainment for O_3 and TSP (DOE 1995c). Operations at Mound emitted a wide variety of nonradioactive contaminants, such as organic solvents, acids, and metals (DOE 1989). Various radioactive contaminants such as Pu-238 and tritium were also released. The site is also a source of radionuclides due to resuspension of contaminated soils related to past practices. Recorded levels of these contaminants are well below DOE guidelines (DOE 1995c).

Tornadoes may touch down along short and narrow paths, but are infrequent in the region. Tornado wind speeds of 146 kilometers (90 miles) per hour or greater have an annual probability of occurrence of one in one thousand. Tornadoes with wind speeds exceeding 368 kilometers (227 miles) per hour have an annual probability of one in one million (DOE 1995c).

The major surface water feature in the area is the Great Miami River, located approximately 450 to 600 meters (1,500 to 2,000 feet) west of the site. The tributary valley between the two main hills contains a drainage ditch, the only perennial stream within Mound boundaries (Holdren et al. 1995). Surface water quality in the vicinity of Mound is satisfactory, with radioactivity levels far below established limits (DOE 1995b).

The major aquifer in the area, the Buried Valley Aquifer (also called the Great Miami Aquifer), is the major source of the area's potable water. Typically, groundwater occurs 6 to 8 meters (20 to 26 feet) below ground surface in the valley. The bedrock also contains groundwater but cannot provide a reliable source. The glacial tills overlying the bedrock may also contain perched water zones but are generally too thin to act as a water supply (Holdren et al. 1995). There has been minor contamination of the groundwater by Mound activities. Tritium and plutonium have been detected in the Miamisburg water supply at levels far below regulatory limits. Some on-site groundwater VOCs exceed EPA levels; however, off-site concentrations are far lower, with none exceeding EPA levels (DOE 1995b).

The site lies within the range of the Indiana bat (*Myotis sodalis*), a federally-listed endangered species. However, the bat has not been seen on-site, and habitats hosting the bat are not present at the site. A single specimen of the Inland rush (*Juncas interior weig*), a state-endangered plant species, was found but it is not considered a viable breeding population. No other rare or endangered species have been found on the site (DOE 1995b).

The only historic landmark in the vicinity of the site is the Miamisburg Mound, an ancient mound located 120 meters (390 feet) east-southeast of the site. It is believed to be a burial place of a member of the Adena culture of Mound Builders which inhabited the Ohio region in prehistoric times (DOE 1979). The site itself does not contain any properties listed or eligible for the NRHP (DOE 1995b).

The city of Miamisburg is largely residential, with limited commercial and industrial development. The 1990 population of the city was 17,770. Within an 8-kilometer (5-mile) radius of the site, the population is estimated to be 76,061, based on 1988 figures (DOE 1995b). The population rises to several hundred thousand within a 16-kilometer (10-mile) radius and to over one million within a

32-kilometer (20-mile) radius. The facility employs about 1,200 people, the majority of whom live either in Miamisburg or in immediately adjacent areas (DOE 1979).

Area routes include the Dayton-Cincinnati Pike, 0.6 kilometers (0.4 miles) west of Mound; State Route 725, 1.4 kilometers (0.9 miles) to the north; and Interstate-75, 5 kilometers (3 miles) to the east. The tracks of the Penn Central Railroad roughly parallel the western boundary of the site at distances ranging from approximately 15 to 60 meters (50 to 200 feet) (DOE 1979).

Mound is included on the CERCLA National Priorities List. There are 22 known radioactively contaminated soil areas on-site and one area off-site. Sediments in the Great Miami River also contain levels of radioactive material that are higher than background levels for the surrounding area. There are also approximately 100 areas on-site that are either known or suspected to be contaminated with nonradioactive hazardous substances (DOE 1989).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 1 x 10^{-3} LCFs. The population within this area was 3,000,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 2 x 10^{-8} probability of an LCF. The corresponding dose is below the NESHAP limit.

4.2.7 Nevada Test Site (NTS)

NTS occupies 3,500 square kilometers (1,350 square miles) of desert valley and Great Basin mountain terrain in southern Nevada, 105 kilometers (65 miles) northwest of Las Vegas, Nevada. Limited access areas, including the Nellis Air Force Base Bombing and Gunnery Range and the Tonopah Test Range, surround the site. The NTS has been the primary location for testing the nation's nuclear explosive devices since 1951 (META/Berger 1995).

Fourteen on-site wells supply an average of 5.15 million liters (1.36 million gallons) of water per day. The Nevada Power Company supplies electricity to NTS. The current site load is 30 megawatts (META/Berger 1995).

NTS is designated as an attainment or unclassified area with respect to all applicable NAAQS. Two PSD Class I areas in the vicinity of NTS are Grand Canyon National Park, Arizona, approximately 193 kilometers (120 miles) to the southeast and Sequoia National Park, California, located approximately 169 kilometers (105 miles) to the west-southwest of the site. Since promulgation of regulations, no PSD permits have been required for any emissions source at NTS (DOE 1996b).

NTS is in an area of moderate historic seismicity on the southern margin of the Southern Nevada East-West Seismic Belt in Seismic Zones 2 and 3. Since about 1848, more than 4,000 earthquakes have been recorded within a 242-kilometer (150-mile) radius of NTS. Most of these were minor events with Richter magnitudes of less than 5.5 (DOE 1995g). The Yucca fault is the only active fault on NTS within the underground nuclear testing area. The Rock Valley fault near the southern boundary of NTS has been the most active fault since 1990. (META/Berger 1995).

There are no continuously flowing streams at NTS, but there are permanent on-site water bodies, including natural springs and water-well overflow ponds, that are not associated with wastewater disposal. Sanitary wastewater influents to ponds and lagoons are regulated under a series of state permits. Surface water bodies at NTS are routinely monitored for radioactive and nonradioactive parameters, and off-site surface water bodies and springs are also monitored for radionuclides (META/Berger 1995).

NTS has three general water-bearing units, and all are classified as Class IIA or Class IIB aquifers. Groundwater is the only source of drinking water in the NTS area. On-site wells are routinely monitored for radioactive and nonradioactive parameters, as required by the Safe Drinking Water Act, State of Nevada regulations, and DOE orders. Off-site groundwater is routinely monitored at 22 locations for radionuclides. Only three locations have evidenced detectable tritium levels on a consistent basis. In all three cases, the tritium activity has been less than 2 percent of the primary maximum contaminant level for tritium (20,000 picocuries per liter) (META/Berger 1995).

Thirteen federal- and state-listed threatened, endangered, and other special status species are present in the vicinity of NTS. The peregrine falcon is the only known species at NTS that is on the federal endangered species list. No critical habitat for threatened or endangered species exists on NTS (DOE 1996b).

Approximately 6 percent of NTS has been inventoried for cultural resources, and over 1,200 prehistoric sites have been recorded (DOE 1996b). Many of these sites may be eligible for listing on the NRHP. The only historic site that is currently listed is the Sedan Crater, which was created as part of the Plowshare Program to identify peaceful uses for nuclear explosions. Native American resources include ceremonial sites, petroglyphs, and traditional-use areas. Native Americans view many natural resources at NTS as cultural resources (DOE 1995g).

Two counties comprise the economic ROI in which 97 percent of the 1,600 NTS employees live. The ROI population totaled 865,144 in 1992 (DOE 1996b). The population in the ROI is predominantly White (81.5 percent), and in 1989, 7.5 percent of the population was below the poverty level (META/Berger 1995). During 1994, unemployment in the ROI was 6.1 percent. The 1993 per capita income in the ROI was $20,561. The service sector is the major economic sector in the ROI, with over half of the region’s nonagricultural activity (DOE 1996b).

DOE has entered into two separate agreements with Consolidated Group of Tribes and Organizations to foster a government-to-government relationship and to encourage involvement in programs associated with NTS operations. This group is composed of 17 Tribes representing three ethnic groups (Western Shoshone, Owens Valley Paiute, and Southern Paiute) from Arizona, California, Nevada, and Utah, with cultural or historic ties to NTS.

Vehicular access to NTS is provided by U.S. Route 95 from the south and off-road access via State Route 375 from the northeast (DOE 1995a). Interstate-15 is the major transportation route in the region (META/Berger 1995). The major railroad in the area is the Union Pacific, which runs through Las Vegas and is located approximately 80 kilometers (50 miles) east of the NTS.

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 2×10^{-4} LCFs. The population within this area was 33,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 8×10^{-8} probability of an LCF. The corresponding dose is below the NESHAP limit. Epidemiologic studies on groups surrounding NTS have concentrated on health effects in soldiers and children associated with aboveground nuclear testing rather than operational emissions. Results are contradictory regarding the observed leukemia incidence and deaths in exposed children (DOE 1996b).

4.2.8 Oak Ridge National Laboratory (ORNL)

ORNL is part of the 13,980-hectare (34,545-acre) Oak Ridge Reservation (ORR) located 32 kilometers (20 miles) west of Knoxville, Tennessee, in the rolling terrain between the Cumberland Mountains and Great Smoky Mountains. The primary mission of ORNL is basic and applied research, technology development, and special DOE research. ORR also contains the Y-12 plant whose missions include dismantling nuclear weapons components, maintaining nuclear production capability and stockpile support, and providing storage for nuclear materials; and the K-25 site, which presently serves as an operations center for environmental restoration and waste management programs. The K-25 site formerly provided enriched uranium for United States nuclear weapons (DOE 1995g). The land surrounding ORR is primarily rural, dominated by agricultural and residential land (Holdren et al. 1995).

The Clinch River provides an average of 69.3 million liters (18.3 million gallons) of water per day to ORNL and ORR. The Tennessee Valley Authority provides electric power. The current site load is 116 megawatts (META/Berger 1995).

As of 1991, the area within the Air Quality Control Region was designated as attainment with respect to all NAAQS for criteria pollutants. The Great Smoky Mountains National Park is the only PSD Class I area in the vicinity of ORNL. Since the promulgation of regulations, no PSD permits have been required for any emissions source at ORNL (DOE 1995g).

Winters are generally mild and summers are warm, with few extremes in precipitation, temperature, or winds (DOE 1995g). Summer thunderstorms are frequent. Tornado occurrence in the general region averages about 0.5 per year (DOE 1995f). The annual average temperature is 14.2 degrees Celsius (57.5 degrees Fahrenheit). The annual average precipitation is 139 centimeters (55 inches) (DOE 1995g).

The topography, primarily ridge-and-valley, is part of the Tennessee Valley and Ridge Province of the Southern Appalachian fold and thrust belt (Holdren et al. 1995). There is no evidence of active faulting in the immediate area, although many inactive faults are present at ORNL (DOE 1995g). Regionally, earthquake frequency averages 1-2 per year (META/Berger 1995). Since 1812, at least 26 earthquakes with a Modified Mercalli Intensity of II to VI have been recorded in the area (DOE 1995f). ORNL lies within Seismic Zone 2, indicating that the probability of future seismic damage is low to moderate (META/Berger 1995). The site lies on moderately-well to well-drained soils. Soil erosion has ranged from light to severe, and the present erosion potential is high in some areas (DOE 1995g). The typical soil in the area is a reddish-brown clay (DOE 1997b).

The Clinch River and its tributaries are the major surface water features of the area (Holdren et al. 1995). ORR streams receive effluents from treated sanitary wastewater, industrial discharges, cooling water blowdown, stormwater, surface water runoff, and groundwater. Substantial cleanup activities are required both on-site and off-site (DOE 1995g).

Although groundwater occurs in all formations that outcrop at ORNL and ORR, three major hydrologic units are present. Mechanisms and rates of flow appear to be controlled by topography, structure, and lithology (Holdren et al. 1995). There are no Class I sole-source aquifers beneath the site. Very little groundwater is used; only one supply well exists on ORR. Background groundwater quality is generally good in surface and bedrock aquifer zones and poor at depths greater than 305 meters (1,000 feet) due to high total dissolved solids. Hazardous chemicals and radionuclides from weapons production process activities have contaminated groundwater in some areas. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (DOE 1995g). ORR is included on the CERCLA National Priorities List.

ORR is heavily forested, with pine and pine-hardwood forest being the most extensive plant community, followed by oak-hickory forest (DOE 1995g). Approximately 20 percent of the site consists of wetlands; half of this is bottomland forest and half is pothole wetlands (META/Berger 1995). Approximately 5,500 hectares (13,590 acres) has been designated as a NERP (DOE 1995f). There are 88 federal- and state-listed threatened, endangered, and other special status species that have been identified on or in the vicinity of ORR. However, no critical habitat for threatened or endangered species exists on ORR (DOE 1995g).

More than 20 cultural resource surveys have been conducted on ORR. Over 45 prehistoric sites have been recorded, one site has been included in the NRHP, and several more are considered eligible. More than 240 historic resources have been recorded, and 50 of those sites may be eligible for the NRHP. The Graphite Reactor is a National Historic Landmark. There are also some resources that may be sensitive to Native American groups, including historic burial mounds, camps, quarries, chipping stations, limited activity locations, and shell scatters (DOE 1995g).

Four counties comprise the economic ROI in which about 92 percent of ORR employees live. The 1990 population of this ROI was about 489,000 (DOE 1995a). Minorities comprised 8.4 percent of this population, while 10.6 percent was below the poverty level (META/Berger 1995). The unemployment rate was 5.9 percent in 1991, and the per capita income was almost $17,000 (DOE 1997b). Major economic sectors include services, with over 26 percent of the region’s total private sector nonagricultural activity; manufacturing (19 percent); and retail trade (17 percent) (DOE 1996b).

Interstate-40, located 2.4 kilometers (1.5 miles) south of the ORR boundary, provides the main access to the cities of Nashville and Knoxville, Tennessee. Interstate-75, located 24 kilometers (15 miles) south of the site serves as a major route to the north and south. Several state routes provide local access and form interchanges with Interstate-40. Railroad service is also available in the area (DOE 1995a).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 2×10^{-2} LCFs. The population within this area was 940,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 9×10^{-7} probability of an LCF. The corresponding dose is below the NESHAP limit.

4.2.9 Rocky Flats Environmental Technology Site (RFETS)

RFETS covers almost 17 square kilometers (7 square miles) in northern Jefferson County, Colorado. The site is located east of the foothills of the Rocky Mountains, approximately 25 kilometers (16 miles) northwest of Denver, Colorado. RFETS is situated in a generally rural area with some ranches and industrial facilities nearby. Before January 1992, RFETS's primary mission was to produce nuclear weapon components from plutonium and other metals. The mission has now changed to decontamination and decommissioning, and the primary focus of the activities at RFETS is currently on environmental remediation and waste and materials management (META/Berger 1995).

The Denver Water Board from the Ralston and Gross Reservoirs provides the water supply for RFETS. Water is treated on-site at a plant with a maximum capacity of 3.8 million liters (1 million gallons) per day. The current site load for the treatment plant is 1.03 million liters (272,000 gallons) per day. The Public Service Company of Colorado supplies power to RFETS. The current site load for electricity is 18.3 megawatts (META/Berger 1995).

RFETS is located in an Air Quality Control Region that is a nonattainment area for the NAAQS criteria pollutants CO, O_3, and PM_{10} and an attainment area for the remaining criteria pollutants, SO_2, NO_2, and lead. Because the site is in a Class II PSD area, any new emission sources would have to adhere to the increment standards for a Class II area. The nearest Class I PSD area is Rocky Mountain National Park, approximately 50 kilometers (30 miles) northwest of RFETS (META/Berger 1995).

The climate in the area is semiarid. July is the warmest month, with daily maximum and minimum temperatures averaging 31 degrees Celsius (88 degrees Fahrenheit) and 15 degrees Celsius (59 degrees Fahrenheit), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 6 degrees Celsius (43 degrees Fahrenheit) and -9 degrees Celsius (16 degrees Fahrenheit), respectively. Annual precipitation is approximately 39 centimeters (15 inches), with about 80 percent falling from April through September (Holdren et al. 1995).

The topography at RFETS is generally flat except for areas along three creeks. Seismic activity in the area is low. An earthquake with a maximum horizontal acceleration of 0.21 gravity has an annual probability of occurrence of 1 in 5,000. The surface soils at the site are moderately deep, well-drained clay, cobbly clay, and sandy loams, with moderate-to-low permeability. Twenty-nine on-site locations monitor soil for plutonium contamination (META/Berger 1995).

There are five ephemeral streams at RFETS that form a west-to-east surface drainage pattern. The primary source of flood potential is from flash flooding in these streams; however, most facilities are located outside the 500-year floodplain. The site has seven National Pollutant Discharge Elimination System (NPDES) permitted outfalls, three of which discharge to surface waters that flow off-site. In 1992, only one case was reported in which the NPDES permit limits were exceeded, and this was for low pH at the wastewater treatment plant. Surface water is also monitored for radioactive and nonradioactive parameters in 3 on-site detention ponds. Monitoring of local drinking water supplies was discontinued in October 1992 (META/Berger 1995).

Groundwater systems at RFETS consist of a shallow, unconfined system in the Rocky Flats Alluvium and valley fill, and a confined system in the deeper sandstone units within the underlying bedrock. Recharge is from rainfall, snowmelt, leakage from other aquifers, and percolation from streams, ditches, and reservoirs. Discharge is by seeps, springs, base flow to streams, and evapotranspiration. Groundwater also leaves the area as subsurface flow. No aquifers in the area are sole source aquifers under the Safe Drinking Water Act regulations. The results of 1992 groundwater quality monitoring indicate that the groundwater in the area contains elevated levels of several VOCs, several radionuclides, and other contaminants (META/Berger 1995).

The major terrestrial communities at RFETS are mesic-mixed and xeric-mixed grassland (mixed tall- and short-grass communities), reclaimed grassland, riparian woodland, complex deciduous woodland and bottomland shrubland, tall upland shrubland, tall marsh, short marsh, and wet meadow. Wetlands represent 3.9 percent of the plant communities at RFETS and comprise a total of 100 hectares (250 acres). There are 40 federal- and state-listed threatened, endangered, proposed, candidate, and other special status species that are known to occur or may occur at RFETS (META/Berger 1995); in addition, the Preble's Meadow Jumping Mouse *(Zapus hudsonius preblei*) was recently proposed for federal listing.

RFETS has no properties designated as National Historic Landmarks or listed in the NRHP. According to the Colorado Historic Society, portions of the site have been the subject of at least three cultural resource investigations. The historic cultural resources in the area are archeological sites or standing structures associated with homesteads and ranching. Many Native American groups historically occupied or traversed the foothills area around RFETS. Important sites, such as burials or vision quest locations, and several unidentified rock features and alignments that have been recorded on RFETS may be of concern to Native American groups (META/Berger 1995).

Five counties comprise the economic ROI in which 92.5 percent of the site's 3,500 employees reside. In 1990, the ROI population was 1,790,600. The population was predominantly White (86.2 percent) with 7.2 percent of the total population living below the poverty level. In 1991, the unemployment rate for the ROI was 4.5 percent, and the per capita income in 1990 was $20,961. The dominant industries in the ROI include services, manufacturing, government, transportation and public utilities. These account for 68.1 percent of total earnings (META/Berger 1995).

The site is well served by both road and rail. Interstate-70, Interstate-25, and State Highways 72 and 93 serve the area. The city of Denver is a major railway hub in the Rocky Mountain region. A Southern Pacific line, approximately 1.6 kilometers (1 mile) south of the site, is the rail line nearest the plant and provides access to Denver. The nearest major airport is in Denver (META/Berger 1995).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 1×10^{-4} LCFs. The population within this area was 2,100,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 1×10^{-9} probability of an LCF. The corresponding dose is below the NESHAP limit. Radiological monitoring of animals shows no notable uptake of radionuclides in deer and no ecologically appreciable quantities of plutonium or americium in small animals (META/Berger 1995).

4.2.10 Savannah River Site (SRS)

SRS is located approximately 20 kilometers (12 miles) south of Aiken, South Carolina, bordering the State of Georgia at the Savannah River. DOE activities conducted at SRS involve tritium recycling, support for the nation's space program missions, storage of plutonium on an interim basis, processing of backlog targets and spent nuclear fuel, waste management, and research and development (DOE 1995g).

Land use at SRS, which comprises 80,200 hectares (198,200 acres), is generally categorized as forest, water, or developed facility locations. A total of 77,400 hectares (191,300 acres) of SRS are undeveloped, of which 72 percent are forested. A majority of the woodlands, comprising 53 percent of the total site, are in revenue producing, managed timber production. DOE designated the entire SRS as a NERP, which allows the scientific study of the cypress swamp, southeastern pine, and hardwood forest ecosystems (DOE 1995g).

On-site wells provide an average of 6.1 million liters (1.6 million gallons) of water per day. The capacity of the system is 19 million liters (5 million gallons) per day. Both on-site and public supply sources provide electrical power. The existing site load is 130 megawatts (META/Berger 1995).

SRS is located near the center of the Augusta-Aiken Interstate Air Quality Control Region. The EPA classifies the areas within SRS and its surrounding counties as attainment areas with respect to the NAAQS for criteria pollutants. There are no known PSD Class I areas in the vicinity of SRS (DOE 1995g).

The SRS region is in a temperate climate with short, mild winters and long, humid summers. The average annual temperature is 19 degrees Celsius (66 degrees Fahrenheit); average daily temperatures vary from 3 degrees Celsius (38 degrees Fahrenheit) in January to 33 degrees Celsius (91 degrees Fahrenheit) in July. The average annual precipitation is 126 centimeters (50 inches) (DOE 1995g). Prevailing winds at SRS are from the southwest through west-northwest and from the northwest and east-northeast. The average annual wind speed is 5.7 meters per second (12.8 miles per hour) (DOE 1995g).

SRS is located in the Aiken Plateau portion of the Upper Atlantic Coastal Plain east of the Fall Line, a major physiographic and structural feature that separates the Piedmont from the Coastal Plain, in southeastern South Carolina. The soils at the site are mainly sandy and sandy loams. The site lies within a Seismic Zone 2 and is in an area where earthquakes capable of producing structural damage are not likely to occur. Probabilistic seismic hazard curves were developed for all DOE sites in the 1980s, and the results for SRS indicated that a peak acceleration of 0.19 gravity was associated with a probability of 2×10^{-4} per year (5,000-year return period). Since 1985, only three earthquakes, all of Richter magnitude 3.0 or less, have occurred in the immediate area of SRS (DOE 1995g).

The primary surface water feature is the Savannah River, which borders the site for approximately 32 kilometers (20 miles) to the southwest. There are six major streams that flow through SRS into the Savannah River, and approximately 190 Carolina bays scattered throughout the site. Carolina bays are naturally occurring land depressions that can hold water. The Savannah River and on-site streams are classified as fresh water suitable for primary and secondary contact recreation, as a source for drinking water supply following conventional treatment, fishing, and industrial and agricultural uses (DOE 1995g).

The most shallow aquifer at SRS is commonly referred to as the water table. Below the water table is the Congaree aquifer, and below it is the Cretaceous aquifer. Although there are variations, groundwater in the Cretaceous aquifer discharges predominantly along the Savannah River. The Cretaceous aquifer is an abundant and important water resource for the SRS region. Some of the local cities, such as Aiken, also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region gets its water from the Congaree or water table. Groundwater quality ranges from excellent (soft and slightly acidic) to poor (exceeding EPA drinking water standards for several constituents) in the vicinity of some waste sites. The Cretaceous aquifer is generally unaffected except for a relatively small portion of the site near existing waste treatment, storage, and disposal facilities that is contaminated with trichloroethylene. The Congaree aquifer is contaminated with trichloroethylene over a relatively small portion of the site in the northeast part of SRS and low levels of tritium in the General Separation areas. The water table is contaminated with solvents, metals, or low levels of radionuclides at several waste sites and facilities (DOE 1995g). SRS is included on the CERCLA National Priorities List.

There have been five major plant communities identified at SRS. The loblolly-longleaf-slash pine community is the dominant community covering approximately 65 percent of the site. Swamp forests and bottomland hardwood forests are found along the Savannah River. SRS supports a diverse and abundant wildlife community, including 43 amphibian, 58 reptile, 213 bird, and 54 mammal species. SRS contains approximately 19,850 hectares (49,030 acres) of wetlands, most of which are associated with floodplains, streams, and impoundments. Sixty-one federal- and state-listed threatened, endangered, and other special status species have been identified at SRS. There is potential habitat in some areas for the Red Cockaded Woodpecker (*Dendrocopus borealis*).

More than 60 percent of SRS has received some level of cultural resources evaluation. More than 800 prehistoric sites have been identified, although fewer than 8 percent have been evaluated for eligibility to the NRHP. Approximately 400 historic sites have been identified within SRS, ten of which are eligible for the NRHP. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the American Indian Religious Freedom Act within the central Savannah River valley.

Four counties in which 87 percent of all SRS employees reside compose the economic ROI. SRS currently employs approximately 16,300 persons (4.6 percent of the total regional economic area employment) (DOE 1995g). The total population in the ROI in 1990 was 460,028 with approximately 37 percent minority and 14 percent below poverty level. The ROI unemployment rate was 8.4 percent in 1991 (META/Berger 1995).

Interstate-20 is located approximately 29 kilometers (18 miles) northeast of SRS, providing the nearest interstate access to the site. State Routes 19, 64, and 125 are used by 40, 10, and 50 percent of the SRS commuters, respectively. SRS is served by more than 200 miles of primary roads on-site. Railroad service is also available through SRS (DOE 1995g).

The annual radiation dose to the population residing within 80 kilometers (50 miles) of the site from normal accident-free operations during 1994 would result in 8×10^{-3} LCFs. The population within this area was 620,000. The annual dose from airborne radionuclides to the MEI during 1994 would result in a 8×10^{-8} probability of an LCF. The corresponding dose is below the NESHAP limit.

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CHAPTER 5
ENVIRONMENTAL IMPACTS

This chapter presents the results of environmental impact analyses for the Proposed Action, the three action alternatives, and the two no action alternatives. Environmental impacts of each alternative are discussed separately.

The environmental impacts that could result should the Proposed Action or any of the alternatives be implemented have been divided into four categories:

- Those impacts that would occur at the treatment sites due to the treatment and storage of transuranic (TRU) waste (for all alternatives), those that would occur both during and after long-term storage (for all alternatives except the Proposed Action), and those due to transporting the waste for treatment (for all alternatives except No Action Alternative 2)
- Those impacts that would occur due to transporting TRU waste from the treatment sites to the Waste Isolation Pilot Plant (WIPP) (except for the two no action alternatives)
- Those impacts that would occur due to waste handling, disposal, and decommissioning at WIPP (for the Proposed Action and all of the action alternatives) and the decommissioning of WIPP (for the no action alternatives)
- Those impacts that would occur due to releases associated with closure of the repository, long-term disposal of the waste, and any retrieval and recovery of the waste (for the Proposed Action and action alternatives)

As noted in Chapter 1, the Record of Decision (ROD) that followed the *Final Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant* (SEIS-I) (DOE 1990) stated that an analysis of the impacts of processing and handling TRU waste at the treatment sites would be conducted. The U.S. Department of Energy (DOE or the Department) has analyzed TRU waste processing and handling at its sites in the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997). Because estimates of TRU waste volumes and radionuclide and hazardous chemical inventories have been updated since those used in the WM PEIS were developed (as reported in Appendix A), a revised analysis of those impacts is included in this chapter. The following points highlight how impacts due to treatment and handling were assessed for this supplemental environmental impact statement (SEIS-II).

- WM PEIS annual air quality impacts at the treatment sites have been incorporated by reference and summarized in SEIS-II. The impacts assessed in the WM PEIS were considered appropriate because the facilities assumed in the WM PEIS analysis would be the same number, type, and size as those assumed in SEIS-II. Though additional waste would be treated under some SEIS-II alternatives, the assumed treatment period is 35 years rather than the 10 years assumed in the WM PEIS; therefore, the annual rate of treatment and annual air impacts would not increase.

- Estimated total life-cycle costs for the treatment and transportation of TRU waste to potential consolidation sites used the methods developed for the cost analysis in the WM PEIS. Total life-cycle costs for TRU waste treatment for the entire DOE Complex have been reported. Additional details on the estimated costs and the methods used for estimating these costs are presented in Appendix D.

- The impacts that may occur due to transporting TRU waste from the treatment sites to WIPP are based upon the alternatives presented in the WM PEIS. The impacts were based upon the updated TRU waste volumes and radionuclide and hazardous chemical inventories reported in SEIS-II. Similarly, the impacts due to waste handling at WIPP also were based on these updated inventories. Details on the transportation analyses are presented in Appendix E.

- Industrial safety impacts due to treatment facility construction and operation were adjusted from those in the WM PEIS. The adjustments were based upon the increased construction and operations time estimated under the SEIS-II alternatives. The WM PEIS anticipated 10 years of planning and construction followed by 10 years of operations. SEIS-II analyses anticipated 35 years of operation for all alternatives. Those SEIS-II alternatives requiring shred and grout facilities or thermal treatment facilities also included a 12-year planning and construction period.

- Impacts to water resources and infrastructure (including wastewater, power, and roadways) may occur due to construction and operation of treatment and storage facilities. The potential impacts presented in the WM PEIS are incorporated by reference and summarized in the following sections. No annual increases to these potential impacts would be anticipated due to differences between the inventories used for the WM PEIS and SEIS-II. As decisions are made regarding the specific location of TRU waste treatment and storage facilities, site-specific National Environmental Policy Act (NEPA) reviews will be conducted, as appropriate.

- Impacts to ecological resources, land use, and cultural resources may occur due to construction and operation of treatment and storage facilities. The WM PEIS reported that “major impacts to the resources at the sites are unlikely” because they can be avoided. The treatment facilities would need less than 1 percent of available land at proposed treatment site locations. Also, as decisions are made regarding the location of TRU waste treatment and storage facilities, site-specific NEPA reviews will be conducted, as appropriate.

ENVIRONMENTAL ANALYSES

The potential environmental impacts presented throughout Chapter 5 rely on information gathered during extensive site characterization and experimental programs and on the various scientific and engineering analyses performed by DOE since investigation of the WIPP site began in the late 1970s. Analyses used throughout SEIS-II are designed to provide conservative estimates of the reasonably foreseeable impacts that may occur.

Where appropriate, conservative assumptions are employed; thus, the analyses have a tendency to overestimate impacts. Typically, the analytical methods employed are examined in the appendices. A summary of the reasonably foreseeable impacts and key assumptions considered are presented throughout this chapter.

COMPARING ALTERNATIVES

When comparing the impacts and costs of SEIS-II alternatives, it is important to recognize that disposal at WIPP would isolate waste for more than 10,000 years, while continuing storage in facilities would isolate waste for a maximum of 100 years before reconstruction or disposal (at WIPP or some other location) would be necessary. SEIS-II alternatives that would dispose of the largest amount of waste at WIPP would isolate more waste for a longer period of time than those alternatives that would dispose of less waste while storing the rest. The differences in the degree of waste isolation that DOE would achieve for a given set of costs and impacts should be considered by the reader when comparing alternatives because these differences, in some cases, are noteworthy.

For purposes of comparison, each alternative presents the impacts that potentially would occur (1) at treatment sites due to waste treatment and storage, (2) as a result of transporting TRU waste among the sites and to WIPP for disposal, (3) at WIPP from TRU waste handling and disposal operations, and (4) as a result of long-term releases from the closed repository or storage facilities.

As appropriate, potential environmental impacts are further identified as either resulting from the Basic Inventory or the Additional Inventory, each of which is composed of contact-handled (CH) TRU waste and remote-handled (RH) TRU waste (see Table 3-18 for a summary of the results).

- Human health impacts from TRU waste treatment were adjusted from the impacts presented in the WM PEIS. Additional details on the methods used for adjusting these results are presented in Appendix B.

Potential environmental impacts from waste treatment, waste storage, transportation, disposal, and releases following WIPP closure are presented below for the Basic Inventory and the Additional Inventory, each of which includes contact-handled (CH)-TRU and remote-handled (RH)-TRU waste. These results are presented to facilitate comparisons within and between alternatives (see Table 3-18 for a summary of the results). Sums and products of numbers in this chapter may not appear consistent because of rounding.

5.1 IMPACTS OF THE PROPOSED ACTION (PREFERRED ALTERNATIVE, RESERVING RAIL TRANSPORTATION FOR FUTURE CONSIDERATION)

The environmental impacts associated with implementation of the Proposed Action are detailed within this section. The Proposed Action would continue with the phased development of WIPP by disposing of TRU waste at the facility. Under the Proposed Action, WIPP would accept only newly generated defense TRU waste and that post-1970, defense TRU waste in retrievable storage. Throughout this document this inventory is referred to as the Basic Inventory. Waste would be treated to meet the Waste Acceptance Criteria (WAC); for purposes of analysis, the current planning-basis WAC were used (DOE 1996c). Any consolidation under the Proposed Action would occur in the manner described in the ROD to be issued for the WM PEIS. For the purposes of analysis in SEIS-II, consolidation was assumed at 10 sites for CH-TRU waste and four sites for RH-TRU; the sites are shown in Figure 3-1 in Chapter 3. (The impacts should consolidation not occur, or limited consolidation as in the WM PEIS preferred alternative occur, are presented in a text box at the end of Section 5.1). Treatment at the sites and disposal at WIPP would occur over a 35-year operating period, through the year 2033. A more detailed description of the Proposed Action is given in Section 3.1.

5.1.1 Land Use and Management

DOE found in the WM PEIS that the facilities needed to manage and treat TRU waste under the Proposed Action would require less than 1 percent of the land available for such activities at each proposed treatment site. In calculating the percentage, DOE removed from consideration any acreage with known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface water. As a result, the WM PEIS states that DOE would "have considerable flexibility in locating those facilities and impacts to on-site land use would probably be minimal." The Department would be able to minimize impacts to on-site land use and avoid conflicts with any off-site land use plans (DOE 1997). The Department also would locate treatment facilities such that sensitive or inappropriate areas would be avoided. These sensitive or inappropriate areas would include flood plains, wetlands, known cultural resource areas, and the habitats of threatened or endangered species.

No substantial changes in this finding due to differences between the WM PEIS and SEIS-II were determined. The WM PEIS also assumed that the facilities would be large enough to treat all of the TRU waste in 10 years (for consistency of analysis across waste types); for SEIS-II, it was assumed that treatment would be completed within 35 years, as the waste is generated. Although the SEIS-II operations time would be three and one-half times longer than that anticipated under the WM PEIS, the size and number of the treatment facilities needed for this SEIS-II alternative would be the same as those analyzed for the WM PEIS. The specific location of treatment and waste management facilities within each site would be selected following additional site-wide or project-level NEPA reviews (for an explanation of tiered NEPA reviews, see Appendix B).

Under the Proposed Action, DOE would continue to occupy the land transferred to it by the WIPP Land Withdrawal Act (LWA). DOE would exercise its easements on land outside the WIPP withdrawal area for such uses as groundwater surveillance pads, signs, and transportation and utility corridors. The total aboveground disturbed area is estimated to be 20 hectares (50 acres), equal to the area of the current aboveground facilities. Additional construction at WIPP would be limited to its underground disposal area. During the closure period when a berm and permanent markers would be constructed over the underground disposal area, a total of 70 hectares (173 acres) would be disturbed.

Local WIPP land use includes grazing, recreation, and mining (Section 4.1.1). Currently, an area of 120 hectares (300 acres) is fenced and posted to prevent grazing, trespassing, or other uses. Other grazing areas within the withdrawn area are managed pursuant to the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996a). Access to a 590-hectare (1,454-acre) area of the WIPP site (the "Off Limits Area") is currently restricted to grazing (see Figure 4-2). Other areas are open to the public; however, various resources in the withdrawn area are protected. The LWA prohibits any surface or subsurface mining unrelated to the WIPP project, with the exception of two hydrocarbon leases. No activity is occurring under these leases, and the Department may acquire these leases in the future. The Proposed Action would continue these restrictions and land use management practices throughout the disposal and post-closure periods.

5.1.2 Air Quality

For TRU waste treatment, the only criteria pollutant postulated to exceed 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be carbon monoxide (CO) at the Rocky Flats Environmental Technology Site (RFETS) (17 percent) (see Appendix C). RFETS, Lawrence Livermore National Laboratory (LLNL), Nevada Test Site (NTS), and Argonne National Laboratory-East (ANL-E) are in nonattainment areas for some of the pollutants. In those areas where air pollution standards are not met (nonattainment areas), activities that introduce new sources of emissions are regulated under the General Conformity Rule. In areas where air pollution standards are met (attainment areas), regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. In both cases, a permit is required for sources that will result in emissions equal to or greater than the limits set by pertinent regulations. No radiological, hazardous, or toxic air pollutants would exceed 10 percent of the applicable regulatory standard during normal accident-free treatment (DOE 1997). Particulate matter less than or equal to 10 microns in diameter (PM_{10}) levels may increase during construction.

For SEIS-II, air quality impacts from operation of WIPP under the Proposed Action have been updated from those contained in Section 9.4.5 of the *Final Environmental Impact Statement for the Waste Isolation Pilot Plant* (FEIS) (DOE 1980) and referenced in SEIS-I (DOE 1990). SEIS-II air quality analyses also include information on the salt pile fugitive dust emissions (Tillman 1988b), emissions of particulates from the ventilation system (Tillman 1988a) not included in SEIS-I, and reflect fewer salt pile releases from bulldozer activity and fewer emissions from mining and support equipment because they would be smaller, electric, or would be used less often (Hollen 1996) than reported in the FEIS or SEIS-I.

The four criteria pollutants considered at WIPP were nitrogen dioxide (NO_2), sulfur dioxide (SO_2), CO, and PM_{10}. Volatile organic compounds (VOC), as ozone precursors, were also considered. Potential impacts were determined using the methods described in Appendix C. There would be only negligible releases of two other criteria pollutants, ozone and lead, under the Proposed Action. Principal emission sources of particulates from operation of WIPP under the Proposed Action are (1) exhaust from underground mining, (2) surface salt handling, (3) wind erosion of the salt pile, and (4) fuel combustion from two back-up diesel generators and mining and support equipment. Fuel combustion would be the principal source of NO_2, SO_2, and CO.

Estimates of criteria pollutant air quality impacts from WIPP disposal operations under the Proposed Action are provided in Table 5-1. WIPP would remain an attainment area for all criteria pollutants, and there would be no impact to nearby national parks (Carlsbad Caverns and Guadalupe Mountains) which are Class I attainment areas. Increases in annual concentrations of each analyzed pollutant would be small (less than 2 percent of the regulatory limit). Some 24-hour impacts could be, on a short-term basis, as high as 65 percent of regulatory limits (for NO_2) due primarily to use of backup generators. These estimates represent an upper limit to the 24-hour impacts owing to the conservative assumptions used in the modeling. These conservative assumptions included that low-velocity wind would blow directly at a receptor under stable atmospheric conditions, thus minimizing dispersion and maximizing concentrations. Calculated VOC releases (an ozone precursor) were compared to the New Mexico PSD regulation (Air Quality Control Regulation [AQCR] 707), a major source screening criteria for ozone (40 tons per year). Calculated VOC emissions (an ozone precursor) from waste disposed of in WIPP would not exceed 2 percent of this level. Radionuclide releases would be less than 0.1 percent of the limit specified in the National Emissions Standard for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations [CFR] 61, Subpart H).

Table 5-1
Impacts on Air Quality at WIPP for the Proposed Action

Criteria Pollutant	Averaging Time	Concentration at Maximally Impacted Point of Unrestricted Public Access (µg per cubic meter)	Regulatory Limit (µg/cubic meter)	Percent of Regulatory Limit
PM_{10}	Annual	0.67	50 [a]	1.3
	24-hour	85	150 [a]	57
NO_2	Annual	0.28	84 [b]	0.3
	24-hour	110	168 [b]	65
SO_2	Annual	0.02	47 [b]	0.05
	24-hour	8.5	234 [b]	3.6
	3-hour	77	1,170 [c]	6.6
CO	8-hour	110	8,900 [b]	1.3
	1-hour	410	13,400 [b]	3.1

[a] National primary ambient air quality standard (40 CFR Part 50).
[b] New Mexico ambient air quality standard (AQCR 201) corrected for altitude.
[c] National secondary ambient air quality standard (40 CFR Part 50) corrected for altitude.

The plans for decommissioning WIPP under the Proposed Action are described in Section 3.1.3.5. Potential air quality impacts could result from the construction of berms around and permanent markers in the surface area overlying the underground disposal area, dismantling all the aboveground structures on the site, and reclaiming the salt pile. Specifically, air quality impacts would be the result of fugitive dust and emissions from heavy-duty construction equipment typical of a large construction project. Reclaimed salt may be used to either close the shafts or as a base for the berm. Excess salt may be sold for other purposes and transported off-site by private carrier. Decommissioning would produce temporary increases in dust and other criteria pollutants but no substantial long-term impacts.

5.1.3 Biological Resources

Analyses conducted during the WM PEIS determined that construction and operation of TRU waste treatment facilities should not have major adverse effects on populations of nonsensitive plant and animal species for two reasons: (1) no more than 11 hectares (28 acres) would be disturbed at any site, and (2) the habitats for these species are well established regionally near the proposed treatment sites. Site activities are not expected to affect ecosystem balance or biodiversity. Also, because so little land would be required for the waste management and treatment facilities, DOE would be able to locate the new facilities to avoid impacts to sensitive habitat areas (see Section 5.1.1).

Threatened and endangered species appear at all of the proposed treatment sites and could potentially be impacted; however, whether there would be impacts depends on the actual location of the facility at a particular site. Such species and their critical habitats would be avoided, and appropriate consultation, monitoring, and mitigation measures would be undertaken. Site selection would be conducted following site-wide or project-level NEPA review during which such impacts would be assessed. The WM PEIS analyses also determined that terrestrial wildlife species were unlikely to be affected by airborne emissions from waste management or treatment facilities, or from spills of TRU waste into aquatic environments due to traffic accidents. These findings of the

WM PEIS also are applicable to SEIS-II, though a larger inventory would be treated under the Proposed Action than that considered for the WM PEIS because the size and number of facilities would be the same.

Federally listed, threatened and endangered, and state-listed species occur in Eddy and Lea counties and potentially at WIPP, although DOE has not observed threatened, endangered, or proposed species or critical habitats at the WIPP site during surveys conducted for recent biennial environmental compliance reports. DOE recently completed a biological survey, during which no threatened, endangered, or state-listed species were identified at the WIPP site, and the results are being shared with the U.S. Fish and Wildlife Service.

At WIPP, vegetation-monitoring data from 1989 through 1993 were consistent with those reported in SEIS-I (DOE 1990), which indicated no salt-related stress in vegetation except for that directly near the salt pile. At the salt pile, based on past observations, increased shrub cover near the salt cuttings is anticipated due to colonization by saline-tolerant species such as the fourwing saltbush (*Atriplex canescens*) (DOE 1995c). Throughout the WIPP site, however, no change in foliage was occurring at the time of SEIS-I, and recent environmental reports indicate that this is still the case (DOE 1991, 1992, 1993, 1994b, and 1995c). SEIS-I also reported a salt buildup in the soil below 75 centimeters (30 inches) but stated that it was not affecting the vegetation and that the buildup was not expected to continue. During disposal operations, the salt pile is anticipated to stabilize as a 12-hectare (30-acre) working pile, which would not affect the ecosystem balance. Salt tolerant plant species would replace less saline-tolerant species such as the black grama grass (*Bouteloua eriopoda*) and are not expected to affect site ecosystem balance or biodiversity (DOE 1994b).

Over 10 years of avian survey data at WIPP (from 1984 through 1994) have revealed no discernible impacts on densities and distributions of breeding birds due to activities in the areas adjacent to the surface facilities. The Cooperative Raptor Research and Management Program has reported no adverse effects to raptors from WIPP activities. In addition, no adverse effects to small mammals from WIPP operations have been reported (DOE 1995c). Negligible impact to plant and animal communities near the WIPP site would be expected because almost all of the proposed operations would be conducted underground or in areas already developed.

Decommissioning and closure of the WIPP site would result in the dismantling of all aboveground structures and reclamation of the area. These activities would affect approximately 70 hectares (175 acres), resulting in the loss of much of the plant community and avian and small mammal habitats within and near the area. DOE would return decommissioned lands used in the operation of WIPP to a stable ecological condition and maintain or enhance the ecological condition of wildlife habitat within the WIPP Land Withdrawal Area (DOE 1996a).

5.1.4 Cultural Resources

Because cultural resources at many of the treatment sites are eligible or potentially eligible for the National Register of Historic Places (NRHP), construction and operation of TRU waste management and treatment facilities could have an adverse effect. Site-level cultural resource surveys would be conducted and protection measures established, where necessary, when specific facility locations are proposed (DOE 1997). These surveys would be part of site-wide or project-level NEPA reviews. Any Native American sacred sites and burial grounds would be avoided and appropriate consultation would be undertaken.

At WIPP, disposal surface activities and salt pile maintenance would take place within already disturbed areas of the Property Protection Area. Because no new construction of surface features would occur, impacts to cultural resource properties are not anticipated as part of the shipping, waste handling, or emplacement operations. Previous research of the site cultural resources has identified and evaluated individual properties and mitigated, as necessary, potential impacts from the construction of surface features in the Property Protection Area. No Native American sacred sites or burial grounds have been identified to date.

Activities undertaken in conjunction with closure and decommissioning under the Proposed Action, may have potentially adverse impacts on cultural resources, depending on the ultimate design of the permanent marking system and the berm. Two prehistoric archaeological sites, LA33179 and LA33180, are located within the proposed surface closure area. Both sites were evaluated as being potentially eligible for inclusion on the NRHP (DOE 1995c). Site LA33179 was subjected to surface collection of artifacts and subsurface testing in 1981 (DOE 1996a). Site LA33180 appears to be partially buried and may require testing and mitigation activities if important subsurface cultural deposits are present.

Measures for ensuring protection of known archaeological and historic resources, or others that may be inadvertently discovered during ground-disturbing activities, are discussed in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996a). These measures include identifying, inventorying, evaluating, and treating cultural resources under the National Historic Preservation Act of 1966. DOE will avoid, to the maximum extent possible, sites found eligible for inclusion in the NRHP. Where avoidance is not possible, mitigation measures will be developed under the recently signed Joint Powers Agreement with the State of New Mexico.

5.1.5 Noise

According to the WM PEIS, treatment facilities would probably be placed at industrial-type sites along high traffic volume corridors; therefore, treatment should not substantially increase ambient noise levels. Still, the WM PEIS notes that sensitive receptors may be impacted. Site-specific noise impacts will be assessed in a site-wide or project-specific NEPA document when siting treatment facilities. Noise impacts due to waste transportation to or from the treatment sites would be less than noise levels near the WIPP site (discussed below). Under this alternative, all waste would travel to WIPP but only a portion of the waste would travel to or from each treatment facility.

Noise impacts at the WIPP site were initially evaluated in the FEIS (DOE 1980) which provided a qualitative evaluation of operational impacts that remains accurate for SEIS-II. The FEIS determined that an overall sound pressure level of 50 decibels might occur 120 meters (400 feet) from the Waste Handling Building due to normal operations. The noise should not be heard at the nearest residence. The FEIS also indicated that should all of WIPP’s equipment be operated at once or its emergency generators tested simultaneously, the noise level may increase. However, the FEIS also states that the levels would typically be within acceptable limits as established by the U.S. Department of Housing and Urban Development (DOE 1980).

Under the Proposed Action, all truck transportation of TRU waste would travel through Carlsbad, New Mexico (see figures in Appendix E for routes). Waste from all of the sites east of the Mississippi River would arrive from the south on U.S. 285. Waste from all other sites would come from the north on U.S. 285, passing through Vaughn, Roswell, and Artesia, New Mexico, prior to arriving at Carlsbad. Trucks would arrive at random times throughout two WIPP working shifts. Impacts were estimated based on a maximum throughput of 50 TRUPACT-IIs and eight RH-72Bs per week, corresponding to a maximum of eight trucks per day. Data from the New Mexico State Highway and Transportation Department (NMSH&TD 1997) showed annual average daily traffic at the intersection of Canal and Greene streets in Carlsbad to be approximately 7,700 in 1994. In 1996, estimated daily traffic was approximately 7,900. The increase in noise associated with the Proposed Action's additional truck traffic would be negligible compared to the background noise level associated with existing automobile and truck traffic in Carlsbad and along the transportation corridors.

5.1.6 Water Resources and Infrastructure

Negligible impacts on water resources are expected at the treatment sites due to the Proposed Action. The WM PEIS assessed water availability issues by identifying whether water needs during construction and operation of treatment facilities would increase by more than 1 percent at the DOE facilities proposed as treatment locations. Under this alternative, only Idaho National Engineering and Environmental Laboratory (INEEL), LLNL, and RFETS would have such increases. The increases would be 1.2, 2.8, and 2.1 percent, respectively, and could be accommodated by existing water supplies.

Although no off-site annual infrastructure impacts would be expected at the treatment sites, proposed TRU waste activities would affect on-site activities. The affected infrastructure elements analyzed were on-site transportation and the capacity of on-site water, power, and wastewater systems. Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because construction wastewater was assumed to be negligible (DOE 1997).

Under the Proposed Action, only the Hanford Site (Hanford) would show an increase in on-site demand for wastewater treatment that would exceed 5 percent of current demand (5.9 percent). Major impacts to water resources at the sites would be unlikely for treatment of TRU waste (DOE 1997).

Minor impacts to the on-site transportation infrastructure under the Proposed Action might occur. These impacts would be the result of an increase in on-site employment of 6 percent at Hanford and INEEL and 7 percent at Los Alamos National Laboratory (LANL). Impacts to the off-site transportation infrastructure are not anticipated because population increases would not exceed five percent (DOE 1997).

Disposal operations at WIPP would result in increased vehicle traffic from both the site work force and waste transport vehicles, but no new construction of roads or rail lines by DOE for waste transport is anticipated. Negligible annual infrastructure impacts would be expected at WIPP under the Proposed Action. Existing water supply and sewer capabilities, and existing and planned power and roadway resources would be able to accommodate proposed disposal operations.

5.1.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts under the Proposed Action are presented in the following subsections.

5.1.7.1 Life-Cycle Costs

Life-cycle costs under the Proposed Action are presented in Table 5-2 for three areas: waste treatment facilities, waste transportation, and WIPP disposal operations. Waste treatment facility costs include construction, operations and maintenance (O&M), and decontamination and decommissioning (D&D) at the TRU waste treatment sites. These sites would process, treat, and package waste over a period of 35 years to meet planning-basis WAC. The waste treatment facility costs, excluding storage costs for any excess RH-TRU waste, are estimated to be $11.83 billion, or an annualized cost of $340 million (in 1994 dollars). The waste transport costs include the costs of consolidating waste volumes at the 10 sites and then shipping the treated volumes to WIPP for disposal over the 35-year period. The waste transport costs are estimated to be $1.59 billion, or an average of $45 million per year. Finally, the WIPP site life-cycle costs are projected to be $5.3 billion, or $150 million per year. The WIPP site life-cycle costs cover a 35-year waste emplacement period followed by a 10-year decommissioning period. The total life-cycle cost of the Proposed Action is $19.03 billion or $10.13 billion when discounted. More details regarding life-cycle costs may be found in Appendix D. The cost impacts would be essentially the same should waste not be consolidated.

DOE is restricted by the Consultation and Cooperation Agreement (C&C) to disposal of a maximum of 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste at WIPP. Thus, there is approximately 43,000 cubic meters (1,530,000 cubic feet) of RH-TRU waste under the Proposed Action that could not be disposed of at WIPP and that would require long-term storage at the treatment facilities.[1] Based on WM PEIS storage cost estimates presented in the site data tables for Hanford and Oak Ridge National Laboratory (ORNL), the additional life-cycle cost of storing the excess RH-TRU waste for 35 years would be approximately $310 million (in 1994 dollars) or $170 million when discounted. (These costs are included in the total life cycle costs for the Proposed Action.) The need for this type of storage is not necessary under the action alternatives because the action alternatives assume that all TRU waste would be disposed of at WIPP.

Table 5-2
Life-Cycle Costs for the Proposed Action
(in millions of 1994 dollars) [a]

Cost Information	Basic Inventory CH-TRU Waste	Basic Inventory RH-TRU Waste	Basic Inventory CH-TRU and RH-TRU Waste	Discounted Basic Inventory CH-TRU and RH-TRU Waste
Treatment Facilities	8,850	2,980	11,830	6,560
Transport by Truck	1,260	330	1,590	880
Disposal at WIPP	4,200	1,100	5,300	2,500
Excess RH-TRU Waste Storage	---	310	310	170
Total Life-Cycle Cost	14,310	4,720	19,030	10,130

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Totals may differ due to rounding.

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[1] The most recent volume estimates for RH-TRU waste are much lower than those used in SEIS-II. Those estimates indicate all currently stored post-1970, defense RH-TRU waste and waste to be generated could be disposed of in WIPP. See Appendix J.

LIFE-CYCLE COSTS AND DISCOUNTING

A life-cycle is the entire life of a project from conceptual design to completion (through decommissioning). For these analyses, life-cycle costs at WIPP comprise waste management and disposal costs at the WIPP facility from the beginning of the disposal phase through decommissioning. At the treatment facilities, the life-cycle costs include all activities from conceptual design through closure. Total life-cycle costs also include transportation costs.

To allow for more consistent program evaluations relative to the various WM PEIS estimates, the SEIS-II estimates are presented in 1994 dollars. Moreover, to allow for more consistent program evaluations relative to the various SEIS-II alternatives the life-cycle cost estimates are also presented in present value terms. The practice of discounting future costs gives more weight to money that is spent in the near future compared to money spent in the distant future. The justification for discounting future dollar values stems from the desire to know the equivalent, present-day values. For example, if $100,000 of expenses are anticipated during the 50th year of a project and the discount value is 5 percent per year, the equivalent present-day value would be $8,208.50, assuming that the $8,208.50 was reinvested continuously for 50 years with 5 percent compound interest. Thus, the process of discounting future dollar values reflects the common-sense understanding that money at the present time is worth more than money at a future time, as it takes only $8,208.50 today to produce $100,000 in 50 years.

The present value of the life-cycle costs was estimated using a 1996, inflation-adjusted annual discount rate of 4.1 percent. Economic impact estimates are based on life-cycle cost estimates and are not discounted further. These estimates represent annual effects over the life of the alternative.

5.1.7.2 Economic Impacts

TRU waste treatment activities would support direct, indirect, and induced jobs. The Proposed Action would support approximately 11,900 jobs in the regions of influence (ROI) of the 10 major treatment sites (ANL-E, Hanford, INEEL, LANL, LLNL, the Mound Plant [Mound], NTS, ORNL, RFETS, Savannah River Site [SRS]).

Estimates of the impacts of the Proposed Action on employment, income, and the production of goods and services within the WIPP ROI are presented in Table 5-3. These regional impacts are estimated using an average project budget of $180 million per year over a 35-year period of waste disposal operations. Over this period, the WIPP facility would remain a stable federal employer in the ROI economy, providing direct employment for 1,095 project personnel annually. The operation of WIPP (from 1998 through 2033) would annually support 2,443 indirect and induced jobs in the ROI work force. The estimates of total WIPP-induced employment within the ROI reflect the sum of these direct, indirect, and induced employment levels. In percentage terms, the Proposed Action could result in supporting as much as 7.9 percent of all employment in the ROI. Appendix D provides details regarding these estimations and impacts specific to the local Carlsbad economy.

Table 5-3
Economic Impacts Within the WIPP ROI for the Proposed Action

Economic Effects	Total Output of Goods and Services (in millions of 1994 dollars)	Total Employment (Full- and Part-Time Jobs)	Total Labor Income (in millions of 1994 dollars)	Carlsbad Output of Goods and Services (in millions of 1994 dollars)	Carlsbad Employment (Full- and Part-Time Jobs)	Carlsbad Labor Income (in millions of 1994 dollars)
Direct – Annual	113	1,095	52	95	979	46
Indirect & Induced – Annual	204	2,443	75	172	2,185	67
Total – Annual	317	3,538	126	267	3,164	113
Total - Operations (35 years)	11,079	123,830 [a]	4,411	9,345	110,740 [a]	3,955

[a] Job-years (number of annual jobs supported multiplied by the number of years in the project).

Because the projected annual budget is close to levels observed from 1988 to 1996, the Proposed Action is not expected to result in additional use of government-provided goods or services (schools, police, fire protection, and health protection) nor should it require major capital investments in public infrastructure within the ROI. For this same reason, the Proposed Action is not expected to impact the local real estate market or result in major changes in the work force population. (Discussion of the economic impacts resulting from WIPP's closure is in the discussion of No Action Alternative 1.)

5.1.8 Transportation

This section examines the potential environmental impacts of transporting TRU waste in accordance with the consolidation, treatment, and disposal methods described for the Proposed Action in Chapter 3. The results shown here update the results of SEIS-I. SEIS-II uses essentially the same methods for assessing transportation impacts as were used for SEIS-I. The major differences between the two sets of analyses are the following:

- SEIS-II analyses use 1990 Census data for population impacts. These data were not available for SEIS-I.
- SEIS-II analyses include transportation of TRU waste from several sites that are storing small quantities of the waste. Transportation of this waste was not considered in SEIS-I.
- SEIS-II analyses use a larger TRU waste inventory.
- SEIS-II analyses consider three transportation risk assessments prepared since SEIS-I was published. They are the *Comparative Study of WIPP Transportation Alternatives* (DOE 1994a), the WM PEIS (DOE 1997), and the *Engineered Alternatives Cost/Benefit Study Final Report* (DOE 1995d).

In assessing the impacts of transporting TRU waste, several measures were used. The most fundamental of these was the number of traffic accidents, fatalities, and injuries likely to occur as a result of transportation unrelated to the waste type. Another impact assessed was that caused by vehicle emissions (diesel exhaust); this impact is termed pollution health effects. A third measure, termed accident-free radiological impacts, is associated with the external radiation present around a TRUPACT-II or RH-72B container as it is being shipped. The general public and transportation workers would be exposed to very low levels of radiation during shipment. The final measure is associated with accidents that are severe enough to breach the waste packages and release some of the radioactive and hazardous material being shipped.

The first step in all of these analyses was to determine the highway routes that would be used for transporting waste to WIPP. All of the impacts are a function of route characteristics, the number of shipments via each route, and, for the accident risks, the accident environment associated with a particular mode of transportation and the behavior of the waste form and packaging in that accident environment. Therefore, a major focus of this section is to summarize important route characteristics, the waste shipment volumes using each route, and the impacts of potential accidents.

The following sections estimate the impacts of shipping TRU waste to WIPP. The first subsection is devoted to developing the data needed. It is followed by subsections devoted to analyzing the various transportation impacts associated with transporting waste. Each section also presents the impacts for transporting waste from sites with smaller quantities to the treatment sites. The results of the truck transportation analyses to WIPP were adjusted to account for the additional miles and shipments between these sites.

5.1.8.1 Route Characteristics and Shipment Projections

Under the Proposed Action, waste destined for WIPP would originate at 18 sites around the United States. Many of these sites have generated small quantities of TRU waste and are no longer generating waste. The waste present at these sites could be shipped to one of 10 sites with larger TRU waste volumes (see Chapter 3 for tables and maps detailing the consolidation). The number of CH-TRU and RH-TRU waste shipments from each of these 10 sites to WIPP under the Proposed Action are shown in Table 5-4. The number of TRU waste shipments is primarily dependent on limitations concerning weight, gas generation, plutonium-239 equivalent curies (PE-Ci), and thermal power limits that are incorporated into the planning-basis WAC. The methods used to determine the number of shipments are outlined in Appendix A.

Table 5-4
Number of Truck Shipments to WIPP for the Proposed Action [a]

Waste Treatment Site	CH-TRU Waste	RH-TRU Waste
Argonne National Laboratory-East	28	0
Hanford Site	13,666	3,178
Idaho National Engineering and Environmental Laboratory & Argonne National Laboratory-West	5,782	3,136
Lawrence Livermore National Laboratory	162	0
Los Alamos National Laboratory	5,009	367
Mound Plant	59	0
Nevada Test Site	86	0
Oak Ridge National Laboratory	251	1,276
Rocky Flats Environmental Technology Site	2,485	0
Savannah River Site	2,238	0
Total	**29,766**	**7,957**

[a] The number of shipments from sites with smaller quantities can be found in Appendix E. There would be 27 CH-TRU waste shipments and 958 RH-TRU waste shipments. Impacts from the transportation of TRU waste to the major treatment sites (see Appendix E) are small relative to impacts from shipment between the major treatment sites and WIPP.

The HIGHWAY code (Johnson et al. 1993) was used to estimate trip lengths from the 10 major treatment facilities to WIPP and to estimate the corresponding population density fractions along the routes. Built into the HIGHWAY code are the routes that were selected by the states and accepted by the Department of Transportation for the shipment of route-controlled quantities of radioactive materials. Not all shipments to WIPP will fall within the definition of a highway route-controlled quantity (HRCQ) (49 CFR Part 173.403(l)), DOE, as a matter of policy, has determined that all shipments, whether they are empty or full and whether or not they meet the definition of HRCQs, will use the U.S. Department of Transportation (DOT) preferred routes as defined in 49 CFR Part 397 Subpart D. Selected routes, shown in Appendix E, generally follow interstate highways. The major exception to this is New Mexico, where the state has selected U.S. Highway 285 as the primary northern route between Interstate-25 near Santa Fe, New Mexico, and WIPP, and the southern route between Interstate-20 at Pecos, Texas, and WIPP. Table 5-5 presents the total miles from the 10 major treatment sites to WIPP and the total miles along the route for rural, suburban, and urban population zones for potential shipments to WIPP under the Proposed Action.

Table 5-5
Mileage for Shipping TRU Waste by Truck to WIPP for the Proposed Action [a]

Origination Site	Total One-Way Truck Mileage	Miles in Each Population Zone		
		Rural	Suburban	Urban
Argonne National Laboratory-East	1,696	1,412	259	25
Hanford Site	1,807	1,645	144	18
Idaho National Engineering and Environmental Laboratory & Argonne National Laboratory-West	1,392	1,263	114	15
Lawrence Livermore National Laboratory	1,452	1,304	100	48
Los Alamos National Laboratory	341	318	21	2
Mound Plant	1,764	1,359	382	23
Nevada Test Site	1,214	1,137	64	13
Oak Ridge National Laboratory	1,439	1,160	265	14
Rocky Flats Environmental Technology Site	704	619	71	14
Savannah River Site	1,535	1,203	315	17

[a] The mileage from sites with small quantities of waste to the treatment sites can be found in Appendix E.

5.1.8.2 Accidents, Injuries, Fatalities, and Pollution-Related Health Effects from Truck Transportation

Although the transportation of TRU waste cannot be made entirely impact free, reasonable planning and control strategies can usually reduce impacts to a level below that of comparable shipments (for example, commercial shipments of hazardous materials such as gasoline). WIPP would use such strategies to reduce impacts. A complete picture of the planning and control strategies are presented in Appendix C, Appendix L, and Appendix M of SEIS-I, and Appendix E of this document. Appendix C of SEIS-I summarizes emergency response training, procedures, and plans for the WIPP shipping campaign. Appendix L of SEIS-I summarizes the design, certification, and operation of the TRUPACT-II shipping container for CH-TRU waste and the NuPac 72B shipping cask for RH-TRU waste (the RH-72B is very similar in design to the NuPac 72B). Appendix M of SEIS-I (and Section 3.1.2.1 of this document) summarizes a trucking contract, including qualification standards and training requirements for drivers, and quality assurance standards applicable to operational activities. The qualifications and quality assurance standards are essentially unchanged since SEIS-I.

As outlined in the *Transuranic Materials Transportation Guide* (DOE 1996b), the trucking contractor is responsible for the routing of shipments in accordance with federal, state, Tribal, and local regulations. DOE, on behalf of the contractor, has coordinated these routes with the affected states. The DOE Carlsbad Area Office (CAO) is responsible for providing a plan (DOE 1995a) for responding to emergencies involving TRU waste transportation. The plan has been completed and is available upon request. The level of response to an accident would be determined by the DOE Albuquerque Office, based on the type of accident as outlined in the CAO emergency response plan. The levels are defined as 0 through III, with 0 representing the lowest severity (a minor accident), I representing potential penetration of TRU waste packaging, II representing definite penetration, and III representing a definite release or the need for repackaging.

Once the appropriate level of response has been established, a team would respond with the necessary equipment. The team would also coordinate with the carrier to expedite recovery of TRU waste and the packaging. Personnel would be on call 24 hours a day when shipments are en route.

For the SEIS-II analyses of accidents, injuries, and fatalities, truck accident statistics compiled for each state by highway type were used to determine route-specific accident, injury, and fatality rates (Saricks and Kvitek 1994). The route mileage through each state, obtained using HIGHWAY, was multiplied by the state traffic accident, injury, or fatality rates. The products were then summed for the route, and the sums were divided by the total route mileage. With the exception of the State of New Mexico, the accident rate data for federally aided interstate highways were used. For New Mexico, because much of the waste would travel on U.S. Highway 285, the rate for federally aided primary roads was used.

Once the route-specific accident, injury, and fatality rates per route were obtained, they were multiplied by the number of shipments along each route to obtain the estimated number of accidents, injuries, and fatalities. These impacts were estimated using round-trip mileage and adjusted to account for the small number of shipments between the 10 sites with small amounts of waste and the 10 major treatment sites.

For the Proposed Action, 56 accidents, 39 injuries, and 5 traffic-related fatalities were estimated over the transportation period of 35 years. Though rail transportation was not analyzed under the Proposed Action, use of rail transportation is reserved for future consideration under the Preferred Alternative; if rail transportation were used, impacts are expected to be lower. The results are shown in Table 5-6.

Table 5-6
Nonradiological Impacts of Transporting TRU Waste by Truck for the Proposed Action [a]

Impact	CH-TRU Waste	RH-TRU Waste	Total Impact
Number of Accidents	43	13	56
Number of Traffic Injuries	30	9	39
Number of Traffic Fatalities	4	1	5
Pollution Health Effects (fatalities)	0.1	0.04	0.1

[a] All numbers include the impacts from potential transportation between sites with small volumes of waste and the 10 major treatment sites.

Similarly, the estimated pollution health effects due to diesel exhaust are shown in Table 5-6. These are potential cancer fatalities attributed to exposure to diesel exhaust. This health effect is based upon the total miles traveled in urban areas and a factor that estimates vehicle exhaust impacts on the public, 9.9×10^{-8} latent cancer fatalities (LCF) per kilometer (1.6×10^{-7} LCF per mile) (Rao et al. 1982). Urban areas have greater concentrations of vehicle exhaust. These areas sometimes have air quality concerns as well. Urban areas were assumed to have the largest mean population density (3,861 persons per square kilometer [10,000 persons per square mile]). The impacts would be smaller for rural areas, as in much of New Mexico.

5.1.8.3 Accident-Free Radiological Impacts from Truck Transportation

Accident-free radiological impacts occur during the routine transportation of radioactive material and result from direct public and worker exposure to radiation at levels allowed by transportation regulations. While the TRUPACT-II and RH-72B packaging provides radiation shielding, workers, vehicle crew members, and the public along the transportation routes would be exposed to radiation at very low dose rates during transportation. The RADTRAN code (Neuhauser and Kanipe 1992) was used to estimate the impacts due to this radiation. The following categories of accident-free occupational and nonoccupational exposures were estimated (the nomenclature provided in RADTRAN is presented in parentheses):

- ***Along Route*** *(Off Link Exposure):* Exposure to individuals adjacent to routes of travel
- ***Sharing Route*** *(On Link Exposure):* Exposure to individuals sharing the right of way
- ***Stops*** *(Stops):* Exposure to individuals while shipments are at rest stops
- ***Occupational*** *(Occupational Exposure):* Exposure to waste transportation crews

The sum of the first three items in the above list equals the total nonoccupational exposure. The important RADTRAN input parameters related to TRU waste shipment characteristics are the transportation index (TI), which is the exposure rate at 1 meter (3.3 feet) from the container (in mrem per hour); the frequency of vehicle stops; the number of people exposed and their distances from the container; and the speed of the vehicle.

The TI for a TRUPACT-II or RH-72B shipment is a function of the radionuclide content of the waste being shipped. Typically, the radionuclide content of the waste is different for each generator site. For WIPP shipments, an average radionuclide inventory was developed for each site (see Appendix A). The TIs were then calculated. Because of the uncertainty of the TRU waste radionuclide inventory, a conservative TI of 4 (4 mrem per hour at 1 meter) was chosen for all CH-TRU waste shipments and a TI of 10 (10 mrem per hour at 1 meter) for all RH-TRU waste shipments. All of the calculated TIs were less than those used to estimate impacts (for details on the process used to calculate the TIs, see Appendix E).

ESTIMATING RADIOLOGICAL IMPACTS

Estimation of potential human health impacts involves a series of calculations that indicate the potential health consequence of a particular action or accident, and the probability that the action or accident would occur. Impacts can be calculated both for individuals and for a population. The probability of occurrence for routine actions is 1.0, meaning the action (e.g., chronic release from a permitted exhaust point) will occur at regular intervals, typically daily, over a year of operations. The probability of occurrence for accidents, therefore, is between zero and 1.0, indicating that the nonroutine event might be expected to occur at some random point in time over the entire operations period.

The health effect of concern from low levels of radiation exposure is a radiation-induced cancer fatality. To quantify the radiological impact, the radiation dose must be calculated. The dose is a function of the exposure pathway (external, inhalation, or ingestion) and the type and quantity of radionuclides involved. After the dose is estimated, the health impact is calculated from current internationally recognized risk factors. For this document, potential radiological impacts are based on a scenario that includes prudently conservative release, exposure, and risk factor estimates. Because of the use of conservative assumptions, the impact estimates bound any that would be expected.

The unit of radiation dose for an individual is the rem. A millirem (mrem) is 1/1,000 of a rem. The unit of dose for a population is person-rem and is determined by summing the individual doses of an exposed population. Dividing the person-rem estimate by the number of people in the population would indicate the average dose to a single individual. The impacts from a small dose to a large number of people can be approximated by the use of population (i.e., collective) dose estimates.

To estimate the human health impact from radiation dose, a dose-to-risk factor that indicates the potential for a latent cancer fatality, or LCF, is used. An LCF is a fatality resulting from a cancer that was originally induced by radiation, but which may occur years after the exposure. The dose-to-risk factor for low (less than 20 rem) annual doses is 0.0005 LCF per person-rem for the general public, which includes the very young and the very old, and 0.0004 for the worker population. For example, a population dose of 2,000 person-rem is estimated to result in one additional cancer fatality (0.0005 x 2,000 = 1) in the general public. The dose-to-risk factor for an individual is doubled if the individual dose is greater than 20 rem/year (20,000 mrem per year).

The average individual in the United States receives a dose of 0.3 rem (300 mrem) each year from background radiation. Background radiation sources include radon that has concentrated in homes from foundation soil sources, uranium found in rocks used as building materials, and cosmic radiation from the earth’s atmosphere. The average lifetime chance or probability of cancer to a member of the public from a 70-year exposure due to background radiation is 0.01 (70 x 0.3 x 0.0005). That is, the best current radiation risk estimates are that one in 100 people will die from cancer due to background radiation.

The accident-free radiological impacts are presented in Table 5-7. These impacts were estimated using factors of 4 x 10^{-4} LCF per person-rem for occupational exposures and 5 x 10^{-4} LCF per person-rem for nonoccupational exposures (ICRP 1991). Table 5-7 also summarizes the impacts to those living along routes, those in vehicles sharing the routes, and those exposed during stops for both CH-TRU and RH-TRU waste shipments. The accident-free impacts for transporting TRU waste under the Proposed Action include the impacts associated with the potential consolidation of TRU waste from those sites with smaller quantities of waste. These impacts contribute approximately 1 percent to the total accident-free transportation impacts under the Proposed Action.

Table 5-7
Aggregate Accident-Free Population Radiological Impacts from Truck Transportation for the Proposed Action (LCFs) [a]

Exposure Category	CH-TRU Waste	RH-TRU Waste	Total
Occupational	0.3	0.03	0.3
Nonoccupational			
Stops	2	0.8	2.8
Sharing Route	0.1	0.05	0.2
Along Route	0.04	0.02	0.06
Nonoccupational Total	2.1	0.9	3.0

[a] Exposure during stops is based upon 50 individuals exposed at 20 meters. Stop time, in hours, is based upon 0.011d where d is the distance traveled in kilometers. These parameters are built into the RADTRAN code but substantially overestimate exposures from WIPP shipments.

A total of 3.0 nonoccupational LCFs are estimated due to routine transportation under the Proposed Action. However, default parameters of the RADTRAN code substantially overestimate impacts due to WIPP shipments. Because WIPP shipments would use two-driver teams (eliminating the need for overnight stops to sleep) and because the shipments would stop at sites chosen, in part, because they are not near population centers, the actual impacts from stops would be much lower.

Accident-free radiological impacts include the probability of incurring an LCF for maximally exposed individuals (MEI). The assumptions and scenarios used to determine the MEIs were as follows:

- *Individual stuck in traffic next to a truck transporting TRU waste*. For this assessment, it was assumed that the individual would have an exposure distance of 1 meter (3.3 feet) for an exposure time of 30 minutes. The individual was assumed to be exposed only once.

- *An inspector of trucks ready for departure*. For this assessment, it was assumed that the inspector would have an exposure distance of 1 meter (3.3 feet) for 30 minutes, that the inspector would work at the same job for 10 years, and that there would be three shifts working the same job. The number of shipments inspected would depend on the total number of shipments to be shipped from the site and the rate at which they would be shipped. In actuality, in accordance with current DOE administrative requirements, such an inspector’s dose would be limited through radiation monitoring, and the inspector would be rotated into a new job should his or her dose climb to the administrative limit. In order to be conservative, this administrative requirement was not taken into consideration for SEIS-II analyses.

- *A person who performs state vehicle safety inspections*. For this assessment, it was assumed that the individual would inspect 20 percent of the TRU waste shipments, that the inspector would work at the same job for 10 years, and that the average exposure distance would be approximately 1 meter (3.3 feet) for 1 hour. To bound the state inspector’s dose, it was assumed that the individual would work on the route on which the majority of the waste enters New Mexico. Again, in actuality this person’s dose would be limited by administrative rules and the inspector would be rotated into a new position. In order to be conservative, this was not taken into consideration for SEIS-II analyses.

UNDERSTANDING SCIENTIFIC AND EXPONENTIAL NOTATION

Scientific notation is used in this document to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 and a positive or negative power of 10. Examples include the following:

Positive Powers of 10	Negative Powers of 10
10^1 = 10 x 1 = 10	10^{-1} = 1/10 = 0.1
10^2 = 10 x 10 = 100	10^{-2} = 1/100 = 0.01
and so on, therefore,	and so on, therefore,
10^6 = 1,000,000 (or 1 million)	10^{-6} = 0.000001 (or 1 in 1 million)

A power of 10 is also commonly expressed as "E", where "E" means "x 10". For example, 3 x 10^5 can also be written as 3E+5, and 3 x 10^{-5} is equivalent to 3E-5. Therefore, 3E+5=300,000 and 3E-5 = 0.00003. This is called exponential notation.

The data tables in this section use exponential notation for numbers that are either very large or very small. The text uses scientific notation to convey these numbers.

Probability is expressed as a number between 0 and 1 (0 to 100 percent likelihood of the occurrence of an event). The notation 3E-6 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur in the period covered by the analysis.

- *Individual residing along a shipment route*. For this assessment, it was assumed that the individual would have an exposure distance of 30 meters (100 feet) over a 70-year period.

- *Individual who is a rest stop employee*. For this assessment, it was assumed that all trucks stop at the same location, that there are three shifts working at the truck stop, and that the individual works at the truck stop for 10 years. It was estimated that the individual would be exposed to 20 percent of all TRU waste shipments sent to WIPP over a 10-year period. The individual was assumed to be exposed over a 2-hour stop duration at a distance of 20 meters (66 feet).

Table 5-8 summarizes the maximum probability of incurring an LCF for these individuals. The departure and state inspectors would have the highest probability of health effects due to the performance of their responsibilities associated with TRU waste shipments.

Table 5-8
Lifetime Accident-Free Radiological Impacts to MEIs from Truck Transportation for the Proposed Action (Probability of an LCF)

MEI	CH-TRU Waste	RH-TRU Waste	Total
Stuck in traffic next to TRU waste shipment	2.5E-6	5.0E-6	7.5E-6
Departure Inspector	2.4E-3	1.6E-3	4.0E-3
State Vehicle Inspector	4.6E-3	3.9E-3	8.5E-3
Residing adjacent to access route	2.5E-4	1.5E-4	4.0E-4
Rest stop employee	1.5E-4	3.5E-4	5.0E-4

5.1.8.4 Radiological Impacts from Truck Transportation Accidents

As part of the U.S. Nuclear Regulatory Commission (NRC) package certification process, computer simulations are used to model the behavior of packaging in a series of tests that are internationally recognized to represent a severe accident. These simulations are followed by physical tests. By comparing the results of the physical tests with the simulation results, it is possible to conclude, with a high degree of confidence, that a properly constructed and maintained package will not be breached in all but a small number of accidents in which forces imposed on the packaging are much more severe than the tests. This section looks at the impacts associated with the small fraction of severe accidents that would cause the release of radioactive material.

Two types of analyses were conducted for SEIS-II radiological impacts from accidents. For the first type of analysis, the RADTRAN code was used to estimate the radiological impact from accidents during transport from each of the assumed 10 major treatment sites to WIPP. For this analysis, a conservative radionuclide inventory was used; it was assumed every TRU waste package would be filled with waste containing the highest level of radionuclides and hazardous material allowable by the planning-basis WAC. The first type of analysis took into account eight different severity categories of accidents, their probabilities of occurrence, the distance from each site, and the number of shipments. The total accident risk from each of the 10 sites was obtained by summing the risks calculated for the severity categories. A complete discussion of these analyses is included in Appendix E.

Assumptions for these analyses included the following:

- Release fractions increase with the severity category.
- Because the TRUPACT-II and RH-72B must endure severity category I and II accidents without a breach, no release was calculated for these two severity categories.
- Only one of the TRUPACT-IIs in a shipment would be breached in an accident of any of the severity categories. This assumption is based on studies that indicate hard targets along roadways are too few or are of the wrong orientation to cause the breach of more than one TRUPACT-II (see Appendix E).

FRACTIONAL LCFs

Sometimes, calculations of the number of latent cancer fatalities associated with radiation exposure do not yield whole numbers, and, especially in environmental applications, may yield numbers less than 1.0. For example, if each member of a population of 100,000 were exposed to a total dose of 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons x 0.001 rem x 0.0005 latent cancer fatalities/person-rem = 0.05 latent fatal cancers).

How should one interpret a nonintegral number of latent cancer fatalities, such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. For most groups, no one would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 latent fatal cancer would result; in exceptionally few groups, 2 or more latent fatal cancers would occur. The *average* number of deaths over all of the groups would be 0.05 latent fatal cancers (just as the average of 0, 0, 0, and 1 is ¼ or 0.25). The most likely outcome is 0 latent cancer fatalities.

ESTIMATING ACCIDENT RISK

Assessing the radiological or hazardous chemical impact due to accidents is typically done by estimating the probability that such an accident might occur and, for a selection of accidents, by estimating the accident's consequences. The probability, or chance, that the accident will occur, and the consequences of the accident are multiplied together to determine the total risk of the accident.

Accident probability is usually determined by historical information on accidents of a similar type or severity. Determining accident consequences requires estimation of the quantity of radionuclides or hazardous chemicals likely to be released, the exposure pathways that will bring the radionuclides or hazardous chemicals into contact with people, and the environmental transport mechanisms. Because of the many variables in these calculations, conservative or bounding assumptions are commonly used and risks tend to be overestimated.

- Only one RH-72B is transported per truck. That one cask would be breached.
- The population densities used to estimate impacts were six persons per square kilometer (16 per square mile) for rural areas, 719 persons per square kilometer (1,863 per square mile) for suburban areas, and 3,861 persons per square kilometer (10,000 per square mile) for urban areas.
- The analyses assumed that stable atmospheric conditions predominated, maximizing impacts.
- Impacts were calculated using a resuspension particle half-life of 365 days.

The results for the first type of accident analysis, route-specific accidents summed over the entire shipping campaign, are presented in Table 5-9.

Table 5-9
Aggregate Radiological Impacts from Potential Truck Transportation Accidents for the Proposed Action (LCFs) [a]

Waste Origin	CH-TRU Waste	RH-TRU Waste	Total
Argonne National Laboratory-East	5.0E-4	---	5.0E-4
Hanford Site	0.3	4.0E-3	0.3
Idaho National Engineering and Environmental Laboratory & Argonne National Laboratory-West	0.08	2.6E-3	0.08
Lawrence Livermore National Laboratory	1.5E-3	---	1.5E-3
Los Alamos National Laboratory	3.5E-3	1.5E-5	3.5E-3
Mound Plant	1.0E-3	---	1.0E-3
Nevada Test Site	5.0E-4	---	5.0E-4
Oak Ridge National Laboratory	3.0E-3	1.0E-3	4.0E-3
Rocky Flats Environmental Technology Site	8.0E-3	---	8.0E-3
Savannah River Site	0.02	---	0.02
Total	**0.42**	**7.6E-3**	**0.43**

[a] Includes both probability of the accident and consequences.

A 1987 NRC study estimated that only 0.6 percent of truck and rail accidents involving Type B containers or casks could cause a radiation hazard to the public (Fischer et al. 1987). There are 56 potential accidents under the Proposed Action, and only half of these accidents are expected to occur when the canister or cask is loaded. Therefore, of the approximately 28 potential transportation accidents estimated to occur under the Proposed Action when the canister or cask is loaded, none would be expected to result in package failure. Still, the second type of analysis was an assessment of four bounding accidents: two assumed a breach of a TRUPACT-II and two assumed a breach of an RH-72B cask. The accidents were assumed to occur under conditions that would maximize, within reasonable bounds, the impacts to exposed population groups. Assumptions for these analyses included the following (see Appendix E for details):

- During the accidents, one TRUPACT-II or RH-72B cask would be breached.
- Each accident would occur in an urban area with a population density of 3,861 persons per kilometer (10,000 persons per square mile), under stable atmospheric conditions that would maximize exposure to nearby populations.
- Two types of inventories were considered for the four accidents: a conservative inventory similar to that used for the first type of analysis above and an inventory based on the average concentrations of radionuclides and hazardous chemicals at Hanford (for RH-TRU waste) and SRS (for CH-TRU waste). The conservative inventory was determined by maximizing the concentrations of radionuclides and hazardous chemicals to the limits allowed by the planning-basis WAC.
- Breach of the TRU waste packaging would result in 0.02 percent of the radioactive material being released to the environment in a respirable form (DOE 1990).
- Impacts were calculated using a resuspension particle half-life of 365 days.

The results for the second type of accident analysis follow. The probability of an accident that would breach a Type B package is 7.5×10^{-7} per accident.

- For the accident with the conservative inventory in a breached TRUPACT-II, the estimated dose would result in 16 LCFs in the exposed population. The estimated maximum individual dose would result in a 0.06 probability of an LCF. The estimated population doses were dominated by inhalation contributions (initial or from resuspension).
- For the accident with a conservative inventory in a breached RH-72B, the estimated dose would result in 16 LCFs in the exposed population. The estimated maximum individual dose would result in a 0.06 probability of an LCF.
- For the accident with average concentrations of radionuclides and hazardous chemicals in a breached TRUPACT-II, the dose estimated would result in 3 LCFs in the exposed population. The estimated maximum individual dose would result in a 0.04 probability of an LCF.
- For the accident with average concentrations of radionuclides and hazardous chemicals in a breached RH-72B, the total population dose estimated would result in a 0.04 LCF in the exposed population. The estimated maximum individual dose would result in a 7×10^{-4} probability of an LCF.

TRANSPORTATION IMPACTS OF THE SANTA FE BYPASS

The Santa Fe Bypass route is an established New Mexico Highway and Transportation Department project that provides for alternative routing for radioactive materials around the Santa Fe, New Mexico urban area. It is a route 22.24 kilometers (13.82 miles) long and connects US-285 north of Santa Fe with I-25 southwest of Santa Fe. The location study was completed in 1985 and adopted by the city on January 8, 1986. To date, approximately two-thirds of the route has been completed; the final one-third has been designed and was originally scheduled for late 1997. However, negotiations are being conducted at this time for the right-of-way for the final phase.

To compare the impacts of using St. Francis Drive to access I-25 through Santa Fe or the Santa Fe bypass under the Proposed Action, the impacts of shipping TRU waste from LANL to WIPP was reevaluated using the Santa Fe bypass route. By this method, the total number of miles traveled would increase from approximately 550 kilometers (342 miles) to 575 kilometers (357 miles). Using the bypass eliminates about 3.2 kilometers (2 miles) of travel in an urban population zone and 7.2 kilometers (4.5 miles) in a suburban population zone along St. Francis Drive. Using the bypass adds approximately 29 kilometers (18 miles) of travel in a suburban population zone and 6.4 kilometers (4 miles) in a rural population zone. The additional 29 kilometers (18 miles) includes 13 kilometers (8 miles) along federally aided interstate (I-25) and 16 kilometers (10 miles) along federally aided primary road (the bypass). The rural miles are along the bypass and are classified as federally aided primary road. The road classifications (federally aided interstate and federally aided primary road) are identified because the accident rates are based upon state-specific data for those road types (Saricks and Kvitek 1994). The following table compares the impacts of shipping TRU waste from Los Alamos to WIPP using the Santa Fe bypass or St. Francis Drive.

Impact	Santa Fe Bypass	St. Francis Drive
Nonradiological		
Accidents	3.3	2.8
Injuries	3.1	2.7
Fatalities	0.5	0.4
Radiological Accident-Free Dose, in rem (LCFs in parentheses)		
Occupational	32.1 (0.013)	30.7 (0.012)
Non-occupational	201.2 (0.101)	192.6 (0.096)

5.1.8.5 Hazardous Chemical Impacts from Severe Truck Transportation Accidents

This section estimates the impacts associated with exposure to hazardous constituents (as defined by the Resource Conservation and Recovery Act [RCRA]) during the transportation of TRU mixed waste to WIPP. Hazardous chemicals in TRU waste include VOCs and certain metals listed as hazardous chemicals in RCRA. During routine transportation of TRU mixed waste, exposures to hazardous chemicals would not occur because the TRUPACT-II and RH-72B packagings are not vented, and the hazardous chemical components in the waste are completely contained. No impacts to human health would be posed by the hazardous constituents under routine transportation conditions. Impacts due to accidents, however, are possible. It is those impacts that are evaluated in this section.

Hazardous chemical inventories were developed as described in Appendix A. For those VOCs where maximum allowable levels are stipulated in the planning-basis WAC, those levels were assumed to be in the container being transported during an accident. Where no maximum level was specified in the planning-basis WAC, the highest level found during waste drum sampling was selected to ensure that the typical concentration is bounded. For heavy metals, the concentration was assumed to be the average of those found during sampling (see Section A.5).

It was assumed that CH-TRU waste hazardous chemical accident scenarios would bound any impacts from RH-TRU waste shipments; therefore, no hazardous chemical accidents were analyzed for RH-TRU shipments. The bases for this assumption included the relative shipment capacity (hazardous chemical inventory) of 14 CH-TRU waste drums or 2.91 cubic meters (103 cubic feet)

ESTIMATING HAZARDOUS CHEMICAL IMPACTS

Hazardous chemical exposures can pose two types of health effects, carcinogenic (causing cancer) and noncarcinogenic (for example, respiratory problems or skin irritation). Some hazardous chemicals can potentially produce both carcinogenic and noncarcinogenic health effects. Health effect analyses require knowledge of the exposure pathway and intake (typically by inhalation, but also by ingestion), and use of health effect risk factors that allow estimated intakes to be converted to estimates of health effects.

Carcinogenic Risk

Carcinogenic risk is probabilistic; that is, every intake carries with it some probability of cancer incidence regardless of how small the intake is. The risk varies linearly with exposure, and there is assumed to be no threshold below which an effect would not occur. The U.S. Environmental Protection Agency (EPA) has published carcinogenic risk factors to be used for estimating potential impacts from chronic (long-term) exposure to hazardous chemicals. The “slope factor” of a hazardous chemical is used to convert chronic hazardous chemical intakes to the probability of cancer incidence. The chronic exposure is assumed to last for a 70-year lifetime. Slope factors are specified as the risk per average daily intake over that 70-year period.

No standard method exists to calculate the carcinogenic risk from an acute (one-time or short-term) intake. The method selected for SEIS-II analyses used the chronic-exposure slope factors and assumed the total acute intake was averaged over the 70-year lifetime. In practice then, slope factors were used but specified as the risk per total acute intake.

Noncarcinogenic Health Effects

In contrast to carcinogenic health effects, noncarcinogenic health effects are deterministic, not probabilistic; that is, these effects are assumed to have an exposure threshold, and unless that threshold is reached no health effect would occur. EPA “reference doses” were used to estimate the potential noncarcinogenic health effects from chronic exposure to hazardous chemicals. Reference doses are specified as the chronic daily intake that would be required for the health effect to occur.

As was the case for acute exposures to carcinogenic hazardous chemicals, no standard method exists for estimating the noncarcinogenic health effects from acute exposures to hazardous chemicals. The method selected for SEIS-II analyses used the National Institute of Occupational Safety and Health (NIOSH) immediately dangerous to life or health (IDLH) values, or calculated IDLH-equivalent intakes. IDLH values are the air concentrations that would result in serious or life-threatening health effects if an individual were to be exposed at that concentration for 30 minutes. IDLH-equivalent intakes were calculated using the IDLH parameters to estimate potential impacts from exposure times less than 30 minutes. The IDLHs are air concentrations with units of milligrams per cubic meter (mg/cubic meter) or parts per million (ppm) of the hazardous chemical in air. IDLH-equivalent values are in mass quantities of intake, such as milligrams (mg).

of waste compared to the capacity of an RH-72B cask or 0.89 cubic meters (32 cubic feet) of waste. A TRUPACT-II, therefore, is likely to hold nearly three times the hazardous chemicals that an RH-72B would hold. For the purpose of analysis, it was assumed that the RH-TRU waste hazardous chemical inventory is the same as the CH-TRU hazardous chemical inventory.

The approach used to assess human health effects from hazardous chemical exposures during transportation accidents was similar to that used for SEIS-I. The assessment criteria used were the immediately dangerous to life or health (IDLH) values provided by the National Institute of Occupational Safety and Health (NIOSH). Each chemical was considered separately; the impacts from each chemical are not additive. As long as the ratio of possible intake to IDLH value was less than 1, the risk of health impact was considered zero, and there was no need to further evaluate an exposure. The hazardous constituents that were analyzed are presented in Table 5-10.

Hazardous chemical impacts were evaluated for a bounding, severity category VIII accident. The accident would breach one of the three TRUPACT-IIs. The entire TRUPACT-II inventory of VOCs was assumed to be released (release fraction = 1.0), and heavy metals would be released as particulates with a release fraction of 2 x 10^{-4} (DOE 1990). The receptor was assumed to be a public MEI located 1,000 meters (3,300 feet) downwind from the accident, exposed at the centerline of the released plume of chemicals for two hours under stable meteorological conditions and low wind speed. Table 5-10 presents the hazardous chemicals analyzed and impacts to the MEI as a fraction of the chemical-specific IDLH value. For all chemicals analyzed, the concentration to which the MEI would be exposed would be no more than about 1/10,000th of the chemical's IDLH value. Therefore, no human health effects would be expected from acute exposure to hazardous chemicals released from a severe transportation accident.

Table 5-10
Hazardous Chemical Impacts for a Severe Truck Transportation Accident for the Proposed Action [a]

Chemical	IDLH (parts per million)	IDLH (milligrams per cubic meter)	Receptor Concentration (milligrams per cubic meter)	Fraction of IDLH Value
Carbon Tetrachloride	200	1,278	5.4E-04	4.2E-07
Chloroform	500	2,480	3.1E-05	1.3E-08
Methylene Chloride	2,300	8,119	1.1E-03	1.3E-07
1,1,2,2-Tetrachloroethane	100	700	1.4E-03	2.0E-06
Chlorobenzene	1,000	4,680	2.0E-04	4.4E-08
Methyl Ethyl Ketone	3,000	9,000	4.0E-04	4.5E-08
Toluene	500	1,915	1.3E-04	7.0E-08
1,2-Dichloroethane	50	206	1.1E-04	5.1E-07
Beryllium	---	4	5.5E-03	1.4E-03
Cadmium	---	9	8.8E-05	9.8E-06
Lead	---	100	2.2E-01	2.2E-03
Mercury	---	10	9.4E-02	9.4E-03

[a] Assumes a severity category VIII accident of a CH-TRU waste shipment.

5.1.9 Human Health Impacts from Waste Treatment and Disposal Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from waste treatment and waste disposal operations under the Proposed Action. Throughout this section, the potential impacts from treating waste to planning-basis WAC and from the disposal operations at WIPP are reported separately.

Impacts from waste treatment under the Proposed Action were adjusted from those presented in the WM PEIS (DOE 1997); a description of this adjustment is provided in Appendix B. Treatment of the waste may result in the release of radioactive materials or hazardous chemicals, impacting the public and workers who would not directly handle waste (noninvolved workers).

Direct radiation from the waste would present potential radiological impacts for workers who would handle waste (involved workers) at the treatment sites. The public MEI impact is presented for the site with the highest estimated impact of all sites evaluated in the WM PEIS. Population impact estimates from waste treatment are the sum of all population impact estimates for all treatment sites.

UNCERTAINTIES IN TRANSPORTATION IMPACT ANALYSES

To account for inherent uncertainties in the data, conservative assumptions were made so that reported impacts would bound potential impacts. The following are descriptions of the sources of uncertainty.

Waste Inventory and Characterization

The physical form and radionuclide content of TRU waste were considered when estimating both the external dose rate during accident-free transport and the dose to exposed individuals from transportation accidents. Therefore, conservative assumptions were applied consistently to the waste data to limit potential differences between sites and across alternatives.

Route Determination

Although highway infrastructure and demographics may change considerably over the next 35 to 190 years, representative routes were established for all origin and destination sites in each of the alternatives. The routes were determined using current guidelines, regulations, and practices.

Radiation Doses

Based on the natural variability of key physical processes (i.e., atmospheric dispersion of radioactive material), conservative assumptions were made regarding radiation dose assessment for transportation activities. Parameter values were selected that would provide reasonable upper limits or, in some cases, bounding estimates of potential impacts. Because parameters and assumptions were applied consistently to all alternatives, the relative comparisons between alternatives would not be affected.

For TRU waste shipments, the largest dose contributors were found to be: (1) accident-free dose to members of the public at stops; (2) accident-free dose to transportation crew members; (3) accident-free dose to members of the public sharing the route; (4) accident-free dose to members of the public living along the route; (5) accident dose risk to members of the public in an urban population zone (mean density of 3,861 persons per kilometer). Approximately 80 percent of the estimated public dose would be incurred at stops, 15 percent would be incurred by the members of the public sharing the route, and 5 percent would be incurred by members of the public living along the route.

Potential impacts from WIPP waste handling and emplacement operations were calculated for the public living near WIPP, for WIPP noninvolved workers, and for WIPP involved workers. Potential impacts from routine releases of VOCs and radioactive gases were calculated because each waste drum or waste box would be vented to reduce gas buildup. Both workers and the public may be exposed to these releases. No release of particulate hazardous chemicals during routine operations would occur at WIPP because the vents on the drums have filters, and the drums would not be opened. For the involved workers, potential impacts also were calculated for exposure to direct radiation from waste container contents. Direct radiation impacts for others at WIPP were not calculated because of the distances between where the drums would be unloaded and emplaced and other work areas. The impacts from the disposal operations were calculated for releases occurring after waste is unloaded from the TRUPACT-II or RH-72B. The detailed methods and assumptions used to calculate the potential impacts are described in Appendix F.

The types and concentrations of VOCs in the TRU mixed waste were estimated from past sampling of CH-TRU waste containers (see Appendix A). Emissions from CH-TRU and RH-TRU waste containers were assumed to have similar concentrations of VOCs. Although an estimated 60 percent of the TRU waste is mixed waste, all TRU waste was considered TRU mixed waste for human health analyses. Weighted average headspace concentrations (concentrations in the void area of a drum) were estimated for waste at each treatment site and were used to estimate impacts from waste emplaced underground at WIPP. More conservative estimates of VOC emissions were used to estimate impacts to workers in the Waste Handling Building. The limited number of drums (or drum-equivalents if the waste is in other containers) that could be present in the Waste Handling Building were assumed to release quantities of VOCs based on weighted maximum headspace concentrations; this assumption was made to bound the potential impacts to a worker in this facility.

Radiological impacts are presented as the estimated number of LCFs in a population, and, for individuals, as the probability of an LCF. As with the transportation analyses, the International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991) dose-to-risk factors of 5 x 10^{-4} LCF per person-rem for the general public and 4 x 10^{-4} LCF per person-rem for the worker population were used to convert radiation dose to LCFs.

Impacts resulting from chronic exposure to hazardous chemicals may be either carcinogenic or noncarcinogenic. Carcinogenic impacts are presented as the estimated cancer incidence (number of cancers occurring) in a population and, for MEIs, as the probability of cancer occurring. The Environmental Protection Agency's (EPA) slope factors were used to estimate cancer incidence from chronic exposure to hazardous chemicals. Noncarcinogenic health effects were evaluated using a hazard index (HI), which is the ratio of the

RADIOLOGICAL IMPACTS OTHER THAN LCFs

For SEIS-II, the impact reported from a radiation dose is the number of LCFs that may occur in a population, and the probability of an LCF occurring in a maximally exposed individual. Other radiological impacts could result from exposure, such as a nonfatal cancer or hereditary effects (physical deformities). The risk of an LCF, however, is the dominant risk.

For the general public, consideration of nonfatal cancers would increase the impact estimate by 20 percent and, for severe hereditary effects, the impact estimate would increase by another 20 percent. For workers, consideration of nonfatal cancers would increase the impact estimate by 20 percent and for severe hereditary effects, by an additional 26 percent (ICRP 1991).

estimated annual intake of a specific chemical divided by the EPA reference dose for that chemical (see the "Estimating Hazardous Chemical Impacts" text box). An HI greater than 1 would predict the occurrence of the chemical-specific noncarcinogenic health effect. Estimates of the HI for involved workers for some prospective cases (such as WIPP waste handling) were done very conservatively, and resulted in an HI greater than 1. In these cases additional evaluations were made.

The air concentration to which the worker would be exposed was conservatively calculated and compared to the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (PEL) values. The PELs are, typically, time-weighted averages that must not be exceeded during any 8-hour work shift or a 40-hour work week. A few hazardous chemicals that may be present in waste accepted at WIPP have PEL values that must not be exceeded over any time period; they are chloroform, methylene chloride, and beryllium. If the air concentration of the hazardous chemical of concern did not exceed the PEL, no worker noncarcinogenic health effects would occur for the scenario evaluated. Evaluation of the potential for noncarcinogenic health effects in waste treatment workers may be expressed as an exposure index, rather than an HI. This methodology was used in the WM PEIS and is based on the ratio of the exposure level divided by an occupational exposure limit, rather than by the reference dose.

5.1.9.1 Public

Impacts to public populations and to the MEIs under the Proposed Action are presented in this section; results are presented in Table 5-11. Impacts from waste treatment and from WIPP disposal operations are presented separately because different populations and individuals would be impacted by these activities. Waste treatment would take place at multiple DOE sites that would not include WIPP, while disposal operations would take place only at WIPP. Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of each treatment facility and WIPP. The MEI from waste treatment is presented for the highest individual waste treatment site, while the MEI from disposal operations would be near the WIPP site. See Chapter 3 for information on where potential treatment could occur.

Table 5-11
Lifetime Human Health Impacts to the Public
from Waste Treatment and WIPP Disposal Operations for the Proposed Action

Category	Waste Treatment Impacts [a]		WIPP Disposal Operations Impacts	
	Radiological (LCF) [b]	Hazardous Chemicals (Cancer Incidence)	Radiological (LCF) [b]	Hazardous Chemical (Cancer Incidence)
MEI [c, d]				
CH-TRU Waste	2E-9 (R)	2E-12 (X)	3E-7	3E-8
RH-TRU Waste	6E-11 (L)	2E-11 (O)	3E-10	1E-9
Total Waste	2E-9 (R)	2E-11 (O)	3E-7	3E-8
Population [c]				
CH-TRU Waste	2E-4	1E-7	3E-4	2E-5
RH-TRU Waste	1E-6	4E-7	4E-7	9E-7
Total Waste	2E-4	4E-7	3E-4	2E-5

[a] Adapted from the WM PEIS (DOE 1997).
[b] The probability of an LCF occurring in the MEI, and number of LCFs occurring in the exposed population.
[c] The MEI and populations evaluated for treatment impacts and WIPP disposal operations impacts are different.
[d] L = LANL, O = ORNL, R = RFETS, X = LLNL

Waste Treatment

No radiation-related LCFs (2 x 10^{-4} LCFs) or cancer incidence (4 x 10^{-7} cancers) would be expected in the total population around the waste treatment sites. The MEIs with the greatest impact would be at RFETS for radiological impacts (2 x 10^{-9} probability of an LCF) and at ORNL for hazardous chemical impacts (2 x 10^{-11} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the MEI would be 3 x 10^{-10}, and no health effect is predicted unless the HI is 1 or higher.

WIPP Disposal Operations

No LCFs would be expected in the population around WIPP from radiation exposure (3 x 10^{-4} LCFs). VOC releases were estimated by assuming that a single panel, fully emplaced with RH-TRU and CH-TRU waste (4.5 percent and 95.5 percent of panel waste volume, respectively) would release VOCs continuously throughout all 35 years of WIPP disposal operations. Because each panel would be filled over a 2.5-year period and then closed, reducing VOC releases, the assumption of a full panel continuously releasing VOCs is conservative. Still, no cancer incidence (2 x 10^{-5} cancers) would be expected in the population from hazardous chemical exposure.

The MEI was assumed to be located at the Land Withdrawal Area boundary, the closest point at which an individual could reside. The MEI would have a 3 x 10^{-7} probability of an LCF from radiation exposure, and a 3 x 10^{-8} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects would occur. The maximum HI for the MEI would be 7 x 10^{-5}, and no health effect is predicted unless the HI is 1 or higher.

5.1.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under the Proposed Action are presented in this section; results are presented in Table 5-12. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, storage, handling or disposal of waste. Impacts from waste treatment and from WIPP disposal operations are presented separately because different noninvolved worker populations and individuals would be impacted by these activities. Waste treatment would take place at multiple DOE sites that would not include WIPP, while disposal operations would take place only at WIPP. Noninvolved worker population impacts were estimated for the total of all treatment sites, and for WIPP. The impact to the maximally exposed noninvolved worker from waste treatment is presented for the highest individual waste treatment site, while the maximally exposed noninvolved worker from disposal operations was assumed to work continuously at the WIPP location where emissions have the least atmospheric dispersion and thus the greatest potential impact. This location was assumed to be 200 meters (660 feet) east of the exhaust filter building. The maximum ground-level concentrations of any airborne contamination would be expected at this location.

Waste Treatment

No LCFs (7 x 10^{-6} LCFs) would be expected in the total noninvolved worker population at the waste treatment sites, and no cancer incidence (1 x 10^{-7} cancers) would be expected in the total noninvolved worker population from hazardous chemical exposure. The maximally exposed noninvolved worker would be at RFETS for radiological impacts (3 x 10^{-9} probability of an LCF)

Table 5-12
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment and WIPP Disposal Operations for the Proposed Action

Category	Waste Treatment Impacts[a]		WIPP Disposal Operations Impacts	
	Radiological (LCF)[b]	Hazardous Chemicals (Cancer Incidence)	Radiological (LCF)[b]	Hazardous Chemical (Cancer Incidence)
Maximally Exposed Noninvolved Worker[c, d]				
CH-TRU Waste	3E-9 (R)	6E-12 (X)	4E-7	1E-7
RH-TRU Waste	3E-11 (L)	1E-10 (O)	7E-10	5E-9
Total Waste	3E-9 (R)	1E-10 (O)	4E-7	1E-7
Population Noninvolved Worker[c]				
CH-TRU Waste	7E-6	2E-8	4E-4	1E-4
RH-TRU Waste	7E-8	1E-7	7E-10	5E-6
Total Waste	7E-6	1E-7	4E-4	1E-4

[a] Adapted from the WM PEIS (DOE 1997).
[b] The probability of an LCF occurring in the maximally exposed noninvolved worker, and the number of LCFs in the population.
[c] The individuals and populations evaluated for treatment impacts and operations impacts are different.
[d] R = RFETS, O = ORNL, L = LANL, X = LLNL

and at ORNL for hazardous chemical impacts (1 x 10^{-10} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the maximally exposed noninvolved worker would be 3 x 10^{-9}, and no health effect is predicted unless the HI is 1 or higher.

WIPP Disposal Operations

No LCFs would be expected in the WIPP noninvolved worker population from radiation exposure (4 x 10^{-4} LCFs). VOC release estimates were the same as for the public. No cancer incidence (1 x 10^{-4} cancers) would be expected in the noninvolved worker population from hazardous chemical exposure. All 1,095 WIPP employees were assumed to be exposed at the same level as the maximally exposed noninvolved worker.

The maximally exposed noninvolved worker would have a 4 x 10^{-7} probability of an LCF from radiation exposure and a 1 x 10^{-7} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects would occur. The maximum HI for the maximally exposed noninvolved worker was found to be 6 x 10^{-4}, and no health effect is predicted unless the HI is 1 or higher.

Appendix F provides additional information on the methods used to determine impacts to noninvolved workers from WIPP disposal.

5.1.9.3 Involved Workers

Impacts to the involved worker populations under the Proposed Action are presented in this section; results are presented in Table 5-13. Involved workers are those directly involved in day-to-day waste treatment, disposal, and management activities. At the waste treatment facilities, such workers would include those who are in direct contact with waste during treatment or packaging to meet planning-basis WAC. At WIPP, they would include workers in the Waste

Table 5-13
Lifetime Human Health Impacts to Involved Workers from Waste Treatment and WIPP Disposal Operations for the Proposed Action

Category	Waste Treatment Impacts [a]		WIPP Disposal Operations Impacts	
	Radiological (LCF)	Hazardous Chemicals (Cancer Incidence)	Radiological (LCF)	Hazardous Chemical (Cancer Incidence)
Involved Worker Population [b]			(36 workers)	(36 workers)
CH-TRU Waste	0.7	8E-6	0.4 to 0.5	9E-3
RH-TRU Waste	0.02	7E-6	≤0.5	5E-4
Total Waste	0.8	2E-5	≤1	< 0.01

[a] Adapted from the WM PEIS (DOE 1997).

[b] The involved worker populations evaluated for treatment impacts and WIPP disposal operations impacts are different.

Handling Building and those who would emplace waste underground. All worker exposures to radiation and hazardous chemicals would be controlled to as low as reasonably achievable (ALARA) levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Waste Treatment

An estimated 0.8 radiation-related LCFs could occur in the worker population, while no cancer incidence (2×10^{-5} cancers) would be expected from hazardous chemical exposure. No noncarcinogenic health impacts are predicted. The maximum exposure index for a waste treatment worker would be 2×10^{-4}. Impacts from waste treatment under the Proposed Action were adjusted from those presented in the WM PEIS (DOE 1997); a description of this adjustment is provided in Appendix B.

WIPP Disposal Operations

Radiological impacts to the involved worker population at WIPP from disposal operations would be less than 1 LCF, and hazardous chemical impacts would be less than 0.01 cancers. No noncarcinogenic health effects would occur. External radiation doses would be the primary source of potential radiological impacts to involved workers; there would be negligible impact from intakes of radioactive material. Worker population impacts were estimated using a total of 36 involved workers (32 Waste Handling Building workers and four underground workers).

The drum vent filters prevent the release of particulates, although small quantities of radioactive gases would be released from containers. Workers would be exposed to external radiation from radioactive decay of radionuclides in the waste and receive an external dose. Worker doses are administratively limited at WIPP to 1 rem per year for the whole-body and 50 rem per year for any extremity (DOE 1995e). CH-TRU waste containers are limited to external dose rates of 200 mrem per hour at the surface of the container. The majority of routine worker doses would result from the disposal of CH-TRU waste rather than RH-TRU waste because of the greater throughput volume of CH-TRU waste and the use of RH-TRU waste remote disposal operations. Estimates of worker whole-body doses were made assuming that the worker would be exposed at 1 meter (3.3 feet) from the CH-TRU waste, 2 hours per workday, 4 workdays per week.

The range of WIPP involved worker radiological impacts were estimated assuming 25 to 35 years of exposure. Impacts to involved workers from RH-TRU waste handling were assumed to be the same or less than those from CH-TRU waste handling. This assumption is conservative because RH-TRU waste is typically handled using remote-handling equipment, workers are usually protected by radiation shielding, and stricter administrative procedures are used. The impact from handling RH-TRU waste, therefore, would be less than the impact from handling CH-TRU waste.

Workers may routinely be exposed to VOCs released from the waste containers. Worker impacts are related to the quantity of VOCs released and the ventilation rate of the area where they work. Involved workers in the Waste Handling Building were assumed to be exposed to VOC emissions from the maximum number of drums or drum-equivalents that could be stationed in the Waste Handling Building at any one time (42 CH-TRU waste drums and 3 RH-TRU waste drum equivalents). All of the drums were assumed to continuously contain concentrations of VOCs equal to the weighted maximum headspace concentrations. A low ventilation rate was assumed for the Waste Handling Building.

An involved worker underground at WIPP was assumed to be exposed to the VOCs released from a nearby panel filled with CH-TRU and RH-TRU waste containers. A low ventilation rate was assumed for the underground area. Underground workers would normally be upwind of the ventilation air that passes over the waste containers. The potential carcinogenic impacts would be greater for the individual underground worker than for a Waste Handling Building worker, but no cancer incidence would be expected (0.01 cancers). Workers were assumed to be exposed for 35 years.

Noncarcinogenic health effects also were estimated for WIPP workers who would handle waste. The initial maximum HI estimates were 2 for the Waste Handling Building worker and 6 for the underground worker, so further evaluation was conducted for those constituents that had an HI near or greater than 1: (1) carbon tetrachloride for the Waste Handling Building (HI of 2) and the underground (HI of 6); and (2) methylene chloride for the Waste Handling Building (HI of 0.9). The air concentrations to which workers would be exposed were calculated and then compared with the PELs. For the VOCs noted above, the air concentrations would be at least three orders of magnitude below the PELs, well within permissible exposure limits, so no noncarcinogenic health effects would be expected.

5.1.9.4 Storage of Excess RH-TRU Waste

Under the Proposed Action, using the conservative RH-TRU waste volume estimates of Baseline Inventory Report, Revision 3 (BIR-3), a portion of the RH-TRU waste at Hanford and ORNL would not be disposed of at WIPP. (Under more recent waste volumes projected in *The National Transuranic Waste Management Plan* (DOE 1996f), all post-1970, defense RH-TRU waste could be disposed of at WIPP [see Appendix J].) The impacts of surface storage of 39,000 cubic meters (1.4 million cubic feet) of RH-TRU waste at Hanford and 4,000 cubic meters (141,000 cubic feet) of RH-TRU waste at ORNL were evaluated. The waste was assumed to be stored in RH-TRU waste canisters packaged to meet the planning-basis WAC. Radiological impacts would result from the release of gaseous radionuclides from the waste containers. The only gaseous radionuclide identified was carbon-14 in RH-TRU waste at ORNL, and no carbon-14 or radium-226 inventories are known for Hanford RH-TRU waste. Impacts from container VOC releases were estimated using the average weighted headspace concentration from waste packaged to the planning-basis WAC.

OVERVIEW OF UNCERTAINTIES IN HUMAN HEALTH IMPACT ESTIMATES

The results of any human health assessment are conditional estimates based on multiple assumptions about exposure, toxicity, release of contaminants into the environment, human behavior patterns, and other variables. Therefore, the uncertainties accompanying the analysis should be evaluated to place these risk estimates in proper perspective. Uncertainties can be classified into three broad categories: model uncertainty, scenario uncertainty, and parameter uncertainty. Each of the SEIS-II analyses has associated uncertainties that fall into each of these categories.

Model uncertainty can result from the general limitations of mathematical models. Modeling involves trying to simulate a process that is inherently complex using a fixed and relatively small number of variables. Model uncertainty is usually estimated in the verification and validation phase of model development. Model uncertainty can also result from the inappropriate application of a model to a particular scenario (for instance, in situations for which no model has been specifically designed, and existing models must be adapted for use).

Scenario uncertainty may result from a generalized or incorrect conceptualization of a contaminant release or an exposure scenario. For example, there may be errors in the generalized assumptions concerning the amount of contaminants released, the spatial distribution of potential receptors, and the intake parameters considered for the receptors. Uncertainty is introduced because of the prospective nature of the scenarios, involving actions that may be take sometime in the future. For example, the performance of facilities not yet designed or built is unknown and is therefore based on current facilities and specifications. Scenarios do not consider major hypothetical technological advances or global changes, such as a cure for cancer, global nuclear war, or a new ice age.

Parameter uncertainty may result from sampling errors, natural variability of the parameter, or the use of generic data (data that are not site-specific). The fate and transport models used to estimated risks require large amounts of data, including meteorological measurements, hydrogeologic settings, and release parameters. Actual data are used where possible, but generic data are often substituted where site-specific data are unavailable.

The WIPP SEIS-II evaluates the absolute and relative magnitude of potential human health impacts. Evaluating the absolute magnitude of human health impacts involves estimating the actual but unknown impact. The approach taken in SEIS-II was to make assumptions and employ methods that would yield reasonably conservative absolute estimates of impacts (i.e., estimates that tend to overestimated rather than underestimate impacts) using the best available data and state-of-the-art models. Impacts estimated for the various alternatives may be compared (relative impacts). Many of the uncertainties associated with the WIPP SEIS-II impact estimates are “systematic;” that is, modeling and scenario assumptions such as the population distribution around a particular site, the inhalation rate, and the way in which a population may be exposed were applied consistently (i.e., systematically) throughout the analysis. The relative differences in impact estimates among alternatives should not be greatly affected by errors associated with systematically applied assumptions. For example, if inhalation of contaminants by the off-site population was overestimated for one alternative, it was similarly overestimated for all other alternatives.

Impacts from long-term storage of the RH-TRU waste are shown in Table 5-14. Impacts to involved workers would be less than those shown for RH-TRU waste treatment in Table 5-13. Exposure of involved workers to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Table 5-14
Impacts from Storage of Excess RH-TRU Waste for the Proposed Action

Impact Area	Radiological	Hazardous Chemical	
	LCFs [a]	Cancer incidence	Maximum HI
Public [b]			
Population	2E-5	3E-4	N/A
MEI	1E-9 (O)	4E-8 (O)	1E-5 (O)
Noninvolved Worker			
Population	4E-5	6E-4	N/A
Maximally Exposed Noninvolved Worker	1E-8 (O)	4E-8 (H)	1E-4 (H)

[a] The probability of an LCF occurring in the ORNL MEI or maximally exposed noninvolved worker, and the number of LCFs in the population.
[b] H = Hanford, O = ORNL

N/A = Not Applicable

5.1.10 Facility Accidents

This section describes potential consequences of facility accidents at the generator-storage sites from treatment of waste to the planning-basis WAC, at two of the generator-storage sites from waste storage after treatment, and at WIPP during waste management and disposal operations. Consequences from treatment accidents were evaluated for the six major generator-storage sites (Hanford, LANL, INEEL, SRS, RFETS, and ORNL) that would treat about 98 percent of the total CH-TRU and RH-TRU waste under the Proposed Action.

Inhalation is the dominant exposure pathway for accidental releases of radionuclides and hazardous chemicals. Radiological consequences are potentially much greater than hazardous chemical consequences and are dominated by inhalation of transuranic radionuclides. Details of the methods and assumptions used in the accident analyses and complete accident scenario descriptions are provided in Appendix G.

5.1.10.1 Waste Treatment Accidents

Three potential waste treatment accidents were evaluated under the Proposed Action; they are presented in Table 5-15. Results are presented only for accidents involving CH-TRU waste. The results from these accidents would be greater than the results for similar accidents involving RH-TRU waste because CH-TRU waste contains greater concentrations of transuranic radionuclides, which are the dominant contributors to dose from the inhalation pathway (see Tables G-23 and G-24). The potential accident consequences at the five sites that would treat the greatest volume of CH-TRU waste were evaluated in detail; these sites would be Hanford, INEEL, LANL, RFETS and SRS. Potential accident consequences at ORNL, Hanford, INEEL, and LANL were evaluated for RH-TRU waste treatment separately. Consequences at LLNL, NTS, Mound, ANL-E, and other smaller sites were not evaluated because these sites would treat relatively small quantities of CH-TRU waste. Because of the small quantities, these sites would be expected to treat this waste (treatment to WAC is required prior to transportation) in small batches (e.g., 1 to 2 drum quantities at some sites). This treatment would not be expected to result in substantial consequences (i.e., no LCFs).

Table 5-15
Treatment Accident Scenarios for the Proposed Action

Accident Scenarios	Annual Occurrence Frequency	Description
Waste Spill (Accident Scenario T1)	0.01	Drum is mispositioned causing waste to spill onto the floor.
Drum Fire (Accident Scenario T2)	1E-4	Pyrophoric material inside a drum causes drum contents to burn.
Earthquake (Accident Scenario T3)	1E-5 or less	An earthquake stronger than that for which the building was designed (beyond-design-basis earthquake) (or other natural event) collapses the roof of the building, causing drums to rupture and high efficiency particulate air (HEPA) filters to fail.

Treatment accident scenarios analyzed included a high-frequency/low-consequence operational accident expected to be applicable under any facility design, a low-frequency/high-consequence operational accident, and a low-frequency/high-consequence beyond-design-basis accident involving a building collapse. Such an accident could potentially be precipitated by an earthquake, a plane crash, or a tornado; for the purposes of analysis in SEIS-II, the accident was assumed to be an earthquake. Accident analysis information is presented in Appendix G. The accidents analyzed are believed to be representative of the spectrum of potential accidents; different or additional accidents may be analyzed in past, ongoing, or future NEPA reviews or safety analysis reports.

A beyond-design-basis earthquake was chosen as the most severe accident. Other natural disasters such as tornadoes, floods, and fires would not be expected to produce more severe consequences. While the annual occurrence frequency of a beyond-design-basis earthquake varies for DOE sites across the country (1×10^{-3} or less), the frequency of a beyond-design-basis earthquake that would result in loss of confinement and collapse the building has been estimated at 1×10^{-5} or less for purposes of these analyses. The analyses were conducted to estimate the difference in consequences among the types of waste treatment and not to make decisions regarding specific treatment sites.

Estimated radiological consequences are presented in the text as the number of LCFs in the exposed population and the probability of an LCF occurring in MEIs. Carcinogenic and noncarcinogenic consequences from hazardous chemicals, both VOCs and heavy metals, also were estimated. Carcinogenic consequences are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic consequences from exposure to VOCs and heavy metals were estimated by two different methods for the waste spill accident scenario (Accident Scenario T1) and drum fire scenario (Accident Scenario T2): IDLH-equivalent ratios and Emergency Response Planning Guideline (ERPG) ratios. The potential noncarcinogenic consequences identified by ERPG ratios would be of minor importance during a beyond-design-basis earthquake and its consequent site-operations upheaval.

In general, potential radiological consequences would be higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-16. Consequences to the maximally exposed involved worker were addressed qualitatively.

Table 5-16
Radiological Consequences of Treatment Accidents for the Proposed Action [a]

Accident Scenarios		Population (Number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
CH-TRU Waste	Waste Spill (Accident Scenario T1)	Maximum: 3E-4 (RFETS)	Maximum: 1E-7 (LANL)	Maximum: 4E-7 (Hanford)
	Drum Fire (Accident Scenario T2)	Maximum: 3E-4 (RFETS)	Maximum: 1E-7 (LANL)	Maximum: 4E-7 (Hanford)
	Earthquake (Accident Scenario T3)	Hanford: 3 INEEL: 0.1 LANL: 1 RFETS: 3 SRS: 0.2	Hanford: 1E-3 INEEL: 8E-5 LANL: 2E-3 RFETS: 2E-4 SRS: 3E-5	Hanford: 9E-3 INEEL: 0.01 LANL: 9E-3 RFETS: 5E-3 SRS: 6E-3
RH-TRU Waste	Waste Spill (Accident Scenario T1)	Maximum: 1E-8 (ORNL)	Maximum: 1E-11 (ORNL)	Maximum: 1E-11 (ORNL)
	Drum Fire (Accident Scenario T2)	Maximum: 2E-6 (ORNL)	Maximum: 2E-9 (ORNL)	Maximum: 6E-9 (INEEL)
	Earthquake (Accident Scenario T3)	Hanford: 6E-5 INEEL: 3E-6 LANL: 2E-5 ORNL: 1E-4	Hanford: 3E-8 INEEL: 1E-9 LANL: 3E-8 ORNL: 1E-7	Hanford: 2E-7 INEEL: 2E-7 LANL: 1E-7 ORNL: 3E-7

[a] The site with the greatest consequences is shown in parentheses. Complete information about accident scenarios T1 and T2 for all sites is contained in Appendix G.

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

The potential radiological consequences from RH-TRU waste treatment accidents would be the greatest at the ORNL site for all accident scenarios and receptors; however, they would be four to five orders of magnitude less than the consequences from CH-TRU waste treatment accidents.

Public

Population consequences from treatment accidents were estimated for the exposed populations around the six major treatment sites. Potential consequences to the population and MEIs at the six sites vary over a wide range because population distributions, the distances to the MEIs, and atmospheric dispersion factors differ among the sites. No LCFs would be expected in the exposed population from the waste spill or drum fire scenarios (Accident Scenarios T1 and T2, respectively), but 3 LCFs were estimated to occur due to the earthquake (Accident Scenario T3) at RFETS and Hanford. One LCF was estimated for LANL. The radiological consequences were estimated to be the highest to the MEI at LANL for all three accident scenarios. For the earthquake scenario (Accident Scenario T3), consequences to the MEI were estimated to range from a 3×10^{-5} (at SRS) to 2×10^{-3} (at LANL) probability of an LCF.

Depending on the treatment site, carcinogenic consequences from VOCs would be two to five orders of magnitude greater than consequences from heavy metals for the waste spill and earthquake scenarios (Accidents T1 and T3, respectively) (see Appendix G). Heavy metals would account for all carcinogenic consequences from the drum fire scenario (Accident Scenario T2) because VOCs would be consumed by the fire. No cancers were estimated to occur in the exposed population from the hazardous chemical releases of any accident. The maximum probability of developing cancer would be 2×10^{-9} to the MEI from any of the accidents. The Hanford and LANL MEI could develop irreversible or severe noncarcinogenic health effects from exposure to hazardous chemicals as a result of the events in the earthquake scenario (Accident Scenario T3).

CRITICALITY

Criticality is defined as a state in which a self-sustaining nuclear chain reaction is achieved. The fissile material in the TRU waste that would be disposed of at WIPP would have to achieve a critical mass (the smallest mass of fissionable material that will support a self-sustaining nuclear chain reaction) in order to drive such a reaction. The minimum critical mass of a fissile material is the amount that can be made critical in a spherical geometry with optimum conditions. These conditions are considered incredible in the WIPP repository environment. Although TRU waste does contain fissile and fissionable material such as Pu-239, Pu-241, U-233, and U-235, DOE safety analysis reports for packaging for the TRUPACT-II (Revisions 0 and 16) and the RH-72B found that a criticality event is not a credible scenario. Indeed, the planning-basis WAC has established nuclear criticality criteria for both CH-TRU and RH-TRU waste that define the maximum allowable quantity of fissile material. These limits are defined in terms of Pu-239 fissile-gram equivalents (FGE) and include a factor allowing for two times the measurement error when the waste packages are assayed. The planning-basis WAC allows up to 200 FGE for a 55-gallon drum and 325 Pu-239 FGE for the RH-72B cask, TRUPACT-II, ten drum overpack, and standard waste box. DOE intends to revise the planning-basis WAC to allow waste transport in pipe overpacks containing up to 2,800 FGEs per TRUPACT-II. NRC has approved use of these overpacks in the TRUPACT-II container. Assumptions regarding use of these overpacks in the SEIS-II transportation analysis are included in a text box in Section A.2.1.4.

The primary difference between CH-TRU waste and RH-TRU waste is the inclusion of other radionuclides, Cs-137 and its decay product Ba-137m, Am-241, Sr-90, and Co-60. These radionuclides, present in sufficient quantities, give a TRU waste container or cask a higher surface dose rate and, thus, the need to handle the waste container or cask remotely for worker protection. However, these radionuclides cannot support self-sustaining nuclear chain reaction and are not factors when determining the potential for criticality. In general, the radionuclides that affect criticality are present in higher concentrations in CH-TRU waste than in RH-TRU waste. Therefore, criticality concerns associated with CH-TRU waste would provide bounding conditions for RH-TRU waste. Therefore, a criticality event involving RH-TRU waste is also considered incredible, although this type of accident is being further investigated.

The portion of the TRU waste Total Inventory that has a noteworthy concentration of radionuclides of concern is the RFETS plutonium residue waste. On average, a drum of RFETS plutonium residue waste would contain 8.6 curies of Pu-239 and 50.5 curies of Pu-241 per drum which represents approximately 139 FGEs in a drum. These concentrations indicate that only two drums of RFETS plutonium residue waste could be shipped in a TRUPACT-II without exceeding the 325 FGE limit for a TRUPACT-II. Other drums could be transported as long as the FGEs remained within the limits of the WAC. Proposed treatment being considered in the ***Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site Environmental Impact Statement (Draft in Preparation)*** could also reduce the FGE concentrations in this waste. No other source of TRU waste contains higher concentrations of fissile or fissionable radionuclides. Assumptions regarding RFETS plutonium residue waste in the SEIS-II transportation analysis are included in a text box in Section A.2.1.4.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker was assumed to be at the location of greatest consequence outside of the waste treatment building. The consequences to the noninvolved worker were estimated to vary over one order of magnitude across the five sites. Radiological consequences to the maximally exposed noninvolved worker would result in a 4 x 10^{-7} probability of an LCF from the events of the waste spill scenario (Accident Scenario T1), a 4 x 10^{-7} probability of an LCF from the events of the drum fire scenario (Accident Scenario T2), and up to a 0.01 probability of an LCF (at INEEL) from the beyond-design-basis earthquake (Accident Scenario T3).

No cancer incidence would be expected from the release of hazardous chemicals or metals from any of the accidents; the greatest probability of cancer would be 7 x 10^{-9} (see Appendix G). If the events of the earthquake scenario should occur (Accident Scenario T3), noninvolved workers at all sites would have chances of developing noncarcinogenic irreversible or severe health effects, but none of them would be life threatening. These effects would be expected from exposure to heavy metals and VOCs.

Maximally Exposed Involved Worker

No consequences to the maximally exposed involved worker would be anticipated from the events in either the waste spill or drum fire scenarios (Accident Scenarios T1 and T2, respectively). These accidents are such that involved workers would be able to evacuate immediately or would not be affected by the events. Substantial consequences would be possible from the events of the earthquake scenario (Accident Scenario T3), ranging from workers killed by debris from collapsing treatment facilities to high external radiation doses from RH-TRU waste being treated. Intakes of radionuclides, VOCs, and heavy metals would also be likely.

5.1.10.2 Excess RH-TRU Waste Storage Accident

Under the Proposed Action, excess RH-TRU waste could potentially be stored at Hanford and ORNL, regardless of whether waste is consolidated. (New estimates indicate all post-1970, defense RH-TRU waste could be disposed of at WIPP; see Appendix J.)

Should excess RH-TRU waste need to be stored, lower transuranic radionuclide activity in RH-TRU waste (lower PE-Ci levels, see Table G-23 and Table G-24), lower RH-TRU waste volume, more robust waste containers for RH-TRU waste, and presumably more robust construction of RH-TRU waste storage facilities (thick concrete walls for external radiation shielding) would all combine to limit potential consequences from excess RH-TRU waste accidents.

Operational accidents involving storage of excess RH-TRU waste were estimated to have no or negligible consequences, so only the bounding case accident, a beyond-design-basis earthquake (with an assumed annual accident frequency of 1 x 10^{-5} or less), was examined. The beyond-design-basis earthquake was assumed to collapse the RH-TRU waste storage facility. Twenty-five percent of the RH-TRU waste canisters were assumed to be breached, and 5 percent of the contents in the drums inside were assumed to spill. The respirable airborne fraction of the spilled contents was assumed to be 5 x 10^{-6}, and 50 percent of this fraction was assumed to escape the debris of the storage structure. In subsequent facility accident sections for the other alternatives, this accident scenario is designated Accident Scenario S3.

Radiological consequences would be much greater than hazardous chemical consequences and are shown in Table 5-17. Consequences would be greater at Hanford than at ORNL in all cases. Exposed populations could experience 3 x 10^{-3} (at ORNL) to 0.9 (at Hanford) LCFs, the MEI could have up to a 5 x 10^{-4} probability of an LCF (at Hanford), and the maximally exposed noninvolved worker could have up to a 3 x 10^{-3} probability of an LCF (Hanford).

Table 5-17
Radiological Consequences of an Excess RH-TRU Waste Storage Accident for the Proposed Action

Accident Scenarios	Population (number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
Earthquake (Accident Scenario S3)	Hanford: 0.9 ORNL: 3E-3	Hanford: 5E-4 ORNL: 3E-6	Hanford: 3E-3 ORNL: 6E-6

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

No cancer would be expected to occur from hazardous chemical exposure. The highest estimate of cancer in the population would be 1 x 10^{-4} from VOCs and 4 x 10^{-7} from heavy metals near Hanford. The MEI near Hanford would have the highest probability of cancer occurring, 7 x 10^{-8} from exposure to VOCs and 2 x 10^{-10} from exposure to heavy metals. The maximally exposed noninvolved worker would be located at Hanford as well, with a 4 x 10^{-7} probability of cancer from exposure to VOCs and a 2 x 10^{-9} probability of cancer from exposure to heavy metals. No noncarcinogenic consequences would be expected.

Catastrophic destruction of the RH-TRU waste storage facility due to an earthquake could result in death or serious injury to the maximally exposed involved worker, principally from falling accident debris and radiation doses.

5.1.10.3 WIPP Disposal Accidents

Eight potential accidents at WIPP during disposal operations were evaluated; they are shown in Table 5-18. Six of the accidents involve only CH-TRU waste (Accident Scenarios W1 through W5 and W7), one involves only RH-TRU waste (Accident Scenario W8), and one was evaluated for consequences from both CH-TRU and RH-TRU waste (Accident Scenario W6).

Potential radiological consequences to the public and maximally exposed noninvolved worker are substantially higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-19.

Public

Population consequences from WIPP disposal accidents were estimated for the 22.5 degree sector west of the site, which includes the City of Carlsbad. The population in this sector is 25,629 and would be affected greater than any other section in the surrounding 80-kilometer (50-mile) region.

Table 5-18
WIPP Disposal Accident Scenarios for the Proposed Action

Accident Scenarios	Annual Occurrence Frequency	Description
Drums Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	0.01	A package of drums is dropped in the Waste Handling Building, a drum on top of the package falls and its lid seal fails.
Drum Drop, Puncture, Lid Failure in Waste Handling Building (Accident Scenario W2)	0.01	Forklift strikes and punctures drums on lower level of stack in the Waste Handling Building. A drum on the upper level falls and the lid seal fails.
Drums Drop, Lid Failure in Underground (Accident Scenario W3)	0.01	Same as accident W1, but it occurs in the underground.
Drum Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	0.01	Same as accident W2, but it occurs in the underground.
Container Fire (Accident Scenario W5)	1E-4 (<8 PE-Ci) <1E-6 (>8 PE-Ci)	Contents of a drum in an underground disposal room spontaneously combusts prior to panel closure.
Hoist Failure (Accident Scenario W6)	<1E-6	Waste hoist braking system fails and fully loaded hoist falls to the bottom of shaft. Both CH-TRU and RH-TRU waste loads were evaluated.
Roof Fall (Accident Scenario W7)	0.01, Panel 1 <1E-6, other panels	A portion of a disposal room roof falls prior to panel closure, crushing drums and causing container breaches.
RH-TRU Canister Breach (Accident Scenario W8)	1E-4 to 1E-6	RH-TRU waste canister is breached during Waste Handling Building operations.

Table 5-19
Radiological Consequences of WIPP Disposal Accident Scenarios for the Proposed Action

Accident Scenarios	Population (LCFs)	MEI (probability of LCF)	Maximally Exposed Noninvolved Worker (probability of LCF)	Maximally Exposed Involved Worker (probability of LCF)
Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	9E-3	1E-4	1E-4	0.03
Drop, Puncture Lid Failure in Waste Handling Building (Accident Scenario W2)	0.02	2E-4	2E-4	0.06
Drop, Lid Failure in Underground (Accident Scenario W3)	9E-3	1E-4	1E-4	0.03
Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	0.02	2E-4	2E-4	0.06
Container Fire (Accident Scenario W5)	0.3	4E-3	3E-3	N/A
Hoist Failure (CH-TRU, RH-TRU) (Accident Scenario W6)	CH-TRU: 5 RH-TRU: 2	CH-TRU: 0.08 RH-TRU: 0.03	CH-TRU: 0.06 RH-TRU: 0.02	See Footnote a
Roof Fall (Accident Scenario W7)	0.2	2E-3	2E-3	See Footnote a
RH-TRU Canister Breach (Accident Scenario W8)	5E-3	7E-5	5E-5	0

[a] These impacts could range from negligible (workers not present, or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris)

N/A = Not Applicable

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Consequences to the MEI were evaluated at the point of closest public access to the DOE Exclusive Use Area boundary and the least atmosphere dispersion of facility exhaust ventilation air, which would be the location of maximum consequence. This point was 300 meters (990 feet) south of the Exhaust Filter Building. No credit was taken for high-efficiency particulate air (HEPA) filtration of estimated accident releases from either the Exhaust Filter Building or the Waste Handling Building.

Radiological consequences from accidents would be higher than consequences from hazardous chemicals. The accident with the largest potential radiological consequence to the population and the MEI would be the failure of a fully loaded waste hoist (Accident Scenario W6), which has a 95th percentile probability of occurrence of 4.5 x 10^{-7} per year (Greenfield and Sargent 1995). Up to 5 LCFs could occur in the exposed population, and the MEI could experience a 0.08 probability of an LCF. The roof fall accident (Accident Scenario W7) would result in the highest potential carcinogenic hazardous chemical consequence, with an estimated 1 x 10^{-6} cancers occurring in the exposed population and an estimated 2 x 10^{-8} probability of cancer for the MEI. No fatalities due to toxicological effects would be expected, with the MEI estimated to inhale no more than of 2 x 10^{-3} percent of an IDLH-equivalent intake of any hazardous chemical under either the hoist failure or roof fall accidents. However, based on ERPG ratios, an extreme circumstance where the hoist fails while carrying a full load of drums, all with bounding methylene chloride concentrations and beryllium content, might result in serious health consequences. High concentrations of 1,1,2,2-tetrachloroethane and heavy metals could also produce serious, although not life-threatening, consequences from a hoist failure or roof fall accident.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker at WIPP was assumed to be located at the location of least atmospheric dispersion, 300 meters (990 feet) south of the Exhaust Filter Building, which is the same location as the MEI. The stack that exhausts the underground ventilation is elevated and, as a result, the location of least plume dispersion is some distance from the release point. Radiological consequences shown in Table 5-19 may be slightly lower than those for the MEI because of the small difference in the radiation dose-to-LCF conversion factors for workers and members of the public. The hazardous chemical consequences would be identical to those of the MEI.

Maximally Exposed Involved Worker

The potentially highest consequences to an involved worker would be underground, from failure of a fully loaded waste hoist (Accident Scenario W6) or roof fall (Accident Scenario W7). These consequences could range from negligible (workers not present or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris). Four workers would be expected to be routinely involved in underground operations and potentially at risk from these accidents.

Radiological consequences of accidents to the maximally exposed involved worker from noncatastrophic accidents are shown in Table 5-19. The consequences from the drop, puncture, and lid failure accidents (Accident Scenarios W2 and W4), would be a 0.06 probability of an LCF. The highest hazardous chemical carcinogenic consequences to an involved worker were estimated to be from the accidental breach of three drums, with a 3 x 10^{-7} probability of cancer due to inhalation of VOCs. No fatalities due to toxicological effects would be expected, with the highest ratio of the IDLH-equivalent intake being 5×10^{-4} for the breach of three drums (Accident Scenarios W2 and W4).

Based on ERPG analyses and conservative exposure assumptions, the involved worker might experience a life-threatening effect from exposures to high concentrations of methylene chloride from drum breaches (Accident Scenarios W1 through W4); irreversible, but not life-threatening consequences from high 1,1,2,2-tetrachloroethane and methylene chloride concentrations.

5.1.11 Industrial Safety

Under the Proposed Action, four fatalities would occur during the waste treatment period from industrial accidents at all treatment sites. This result was found by adjusting the physical-hazard fatality estimate of the WM PEIS.

At WIPP, the management and operating contractor has been awarded the star status in the DOE Voluntary Protection Program. This star status recognizes as “exemplary” the safety culture at the WIPP site. It is reciprocal with OSHA’s Voluntary Protection Program star recognition. This star status indicates that the WIPP work force tends to have far fewer accidents and injuries than those at other DOE facilities. Regardless, estimates of potential industrial safety impacts to workers for proposed operations at WIPP were made using the average DOE occupational injury/illness and fatality rates shown in Table 5-20. DOE as a whole is well below the national average with respect to accident rates. DOE's average total recordable case (TRC) rate for 1988 to 1992 was 0.032 accidents per worker-year. The average TRC rate for private industry from 1983 to 1992 was 0.084 accidents per worker-year.

Table 5-20
Average Occupational Injury/Illness and Fatality Rates (per worker-year) [a]

	All Labor Categories (Operations)		Construction Worker (Excavation and Decommissioning)	
Category	**Total Injury/Illness**	**Fatalities**	**Total Injury/Illness**	**Fatalities**
DOE and Contractors [b]	0.032	3.2E-5	0.062	1.1E-4
Private Industry [c]	0.084	9.7E-5	0.13	3.4E-4

[a] Taken from DOE 1995b, Vol 2, Table F-4-7

[b] 1988-1992 averages from DOE (U.S. Department of Energy), 1993, “Occupational Injury and Property Damage Summary, January-March 1993,” DOE/EH/015370-H2, March, Washington, D.C.

[c] 1983-1992 averages from NSC (National Safety Council), 1993, “Accident Facts,” Itasca, New York.

For the purpose of estimating impacts, salt excavation activities were considered to be equivalent to construction activities, which have a higher rate of injury and illness than all other labor categories combined, and all other WIPP operations activities were considered jointly under all labor categories.

During the 35-year WIPP disposal operations period under the Proposed Action, the work force was assumed to remain constant at 1,095. Salt excavation would be undertaken by a crew of 10, with the remaining 1,085 workers employed in other operational activities. At the conclusion of operations, there would be a 10-year decommissioning period. For the purpose of estimating industrial safety impacts during this 10-year period, it was assumed that the work force would decrease by 10 percent each year and that half of the work force would be involved in decommissioning activities equivalent to construction activities.

The estimated number of injuries/illnesses and fatalities among workers from operations, excavation, and decommissioning are shown in Table 5-21. Fewer than two worker fatalities would be expected from industrial-related occurrences during the 45 years of operations and decommissioning. Oversight and inspections by the Mining Safety and Health Administration (MSHA) and adherence to OSHA regulations would likely reduce actual occurrences below these estimated values.

Table 5-21
Industrial Safety Impacts from Operations
and Decommissioning of WIPP for the Proposed Action

	Injury/Illness			Fatalities		
Years	**Construction**	**Operations**	**Total**	**Construction**	**Operations**	**Total**
Operations 1998-2033	22	1,225	1,247	0.035	1.2	1.3
Decommissioning 2033-2043	187	96	283	0.3	0.1	0.4
Operations & Decommissioning Total	209	1,321	1,530	0.4	1.3	1.7

5.1.12 Long-Term Performance

This section presents the potential impacts associated with the long-term performance of the WIPP repository for the Proposed Action evaluated for the 10,000-year period after the site is closed. These impacts were estimated based on computer simulations that predicted radionuclide and heavy metal releases from TRU waste in the repository under undisturbed and disturbed conditions.

The conceptual and computational models used in the analyses were based on models and tools used by the Department in current regulatory compliance analyses. The WIPP Program has been conducting analyses of long-term performance as a part of regulatory compliance with RCRA regulations and certification under 40 CFR Part 191 and 40 CFR Part 194. Although SEIS-II does not directly address these regulatory requirements, the scenarios analyzed in SEIS-II were chosen to represent the types of analyses that are being conducted for regulatory compliance applications.

The results presented here are consistent with those in the *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (DOE 1996g). SEIS-II results were determined using the same computer codes employed for the regulatory compliance documents.

Analysis of the long-term impacts of WIPP was previously performed in SEIS-I. New analyses were deemed necessary in SEIS-II for the following reasons: (1) the current alternatives are different from those analyzed for SEIS-I in 1990, (2) the waste volumes and inventories for the Proposed Action and action alternatives are different from those used for SEIS-I in 1990, (3) new data have been collected for use in performance assessment models since 1990, and (4) substantial improvements have been made in the WIPP performance assessment approaches and computational tools (DOE 1996g). A discussion of developments since SEIS-I is provided in Appendix H.

For the purposes of analyses, the CH-TRU waste volumes were assumed to be 168,500 cubic meters (5.95 million cubic feet). Because of limits on the amount of RH-TRU waste currently permitted at WIPP, only 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste were assumed to be emplaced with the Proposed Action. The radionuclide inventory was adjusted, using the ratio derived from these volume changes, to 5.8×10^6 Ci in CH-TRU waste and 4.3×10^5 Ci in RH-TRU waste. Additional information on waste volumes and inventories is presented in Chapter 3 and in Appendix A.

The approach for SEIS-II had five major elements:

- The computational approach used a selected set of computer simulations rather than a full probabilistic analysis to represent the broad range of impacts that could be expected from long-term undisturbed and disturbed performance.
- Performance analyses were conducted using both median and 75th percentile values for model parameters.
- Both undisturbed and disturbed (i.e., human intrusion) conditions were analyzed.
- Numerical evaluation of performance was done using codes developed for WIPP.
- Results for long-term performance assessment were provided for the first 10,000 years after repository closure.

Though many parameters are employed for long-term performance assessment, only a small number have a potential impact on the estimate of contaminants released. Some of the important parameters include the solubility of contaminants in the waste form, sorption of contaminants on salt, hydraulic conductivity of the salt beds near the repository, volume and pressure of the hypothetical brine reservoir in the event of an intrusion, and underground water travel times.

Estimates were made for expected performance conditions and for degraded performance. Expected performance was analyzed using median values of the statistical distributions that describe the input parameters for the full probabilistic analysis required by 40 CFR Part 194. Degraded performance was analyzed using the 75th percentile parameter values from the statistical distributions of the input parameters.

The use of median parameter values means that the results would be expected to fall in the middle of the results produced from a full probabilistic analysis. A model run using all median parameters would not yield the same result as the median output. Use of the 75th percentile parameter values would produce a conservative result, yielding model results that should fall in the upper tail of a full probabilistic analysis. They are not expected to yield higher impacts than the highest impact calculated from a full probabilistic analysis.

Both undisturbed and disturbed repository conditions were considered. Undisturbed conditions examined repository performance for 10,000 years post-closure with no human intrusion. Two release and exposure scenarios for disturbed conditions were considered:

- Surface release caused by drilling into the repository. Drilling into the repository may cause a direct release of drill cuttings containing waste material to the land surface, exposing individuals involved in the drilling processes to radioactive material and heavy metals.

- Drilling through the repository and into a pressurized brine reservoir in the Castile Formation below the repository. This condition may allow brine in the pressurized reservoir to come into contact with waste in the repository. The brine could then move further up the borehole to the more permeable units lying above the repository horizon, like the Culebra Dolomite in the Rustler Formation, allowing migration of radionuclides and heavy metals into the accessible environment. Impacts of two different mining conditions were considered: partial mining that would remove all potash reserves outside the Land Withdrawal Area and full mining that would remove all potash reserves both outside and inside the Land Withdrawal Area.

Drilling intrusions analyzed in SEIS-I considered a family farm scenario that was assumed to be located 500 meters (1,640 feet) from the discarded drill cuttings. Currently, no farms exist near the WIPP site. Agricultural use of land in the region is limited mainly to cattle grazing due to poor soil conditions, a limited supply of stock-potable water, and no source of water for farming. Even if water were available, saline soil conditions make farming unlikely. For these reasons, the family farm scenario was not considered in SEIS-II analyses of drilling intrusion impacts.

The four cases below were analyzed for the Proposed Action:

- Case 1 considered undisturbed repository conditions. Median parameter values were used for input variables where probability distributions have been defined.

- Case 2 considered disturbed conditions resulting from a borehole assumed to pass through the repository and intercept a pressurized brine reservoir in the Castile Formation. Median parameters values were used for input variables where probability distributions have been defined.

- Case 3 was the same as Case 1 but used 75th percentile parameter values for input variables where probability distributions have been defined.

- Case 4 was the same as Case 2 but used 75th percentile parameter values for input variables where probability distributions have been defined.

5.1.12.1 Impacts of Undisturbed Conditions

The NUclide Transport System (NUTS) code was used to simulate radionuclide and heavy metal transport using the time-varying brine and gas flow fields computed by BRAGFLO. The two-dimensional modeling domain extended 23.3 kilometers (14.5 miles) laterally in each direction from the edge of the repository and vertically from the Castile Formation below the repository to the ground surface.

The extent of radionuclide and heavy metal (lead, mercury, beryllium, and cadmium) migration for undisturbed conditions at 10,000 years after closure for Case 3 (using 75th percentile parameter values) over the model domain is presented in Figure 5-1. Case 3 resulted in slightly more extensive migration than Case 1. Figure 5-1 shows the locations in the modeled region where the

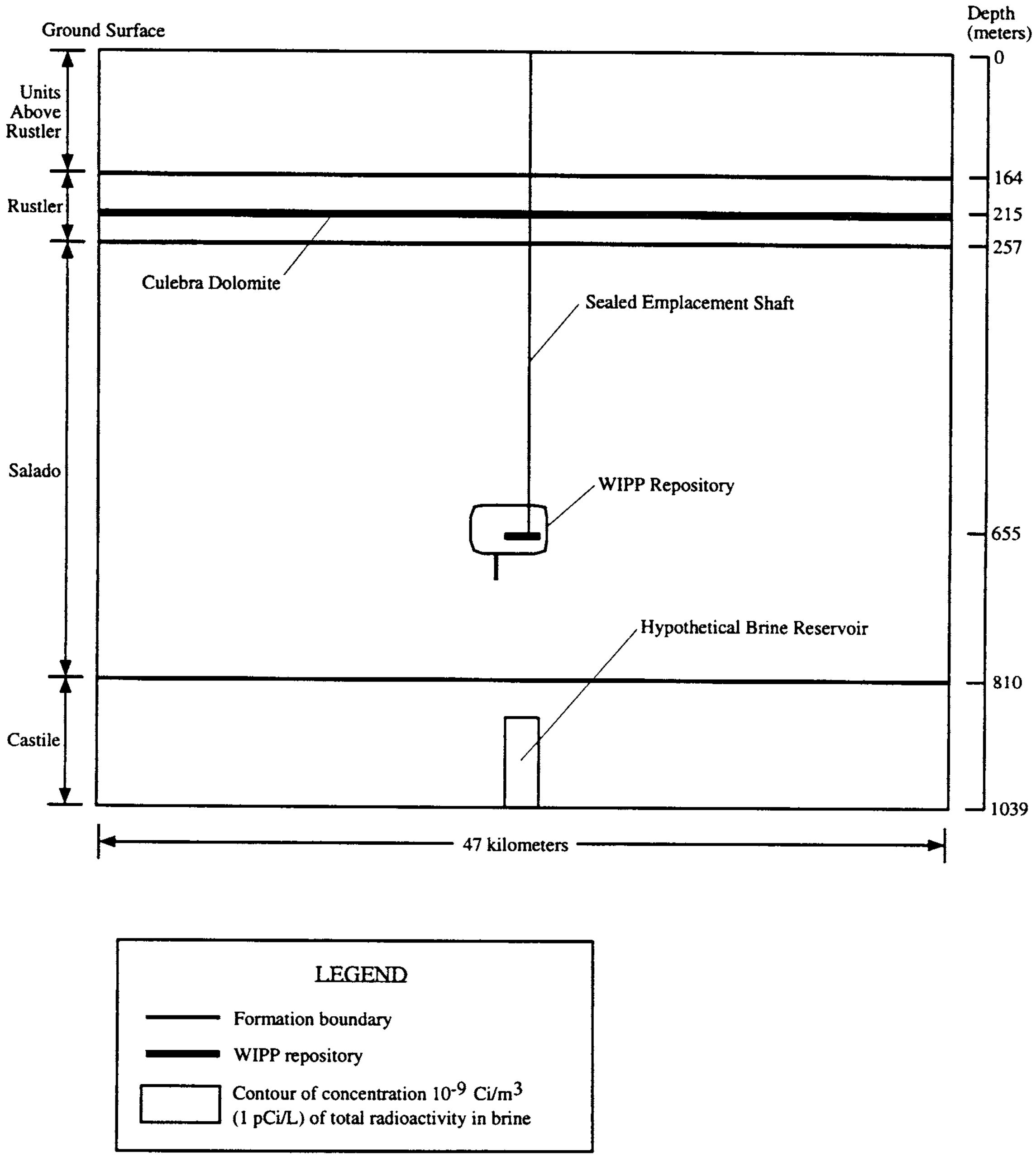

Figure 5-1
Extent of Radionuclide Migration at 10,000 Years with Undisturbed Conditions Using 75th Percentile Parameter Values (Case 3) for the Proposed Action

concentration of total radionuclide activity in the brine, summed over 30 radionuclides, is equal to 1 picocurie (pCi) per liter (1×10^{-9} Ci per cubic meter). Total heavy metal concentration of one part per billion (1×10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration.

The total vertical scale of the modeled region is 1,039 meters (3,409 feet). The horizontal extent of the modeled region represented in Figure 5-1 is approximately 47 kilometers (29 miles). The vertical scale is greatly exaggerated so the extent of vertical migration can be seen in the figure. For the Proposed Action, total radionuclide activity concentrations of one pCi per liter would extend about 60 meters (200 feet) below the repository, 40 meters (130 feet) above the repository, and about 1,900 meters (6,200 feet) laterally from the south edge of the repository.

Analysis of undisturbed repository conditions (Cases 1 and 3) during the first 10,000 years showed that no radionuclides or heavy metals would be released to the Culebra Dolomite. No total radionuclide activity concentrations greater than 1 pCi per liter or heavy metal concentrations greater than 1 part per billion would be found beyond the 5-kilometer (3-mile) subsurface lateral boundary. There would be no release to the accessible environment and therefore no human health impact. Additional information is provided in Appendix H.

5.1.12.2 Impacts of Disturbed Conditions

This section presents the impacts of two exposure scenarios evaluated for the disturbed conditions of the Proposed Action.

Surface Release Caused by Drilling into the Repository

In this scenario, a drilling operation penetrates a waste panel in the repository. The analysis here is for only one event, although DOE recognizes that during a 10,000-year period more than one borehole could penetrate the repository. The drilling operation was assumed to bring waste originating in the repository to the land surface through a number of physical processes. These processes create cuttings (created by the cutting action of the drill bit), cavings (waste introduced into the borehole is eroded as drilling fluids move up or down the borehole), and spallings (waste and brine caused by the movement of repository gas to the low pressure conditions existing in the borehole). The generation of spallings in a borehole could be affected by very high-pressure repository conditions, causing waste to move into the borehole under blowout or direct gas erosion conditions.

The quantity of waste released would be dependent on repository gas- and brine-pressure conditions and the overall waste characteristics (primarily porosity and permeability) at the time the repository is breached by the borehole.[1] The relationship of repository pressure and these release processes has been quantified and provides the basis for calculations of direct waste releases for the CUTTINGS_S computer code. The values of brine and gas pressure in the repository and the permeability of the waste used to determine the release process under this model were obtained from the fluid flow simulations performed with the BRAGFLO computer code. Simulated brine and gas pressures were derived for undisturbed conditions calculated for Cases 1 and 3 (the

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[1] For a multiple-intrusion scenario, the maximum impact would be seen in the first intrusion; less material would be released at any one borehole following the first intrusion because gas pressure would likely dissipate after the first intrusion.

pressure history in the repository is the same until the time of intrusion, so the pressure encountered for any given intrusion time is represented by the analagous undisturbed case). The calculations of direct waste releases for the simulated BRAGFLO conditions were carried out using the CUTTINGS_S code.

Human health impacts would be limited to individuals involved in the drilling operation. No population impacts were calculated because only small amounts of radioactive material would be brought to the surface, remain in a wet, relatively nondispersable form, and would remain localized. Impacts were estimated for two types of exposed individuals:

- A member of a drilling crew directly involved in the borehole drilling. This individual was assumed to be exposed to external radiation from materials at the drill head and in the drill cutting pond and to inadvertently ingest 100 milligrams per day of borehole material. This individual was assumed to be exposed for 168 hours (8 hours per day for a 21-day working period).

- A well-site geologist involved in the periodic examination of cuttings generated by the drilling process. This individual would be exposed to external radiation through the direct handling of an exhumed fragment of waste. The concentration of radionuclides in the exhumed waste fragment was assumed to be the emplacement concentration decayed to the time of intrusion. The geologist was assumed to pick up a cylindrical waste fragment 5 centimeters (2 inches) in radius with a volume of 524 cubic centimeters (32 cubic inches). An exposure time of one hour was assumed.

The drilling intrusions were timed to maximize the estimated health impacts to exposed individuals. The earliest time that intrusion could occur was assumed to be 100 years after repository closure, the end of the active institutional control period. Because results of BRAGFLO calculations showed a steady increase in brine pressures in the repository (approximately 5 to 14 MPa) over the initial 2,000 years following repository closure, the potential impact of repository pressure conditions on the release of materials up the borehole was examined. Radiation dose calculations were performed for intrusions 100, 200, 300, 400, 500, 800, 1,200, and 2,000 years after closure. These calculations showed that an intrusion event at 400 years after closure for Case 2 (median parameter values) and an intrusion event at 300 years after closure for Case 4 (75th percentile parameter values) would lead to the greatest potential health impacts. As a result, impact analysis of the drilling intrusion under the Proposed Action (and all other action alternatives) assumed the intrusion occurred at these respective times. Additional information on this analysis is presented in Appendix H.

The estimated activity of radionuclides released to the ground surface during the drilling event for Case 2 (median parameter values) was 3.1 Ci, consisting mainly of Am-241, Pu-239, and Pu-238. For Case 4 (75th percentile parameter values), the release was 4.5 Ci, again consisting mainly of Am-241, Pu-239, and Pu-238. Heavy metal releases were 24 kilograms (53 pounds) of lead and 2 kilograms (4 pounds) of mercury for Case 2 and 31 kilograms (68 pounds) of lead and 3 kilograms (7 pounds) of mercury for Case 4.

Radiological impacts to a member of the drilling crew for Case 2 (median parameter values) would be a 2×10^{-4} probability of an LCF. For Case 4 (75th percentile parameter values), the impacts would be slightly higher with a 4 x 10^{-4} probability of an LCF. The impact in these cases would be primarily due to the inadvertent ingestion of drill cuttings. The radionuclide with the greatest impact contribution (approximately 97 percent) was Am-241.

The drilling crew member may also ingest heavy metals (lead, beryllium, cadmium, and mercury) in the drill cuttings. There would be a 2.2 x 10^{-8} probability of a cancer incidence to the drill crew member from heavy metal ingestion. There would be no noncarcinogenic impacts expected from the ingestion of the metals because all hazard indices would be much less than one. Impacts of exposure to VOCs were not analyzed (see Appendix H) but were expected to be bounded by impacts of VOC exposure for WIPP disposal accidents (see Appendix G). There would be a 3 x 10^{-7} probability of a cancer incidence. Some short-term toxicological effects from inhalation of VOCs could occur (see Appendix G) under these assumptions.

Radiological impacts to a well-site geologist from external radiation exposure for Case 2 (median parameter values) would be a 3 x 10^{-9} probability of an LCF from CH-TRU waste and a 9 x 10^{-10} probability of an LCF from RH-TRU waste. For Case 4 (75th percentile parameter values), the radiological impacts would be a 3 x 10^{-9} probability of an LCF from CH-TRU waste and a 3 x 10^{-9} probability of an LCF from RH-TRU waste. The major dose contributors from CH-TRU waste were Am-241 and U-234, while Sr-90 and Cs-137 were major dose contributors from RH-TRU waste.

Drilling Through the Repository into a Pressurized Brine Reservoir

In this scenario, a borehole would be drilled through the repository into a pressurized brine reservoir, introducing a high permeability (relative to the permeability of the intact salt) groundwater pathway from the repository to the Culebra Dolomite. Contaminants could migrate up the borehole and move laterally through the Culebra Dolomite.

Because current drilling practices are to plug all deep boreholes in the Delaware Basin (Thompson et al. 1996), it was assumed for SEIS-II analyses that all deep intrusion boreholes would be plugged. Boreholes were assumed to have two low permeability concrete plugs that would degrade after 200 years. Additional information on the hydrologic properties of the plugged borehole are given in Appendix H.

The extent of radionuclide migration at 10,000 years after closure for Case 4 (75th percentile parameter values) is presented schematically in Figure 5-2. Total radionuclide activity concentrations of one pCi per liter are shown. Simulations showed radionuclides migrated upward and downward into the borehole and penetrated into rocks directly in contact with the borehole for a limited distance. For Case 4 at 10,000 years, migration extends upward into the Culebra Dolomite. Migration also extends downward in the borehole (for both Cases 2 and 4) to the Castile Formation and into the brine reservoir. This would occur after the initial pressure in the pressurized brine pocket dissipates and equilibrates with pressures in the repository and overlying units penetrated by the borehole. A total heavy metal concentration of one part per billion (1 x 10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration. Predicted brine pressures and additional modeling information is provided in Appendix H.

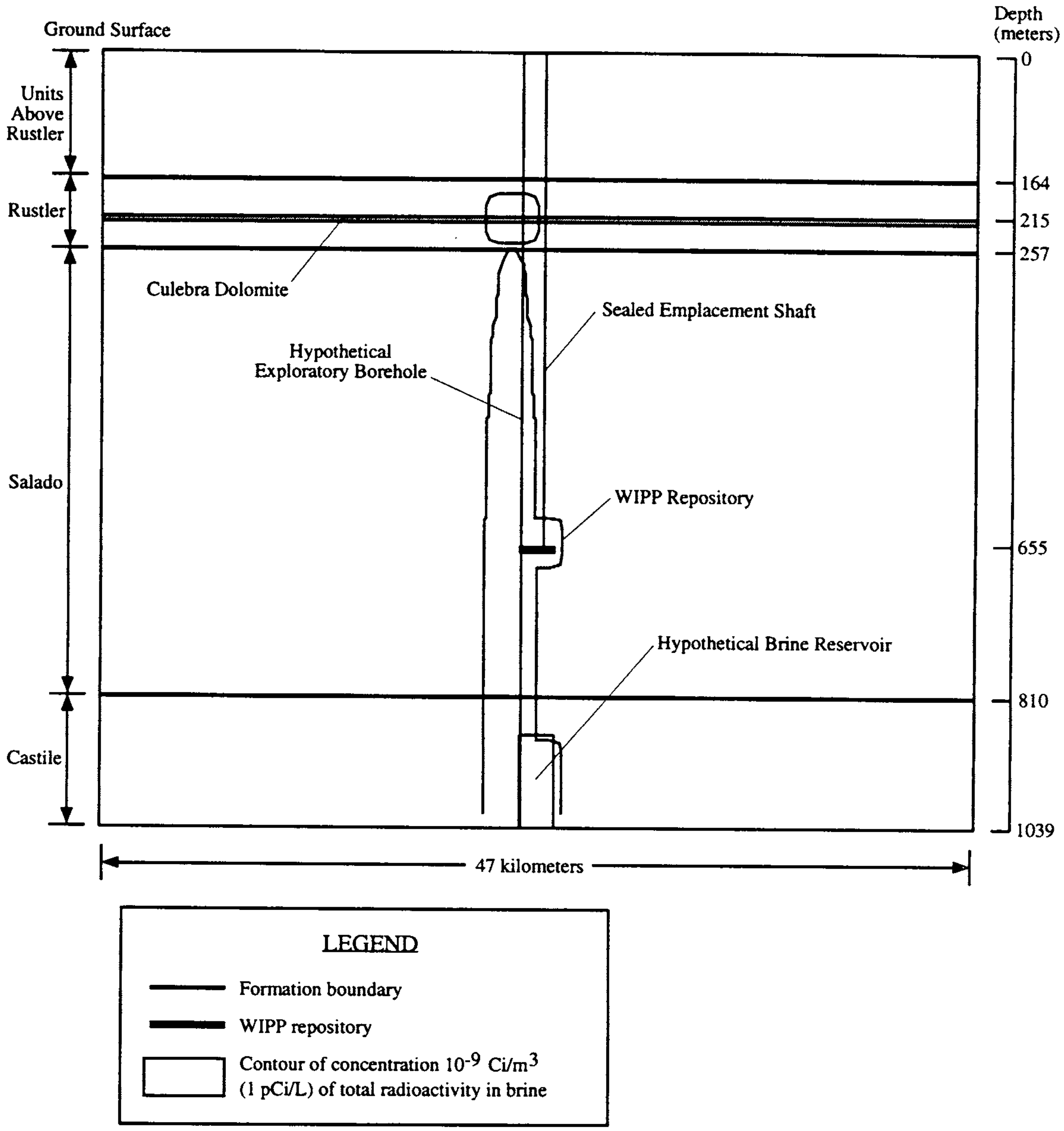

Figure 5-2
Extent of Radionuclide Migration at 10,000 Years with Disturbed Conditions Using 75th Percentile Parameter Values (Case 4) for the Proposed Action

THE PROPOSED ACTION AND THE ADDITIONAL INVENTORY

During the public comment period that followed publication of the Draft SEIS-II, several stakeholders requested that the Additional Inventory be included in the Proposed Action. The Additional Inventory, as defined in Chapter 2, is largely TRU waste disposed of prior to 1970 by near surface burial at sites throughout the DOE Complex. The Department currently has no plans to excavate all of this waste and would do so only following Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or RCRA investigations and possibly following additional NEPA review. The Additional Inventory, therefore, is still not a part of the Proposed Action. This text box, though, is provided to assist those wishing a general understanding of the impacts of this waste under four scenarios. The scenarios and their impacts follow:

All Additional Inventory would be left as currently stored or buried: The impacts for this scenario would be similar to the Additional Inventory impacts of No Action Alternative 2. Because no treatment or transportation of this waste would occur, no treatment or transportation impacts would occur. Most of the waste would remain buried, so no biological, cultural, infrastructure, water, land use, or socioeconomic impacts would occur due to the Additional Inventory. Approximately 13 LCFs are estimated at the sites where the waste is currently stored should it be left in place for 10,000 years and no intrusion occur. The principal sites where these impacts are estimated are INEEL (at 7.6 LCFs) and LANL (at 5.6). For additional results, see the Additional Waste columns on each table of Section 5.6, later in this chapter.

All Additional Inventory would be excavated, treated to WAC, and stored where currently located for approximately 70 years: During the 70 years, the Department, would look for a disposal solution. The impacts for this scenario would be very similar to the Additional Inventory storage impacts presented for treatment and storage under Action Alternative 1. No transportation would occur, so no transportation impacts are expected. No impacts to the public or noninvolved workers from treatment and storage of this waste are expected. Involved worker impacts would include up to 2 LCFs for treatment and 3 LCFs for storage. For additional results, see the Additional Waste columns of Section 5.2, immediately following this section.

All Additional Inventory would be excavated, shipped to six thermal treatment facilities, treated, and then stored for approximately 70 years: During the 70 years, the Department, would look for a disposal solution. The impacts for this scenario would be very similar to the Additional Inventory impacts for treatment and storage under Action Alternative 2A and No Action Alternative 1A. As noted in No Action Alternative 1A, transportation only to treatment facilities would result in no estimated accidents, injuries, or fatalities. No impacts to the public or noninvolved workers due to storage would be expected; about 1 LCF would be expected to involved workers. For treatment, 1 LCF is estimated for the involved workers. For additional results, see the Additional Waste columns concerning Action Alternative 2A and No Action Alternative 1A on each table of Sections 5.3 and 5.5.

All Additional Inventory would be excavated, shipped to four thermal treatment facilities, treated, and then stored for 70 years: During the 70 years, the Department, Congress, and the nation would look for a disposal solution. The impacts for this scenario would be very similar to the Additional Inventory impacts presented for treatment and storage under Action Alternative 2B and No Action Alternative 1B. As noted in No Action Alternative 1B, transportation for treatment would result in two transportation accidents resulting in two injuries. An estimated 1 LCF each would be expected to the population and involved workers due to treatment. No impacts due to storage would be expected to the population or noninvolved workers; about 1 LCF would be expected to the involved workers. For additional results, see the Additional Waste columns concerning Action Alternative 2B and No Action Alternative 1B on each table of Sections 5.3 and 5.5.

THE WM PEIS PREFERRED ALTERNATIVE

For the purposes of analysis in the Draft SEIS-II Proposed Action, the Department assumed that TRU waste treatment would be partially consolidated in accordance with the Decentralized Alternative of the WM PEIS. Since publication of the Draft SEIS-II, the Final WM PEIS identified a preferred alternative which was a combination of the WM PEIS Alternatives. If TRU waste were treated at the locations identified in the WM PEIS preferred alternative, there would be a slight impact on the analysis set forth in SEIS-II, although there would be no changes in health and other impacts. The modifications to impacts, should the Department select the WM PEIS preferred alternative, are shown below.

RH-TRU waste from SRS would be consolidated at ORNL before disposal at WIPP.

For purposes of analysis of this potential consolidation, the waste volumes used for the WM PEIS have been used. The inventory used for other SEIS-II analyses shows no RH-TRU waste at SRS. The WM PEIS inventory includes up to 21 cubic meters [700 cubic feet] of RH-TRU waste, nearly all of it to be generated during the next 20 years. The number of shipments of RH-TRU waste involved would be approximately 23. The additional miles would also be small because SRS is east of ORNL (the waste would travel west, then south to WIPP). The overall additional impacts (when added to the impacts of the 7,957 shipments in the Basic Inventory) would be small (0.03 additional accidents, 0.03 additional injuries, and 0.004 additional fatalities). Radiological impacts to the occupational population would be 1 x 10^{-4} LCFs and for nonoccupational populations would be 3 x 10^{-3} LCFs. (If this waste went directly to WIPP, the impacts would be the same as those presented for the Proposed Action.)

The CH-TRU waste at ORNL would be consolidated at SRS before disposal at WIPP.

A total of 1,700 cubic meters (60,000 cubic feet) or 251 shipments of waste would be transported. The additional transportation would result in 0.1 additional accidents, 0.1 additional injuries, and no additional fatalities. Additional radiological impacts to the occupational population would be 4 x 10^{-4} LCFs. The radiological impacts to the public would decrease slightly (by 5 x 10^{-5} LCFs) because of a difference in accident rates along the roadways. The number of shipments would be spread over 35 years, averaging less than 10 shipments per year. Because CH-TRU waste at SRS would be transported to WIPP during the same 35-year period, only small additional impacts to the cost and risk from storage would occur.

Some RFETS CH-TRU waste would be shipped to INEEL for treatment before shipment to WIPP.

Recent estimates are that about 1,000 cubic meters (35,000 cubic feet) of RH-TRU waste would be shipped to INEEL for treatment before shipment to WIPP. For purposes of analysis, the number of shipments was conservatively estimated at 250, though would probably be lower. Additional impacts from this transportation would be 0.25 additional accidents, 0.06 additional injuries, and 0.1 additional fatalities.

Waste from small generator sites (with the exception of Sandia) would be shipped directly to WIPP instead of being consolidated before shipment to WIPP. Waste from Sandia would be consolidated at LANL.

Approximately 25 shipments of CH-TRU waste at the small generator sites would be directly shipped to WIPP under either the WM PEIS preferred alternative (or scenarios where there is no consolidation), and the number of shipments from the potential consolidation sites would probably be reduced. Although routes from the small generator sites have not been proposed, impacts from the additional miles, if any, to be traveled by so few shipments (when compared to the 29,766 shipments for the total campaign) would be so small that the results from the total shipping campaign would not change. For RH-TRU waste, 958 shipments (931 of them from Battelle Columbus Laboratory) would transport waste directly to WIPP, and there would be a one for one reduction in the number of RH-TRU waste shipments from the consolidation sites (because RH-TRU waste would not be repackaged at the potential consolidation sites). The mileage when shipping directly to WIPP would be nearly the same as when first consolidating that waste. Therefore, it is unlikely that there would be additional impacts during the shipping campaign.. Therefore, it is unlikely that there would be additional impacts during the shipping campaign.

Impacts of radionuclide and heavy metals migration were evaluated for Case 4 (75th percentile parameter values) since a release of contaminants into the Culebra Dolomite was indicated for this case only. The potential human health impacts were evaluated at a stock well assumed to be located 3 kilometers (2 miles) downgradient from the borehole (point of intrusion). It was assumed that this well would provide contaminated water to stock ponds used by cattle. Direct uses by humans were not considered because of the high salinity of groundwater in the area. Beef cattle were assumed to drink 50 liters (13.2 gallons) of water per day from the well. Beef from cattle using this water was assumed to be consumed by an individual such as a cattle rancher at a rate of 42 kilograms (93 pounds) annually (about 4 ounces per day) over a 70-year lifetime.

Both partial potash mining (mining only outside the Land Withdrawal Area boundary) and full potash mining (mining inside and outside the Land Withdrawal Area boundary only) conditions were evaluated. Partial mining would result in a 7×10^{-28} probability of an LCF to an individual ingesting beef from cattle using the water from this well over the individual's lifetime. Full mining would result in a 4×10^{-41} probability of an LCF to this individual. The probability of a cancer incidence from ingesting heavy metals would not exceed 3×10^{-27} and 3×10^{-37} for partial and full mining, respectively. No noncarcinogenic impacts would be expected because the estimated hazard index would not exceed 1×10^{-20}. Additional information is presented in Appendix H.

5.1.12.3 Long-Term Storage of Excess RH-TRU Waste

DOE may continue to store excess defense RH-TRU waste beyond the WIPP authorized disposal capacity at Hanford and ORNL under the Proposed Action. (The most recent estimates indicate all post-1970, defense RH-TRU waste can be disposed of at WIPP; see Appendix J.)

Continued storage of excess waste, should it be necessary, would result in less than two worker deaths for each 100 years of storage. If institutional control were lost and the waste were released, it would be expected to cause about 0.02 aggregate deaths over a 10,000-year period, assuming current population distributions.

5.2 IMPACTS OF ACTION ALTERNATIVE 1

This section describes the environmental impacts associated with implementation of Action Alternative 1. This alternative proposes treating waste to WAC[1], consolidating the waste at the same sites discussed under the Proposed Action, and disposing of the waste at WIPP. In addition to the Basic Inventory, WIPP would accept nearly all other DOE-controlled waste (i.e., the Additional Inventory without the polychlorinated biphenyl (PCB) commingled waste). The treatment time frame would remain 35 years. Though additional waste would be treated under this alternative, the treatment time period would be three and a half times that assessed in the WM PEIS. The total consolidated volume of waste to be treated under this alternative is 312,000 cubic meters (11 million cubic feet) (see Tables 3-2 and 3-3), less than three times the 110,000 cubic meters (3.9 million cubic feet) assessed in the WM PEIS. The WIPP operational time frame would extend to the year 2158 (160 years) so that the additional waste could be emplaced. (See Section 5.2.13 for discussion of how the impacts change should the operational time frame be reduced to 60 years.)

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[1] For purposes of analysis, the current planning-basis WAC was used.

FACTORS TO CONSIDER IN COMBINING ALTERNATIVES

When considering whether to implement a combination of alternatives, it is important to identify factors that lead to differences in impacts. How impacts change in relation to several factors is examined here.

WASTE VOLUME: In general, impacts (particularly treatment and transportation impacts) vary directly according to waste volume. The greater the waste volume, the greater the impacts. Preliminary figures from recent data indicate that projected waste volumes through 2033 could be lower than BIR-3 projections through 2022 by about 30,000 cubic meters for CH-TRU waste (which translates to a decrease of about 34,000 cubic meters from SEIS-II 2033 CH-TRU waste projections) and about 20,000 cubic meters for RH-TRU waste (which translates to a decrease of about 25,000 cubic meters from the SEIS-II 2033 RH-TRU waste projections). The accuracy of these projections depends, in part, on remediation decisions that would be made in the future and the effect these decisions could have on the timing of TRU waste generation. Much of this potential decrease could result if DOE were to decide to leave some of the instrumentation and machinery related to facilities with high radiation levels (such as instrument trees, and mixer pumps in the Hanford high-level waste tanks, which are projected to be RH-TRU waste when removed from the tanks) in place at those facilities until the facilities themselves are remediated, thus resulting in reduced TRU waste generation through 2033. This decrease would not affect waste volumes proposed to be disposed of under the Proposed Action and would not affect the analysis of the impacts of that action, except that impacts from storage of excess RH-TRU waste would decrease. The waste volumes for alternatives that involve disposing of all of the waste have changed (see Appendix J). Impacts directly related to waste volume may be reduced for the action alternatives that consider disposing of all DOE TRU waste, including impacts from transportation and routine waste treatment operations. The need to dispose of a lower volume of TRU waste could reduce operational time periods for the alternatives by about 50 (Alternative 2) to about 75 years (Alternative 3) and would also reduce the land area above the repository that would be impacted by closure activities. The annual probability of an accident occurring would be the same, but the number of years during which an accident could occur would be reduced. The lower waste volumes would not affect the ability of WIPP to isolate the waste once it is disposed of.

WASTE TREATMENT: Health impacts related to treatment for both workers and the public in the short-term increase as the complexity of waste treatment increases. Treatment to planning-basis WAC has the least impact, followed by shred and grout treatment, with thermal treatment having the highest treatment related impacts of the three treatment alternatives examined.

WASTE MANAGMENT: The long-term impacts of disposal at WIPP are lower than the long-term impacts of the waste storage. This is particularly true when loss of institutional control of the waste is assumed. Also, industrial accidents could lead to substantial impacts if waste were stored for long time periods.

WASTE TYPE (CH-TRU or RH-TRU): Transportation of RH-TRU waste would have relatively greater transportation impacts than CH-TRU waste primarily because of the smaller volume of RH-TRU waste per shipment which increases the number of shipments required to move the RH-TRU waste. Otherwise, on a per unit volume basis, the impacts from treatment and storage of RH-TRU waste are less than those for CH-TRU waste.

TRANSPORTATION MODE: Overall, regular rail transportation would have the least impacts, truck transportation impacts would have about 2 to 3 times that of regular rail service, and dedicated rail service would be about 23 times those of regular rail transportation.

DURATION OF ALTERNATIVE: Longer durations would spread the impacts out over more generations, exposing more people to potential impacts; the risk to each population therefore, would be less. Shorter durations would expose fewer people to potential impacts, the risk to each population would be slightly higher.

As appropriate, analyses include assessment of the impacts of storage of treated TRU waste before disposal. For the purposes of this document, this storage is called lag storage. Analyses in Action Alternative 1 also include a qualitative assessment of the impacts of rail transportation. A detailed description of Action Alternative 1 is given in Section 3.2.2.

5.2.1 Land Use and Management

At the treatment sites, land use impacts under Action Alternative 1 would be the same as those under the Proposed Action. The type, size, and number of treatment and consolidation facilities needed under this alternative would be comparable to those for the Proposed Action. The Department would be able to minimize impacts to on-site land use and avoid conflicts with off-site land use plans. It also would be able to avoid sensitive or inappropriate areas, including cultural resource areas, the habitats of threatened or endangered species, wetlands, and flood plains. Before treatment facilities would be constructed, further NEPA reviews would be undertaken at a site-wide or project-specific level.

At WIPP, land use impacts on the surface during disposal operations under Action Alternative 1 would be similar to those under the Proposed Action discussed in Section 5.1.1. These impacts would be similar because the surface facilities would be the same as those for the Proposed Action. One difference from the Proposed Action would occur during the decommissioning and closure process; approximately 360 hectares (890 acres) would be affected due to an increased underground waste disposal area. This area would be included in the bermed and permanently marked area once closure was begun. Like the Proposed Action, the rest of the Land Withdrawal Area would be available to the public for nonintrusive surface activities following decommissioning and closure. Restrictions on slant drilling would continue.

5.2.2 Air Quality

At the treatment sites, the potential annual air quality impacts would not differ substantially from those presented for the Proposed Action in Section 5.1.2. The only criteria pollutant postulated to exceed 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be CO at RFETS (17 percent), the same as for the Proposed Action. RFETS, LLNL, NTS, and ANL-E are in nonattainment areas for some pollutants. In nonattainment areas, activities that introduce new sources of emissions are regulated under the General Conformity Rule. In attainment areas, regulations for the PSD of ambient air quality apply. In both cases, a permit is required for sources which will result in emissions equal to or greater than the limits set by pertinent regulations. No radiological, hazardous, or toxic air pollutants would exceed 10 percent of the applicable regulatory standard (DOE 1997). Potential minor emissions of PM_{10} may occur during construction.

At WIPP, the potential annual air quality impacts under Action Alternative 1 would be the same as those anticipated under the Proposed Action. Although the increased waste disposal volume would increase the duration of disposal activities, there would be no substantial differences in the rates of pollutant emissions on an annual or short-term basis.

Potential air quality impacts due to decommissioning of WIPP under Action Alternative 1 would be similar to those anticipated under the Proposed Action. Because the waste disposal area would increase, the construction of berms and permanent markers and other decommissioning activities would take longer, although these activities would still be within the 10-year decommissioning period. Thus, there would be no substantial difference in the rate of pollutant emissions.

5.2.3 Biological Resources

The potential impacts on biological resources at the treatment sites under Action Alternative 1 would be the same as those under the Proposed Action described in Section 5.1.3. Threatened and endangered species may be present at all of the proposed treatment sites and could potentially be impacted; however, whether there would be impacts depends on the actual location of the facility at a particular site. Site selection would be conducted following site-wide or project-level NEPA review during which such impacts would be assessed and mitigated as necessary. Endangered, threatened, or proposed species and all critical habitats would be avoided and appropriate consultation, monitoring, and mitigation measures would be undertaken as necessary. The longer treatment period proposed for Action Alternative 1 is not expected to have any additional impact to species over the life of the campaign. Analyses also determined that terrestrial wildlife species would not be affected by airborne emission from waste management or treatment facilities nor from spills of TRU waste into aquatic environments due to traffic accidents (DOE 1997).

Federally listed, threatened and endangered, and state-listed species occur in Eddy County and potentially at the WIPP, although DOE has not observed threatened, endangered, or proposed species or critical habitats at the WIPP site during surveys conducted for recent biennial environmental compliance reports. DOE recently completed a site-specific biological survey, during which no endangered, threatened, or state-listed species were identified.

At WIPP, the potential impacts on biological resources under Action Alternative 1 would be similar to those under the Proposed Action (described in Section 5.1.3) except for impacts resulting from the increased underground waste disposal area. A total of 360 hectares (890 acres) of aboveground area would be disturbed during salt pile reclamation and construction of berms and permanent markers during closure. These activities would disturb avian and small mammal habitat. These areas would be attractive after natural vegetation recolonizes.

5.2.4 Cultural Resources

At the treatment sites, the potential impacts on cultural resources are expected to be the same under Action Alternative 1 as for the Proposed Action. This is because the size and number of the facilities would be the same as those assessed for the Proposed Action. The construction and operation of TRU waste treatment facilities could adversely affect cultural resources; however, site-level cultural resource surveys would be conducted and protection measures would be established, where necessary, when specific facility construction locations are proposed (DOE 1997). These surveys would be part of site-wide or project-level NEPA reviews. Sacred sites and burials would be avoided when siting the facilities, and appropriate consultation would be undertaken during the reviews.

At WIPP, all of the surface area included under Action Alternative 1 has been inventoried for cultural resources as part of the initial survey of the 1,040-hectare (4-square mile) central WIPP site. Eleven prehistoric archaeological sites (LA14307, LA14308, LA33155, LA33156, LA33157, LA33159, LA33160, LA33163, LA33170, LA33179, and LA33180) are located in the previously surveyed areas within Sections 28 and 29, T. 22S, R. 31E. Each of these sites was evaluated by the original investigators as being potentially eligible for inclusion in the NRHP (DOE 1995c).

TRU waste shipping and operational activities at WIPP would not have an impact on these or other archaeological sites. Depending on final project design, some of these archaeological sites could be affected by closure and decommissioning-related activities. Surface ground disturbance for construction of long-term decommissioning features such as various types of markers, earthen berms, and informational centers could impact some archaeological sites.

Measures for ensuring protection of known archaeological and historic resources (or others that may be inadvertently discovered during ground-disturbing activities) are discussed in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996a). These measures include identifying, inventorying, evaluating, and treating cultural resources under the National Historic Preservation Act of 1966. DOE will avoid, to the extent possible, sites found eligible for inclusion in the NRHP. Where avoidance is not possible, mitigation measures will be developed under the Joint Powers Agreement between DOE and the State of New Mexico.

5.2.5 Noise

Treatment facilities would probably be located in industrial areas along high-volume roadways, and, therefore, ambient noise levels would not increase substantially (DOE 1997). Sensitive receptors, however, may be impacted. Further analysis has been reserved for site-wide or project-level NEPA review (DOE 1997). Because all waste would travel to WIPP but only a portion of the waste would travel to or from each treatment facility under this alternative, the greatest impacts due to transportation noise would be near the WIPP site and are discussed below.

At WIPP, potential noise impacts under Action Alternative 1 for truck transportation and operations would be similar to those described under the Proposed Action in Section 5.1.5. This is because the throughput rate was assumed to remain the same (50 TRUPACT-IIs and eight RH-72B casks per day). The trucks would still arrive at random times throughout the day.

Unlike the Proposed Action, Action Alternative 1 examines rail transportation. All rail transportation of TRU waste destined for WIPP would travel through Carlsbad, New Mexico, to Loving, New Mexico, where it would be diverted to WIPP via a dedicated spur. Rail noise may be disruptive to certain public and private institutions. The commercial rail noise impact would result from the addition of rail cars carrying TRUPACT-IIs or RH-72Bs to existing commercial trains. A single rail car may carry up to six TRUPACT-IIs or two RH-72Bs. The noise impact would be a slight increase in the duration of propagated noise resulting from trains passing through the affected communities. The estimated impact would depend on the speed of the rail car and the total number of rail cars. Use of dedicated trains would result in increased rail traffic through Carlsbad and Loving and would be potentially more disruptive than use of commercial rail. Assuming each dedicated train contained three fully loaded rail cars, four additional trains could pass through these cities each week, averaging less than one additional train per day. Therefore, the overall noise impact would be negligible.

5.2.6 Water Resources and Infrastructure

Because the SEIS-II operations time would be three and a half times longer and the volume of waste treated less than three times higher than that anticipated under the WM PEIS, the size of the treatment facilities needed for Action Alternative 1 would be comparable, if not smaller, than those analyzed for the WM PEIS. Therefore, the incremental impacts to site infrastructure are estimated to be the same as those reported in the WM PEIS.

Although no off-site infrastructure impacts are expected to occur, proposed TRU waste activities at the treatment sites would affect on-site activities, including the capacities of on-site water, power, and wastewater systems, and on-site transportation. The impacts would be the same as those for the Proposed Action. Only Hanford would show an increase in on-site demand for wastewater that would exceed five percent of current demand (5.9 percent). Major impacts to water resources at the treatment sites would be unlikely (DOE 1997).

Minor impacts to the on-site transportation infrastructure are expected under Action Alternative 1. These impacts are a result of an increase in on-site employment of 6 percent at Hanford and INEEL and 7 percent at LANL. Impacts to the off-site transportation infrastructure are not anticipated because population increases do not exceed 5 percent (DOE 1997).

At WIPP, negligible annual infrastructure impacts would be expected under Action Alternative 1. Existing water supply and sewer capabilities and existing and planned power and roadway resources will be able to accommodate proposed disposal operations.

5.2.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts for Action Alternative 1 are presented in the following subsections.

5.2.7.1 Life-Cycle Costs

Life-cycle costs under Action Alternative 1 are presented in Table 5-22 for three areas: treatment facilities, waste transport, and WIPP disposal operations. Waste treatment facility costs include construction, O&M, and D&D at the treatment sites. For the purposes of SEIS-II analyses, it was assumed that the treatment sites would process, treat, and package waste to planning-basis WAC over a period of 35 years (as in the Proposed Action, but for larger waste volumes). Correspondingly, sites with large volumes (INEEL, Hanford, and ORNL) would be required to store portions of the treated waste volumes over some or all of the 160-year disposal operations period, mainly due to RH-TRU waste throughput limitations at WIPP. The waste treatment facility life-cycle costs would be $21.39 billion (in 1994 dollars).

Table 5-22

Life-Cycle Costs for Action Alternative 1 (in millions of 1994 dollars) [a]

Cost Information	Basic Inventory			Additional Inventory			Total	Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste
Treatment Facilities	8,430	3,120	11,550	8,860	980	9,840	21,390	11,860
Transport by Truck	1,200	2,690	3,890	750	270	1,020	4,910	778
Transport by Regular Rail	400	890	1,300	250	90	340	1,640	260
Transport by Dedicated Rail	2,760	6,200	8,960	1,740	620	2,360	11,320	1,790
Disposal at WIPP	10,600	2,700	13,300	11,100	250	11,350	24,650	3,680
Total Life-Cycle Cost (Truck Transport)	20,230	8,510	28,740	20,710	1,500	22,210	50,950	16,320
Total Life-Cycle Cost (Regular Rail)	19,430	6,720	26,150	20,210	1,320	21,530	47,680	15,800
Total Life-Cycle Cost (Dedicated Rail)	21,790	12,020	33,810	21,700	1,850	23,550	57,360	17,330

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

Action Alternative 1 considers three waste transportation options from the treatment sites to WIPP: (1) trucks only, as in the Proposed Action, (2) trucks with maximum regular (commercial) rail service, and (3) trucks with maximum dedicated rail service. Under transportation options 2 and 3, rail routes would be used to the greatest extent practical. LANL and NTS would be the two exceptions because there are no rail routes to these sites; thus, their waste would be entirely transported by truck. Under these options, the transportation costs reflect consolidation of the waste volumes at the treatment sites and shipment of the treated volumes via truck or rail to WIPP for emplacement. The waste transport life-cycle costs would be $4.91 billion by truck, $1.64 billion by regular rail, and $11.32 billion by dedicated rail.

The WIPP life-cycle costs would be $24.65 billion. The total life-cycle costs for the Total Inventory under Action Alternative 1 would be $50.95 billion ($16.32 billion when discounted) using truck transportation, $47.68 billion ($15.80 billion when discounted) using regular rail transportation, or $57.36 billion ($17.33 billion when discounted) using dedicated rail transportation.

5.2.7.2 Economic Impacts

Treatment activities would support direct, indirect, and induced jobs. Action Alternative 1 would support approximately 22,500 annual jobs in the ROIs of the 10 major treatment sites (ANL-E, Hanford, INEEL, LANL, LLNL, Mound, NTS, ORNL, RFETS, SRS).

Within the WIPP ROI, estimates of the impacts of Action Alternative 1 on employment, income, and the production of goods and services are presented in Table 5-23. These regional impacts are estimated using an annual average project budget of $180 million per year over a 160-year period of disposal operations. During this extended period of waste emplacement operations, the WIPP facility would remain a stable federal employer in the ROI economy by providing direct employment for 1,095 project personnel annually. Indirectly, the operation of WIPP (from 1998 through 2158) would annually support 2,443 jobs in the ROI work force. Total annual WIPP-induced employment within the ROI would be 3,538.

Because the projected average annual project budget is close to historical levels, Action Alternative 1 would not be expected to result in additional use of government-provided goods or services (schools, police, fire protection, and health protection) nor require major capital investments in public infrastructure within the ROI. For this same reason, Action Alternative 1 would not be expected to impact the local real estate markets nor result in major changes in the work force population.

Table 5-23
Economic Impacts within the ROI for Action Alternative 1

Economic Effects	Total Output of Goods and Services (in millions of 1994 dollars)	Total Employment (Full- and Part-Time Jobs)	Total Labor Income (in millions of 1994 dollars)	Carlsbad Output of Goods and Services (in millions of 1994 dollars)	Carlsbad Employment (Full- and Part-Time Jobs)	Carlsbad Labor Income (in millions of 1994 dollars)
Direct – Annual	113	1,095	52	95	979	46
Indirect & Induced – Annual	204	2,443	75	172	2,185	67
Total – Annual	317	3,538	126	267	3,164	113
Total - Operations (160 years)	50,720	566,080 [a]	20,160	42,720	506,240 [a]	18,080

[a] Job-years (number of annual jobs supported multiplied by the number of years in the project).

5.2.8 Transportation

This section presents the transportation impacts for Action Alternative 1. Treatment and consolidation of TRU waste and the radionuclide and hazardous chemical concentrations in the waste are the same for truck transportation in the Proposed Action and Action Alternative 1; therefore, the differences between the transportation impacts are due solely to the increased number of shipments under Action Alternative 1. Rail transportation impacts for both regular and dedicated train options for Action Alternative 1 are presented at the end of this section.

5.2.8.1 Route Characteristics and Shipment Projections

The methods used to determine route characteristics and the number of shipments were identical to the approach as presented in Section 5.1.8.1. Table 5-24 presents the number of shipments required under Action Alternative 1. Because the consolidation and treatment of waste would be the same for the Proposed Action and Action Alternative 1, the mileage for each route would also be the same (see Table 5-5).

Table 5-24
Number of Truck Shipments to WIPP for Action Alternative 1 [a]

Waste Treatment Site	CH-TRU Waste			RH-TRU Waste		
	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total
Argonne National Laboratory - East	24	---	24	---	---	---
Hanford Site	11,562	7,167	18,729	47,156	1,651	48,807
Idaho National Engineering and Environmental Laboratory/ANL-W	4,892	6,474	11,366	3,136	711	3,847
Lawrence Livermore National Laboratory	137	---	137	---	---	---
Los Alamos National Laboratory	4,238	1,590	5,828	367	190	557
Mound Plant	50	23	73	---	---	---
Nevada Test Site	73	---	73	---	---	---
Oak Ridge National Laboratory	212	8	220	5,875	3,076	8,951
Rocky Flats Environmental Technology Site	2,102	---	2,102	---	---	---
Savannah River Site	1,893	558	2,451	---	---	---
Total	**25,183**	**15,820**	**41,003**	**56,534**	**5,628**	**62,162**

[a] The number of shipments from sites with smaller quantities can be found in Appendix E. There would be 53 CH-TRU waste shipments and 3,850 RH-TRU waste shipments. Impacts from the transportation of TRU waste to the treatment sites is small relative to the 10 major generator-storage sites above (see Appendix E).

5.2.8.2 Accidents, Injuries, Fatalities, and Pollution-Related Health Effects from Truck Transportation

The total number of accidents, injuries, and fatalities over the transportation period of 160 years for Action Alternative 1 are shown in Table 5-25. For Action Alternative 1, a total of 171 accidents, 119 injuries, and 16 traffic-related fatalities were estimated. Also shown in Table 5-25 are the estimated cancer fatalities attributed to diesel exhaust (pollution health effects).

Table 5-25
Nonradiological Impacts of Transporting TRU Waste by Truck for Action Alternative 1

Impact	CH-TRU Waste			RH-TRU Waste			Total		
	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total
Number of Accidents	36	25	62	100	9	109	136	34	171
Number of Injuries	26	17	43	68	8	76	94	25	119
Number of Fatalities	4	2	6	9	1	10	13	3	16
Pollution Health Effects (fatalities)	0.1	0.08	0.2	0.3	0.04	0.3	0.4	0.1	0.5

These effects are based upon the total miles traveled in an urban area and 9.9×10^{-8} LCFs per kilometer (1.6×10^{-7} per mile) (Rao et al. 1982). The impacts of shipping waste from the small quantity sites to the larger treatment sites are included in Table 5-25.

5.2.8.3 Accident-Free Radiological Impacts from Truck Transportation

Accident-free radiological impacts occur during routine transportation and are the result of public and worker exposure to direct radiation at levels allowed by transportation regulations. The methods used to determine accident-free radiological impacts for Action Alternative 1 were identical to those described for the Proposed Action.

Table 5-26 presents a summary of the accident-free population radiological impacts for Action Alternative 1. Approximately 0.7 occupational LCFs and 10.5 nonoccupational LCFs would be expected in the exposed population groups. The accident-free radiological impacts of shipping waste from the small quantity sites to the larger treatment sites to consolidate TRU waste are included in the results in Table 5-26.

Table 5-26
Aggregate Accident-Free Population Radiological Impacts from Truck Transportation for Action Alternative 1 (LCFs) [a]

Exposure Category	CH-TRU Waste			RH-TRU Waste			Total		
	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total
Occupational	0.2	0.2	0.4	0.3	0.03	0.3	0.5	0.2	0.7
Nonoccupational									
Stops	1.7	1.1	2.8	6.3	0.7	7.0	8.0	1.8	9.8
Sharing Route	0.09	0.06	0.2	0.4	0.04	0.4	0.5	0.1	0.6
Along Route	0.04	0.02	0.06	0.1	0.02	0.1	0.1	0.04	0.2
Nonoccupational Total	1.8	1.2	3.0	6.8	0.7	7.5	8.6	1.9	10.5

[a] Exposure during stops is based upon 50 individuals exposed at 20 meters. Stop time, in hours, is based upon 0.011d where d is the distance traveled in kilometers. These parameters are built into the RADTRAN code but substantially overestimate exposures from WIPP shipments. Because WIPP shipments would use two-driver teams (eliminating the need for overnight stops to sleep) and because the shipments would stop at sites chosen, in part, for their lack of population, the actual impacts from stops would be much lower.

Table 5-27 summarizes the impacts to MEIs who might be exposed to radiation because of traffic jams, lifestyles, or occupations. The discussion in Section 5.1.8.3 presents the methods used to determine the impacts presented in Table 5-27. The state vehicle inspector was estimated to have the highest potential impact with an 8.6 x 10^{-3} probability of an LCF.

Table 5-27
Radiological Impacts to MEIs from Truck Transportation for Action Alternative 1 (Probability of an LCF)

Individual	CH-TRU Waste	RH-TRU Waste	Total
Stuck in traffic next to shipment	2.5E-6	5.0E-6	7.5E-6
Departure Inspector	4.4E-4	5.5E-3	5.9E-3
State Vehicle Inspector	1.5E-3	7.1E-3	8.6E-3
Residing adjacent to access route	1.5E-4	6.0E-4	7.5E-4
Rest stop employee	1.0E-4	3.0E-4	4.0E-4

5.2.8.4 Radiological Impacts from Truck Transportation Accidents

Two types of analyses were conducted for SEIS-II radiological impacts from accidents. The first type of analysis determined the radiological impact from accidents during transportation from each of the 10 treatment sites to WIPP. This analysis took into account eight different severities of accidents, the number of miles from each site, and the number of shipments. The methods used were the same as those presented in Section 5.1.8.4.

The results of the analyses for route-specific accidents for the entire shipping campaign are presented in Table 5-28. The aggregate radiological impact was estimated to be 0.8 LCF.

Table 5-28
Aggregate Radiological Population Impacts from Truck Transportation Accidents for Action Alternative 1 (LCFs)

	CH-TRU Waste			RH-TRU Waste			Total		
Originating Site	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**
Argonne National Laboratory-East	4.0E-4	---	4.0E-4	---	---	---	4.0E-4	---	4.0E-4
Hanford Site	0.3	0.2	0.5	0.06	2.0E-3	0.07	0.4	0.2	0.6
Idaho National Engineering and Environmental Laboratory & Argonne National Laboratory – West	0.07	0.09	0.2	2.5E-3	5.0E-4	3.0E-3	0.07	0.09	0.2
Lawrence Livermore National Laboratory	1.5E-3	---	1.5E-3	---	---	---	1.5E-3	---	1.5E-3
Los Alamos National Laboratory	3.0E-3	1.0E-3	4.0E-3	1.5E-5	5.0E-6	2.0E-5	3.0E-3	1.0E-3	4.0E-3
Mound Plant	1.0E-3	0	1.0E-3	---	---	---	1.0E-3	---	1.0E-3
Nevada Test Site	5.0E-4	0	5.0E-4	---	---	---	5.0E-4	---	5.0E-4
Oak Ridge National Laboratory	2.5E-3	5.0E-4	3.0E-3	4.5E-3	2.5E-3	7.0E-3	7.0E-3	3.0E-3	0.01
Rocky Flats Environmental Technology Site	7.0E-3	---	7.0E-3	---	---	---	7.0E-3	---	7.0E-3
Savannah River Site	0.02	6.0E-3	0.03	---	---	---	0.02	6.0E-3	0.03
Total LCFs							**0.5**	**0.3**	**0.8**

The second type of analysis was an assessment of four conservative, bounding accident scenarios: two involving the breach of a TRUPACT-II, and two involving the breach of an RH-72B. Methods of estimating impacts from bounding case accidents are presented in Appendix E and Section 5.1.8.4. For Action Alternative 1, the potential radiological impacts from the bounding case accidents would be the same as those presented for the Proposed Action in Section 5.1.8.4. For both alternatives, TRU waste would be treated to planning-basis WAC.

5.2.8.5 Hazardous Chemical Impacts from Severe Truck Transportation Accidents

As with the Proposed Action, the hazardous chemical releases from a severe accident would present negligible hazard to the exposed population. Though the inventory for Action Alternative 1 is larger than that for the Proposed Action, the concentration of VOCs and metals in each TRUPACT-II or RH-72B would be the same. Hazardous chemical impacts from accidents would be the same as those presented for the Proposed Action in Table 5-10.

5.2.8.6 Impacts from Rail Transportation

This section presents a summary of potential impacts due to transportation by both regular and dedicated rail service. Rail service would be used to the fullest extent practical (called maximum rail), whereas truck transportation would be used only for the two sites with no rail service, LANL and NTS. SEIS-II rail impacts were determined by adjusting the SEIS-II impacts from truck transportation presented earlier in this section. Overall, these adjustments were based on the similarities and differences between the two transportation modes based on models presented in RADTRAN (Neuhauser and Kanipe 1992) and truck and rail accident statistics (Saricks and Kviteck 1994). The similarities and differences are presented in Appendix E. Some key differences are noted below:

- Overall, rail cars move slower than trucks. When vehicles move slower, those individuals living or traveling along a route are exposed for longer periods of time.

- Six TRUPACT-IIs would be put on each rail car instead of the three transported per truck. Two RH-72Bs would be put on each rail car instead of the one transported per truck.

- Each train can include many rail cars. For the purpose of SEIS-II analyses, it was assumed that a train transporting TRU waste would include three rail cars loaded with TRUPACT-IIs or RH-72Bs. For dedicated rail service, it was assumed that each train would only have the three rail cars. For regular rail service, it was assumed that the three rail cars of TRU waste would be included in a train of 70 rail cars (the average number of cars in regular rail service trains).

- When a train stops at a rail yard, there typically are other rail cars there. These other rail cars provide shielding for the potential radiation coming from TRU waste packaging.

- While many people would share a roadway with a truck transporting TRU waste, very few people would travel along a rail route at the same time as a train transporting TRU waste.

These differences result in the following adjustments to truck transportation results:

- The slower average train speed would increase the radiation dose to individuals living along rail routes by 1.5 times over that for individuals living along truck routes.
- When a shipment stops, the individual dose would be one-tenth of the dose to individuals near a stopped truck. This difference is due to the shielding provided by the other rail cars when the shipment stops in a railyard.
- When these two factors are considered together, accident-free radiological impacts are greatly reduced for rail transportation compared to truck transportation. Accident-free radiological impacts from truck or rail transportation were dominated by radiation doses received at stops.

Rail accident statistics typically include the number of trains and the number of accidents and fatalities. The statistics do not typically include information concerning the number of fatalities per rail car. For the purpose of SEIS-II analyses, it is important to understand the number of accidents and fatalities per rail car, because a commercial train has the same probability of being in an accident whether it contains rail cars with TRU waste or not. The standard method of calculating the number of accidents and fatalities per commercial train is to divide the number of accidents or fatalities per train by the average number of rail cars per train, which is 70. Therefore, when a train of 70 cars is in an accident that results in one death, that fatality would count as 1/70th of a fatality for each rail car. If that train included three rail cars of TRU waste, 3/70ths of that fatality would be apportioned to rail cars of TRU waste.

There are no statistics on the average number of cars in dedicated trains; as a result, making such adjustments becomes more difficult. The assumption for SEIS-II is that each dedicated train would only have three rail cars carrying TRU waste. Should a dedicated train be involved in an accident that results in a fatality, that fatality would be apportioned as 1/5 a fatality for each rail car. This number could be changed a great deal, though, by increasing the number of rail cars per train.

Differences in impacts between regular and dedicated rail service would be primarily due to the differences in apportioning fatalities to rail cars. For SEIS-II, it was estimated that the fatality rate for dedicated rail would be 14 times greater than for regular rail.

Table 5-29 presents the impacts of transportation by regular and dedicated rail for Action Alternative 1. The impacts presented in this table represent three rail cars of TRU waste in either regular or dedicated rail transport. Further details on the estimation of rail impacts can be found in Appendix E.

Radiological impacts from rail transportation accidents were estimated relative to impacts presented for truck transportation accidents. As described under Action Alternative 1, two types of analyses were conducted for SEIS-II radiological impacts due to accidents. The first estimated impacts over the entire shipping campaign and the second estimated impacts from four bounding case accidents.

Table 5-29
Impacts from Rail Transportation for Action Alternative 1

Aggregate Traffic-Related Fatalities	
Regular Rail	8
Dedicated Rail	112
Aggregate Accident-Free Radiological Impacts (LCFs)	
CH-TRU Waste	
Occupational	0.02
Nonoccupational	
Stops	0.3
Sharing Route	1.6E-3
Along Route	0.09
Nonoccupational Total	0.4
RH-TRU Waste	
Occupational	0.01
Nonoccupational	
Stops	0.8
Sharing Route	3.9E-3
Along Route	0.2
Nonoccupational Total	1.1
Total CH-TRU and RH-TRU Waste	
Occupational	0.03
Nonoccupational	
Stops	1.2
Sharing Route	5.5E-3
Along Route	0.3
Nonoccupational Total	1.5
Aggregate Radiological Impacts from Rail Transportation Accidents (LCFs)	
CH-TRU Waste	0.7
RH-TRU Waste	0.08
Total CH-TRU and RH-TRU Waste	0.8

For the first analysis, the impacts were estimated based on the number of shipments, the accident frequency for each route, and the eight accident severity categories presented in RADTRAN. Because the number of miles traveled are similar between truck and rail and the rail car accident frequency is less than the truck accident frequency, it was conservatively estimated that the aggregate radiological impacts for rail transportation would be the same as those reported for truck transportation.

The estimation of radiological impacts for bounding truck accidents was done assuming that only one TRUPACT-II or RH-72B would fail in an impact event. The basis for this assumption was Fischer et al. (1987), which states that impact with a hard target, such as a bridge abutment, could potentially breach one container per shipment. To breach the container, though, it must strike a hard target head on.

For rail shipments, it was assumed that each train would include three rail cars of TRU waste. Each rail car would carry six TRUPACT-IIs or two RH-72Bs. It was also assumed that for the bounding case accidents two TRUPACT-IIs or RH-72Bs could potentially be breached. The accidents would be derailments where two rail cars would strike bridge abutments on either side of the tracks. Although other TRUPACT-IIs or RH-72B casks might experience impact forces, it was assumed that the forces would be insufficient to breach the containers. The estimated population doses would be dominated by inhalation contributions (initial or from resuspension). The impacts are presented below:

- For the accident with the conservative inventory in two breached TRUPACT-IIs, the total population dose would result in 32 LCFs in the exposed population. The estimated maximum individual dose would result in a 0.12 probability of a cancer fatality.
- For the accident with a conservative inventory in two breached RH-72Bs, the total population dose would result in 32 LCFs in the exposure population. The estimated maximum individual dose would result in a 0.12 probability of a cancer fatality.
- For the accident with average concentrations of radionuclides in two breached TRUPACT-IIs, approximately 6 LCFs in the exposed population would be expected. The estimated maximum individual dose would result in a 0.08 probability of a cancer fatality.
- For the accident with average concentrations of radionuclides in two breached RH-72Bs, the total population dose would result in an expectation of 0.08 LCF in the population. The estimated maximum individual dose would result in a 1.4×10^{-4} probability of a cancer fatality.

As in the case for truck transportation, there would be negligible impacts from hazardous chemical releases in a rail transportation severe accident.

5.2.9 Human Health Impacts from Waste Treatment, Storage, and Disposal Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from waste treatment, lag storage, and waste disposal operations under Action Alternative 1. The methods and assumptions used were similar to those used for the Proposed Action and described in Section 5.1.9, except that the inventory to be disposed of would include the Total Inventory (except for the PCB-commingled waste).

Impacts from waste treatment were adjusted from those presented in the WM PEIS, and a description of this adjustment is provided in Appendix B. Action Alternative 1 also includes analysis of potential impacts from TRU waste in lag storage (waste that would be treated and stored awaiting shipment to WIPP for disposal). Lag storage impact estimates were made assuming the waste would be at the lag storage site for the same lifetime exposure periods as for WIPP disposal operations: 70 years for an MEI, 35 years for the surrounding population, and 35 years for noninvolved and involved workers. The shorter exposure time for the population reflects population turnover resulting from deaths, immigration, and emigration. Appendix F provides additional information on the methods used to determine the impacts from lag storage and WIPP disposal operations.

5.2.9.1 Public

Impacts to the populations and to the MEIs under Action Alternative 1 are presented in this section; results are presented in Table 5-30. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different populations and individuals would be impacted by these activities. Waste treatment and lag storage would take place at multiple DOE sites but not WIPP, while disposal operations would take place only at WIPP. Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of all treatment sites, all lag storage sites, and at WIPP. The impacts to the MEIs from waste treatment and lag storage are presented for the highest individual waste treatment sites, while the MEI from disposal operations is near the WIPP site. See Chapter 3 for additional information on where treatment and storage would occur under Action Alternative 1.

Table 5-30
Lifetime Human Health Impacts to the Public from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 1

Category	Waste Treatment Impacts		Lag Storage Impacts [a]		WIPP Disposal Operations Impacts	
	Radiological (LCF) [b]	Hazardous Chemical (Cancer Incidence)	Radiological (LCF) [b]	Hazardous Chemical (Cancer Incidence)	Radiological (LCF) [b]	Hazardous Chemical (Cancer Incidence) [c]
MEI [d, e]						
Basic Inventory						
CH-TRU Waste	1E-9 (R)	2E-12 (X)	2E-6 (O)	6E-8 (L)	3E-7	1E-8
RH-TRU Waste	6E-11 (L)	2E-11 (O)	1E-9 (O)	5E-8 (O)	8E-10	2E-9
Total Waste	1E-9 (R)	2E-11 (O)	2E-6 (O)	6E-8 (L)	3E-7	1E-8
Total Inventory						
CH-TRU Waste	1E-9 (R)	2E-12 (X)	2E-6 (O)	1E-7 (L)	5E-7	2E-8
RH-TRU Waste	1E-10 (L)	3E-11 (O)	2E-9 (O)	7E-8 (O)	7E-10	2E-9
Total Waste	1E-9 (R)	3E-11 (O)	2E-6 (O)	1E-7 (L)	5E-7	2E-8
Population [d]						
Basic Inventory						
CH-TRU Waste	1E-4	1E-7	1E-2	2E-3	2E-4	2E-5
RH-TRU Waste	1E-6	4E-7	3E-5	4E-4	1E-6	9E-7
Total Waste	1E-4	4E-7	1E-2	2E-3	2E-4	2E-5
Total Inventory						
CH-TRU Waste	2E-4	1E-7	1E-2	2E-3	3E-4	2E-5
RH-TRU Waste	2E-6	5E-7	4E-5	5E-4	9E-7	9E-7
Total Waste	2E-4	6E-7	1E-2	3E-3	3E-4	2E-5
Aggregate Total	2E-4	6E-7	1E-2	5E-3	4E-4	3E-5

[a] These sites would have the maximum impacts.
[b] The probability of an LCF occurring to the MEI, and the number of LCFs in the population.
[c] If a panel full of CH-TRU waste remained open during the entire 70-year lifetime of the MEI and VOCs were released at a constant rate, the MEI lifetime risk from the CH-TRU waste would be 5E-8.
[d] The MEI and populations evaluated for treatment, storage, and operations impacts are different.
[e] R = RFETS, L = LANL, O = ORNL, X = LLNL

Waste Treatment

No LCFs (2 x 10^{-4} LCFs) would be expected in the total population around the waste treatment sites, and no cancer incidence (6 x 10^{-7} cancers) would be expected in the total population from hazardous chemical exposure. The MEI would be at RFETS for radiological impacts (1 x 10^{-9} probability of an LCF) and at ORNL for hazardous chemical impacts (3 x 10^{-11} probability of a cancer incidence). No noncarcinogenic health effects would occur because the maximum HI for the MEI would be 4 x 10^{-10}, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

No LCFs (1 x 10^{-2} LCFs) would be expected in the total population around the lag storage sites, and no cancer incidence (3 x 10^{-3} cancers) would be expected in the total population from hazardous chemical exposure. The MEI would be at ORNL for radiological impacts (2 x 10^{-6} probability of an LCF) and at LANL for hazardous chemical impacts (1 x 10^{-7} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the MEI would be 6 x 10^{-4}, and no health effect is predicted unless the HI is 1 or higher.

The aggregate total indicated in Table 5-30 refers to the impacts to the public expected over the entire operational period under Action Alternative 1. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 42 years for CH-TRU waste and 160 years for RH-TRU waste. No LCFs (1 x 10^{-2} LCFs) or cancer incidence (5 x 10^{-3} cancers) would be expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials under incident-free operations.

WIPP Disposal Operations

No LCFs (3 x 10^{-4} LCFs) would be expected in the population around WIPP from radiation exposure, or cancer incidence (2 x 10^{-5} cancers) would be expected in the population from hazardous chemical exposure.

The MEI was assumed to be located at the Land Withdrawal Area boundary, the closest point at which an individual could reside. The MEI would have a 5 x 10^{-7} probability of an LCF from radiation exposure and a 2 x 10^{-8} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects are predicted. The maximum HI for the MEI was estimated to be 7 x 10^{-5}, and no health effect is predicted unless the HI is 1 or higher.

The aggregate total indicated in Table 5-30 refers to the impacts to the public expected over the entire operational period. The operations period for the disposal of the Total Inventory is expected to be 42 years for CH-TRU waste and 160 years for RH-TRU waste. Under Action Alternative 1, no LCFs (4 x 10^{-4} LCFs) or cancer incidence (3 x 10^{-5} cancers) would be expected over the several generations of exposure to the estimated releases.

5.2.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under Action Alternative 1 are presented in this section; results are presented in Table 5-31. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, storage, handling, or disposal of waste. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different noninvolved worker populations and individuals would be impacted by these activities. Waste treatment and lag storage would take place at multiple DOE sites but would not include WIPP. Disposal operations would take place only at WIPP. The impacts to the maximally exposed noninvolved worker from waste treatment and lag storage are presented for the highest individual waste treatment sites, while the maximally exposed noninvolved worker from disposal operations was assumed to work at the WIPP location where emissions have the least atmospheric dispersion and thus the greatest potential impact. This location was assumed to be 200 meters (660 feet) east of the exhaust filter building. The maximum ground-level concentrations of any airborne contamination would be expected at this location.

Table 5-31
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 1

	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
Category	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)** [b]
Maximally Exposed Noninvolved Worker [c, d]						
Basic Inventory						
CH-TRU Waste	3E-9 (R)	6E-12 (X)	8E-6 (O)	2E-7 (I)	2E-7	5E-8
RH-TRU Waste	3E-11 (L)	1E-10 (O)	1E-8 (O)	4E-8 (H)	2E-9	4E-9
Total Waste	3E-9 (R)	1E-10 (O)	8E-6 (O)	2E-7 (I)	2E-7	5E-8
Total Inventory						
CH-TRU Waste	8E-9 (R)	6E-12 (X)	8E-6 (O)	5E-7 (I)	4E-7	9E-8
RH-TRU Waste	5E-11 (L)	2E-10 (O)	4E-9 (O)	4E-8 (H)	2E-9	4E-10
Total Waste	8E-9 (R)	2E-10 (O)	8E-6 (O)	5E-7 (I)	4E-7	9E-8
Population Noninvolved Worker [c]						
Basic Inventory						
CH-TRU Waste	6E-6	2E-8	3E-2	4E-3	2E-4	5E-5
RH-TRU Waste	7E-8	1E-7	6E-5	7E-4	2E-6	4E-6
Total Waste	6E-6	1E-7	3E-2	5E-3	2E-4	5E-5
Total Inventory						
CH-TRU Waste	8E-6	3E-8	4E-2	9E-3	4E-4	1E-4
RH-TRU Waste	1E-7	2E-7	9E-5	8E-4	2E-6	4E-7
Total Waste	8E-6	2E-7	4E-2	5E-3	4E-4	1E-4
Aggregate Total	8E-6	2E-7	0.05	0.01	5E-4	1E-4

[a] The probability of an LCF occurring to the maximally exposed noninvolved worker and the number of LCFs in the population.
[b] If a panel full of CH-TRU waste remained open during the entire 70-year lifetime of the MEI and VOCs were released at a constant rate, the noninvolved worker lifetime risk from CH-TRU waste would be 5E-8.
[c] The noninvolved workers considered for treatment impacts and operations impacts are different.
[d] R = RFETS, L = LANL, O = ORNL, X = LLNL, I = INEEL, H = Hanford

Waste Treatment

No LCFs (8 x 10^{-6} LCFs) or cancer incidence (2 x 10^{-7} cancers) would be expected in the total noninvolved worker population around the waste treatment sites. The maximally exposed noninvolved worker would be at RFETS for radiological impacts (8 x 10^{-9} probability of an LCF) and at ORNL for hazardous chemical impacts (2 x 10^{-10} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the maximally exposed noninvolved worker would be 3 x 10^{-9}, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

Radiological impacts from lag storage would be somewhat greater than nonradiological impacts to noninvolved workers under Action Alternative 1. No LCFs would be expected in the total noninvolved worker population at the lag storage sites (4 x 10^{-2} LCFs), and no cancer incidence (5 x 10^{-3} cancers) would be expected in the total noninvolved worker population from hazardous chemical exposure. The maximally exposed noninvolved worker would be at ORNL for radiological impacts (8 x 10^{-6} probability of an LCF) and at INEEL for hazardous chemical impacts (5 x 10^{-7} probability of a cancer incidence). No noncarcinogenic health effects would occur; the maximum HI for any maximally exposed noninvolved worker would be 4 x 10^{-3}.

The aggregate total indicated in Table 5-31 refers to the impacts to noninvolved worker population at the lag storage sites expected over the entire operational period under Action Alternative 1. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 42 years for CH-TRU waste and 160 years for RH-TRU waste. No LCFs (0.05 LCFs) or cancer incidence (0.01 cancers) would be expected in the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials under incident-free operations.

WIPP Disposal Operations

No LCFs would be expected in the WIPP noninvolved worker population from radiation exposure (4×10^{-4} LCFs). VOC release estimates were the same as for the public. No cancer incidence (1×10^{-4} cancers) would be expected in the noninvolved worker population from hazardous chemical exposure. All 1,095 WIPP employees were assumed to be exposed at the same level as the maximally exposed noninvolved worker.

The maximally exposed noninvolved worker would have a 4×10^{-7} probability of an LCF from radiation exposure, and a 9×10^{-8} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects are predicted. The maximum HI for the maximally exposed noninvolved worker would be 6×10^{-4}, and no health effect is predicted unless the HI is 1 or higher.

The aggregate total to noninvolved workers at the WIPP site indicated in Table 5-31 shows that no LCFs (5×10^{-4} LCFs) or cancer incidence (1×10^{-4} cancers) would be expected during the entire disposal operations period under Action Alternative 1.

5.2.9.3 Involved Workers

Impacts to involved workers who would handle waste during treatment, lag storage, and WIPP disposal operations under Action Alternative 1 are presented in this section. Results are presented in Table 5-32. The methods used to estimate impacts from waste treatment and WIPP disposal operations are described at the beginning of Section 5.1.9 and in Section 5.1.9.3. Additional information is presented in Appendix F. In actuality, all worker exposures to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Waste Treatment

Radiological impacts to the involved worker population from waste treatment would be greater than nonradiological impacts. A maximum of 1.5 radiation-related LCFs could occur in the worker population, while no cancer incidence (3×10^{-5} cancers) would be expected from hazardous chemical exposure. No noncarcinogenic health effects are predicted. The maximum exposure index for a waste treatment worker would be 3×10^{-4}, and no health effect is predicted unless the HI is 1 or higher. Additional information is presented in Appendix F.

Table 5-32
Lifetime Human Health Impacts to Involved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 1 [a]

Category	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
	Radiological (LCF)	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**
Population					(36 workers)	(36 workers)
Basic Inventory						
CH-TRU Waste	0.7	8E-6	0.5	0.02	0.3	0.01
RH-TRU Waste	0.02	7E-6	≤0.5	≤0.02	≤0.3	1E-3
Total Waste	0.8	2E-5	≤1	≤0.04	≤0.6	0.01
Total Inventory						
CH-TRU Waste	1.5	2E-5	0.5	0.02	0.5	0.03
RH-TRU Waste	0.03	1E-5	≤0.5	≤0.02	≤0.5	1E-3
Total Waste	1.5	3E-5	≤1	≤0.04	≤1	0.03
Aggregate Total	1.5	3E-5	≤1	≤0.1	≤1	0.04

[a] The involved worker populations considered for treatment impacts and operations impacts are different.

Lag Storage

Radiological impacts to the involved worker population from lag storage would be less than or equal to 1 LCF, and hazardous chemical impacts would be less than 0.04 cancers. No noncarcinogenic health effects would occur. Involved worker lag storage impacts would be larger from CH-TRU waste storage operations than from RH-TRU waste storage operations because of remote RH-TRU waste handling and greater administrative controls for RH-TRU waste. Therefore, no specific RH-TRU waste lag storage impact estimates were made. Impacts were assumed to be less than or equal to those for CH-TRU waste.

The impacts from CH-TRU waste would be from the external radiation dose received during waste container handling. Potential radiological impacts from inhalation of radioactive gases released from waste containers would be negligible. Involved worker impacts from lag storage were calculated by assuming waste handlers would spend 2 hours every workday at 1 meter (3.3 feet) from the CH-TRU waste containers. The workers were assumed to be exposed over a 35-year career. Container dose rates were decay-corrected over the 35 years, and all sites were assumed to monitor 20 percent of the Total Inventory annually.

The aggregate total indicated in Table 5-32 refers to the impacts to the involved worker population at the lag storage sites over the entire operational period under Action Alternative 1. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 42 years for CH-TRU waste and 160 years for RH-TRU waste. Less than 1 LCF and no cancer incidence (less than 0.1 cancers) would be expected over the several generations of involved workers that would be exposed externally or via inhalation of hazardous chemicals from lag storage operations. The radiological impact estimates reflect the aggregate impacts analyses presented in detail in Appendix F. The hazardous chemical impacts were estimated in the same manner as the public and noninvolved worker estimates.

WIPP Disposal Operations

Workers would be exposed under the same circumstances as described for the Proposed Action in Section 5.1.9.3. Radiological impacts to the involved worker population from disposal operations at WIPP would be less than 1 LCF. WIPP involved worker radiological impact estimates were made assuming each involved worker handled the CH-TRU waste for 400 hours per year. The operational period was determined by assuming that 2.5 years of disposal operations were required to fill each panel. Impacts to involved workers from RH-TRU waste handling were assumed to be the same or less than those from CH-TRU waste handling. This assumption is conservative because RH-TRU waste is typically handled using remote-handling equipment, workers are usually protected by radiation shielding, and stricter administrative procedures are used. The impact from handling RH-TRU waste, therefore, would probably be less than the impact from handling CH-TRU waste.

Hazardous chemical impacts to the involved worker population would be 0.03 cancers, and no noncarcinogenic health effects would occur. Involved worker exposures to VOCs were evaluated in the Waste Handling Building and underground, as was done for the Proposed Action. The potential carcinogenic impacts would be greatest for the individual underground worker. Noncarcinogenic health effects were also estimated. The same methods and assumptions were used as for the Proposed Action (Section 5.1.9.3). Workers were assumed to be exposed for 35 years. The results were the same as those presented for the Proposed Action.

The aggregate total indicated in Table 5-32 refers to the impacts to the involved worker population at WIPP over the entire disposal operations period under Action Alternative 1. Less than 1 LCF and 0.04 cancers are expected from external radiation or hazardous chemical exposures, respectively, over the several generations of involved workers at WIPP. Radiological impacts over the entire operational period would be approximately twice the number of impacts estimated for the individual during the first 35 years of CH-TRU waste disposal operations at WIPP. Radiological decay would reduce the radiological impacts to each generation of WIPP workers. Hazardous chemical impacts were conservatively estimated by assuming continuous exposure to the same releases over the entire disposal operations period.

5.2.10 Facility Accidents

Impacts under Action Alternative 1 would be the same as those for the Proposed Action for treatment and WIPP disposal accidents. However, there would be lag storage of CH-TRU and RH-TRU waste under Action Alternative 1; therefore, impacts resulting from storage accidents are discussed for the six sites under evaluation (Hanford, LANL, INEEL, SRS, RFETS, and ORNL). Impacts of storage accidents were evaluated for storage at these six sites because they would store about 99 percent of the CH-TRU and RH-TRU waste under Action Alternative 1.

5.2.10.1 Waste Treatment Accidents

The impacts from waste treatment accidents under Action Alternative 1 would be the same as those under the Proposed Action (see Section 5.1.10.1).

5.2.10.2 Waste Storage Accidents

Three potential waste storage accidents were evaluated for Action Alternative 1 (see Table 5-33). The results are presented only for accidents involving CH-TRU waste because they would be greater than the results for similar accidents involving RH-TRU waste. (The impacts from failure of RH-TRU storage facilities as a result of an earthquake are presented in Appendix G). Lower transuranic radionuclide activity in RH-TRU waste (lower PE-Ci levels, see Table G-23 and

Table G-24), lower RH-TRU waste volume, more robust waste containers for RH-TRU waste, and presumably more robust construction of RH-TRU waste storage facilities (thick concrete walls for external radiation shielding) would all combine to limit potential impacts from RH-TRU waste accidents. Waste would be consolidated at 10 sites for lag storage under Action Alternative 1.

Table 5-33
Storage Accident Scenarios Evaluated for Action Alternative 1

Accident Scenarios	Annual Occurrence Frequency	Description
Drum Puncture, Drop, and Lid Failure (Accident Scenario S1)	1E-2 to 1E-4	A forklift strikes and punctures a drum on a lower level of a stack in the storage facility. The stack is destabilized and two drums fall to the ground and lose their lids upon impact.
Drum Fire (Accident Scenario S2)	1E-4 to 1E-6 (<8 PE-Ci) <1E-6 (>8 PE-Ci)	A fire spontaneously erupts in a waste drum.
Earthquake (Accident Scenario S3)	1E-5 or less	A beyond-design-basis earthquake (or other natural event) occurs, causing the storage building to collapse.

Storage accidents analyzed include a high-frequency/low-consequence operational accident which is expected to be applicable under any facility design, a low-frequency/high-consequence operational accident, and a beyond-design-basis natural disaster accident. For Accident Scenarios S1 and S2, CH-TRU waste involved in the accidents was assumed to have the highest levels of radionuclides (80 PE-Ci per drum) permitted by the planning-basis WAC, conservative concentrations of VOCs (based on CH-TRU waste sampling and planning-basis WAC limits) and conservative concentrations of heavy metals. Accident Scenario S3 involves a large number of waste containers; therefore, site-specific drum PE-Ci values and average hazardous chemical concentrations were used in the analyses. Additional details on the accident analyses are presented in Appendix G.

Estimated radiological impacts are presented as the number of LCFs in the exposed population and as the probability of an LCF occurring in MEIs. Carcinogenic and noncarcinogenic impacts from hazardous chemicals, both VOCs and heavy metals, were estimated. Carcinogenic impacts are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic impacts from exposure to VOCs and heavy metals were estimated by two different methods for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2, respectively): IDLH-equivalent ratios and ERPG ratios. Only IDLH-equivalent ratios were calculated for the earthquake scenario (Accident Scenario S3). The potential noncarcinogenic impacts identified by ERPG ratios would be of minor importance during such a catastrophic event and its consequent site-operations upheaval.

In general, potential radiological impacts would be higher than hazardous chemical impacts, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-34.

Table 5-34
Radiological Consequences from Storage Accidents for Action Alternative 1 [a]

Accident Scenarios	Population (number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
Drum Puncture and Lid Failure (Accident Scenario S1)	Maximum: 5E-4 (RFETS)	Maximum: 3E-7 (ORNL)	Maximum: 4E-7 (Hanford)
Drum Fire (Accident Scenario S2)	Maximum: 2E-3 (RFETS, ORNL)	Maximum: 1E-6 (ORNL)	Maximum: 2E-6 (Hanford, LANL, ORNL)
Earthquake (Accident Scenario S3-CH)	Hanford: 200 INEEL: 6 LANL: 50 RFETS: 300 ORNL: 6 SRS: 38	Hanford: 0.1 INEEL: 3E-3 LANL: 0.1 RFETS: 0.02 ORNL: 6E-3 SRS: 4E-3	Hanford: 1 INEEL: 0.6 LANL: 0.6 RFETS: 0.6 ORNL: 0.01 SRS: 1

[a] The site with the greatest impact is shown in parentheses.

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Public

Population impacts from storage accidents were estimated for the exposed populations around the six major treatment sites. Potential impacts to the population and MEIs at the six sites vary over a wide range because of different population distributions, distances to the MEIs, and atmospheric dispersion factors among the sites. No LCFs would be expected in the exposed population from drum puncture or drum fire accidents (Accident Scenarios S1 and S2, respectively), but LCFs were estimated to occur from the earthquake accident (Accident Scenario S3) at all sites. The number of LCFs ranged from 6 (at ORNL and INEEL) to 300 (at RFETS). The radiological impacts were estimated to be the highest to the MEI at ORNL for the drum puncture and drum fire accidents (Accident Scenarios S1 and S2). Impacts from the earthquake accident (Accident Scenario S3) were estimated to range from 3 x 10^{-3} to 0.1 probability of an LCF to the MEI.

Carcinogenic impacts from VOCs would be one to six orders of magnitude greater than impacts from heavy metals for the drum puncture and earthquake scenarios (Accident Scenarios S1 and S3, respectively). Heavy metals account for all carcinogenic impacts from the drum fire accident (Accident Scenario S2) because VOCs would be consumed by the fire. No cancer was estimated to occur in the exposed population from the hazardous chemical releases of any accident. The maximum probability of cancer to an MEI would be 9 x 10^{-10} for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2, respectively). The maximum probability of cancer to the MEI would be 9 x 10^{-7} for the earthquake accident (Accident Scenario S3). No noncarcinogenic impacts would be expected for any of the three accidents evaluated.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker was assumed to be at the location of greatest impact outside of the waste storage facility. The impacts to the noninvolved worker would vary over a narrow range across the six sites evaluated. The range was narrow because similar conditions were assumed to exist at the six sites.

Radiological impacts to the maximally exposed noninvolved worker would result in a 4×10^{-7} probability of an LCF (at Hanford) from events of the drum puncture scenario (Accident Scenario S1), a 2×10^{-6} probability of an LCF (at Hanford, LANL, or ORNL) from the events of the drum fire scenario (Accident Scenario S2), and up to a probability of 1 of an LCF (at Hanford and SRS) from the beyond-design-basis earthquake (Accident Scenario S3).

Hazardous chemical impacts would be relatively minor in comparison to the radiological impacts. The maximum probability of cancer to the maximally exposed noninvolved worker from VOC and heavy metal intakes would be 1×10^{-9} for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2, respectively). The corresponding impact for the earthquake scenario (Accident Scenario S3) would be a 5×10^{-6} probability of cancer. A Hanford noninvolved worker could experience a minor noncarcinogenic health effect from drum puncture releases (Accident Scenario S1) of 1,1,2,2-tetrachloroethane.

Maximally Exposed Involved Worker

The involved worker would be the individual most seriously impacted by the events of the drum puncture and earthquake scenarios (Accident Scenarios S1 and S3, respectively) because of close proximity to the accidents. Impacts were quantitatively estimated for the drum puncture scenario (Accident Scenario S1). The maximally exposed involved worker could have a 0.06 probability of an LCF as a result of the radionuclide intake from this accident. The analysis assumed the instantaneous radioactive material releases from the three containers, expanding in a uniform hemisphere of 5 meters (16 feet) in radius. The worker was assumed to inhale this air for 1 minute prior to exiting to a fresh air source.

The involved worker could have a 7×10^{-8} probability of contracting cancer from estimated hazardous chemical intakes due to the events of the drum puncture scenario (Accident Scenario S1). Noncarcinogenic impacts could be irreversible but would not be life-threatening under the assumed exposure assumptions. These impacts could result from the potential releases of 1,1,2,2-tetrachloroethane, and methylene chloride. Mild impacts might result from lead and mercury releases.

Impacts from the drum fire scenario (Accident Scenario S2) would be serious if the worker happened to be adjacent to the drum when the fire began. However, a worker's actions are not required to initiate the accident; therefore the probability of exposure of a worker adjacent to the fire is small. The smoke being released from the drum would alert workers to the incident, and it can be reasonably assumed that workers would avoid exposure to the smoke.

Catastrophic destruction of the storage facility during an earthquake or other natural events (Accident Scenario S3) could result in death or serious injury to the maximally exposed involved worker due to a falling ceiling or other debris and radiation doses.

5.2.10.3 WIPP Disposal Accidents

The impacts from accidents during WIPP disposal operations under Action Alternative 1 would be the same as those under the Proposed Action (see Section 5.1.10.3).

5.2.11 Industrial Safety

A total of four fatalities from industrial accidents would occur under Action Alternative 1 during waste treatment at all treatment sites. This result was determined by adjusting the physical-hazard fatality estimate of the WM PEIS.

Under Action Alternative 1, the WIPP operational activities would be essentially the same as those conducted under the Proposed Action but would last approximately 160 years rather than 35 years. Decommissioning activities would be the same as under the Proposed Action. Estimated industrial safety impacts to workers under Action Alternative 1 are presented in Table 5-35. Oversight and inspections by the MSHA and adherence to OSHA regulations would probably reduce actual occurrences below these estimated values.

Table 5-35
Industrial Safety Impacts from WIPP
Operations and Decommissioning for Action Alternative 1

	Injuries/Illnesses			Fatalities		
Years	**Construction**	**Operations**	**Total**	**Construction**	**Operations**	**Total**
Operations 1998-2158	99	5,600	5,699	0.2	5.6	5.8
Decommissioning 2159-2168	187	96	283	0.3	0.1	0.4
Total	286	5,696	5,982	0.5	5.7	6.2

5.2.12 Long-Term Performance

This section presents the potential impacts associated with the long-term performance of the WIPP repository for Action Alternative 1 over the 10,000-year period after the site is closed. These impacts were estimated based on computer simulations that predicted radionuclide and heavy metal releases from TRU waste in the repository under undisturbed and disturbed conditions. Analyses were conducted using the same methods as for the Proposed Action and other action alternatives; additional information is presented in Appendix H. The waste volume emplaced would be 281,000 cubic meters (9.9 million cubic feet) of CH-TRU waste and 55,000 cubic meters (1.9 million cubic feet) of RH-TRU waste. The repository size was increased from the 10 panels of the Proposed Action to 68 panels to accommodate the increased waste volume. The radionuclide inventory was increased to 7.3 x 10^6 Ci in CH-TRU waste and 5.1 x 10^6 Ci in RH-TRU waste. There were similar increases in heavy metal inventories. Detailed information on the radionuclide and heavy metal inventories is provided in Appendix A.

The four cases below were analyzed for Action Alternative 1. The cases are the same as the Proposed Action and other action alternatives but include alternative-specific differences, such as repository size and radionuclide and heavy metal inventories.

- Case 6 considered undisturbed repository conditions. Median parameter values were used for input variables where probability distributions have been defined.

- Case 7 considered disturbed conditions resulting from a borehole assumed to pass through the repository and intercept a pressurized brine reservoir in the Castile Formation. Median parameters values were used for input variables where probability distributions have been defined.

- Case 8 was the same as Case 6 but used 75th percentile parameter values for input variables where probability distributions have been defined.

- Case 9 was the same as Case 7 but used 75th percentile parameter values for input variables where probability distributions have been defined.

5.2.12.1 Impacts of Undisturbed Conditions

Radionuclide and heavy metal (predominantly lead) migration for undisturbed conditions at 10,000 years after closure for Case 8 (75th percentile parameter values) is presented in Figure 5-3. Case 8 resulted in slightly more extensive migration than Case 6 (median parameter values). Figure 5-3 shows the locations in the modeled region where the concentration of total radionuclide activity in the brine, summed over 30 radionuclides, is equal to 1 pCi per liter (1×10^{-9} Ci per cubic meter). A total heavy metal concentration of one part per billion (1×10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration.

Approximately the same vertical and lateral migration of radionuclides and heavy metals would occur for Action Alternative 1 as for the Proposed Action. Total radionuclide concentrations of one pCi per liter would extend about 20 meters (65 feet) below the repository, 40 meters (130 feet) above the repository, and about 1,900 meters (6,200 feet) laterally.

Analysis of undisturbed repository conditions (Cases 6 and 8) during the first 10,000 years showed that no radionuclides or heavy metals would be released to the Culebra Dolomite. No total radionuclide activity concentrations greater than 1 pCi per liter or heavy metal concentrations greater than 1 part per billion would be found beyond the 5-kilometer (3-mile) subsurface lateral boundary. There would be no release to the accessible environment and therefore no human health impact. Additional information is provided in Appendix H.

5.2.12.2 Impacts of Disturbed Conditions

This section presents the impacts of two exposure scenarios evaluated for disturbed conditions of Action Alternative 1.

Surface Release Caused by Drilling into the Repository

The human health impacts of drilling into the repository (Case 7 and Case 9) were evaluated for a drilling crew member and a well-site geologist. These individuals were assumed to be exposed to waste material brought to the land surface by drilling, as described in Section 5.1.12.2 and Appendix H. Under Action Alternative 1, 17 repository panels would hold both CH-TRU and RH-TRU waste, and 51 waste panels would hold only RH-TRU waste, so a drilling event could contact CH-TRU, RH-TRU, or both CH-TRU and RH-TRU waste.

The estimated radionuclide releases to the ground surface for Case 7 (median parameter values) would be 2.6, 0.1, and 2.7 Ci, respectively, from CH-TRU waste, RH-TRU waste, and both

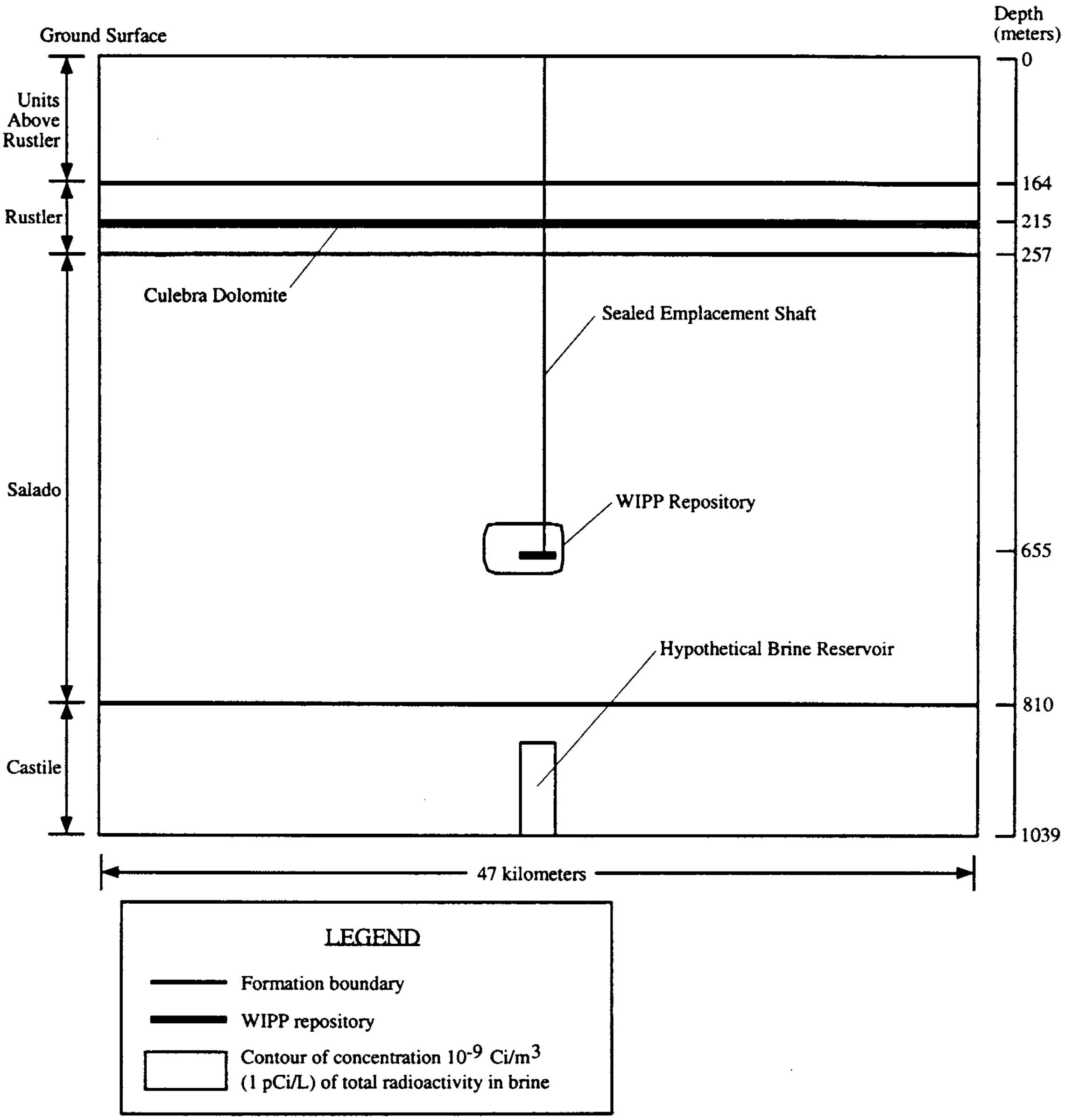

Figure 5-3
Extent of Radionuclide Migration at 10,000 Years with Undisturbed Conditions Using 75th Percentile Parameter Values (Case 8) for Action Alternative 1

CH-TRU and RH-TRU waste. For Case 9 (75th percentile parameter values), the releases would be 3.5 Ci from CH-TRU waste, 0.15 Ci from RH-TRU waste, and 3.6 Ci from CH-TRU and RH-TRU waste. The releases would consist mainly of Pu-238, Pu-239, and Am-241 for all these events. Heavy metal releases from these drilling intrusions would be 6, 22, and 23 kilograms (13, 49, and 50 pounds), respectively, from CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste for Case 7 (median parameter values). For Case 9 (75th percentile parameter values), the releases would be 8 kilograms (18 pounds) from CH-TRU waste, 30 kilograms (65 pounds) from RH-TRU waste, and 31 kilograms (67 pounds) from both CH-TRU and RH-TRU waste. Additional information is provided in Appendix H.

The radiological impacts to a drilling crew member for Case 7 (median parameter values) would be a 2×10^{-4}, 7×10^{-6}, and 2×10^{-4} probability of an LCF, respectively, from drilling intrusions of CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. For Case 9 (75th percentile parameter values), the impacts would be higher with a 4×10^{-4}, 1×10^{-5}, and 4×10^{-4} probability of an LCF for the same respective waste type intrusions. Most of the impact would be due to the inadvertent ingestion of drill cuttings (ranging from 83 percent to about 100 percent), with less impact from external radiation dose. Americium-241 would be the major dose contributor. Ingestion of heavy metals for this scenario would result in a 1.7×10^{-8}, 1.0×10^{-9}, and 1.8×10^{-8} probability of cancer incidence, respectively. There would be no noncarcinogenic impacts expected from the ingestion of the metals because all hazard indices would be much less than one. Impacts of exposure to VOCs were not analyzed (see Appendix H) but were expected to be bounded by impacts of VOC exposure under WIPP disposal accidents (see Appendix G). There would be a 3×10^{-7} probability of a cancer incidence. Some short-term toxicological effects from inhalation of VOCs could occur under these assumptions (see Appendix G).

Radiological impacts to the well-site geologist from external radiation exposure for Case 7 (median parameter values) would result in a 2×10^{-9} probability of an LCF from CH-TRU waste and a 2×10^{-9} probability of an LCF from RH-TRU waste. For Case 9 (75th percentile parameter values), the radiological impacts would be a 3×10^{-9} probability of an LCF from CH-TRU waste and a 5×10^{-9} probability of an LCF from RH-TRU waste. Am-241 and U-234 were major external dose contributors in CH-TRU and RH-TRU waste for Case 7 and in CH-TRU waste for Case 9, while Sr-90 and Cs-137 were the major external dose contributors in RH-TRU waste for Case 9.

Drilling through the Repository into a Pressurized Brine Reservoir

Impacts of drilling through the repository into a pressurized brine reservoir were analyzed as described in Section 5.1.12.2 and in Appendix H, using information specific to Action Alternative 1 where appropriate. Analysis of radionuclide and heavy metal migration for this scenario at 10,000 years after closure for Case 7 (median parameters values) showed there would be no radionuclide or heavy metal releases into the Culebra Dolomite or the accessible environment.

The extent of radionuclide (predominantly Pu-238, Pu-239, and Am-241) migration for disturbed conditions at 10,000 years after closure for Case 9 (75th percentile parameters values) is presented schematically in Figure 5-4. Total radionuclide activity concentrations of one pCi per liter are shown. Simulations showed radionuclides migrated upward and downward into the borehole and penetrated into rocks directly in contact with the borehole for a limited distance. For Case 9 only, migration extends upward into the Culebra Dolomite at 10,000 years. Migration also extends downward in the borehole (for both Cases 7 and 9) to the Castile Formation and into the brine

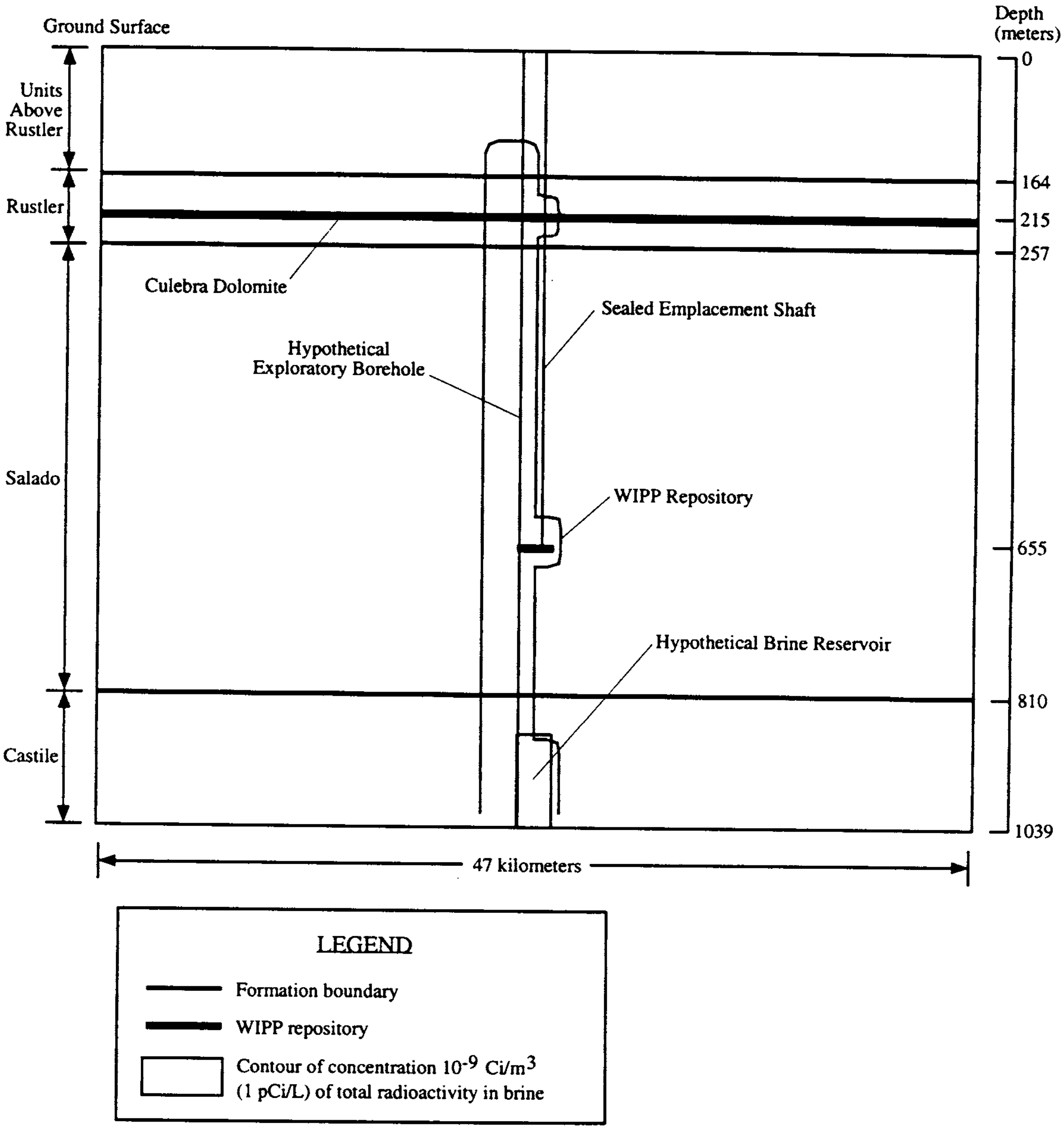

Figure 5-4
Extent of Radionuclide Migration at 10,000 Years with Disturbed Conditions Using 75th Percentile Parameter Values (Case 9) for Action Alternative 1

reservoir. This would occur after the initial pressure in the pressurized brine pocket dissipates and equilibrates with pressures in the repository and overlying units penetrated by the borehole. Total heavy metal concentration of one part per billion (1 x 10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration. Predicted brine pressures and additional modeling information is provided in Appendix H.

Impacts of radionuclide and heavy metal migration to the accessible environment were evaluated for Case 9 (75th percentile parameter values) since a release of contaminants into the Culebra Dolomite was indicated for this case only. The exposure scenario was the same as that evaluated for the Proposed Action and other action alternatives, with an individual consuming beef from cattle using the water from a stock well 3 kilometers (2 miles) from the point of intrusion. Results are presented only for partial mining conditions since calculated impacts for full mining conditions were significantly lower (see Section H.8.2). Radiological impacts would be negligible, with a 2 x 10^{-27} probability of an LCF. The dominant dose contributor was Pu-239. Ingestion of heavy metals from consumption of contaminated beef was also found to result in negligible impacts, with a probability of cancer incidence of 3 x 10^{-27}. No noncarcinogenic impacts would be expected. Additional information is presented in Appendix H.

5.2.13 Reducing WIPP Operations for Action Alternative 1

As noted in Chapter 3, stakeholders requested a discussion in greater detail of the changes to impacts should the Department reduce the period of operations for WIPP under Action Alternative 1. The period of operations is 160 years, but it could be reduced to 60 years by constructing an additional waste handling building for RH-TRU waste, constructing four new shafts, and tripling the number of excavation and emplacement crews. Additional costs would total $80 million in capital costs and $165 million in annual operating costs.

No additional impacts would be expected at treatment facilities because the facilities and their periods of operation would be identical to those discussed earlier.

The time to ship to WIPP from the treatment facilities would decrease from 160 years to 53 years. The aggregate nonradiological impacts would be the same as those described earlier, except that they would occur within the shorter time period. The accident-free radiological impacts to occupational and nonoccupational populations were reported as aggregate impacts over the entire shipping campaign. Therefore, no increase in impacts would be noted. However, because the MEIs would be exposed to more shipments, the estimated exposure to MEIs would triple. All accident impacts would be identical to those described earlier.

Because the size of the WIPP underground facility would remain the same and because the new facility would be constructed within the footprint of the repository, land use, biological resource, and cultural resource impacts would be similar to those described earlier in this section. Construction of the new waste handling building would increase the air quality impacts slightly for the period of construction. Other air quality impacts would be negligible. Noise impacts would triple because the rate of shipments through Carlsbad would triple. Water quality and infrastructure impacts may be impacted by the new facilities and additional work crews.

Human health impacts would decrease for lag storage. The impacts to the public, noninvolved workers, and involved workers over the entire operations period would remain the same, but be compressed into about a third of the time. Impacts to the MEIs would triple because triple the waste would be emplaced during a lifetime. Industrial safety impacts would decrease by approximately 50 percent, considering the reduced operation times, construction of new facilities, and the increased number of workers. There would be no change in long-term performance assessment results.

The greatest change in Action Alternative 1 results would be in life-cycle costs, which would drop from $50.95 billion in 1994 dollars ($16.32 billion discounted) to $35.80 billion ($13.24 billion discounted) should only trucks be used. Life-cycle costs should regular rail transportation be used would decrease from $47.68 billion ($15.80 billion discounted) to $32.53 billion ($12.03 billion discounted), and life-cycle costs should dedicated rail transportation be used would decrease from $57.36 billion ($17.33 billion discounted) to $42.21 billion ($15.62 billion discounted).

5.3 IMPACTS OF ACTION ALTERNATIVE 2

This section describes the environmental impacts associated with the implementation of the subalternatives of Action Alternative 2. Under each subalternative, WIPP would accept the Basic Inventory and the Additional Inventory including PCB-commingled TRU waste. All TRU waste would be thermally treated to meet Land Disposal Restrictions (LDR). SEIS-II analyzed three different consolidation and treatment subalternatives, Action Alternatives 2A, 2B and 2C. Action Alternative 2C includes treatment of all CH-TRU waste at WIPP.[1] Each subalternative is described in Section 3.2.3.

The total consolidated, pretreatment volume of waste to be treated under this alternative would be 313,000 cubic meters (11 million cubic feet) (see Tables 3-4 through 3-9). The type, size, and number of treatment facilities needed under this alternative would be comparable to those assessed in the thermal treatment alternatives of the WM PEIS. Treatment under each subalternative would continue for 35 years. The waste would be stored at the treatment facilities until disposal (this storage is called lag storage). The WIPP operational time frame under this alternative would extend to the year 2148 (150 years).

5.3.1 Land Use Management

Land use impacts at the treatment sites for each of the Action Alternative 2 subalternatives would be similar to those under the Proposed Action discussed in Section 5.1.1. Additional waste would be treated under this alternative, but the treatment time period would be extended to 35 years. Though the SEIS-II Action Alternative 2 subalternatives propose treating TRU waste at various DOE locations, in no case would the treatment facilities require more than 1 percent of the available land at those DOE locations. The Department would have a great deal of flexibility when determining the locations of such facilities (DOE 1997). The Department would be able to minimize impacts to on-site land use and would be able to avoid conflicts with off-site land use plans. It also would be able to avoid sensitive or inappropriate land areas (including wetlands, flood plains, cultural resource areas, and the habitats of endangered and threatened species) (DOE 1997). Before treatment facilities would be constructed, further NEPA review would be undertaken at a site-wide or project-specific level.

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[1] If the Department decides, based on the WM PEIS analyses, to centralize treatment at WIPP, the Department would prepare further project-specific NEPA review for any proposed treatment facility. Such review would be tiered from SEIS-II.

Land use impacts during disposal operations at WIPP under Action Alternatives 2A, 2B, and 2C would be similar to those under the Proposed Action, discussed in Section 5.1.1. A difference from the Proposed Action would occur during decommissioning and closure, when approximately 395 hectares (976 acres) would be affected due to an increased underground waste disposal area. Like the Proposed Action, the rest of the Land Withdrawal Area would be available to the public for nonintrusive surface activities following decommissioning and closure.

5.3.2 Air Quality

For Action Alternative 2A, the levels of criteria pollutants exceeding 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be those for CO at RFETS (24 percent) and PM_{10} at INEEL (10 percent). For Action Alternative 2B, the levels of criteria pollutants exceeding 10 percent would be PM_{10} at INEEL (10 percent). For Action Alternative 2C, the levels of criteria pollutants exceeding 10 percent would be PM_{10} (25 percent) and SO_2 (12 percent) at WIPP (DOE 1997) (see Appendix C for additional detail). Minor increases in PM_{10} levels may occur during construction.

RFETS, LLNL, NTS, and ANL-E are in nonattainment areas for some of the pollutants. In those areas where air pollution standards are not met (nonattainment areas), activities that introduce new sources of emissions are regulated under the General Conformity Rule. In areas where air pollution standards are met (attainment areas), regulations for the PSD of ambient air quality apply. In both cases, a permit is required for sources that will result in emissions equal to or greater than the limits set by pertinent regulations.

Of hazardous or toxic air pollutant releases, only radionuclide releases would exceed 10 percent of the applicable regulatory standard. For Action Alternative 2A, treatment-related releases could reach 134 percentof the regulatory standard at LANL. For Action Alternative 2B, treatment-related releases could reach 10 percent of the regulatory standard at INEEL. For Action Alternative 2C, releases could reach 137 percent of the regulatory standard at WIPP. Postulated waste treatment-related releases above the regulatory standard would require mitigation measures, such as HEPA filtration, to ensure they remained below the allowable limit.

The potential air quality impacts from the operation of WIPP for disposal under Action Alternatives 2A, 2B, and 2C would be the same as those anticipated under the Proposed Action. Although the increased waste disposal volume at WIPP would increase the duration of disposal activities, there would be no substantial difference in the rate of pollutant emissions on either an annual or a short-term basis.

Potential air quality impacts due to the decommissioning of WIPP under Action Alternative 2 would be similar to those under the Proposed Action. Construction of the berm and permanent markers and other decommissioning activities would last longer than under the Proposed Action and other alternatives, but would probably produce negligible increases in annual pollutant emissions compared to the other alternatives.

5.3.3 Biological Resources

The biological impacts at the treatment sites (including WIPP) for Action Alternatives 2A, 2B, and 2C would be the same as those for the Proposed Action. Though additional waste would be treated using a different treatment method, the size, type, and number of the treatment facilities would be comparable to those assessed in the WM PEIS, which determined that construction and operation of the treatment facilities should not affect populations of nonsensitive plant and animal species. Also, terrestrial wildlife species probably would not be affected by airborne emissions nor by spills into aquatic environments due to traffic accidents (DOE 1997). Threatened and endangered species may be present at all of the proposed treatment sites; however, impacts to these species would depend on the actual location of the facility at a particular site. Site selection would be conducted following appropriate Endangered Species Act consultation and site-wide or project-level NEPA review during which such impacts would be assessed and mitigated, if necessary. The critical habitats of species listed by the state and federal governments as endangered, threatened or candidates would be avoided.

Federally listed, threatened and endangered, and state-listed species occur in Eddy County and potentially at the WIPP, although DOE has not observed threatened, endangered, or proposed species or critical habitats at the WIPP site during surveys conducted for recent biennial environmental compliance reports. DOE recently completed a site-specific biological survey yet to be published, during which no endangered, threatened, or state-listed species were identified.

At WIPP, potential impacts on biological resources for disposal operations would be similar to those under the Proposed Action, described in Section 5.1.3. The increased underground waste disposal area, though, would lead to greater impacts during closure and post-closure activities. Approximately 395 hectares (976 acres) of aboveground area would be affected by decommissioning, salt pile reclamation, and closure construction of berms and permanent markers. These activities would disturb avian and small mammal habitat within and near the area. These disturbed areas would be attractive as habitat after natural vegetation recolonizes.

5.3.4 Cultural Resources

The impacts to cultural resources at the treatment sites under Action Alternatives 2A, 2B, and 2C would be the same as those for the Proposed Action. Construction and operation of treatment facilities (including that proposed for WIPP under Action Alternative 2C) could adversely affect cultural resources, but site-level cultural resource surveys would be conducted, and protection measures established, where necessary, when specific facility construction locations are proposed. These surveys would be part of site-wide or project-level NEPA reviews.

Waste shipment and disposal activities at WIPP would not have an impact on archaeological sites; however, some sites could be affected by expansion of the disposal area and closure- and decommissioning-related activities. The land that would be disturbed due to closure and decommissioning under Action Alternatives 2A, 2B, and 2C covers a substantially larger area (395 hectares [976 acres]) than that under the Proposed Action.

Since publication of SEIS-I in 1990, additional cultural resource surveys have been conducted at WIPP. Based on inventory data, and assuming environmental homogeneity and a fairly even distribution of archaeological sites, DOE estimates that the WIPP site may contain about 99 archaeological sites and 153 locations where isolated artifacts may exist. There are no known Native American sacred sites or burials in the Land Withdrawal Area.

Measures for ensuring protection of known archaeological and historic resources, or others that may be inadvertently discovered during ground-disturbing activities, are discussed in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996a). DOE will avoid, to the extent possible, sites found eligible for inclusion in the NRHP. Where avoidance is not possible, mitigation measures will be developed under the Joint Powers Agreement with the State of New Mexico.

5.3.5 Noise

Treatment sites would probably be located in industrial areas along high-volume highway corridors; therefore, ambient noise levels are not likely to increase substantially, although some sensitive receptors may be affected (DOE 1997). Further assessment of these impacts was reserved until actual siting of treatment facilities is proposed in a site-wide or project-specific NEPA document. Under each Action Alternative 2 subalternative, all waste would travel to WIPP, but only a portion of the waste would travel from or to each treatment facility; therefore, the greatest impacts due to transportation noise would be near the WIPP site.

Disposal operations at WIPP would result in noise impacts similar to those discussed for the Proposed Action in Section 5.1.5. Potential noise impacts at WIPP from truck transportation also would be similar to those under the Proposed Action (Section 5.1.5). Estimated rail noise from transportation would be similar to those under Action Alternative 1 (Section 5.2.5).

5.3.6 Water Resources and Infrastructure

The following sections discuss the water resource and infrastructure impacts of the three Action Alternative 2 subalternatives.

Action Alternative 2A

Although no off-site infrastructure impacts would be expected to occur; proposed TRU waste activities may affect on-site activities. The affected infrastructure elements analyzed were on-site transportation and the capacity of on-site water, power, and wastewater systems. For Action Alternative 2A, on-site demand for wastewater at Hanford would exceed 5 percent of current demand (7.8 percent) and at INEEL, an increase in the on-site demand for power of 6.6 percent would occur.

Minor impacts to the on-site transportation infrastructure would be expected under Action Alternative 2A. These impacts would result from an increase in on-site employment of 9 percent at Hanford and INEEL and 7 percent at LANL. Impacts to the off-site transportation infrastructure would not occur because population increases would not exceed 5 percent.

Negligible annual infrastructure impacts would be expected at WIPP under Action Alternative 2A. Existing water supply and sewer capabilities and existing and planned power and roadway resources will be able to accommodate proposed disposal operations.

Action Alternative 2B

For Action Alternative 2B, Hanford would have an increase in on-site demand for wastewater that would exceed 5 percent of current demands (7.8 percent) and INEEL would have an increase in the on-site demand for power by 6.6 percent.

Minor impacts to the on-site transportation infrastructure would be expected under Action Alternative 2B. These impacts would result from an increase in on-site employment of 9 percent at

Hanford and 11 percent at INEEL. Impacts to the off-site transportation infrastructure would not occur because population increases would not exceed 5 percent.

Negligible annual infrastructure impacts at WIPP would be expected under Action Alternative 2B for disposal operations. Existing water supply and sewer capabilities and existing and planned power and roadway resources will be able to accommodate proposed disposal operations.

Action Alternative 2C

The greatest incremental impacts to infrastructure would occur under Action Alternative 2C due to treatment activities at the WIPP site. Expected impacts under Action Alternative 2C include INEEL increasing on-site demand for power by 6.6 percent and WIPP increasing wastewater treatment demand by approximately 80 percent and power by 50 percent. The increase in wastewater treatment demand at WIPP could exceed the current system capacity by approximately 60 percent. The increase in power demand at WIPP would not cause total power demand to exceed 90 percent of current capacity.

Minor impacts to the on-site transportation infrastructure would be expected under Action Alternative 2C. These impacts result from an increase in on-site employment of 6 percent at Hanford and 162 percent at WIPP. Impacts to the off-site transportation infrastructure would not be anticipated because population increases would not exceed 5 percent.

Negligible annual infrastructure impacts would be expected at WIPP under Action Alternative 2C for disposal operations. Existing water supply and sewer capabilities and existing and planned power and roadway resources will be able to accommodate proposed disposal operations.

5.3.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts for the Action Alternative 2 subalternatives are presented in the following subsections.

5.3.7.1 Life-Cycle Costs

The life-cycle costs of the three Action Alternative 2 subalternatives are presented in the following subsections.

Life-Cycle Costs for Action Alternative 2A

Table 5-36 shows the life-cycle costs under Action Alternative 2A. Waste treatment facility costs reflect construction, O&M, and D&D at the waste treatment sites, which would thermally treat waste to meet the LDRs and package the waste over a period of 35 years. In addition, Hanford, which has the largest volume, would store portions of the treated waste over a period of 150 years because of WIPP emplacement limitations. Life cycle costs include an additional $700 million to account for treatment to planning-basis WAC of waste that would be shipped for thermal treatment. The waste treatment facility life-cycle costs would be $27.69 billion (in 1994 dollars).

Table 5-36
Life-Cycle Costs for Action Alternative 2A (in millions of 1994 dollars) [a]

Cost Information	Basic Inventory			Additional Inventory			Total	Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste
Treatment Facilities	11,000	4,500	15,500	11,340	850	12,190	27,690	15,360
Transport by Truck	870	920	1,790	1,100	100	1,200	2,990	510
Transport by Regular Train	290	310	600	370	30	400	1,010	170
Transport by Dedicated Train	2,010	2,100	4,110	2,530	220	2,750	6,860	1,160
Disposal at WIPP	10,000	2,600	12,600	10,500	230	10,730	23,330	3,700
Total Life-Cycle Cost (Truck)	21,870	8,020	29,890	22,940	1,180	24,120	54,010	19,560
Total Life-Cycle Cost (Regular Train)	21,290	7,410	28,700	22,210	1,110	23,320	52,030	19,220
Total Life-Cycle Cost (Dedicated Train)	23,010	9,200	32,210	24,370	1,300	25,670	57,880	20,210

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

Life-cycle costs also include one of three options for TRU waste transportation between consolidation sites and WIPP: (1) trucks, as explained under the Proposed Action, (2) truck and rail using commercial rail as explained under Action Alternative 1, and (3) truck and rail using dedicated rail, also as explained in Action Alternative 1. Rail routes would be used to the greatest extent practicable. Under these options, transportation costs include the consolidation of waste volumes at the treatment sites and shipment via truck or rail to WIPP for emplacement. The waste transport life-cycle costs would be about $2.99 billion by truck, $1.01 billion by regular rail, and $6.86 billion by dedicated rail.

The WIPP life-cycle costs would be $23.33 billion. The total life-cycle costs of Action Alternative 2A would be $54.01 billion ($19.56 billion when discounted) using truck, $52.03 billion ($19.22 billion when discounted) using regular rail, or $57.88 billion ($20.21 billion when discounted) using dedicated rail transportation.

Life-Cycle Cost for Action Alternative 2B

The life-cycle costs of Action Alternative 2B are presented in Table 5-37. This alternative would involve the same combined CH-TRU and RH-TRU waste volumes considered under Action Alternative 2A. However, the waste management facility costs include waste treatment at fewer TRU waste treatment sites. Again, due to WIPP emplacement limitations, the site with the largest volume (Hanford) would incur additional storage costs over the life of the project. Life-cycle costs include an additional $3.8 billion to account for treatment to planning-basis WAC of waste that would be shipped for thermal treatment. The waste treatment facility life-cycle costs at the treatment sites would be $30.55 billion (in 1994 dollars).

Table 5-37
Life-Cycle Costs for Action Alternative 2B (in millions of 1994 dollars) [a]

	Basic Inventory			Additional Inventory			Total	Total Discounted
Cost Information	**CH-TRU Waste**	**RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU Waste**	**RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU and RH-TRU Waste**
Treatment Facilities	12,150	4,960	17,110	12,500	940	13,440	30,550	16,940
Transport by Truck	960	1,010	1,970	1,220	110	1,330	3,300	560
Transport by Regular Train	330	350	680	420	40	460	1,140	190
Transport by Dedicated Train	2,190	2,290	4,480	2,760	240	3,000	7,480	1,260
Disposal at WIPP	10,000	2,600	12,600	10,500	230	10,730	23,330	3,700
Total Life-Cycle Cost (Truck)	23,110	8,570	31,680	24,220	1,280	25,500	57,180	21,190
Total Life-Cycle Cost (Regular Train)	22,480	7,910	30,390	23,420	1,210	24,630	55,020	20,830
Total Life-Cycle Cost (Dedicated Train)	24,340	9,850	34,190	25,760	1,410	27,170	61,360	21,900

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

As under Action Alternative 2A, three options for waste transportation between consolidation sites and WIPP were examined: (1) trucks, as in the Proposed Action, (2) truck and rail using commercial rail as in Action Alternative 1, and (3) truck and rail using dedicated rail service, also as in Action Alternative 1. Rail routes would be used to greatest extent practicable. Transportation costs reflect consolidating the waste volumes at the treatment sites, and then shipping the waste to WIPP for emplacement. The life-cycle waste transport costs would be about $3.30 billion by truck, $1.14 billion by regular rail, and $7.48 billion by dedicated rail.

The WIPP life-cycle costs would be $23.33 billion. The total life-cycle costs of Action Alternative 2B would be $57.18 billion ($21.19 billion when discounted) using truck, $55.02 billion ($20.83 billion when discounted) using regular rail, or $61.36 billion ($21.90 billion when discounted) using dedicated rail transportation.

Life-Cycle Costs for Action Alternative 2C

The life-cycle costs for Action Alternative 2C are presented in Table 5-38. The same combined CH-TRU and RH-TRU waste volumes were considered for this subalternative as were considered under the other Action Alternative 2 subalternatives. Life-cycle costs include an additional $18.5 billion to account for treatment of waste to planning-basis WAC so the waste can be shipped for thermal treatment. Waste treatment facility costs include the activities at Hanford and ORNL for RH-TRU waste and WIPP for CH-TRU waste. The largest site (Hanford) would incur additional storage costs over the 150-year period due to WIPP emplacement limitations. The waste treatment facility life-cycle costs would be $28.7 billion (in 1994 dollars).

The RH-TRU waste transportation costs reflect consolidation of the RH-TRU waste volumes at Hanford and ORNL for treatment and shipment to WIPP. The CH-TRU transportation costs reflect consolidation of CH-TRU waste volumes at WIPP. Transportation modes analyzed included truck, regular rail service, and dedicated rail service. The life-cycle waste transportation costs would be about $2.91 billion by truck, $910 million by regular rail, and $6.54 billion by dedicated rail.

Table 5-38
Life-Cycle Costs for Action Alternative 2C (in millions of 1994 dollars) [a]

Cost Information	Basic Inventory			Additional Inventory			Total	Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU Waste and RH-TRU Waste	CH-TRU Waste	RH-TRU Waste	CH-TRU Waste and RH-TRU Waste	CH-TRU Waste and RH-TRU Waste	CH-TRU Waste and RH-TRU Waste
Treatment Facilities [b]	8,330	9,630	17,960	8,730	2,010	10,740	28,700	15,910
Transport by Truck	1,160	910	2,070	740	100	840	2,910	490
Transport by Regular Train	360	290	650	230	30	260	910	150
Transport by Dedicated Train	2,610	2,050	4,660	1,660	220	1,880	6,540	1,100
Disposal at WIPP	10,000	2,600	12,600	10,500	230	10,730	23,330	3,700
Total Life-Cycle Cost (Truck)	19,490	13,140	32,630	19,970	2,340	22,310	54,940	20,100
Total Life-Cycle Cost (Regular Rail)	18,690	12,520	31,210	19,460	2,270	21,730	52,940	19,760
Total Life-Cycle Cost (Dedicated Rail)	20,940	14,280	35,220	20,890	2,460	23,350	58,570	20,720

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

[b] All CH-TRU waste treatment occurs at the WIPP site under this subalternative.

The WIPP life-cycle disposal costs would be $23.33 billion. The total life-cycle costs of Action Alternative 2C would be $54.94 billion ($20.10 billion when discounted) using truck, $52.94 billion ($19.76 billion when discounted) using regular rail or $58.57 billion ($20.72 billion when discounted) using dedicated rail transportation.

5.3.7.2 Economic Impacts

TRU waste treatment activities would support direct, indirect, and induced jobs. Action Alternative 2A would support approximately 28,000 jobs in the ROIs of the six treatment sites (Hanford, INEEL, LANL, ORNL, RFETS, and SRS). Action Alternative 2B would support approximately 28,500 jobs in the ROIs of the four treatment sites (Hanford, INEEL, ORNL, and SRS). Action Alternative 2C would support approximately 7,200 jobs in the ROIs of the three treatment sites (Hanford, ORNL, and WIPP).

Estimates of the impacts of Action Alternatives 2A, 2B, and 2C on employment, income, and the production of goods and services within the WIPP ROI are presented in Table 5-39. For Action Alternatives 2A and 2B, these impacts were estimated using an average annual budget of $180 million per year (in 1994 dollars) over a 150-year period of waste disposal operations. Over this period, the WIPP facility would remain a stable federal employer in the ROI economy, providing direct employment for 1,095 site personnel annually. Indirectly, the operation of WIPP as a waste emplacement facility (from 1998 through 2148) would annually support 2,443 indirect and induced jobs in the ROI work force. The total WIPP-induced employment within the ROI is estimated to be 3,538 per year reflecting the sum of these direct and indirect employment levels.

Table 5-39
Economic Impacts within the WIPP ROI for Action Alternatives 2A, 2B, and 2C

Economic Effects	Total Output of Goods and Services (in millions of 1994 dollars)	Total Employment and Part-Time Jobs)	Total Labor Income (in millions of 1994 dollars)	Carlsbad Output of Goods and Services (in millions of 1994 dollars)	Carlsbad Employment (Full- and Part-Time Jobs)	Carlsbad Labor Income (in millions of 1994 dollars)
Action Alternatives 2A and 2B						
Direct – Annual	113	1,095	52	95	979	46
Indirect & Induced – Annual	204	2,443	75	172	2,185	67
Total – Annual	317	3,538	126	267	3,164	113
Total - Operations (150 years)	47,550	530,700	18,900	40,050	474,600	16,950
Action Alternative 2C						
Direct – Annual	220	2128	100	185	1903	90
Indirect & Induced – Annual	396	4748	145	334	4246	130
Total – Annual	616	6876	245	519	6148	220
Total - Operations (150 years)	92,400	1,031,400[a]	36,750	77,850	922,200 [a]	33,000

[a] Job-years (number of annual jobs supported multiplied by the number of years in the project).

Action Alternatives 2A and 2B would not be expected to result in any socioeconomic impacts in the WIPP ROI beyond those associated with WIPP disposal operations, such as additional government-provided goods or services (schools, police, fire protection, and health protection), or major capital investments in public infrastructure within the ROI. Action Alternatives 2A and 2B would not be expected to impact the local real estate market, nor result in major changes in WIPP ROI work force population.

Under Action Alternative 2C, however, the economic impacts were estimated using an average annual budget of $350 million per year over a 150-year period. Because of the relatively larger scope of operations, Action Alternative 2C would have relatively larger economic impacts in the WIPP ROI, and Carlsbad, in particular. The combination of treatment and emplacement operations is estimated to provide direct employment for 2,128 site personnel annually. The combined operations would annually support 4,748 indirect and induced jobs in the ROI work force. The total WIPP-related employment impact within the ROI is estimated to be 6,876 per year, reflecting the sum of these direct and indirect employment levels.

Action Alternative 2C may have a relatively large economic impact in WIPP ROI due to the projected budget of $350 million per year, almost twice the levels observed during the 1988-1996 period. The relatively larger budget reflects waste treatment and storage costs for the CH-TRU waste inventory. Given the relatively larger scope of activities at the WIPP site, Action Alternative 2C has the potential of increasing the demand for government-provided goods and services (schools, police, fire protection, and health protection) within the ROI, as well as requiring additional capital investments in public infrastructure. Similarly, this subalternative would have the potential of increasing the level of activity within the local real estate market due to resulting changes in the WIPP ROI population and work force characteristics.

5.3.8 Transportation

This section describes the transportation impacts associated with the implementation of Action Alternatives 2A, 2B, and 2C. Descriptions of these alternatives are provided in Chapter 3.

Detailed results are presented for truck transportation. Rail transportation impacts adjusted from truck transportation results are presented in the final subsection for both the regular and dedicated rail options.

5.3.8.1 Route Characteristics and Shipment Projections

The methods used to determine route characteristics and the number of shipments for this alternative were identical to those presented in Section 5.1.8.1. Table 5-40 presents the number of shipments required under Action Alternatives 2A, 2B, and 2C.

Although the consolidation and treatment of waste would be different under each Action Alternative 2 subalternative than under the Proposed Action, those sites that would ship to WIPP would use the same routes. The one-way mileages from the treatment sites to WIPP, therefore, are the same as those presented for the Proposed Action in Table 5-5.

Table 5-40
Number of Truck Shipments to WIPP for Action Alternatives 2A, 2B, and 2C [a]

	Action Alternative 2A			**Action Alternative 2B**			**Action Alternative 2C**		
Waste Treatment Site	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**
CH-TRU Waste									
Argonne National Laboratory - East	---	---	---	---	---	---	22	---	22
Hanford Site	8,230	8,813	17,043	8,230	8,813	17,043	11,562	7,194	18,756
Idaho National Engineering and Environmental Laboratory/ANL-West	4,178	12,388	16,566	8,653	14,335	22,988	4,892	6,639	11,531
Lawrence Livermore National Laboratory	---	---	---	---	---	---	137	---	137
Los Alamos National Laboratory	2,952	1,947	4,899	---	---	---	4,236	1,590	5,826
Mound Plant	---	---	---	---	---	---	50	3	53
Nevada Test Site	---	---	---	---	---	---	73	---	73
Oak Ridge National Laboratory	---	---	---	---	---	---	192	8	200
Rocky Flats Environmental Technology Site	1,524	---	1,524	---	---	---	2,102	---	2,102
Savannah River Site	2,020	723	2,743	2,020	723	2,743	1,893	558	2451
Total CH-TRU Waste	18,904	23,871	42,775	18,903	23,871	42,774	25,159	15,992	41,151
RH-TRU Waste									
Hanford Site	17,730	1,031	18,761	17,730	1,031	18,761	17,730	1,031	18,761
Oak Ridge National Laboratory	2,057	1,077	3,134	2,057	1,077	3,134	2,057	1,077	3,134
Total RH-TRU Waste	19,787	2,108	21,895	19,787	2,108	21,895	19,787	2,108	21,895

[a] The total number of shipments under any of the subalternatives presented here do not include shipments from the generator sites to the consolidation sites. The number of consolidation shipments are: Subalternative 2A – 538 (CH-TRU waste), 8,254 (RH-TRU waste); Subalternative 2B – 8,466 (CH-TRU waste), 8,254 (RH-TRU waste); Subalternative 2C – 0 (CH-TRU waste), 8,254 (RH-TRU waste).

5.3.8.2 Accidents, Injuries, Fatalities, and Pollution-Related Health Effects from Truck Transportation

The following subsections present the number of nonradiological accidents, injuries, and fatalities expected under Action Alternatives 2A, 2B, and 2C. Table 5-41 presents a summary of these impacts as well as the pollution health effects (in fatalities), which are based upon the total miles traveled in urban areas and 9.9 x 10^{-8} fatalities per kilometer (1.6 x 10^{-7} per mile) (Rao et al. 1982). Also included in the results of Table 5-41 are the impacts due to TRU waste consolidation prior to thermal treatment. For additional details on the adjustment process, see Appendix E.

For Action Alternative 2A, the total number of nonradiological accidents, injuries and fatalities over the entire shipping campaign were estimated to be 109, 76, and 10, respectively. For Action Alternative 2B, the total numbers were 123 accidents, 86 injuries, and 11 fatalities. For Action Alternative 2C, the total numbers were 105 accidents, 74 injuries, and 11 fatalities, respectively.

Table 5-41
Nonradiological Impacts of Transporting TRU Waste by Truck for Action Alternatives 2A, 2B, and 2C

	Action Alternative 2A			Action Alternative 2B			Action Alternative 2C		
Impact	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**	**Basic Inventory**	**Additional Inventory**	**Total**
CH-TRU Waste									
Number of Accidents	28	38	66	38	42	80	36	26	62
Number of Injuries	20	25	45	27	28	55	26	17	43
Number of Fatalities	3	3	6	4	4	8	4	3	7
Pollution Health Effects (fatalities)	0.09	0.1	0.2	0.1	0.1	0.2	0.1	0.08	0.2
RH-TRU Waste									
Number of Accidents	38	6	43	38	6	43	38	6	43
Number of Injuries	26	5	31	26	5	31	26	5	31
Number of Fatalities	4	1	4	4	1	4	4	1	4
Pollution Health Effects (fatalities)	0.1	0.03	0.1	0.1	0.03	0.1	0.1	0.03	0.2
Total									
Number of Accidents	66	44	109	76	48	123	74	32	105
Number of Injuries	46	30	76	53	33	86	51	22	74
Number of Fatalities	6	4	10	6	5	11	7	4	11
Pollution Health Effects (fatalities)	0.2	0.1	0.4	0.2	0.1	0.5	0.2	0.1	0.4

5.3.8.3 Accident-Free Radiological Impacts from Truck Transportation

The methods used to determine accident-free radiological impacts for Action Alternatives 2A, 2B, and 2C were identical to those used for the Proposed Action.

Table 5-42 presents a summary of the accident-free radiological impacts. For Action Alternative 2A, the total occupational and nonoccupational population doses would result in 0.5 LCF and 6.2 LCFs, respectively. For Action Alternative 2B, the total occupational and nonoccupational population doses estimated would result in 0.7 LCF and 6.9 LCFs, respectively. For Action Alternative 2C, the total occupational and nonoccupational population doses estimated would result in 0.5 LCF and 6.0 LCFs, respectively.

Table 5-42
Aggregate Accident-Free Population Radiological Impacts from Truck Transportation for Action Alternatives 2A, 2B, and 2C (LCFs) [a]

Impact	Action Alternative 2A			Action Alternative 2B			Action Alternative 2C		
	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total
CH-TRU Waste									
Occupational	0.2	0.2	0.4	0.3	0.3	0.6	0.2	0.2	0.4
Nonoccupational									
Stops	1.3	1.7	3.0	1.8	1.9	3.7	1.6	1.1	2.7
Sharing Route	0.07	0.09	0.2	0.1	0.1	0.2	0.09	0.06	0.2
Along Route	0.03	0.03	0.06	0.04	0.04	0.08	0.04	0.02	0.06
Nonoccupational - Total	1.4	1.8	3.2	1.9	2.0	3.9	1.8	1.2	3.0
RH-TRU Waste									
Occupational	0.1	0.02	0.1	0.1	0.02	0.1	0.1	0.02	0.1
Nonoccupational									
Stops	2.4	0.4	2.8	2.4	0.4	2.8	2.4	0.4	2.8
Sharing Route	0.1	0.03	0.1	0.1	0.03	0.1	0.1	0.03	0.1
Along Route	0.05	0.02	0.07	0.05	0.02	0.07	0.05	0.02	0.07
Nonoccupational - Total	2.6	0.5	3.0	2.6	0.5	3.0	2.6	0.5	3.0
Total CH-TRU and RH-TRU Waste									
Occupational	0.3	0.2	0.5	0.4	0.3	0.7	0.3	0.2	0.5
Nonoccupational									
Stops	3.7	2.1	5.8	4.2	2.3	6.5	4.0	1.5	5.5
Sharing Route	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.09	0.3
Along Route	0.08	0.05	0.1	0.09	0.06	0.2	0.09	0.04	0.1
Nonoccupational - Total	4.0	2.3	6.2	4.5	2.5	6.9	4.4	1.7	6.0

[a] Exposure during stops is based upon 50 individuals exposed at 20 meters. Stop time, in hours, is based upon 0.011d where d is the distance traveled in kilometers. These parameters are built into the RADTRAN code but substantially overestimate exposures from WIPP shipments. Because WIPP shipments would use two-driver teams (eliminating the need for overnight stops to sleep) and because the shipments would stop at sites chosen, in part, for their lack of population, the actual impacts from stops would be much lower.

As in Table 5-41, Table 5-42 includes the impacts from consolidation prior to the thermal LDR treatment. For details on the adjustment method, see Appendix E.

Table 5-43 summarizes the radiological impacts to maximally exposed individuals for TRU waste shipments under Action Alternatives 2A, 2B, and 2C. Section 5.1.8.3 and Appendix E describe the methods used to estimate the impacts presented in Table 5-43. The results in Table 5-43 indicate that the departure inspectors and state inspectors would have the greatest probability of an LCF.

Table 5-43
Radiological Impacts to MEIs from Truck Transportation for Action Alternatives 2A, 2B, and 2C (Probability of an LCF)

Individual	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C
CH-TRU Waste			
Stuck in traffic next to shipment	2.5E-6	2.5E-6	2.5E-6
Departure Inspector	6.8E-4	6.8E-4	7.6E-4
State Vehicle Inspector	1.7E-3	2.0E-3	1.6E-3
Residing adjacent to access route	1.5E-4	1.5E-4	1.5E-4
Rest stop employee	1.0E-4	1.0E-4	1.0E-4
RH-TRU Waste			
Stuck in traffic next to shipment	5.0E-6	5.0E-6	5.0E-6
Departure Inspector	2.2E-3	2.2E-3	2.2E-3
State Vehicle Inspector	2.9E-3	2.9E-3	2.9E-3
Residing adjacent to access route	2.0E-4	2.0E-4	2.0E-4
Rest stop employee	1.0E-4	1.0E-4	1.0E-4
Total CH-TRU and RH-TRU Waste			
Stuck in traffic next to shipment	7.5E-6	7.5E-6	7.5E-6
Departure Inspector	2.9E-3	2.9E-3	3.0E-3
State Vehicle Inspector	4.6E-3	4.9E-3	4.5E-3
Residing adjacent to access route	3.5E-4	3.5E-4	3.5E-4
Rest stop employee	2.0E-4	2.0E-4	2.0E-4

5.3.8.4 Radiological Impacts from Truck Transportation Accidents

Two types of analyses were conducted for SEIS-II radiological impacts due to accidents. The first type of analysis determined the radiological impact due to accidents during transportation from treatment or generator-storage sites to WIPP. This analysis took into account eight different severities of accidents, the number of miles from each site, and the number of shipments. The results of the analyses for route-specific accidents summed over the entire shipping campaign are presented in Table 5-44.

The second type of analysis was an assessment of four conservative, bounding accident scenarios. Two involving the breach of a TRUPACT-II, and two involving the breach of an RH-72B cask. Details on the estimation of impacts from these bounding case accidents are presented in Appendix E and in Section 5.1.8. For Action Alternatives 2A and 2B, the potential radiological releases from bounding case accidents that would occur after treatment would be smaller than those presented for the Proposed Action, with less than 1 LCF estimated. Those during consolidation for treatment would be similar to those presented for the Proposed Action. For Action Alternative 2C, the transportation impacts for RH-TRU waste that has been treated would be similar to those for Action Alternatives 2A and 2B. All of the impacts due to CH-TRU waste and due to consolidation of RH-TRU waste for treatment would be similar to the impacts presented for the Proposed Action.

Although the radionuclide inventory concentration for waste that is thermally treated increases by a factor of about 2.8, the thermal treatment of the waste reduces the release fraction for a bounding accident by a factor greater than 1,000. A release fraction is the quantity of material that would be released in an accident. The assumptions and methods used for these analyses are presented in Appendix E.

Table 5-44
Aggregate Radiological Population Impacts by Truck for Action Alternatives 2A, 2B, and 2C (LCFs)

Origin	Action Alternative 2A			Action Alternative 2B			Action Alternative 2C		
	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total	Basic Inventory	Additional Inventory	Total
CH-TRU Waste									
Argonne National Laboratory-East	-----	-----	-----	-----	-----	-----	3.5E-4	-----	3.5E-4
Hanford Site	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.2	0.5
Idaho National Engineering and Environmental Laboratory/ANL-W	0.06	0.2	0.3	0.1	0.2	0.3	0.07	0.09	0.2
Lawrence Livermore National Laboratory	-----	-----	-----	-----	-----	-----	1.5E-3	-----	1.5E-3
Los Alamos National Laboratory	2.0E-3	1.5E-3	3.5E-3	-----	-----	-----	3.0E-3	1.0E-3	4.0E-3
Mound Plant	-----	-----	-----	-----	-----	-----	1.0E-3	5.0E-5	1.0E-3
Nevada Test Site	-----	-----	-----	-----	-----	-----	5.0E-4	-----	5.0E-4
Oak Ridge National Laboratory	-----	-----	-----	-----	-----	-----	2.5E-3	1.0E-4	2.5E-3
Rocky Flats Environmental Technology Site	5.0E-3	-----	5.0E-3	-----	-----	-----	7.0E-3	-----	7.0E-3
Savannah River Site	0.02	8.0E-3	0.03	0.02	8.0E-3	0.03	0.02	6.0E-3	0.03
RH-TRU Waste									
Hanford Site	0.02	1.5E-3	0.03	0.02	1.5E-3	0.03	0.02	1.5E-3	0.03
Oak Ridge National Laboratory	1.5E-3	1.0E-3	2.5E-3	1.5E-3	1.0E-3	2.5E-3	1.5E-3	1.0E-3	2.5E-3
Total CH-TRU and RH-TRU Waste									
Argonne National Laboratory-East	-----	-----	-----	-----	-----	-----	3.5E-4	-----	3.5E-4
Hanford Site	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.2	0.5
Idaho National Engineering and Environmental Laboratory/ANL-W	0.06	0.2	0.3	0.1	0.2	0.3	0.07	0.09	0.2
Lawrence Livermore National Laboratory	-----	-----	-----	-----	-----	-----	1.5E-3	-----	1.5E-3
Los Alamos National Laboratory	2.0E-3	1.5E-3	3.5E-3	-----	-----	-----	3.0E-3	1.0E-3	4.0E-3
Mound Plant	-----	-----	-----	-----	----	-----	1.0E-3	5.0E-5	1.0E-3
Nevada Test Site	-----	-----	-----	-----	-----	-----	5.0E-4	-----	5.0E-4
Oak Ridge National Laboratory	1.5E-3	1.0E-3	2.5E-3	1.5E-3	1.0E-3	2.5E-3	4.0E-3	1.0E-3	5.0E-3
Rocky Flats Environmental Technology Site	5.0E-3	-----	5.0E-3	-----	-----	-----	7.0E-3	-----	7.0E-3
Savannah River Site	0.02	8.0E-3	0.03	0.02	8.0E-3	0.03	0.02	6.0E-3	0.03
Total	0.3	0.4	0.7	0.3	0.4	0.7	0.4	0.3	0.7

5.3.8.5 Hazardous Chemical Impacts from Severe Truck Transportation Accidents to WIPP

During a severe accident, hazardous chemical releases under Action Alternatives 2A, 2B, and 2C would not pose a threat because the waste would have been thermally treated before being transported. Thermal treatment would eliminate the presence of all VOCs and greatly reduce the release fraction for heavy metals.

5.3.8.6 Impacts from Rail Transportation

This section presents a summary of transportation impacts for both the regular and dedicated rail transportation options. These impacts were estimated by scaling the transportation impacts from truck transportation to the impacts for rail transportation. In Appendix E, each of the impact parameters are identified, and the differences between truck and rail transportation are explained. Table 5-45 presents the estimated rail impacts for Action Alternatives 2A, 2B, and 2C.

Table 5-45
Impacts from Rail Transportation
for Action Alternatives 2A, 2B, and 2C

	Action Alternative 2A	Action Alternative 2B	Action Alternative 2C
Aggregate Traffic-Related Fatalities			
Regular Rail	5	6	6
Dedicated Rail	70	84	84
Aggregate Accident-Free Radiological Impacts (LCFs)			
CH-TRU Waste			
Occupational	0.02	0.03	0.02
Nonoccupational			
Stops	0.4	0.4	0.3
Sharing Route	1.7E-3	2.0E-3	1.6E-3
Along Route	0.09	0.1	0.09
Nonoccupational -Total	0.5	0.6	0.4
RH-TRU Waste			
Occupational	5.7E-3	5.7E-3	5.7E-3
Nonoccupational			
Stops	0.3	0.3	0.3
Sharing Route	1.6E-3	1.6E-3	1.6E-3
Along Route	0.1	0.1	0.1
Nonoccupational - Total	0.4	0.4	0.4
Total CH-TRU and RH-TRU Waste			
Occupational	0.03	0.03	0.03
Nonoccupational			
Stops	0.7	0.8	0.7
Sharing Route	3.3E-3	3.7E-3	3.2E-3
Along Route	0.2	0.2	0.2
Nonoccupational - Total	0.9	1.0	0.9
Aggregate Radiological Impacts from Rail Transportation Accidents (LCFs)			
CH-TRU Waste	0.7	0.7	0.7
RH-TRU Waste	0.03	0.03	0.03
Total CH-TRU and RH-TRU Waste	0.7	0.7	0.7

The analyses of bounding case accidents assumed similar accidents to those described in Section 5.2.8.6. For that waste treated thermally before shipment by train, the release fraction would be reduced by a factor of 1,000. However, thermal treatment increases the concentration of radionuclides by approximately a factor of 2.8. The combination of these two factors reduces the impacts for rail accidents to the following:

- For the accident with the conservative inventory in two breached TRUPACT-IIs, the total population dose under Action Alternatives 2A and 2B would result in 0.09 LCF in the exposed population. The estimated maximum individual dose would result in a 3×10^{-4} probability of a cancer fatality. Impacts for Action Alternative 2C would be the same as those presented for Action Alternative 1.

- For the accident with a conservative inventory in two breached RH-72Bs, the total population dose would result in 0.09 LCF in the exposed population. The estimated maximum individual dose would result in a 3×10^{-4} probability of a cancer fatality.

- For the accident with average concentrations of radionuclides in two breached TRUPACT-IIs, approximately 0.02 LCF in the exposed population would be expected under Action Alternatives 2A and 2B. The estimated maximum individual dose under these two subalternatives would result in a 2×10^{-4} probability of a cancer fatality. Impacts for Action Alternative 2C would be the same as those presented for Action Alternative 1.

- For the accident with average concentrations of radionuclides in two breached RH-72B casks, the total population dose would result in an expectation of 2×10^{-4} LCF in the population. The estimated maximum individual dose would result in a 4×10^{-6} probability of a cancer fatality.

5.3.9 Human Health Impacts from Waste Treatment, Storage, and Disposal Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from waste treatment, lag storage, and WIPP disposal operations under Action Alternatives 2A, 2B, and 2C. Impacts from waste treatment were adjusted from those presented in the WM PEIS, and a description of this adjustment is provided in Appendix B. Impacts from lag storage at the treatment sites (including WIPP under Action Alternative 2C) and WIPP disposal operations were estimated using the general methods and assumptions used for the human health analyses of the Proposed Action and Action Alternative 1. Action Alternative 2 is the only action alternative that eliminates the risk from storage of PCB-commingled TRU waste at the three sites known to store such waste (242 cubic meters [8,550 cubic feet] at Hanford, 461 cubic meters [16,300 cubic feet] at INEEL, and 19 cubic meters [670 cubic feet] at Mound). All VOCs in the waste under these subalternatives would be destroyed during thermal treatment, and all heavy metals would be immobilized. Therefore, no routine releases of hazardous chemicals would occur in subsequent lag storage or WIPP disposal operations. Thermal treatment also concentrates the waste and radionuclides into a smaller, more dense volume. Denser waste matrices tend to decrease surface dose rates because of more self-absorption of the external radiation emitted by radionuclides in the waste. Worker radiological impacts reflect the impact of these factors. Appendix F provides additional information on the methods used to determine the impacts from lag storage and WIPP disposal operations.

5.3.9.1 Public

Impacts to the populations and to the MEIs under Action Alternatives 2A, 2B, and 2C are presented in this section; results are presented in Table 5-46. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different populations and individuals would be impacted by these activities. Waste treatment and lag storage would take place at six DOE sites under Action Alternative 2A, four sites under Action Alternative 2B, and three sites (including WIPP) under Action Alternative 2C. Waste disposal operations would take place only at WIPP.

Table 5-46
Lifetime Human Health Impacts to the Public from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternatives 2A, 2B, and 2C

	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
Category	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**
MEI [b, c]						
Basic Inventory						
2A CH-TRU Waste	3E-5 (R)	3E-13 (L)	1E-7 (L)	0	5E-8	0
2B CH-TRU Waste	2E-5 (H)	3E-13 (I)	5E-9 (S)	0	5E-8	0
2C CH-TRU Waste	1E-4 (W)	3E-13 (W)	5E-8 (W)	0	5E-8	0
RH-TRU Waste	4E-7 (O)	1E-11 (O)	1E-9 (H)	0	7E-10	0
2A Total Waste	3E-5 (R)	1E-11 (O)	1E-7 (L)	0	5E-8	0
2B Total Waste	2E-5 (H)	1E-11 (O)	5E-9 (S)	0	5E-8	0
2C Total Waste	1E-4 (W)	1E-11 (O)	5E-8 (W)	0	5E-8	0
Total Inventory						
2A CH-TRU Waste	3E-5 (R)	5E-13 (I)	2E-7 (L)	0	1E-7	0
2B CH-TRU Waste	5E-5 (H)	6E-13 (I)	1E-8 (S)	0	1E-7	0
2C CH-TRU Waste	2E-4 (W)	5E-13 (W)	1E-7 (W)	0	1E-7	0
RH-TRU Waste	6E-7 (O)	2E-11 (O)	2E-9 (H)	0	8E-10	0
2A Total Waste	3E-5 (R)	2E-11 (O)	2E-7 (L)	0	1E-7	0
2B Total Waste	5E-5 (H)	2E-11 (O)	1E-8 (S)	0	1E-7	0
2C Total Waste	2E-4 (W)	2E-11 (O)	1E-7 (W)	0	1E-7	0
Population [c]						
Basic Inventory						
2A CH-TRU Waste	2.2	5E-9	7E-4	0	2E-5	0
2B CH-TRU Waste	1.1	2E-9	4E-4	0	2E-5	0
2C CH-TRU Waste	0.4	7E-10	2E-5	0	2E-5	0
RH-TRU Waste	0.02	2E-7	3E-5	0	9E-7	0
2A Total Waste	2.2	2E-7	7E-4	0	2E-5	0
2B Total Waste	1.1	2E-7	4E-4	0	2E-5	0
2C Total Waste	0.4	2E-7	5E-5	0	2E-5	0
Total Inventory						
2A CH-TRU Waste	2.3	9E-9	1E-3	0	5E-5	0
2B CH-TRU Waste	2.3	4E-9	6E-4	0	5E-5	0
2C CH-TRU Waste	0.9	1E-9	5E-5	0	5E-5	0
RH-TRU Waste	0.02	3E-7	5E-5	0	1E-6	0
2A Total Waste	2.4	3E-7	1E-3	0	5E-5	0
2B Total Waste	2.3	3E-7	6E-4	0	5E-5	0
2C Total Waste	0.9	3E-7	1E-4	0	5E-5	0
Aggregate Total						
2A	2.4	3E-7	1E-3	0	5E-5	0
2B	2.3	3E-7	8E-4	0	5E-5	0
2C	0.9	3E-7	3E-4	0	5E-5	0

[a] The probability of an LCF occurring to the MEI, and the number of LCFs in the population.
[b] H = Hanford, L = LANL, S = SRS, O = ORNL, R = RFETS, W = WIPP, I = INEEL
[c] The MEI and populations evaluated for treatment, storage, and operations impacts are different.

Note: Sites in parentheses indicate where the greatest MEI impact occurs.

Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of all treatment sites, all lag storage sites, and at WIPP. The impacts to the MEIs from waste treatment and lag storage are presented for the highest individual waste treatment sites, while the impacts to the MEI from disposal operations are presented for an individual near WIPP. See Chapter 3 for additional information on where treatment and storage would occur.

Waste Treatment

Radiological impacts to the public from waste treatment under Action Alternatives 2A, 2B, and 2C would be 2.4, 2.3 and 0.9 LCFs, respectively, in the total population around the waste treatment sites. No cancer incidence would be expected in the total population from hazardous chemical exposure (3 x 10^{-7} cancers) under Action Alternatives 2A, 2B, and 2C. For radiological impacts, the MEI would be at RFETS under Action Alternative 2A (3 x 10^{-5} probability of an LCF), at Hanford under Action Alternative 2B (5 x 10^{-5} probability of an LCF), and at WIPP under Action Alternative 2C (2 x 10^{-4} probability of an LCF). Hazardous chemical impacts would not exceed a 2 x 10^{-11} probability of a cancer incidence at any site. No noncarcinogenic health effects are predicted. The maximum HIs for the MEIs would be 2 x 10^{-8} under Action Alternative 2A, 5 x 10^{-9} under Action Alternative 2B, and 1 x 10^{-7} under Action Alternative 2C, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

Only radiological impacts would result from lag storage because VOCs would be removed by thermal treatment under Action Alternatives 2A, 2B, and 2C. No LCFs would be expected in the total population around the lag storage sites under any of the alternatives, with 1 x 10^{-3}, 6 x 10^{-4}, and 1 x 10^{-4} LCFs expected under Action Alternatives 2A, 2B, and 2C, respectively. The MEI would be at LANL for Action Alternative 2A (2 x 10^{-7} probability of an LCF), at SRS for Action Alternative 2B (1 x 10^{-8} probability of an LCF), and at WIPP for Action Alternative 2C (1 x 10^{-7} probability of an LCF). No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

The aggregate total indicated in Table 5-46 refers to the impacts to the public expected over the entire operational period under Action Alternative 2. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 22 years for CH-TRU waste and 150 years for RH-TRU waste. No LCFs (a maximum of 1 x 10^{-3} LCFs under Action Alternative 2A) are expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials.

WIPP Disposal Operations

Only radiological impacts would result from disposal operations at WIPP because VOCs would be removed by thermal treatment. No LCFs would be expected in the population around WIPP from radiation exposure, with 5 x 10^{-5} LCFs expected under all three of the subalternatives.

The MEI was assumed to be located at the Land Withdrawal Area boundary, the closest point at which an individual could reside. The MEI would have a 1 x 10^{-7} probability of an LCF from radiation exposure under all three subalternatives. No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

The aggregate total indicated in Table 5-46 refers to the impacts expected over the entire operational period to the public residing within 80 kilometers (50 miles) at the WIPP site. The operational period for the disposal of the Total Inventory is expected to be 22 years for CH-TRU waste and 150 years for RH-TRU waste. No LCFs (5×10^{-5} LCFs) are expected to result from exposure to the estimated releases over the several generations.

5.3.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under Action Alternatives 2A, 2B, and 2C are presented in this section; results are presented in Table 5-47. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, storage, handling or disposal of waste. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different noninvolved worker populations and individuals would be impacted by these activities. Waste treatment and lag storage would take place at six DOE sites under Action Alternative 2A, four sites under Action Alternative 2B, and three sites (including WIPP) under Action Alternative 2C. Waste disposal operations would take place only at WIPP.

The impacts to the maximally exposed noninvolved worker from waste treatment and lag storage are presented for the highest individual waste treatment sites. The maximally exposed noninvolved worker from disposal operations would be at the WIPP site and was assumed to work continuously at the location where emissions have the least atmospheric dispersion and thus the greatest potential impact. This location was 200 meters (660 feet) east of the exhaust filter building. The maximum ground-level concentrations of any airborne contamination would be expected at this location.

Waste Treatment

No LCFs would be expected in the total noninvolved worker population at the waste treatment sites, with 0.1, 0.1, and 0.06 LCFs under Action Alternatives 2A, 2B, and 2C, respectively. No cancer incidence would be expected in the total noninvolved worker population from hazardous chemical exposure, with 1×10^{-7} cancers under each of the three subalternatives. The maximally exposed noninvolved worker for radiological impacts would be at RFETS under Action Alternative 2A (5×10^{-5} probability of an LCF), at Hanford under Action Alternative 2B (2×10^{-4} probability of an LCF), and at WIPP under Action Alternative 2C (2×10^{-4} probability of an LCF). Hazardous chemical impacts would not exceed a 1×10^{-10} probability of a cancer incidence at any site. No noncarcinogenic health effects are predicted. The maximum HIs for the maximally exposed noninvolved worker would be 2×10^{-7} under Action Alternative 2A, 1×10^{-7} under Action Alternative 2B, and 8×10^{-7} under Action Alternative 2C, and no health effects are predicted unless the HI is 1 or higher.

Lag Storage

Only radiological impacts would result from lag storage because VOCs would be removed by thermal treatment. No LCFs would be expected in the total noninvolved worker population at the lag storage sites under any of the alternatives, with 2×10^{-2}, 2×10^{-2}, and 4×10^{-4} LCFs expected under Action Alternatives 2A, 2B, and 2C, respectively. The maximally exposed noninvolved worker would be at SRS for Action Alternatives 2A and 2B (1×10^{-6} probability of an LCF), and at WIPP for Action Alternative 2C (1×10^{-7} probability of an LCF). No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

Table 5-47
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternatives 2A, 2B, and 2C

	Waste Treatment Impacts		**Lag Storage Impacts**		**WIPP Disposal Operations Impacts**	
Category	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**
Maximally Exposed Noninvolved Worker [b, c]						
Basic Inventory						
2A CH-TRU Waste	5E-5 (R)	1E-12 (I)	8E-7 (S)	0	8E-8	0
2B CH-TRU Waste	7E-5 (H)	2E-12 (I)	8E-7 (S)	0	8E-8	0
2C CH-TRU Waste	1E-4 (W)	2E-12 (W)	8E-8 (W)	0	8E-8	0
RH-TRU Waste	3E-7 (O)	6E-11 (O)	1E-8 (H)	0	2E-9	0
2A Total Waste	5E-5 (R)	6E-11 (O)	8E-7 (S)	0	8E-8	0
2B Total Waste	7E-5 (H)	6E-11 (O)	8E-7 (S)	0	8E-8	0
2C Total Waste	1E-4 (W)	6E-11 (O)	8E-8 (W)	0	8E-8	0
Total Inventory						
2A CH-TRU Waste	5E-5 (R)	4E-12 (I)	1E-6 (S)	0	2E-7	0
2B CH-TRU Waste	2E-4 (H)	4E-12 (I)	1E-6 (S)	0	2E-7	0
2C CH-TRU Waste	2E-4 (W)	3E-12 (W)	1E-7 (W)	0	2E-7	0
RH-TRU Waste	5E-7 (O)	1E-10 (O)	2E-9 (H)	0	2E-9	0
2A Total Waste	5E-5 (R)	1E-10 (O)	1E-6 (S)	0	2E-7	0
2B Total Waste	2E-4 (H)	1E-10 (O)	1E-6 (S)	0	2E-7	0
2C Total Waste	2E-4 (W)	1E-10 (O)	1E-7 (W)	0	2E-7	0
Population [c]						
Basic Inventory						
2A CH-TRU Waste	0.09	3E-9	2E-2	0	9E-5	0
2B CH-TRU Waste	0.06	3E-9	2E-2	0	9E-5	0
2C CH-TRU Waste	0.03	3E-10	7E-5	0	9E-5	0
RH-TRU Waste	4E-4	7E-8	2E-4	0	2E-6	0
2A Total Waste	0.09	7E-8	2E-2	0	9E-5	0
2B Total Waste	0.06	7E-8	2E-2	0	9E-5	0
2C Total Waste	0.03	7E-8	3E-4	0	9E-5	0
Total Inventory						
2A CH-TRU Waste	0.1	7E-9	2E-2	0	2E-4	0
2B CH-TRU Waste	0.1	6E-9	2E-2	0	2E-4	0
2C CH-TRU Waste	0.06	7E-10	2E-4	0	2E-4	0
RH-TRU Waste	6E-4	1E-7	2E-4	0	2E-6	0
2A Total Waste	0.1	1E-7	2E-2	0	2E-4	0
2B Total Waste	0.1	1E-7	2E-2	0	2E-4	0
2C Total Waste	0.06	1E-7	4E-4	0	2E-4	0
Aggregate Total						
2A	0.1	1E-7	2E-2	0	2E-4	0
2B	0.1	1E-7	2E-2	0	2E-4	0
2C	0.06	1E-7	1E-3	0	2E-4	0

[a] The probability of an LCF occurring to the maximally exposed noninvolved worker, and the number of LCFs in the population.
[b] H = Hanford, I = INEEL, L = LANL, O = ORNL, R = RFETS, S = SRS, W = WIPP, I=INEEL
[c] The noninvolved workers considered for treatment, lag storage, and operations impacts are different.

Note: Sites in parentheses indicate where the greatest MEI impact would occur.

The aggregate total indicated in Table 5-47 refers to the impacts to noninvolved workers expected over the entire operational period under Action Alternative 2. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 22 years for CH-TRU waste and 150 years for RH-TRU waste. No LCFs (a maximum of 0.02 LCFs under Action Alternatives 2A and 2B) are expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials under incident-free operations.

WIPP Disposal Operations

Only radiological impacts would result from disposal operations at WIPP because VOCs would be removed by thermal treatment. No LCFs would be expected in the noninvolved worker population at WIPP from radiation exposure, 2×10^{-4} LCFs under all three subalternatives. All 1,095 WIPP employees were assumed to be exposed at the same level as the maximally exposed noninvolved worker. The maximally exposed noninvolved worker would have a 2×10^{-7} probability of an LCF from radiation exposure under all three subalternatives. No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

The aggregate total indicated in Table 5-47 shows that no LCFs (2×10^{-4} LCFs) are expected in the multiple noninvolved worker populations that would be exposed to potential radioactive releases over the entire WIPP disposal operations period under Action Alternative 2.

5.3.9.3 Involved Workers

Impacts to involved workers under Action Alternatives 2A, 2B and 2C are presented in this section. Results are presented in Table 5-48, and additional information is presented in Appendix F. All worker exposures to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Waste Treatment

Under Action Alternative 2, radiological impacts to the involved worker population from waste treatment would be greater than nonradiological impacts. A maximum of 1.7, 1.3, and 0.6 radiation-related LCFs could occur in the worker population under Action Alternatives 2A, 2B, and 2C, respectively, while no cancer incidence (6×10^{-5}, 9×10^{-5}, and 8×10^{-5} cancers, respectively) would be expected from hazardous chemical exposure. No noncarcinogenic health effects are predicted because the maximum exposure index for a waste treatment worker under any of the subalternatives would be 6×10^{-3} under Action Alternatives 2A and 2B and 5×10^{-3} under Action Alternative 2C, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

Lag storage would take place under all three subalternatives. Assuming 35 years of management of the entire inventory, radiological impacts to the lag storage involved worker population would be less than 0.4 LCF under each subalternative. No hazardous chemical impacts, either carcinogenic or noncarcinogenic, would occur because of the removal of VOCs from the waste during thermal treatment. Involved worker lag storage impacts would be larger from CH-TRU

Table 5-48
Lifetime Human Health Impacts to Involved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for the Action Alternative 2 Subalternatives [a]

	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
Category	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**
Population						
Basic Inventory					(36 workers)	(36 workers)
2A CH-TRU Waste	0.7	2E-5	0.09	0	0.1	0
2B CH-TRU Waste	0.5	4E-5	0.08	0	0.1	0
2C CH-TRU Waste	0.02	3E-5	0.08	0	0.1	0
RH-TRU Waste	0.2	9E-6	≤0.09	0	≤0.1	0
2A Total Waste	0.9	3E-5	≤0.2	0	≤0.2	0
2B Total Waste	0.7	5E-5	≤0.2	0	≤0.2	0
2C Total Waste	0.3	4E-5	≤0.2	0	≤0.2	0
Total Inventory					(36 workers)	(36 workers)
2A CH-TRU Waste	1.4	5E-5	0.2	0	0.2	0
2B CH-TRU Waste	1.1	8E-5	0.2	0	0.2	0
2C CH-TRU Waste	0.3	1E-5	0.2	0	0.2	0
RH-TRU Waste	0.3	1E-5	≤0.2	0	≤0.2	0
2A Total Waste	1.7	6E-5	≤0.4	0	≤0.4	0
2B Total Waste	1.3	9E-5	≤0.4	0	≤0.4	0
2C Total Waste	0.6	8E-5	≤0.4	0	≤0.4	0
Aggregate Total						
2A	1.7	6E-5	0.01	0	< 0.4	0
2B	1.3	9E-5	0.02	0	< 0.4	0
2C	0.6	8E-5	0	0	< 0.4	0

[a] The workers considered for treatment impacts, lag storage impacts, and operations impacts are different.

waste storage operations than from RH-TRU waste storage operations. Impacts from RH-TRU waste lag storage operations would be less because of remote RH-TRU waste handling and greater administrative controls for RH-TRU waste. Lag storage impacts would be assessed in future site-wide or project-specific NEPA reviews.

The impacts from CH-TRU waste would be from the external radiation dose received during waste container handling. Potential radiological impacts from inhalation of radioactive gases released from waste containers would be negligible. Involved worker impacts from lag storage were calculated by assuming waste handlers would spend 2 hours every workday at 1 meter (3.3 feet) from the CH-TRU waste containers and were assumed to be exposed over a 35-year career. Container dose rates were decay-corrected over 35 years and 20 percent of the Total Inventory were assumed to be monitored annually.

The aggregate total indicated in Table 5-48 refers to the impacts to involved workers at the lag storage sites over the entire operational period under Action Alternative 2. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 22 years for CH-TRU waste and 150 years for RH-TRU waste. Fewer than 0.4 LCFs would be expected over the several generations of involved workers that would be exposed externally from lag storage operations. The radiological impact estimates reflect the aggregate impacts analyses presented in detail in Appendix F.

WIPP Disposal Operations

Radiological impacts to the involved worker population at WIPP from disposal operations would be less than 0.4 LCF for each subalternative. WIPP involved worker radiological impact estimates were made assuming each involved worker handled the CH-TRU waste for 400 hours per year. The operational period was determined by assuming that 2.5 years of disposal operations were required to fill each panel. Impacts to involved workers from RH-TRU waste handling were assumed to be the same or less than those from CH-TRU waste handling. This assumption is conservative because RH-TRU waste is typically handled using remote-handling equipment, workers are usually protected by radiation shielding, and stricter administrative procedures are used. The impact from handling RH-TRU waste, therefore, would probably be less than the impact from handling CH-TRU waste. No hazardous chemical impacts, either carcinogenic or noncarcinogenic, would occur because of the removal of VOCs from the waste during thermal treatment.

The aggregate total indicated in Table 5-48 refers to the impacts to WIPP involved workers from incident-free operations over the entire disposal operations period under Action Alternative 2. Fewer than 0.4 LCFs from external radiation exposures would be expected over several generations of involved workers at WIPP. Radiological impacts over the entire operational period would be approximately twice the number of impacts estimated for the maximally exposed population during the first 35 years of CH-TRU waste disposal operations. Radiological decay would reduce the radiological impacts to each generation of WIPP workers.

5.3.10 Facility Accidents

This section describes potential consequences of facility accidents at the treatment sites from thermal treatment of waste, from waste storage after treatment but before shipment to WIPP, and at WIPP from waste management and disposal. Consequences of treatment and storage were evaluated at seven treatment sites (Hanford, LANL, INEEL, SRS, RFETS, ORNL, and WIPP); these seven sites would treat and store all of the CH-TRU and RH-TRU waste under the Action Alternative 2 subalternatives. The difference between Action Alternatives 2A and 2B is that no CH-TRU waste treatment and storage (and no consequences) would occur at LANL and RFETS under Action Alternative 2B. CH-TRU waste treatment and storage would occur only at WIPP under Action Alternative 2C.

Inhalation would be the dominant exposure pathway for accidental releases of radionuclides and hazardous chemicals. Radiological consequences are potentially much greater than hazardous chemical consequences and are dominated by inhalation of transuranic radionuclides. Details of the methods and assumptions used and complete accident descriptions and results are provided in Appendix G.

5.3.10.1 Waste Treatment Accidents

Three potential waste treatment accidents were evaluated for the Action Alternative 2 subalternatives; they are shown in Table 5-49. The results are presented only for accidents involving CH-TRU waste. The results from these accidents would be greater than results on similar accidents involving RH-TRU waste because CH-TRU waste contains a higher concentration of transuranic radionuclides.

Table 5-49
Treatment Accident Scenarios Evaluated for the Action Alternative 2 Subalternatives

Accident Scenarios	Annual Occurrence Frequency	Description
Drum Failure (Accident Scenario T4)	0.01	Cover block falls on a drum filled with hot glass causing shattering of glass.
Steam Explosion (Accident Scenario T5)	1E-4	Steam explosion in glass melter causes fragmentation of glass.
Earthquake (Accident Scenario T6)	1E-5 or less	A beyond-design-basis earthquake (or other natural event) collapses the roof, causing drums to rupture and HEPA filters to fail.

The potential accident consequences under Action Alternatives 2A and 2B were evaluated in detail for the five major sites that would treat and store the greatest volume of CH-TRU waste: Hanford, INEEL, LANL, RFETS, SRS for Action Alternatives 2A and 2B. Under Action Alternative 2C, consequences were evaluated at WIPP for the treatment of CH-TRU waste.

Treatment accidents analyzed include a high-frequency/low-consequence operational accident which is expected to be applicable under any facility design, a low-frequency/high-consequence operational accident, and a beyond-design-basis natural disaster accident. Accident analysis information is presented in Appendix G.

Estimated radiological consequences are presented as the number of LCFs in the exposed population and the probability of an LCF occurring in MEIs. Carcinogenic and noncarcinogenic consequences from hazardous chemicals, both VOCs and heavy metals, were estimated. Carcinogenic consequences are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic consequences from exposure to VOCs and heavy metals were estimated by two different methods for the drum failure and steam explosion scenarios (Accident Scenarios T4 and T5, respectively): IDLH-equivalent ratios and ERPG ratios. Only IDLH-equivalent ratios were calculated for the catastrophic treatment facility failure of the earthquake (Accident Scenario T6). The potential noncarcinogenic consequences identified by ERPG ratios would be of minor importance during such a catastrophic event and its consequent site-operations upheaval.

In general, potential radiological consequences were found to be higher than hazardous chemical consequences, which would be very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-50. Consequences to the maximally exposed involved worker are addressed qualitatively.

The potential radiological consequences from RH-TRU waste treatment accidents are greatest at the ORNL site for all accident scenarios and receptors; however, they are four to five orders of magnitude less than the consequences from CH-TRU waste treatment accidents.

Table 5-50
Radiological Consequences of Treatment Accidents for the Action Alternative 2 Subalternatives

Accident Scenarios		Population (Number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
CH-TRU Waste	Drum Failure (Accident Scenario T4)	Maximum: 1E-3 (RFETS)	Maximum: 5E-7 (LANL)	Maximum: 1E-6 (Hanford)
	Steam Explosion (Accident Scenario T5)	Maximum: 0.2 (RFETS)	Maximum: 8E-5 (LANL)	Maximum: 2E-4 (Hanford/LANL)
	Earthquake (Accident Scenario T6)	Hanford: 440 INEEL: 25 LANL: 180 RFETS: 480 SRS: 42 WIPP: 28	Hanford: 0.4 INEEL: 0.01 LANL: 0.6 RFETS: 0.03 SRS: 5E-3 WIPP: 1	Hanford: 1 INEEL: 1 LANL: 1 RFETS: 1 SRS: 1 WIPP: 1
RH-TRU Waste	Drum Failure (Accident Scenario T4)	Maximum: 4E-8 (ORNL)	Maximum: 3E-11 (ORNL)	Maximum: 4E-11 (ORNL)
	Steam Explosion (Accident Scenario T5)	Maximum: 7E-6 (ORNL)	Maximum: 5E-9 (ORNL)	Maximum: 6E-9 (ORNL)
	Earthquake (Accident Scenario T6)	Hanford: 1E-2 ORNL: 2E-2	Hanford: 5E-6 ORNL: 2E-5	Hanford: 3E-5 ORNL: 5E-5

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Public

Under Action Alternatives 2A and 2B, population consequences from treatment accidents were estimated for the exposed populations around the six treatment sites. Potential consequences to the population and MEIs at the six sites vary over a wide range because of differences in the population distributions, distances to MEIs, and atmospheric dispersion factors among the sites. No LCFs would be expected in the exposed population from the drum failure or steam explosion scenarios (Accident Scenarios T4 or T5, respectively), but 480 and 440 LCFs were estimated to occur from the earthquake (Accident Scenario T6) at RFETS and Hanford, respectively. Due to the events of the earthquake scenario, 180, 42, and 25 LCFs were estimated at LANL, SRS, and INEEL, respectively. The radiological consequences to the MEI were estimated to be the highest at LANL for all three accidents. Consequences to the MEI due to the earthquake or other natural phenomenon (Accident Scenario T6) were found to range from a 5 x 10^{-3} (at SRS) to 0.6 (at LANL) probability of an LCF.

Under Action Alternative 2C, population consequences from treatment accidents were estimated for the exposed population around the WIPP site. The radiological population consequences for the drum failure, steam explosion, and earthquake scenarios (Accident Scenarios T4, T5, and T6, respectively) would be 5 x 10^{-5}, 9 x 10^{-3}, and 28 LCFs, respectively. Consequences to the MEI due to the earthquake (Accident Scenario T6) were estimated to be 1 probability of an LCF to the MEI at the WIPP site.

For the Action Alternative 2 subalternatives, all carcinogenic consequences from the drum failure or steam explosion (Accident Scenarios T4 and T5, respectively) would be attributable to heavy metals because VOCs would be consumed by the fire or thermal treatment. Under Action Alternatives 2A and 2B, no cancers were estimated to occur in the exposed population from the hazardous chemical releases of any accident. The maximum probability of cancer to the MEI would be 4 x 10^{-9} from any of the three treatment accidents. The MEIs at all sites could develop irreversible or severe health effects from both metals (lead and mercury) and VOCs (1,1,2,2-tetrachlorethane) released during the earthquake. Life threatening effects could be expected at all sites but SRS from beryllium. Under Action Alternative 2C, no cancers were estimated to occur in the exposed population from the hazardous chemical releases of any accident. The probability of cancer to the WIPP MEI would be 2 x 10^{-7} from hazardous chemical releases during the earthquake.

Under Action Alternatives 2A, 2B, and 2C, RH-TRU waste would be treated at Hanford and ORNL. Consequences under Accident Scenarios T4, T5, and T6 would be bounded by those presented for CH-TRU waste treatment. The maximum population consequence (20 LCFs) would be expected at ORNL under Accident Scenario T6. The maximum probability of an LCF (0.02) would also be at ORNL. No cancer incidents would be expected in the population as a result of exposure to hazardous chemicals from any accident scenarios. Irreversible or severe health effects would be expected for both the ORNL and Hanford MEI as a result of the earthquake.

Maximally Exposed Noninvolved Worker

Under Action Alternatives 2A and 2B, the maximally exposed noninvolved worker was assumed to be at the location of greatest consequence outside of the waste treatment building. The estimated consequences to the noninvolved worker would not vary significantly across the six sites. Radiological consequences to the maximally exposed noninvolved worker would result in a 1 x 10^{-6} probability of an LCF from the events of the drum failure scenario (Accident Scenario T4), a 2 x 10^{-4} probability of an LCF from the events of the steam explosion scenario (Accident Scenario T5), and a maximum probability of 1 LCF (at all sites) from the events caused by the beyond-design-basis earthquake (Accident Scenario T6).

No cancers would be expected from the release of hazardous chemicals or metals from any of the accidents; the greatest probability of cancer would be 2 x 10^{-8}. During the earthquake (Accident Scenario T6), the noninvolved workers at all of the sites have a chance of developing noncarcinogenic irreversible or severe health effects, and life threatening effects were estimated for all sites INEEL. These effects would be expected from exposures to both VOCs and heavy metals. Under Action Alternative 2C, the only effects due to hazardous chemicals or metals were estimated under the earthquake accident (Accident Scenario T6) where the noninvolved worker would develop irreversible health effects from exposure to 1,1,2,2-tetrachloroethane, mercury, and lead and may expect life threatening effects from beryllium, mercury and lead.

Under Action Alternative 2, RH-TRU waste would be processed at ORNL and Hanford. The maximum consequence from RH-TRU waste treatment would be about 2 percent of that listed for CH-TRU waste treatment. The radiological consequence to the noninvolved worker would be a 0.04 probability of an LCF for Accident Scenario T6. Consequences from hazardous chemicals would be equal to those described above in the discussion for CH-TRU waste treatment.

Maximally Exposed Involved Worker

For all of the Action Alternative 2 subalternatives, no consequences to the maximally exposed involved worker would be anticipated from either the drum failure or steam explosion accidents (Accident Scenarios T4 or T5, respectively). These accidents are such that involved workers would be able to evacuate immediately or would not be affected by the events. Substantial consequences would be possible from the earthquake (Accident Scenario T6), including workers killed by debris from collapsing treatment facilities and radiation doses from TRU waste being treated. Intakes of VOCs, and heavy metals would also be expected.

5.3.10.2 Waste Storage Accidents

Two potential waste storage accidents were evaluated under the Action Alternative 2 subalternatives and are described in Table 5-51. The drum fire (Accident Scenario S2) analyzed under Action Alternative 1 is not credible for thermally treated waste because waste treatment would remove all combustible components. The results are presented only for accidents involving CH-TRU waste because the would be greater than the results for similar accidents involving RH-TRU waste. However, the consequences from catastrophic failure of an RH-TRU waste storage facility as a result of an earthquake are presented in Appendix G.

Table 5-51
Storage Accident Scenarios Evaluated
for the Action Alternative 2 Subalternatives

Accident Scenarios	Annual Occurrence Frequency	Description
Drum Puncture, Drop, and Lid Failure (Accident Scenario S1) [a]	1E-2 to 1E-4	A forklift strikes and punctures a drum on a lower level of a stack in the storage facility. The stack is destabilized and two drums fall to the ground and lose their lids upon impact.
Drum Fire (Accident Scenario S2)	---	Not credible for thermally treated waste.
Earthquake (Accident Scenario S3)	1E-5 or less	A beyond design-basis earthquake (or other natural event) occurs, causing the collapse of the building.

[a] Occurrence frequency for Accident Scenario S1 was taken from reference documents applicable to waste packaged to meet the planning-basis WAC. The quantity of waste handled would be lower under this alternative and frequency of occurrence would likely be lower as well.

Lower transuranic radionuclide activity in RH–TRU waste (lower PE-Ci levels, see Table G-23 and Table G-24), lower RH-TRU waste volume, more robust waste containers for RH-TRU waste, and presumably more robust construction of RH-TRU waste storage facilities (thick concrete walls for external radiation shielding) all combine to limit potential consequences from RH-TRU waste accidents. Waste would be stored at Hanford, INEEL, RFETS, ORNL (RH-TRU waste only), and SRS under Action Alternative 2A; at Hanford, INEEL, ORNL (RH-TRU waste only) and SRS under Action Alternative 2B; and at WIPP, ORNL (RH-TRU waste only), and Hanford (RH-TRU waste only) under Action Alternative 2C. Consequences at a particular site were analyzed only for the subalternative that would result in the greatest potential consequences.

Storage accidents analyzed include a high-frequency/low-consequence operational accident which is expected to be applicable under any facility design (Accident Scenario S1) and a beyond-design-basis natural disaster accident (Accident Scenario S3). For Accident Scenarios S1 and S2, CH-TRU waste involved in the accidents was assumed to have the maximum radionuclide levels allowable under the planning-basis WAC (80 PE-Ci per drum), conservative concentrations of VOCs (based on CH-TRU sampling and WAC limits), and conservative concentrations of heavy metals. Accident Scenario S3 involves a large number of waste containers; therefore, site-specific drum PE-Ci values and average hazardous chemical concentrations were used in the analyses. Additional details on the accident analyses are presented in Appendix G.

Estimated radiological consequences are presented as the number of LCFs in the exposed population and the probability of an LCF occurring in the MEI. Carcinogenic and noncarcinogenic consequences from heavy metals were estimated. Carcinogenic consequences are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic consequences from exposure to heavy metals were estimated by two different methods for the drum puncture (Accident Scenario S1): IDLH-equivalent ratios and ERPG ratios. Only IDLH-equivalent ratios were calculated for the catastrophic storage facility failure of the earthquake (Accident Scenario S3). The potential noncarcinogenic consequences identified by ERPG ratios would be of minor importance during such a catastrophic event and its consequent site-operations upheaval.

In general, potential radiological consequences would be higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-52.

Table 5-52
Radiological Consequences of Storage Accidents for the Action Alternative 2 Subalternatives [a]

Accident Scenarios	Population (number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
Drum Puncture and Lid Failure (Accident Scenario S1)	Maximum: 3E-5 (RFETS)	Maximum: 1E-8 (WIPP)	Maximum: 2E-8 (Hanford, LANL)
Earthquake (Accident Scenario S3)	Hanford: 9 INEEL [b]: 0.8 LANL [c]: 2 RFETS [c]: 10 SRS: 2 WIPP [d]: 2	Hanford: 5E-3 INEEL [b]: 4E-4 LANL [c]: 4E-3 RFETS [c]: 7E-4 SRS: 2E-4 WIPP [d]: 0.08	Hanford: 0.03 INEEL [b]: 0.05 LANL [c]: 0.02 RFETS [c]: 0.02 SRS: 0.04 WIPP [d]: 0.1

[a] The site with the greatest consequence is shown in parentheses.
[b] Consequences are greatest at INEEL under Action Alternative 2B.
[c] CH-TRU waste is stored at LANL and RFETS only under Action Alternative 2A.
[d] CH-TRU waste is stored at WIPP only under Action Alternative 2C.

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Public

Population consequences from storage accidents were estimated for the exposed populations around the six treatment sites. Potential consequences to the population and MEIs at the six sites vary over a wide range because the population distributions, distances to MEIs, and atmospheric dispersion factors vary from site to site. No LCFs would be expected in the exposed population from the drum puncture accident (Accident Scenario S1), but LCFs were estimated to occur from the earthquake (Accident Scenario S3) at almost all sites; the LCFs would range from 0.8 (at INEEL) to 10 (at RFETS). The radiological consequences to the MEI would be highest for the WIPP MEI under the drum puncture scenario (Accident Scenario S1), with a 1×10^{-8} probability of an LCF. Consequences from the earthquake scenario (Accident Scenario S3) were estimated to range from a 2×10^{-4} (at SRS) to 0.08 (at WIPP) probability of an LCF to the MEI.

No cancers would be expected in the exposed population from the heavy metal releases of any accident. The maximum probability of cancer incidence to the MEI from the heavy metal releases of either accident would be 2×10^{-7} (Accident Scenario S3 at WIPP). No noncarcinogenic consequences would be expected from either accident.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker was assumed to be at the location of greatest consequence outside of the waste storage facility. The consequences to the noninvolved worker were estimated to vary over a narrow range. The range was narrow because of the uniform release heights assumed and the close distances considered for all noninvolved workers.

Radiological consequences to the maximally exposed noninvolved worker would result in a 2×10^{-8} probability of an LCF from the events of the drum puncture scenario (Accident Scenario S1) and up to a 0.05 probability of an LCF (at INEEL under Action Alternative 2B) from the events of the beyond-design-basis earthquake scenario (Accident Scenario S3).

For hazardous chemical consequences, the maximum probability of cancer to the maximally exposed noninvolved worker from heavy metal intakes would be 5×10^{-16} from the drum puncture scenario (Accident Scenario S1). The corresponding consequence for the earthquake scenario (Accident Scenario S3) would be 2×10^{-8} probability of cancer. No noncarcinogenic consequences would be expected from any accident release.

Maximally Exposed Involved Worker

The involved worker would be the individual most seriously affected by the two accidents analyzed. Consequences were quantitatively estimated for the drum puncture scenario (Accident Scenario S1). The maximally exposed involved worker could potentially have a 3×10^{-3} probability of an LCF as a result of the radionuclide intake due to the events of the drum puncture scenario. The analysis assumed the instantaneous radioactive material releases from the three containers, expanding in a uniform hemisphere 5 meters (16 feet) in radius. The worker was assumed to inhale this air for 1 minute prior to exiting to a fresh air source. The involved worker could have a 6×10^{-11} probability of cancer from estimated hazardous chemical intakes due to the drum puncture accident (Accident Scenario S1). No noncarcinogenic consequences would be expected.

Catastrophic destruction of the storage facility due to an earthquake (Accident Scenario S3) could result in death or serious injury to the maximally exposed involved worker due to falling debris and releases from stored waste.

5.3.10.3 WIPP Disposal Accidents

Seven potential accidents at WIPP during disposal operations were evaluated for the Action Alternative 2 subalternatives; they are shown in Table 5-53. Because thermal treatment would eliminate the combustibility of the waste, Accident Scenario W5, a drum fire, is not credible and was not evaluated. Five of the accidents involve only CH-TRU waste (Accident Scenarios W1 through W4 and W7), one involves only RH-TRU waste (Accident Scenario W8), and one was evaluated for consequences from CH-TRU and RH-TRU waste (Accident Scenario W6). Annual accident frequencies are one-half those of other alternatives because of the smaller waste volumes and the limited amount of waste that could be placed in each panel due to the thermal power limitation of the WIPP underground.

Potential radiological consequences are substantially higher than consequences from heavy metals, which are very small for all accident cases. There would be no VOCs in thermally treated waste, and VOCs were the primary contributors to hazardous chemical consequences (though small) under the Proposed Action and Action Alternative 1. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below.

Table 5-53
WIPP Disposal Accident Scenarios
for the Action Alternative 2 Subalternatives

Accident Scenarios	Annual Occurrence Frequency	Description
Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	5E-3	A package of drums is dropped in the Waste Handling Building, a drum on top of the package falls and its lid seal fails.
Drop, Puncture Lid Failure in Waste Handling Building (Accident Scenario W2)	5E-3	Forklift strikes and punctures drums on lower level of stack in the Waste Handling Building. A drum on the upper level falls and the lid seal fails.
Drop, Lid Failure in Underground (Accident Scenario W3)	5E-3	Same as accident W1, but it occurs in the underground.
Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	5E-3	Same as accident 2, but it occurs in the underground.
Container Fire (Accident Scenario W5)	---	Not credible for thermally treated waste.
Hoist Failure (Accident Scenario W6)	<1E-6	Waste hoist braking system fails and fully loaded hoist falls to the bottom of shaft. Both CH-TRU and RH-TRU waste loads were evaluated.
Roof Fall (Accident Scenario W7)	5E-3, Panel 1 <1E-6, other panels	A portion of a disposal room roof falls prior to panel closure, crushing drums and causing lid seal failures.
RH-TRU Canister Breach (Accident Scenario W8)	5E-5 to 5E-7	RH-TRU waste canister is breached during Waste Handling Building operations.

With the exception of the waste hoist failure (Accident Scenario W6), the consequences of postulated accidents under the Action Alternative 2 subalternatives would be less than those under the Proposed Action by at least a factor of ten. Thermal treatment also eliminates potential consequences of an RH-TRU container breach (Accident Scenario W8). In such an event, thermally treated waste would be less likely to release particles of respirable size. However, in the event of a hoist failure, the more uniform, brittle waste matrix (as compared to waste treated to planning-basis WAC) is more likely to shatter upon impact into respirable particles. The thermal treatment also concentrates the heavy metals in the waste form, which also increases the potential consequences. Consequences of the hoist failure are approximately five to seven times higher than those estimated for waste treated to planning-basis WAC under the Proposed Action and Action Alternative 1. Radiological consequences of accidents under the Action Alternative 2 subalternatives are shown in Table 5-54.

Public

Population consequences from WIPP disposal accidents were estimated for the 22.5 degree sector west of the site, which includes the City of Carlsbad. The population in this sector is 25,629 and would be affected greater than any other section in the surrounding 80-kilometer (50-mile) region. Consequences to the MEI were evaluated at the point of closest public access to the DOE Exclusive Use Area boundary and the least atmosphere dispersion of facility exhaust ventilation air, which would be the location of maximum consequence. This point was 300 meters (990 feet) south of the Exhaust Filter Building. No credit was taken for HEPA filtration of accident releases from either the Exhaust Filter Building or the Waste Handling Building.

Table 5-54
Radiological Consequences of WIPP Disposal Accidents for the Action Alternative 2 Subalternatives

Accident Scenarios	Population (LCFs)	MEI (probability of LCF)	Maximally Exposed Noninvolved Worker (probability of LCF)	Maximally Exposed Involved Worker (probability of LCF)
Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	9E-4	1E-5	1E-5	3E-3
Drop, Puncture Lid Failure in Waste Handling Building (Accident Scenario W2)	9E-4	1E-5	1E-5	3E-3
Drop, Lid Failure in Underground (Accident Scenario W3)	9E-4	1E-5	1E-5	3E-3
Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	9E-4	1E-5	1E-5	3E-3
Container Fire (Accident Scenario W5)	Not Credible	Not Credible	Not Credible	Not Credible
Hoist Failure (both CH-TRU and RH-TRU waste) (Accident Scenario W6)	CH-TRU: 29 RH-TRU: 9	CH-TRU: 0.6 RH-TRU: 0.1	CH-TRU: 0.5 RH-TRU: 0.1	See Footnote a
Roof Failure (Accident Scenario W7)	0.02	2E-4	2E-4	See Footnote a
RH-TRU Waste Canister Breach (Accident Scenario W8)	0	0	0	0

[a] These consequences could range from negligible (workers not present, or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris)

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Radiological consequences from accidents would be higher than consequences from heavy metals. The accident with the largest potential radiological consequence to the population and the MEI would be the failure of a fully loaded waste hoist (Accident Scenario W6). Up to 29 LCFs could occur in the exposed population, and the MEI could experience a 0.6 probability of an LCF. The hoist failure accident would also result in the highest potential carcinogenic heavy metal consequence, with an estimated 4 x 10^{-7} cancers occurring in the exposed population and an estimated 5 x 10^{-9} probability of cancer for the MEI. No fatalities due to hazardous chemical effects would be expected under any accident scenario.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker at WIPP was assumed to be located at the location of least atmospheric dispersion, 300 meters (990 feet) south of the Exhaust Filter Building, which is the same location as the MEI. The stack that exhausts the underground ventilation is elevated and, as a result, the location of least plume dispersion is some distance from the release point. Radiological consequences (shown in Table 5-54) may be slightly lower than those for the MEI because of the small different in the radiation dose-to-LCF conversion factors for workers and members of the public. Consequences from exposure to heavy metals would be identical to those of the MEI.

Maximally Exposed Involved Worker

The potentially highest consequences to an involved worker would be underground, from failure of a fully loaded waste hoist (Accident Scenario W6) or roof fall (Accident Scenario W7). These consequences could range from negligible (workers not present, or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris). Four workers would be expected to be routinely involved in underground operations and potentially at risk from these accidents.

Radiological consequences of accidents to the maximally exposed involved worker from noncatastrophic accidents are shown in Table 5-54. Consequences would come from the drop and lid failure (Accident Scenarios W1 and W3) and drum puncture accidents (Accident Scenarios W2 and W4), all with a 3 x 10^{-3} probability of an LCF. The highest heavy metal carcinogenic consequences to an involved worker were estimated to be a 6 x 10^{-11} probability of a cancer incidence. No fatalities due to toxicological effects would be expected.

5.3.11 Industrial Safety

A total of nine, seven, and six fatalities would occur under Action Alternatives 2A, 2B, and 2C, respectively, from industrial accidents during waste treatment at all treatment sites. These estimates were adjusted from the physical-hazard fatality estimates of the WM PEIS.

Under Action Alternatives 2A, 2B and 2C, WIPP operational activities would be essentially the same as those conducted under the Proposed Action but would last approximately 150 years rather than 35 years. Decommissioning activities would be the same as those for the Proposed Action. Estimated industrial safety impacts to workers under Action Alternatives 2A, 2B, and 2C are presented in Table 5-55. Oversight and inspections by the MSHA and adherence to OSHA regulations would likely reduce actual occurrences below these estimated values.

Table 5-55
Industrial Safety Impacts from WIPP Operations and Decommissioning for the Action Alternative 2 Subalternatives

Years	Injury/Illness			Fatalities		
	Excavation	Operations	Total	Excavation	Operations	Total
Operations 1998-2148	93	5,250	5,343	0.2	5.2	5.4
Decommissioning 2148-2158	187	96	283	0.3	0.1	0.4
Total	280	5,346	5,626	0.5	5.3	5.8

5.3.12 Long-Term Performance

This section presents the potential impacts associated with the long-term performance of the WIPP repository for Action Alternative 2 evaluated for the 10,000-year period after the site is closed. These impacts were estimated based on computer simulations that predicted radionuclide and heavy metal releases from TRU waste in the repository under undisturbed and disturbed conditions. Analyses were conducted using the same methods as for the Proposed Action and other action alternatives; additional information is presented in Appendix H. The waste volume emplaced would be 107,000 cubic meters (3.8 million cubic feet) of CH-TRU waste and 19,000 cubic meters (671,000 cubic feet) of RH-TRU waste. The repository size was increased from the 10 panels of the Proposed Action to 75 panels to accommodate the increased waste volume. The radionuclide inventory was increased to 7.3 x 10^6 Ci in CH-TRU waste and 5.1 x 10^6 Ci in RH-TRU waste, essentially the same as the inventories of Action Alternatives 1 and 3. There were similar increases in heavy metal inventories. Detailed information on the radionuclide and heavy metal inventories is provided in Appendix A.

The four cases below were analyzed for Action Alternative 2. The cases are the same as the Proposed Action and other action alternatives but include alternative-specific differences, such as repository size and radionuclide and heavy metal inventories.

- Case 11 considered undisturbed repository performance. Median parameter values were used for input variables where probability distributions have been defined.

- Case 12 considered disturbed conditions resulting from a borehole assumed to pass through the repository and intercept a pressurized brine reservoir in the Castile Formation. Median parameter values were used for input variables where probability distributions have been defined.

- Case 13 was the same as Case 11 but used 75th percentile parameter values for input variables where probability distributions have been defined.

- Case 14 was the same as Case 12 but used 75th percentile parameter values for input variables where probability distributions have been defined.

5.3.12.1 Impacts of Undisturbed Conditions

Radionuclide and heavy metal (predominantly lead) migration for undisturbed conditions at 10,000 years after closure for Case 13 (75th percentile parameter values) is presented in Figure 5-5. Case 13 resulted in slightly more extensive migration than Case 11 (median parameter values). Figure 5-5 shows the locations in the modeled region where the concentration of total radionuclide activity in the brine, summed over 30 radionuclides, is equal to 1 pCi per liter (1 x 10^{-9} Ci per cubic meter). A total heavy metal concentration of one part per billion (1 x 10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration.

Approximately the same vertical and lateral migration of radionuclides and heavy metals would occur for Action Alternative 2 as for the Proposed Action. Total radionuclide concentrations of one pCi per liter would extend about 20 meters (65 feet) below the repository, about 40 meters (130 feet) above the repository, and about 1,900 meters (6,200 feet) laterally.

Analysis of undisturbed repository conditions (Cases 11 and 13) during the first 10,000 years showed that no radionuclides or heavy metals would be released to the Culebra Dolomite. No total radionuclide activity concentrations greater than 1 pCi per liter or heavy metal concentrations greater than 1 part per billion would be found beyond the 5-kilometer (3-mile) subsurface lateral boundary. There would be no release to the accessible environment and therefore no human health impact. Additional information is provided in Appendix H.

5.3.12.2 Impacts of Disturbed Conditions

This section presents the impacts of two exposure scenarios evaluated for disturbed conditions of Action Alternative 2**.**

Surface Release Caused by Drilling into the Repository

The human health impacts of drilling into the repository (Case 12 and Case 14) were evaluated for a drilling crew member and a well-site geologist. These individuals were assumed to be exposed to waste material brought to the land surface by drilling, as described in Section 5.1.12.2 and Appendix H. For Action Alternative 2, 12 waste panels would hold only CH-TRU waste and 63 panels would hold only RH-TRU waste, so a drilling event could contact either CH-TRU waste or RH-TRU waste but not both.

The estimated radionuclide release to the ground surface for Case 12 (median parameter values) totaled 0.8 and 0.02 Ci for intrusions into CH-TRU waste and RH-TRU waste, respectively. For Case 14 (75th percentile parameter values), the estimated radionuclide releases totaled 1.0 Ci and 0.02 Ci, respectively. The releases would consist mainly of Pu-238, Pu-239, and Am-241 for all of these events. For Case 12, total heavy metal releases would be 1.9 and 3.4 kilograms (4.2 and 7.5 pounds) from CH-TRU waste and RH-TRU waste, respectively. For Case 14, the releases would be 2.3 and 4.2 kilograms (5.1 and 9.3 pounds), respectively. Additional information is provided in Appendix H.

The radiological impacts to a drilling crew member for Case 12 (median parameter values) would be a 5 x 10^{-5} and 1 x 10^{-6} probability of an LCF, respectively, from drilling intrusions of CH-TRU waste and RH-TRU waste. For Case 14 (75th percentile parameter values), the probability of an

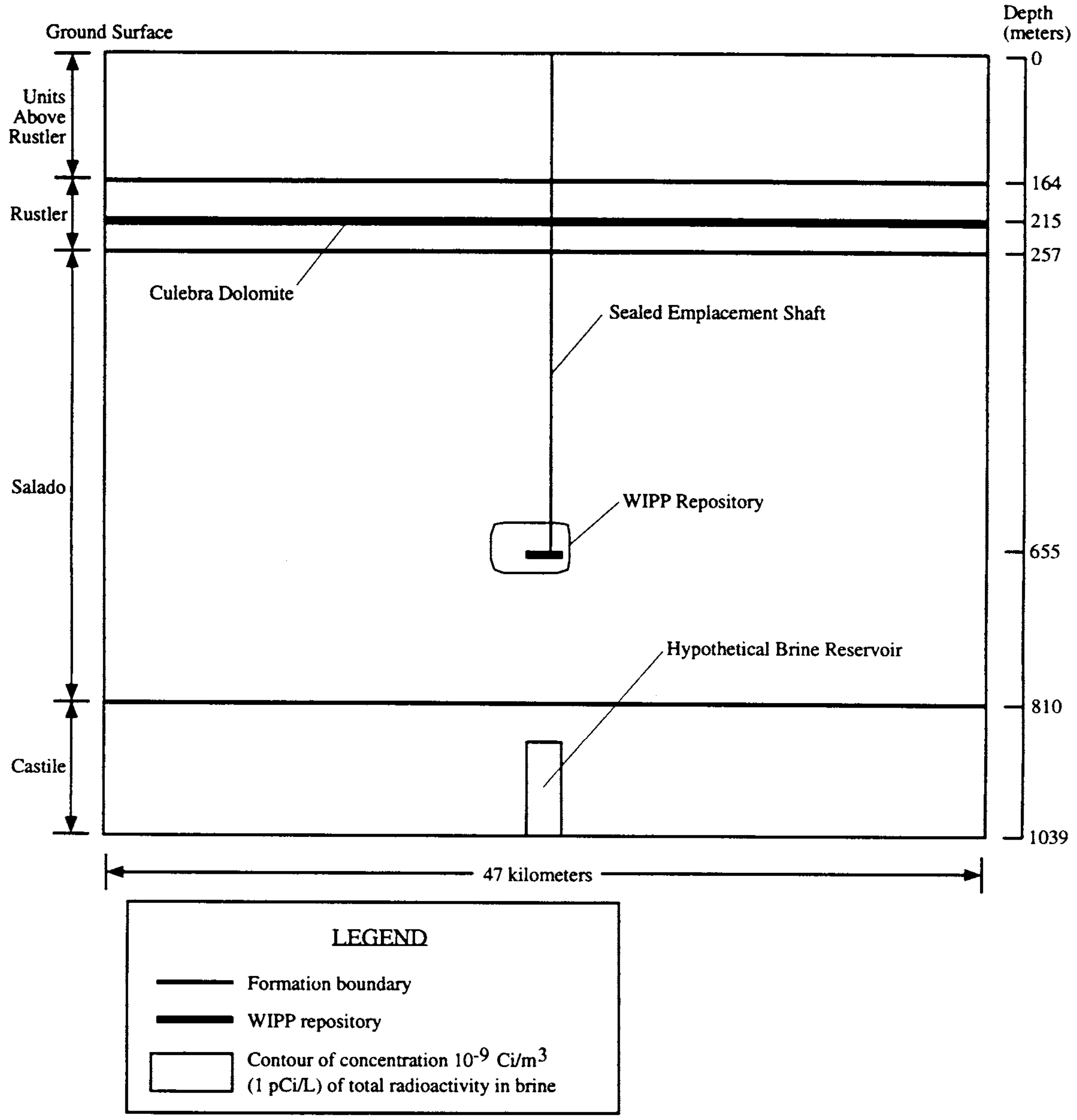

Figure 5-5
Extent of Radionuclide Migration at 10,000 Years with Undisturbed Conditions Using 75th Percentile Parameter Values (Case 13) for Action Alternative 2

LCF would be 1×10^{-4} and 2×10^{-6} for the same respective intrusions. The majority of the impacts would be due to the inadvertent ingestion of drill cuttings (ranging from about 90 to 99 percent), with lesser impact from external radiation dose. Americium-241 would be the major dose contributor. Ingestion of heavy metals for this scenario would result in a 3.2×10^{-8} and 8.5×10^{-10} probability of cancer incidence for intrusions in CH-TRU waste and RH-TRU waste, respectively. There would be no noncarcinogenic impacts expected from the ingestion of the metals because all hazard indices would be much less than one. There would be no VOCs in waste disposed of under Action Alternative 2 and thus no impacts.

Radiological impacts to the well-site geologist from external radiation exposure for Case 12 (median parameter values) would result in a 6×10^{-9} probability of an LCF from CH-TRU waste and a 4×10^{-9} probability of an LCF from RH-TRU waste. For Case 13 (75th percentile parameter values), the radiological impacts would be a 7×10^{-9} probability of an LCF from CH-TRU waste and a 1×10^{-8} probability of an LCF from RH-TRU waste. Am-241 and U-234 were major external dose contributors in CH-TRU and RH-TRU waste for Case 12 and in CH-TRU waste for Case 14, while Sr-90 and Cs-137 were the major external dose contributors in RH-TRU waste for Case 14.

Drilling through the Repository into a Pressurized Brine Reservoir

Impacts of drilling through the repository into a pressurized brine reservoir were analyzed as described in Section 5.1.12.2 and in Appendix H, using information specific to Action Alternative 2 where appropriate. Analysis of radionuclide and heavy metal migration for this scenario within 10,000 years after closure for Case 12 (median parameter values) showed there would be no radionuclide or heavy metal releases into the Culebra Dolomite or the accessible environment.

The extent of radionuclide (predominantly Pu-238, Pu-239, and Am-241) migration for disturbed conditions at 10,000 years after closure for Case 14 (75th percentile parameters values) is presented schematically in Figure 5-6. Total radionuclide activity concentrations of 1 pCi per liter are shown. Simulations showed radionuclides migrated upward and downward into the borehole and penetrated into rocks directly in contact with the borehole for a limited distance. For Case 14 only, migration extends upward into the Culebra Dolomite at 10,000 years. Migration also extends downward in the borehole (for both Cases 12 and 14) to the Castile Formation and into the brine reservoir. This would occur after the initial pressure in the pressurized brine pocket dissipates and equilibrates with pressures in the repository and overlying units penetrated by the borehole. A total heavy metal concentration of one part per billion (1×10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the 1 pCi per liter level of total radionuclide activity concentration. Predicted brine pressures and additional modeling information is provided in Appendix H.

Impacts of radionuclide and heavy metal migration to the accessible environment were evaluated for Case 14 (75th percentile parameter values) since a release of contaminants into the Culebra Dolomite was indicated for this case only. The exposure scenario was the same as evaluated for the Proposed Action and other action alternatives, for an individual consuming beef from cattle using the water from a stock well 3 kilometers (2 miles) from the point of intrusion. Results are presented only for partial mining conditions, since calculated impacts for full mining conditions were significantly lower (see Section H.8.2). Radiological impacts would be negligible, with a 7×10^{-28} probability of an LCF. The dominant dose contributor was Pu-239. Ingestion of heavy

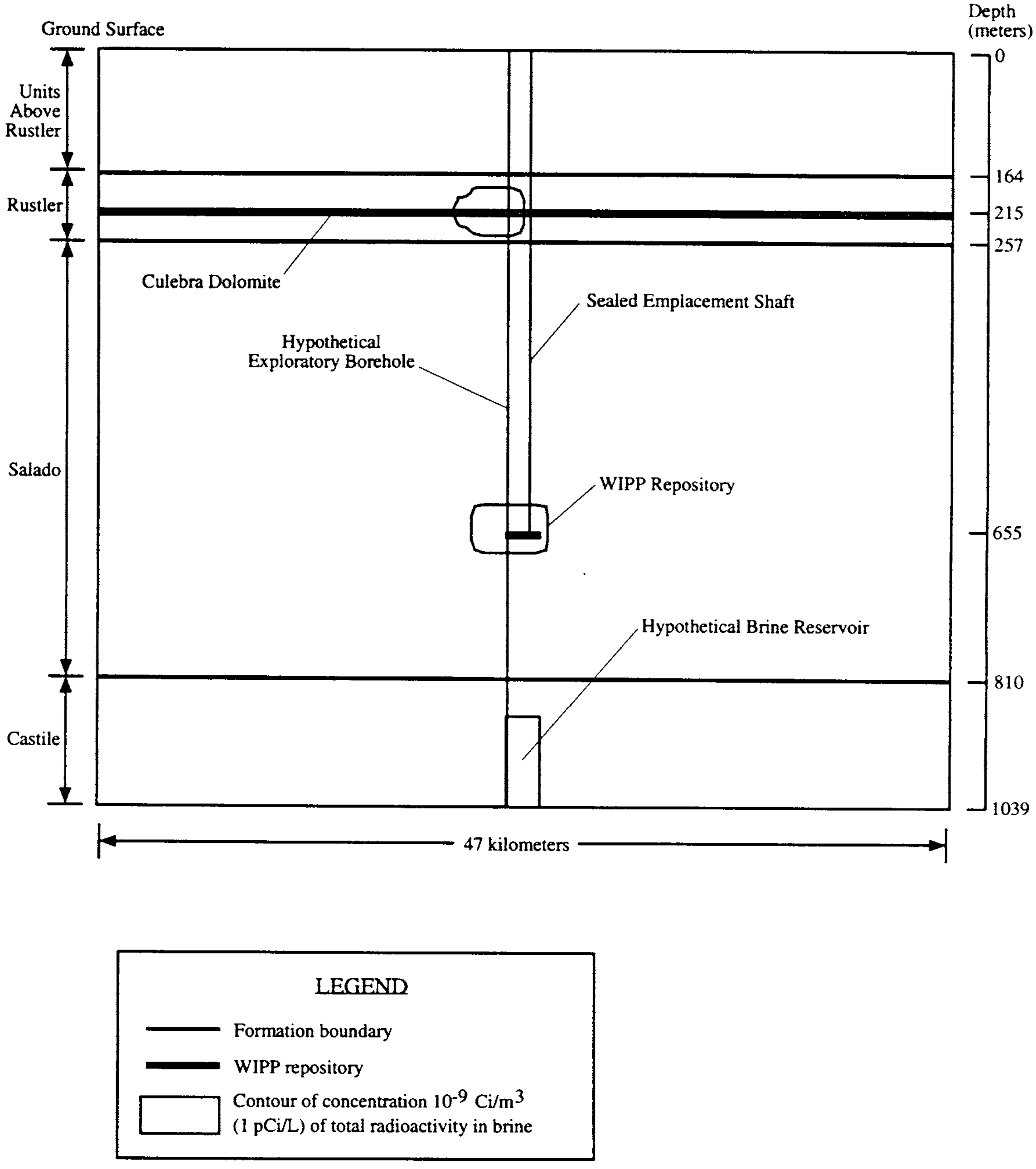

Figure 5-6
Extent of Radionuclide Migration at 10,000 Years with Disturbed Conditions Using 75th Percentile Parameter Values (Case 14) for Action Alternative 2

metals from consumption of contaminated beef was also found to result in negligible impacts, with a probability of cancer incidence of 3 x 10^{-27}. No noncarcinogenic impacts would be expected. There would be no VOCs in waste disposed of under Action Alternative 2 and thus no impacts. Additional information is presented in Appendix H.

5.3.13 Reducing WIPP Operations for Action Alternative 2

As noted in Chapter 3, stakeholders requested a discussion in greater detail of the changes to impacts should the Department reduce the period of operations for WIPP under Action Alternative 2. The period of operations is 150 years, but it could be reduced to 70 years by constructing three new shafts and tripling the number of excavation and emplacement crews. Additional costs would total $24 million in capital costs and $155 million in annual operating costs.

As with Action Alternative 1, no additional impacts would be expected at treatment facilities because the facilities and their periods of operation would be identical to those discussed earlier. The time to ship to WIPP from the treatment facilities would decrease from 150 years to 58 years. The aggregate nonradiological impacts would be the same as those described earlier, except that they would occur within the shorter time period. The accident-free radiological impacts to occupational and nonoccupational populations were reported as aggregate impacts over the entire shipping campaign; therefore, no increase in impacts would be noted. However, because the MEIs would be exposed to more shipments, the estimated exposure to MEIs would increase by a factor of 2.6. All accident impacts would be identical to those described earlier.

Because the size of the WIPP underground facility would remain the same, land use, biological resource, air quality, and cultural resource impacts would be similar to those described earlier in this section. Noise impacts would triple because the rate of shipments through Carlsbad would triple. Water quality and infrastructure impacts may be impacted by the additional work crews.

Human health impacts would decrease for lag storage. The impacts to the public, noninvolved workers, and involved workers over the entire operations period would remain the same, but they would be compressed into one-third of the time. Impacts to the MEIs would triple because the waste that would be emplaced during a lifetime would triple. Industrial safety impacts would decrease by 40 percent, considering the reduced operation time, construction of the shafts, and the increased number of workers. There would be no change in long-term performance assessment results.

Life-cycle cost impacts would change the most. Should only trucks be used, life-cycle costs would drop from a low of $54.01 billion for Action Alternative 2A and a high of $57.18 billion for Action Alternative 2B in 1994 dollars ($19.56 billion and $21.19 billion discounted) to $41.11 billion and $44.27 billion, respectively ($13.46 billion and $14.50 billion discounted). Should regular rail transportation be used, life-cycle costs would decrease for these alternatives from $52.03 billion and $55.02 billion ($19.22 billion and $20.83 billion discounted) to $39.13 billion and $42.11 billion ($12.81 billion and $13.79 billion discounted). Should dedicated rail transportation be used, life-cycle costs would decrease for these alternatives from $57.88 billion and $61.36 billion ($20.21 billion and $21.90 billion discounted) to $44.98 billion and $48.45 billion ($14.73 billion and $15.87 billion discounted).

5.4 IMPACTS OF ACTION ALTERNATIVE 3

This section describes the environmental impacts associated with the implementation of Action Alternative 3. Under this alternative, WIPP would accept the Additional Inventory (except for PCB-commingled waste) as well as the Basic Inventory for disposal, and all of the waste would be treated by a shred and grout process. The total volume of waste to be treated under this alternative would be 312,000 cubic meters (11 million cubic feet) (see Tables 3-10 and 3-11). The operational time frame would extend to the year 2200 (190 years). A detailed description of Action Alternative 3 is given in Section 3.2.4.

5.4.1 Land Use and Management

Land use impacts at the treatment sites for Action Alternative 3 would be similar to those under the Proposed Action, discussed in Section 5.1.1. Additional waste would be treated under this alternative, but the treatment time period would be extended to 35 years, and the land requirements for the number and size of the treatment facilities would be about the same as for the Proposed Action. Treatment facilities would be located to avoid sensitive and inappropriate areas (including flood plains, known cultural resource areas, and the habitats of endangered or threatened species) (DOE 1997). Before treatment facilities would be constructed, further NEPA reviews would be undertaken at a site-wide or project-specific level.

Surface land use impacts during disposal operations under Action Alternative 3 would be similar to those under the Proposed Action, as discussed in Section 5.1.1 because the size of the surface facilities would be similar to those for the Proposed Action. A difference from the Proposed Action would be noted for decommissioning and closure; approximately 375 hectares (927 acres) would be affected due to an increased underground waste disposal area. As in the Proposed Action, the Land Withdrawal Area would be available to the public for nonintrusive surface activities following decommissioning and closure.

5.4.2 Air Quality

From TRU waste treatment, the only criteria pollutant postulated to exceed 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be CO at RFETS (20 percent) (DOE 1997). RFETS, LLNL, NTS, and ANL-E are in nonattainment areas for some of the pollutants. In nonattainment areas, activities that introduce new sources of emissions are regulated under the General Conformity Rule. In attainment areas, regulations for the PSD of ambient air quality apply. In both cases, a permit is required for sources which will result in emissions equal to or greater than the limits set by pertinent regulations. No radiological, hazardous, or toxic air pollutants would exceed 10 percent of the applicable regulatory standard during normal treatment operations (DOE 1997). Potential minor emissions of PM_{10} may occur during construction.

At WIPP, potential air quality impacts from disposal operations under Action Alternative 3 would be similar to those anticipated under the Proposed Action. Although the volume of waste disposed of under this alternative would increase the duration of disposal activities, there would be no substantial difference in the rate of pollutant emissions on either an annual or short-term basis.

Potential air quality impacts due to the decommissioning of WIPP would be similar to those under the Proposed Action. Construction of the berm and permanent markers and other decommissioning activities would last longer than under the Proposed Action but would probably produce no substantial increase in annual pollutant emissions.

5.4.3 Biological Resources

The biological impacts at the treatment sites under Action Alternative 3 would be the same as those for the Proposed Action. Additional waste would be treated, but the size and type of the treatment facilities would be similar to those discussed in Section 5.1.3. Also, construction and operation of the treatment facilities should not affect populations of nonsensitive plant and animal species. Terrestrial wildlife species probably would not be affected by airborne emissions or spills into aquatic environments due to traffic accidents (DOE 1997). Threatened and endangered species may be present at all of the proposed treatment sites; however, impacts to these species would depend on the actual location of the facility at a particular site. Site selection would be conducted following site-wide or project-level NEPA review and appropriate Endangered Species Act consultation, during which impacts would be assessed and mitigated, if necessary. During site selection critical habitats of species listed as threatened, endangered, or candidates would be avoided.

Federally listed, threatened and endangered, and state-listed species occur in Eddy County and potentially at the WIPP, although DOE has not observed threatened, endangered, or proposed species or critical habitats at the WIPP site during surveys conducted for recent biennial environmental compliance reports. DOE recently completed a site-specific biological survey, during which no endangered, threatened, or state-listed species were identified.

At WIPP, a total of 375 hectares (927 acres) of aboveground area would be affected by decommissioning, salt pile reclamation, closure, and construction of berms and permanent markers. These activities would disturb avian and small mammal habitat. The disturbed areas would probably be attractive as habitat after natural vegetation recolonizes.

5.4.4 Cultural Resources

At the treatment sites, cultural resource impacts are expected to be the same for this alternative as for the Proposed Action. Construction and operation of TRU waste management and treatment facilities could adversely affect cultural resources, but site-level cultural resource surveys would be conducted and protection measures established, where necessary, when specific facility construction locations are proposed. These surveys would be part of site-wide or project-level NEPA reviews.

At WIPP, TRU waste shipping and operational activities would not have an impact on the archaeological sites on the disturbed land; however, some sites could be affected by closure- and decommissioning-related activities. Measures for ensuring protection of known archaeological and historic resources (or others that may be inadvertently discovered during ground-disturbing activities) are discussed in the *Waste Isolation Pilot Plant Land Management Plan* (DOE 1996a). They include identifying, inventorying, evaluating, and treating cultural resources under the National Historic Preservation Act of 1966. DOE will avoid, to the maximum extent possible, sites found eligible for inclusion in the NRHP. Where avoidance is not possible, mitigation measures will be developed under the Joint Powers Agreement in consultation with the State Historic Preservation Office, Advisory Council on Historic Preservation, and the Bureau of Land Management (BLM).

5.4.5 Noise

The WM PEIS stated that treatment sites would probably be located in industrial areas along high-volume highway corridors; therefore, ambient noise levels are not likely to increase substantially. Still, some sensitive receptors may be affected (DOE 1997). Site-specific noise impacts will be assessed in site-wide or project-specific NEPA documents. Because all waste would travel to WIPP but only a portion of the waste would travel from or to each treatment facility, the greatest noise impacts due to transportation noise would be near the WIPP site.

At WIPP, potential noise impacts under Action Alternative 3 would be similar to those under Action Alternative 1 (Section 5.2.5). Like Action Alternative 1, the increase in noise associated with this alternative would be negligible when compared to the background noise level associated with normal automobile, truck, and rail traffic in Carlsbad, New Mexico.

5.4.6 Water Resources and Infrastructure

At the treatment sites, proposed TRU waste activities might affect on-site infrastructures although no off-site infrastructure impacts would be expected. The infrastructure elements analyzed were the capacity of on-site water, power, and wastewater systems, and on-site transportation. For Action Alternative 3, Hanford would have an increased on-site demand for wastewater treatment that would exceed 5 percent of the current demand (7 percent), and INEEL would have an increase in on-site demand for power by 6.4 percent (DOE 1997).

Minor impacts to the on-site transportation infrastructure under Action Alternative 3 may occur. These impacts would result from an increase to on-site employment of 7 percent at Hanford and INEEL and 8 percent at LANL. Impacts to the off-site transportation infrastructure are not anticipated because population increases would not exceed 5 percent. On-site increases could be accommodated by existing and anticipated water supplies, power, water treatment, and transportation systems (DOE 1997).

Negligible annual infrastructure impacts would occur at WIPP under Action Alternative 3. Existing water supply and sewer capabilities and existing and planned power and roadway resources will be able to accommodate proposed disposal operations.

5.4.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts for Action Alternative 3 are presented in the following subsections.

5.4.7.1 Life-Cycle Costs

The life-cycle costs of Action Alternative 3 are presented in Table 5-56 and are discussed below. Six TRU waste treatment sites would process, treat, and package waste over a period of 35 years. In addition, the largest sites (INEEL, Hanford, and ORNL) would be required to store portions of their treated waste volumes over some or all of the 190-year period of disposal operations because of WIPP emplacement limitations. Life-cycle costs include an additional $640 million to account for treatment to planning-basis WAC of waste that would be shipped for treatment. The waste treatment facility life-cycle costs at these six sites would be $24.34 billion (in 1994 dollars).

Table 5-56
Life-Cycle Costs for Action Alternative 3 (in millions of 1994 dollars) [a]

	Basic Inventory			**Additional Inventory**			**Total**	**Total Discounted**
Cost Information	**CH-TRU Waste**	**RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU Waste**	**RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU and RH-TRU Waste**	**CH-TRU and RH-TRU Waste**
Treatment Facilities	9,550	4,380	13,930	9,940	470	10,410	24,340	13,500
Transport by Truck	2,330	3,270	5,600	910	330	1,240	6,840	910
Transport by Regular Train	800	1,120	1,920	310	110	420	2,340	310
Transport by Dedicated Train	5,340	7,500	12,840	2,100	750	2,850	15,690	2,100
Disposal at WIPP	12,300	3,100	15,400	12,800	290	13,090	28,490	3,610
Total Life-Cycle Cost (Truck)	24,180	10,750	34,930	23,560	1,090	24,740	59,670	18,030
Total Life-Cycle Cost (Regular Train)	22,650	8,600	31,250	23,050	870	23,920	55,170	17,420
Total Life-Cycle Cost (Dedicated Train)	27,190	14,980	42,170	24,840	1,510	26,350	68,520	19,210

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

Waste transport costs include one of three transportation options between the six consolidation sites and the WIPP site: (1) trucks, as in the Proposed Action, (2) trucks with maximum practical commercial rail, and (3) trucks with maximum practical dedicated rail. Under these options, transportation costs include the consolidation of the waste volumes at the six large sites, and then shipment to WIPP via truck or rail for emplacement. The waste transport costs would be about $6.84 billion by truck, $2.34 billion by regular rail, and $15.69 billion by dedicated rail.

The WIPP site life-cycle costs of the project would be projected to be $28.49 billion. The total life-cycle costs of Action Alternative 3 would be $59.67 billion ($18.03 billion when discounted) using trucks, $55.17 billion ($17.42 billion when discounted) using regular rail, and $68.52 billion ($19.21 billion when discounted) using dedicated rail.

5.4.7.2 Economic Impacts

TRU waste treatment activities would support direct, indirect, and induced jobs. Action Alternative 3 would support approximately 24,900 jobs in the ROIs of the six treatment sites (Hanford, INEEL, LANL, ORNL, RFETS, and SRS).

Estimates of the impacts of Action Alternative 3 on employment, income, and the production of goods and services within the ROI are presented in Table 5-57. These regional impacts were estimated using an annual average project budget of $180 million per year over a 190-year period of waste disposal operations. Over this extended period of waste emplacement operations, WIPP would remain a stable federal employer in the ROI economy, providing direct employment for 1,095 site personnel annually. Indirectly, the operation of WIPP as a waste emplacement facility (from 2010 through 2200) would annually support 2,443 jobs in the ROI work force.

Table 5-57
Economic Impacts within the WIPP ROI for Action Alternative 3

Economic Effects	Total Output of Goods and Services (in millions of 1994 dollars)	Total Employment (Full- and Part-Time Jobs)	Total Labor Income (in millions of 1994 dollars)	Carlsbad Output of Goods and Services (in millions of 1994 dollars)	Carlsbad Employment (Full- and Part-Time Jobs)	Carlsbad Labor Income (in millions of 1994 dollars)
Direct – Annual	113	1,095	52	95	979	46
Indirect & Induced – Annual	204	2,443	75	172	2,185	67
Total – Annual	317	3,538	126	267	3,164	113
Total - Operations (190 years)	60,230	672,220 [a]	23,940	50,730	601,160 [a]	21,470

[a] Job-years (number of annual jobs supported multiplied by the number of years in the project).

Because the projected average annual project budget would be close to historical levels, Action Alternative 3 would not be expected to result in additional use of government-provided goods or services (schools, police, fire protection, and health protection), nor require major capital investments in public infrastructure within the ROI. For this same reason Action Alternative 3 would not be expected to impact the local real estate market, nor result in major changes in WIPP ROI work force population.

5.4.8 Transportation

This section presents the transportation impacts for Action Alternative 3.

5.4.8.1 Route Characteristics and Shipment Projections

The methods used to estimate route characteristics and the number of shipments for Action Alternative 3 were the same as those presented in Section 5.1.8.1. Table 5-58 presents the number of shipments that would be required.

Table 5-58
Number of Truck Shipments to WIPP for Action Alternative 3 [a]

Waste Treatment Site	CH-TRU Waste			RH-TRU Waste		
	Basic Inventory	Additional Inventory	Total Inventory	Basic Inventory	Additional Inventory	Total Inventory
Hanford Site	24,531	8,600	33,131	60,789	3,076	63,865
Idaho National Engineering and Environmental Laboratory Argonne/National Laboratory-West	10,386	7,769	18,155	---	---	---
Los Alamos National Laboratory	7,628	1,907	9,535	---	---	---
Oak Ridge National Laboratory	---	---	---	7,050	3,691	10,741
Rocky Flats Environmental Technology Site	2,897	---	2,897	---	---	---
Savannah River Site	2,885	706	3,591	---	---	---
Total	48,327	18,982	67,309	67,839	6,767	74,606

[a] The total number of shipments presented here do not include shipments from the generator sites to the consolidation sites. The number of consolidation shipments are 535 for CH-TRU waste and 8,254 for RH-TRU waste.

5.4.8.2 Accidents, Injuries, Fatalities, and Pollution-Related Health Effects from Truck Transportation

Table 5-59 presents a summary of the nonradiological impacts for Action Alternative 3. The fatalities due to the pollution-related health effects of diesel fuel and the impacts due to transporting the waste to treatment sites are also presented. The number of pollution-related fatalities was based upon the total miles traveled in urban areas and a conversion factor of 9.9×10^{-8} LCFs per kilometer (1.6×10^{-7} LCFs per mile) (Rao et al. 1982). For Action Alternative 3, the total number of accidents, injuries, and fatalities over the entire shipping campaign were estimated to be 239, 165, and 22, respectively. Details on the methods used are presented in Appendix E.

Table 5-59
Nonradiological Impacts of Transporting
TRU Waste by Truck for Action Alternative 3

Category	CH-TRU Waste			RH-TRU Waste			Total		
	Basic Inventory	Additional Inventory	Total Inventory	Basic Inventory	Additional Inventory	Total Inventory	Basic Inventory	Additional Inventory	Total Inventory
Number of Accidents	73	31	104	124	12	135	197	43	239
Number of Injuries	51	20	71	85	10	94	136	30	165
Number of Fatalities	7	3	10	11	1	12	18	4	22
Pollution Health Effects (fatalities)	0.2	0.09	0.3	0.4	0.05	0.4	0.6	0.1	0.7

5.4.8.3 Accident-Free Radiological Impacts from Truck Transportation

Accident-free radiological impacts occur during routine transportation and are the result of public and worker exposure to direct radiation at levels allowed by transportation regulations. The methods used to estimate accident-free radiological impacts for Action Alternative 3 were identical to those described for the Proposed Action.

Table 5-60 presents a summary of the accident-free radiological impacts for Action Alternative 3. It includes the impacts due to transporting waste to the treatment sites for treatment (see Appendix E). The total occupational and nonoccupational impacts were estimated to be 1 LCF and 14.5 LCFs, respectively.

Table 5-61 summarizes the radiological impacts to MEIs for accident-free shipments by truck under Action Alternative 3.

Table 5-60
Aggregate Accident-Free Population Radiological Impacts from Truck Transportation for Action Alternative 3 (LCFs) [a]

Exposure Category	CH-TRU Waste			RH-TRU Waste			Total		
	Basic Inventory	Additional Inventory	Total Inventory	Basic Inventory	Additional Inventory	Total Inventory	Basic Inventory	Additional Inventory	Total Inventory
Occupational	0.5	0.2	0.7	0.3	0.04	0.4	0.8	0.2	1.0
Nonoccupational									
Stops	3.3	1.4	4.7	7.8	.9	8.7	11.1	2.3	13.4
Sharing Route	0.2	0.08	0.3	0.4	0.05	0.5	0.6	0.1	0.8
Along Route	0.07	0.03	0.1	0.2	0.03	0.2	0.3	0.06	0.3
Nonoccupational - Total	3.6	1.5	5.1	8.4	1.0	9.4	12.0	2.5	14.5

[a] Exposure during stops is based upon 50 individuals exposed at 20 meters. Stop time, in hours, is based upon 0.011d where d is the distance traveled in kilometers. These parameters are built into the RADTRAN code but substantially overestimate exposures from WIPP shipments. Because WIPP shipments would use two-driver teams (eliminating the need for overnight stops to sleep) and because the shipments would stop at sites chosen, in part, for their lack of population, the actual impacts from stops would be much lower.

Table 5-61
Radiological Impacts to MEIs from Truck Transportation for Action Alternative 3 (Probability of an LCF)

Individual	CH-TRU Waste	RH-TRU Waste	Total
Stuck in traffic next to shipment	2.5E-6	5.0E-6	7.5E-6
Departure Inspector	1.0E-3	6.0E-3	7.0E-3
State Vehicle Inspector	2.1E-3	7.8E-3	9.9E-3
Residing adjacent to access route	2.0E-4	6.0E-4	8.0E-4
Rest stop employee	1.0E-4	3.0E-4	4.0E-4

5.4.8.4 Radiological Impacts from Truck Transportation Accidents

Two types of analyses were conducted for SEIS-II radiological impacts due to traffic accidents. The first analysis determined the radiological impacts due to accidents occurring from each of the principal treatment sites to WIPP. The results for route-specific accidents summed over the entire shipping campaign are presented in Table 5-62.

The second analysis assessed four bounding accident scenarios, two involving the breach of a TRUPACT-II and the other two involving the breach of an RH-72B cask. These assessments were to estimate the maximum potential impacts posed by a severe transportation accident. Details on the methods used to estimate impacts from bounding case accidents are presented in Section 5.1.8.4 and Appendix E.

Table 5-62
Aggregate Radiological Population Impacts for Truck Transportation Accidents for Action Alternative 3 (LCFs)

	CH-TRU Waste			**RH-TRU Waste**			**Total**		
Originating Site	**Basic Inventory**	**Additional Inventory**	**Total Inventory**	**Basic Inventory**	**Additional Inventory**	**Total Inventory**	**Basic Inventory**	**Additional Inventory**	**Total Inventory**
Argonne National Laboratory-East	---	---	---	---	---	---	---	---	---
Hanford Site	0.6	0.2	0.8	0.08	4.0E-3	0.09	0.7	0.2	0.9
Idaho National Engineering and Environmental Laboratory/ANL-W	0.1	0.1	0.2	3.0E-3	5.0E-4	3.5E-3	0.1	0.1	0.2
Lawrence Livermore National Laboratory	---	---	---	---	---	---	---	---	---
Los Alamos National Laboratory	5.0E-3	1.5E-3	6.5E-3	2.0E-5	1.0E-5	3.0E-5	5.0E-3	1.5E-3	6.5E-3
Oak Ridge National Laboratory	---	---	---	5.0E-3	3.0E-3	8.0E-3	5.0E-3	3.0E-3	8.0E-3
Rocky Flats Environmental Technology Site	0.01	---	0.01	---	---	---	0.01	- - -	0.01
Savannah River Site	0.03	7.5E-3	0.04	---	---	---	0.03	7.5E-3	0.04
Total LCFs							**0.9**	**0.3**	**1.2**

For Action Alternative 3, the potential radiological releases from the bounding case accidents were assumed to be the same as those presented under the Proposed Action (a maximum of 16 LCFs to the population and 0.06 probability of cancer to the maximally exposed individual.) The shred and grout treatment process used for treating TRU waste under Action Alternative 3 would reduce the void space in the drums, but increase the waste volume by approximately 20 percent. It was assumed that the release fraction for waste treated using a shred and grout process would be the same as for waste treated under the Proposed Action. The bounding accident consequences therefore, are assumed to be the same as those for the Proposed Action (see Section 5.1.8.4).

5.4.8.5 Hazardous Chemical Impacts from Severe Truck Transportation Accidents

Exposures to hazardous chemical releases from a severe accident would present a negligible hazard to the exposed population under Action Alternative 3. Although the TRU waste for Action Alternative 3 would be treated using a shred and grout process and the inventory for Action Alternative 3 is larger than that for the Proposed Action, the bounding concentrations of VOCs and metals in the TRUPACT-II or RH-72B cask and the release fractions in an accident were estimated to be the same, and so potential impacts would be the same as for the Proposed Action.

5.4.8.6 Impacts from Rail Transportation

This section presents a summary of transportation impacts for both regular and dedicated rail transportation. These impacts were determined by scaling the transportation impacts for truck shipments to estimate the impacts for rail. In Section 5.2.8.6 and Appendix E, the impact parameters are identified, and the differences between truck and rail transportation are explained. Table 5-63 presents the rail impacts under Action Alternative 3.

Table 5-63
Impacts from Rail Transportation for Action Alternative 3

Aggregate Traffic Related Fatalities	
Regular Rail	11
Dedicated Rail	154
Aggregate Accident-Free Radiological Impacts (LCFs)	
CH-TRU Waste	
Occupational Exposure	0.03
Nonoccupational	
Stops	0.6
Sharing Route	2.6E-3
Along Route	0.1
Nonoccupational Exposure - Total	0.7
RH-TRU Waste	
Occupational Exposure	0.02
Nonoccupational	
Stops	1.1
Sharing Route	4.9E-3
Along Route	0.3
Nonoccupational Exposure - Total	1.3
Total CH-TRU and RH-TRU Waste	
Occupational Exposure	0.05
Nonoccupational	
Stops	1.6
Sharing Route	7.5E-3
Along Route	0.4
Nonoccupational Exposure - Total	2.0
Aggregate Radiological Impacts from Rail Transportation Accidents (LCFs)	
CH-TRU Waste	1.1
RH-TRU Waste	0.1
Total CH-TRU and RH-TRU Waste	1.2

The bounding case accident analyses for rail transportation were based on assumptions presented in Section 5.2.8.6. Though the waste would be treated by a shred and grout process, the impacts would be similar to those presented for the Action Alternative 1 rail accident analyses. The greatest impacts were found for the two accidents in which conservative inventories were assumed, 32 LCFs to the exposed population and a 0.12 probability of a cancer fatality for the maximally exposed individual.

5.4.9 Human Health Impacts from Waste Treatment, Storage, and Disposal Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from waste treatment, lag storage, and WIPP disposal operations under Action Alternative 3. As for other action alternatives, impacts from waste treatment were adjusted from those presented in the WM PEIS; a description of the adjustments is provided in Appendix B.

Impacts from lag storage at the treatment sites and WIPP disposal operations were estimated using the general methods and assumptions used for the human health analyses of Proposed Action and Action Alternative 1. Action Alternative 3 includes the Total Inventory (except for PCB-commingled waste). PCB-commingled TRU waste is known to exist at three sites: 242 cubic meters (8,550 cubic feet) at Hanford, 461 cubic meters (16,300 cubic feet) at INEEL, and 19 cubic meters (670 cubic feet) at Mound.

The major distinction of this alternative for human health analyses is the shred and grout treatment method. Shred and grout treatment of waste reduces gas generation and changes the quantity of

VOCs emitted from the waste containers; it also results in a net waste volume increase of about 20 percent overall. The increase in volume would reduce the concentration of the radionuclides in the waste, which decreases the estimated average container dose rates. Denser waste matrices, such as grout, tend to decrease surface dose rates because of more self-absorption of the external radiation emitted by radionuclides in the waste. Worker radiological impacts reflect the impact of these factors. Appendix F provides additional information on the methods used to determine the impacts from lag storage and WIPP disposal operations.

5.4.9.1 Public

Impacts to the populations and to the MEIs under Action Alternative 3 are presented in this section; results are presented in Table 5-64. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different populations and individuals would be impacted by these activities. Waste treatment and lag storage would take place at six DOE sites; none of them WIPP. Waste disposal operations would take place only at WIPP. Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of all treatment sites, all lag storage sites, and at WIPP. The impacts to the MEIs from waste treatment and lag storage are presented for the highest individual waste treatment sites; the MEI from disposal operations is near the WIPP site. See Chapter 3 for additional information on where treatment and storage would occur under Action Alternative 3.

Table 5-64
Lifetime Human Health Impacts to the Public from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 3

	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
Category	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemical (Cancer Incidence)** [b]
MEI [c, d]						
Basic Inventory						
CH-TRU Waste	2E-7 (L)	4E-13 (L)	2E-7 (L)	1E-7 (L)	2E-7	5E-9
RH-TRU Waste	7E-12 (O)	1E-11 (O)	1E-9 (O)	4E-8 (H)	7E-10	9E-10
Total Waste	2E-7 (L)	1E-11 (O)	2E-7 (L)	1E-7 (L)	2E-7	6E-9
Total Inventory						
CH-TRU Waste	4E-7 (L)	7E-13 (I)	3E-7 (L)	2E-7 (L, H)	3E-7	1E-8
RH-TRU Waste	1E-11 (O)	2E-11 (O)	2E-9 (O)	4E-8 (H)	8E-10	9E-10
Total Waste	4E-7 (L)	2E-11 (O)	3E-7 (L)	3E-7 (H)	3E-7	1E-8
Population [b]						
Basic Inventory						
CH-TRU Waste	3E-3	5E-9	1E-3	2E-3	1E-4	5E-6
RH-TRU Waste	3E-7	3E-7	3E-5	2E-4	9E-7	5E-7
Total Waste	3E-3	3E-7	1E-3	2E-3	1E-4	6E-6
Total Inventory						
CH-TRU Waste	4E-3	1E-8	2E-3	2E-3	2E-4	1E-5
RH-TRU Waste	4E-7	4E-7	5E-5	2E-4	1E-6	5E-7
Total Waste	4E-3	4E-7	2E-3	2E-3	2E-4	1E-5
Aggregate Total	4E-3	4E-7	3E-3	4E-3	3E-4	2E-5

[a] The probability of an LCF to the MEI, and the number of LCFs in the population

[b] If a panel full of CH-TRU waste remained open during the entire 70-year lifetime of the MEI and VOCs were emitted at a constant rate, the MEI lifetime risk from the CH-TRU waste would be 2E-8.

[c] I = INEEL, L = LANL, H = Hanford, O = ORNL.

[d] The workers considered for treatment impacts, lag storage impacts, and operations impacts are different.

Note: Sites in parentheses indicate where the greatest MEI impact would occur.

Waste Treatment

No LCFs (4 x 10^{-3} LCF) or cancer incidence (4 x 10^{-7} cancers) would be expected in the total population around the waste treatment sites. The MEI would be at LANL for radiological impacts (4 x 10^{-7} probability of an LCF), and impacts at all sites would not exceed a 2 x 10^{-11} probability of a cancer incidence. The maximum HI for the MEI would be 7 x 10^{-10}.

Lag Storage

No LCFs would be expected in the total population around the lag storage sites (2 x 10^{-3} LCFs); no cancer incidence (2 x 10^{-3} cancers) would be expected in the total population from hazardous chemical exposure. The MEI would be at LANL for radiological impacts (3 x 10^{-7} probability of an LCF) and at Hanford for hazardous chemical impacts (also 3 x 10^{-7} probability of a cancer incidence). No noncarcinogenic health effects would occur because the maximum HI for any MEI would be 9 x 10^{-4}.

The aggregate total indicated in Table 5-64 refers to the impacts expected over the entire operational period under Action Alternative 3. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 57 years for CH-TRU waste and 190 years for RH-TRU waste. No LCFs (3 x 10^{-3} LCFs) or cancer incidence (4 x 10^{-3} cancers) would be expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials.

WIPP Disposal Operations

No LCFs would be expected in the population around WIPP from radiation exposure (2 x 10^{-4} LCF). No cancer incidence (1 x 10^{-5} cancers) would be expected in the population from hazardous chemical exposure.

The MEI was assumed to be located at the Land Withdrawal Area boundary, the closest point at which an individual could reside. The MEI would have a 3 x 10^{-7} probability of an LCF from radiation exposure and a 1 x 10^{-8} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects would occur; the maximum HI for the MEI would be 1 x 10^{-4}.

The aggregate total indicated in Table 5-64 refers to the impacts expected over the entire operational period. The operational period for the disposal of the Total Inventory is expected to be 57 years for CH-TRU waste and 190 years for RH-TRU waste. No LCFs (3 x 10^{-4} LCFs) or cancer incidence (2 x 10^{-5} cancers) would be expected over the several generations of exposure to the estimated releases.

5.4.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under Action Alternative 3 are presented in this section; results are presented in Table 5-65. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, storage, handling, or disposal of waste. Impacts from waste treatment, lag storage, and WIPP disposal operations are presented separately because different noninvolved worker populations and individuals would be impacted by these activities. Waste treatment and lag storage

Table 5-65
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 3

Category	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
	Radiological (LCF) [a]	**Hazardous Chemicals (Cancer Incidence)**	**Radiological (LCF) [a]**	**Hazardous Chemicals (Cancer Incidence)**	**Radiological (LCF) [a]**	**Hazardous Chemicals (Cancer Incidence)**
Maximally Exposed Noninvolved Worker [b, c]						
Basic Inventory						
CH-TRU Waste	1E-7 (L)	2E-12 (I)	8E-7 (S)	2E-7 (H)	2E-7	3E-8
RH-TRU Waste	6E-12 (O)	9E-11 (O)	1E-8 (O)	8E-8 (H)	2E-9	2E-9
Total Waste	1E-7 (L)	9E-11 (O)	8E-7 (S)	3E-7 (H)	2E-7	3E-8
Total Inventory						
CH-TRU Waste	2E-7 (L)	6E-12 (I)	2E-6 (S)	3E-7 (H)	3E-7	5E-8
RH-TRU Waste	9E-12 (O)	1E-10 (O)	2E-8 (O)	9E-8 (H)	2E-9	2E-9
Total Waste	2E-7 (L)	1E-10 (O)	2E-6 (S)	4E-7 (H)	3E-7	5E-8
Population [c]						
Basic Inventory						
CH-TRU Waste	5E-4	4E-9	0.02	4E-3	2E-4	3E-5
RH-TRU Waste	9E-9	9E-8	2E-4	1E-3	2E-6	2E-6
Total Waste	5E-4	1E-7	0.02	5E-3	2E-4	3E-5
Total Inventory						
CH-TRU Waste	7E-4	9E-9	0.04	8E-3	3E-4	5E-5
RH-TRU Waste	1E-8	1E-7	2E-4	1E-3	2E-6	2E-6
Total Waste	7E-4	1E-7	0.04	9E-3	3E-4	5E-5
Aggregate Total	7E-4	1E-7	0.07	0.02	5E-4	9E-5

[a] The probability of an LCF occurring to the maximally exposed noninvolved worker, and the number of LCFs in the population.

[b] L = LANL, H = Hanford, I = INEEL, O = ORNL, S = SRS

[c] The workers considered for treatment impacts, lag storage impacts, and operations impacts are different.

Note: Sites in parentheses indicate where the greatest MEI impact would occur.

would take place at six DOE sites not including WIPP, while disposal operations would take place only at WIPP. Noninvolved worker population impacts were estimated as the total for all treatment sites, for all lag storage facilities, and at WIPP. The impacts to the maximally exposed noninvolved worker from waste treatment and lag storage are presented for the highest individual waste treatment sites. The maximally exposed noninvolved worker from disposal operations was assumed to work continuously at the WIPP location where emissions have the least atmospheric dispersion and thus the greatest potential impact. This location was 200 meters (660 feet) east of the exhaust filter building. The maximum ground-level concentrations of any airborne contamination would be expected at this location.

Waste Treatment

Under Action Alternative 3, radiological impacts to the noninvolved workers from waste treatment would be somewhat greater than nonradiological impacts. No LCFs (7 x 10^{-4} LCFs) or cancer incidence (2 x 10^{-7} cancers) would be expected in the total noninvolved worker population at the waste treatment sites. The maximally exposed noninvolved worker would be at LANL for radiological impacts (2 x 10^{-7} probability of an LCF) and at ORNL for hazardous chemical impacts

(1 x 10^{-10} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the maximally exposed noninvolved worker would be 8 x 10^{-9}, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

No LCFs would be expected in the total noninvolved worker population at the lag storage sites (4 x 10^{-2} LCF); no cancer incidence (9 x 10^{-3} cancers) would be expected in the total noninvolved worker population from hazardous chemical exposure. The maximally exposed noninvolved worker would be at SRS for radiological impacts (2 x 10^{-6} probability of an LCF) and at Hanford for hazardous chemical impacts (4 x 10^{-7} probability of a cancer incidence). No noncarcinogenic health effects would occur; the maximum HI for the maximally exposed noninvolved worker would be 4 x 10^{-3}.

The aggregate total indicated in Table 5-65 refers to the impacts to the noninvolved worker population at the lag storage sites expected over the entire operational period under Action Alternative 3. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 57 years for CH-TRU waste and 190 years for RH-TRU waste. No LCFs (0.07 LCFs) or cancer incidence (0.02 cancers) would be expected in the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials under incident-free operations.

WIPP Disposal Operations

No LCFs would be expected in the WIPP noninvolved worker population from radiation exposure (3 x 10^{-4} LCF). VOC release estimates were the same as for the public. No cancer incidence (5 x 10^{-5} cancers) would be expected in the noninvolved worker population from hazardous chemical exposure. All 1,095 WIPP employees were assumed to be exposed at the same level as the maximally exposed noninvolved worker.

The maximally exposed noninvolved worker would have a 3 x 10^{-7} probability of an LCF from radiation exposure and a 5 x 10^{-8} probability of a cancer incidence from hazardous chemical exposure. No noncarcinogenic health effects would occur; the maximum HI for the maximally exposed noninvolved worker would be 1 x 10^{-3}.

The aggregate total indicated in Table 5-65 shows that no LCFs (5 x 10^{-4} LCFs) or cancer incidence (9 x 10^{-5} cancers) would be expected to the noninvolved workers at the WIPP site during the entire disposal operations period under Action Alternative 3.

5.4.9.3 Involved Workers

Impacts to involved workers who would handle waste during treatment, lag storage, and WIPP disposal operations under Action Alternative 3 are presented in this section. Results are presented in Table 5-66, and additional information is presented in Appendix F and Appendix B for waste treatment impacts. All worker exposures to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Table 5-66
Lifetime Human Health Impacts to Involved Workers from Waste Treatment, Lag Storage, and WIPP Disposal Operations for Action Alternative 3 [a]

Category	Waste Treatment Impacts		Lag Storage Impacts		WIPP Disposal Operations Impacts	
	Radiological (LCF)	**Hazardous Chemicals (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemicals (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemicals (Cancer Incidence)**
Population					(36 workers)	(36 workers)
Basic Inventory						
CH-TRU Waste	0.7	1E-5	0.2	0.03	0.05	4E-3
RH-TRU Waste	9E-3	6E-6	≤0.2	≤0.03	≤0.05	4E-4
Total Waste	0.7	2E-5	≤0.4	≤0.06	≤0.1	≤4E-3
Total Inventory						
CH-TRU Waste	1.5	3E-5	0.3	0.06	0.1	7E-3
RH-TRU Waste	0.01	9E-6	≤0.3	≤0.06	≤ 0.1	4E-4
Total Waste	1.5	4E-5	≤0.6	≤0.1	≤ 0.2	≤7E-3
Aggregate Total	1.5	4E-5	0.6	≤0.4	0.3	≤0.01

[a] The workers considered for treatment impacts, lag storage impacts, and operations impacts are different.

Waste Treatment

A maximum of 1.5 radiation-related LCFs could occur in the involved worker population, while no cancer incidence (4 x 10^{-5} cancers) would be expected from hazardous chemical exposure. No noncarcinogenic health effects are predicted. The maximum exposure index for a waste treatment worker would be 3 x 10^{-4}, and no health effect is predicted unless the HI is 1 or higher.

Lag Storage

Assuming 35 years of management of the entire inventory, radiological impacts to the lag storage involved worker population would be less than 0.6 LCF, and hazardous chemical impacts would be less than 0.1 cancers. No noncarcinogenic health effects would occur. Involved worker lag storage impacts would be larger from CH-TRU waste storage operations than from RH-TRU waste storage operations. Impacts from RH-TRU waste lag storage operations would be less because of remote RH-TRU waste handling and greater administrative controls for RH-TRU waste. No specific RH-TRU lag storage impact estimates were made because specific RH-TRU waste handling configurations and procedures are unknown. RH-TRU waste lag storage impacts would be assessed in greater detail in future site-wide or project-specific NEPA reviews.

The impacts from CH-TRU waste would be from the external radiation dose received during waste container handling. Potential radiological impacts from inhalation of radioactive gases released from waste containers would be negligible. Involved worker impacts from lag storage were calculated by assuming waste handlers would spend 2 hours every workday at 1 meter (3.3 feet) from the CH-TRU waste containers and were assumed to be exposed over a 35-year career. Container dose rates were decay-corrected over 35 years, and 20 percent of the Total Inventory was assumed to be monitored annually.

The aggregate total indicated in Table 5-66 refers to the impacts to the involved worker population at the lag storage sites over the entire operational period under Action Alternative 3. Lag storage impact estimates conservatively assume that the lag storage period is equivalent to the disposal operations period, which is estimated to be 57 years for CH-TRU waste and 190 years for RH-TRU waste. A maximum of 0.6 LCFs and less than 0.4 cancers would be expected over the several generations of involved workers that would be exposed externally or via inhalation of hazardous chemicals during lag storage operations. The radiological impact estimates reflect the aggregate impacts analyses presented in detail in Appendix F. The hazardous chemical impacts were estimated in the same manner as the public and noninvolved worker estimates.

WIPP Disposal Operations

Radiological impacts to the involved worker population at WIPP from disposal operations would be less than 0.2 LCF. WIPP involved worker radiological impacts would be from external radiation dose, and it was assumed that each involved worker who handled CH-TRU waste for 400 hours per year. The operational period was determined by assuming that 2.5 years of disposal operations were required to fill each panel. Impacts to involved workers from RH-TRU waste handling were assumed to be the same or less than those from CH-TRU waste handling. This assumption is conservative because RH-TRU waste is typically handled using remote-handling equipment, workers are usually protected by radiation shielding, and stricter administrative procedures are used. The impact from handling RH-TRU waste, therefore, would probably be less than the impact from handling CH-TRU waste.

Hazardous chemical carcinogenic impacts to the involved worker population would be less than 7×10^{-3} cancers. Involved worker exposures to VOCs were evaluated for workers in the Waste Handling Building and underground. The potential carcinogenic impacts would be greatest for the individual underground worker. Noncarcinogenic health effects were also estimated for WIPP workers who would handle waste. The same methods were used as for the Proposed Action (Section 5.1.9.3).

No hazardous chemical noncarcinogenic health effects would occur. The initial maximum HI estimates for involved workers were from carbon tetrachloride, with values of 2 and 10, respectively, for workers in the Waste Handling Building and the underground. Further evaluation was conducted by comparing the worker exposure air concentration to the PEL for carbon tetrachloride. The worker air concentrations would be, at a minimum, two orders of magnitude below the PEL, so no noncarcinogenic health effects would occur. Workers were assumed to be exposed for a working lifetime of 35 years.

The aggregate total indicated in Table 5-66 refers to the impacts to the involved worker population at WIPP over the entire disposal operations period under Action Alternative 3. No LCFs (0.3 LCFs) or cancer incidence (less than 0.01 cancers) would be expected over the several generations of involved workers at WIPP. Total radiological impacts would be approximately twice the number of impacts estimated for the individual during the first 35 years of CH-TRU waste disposal operations at WIPP. Radiological decay would reduce the radiological impacts to each generation of WIPP workers. Hazardous chemical impacts were conservatively estimated by assuming continuous exposure to the same releases over the entire disposal operations period.

5.4.10 Facility Accidents

This section describes potential consequences of facility accidents at the treatment sites from the shred and grout treatment of waste, at the treatment sites from waste storage after treatment but before shipment to WIPP, and at WIPP during waste management and disposal operations. Consequences of treatment and storage accidents were evaluated at the six treatment sites (Hanford, LANL, INEEL, SRS, RFETS, and ORNL) that would handle all of the CH-TRU and RH-TRU waste under Action Alternative 3.

Inhalation is the dominant exposure pathway for accidental releases of radionuclides and hazardous chemicals. Radiological consequences are potentially much greater for members of the public and the noninvolved workers than hazardous chemical consequences and are dominated by inhalation of transuranic radionuclides. Details of the methods and assumptions used and complete accident descriptions are provided in Appendix G.

5.4.10.1 Waste Treatment Accidents

Three potential waste treatment accidents were evaluated under Action Alternative 3; they are presented in Table 5-67. Results are presented only for accidents involving CH-TRU waste. They would be greater than similar accidents involving RH-TRU waste. Treatment accidents analyzed include a high-frequency/low-consequence operational accident which is expected to be applicable under any facility design, a low-frequency/high-consequence operational accident, and a beyond-design-basis natural disaster accident. For the purposes of analyses, an earthquake was assumed to be the initiating event the beyond-design-basis accident for analysis (rather than a plane crash or tornado, for instance). Accident analysis information is presented in Appendix G.

Table 5-67
Treatment Accident Scenarios Evaluated for Action Alternative 3

Accident Scenarios	Annual Occurrence Frequency	Description
Waste Spill (Accident Scenario T7)	0.01	Wet grout is spilled onto facility floor before it is placed in a drum.
Fire (Accident Scenario T8)	1E-4	Pyrophoric material inside a shredder causes shredder contents to burn.
Earthquake (Accident Scenario T9)	1E-5 or less	A beyond-design-basis earthquake (or other natural event) collapses the roof, causing drums to rupture and HEPA filters to fail.

Estimated radiological consequences are presented as the number of LCFs in the exposed population and the probability of an LCF occurring in MEIs (in tables the probability of an LCF is presented for MEIs). Carcinogenic and noncarcinogenic consequences from hazardous chemicals, both VOCs and heavy metals, were estimated. Carcinogenic consequences are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic consequences from exposure to VOCs and heavy metals were estimated by two different methods: IDLH-equivalent ratios and ERPG ratios.

In general, potential radiological consequences would be higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the

Table 5-68
Radiological Consequences of Treatment Accidents for Action Alternative 3 [a]

Accident Scenarios		Population (Number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
CH-TRU Waste	Waste Spill (Accident Scenario T7)	Maximum: 1E-4 (RFETS)	Maximum: 6E-8 (LANL)	Maximum: 2E-7 (Hanford)
	Fire (Accident Scenario T8)	Maximum: 6E-3 (RFETS)	Maximum: 3E-6 (LANL)	Maximum: 8E-6 (Hanford)
	Earthquake (Accident Scenario T9)	Hanford: 6 INEEL: 0.3 LANL: 2 RFETS: 6 SRS: 0.5	Hanford: 3E-3 INEEL: 2E-4 LANL: 5E-3 RFETS: 4E-4 SRS: 6E-5	Hanford: 0.02 INEEL: 0.02 LANL: 0.02 RFETS: 0.01 SRS: 0.01
RH-TRU Waste	Waste Spill (Accident Scenario T7)	Maximum: 5E-9 (ORNL)	Maximum: 4E-12 (ORNL)	Maximum: 4E-12 (ORNL)
	Fire (Accident Scenario T8)	Maximum: 3E-7 (ORNL)	Maximum: 2E-10 (ORNL)	Maximum: 2E-10 (ORNL)
	Earthquake (Accident Scenario T9)	Hanford: 1E-4 ORNL: 3E-4	Hanford: 7E-8 ORNL: 3E-7	Hanford: 4E-7 ORNL: 7E-7

[a] The site with the greatest consequence is shown in parentheses.

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-68. Consequences to the maximally exposed involved worker were addressed qualitatively.

Public

Population consequences from treatment accidents were estimated for the exposed populations around the six treatment sites. Potential consequences to the population and MEIs at the five sites vary over a wide range because population distributions, distances to MEIs, and atmospheric dispersion factors differ among sites. No LCFs would be expected in the exposed population from the waste spill accident or fire in a waste shredder accident (Accident Scenario T7 and T8). Up to 6 LCFs were estimated to occur from the earthquake (Accident Scenario T9) at RFETS and Hanford. The radiological consequences were estimated to be the highest to the MEI at LANL for all three accidents. Consequences due to the earthquake (Accident Scenario T9) were estimated to range from a 6×10^{-5} (at SRS) to 5×10^{-3} (at LANL) probability of an LCF to the MEI.

Carcinogenic consequences from VOCs would be one to five orders of magnitude greater than consequences from heavy metals for the waste spill and earthquake accidents (Accident Scenarios T7 and T9, respectively). Heavy metals would account for all carcinogenic consequences from the fire accident (Accident Scenario T8) because VOCs would be consumed by the fire. No cancers were estimated to occur in the exposed population from the hazardous chemical releases of any accident. The maximum probability of cancer to the MEI would be 6×10^{-9} from any of the three treatment accidents. The ORNL, Hanford, LANL, and RFETS MEIs could all develop irreversible or severe noncarcinogenic health effects from exposure to hazardous chemicals as a result of the earthquake.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker was assumed to be at the location of greatest consequence outside of the waste treatment building. The consequences to the noninvolved worker were estimated to not vary significantly across the five sites. Radiological consequences to the maximally exposed noninvolved worker would result in a 2 x 10^{-7} probability of an LCF from the waste spill accident (Accident Scenario T7 at Hanford), 8 x 10^{-6} probability of an LCF from the fire accident (Accident Scenario T8 at Hanford), and up to 0.02 probability of an LCF (at Hanford, INEEL, and LANL) from the beyond-design-basis earthquake (Accident Scenario T9).

No cancer incidents would be expected from the release of hazardous chemicals or metals from any of the accidents; the greatest probability of cancer would be 2 x 10^{-8}. Under the earthquake scenario (Accident Scenario T9), the maximally exposed noninvolved worker at all the sites would have a chance of developing irreversible or severe noncarcinogenic health effects, and could develop life threatening effects. These effects would be because of exposures to heavy metals and VOCs.

Maximally Exposed Involved Worker

No consequences to the maximally exposed involved worker would be anticipated from either the waste spill or fire accidents (Accident Scenarios T7 or T8, respectively). These accidents are such that involved workers would be able to evacuate immediately or would not be affected by the event. Substantial consequences would be possible due to the events of the earthquake scenario (Accident Scenario T9), ranging from workers killed by debris from collapsing treatment facilities to high external radiation doses from RH-TRU waste being treated. Intakes of radionuclides, VOCs, and heavy metals would also occur.

5.4.10.2 Waste Storage Accidents

Three potential waste storage accidents were evaluated for Action Alternative 3; they are presented in Table 5-69. CH-TRU waste would be consolidated at five sites for lag storage under Action Alternative 3. The potential accident consequences at the five sites were evaluated in detail; the sites would be Hanford, INEEL, LANL, RFETS, and SRS. A sixth site, ORNL, would store only for RH-TRU waste under Action Alternative 3. Only CH-TRU accident consequences are presented in this section; the consequences of an RH-TRU storage facility failure in the event of an earthquake are presented in detail in Appendix G.

Table 5-69
Storage Accident Scenarios Evaluated for Action Alternative 3

Accident Scenarios	Annual Occurrence Frequency	Description
Drum Puncture, Drop and Lid Failure (Accident Scenario S1) [a]	1E-2 to 1E-4	A forklift strikes and punctures a drum on a lower level of a stack in the storage facility. The stack is destablilized and two drums fall to the ground and lose their lids upon impact.
Drum Fire (Accident Scenario S2) [a]	1E-4 to 1E-6	A fire spontaneously erupts in a waste drum.
Earthquake (Accident Scenario S3)	1E- 5 or less	A beyond-design-basis earthquake (or other natural event) occurs, causing the collapse of the storage buildings.

[a] Occurrence frequencies for Accident Scenarios S1 and S2 were taken from reference documents applicable to waste packaged to meet the planning-basis WAC. The same range of frequencies were assumed to apply to grouted waste. In reality, the frequency of occurrence of Accident Scenario S2 would probably be substantially lower for the grouted waste than for the waste treated to planning-basis WAC.

Storage accidents analyzed include a high-frequency/low-consequence operational accident which is expected to be applicable under any facility design, a low-frequency/high-consequence operational accident, and a beyond-design-basis natural disaster accident (an earthquake). For Accident Scenarios S1 and S2, CH-TRU waste involved in the accidents was assumed to have the maximum radionuclide content allowable under the planning-basis WAC (80 PE-Ci per drum), conservative concentrations of VOCs (based on CH-TRU sampling and WAC limits), and conservative concentrations of heavy metals. Accident Scenario 3 involves a large number of waste containers; therefore, average site-specific drum PE-Ci values and average hazardous chemical concentrations were used in the analyses. Additional details on the accident analyses are presented in Appendix G.

Estimated radiological consequences are presented as the number of LCFs in the exposed population and the probability of an LCF occurring in MEIs. Carcinogenic and noncarcinogenic consequences from hazardous chemicals, both VOCs and heavy metals, were estimated. Carcinogenic consequences are presented as the number of cancers in the exposed population and the probability of cancer for MEIs. Noncarcinogenic consequences from exposure to VOCs and heavy metals were estimated by two different methods for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2, respectively): IDLH-equivalent ratios and ERPG ratios. Only IDLH-equivalent ratios were calculated for the catastrophic storage facility failure due to the earthquake (Accident Scenario S3). The potential noncarcinogenic consequences identified by ERPG ratios would be of minor importance during such a catastrophic event and its consequent site-operations upheaval.

In general, potential radiological consequences would be higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below and in Table 5-70.

Public

Population consequences from storage accidents were estimated for the exposed populations around the five CH-TRU waste treatment sites. Potential consequences to the population and MEIs at the five sites vary over a wide range because the population distributions, distances to MEIs, and

Table 5-70
Radiological Consequences of Storage Accidents for Action Alternative 3 [a]

Accident Scenarios	Population (number of LCFs)	MEI (probability of an LCF)	Maximally Exposed Noninvolved Worker (probability of an LCF)
Puncture and Lid Failure (Accident Scenario S1)	Maximum: 3E-5 (RFETS)	Maximum: 8E-9 (LANL)	Maximum: 2E-8 (Hanford, LANL)
Drum Fire (Accident Scenario S2)	Maximum: 5E-5 (RFETS)	Maximum: 2E-8 (LANL)	Maximum: 5E-8 (Hanford)
Earthquake (Accident Scenario S3)	Hanford: 9 INEEL: 0.3 LANL: 2 RFETS: 10 SRS: 2	Hanford: 5E-3 INEEL: 1E-4 LANL: 4E-3 RFETS: 6E-4 SRS: 2E-4	Hanford: 0.03 INEEL: 0.02 LANL: 0.02 RFETS: 0.02 SRS: 0.04

[a] The site with the greatest consequence is shown in parentheses.

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

atmospheric dispersion factors differ among sites. No LCFs would be expected in the exposed population due to the drum puncture or drum fire scenarios (Accident Scenarios S1 and S2, respectively), but LCFs were estimated to occur due to the earthquake scenario (Accident Scenario S3) at most sites. The consequences due to the earthquake ranged from 0.3 (at INEEL) to 10 (at RFETS) LCFs. The radiological consequences were estimated to be the highest to the MEI at LANL for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2). Consequences due to the earthquake scenario (Accident Scenario S3) were estimated to range from a 1×10^{-4} (at INEEL) to 5×10^{-3} probability of an LCF to the MEI.

Carcinogenic consequences from VOCs would be two to seven orders of magnitude greater than consequences from heavy metals for the drum puncture and earthquake accidents (Accident Scenarios S1 and S3, respectively). Heavy metals would account for all carcinogenic consequences from the drum fire (Accident Scenario S2) because VOCs would be consumed by the fire. No cancers were estimated to occur in the exposed population from the hazardous chemical releases of any accident. The maximum probability of cancer to the MEI would be 3×10^{-10} from the drum puncture or drum fire scenarios (Accident Scenarios S1 and S2). The maximum probability of cancer to the MEI would be 6×10^{-7} for the earthquake scenario (Accident Scenario S3 at Hanford). No noncarcinogenic consequences would be expected for any of the three accidents evaluated.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker was assumed to be at the location of greatest consequence outside of the waste storage facility. The consequences to the noninvolved worker were estimated to vary over a narrow range. The range was narrow because of the uniform release height and close distances considered.

Radiological consequences to the maximally exposed noninvolved worker would result in a 2×10^{-8} probability of an LCF from the drum puncture scenario (Accident Scenario S1), 5×10^{-8} probability of an LCF from the events of the drum fire scenario (Accident Scenario S2), and up to a 0.04 probability of an LCF (at SRS) from the beyond-design-basis earthquake (Accident Scenario S3). Hazardous chemical consequences would be relatively minor in comparison to radiological consequences. The maximum probability of cancer to the maximally exposed noninvolved worker from VOC and heavy metal intakes would be 8×10^{-10} for the drum puncture and drum fire scenarios (Accident Scenarios S1 and S2). The corresponding consequence for the earthquake (Accident Scenario S3) would be 3×10^{-6} probability of cancer. No noncarcinogenic consequences to the noninvolved worker would be expected to result from the hazardous chemical releases for the accidents evaluated.

Maximally Exposed Involved Worker

The maximally exposed involved worker would be the individual most seriously affected by the events of the drum puncture scenario or earthquake (Accident Scenarios S1 and S3, respectively) because of close proximity to the accident. Consequences were quantitatively estimated for Accident S1 and qualitatively for Accident Scenarios S2 and S3. The worker could potentially have a 3×10^{-3} probability of an LCF as a result of the radionuclide intake during the events of the drum puncture scenario (Accident Scenario S1). The analysis assumed instantaneous radioactive material release from the three containers, expanding in a uniform hemisphere 5 meters (16 feet) in radius. The worker was assumed to inhale this air for 1 minute prior to exiting to a fresh air source. The involved worker could have a 5 x 10^{-8} probability of contracting cancer from hazardous chemicals inhaled following the drum puncture (Accident Scenario S1). Noncarcinogenic consequences would include consequences to the maximally exposed involved worker from methylene chloride and would be irreversible, although not life-threatening.

Consequences due to the drum fire (Accident Scenario S2) would be serious if the worker happened to be adjacent to the drum when the fire began. However, a worker's actions are not required to initiate the accident; therefore, the probability of exposure of a worker adjacent to the fire is small. The smoke released from the drum would alert workers to the incident, and it, therefore, can be reasonably assumed that workers would avoid exposure to the smoke.

Catastrophic destruction of the storage facility during an earthquake (Accident Scenario S3) could result in death or serious injury to the maximally exposed involved worker.

5.4.10.3 WIPP Disposal Accidents

Eight potential accidents at WIPP during disposal operations were evaluated; they are presented in Table 5-71. Six of the accidents involve only CH-TRU waste (Accident Scenarios W1 through W5 and W7), one involves only RH-TRU waste (Accident Scenario W8), and one was evaluated for consequences from CH-TRU and RH-TRU waste (Accident Scenario W6). The drum fire accident (Accident Scenario W5) that was evaluated under the Proposed Action and Action Alternative 1 may not be relevant for the relatively noncombustible shred-and-grout waste matrix evaluated under Action Alternative 3. Accident consequences were nevertheless estimated, and the same annual occurrence frequency for the accident under the Proposed Action and Action Alternative 1 was conservatively applied. Annual occurrence frequencies are the same in all cases as those indicated for the Proposed Action and Action Alternative 1.

Table 5-71
WIPP Disposal Accident Scenarios for Action Alternative 3

Accident Scenarios	Annual Occurrence Frequency	Description
Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	0.01	A package of drums is dropped in the Waste Handling Building, a drum on top of the package falls and its lid seal fails.
Drop, Puncture Lid Failure in the Waste Handling Building (Accident Scenario W2)	0.01	Forklift strikes and punctures drums on lower level of stack in the Waste Handling Building. A drum on the upper level falls and the lid seal fails.
Drop, Lid Failure in Underground (Accident Scenario W3)	0.01	Same as Accident Scenario W1, but it occurs in the underground.
Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	0.01	Same as Accident Scenario W2, but it occurs in the underground.
Container Fire (Accident Scenario W5)	1E-4 (<8 PE-Ci) <1E-6 (>8 PE-Ci)	Contents of a drum in an underground disposal room spontaneously combusts prior to panel closure.
Hoist Failure (Accident Scenario W6)	<1E-6	Waste hoist braking system fails and fully loaded hoist falls to the bottom of shaft. Both CH-TRU and RH-TRU waste loads were evaluated.
Roof Fall (Accident Scenario W7)	0.01, Panel 1 < 1E-6, other panels	A portion of a disposal room roof falls prior to panel closure, crushing drums and causing lid seal failures.
RH-TRU Waste Canister Breach (Accident Scenario W8)	1E-4 to 1E-6	RH-TRU waste canister is breached Waste Handling Building operations.

Potential radiological consequences would be substantially higher than hazardous chemical consequences, which are very small for most accident cases. Estimated results for members of the public, the maximally exposed noninvolved worker, and the maximally exposed involved worker are presented below.

The greatest radiological consequences of facility accidents under Action Alternative 3 would be the same as the greatest consequences under the Action Alternative 2 subalternatives because characteristics of the thermally-treated and grouted waste forms were assumed to be the same. However, average radionuclide concentrations in the treated waste under the Action Alternative 2 subalternatives would realistically be two to five times higher than that of Action Alternative 3 waste. Therefore, average accident consequences for the Action Alternative 2 subalternatives would be higher than those for Action Alternative 3. For the disposal room roof failure (Accident Scenario W7), the consequences of postulated accidents under Action Alternative 3 would be less than those under the Proposed Action and Action Alternative 1 by at least a factor of ten. The grout treatment increases waste volume by 20 percent overall, and therefore reduces average concentrations by 20 percent, as well. The grouted waste is less likely to release particles of respirable size in the event of a container breach caused by a minor accident. However, in the event of a hoist failure, the more uniform, grouted waste matrix (as compared to waste treated to planning-basis WAC) is more likely to shatter upon impact into respirable particles. Consequences of the hoist failure would be approximately five to seven times higher than those estimated for waste treated to planning-basis WAC under the Proposed Action and Action Alternative 1. Radiological consequences of accidents under Action Alternative 3 are shown in Table 5-72.

Table 5-72
Radiological Consequences of WIPP Disposal Accidents for Action Alternative 3

Accident Scenarios	Population (LCFs)	MEI (probability of LCF)	Maximally Exposed Noninvolved Worker (probability of LCF)	Maximally Exposed Involved Worker (probability of LCF)
Drop, Lid Failure in Waste Handling Building (Accident Scenario W1)	9E-4	1E-5	1E-5	3E-3
Drop, Puncture Lid Failure in Waste Handling Building (Accident Scenario W2)	9E-4	1E-5	1E-5	3E-3
Drop, Lid Failure in Underground (Accident Scenario W3)	9E-4	1E-5	1E-5	3E-3
Drop, Puncture, Lid Failure in Underground (Accident Scenario W4)	9E-4	1E-5	1E-5	3E-3
Container Fire (Accident Scenario W5)	5E-3	7E-5	6E-5	Not Credible
Hoist Failure (CH-TRU, RH-TRU) (Accident Scenario W6)	CH-TRU: 29 RH-TRU: 9	CH-TRU: 0.6 RH-TRU: 0.1	CH-TRU: 0.5 RH-TRU: 0.1	See Footnote a
Roof Failure (Accident Scenario W7)	0.02	2 E-4	2 E-4	See Footnote a
RH-TRU Canister Breach (Accident Scenario W8)	0	0	0	0

[a] These consequences could range from negligible (workers not present, or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris)

Note: This table presents estimates of the consequences of accident scenarios and does not reflect the frequency (or probability) of the accident occurring.

Public

Population consequences from WIPP disposal accidents were estimated for the 22.5 degree sector west of the site, which includes the city of Carlsbad. The population in this sector is 25,629 and would be affected greater than any other section in the surrounding 80-kilometer (50-mile) region. Consequences to the MEI were evaluated at the point of closest public access to the DOE Exclusive Use Area boundary and the least atmospheric dispersion of facility exhaust ventilation air, which would be the location of maximum consequence. This point was 300 meters (990 feet) south of the Exhaust Filter Building. No credit was taken for HEPA filtration from either the Exhaust Filter Building or the Waste Handling Building.

Radiological consequences from accidents would be higher than consequences from hazardous chemicals. The accident with the largest potential radiological consequence to the population and the MEI would be the failure of a fully loaded waste hoist carrying CH-TRU waste (Accident Scenario W6). Up to 29 LCFs could occur in the exposed population, and the MEI could experience a 0.6 probability of an LCF. The roof fall accident (Accident Scenario W7) would result in the highest potential carcinogenic hazardous chemical consequence, with an estimated 7×10^{-7} cancers occurring in the exposed population and an estimated 1×10^{-8} probability of cancer for the MEI. No fatalities due to toxicological effects would be expected. Noncarcinogenic consequence analyses based on ERPGs indicated potentially life-threatening exposures to methylene chloride and beryllium from a hoist failure accident and less serious consequences from lead, mercury, and carbon tetrachloride exposures. Consequences of the roof fall could involve serious, but not life-threatening exposures to 1,1,2,2,-tetrachloroethane releases and less serious consequences from carbon tetrachloride releases.

Maximally Exposed Noninvolved Worker

The maximally exposed noninvolved worker at WIPP was assumed to be located at the location of least atmospheric dispersion, 300 meters (990 feet) south of the Exhaust Filter Building, which is the same location as the MEI. The stack that exhausts the underground ventilation is elevated and, as a result, the location of least plume dispersion is some distance from the release point. Radiological consequences shown in Table 5-72 may be slightly lower than those for the MEI because of the small difference in the radiation dose-to-LCF conversion factors for workers and members of the public. The hazardous chemical consequences would be identical to those of the MEI.

Maximally Exposed Involved Worker

The potentially highest consequences to an involved worker would be underground from failure of a fully loaded waste hoist (Accident Scenario W6) or roof fall (Accident Scenario W7). These consequences could range from negligible (workers not present or warned of the falling hoist and evacuated) to catastrophic (all workers in the immediate vicinity killed by accident debris). Four workers would be expected to be routinely involved in underground operations and potentially at risk from these accidents.

Radiological consequences of accidents to the maximally exposed involved worker from noncatastrophic accidents are shown in Table 5-72. The highest radiological consequences would come from an accident causing three drums to breach (Accident Scenarios W1-W4), both with a 3×10^{-3} probability of an LCF. No fatalities due to hazardous chemical effects would be expected.

These same accidents, however, evaluated by ERPG ratios, might result in irreversible, non-life-threatening consequences from methlyene chloride and 1,1,2,2-tetrachloroethane exposure.

5.4.11 Industrial Safety

Five fatalities from industrial accidents would occur under Action Alternative 3 during waste treatment at all treatment sites. This result was estimated by adjusting the physical-hazard fatality estimate of the WM PEIS.

Under Action Alternative 3, WIPP operational activities would be essentially the same as those conducted under the Proposed Action but would last approximately 190 years rather than 35 years. Decommissioning activities would be the same as those for the Proposed Action. Estimated industrial safety impacts to WIPP workers under Action Alternative 3 are presented in Table 5-73. Oversight and inspections by the MSHA and adherence to OSHA regulations would probably reduce actual occurrences below these estimated values.

Table 5-73
Industrial Safety Impacts from WIPP
Operations and Decommissioning for Action Alternative 3

	Injury/Illness			Fatalities		
Years	**Construction**	**Operations**	**Total**	**Construction**	**Operations**	**Total**
Operations 1998-2200	118	6,650	6,768	0.2	6.6	6.8
Decommissioning 2200-2210	187	96	283	0.3	0.1	0.4
Total	305	6,746	7,051	0.5	6.7	7.3

5.4.12 Long-Term Performance

This section presents the potential impacts associated with long-term performance of the WIPP repository for Action Alternative 3 evaluated for the 10,000-year period after the site is closed. These impacts were estimated based on computer simulations that predicted radionuclide and heavy metal releases from TRU waste in the repository under undisturbed and disturbed conditions. Analysis was conducted using the same methods as those used for the Proposed Action and other action alternatives; additional information is presented in Appendix H. The waste volume emplaced would be 334,000 cubic meters (11.8 million cubic feet) of CH-TRU waste and 66,000 cubic meters (2.3 million cubic feet) of RH-TRU waste. The repository size was increased from the 10 panels of the Proposed Action to 71 panels to accommodate the increased waste volume. The radionuclide inventory was increased to 7.3×10^6 Ci in CH-TRU waste and 5.1×10^6 Ci in RH-TRU waste, essentially the same as the inventories of Action Alternatives 1 and 2. There were similar increases in heavy metal inventories. Additional information on the radionuclide and heavy metal inventories is provided in Appendix A.

The four cases below were analyzed for Action Alternative 3. The cases are the same as the Proposed Action and other action alternatives but include alternative-specific differences, such as repository size and radionuclide and heavy metal inventories.

- Case 16 considered undisturbed repository conditions. Median parameter values were used for input variables where probability distributions have been defined.

- Case 17 considered disturbed conditions resulting from a borehole assumed to pass through the repository and intercept a pressurized brine reservoir in the Castile Formation. Median parameters values were used for input variables where probability distributions have been defined.

- Case 18 was the same as Case 16 but used 75th percentile parameter values for input variables where probability distributions have been defined.

- Case 19 was the same as Case 17 but used 75th percentile parameter values for input variables where probability distributions have been defined.

5.4.12.1 Impacts of Undisturbed Conditions

For Action Alternative 3, the extent of radionuclide (predominantly Pu-238, Pu-239, and Am-241) migration for undisturbed conditions 10,000 years after closure for Case 18 (75th percentile parameter values) would be very similar to that shown for Case 8 of Action Alternative 1 in Figure 5-3. Figure 5-3 shows the locations in the modeled region where the concentration of total radionuclide activity in the brine, summed over 30 radionuclides, is equal to 1 pCi per liter (1×10^{-9} Ci per cubic meter). A total heavy metal concentration of one part per billion (1×10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration.

Approximately the same vertical and lateral migration of radionuclides and heavy metals would occur under Action Alternative 3 as for the Proposed Action and other action alternatives. Total radionuclide concentrations of one pCi per liter would extend about 20 meters (65 feet) below the repository, 40 meters (130 feet) above the repository, and about 1,900 meters (6,200 feet) laterally.

Analysis of undisturbed repository conditions (Cases 16 and 18) during the first 10,000 years showed that no radionuclides or heavy metals would be released to the Culebra Dolomite. No total radionuclide activity concentrations greater than 1 pCi per liter or heavy metal concentrations greater than 1 part per billion would be found beyond the 5-kilometer (3-mile) subsurface lateral boundary. There would be no release to the accessible environment and therefore no human health impact. Additional information is provided in Appendix H.

5.4.12.2 Impacts of Disturbed Conditions

This section presents the impacts of two exposure scenarios evaluated for disturbed conditions for Action Alternative 3.

Surface Release Caused by Drilling into the Repository

The human health impacts of drilling into the repository (Case 17 and Case 19) were evaluated for a drilling crew member and a well-site geologist. These individuals were assumed to be exposed to waste material brought to the land surface by drilling, as described in Section 5.1.12.2 and Appendix H. Under Action Alternative 3, 20 repository panels would hold both CH-TRU and

RH-TRU waste and 51 waste panels would hold only RH-TRU waste; therefore, a drilling event could contact CH-TRU, RH-TRU, or both CH-TRU and RH-TRU waste.

The estimated radionuclide releases to the ground surface from a drilling intrusion for Case 17 (median parameter values) would be 2.2, 0.1, and 2.3 Ci, respectively, for CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. For Case 19 (75th percentile parameter values), the estimated radionuclide releases would be 3.0, 0.15, and 3.0 Ci, respectively, for CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. The releases would be mainly of Pu-238, Pu-239 and Am-241 for all events. Heavy metal releases from these drilling intrusions would be 5, 22, and 18 kilograms (11, 49, and 39 pounds) from CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste for Case 17. For Case 19, the heavy metal releases would be 7, 30, and 23 kilograms (15, 65, and 52 pounds) from CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. Additional information is provided in Appendix H.

The radiological impacts to a drilling crew member for Case 17 (median parameter values) would be a 1×10^{-4}, 7×10^{-6}, and 1×10^{-4} probability of an LCF, respectively, from CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. For Case 19 (75th percentile parameter values), the probability of an LCF would be a 3×10^{-4}, 1×10^{-5}, and 3×10^{-4} probability of an LCF for the same respective panel types. Most of the impact would be due to the inadvertent ingestion of drill cuttings (ranging from 83 percent to about 96 percent), with less impact from external radiation dose. Americium-241 would be the major dose contributor. Ingestion of heavy metals under this scenario would result in a 1.5×10^{-8}, 1.0×10^{-9}, and 1.5×10^{-8} probability of cancer incidence, respectively, for intrusions into CH-TRU waste, RH-TRU waste, and both CH-TRU and RH-TRU waste. There would be no noncarcinogenic impacts expected from ingestion of the metals becaues all hazard indices would be much less than one. Impacts of exposure to VOCs were not analyzed (see Appendix H), but were expected to be bounded by impacts of VOC exposure under WIPP disposal accidents (see Appendix G). There would be a 2×10^{-7} probability of a cancer incidence. Some short-term toxicological effects from inhalation of VOCs could occur under these assumptions (see Appendix G).

Radiological impacts to the well-site geologist from external radiation exposure for Case 17 (median parameter values) would be a 2×10^{-9} probability of an LCF from CH-TRU waste and a 1×10^{-9} probability of an LCF from RH-TRU waste. For Case 19 (75th percentile parameter values), the radiological impacts would be a 2×10^{-9} probability of an LCF from CH-TRU waste and a 4×10^{-9} probability of an LCF from RH-TRU waste. Am-241 and U-234 were major external dose contributors in CH-TRU and RH-TRU waste for Case 17 and in CH-TRU waste for Case 19, while Sr-90 and Cs-137 were the major external dose contributors in RH-TRU waste for Case 19.

Drilling through the Repository into a Pressurized Brine Reservoir

Impacts of drilling through the repository into a pressurized brine reservoir were analyzed as described in Section 5.1.12.2 and in Appendix H, using information specific to Action Alternative 3 where appropriate. Analysis of radionuclide and heavy metal migration for this scenario 10,000 years after closure for Case 17 (median parameter values) showed there would be no radionuclide or heavy metal releases into the Culebra Dolomite or the accessible environment.

The extent of radionuclide (predominantly Pu-238, Pu-239, and Am-241) migration for disturbed conditions at 10,000 years after closure for Case 19 (75th percentile parameters values) were very similar to the results of Case 9 (also 75th percentile parameter values) for Action Alternative 1 and are presented schematically in Figure 5-4. Total radionuclide activity concentrations of one pCi per liter are shown. Simulations showed radionuclides migrated upward and downward into the borehole and penetrated into rocks directly in contact with the borehole for a limited distance. For Case 19 only (not Case 17), migration extends upward into the Culebra Dolomite at 10,000 years. Migration also extends downward in the borehole (for both Cases 17 and 19) to the Castile Formation and into the brine reservoir. This would occur after the initial pressure in the pressurized brine pocket dissipates and equilibrates with pressures in the repository and overlying units penetrated by the borehole. A total heavy metal concentration of one part per billion (1×10^{-3} milligrams per cubic meter) showed approximately the same extent of migration from the repository as the one pCi per liter level of total radionuclide activity concentration in Figure 5-4. Predicted brine pressures and additional modeling information is provided in Appendix H.

Impacts of radionuclide and heavy metal migration to the accessible environment were evaluated for Case 19 (75th percentile parameter values) since a release of contaminants into the Culebra Dolomite was indicated for this case only. The exposure scenario was the same as that evaluated for the Proposed Action and other action alternatives, for an individual consuming beef from cattle using the water from a stock well 3 kilometers (2 miles) from the point of intrusion. Results are presented only for partial mining conditions since calculated impacts for full mining conditions were significantly lower (see Section H.8.2). Radiological impacts would be negligible, with a 2×10^{-27} probability of an LCF. The dominant dose contributor was Pu-239. Ingestion of heavy metals from consumption of contaminated beef was also found to result in negligible impacts, with a probability of cancer incidence of 3×10^{-25}. No noncarcinogenic impacts would be expected. Additional information is presented in Appendix H.

5.4.13 Reducing WIPP Operations for Action Alternative 3

As noted in Chapter 3, stakeholders requested that the Department discuss in greater detail the changes to impacts should the Department reduce the period of operations for WIPP under Action Alternative 3. The period of operations is 190 years, but it could be reduced to 75 years by constructing an additional waste handling building for RH-TRU waste, constructing four new shafts, and tripling the number of excavation and emplacement crews. Additional costs would total $80 million in capital costs and $165 million in annual operating costs.

No additional impacts would be expected at treatment facilities because the facilities and their periods of operation would be identical to those discussed earlier.

The time to ship to WIPP from the treatment facilities would decrease from 190 years to 63 years. The aggregate nonradiological impacts would be the same as those described earlier, except that they would occur within the shorter time period. The accident-free radiological impacts to occupational and nonoccupational populations were reported as aggregate impacts over the entire shipping campaign; therefore, no increase in impacts would be noted. However, because the MEI would be exposed to more shipments, the estimated exposure to the MEI would be three times higher. All accident impacts would be identical to those described earlier.

Because the size of the WIPP underground facility would remain the same, and because the new facility would be constructed within the footprint of the repository, land use, biological resource, and cultural resource impacts would be similar to those described earlier in this section. Construction of the new waste handling building would increase the air quality impacts slightly for the period of construction. Other air quality impacts would be negligible. Noise impacts would triple because the rate of shipments through Carlsbad would triple. Water quality and infrastructure impacts may be impacted by the new facilities and additional work crews.

Human health impacts would decrease for lag storage. The impacts to the public, noninvolved workers, and involved workers over the entire operations period would remain the same, but they would be compressed into about one-third of the time. Impacts to the MEIs would triple because the waste emplaced during a lifetime would triple. Industrial safety impacts would decrease by approximately 50 percent, considering the shorter operations period, construction of facilities, and an increase in the number of workers. There would be no change in long-term performance assessment results.

The greatest change in Action Alternative 3 results would be in life-cycle costs, which would drop from $59.67 billion in 1994 dollars ($18.03 billion discounted) to $43.02 billion ($13.30 billion discounted) should only trucks be used. Life-cycle costs should regular rail transportation be used would decrease from $55.17 billion ($17.42 billion discounted) to $38.52 billion ($11.91 billion discounted), and life-cycle costs should dedicated rail transportation be used would decrease from $68.52 billion ($19.21 billion discounted) to $51.87 billion ($16.04 billion discounted).

5.5 IMPACTS OF NO ACTION ALTERNATIVE 1

This section describes the environmental impacts associated with the implementation of No Action Alternative 1. Two subalternatives are included, one similar to Action Alternative 2A and the other similar to Action Alternative 2B. Under this alternative, the Basic Inventory and the Additional Inventory (including the PCB-commingled waste) would be shipped to treatment sites for treatment using a thermal process, but no waste would be shipped to WIPP for disposal. Instead, under No Action Alternative 1A, waste would remain at six sites in aboveground, retrievable storage. These sites are Hanford, INEEL, LANL, SRS, RFETS, and ORNL. Under No Action Alternative 1B, waste would remain at four sites in aboveground, retrievable storage. These sites are Hanford, INEEL, SRS and ORNL. The total consolidated, pretreatment volume of waste to be treated under this alternative would be 313,000 cubic meters (11 million cubic feet) (see Tables 3-12 through 3-15). A detailed description of No Action Alternative 1 is given in Section 3.2.5.

5.5.1 Land Use and Management

Land use impacts due to treatment under No Action Alternatives 1A and 1B would be similar to those under the Proposed Action discussed in Section 5.1.1. The WM PEIS estimated that treatment facilities would not require more than 1 percent of the available land, and the Department would have a great deal of flexibility when determining the locations of such facilities (DOE 1997). The Department would be able to minimize impacts to on-site land use and would be able to avoid conflicts with off-site land use plans. It also would be able to avoid sensitive or inappropriate habitats, including flood plains, wetlands, known cultural resource areas, and the habitats of threatened or endangered species. Before the sites for the treatment facilities would be selected, site-wide or project level NEPA reviews would be conducted.

Land use requirements due to storing the waste for an indefinite period of time would probably increase the land use impacts at the treatment and storage sites. The storage facilities, though, are not likely to increase the amount of land needed for overall operations at these sites to more than 1 or 2 percent of that available. Land use needs for the storage facilities, therefore, are not likely to conflict with other planned activities or impact sensitive or inappropriate areas.

At WIPP, under No Action Alternatives 1A and 1B, decommissioning and closure would begin immediately. No surface marking system would be necessary because no waste would be disposed of underground. Decommissioning, therefore, would be less extensive than under the Proposed Action and Action Alternatives 1, 2A, 2B, 2C, and 3. Surface structures in the Property Protection Area would be dismantled and removed, and the existing salt pile would either be returned to the underground, sold, or disposed of. The disturbed areas, estimated not to exceed 20 hectares (50 acres), would be returned to pre-WIPP condition to the extent possible. The restrictions of the LWA would probably be lifted and the land returned to BLM.

5.5.2 Air Quality

Air quality impacts from TRU waste treatment at the sites would be similar to those presented for Action Alternatives 2A and 2B in Section 5.3.2. For No Action Alternative 1A, the levels of criteria pollutants exceeding 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be those for CO at the RFETS (24 percent) and PM_{10} at INEEL (10 percent) (See Appendix C for details) (DOE 1997). Under No Action Alternative 1B, the levels of criteria pollutants exceeding 10 percent would be PM_{10} at INEEL (10 percent). RFETS, LLNL, NTS, and ANL-E, are in nonattainment areas for some pollutants (See Appendix C for details) (DOE 1997). In nonattainment areas, activities that introduce new sources of emissions are regulated under the General Conformity Rule. In attainment areas, regulations for the PSD of ambient air quality apply. In both cases, a permit is required for sources that will result in emissions equal to or greater than the limits set by pertinent regulations.

Of hazardous or toxic air pollutant releases, only radionuclide releases could exceed 10 percent of the applicable regulatory standard. For No Action Alternative 1A, treatment-related radiological releases could reach 134 percent of the NESHAP standard at LANL. For No Action Alternative 1B, treatment-related releases could reach 10 percent at INEEL (DOE 1997). Postulated waste treatment-related releases above the regulatory standard would require mitigation measures, such as HEPA filters, to ensure they remained below the allowable limit.

At WIPP, potential air quality impacts due to decommissioning activities under No Action Alternatives 1A and 1B would be similar to those under the Proposed Action for decommissioning of the aboveground structures. There would be no construction of berms and permanent markers, so overall air quality impacts at WIPP would be less than for the Proposed Action. This alternative would also require building retrievable storage facilities at six DOE sites for the consolidation, treatment, and storage of TRU waste. Any impacts from construction of the storage facility would be from fugitive dust and equipment emissions. PM_{10} emissions may occur due to such construction; dust suppression would be used to limit these short-term impacts.

5.5.3 Biological Resources

The biological impacts at the treatment sites under No Action Alternatives 1A and 1B would be the same as those for Action Alternatives 2A and 2B. Construction and operation of the treatment and storage facilities should not affect populations of nonsensitive plant and animal species. Terrestrial wildlife species probably would not be affected by airborne emissions nor by spills into aquatic environments due to traffic accidents (DOE 1997). Threatened and endangered species appear at all of the proposed treatment sites; however, impacts to these species would depend on the actual location of the facility at a particular site. Site selection would be conducted following appropriate Endangered Species Act consultation and site-wide or project-level NEPA review during which such impacts would be assessed and mitigated, if necessary. Critical habitats and the habitats of endangered, threatened, and proposed species would be avoided, and appropriate consultation, monitoring, and mitigation measures would be undertaken, as necessary.

At WIPP, No Action Alternatives 1A and 1B would entail beginning the immediate decommissioning of the site, including dismantling all aboveground structures and closing all shafts. No waste would be disposed of, so there would be no permanent aboveground marking of the underground waste disposal area. Only about 20 hectares (50 acres) would be disturbed. Therefore, decommissioning and closure at the WIPP site would have less potential impact than the Proposed Action.

5.5.4 Cultural Resources

At the treatment sites, cultural resource impacts would be the same for this alternative as for the Proposed Action. Construction and operation of TRU waste treatment and storage facilities could adversely affect cultural resources, but site-level cultural resource surveys would be conducted, and protection measures established, where necessary, when specific facility construction locations are proposed. Appropriate Native American tribes would be consulted, if necessary. These surveys would be in conjunction with site-wide or project-specific NEPA reviews.

At WIPP, no impacts to known cultural resource properties are anticipated under this alternative.

5.5.5 Noise

The WM PEIS stated that treatment sites would probably be located in industrial areas along high-volume highway corridors; therefore, ambient noise levels are not likely to increase substantially. Still, the WM PEIS states that some sensitive receptors may be affected. Assessment of these impacts would be conducted in site-wide or project-specific NEPA documents when the treatment facilities are proposed. Noise impacts due to transportation of waste to or from the treatment sites also was not evaluated in the WM PEIS. Overall, though, less transportation would be conducted under this alternative because no waste would leave the treatment sites for disposal at WIPP. The transportation noise impacts, therefore, would be negligible.

There would be no impacts from truck or rail transportation to WIPP because waste transportation activities to WIPP would not be initiated.

5.5.6 Water Resources and Infrastructure

Water resource and infrastructure impacts at the treatment and storage sites under No Action Alternatives 1A and 1B would be the same as under Action Alternatives 2A and 2B (See Section 5.3.6). During decommissioning at WIPP, there would be a decreasing need and use of water, power, and wastewater systems and a decreasing demand on-site transportation infrastructure. There would be no demand or use of these resources following decommissioning.

5.5.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts for No Action Alternatives 1A and 1B are presented in the following subsections.

5.5.7.1 Life-Cycle Costs

Under No Action Alternatives 1A and 1B, WIPP would not receive waste. All waste volumes would remain indefinitely at the sites where treated. The CH-TRU waste portion of the waste inventory would be packaged every 20 years. Impacts from this packaging were evaluated over a 100-year period. No Action Alternatives 1A and 1B include the same waste treatment sites and the same waste volumes as those in Action Alternatives 2A and 2B. Cost for storage facilities are included with the cost of the treatment facilities. The WIPP site costs reflect a 10-year period of decommissioning. The waste transport costs reflect shipments between small sites and the treatment sites.

The transportation options include using trucks, regular rail, and dedicated rail services. Life-cycle costs for No Action Alternative 1A and 1B include additional costs of $700 million and $3.8 billion, respectively, to account for treatment to planning-basis WAC of waste to be shipped for treatment. These costs were based on dual treatment (WAC and thermal) of 34 percent and 18.4 percent, respectively, of the total waste volume. The total life-cycle cost of No Action Alternative 1A (shown in Table 5-74) vary slightly with mode of transportation: $30.28 billion ($17.09 billion when discounted) for truck, $30.24 billion ($17.07 billion when discounted) for regular-class rail service, and $30.46 billion ($17.19 billion when discounted) for dedicated-class rail service.

Table 5-74
Life-Cycle Costs for No Action Alternative 1A (in millions of 1994 dollars) [a]

Life-Cycle Cost Information	Basic Inventory			Additional Inventory			Total	Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste
Treatment and Storage Facilities	12,670	3,280	15,950	13,040	370	13,410	29,360	16,280
Transport by Truck	30	10	40	30	0	30	70	40
Transport by Regular Train	10	0	10	20	0	20	30	20
Transport by Dedicated Train	110	30	140	110	0	110	250	140
WIPP Decommissioning [b]	N/A	N/A	N/A	N/A	N/A	N/A	850	770
Total Life-Cycle Cost (Truck)	12,700	3,290	15,990	13,070	370	13,440	30,280	17,090
Total Life-Cycle Cost (Regular Rail)	12,680	3,280	15,960	13,060	370	13,430	30,240	17,070
Total Life-Cycle (Dedicated Rail)	12,780	3,310	16,090	13,150	370	13,520	30,460	17,190

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.
[b] The WIPP decommissioning cost of $850 million is applied to the total column only because it is not attributed to storage of CH-TRU or RH-TRU waste but must be considered in the life-cycle cost of the alternative.

N/A = Not Applicable

The total life-cycle costs of No Action Alternative 1B (shown in Table 5-75) vary slightly depending on the mode of transportation, ranging from $32.77 billion ($18.47 billion when discounted) for regular-class rail service to $33.79 billion ($19.04 billion when discounted) for dedicated-class rail service.

Table 5-75
Life-Cycle Costs for No Action Alternative 1B (in millions of 1994 dollars) [a]

Life-Cycle Cost Information	Basic Inventory			Additional Inventory			Total	Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste
Treatment and Storage Facilities	13,700	3,550	17,250	14,100	350	14,450	31,760	17,610
Transport by Truck	100	30	130	110	0	110	240	130
Transport by Regular Train	70	20	90	70	0	70	160	90
Transport by Dedicated Train	510	130	640	530	10	540	1,180	650
WIPP Decommissioning	N/A	N/A	N/A	N/A	N/A	N/A	850	770
Total Life-Cycle Cost (Truck)	13,800	3,580	17,380	14,210	350	14,560	32,850	18,520
Total Life-Cycle Cost (Regular Rail)	13,770	3,570	17,340	14,170	350	14,520	32,770	18,470
Total Life-Cycle Cost (Dedicated Rail)	14,210	3,680	17,890	14,630	350	14,990	33,790	19,040

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

N/A = Not Applicable

5.5.7.2 Economic Impacts

TRU waste treatment activities would support direct, indirect, and induced jobs. No Action Alternative 1A would support approximately 29,300 jobs in the ROIs of the six treatment sites (Hanford, INEEL, LANL, ORNL, RFETS, and SRS). No Action Alternative 1B would support approximately 29,800 jobs in the ROIs of four treatment sites (Hanford, INEEL, ORNL, and SRS).

Estimates of the impacts of No Action Alternative 1 on employment, income, and the production of goods and services within the WIPP ROI are presented in Table 5-76. These regional impacts are estimated on the basis of a constant declining operating budget over a 10-year decommissioning period (from 1998 to 2008). Over this 10-year period, direct employment at the WIPP facility would be reduced at an annual rate of 10 percent of the 1998 employment level of 1,095 workers, or 110 workers per year. Accordingly, the WIPP site would employ about half its present work force by the year 2003. It is possible, however, that a more aggressive (front-loaded) downsizing could result in equivalent job losses within a two-year period, assuming an exponentially declining WIPP budget. Compared to WIPP operations levels assumed for all action alternatives, approximately 3,500 jobs (1,095 direct and 2,443 indirect) could be lost in the WIPP ROI, over a period of about 10 years. The accompanying annual reduction in labor income and output of goods and services in the ROI could be $126 million and $317 million, respectively, from those which could occur were waste disposal operations to take place. These impacts would be concentrated in the Carlsbad area of the ROI.

Table 5-76
Economic Impacts Within the WIPP ROI for No Action Alternative 1

Economic Effects	Total Output of Goods and Services (in millions of 1994 dollars)	Total Employment and Part-Time Jobs	Total Labor Income (in millions of 1994 dollars)	Carlsbad Output of Goods and Services (in millions of 1994 dollars)	Carlsbad Employment (Full- and Part-Time Jobs)	Carlsbad Labor Income (in millions of 1994 dollars)
Direct – Average Annual	51	493	23	43	441	21
Indirect & Induced – Average Annual	92	1,099	34	77	983	30
Total – Average Annual	143	1,592	57	120	1,424	51
Total – Operations (10 years)	1,427	15,921 [a]	572	1,202	14,238 [a]	509

[a] Job-years (number of annual jobs supported multiplied by the number of years in the project).

5.5.8 Transportation

The transportation impacts presented in this section for No Action Alternatives 1A and 1B are the impacts due to transporting the waste to the treatment sites (details are included in Appendix E).

5.5.8.1 Route Characteristics and Shipment Projections

The number of shipments was estimated to be 538 and 8,466 CH-TRU waste shipments for No Action Alternatives 1A and 1B, respectively. The number of RH-TRU waste shipments were estimated to be 8,254 for both No Action Alternatives 1A and 1B. The methods used to estimate the number of shipments were the same as those presented in Section 5.1.8.1. The total estimated one-way mileage for consolidation of TRU waste under No Action Alternatives 1A and 1B is presented in Table 5-77.

Table 5-77
One-Way Waste Transportation Miles for No Action Alternative 1

Alternative	CH-TRU Waste	RH-TRU Waste	Total
No Action Alternative 1A	292,000	4,900,000	5,192,000
No Action Alternative 1B	8,545,000	4,900,000	13,445,000

5.5.8.2 Accidents, Injuries, Fatalities, and Pollution-Related Health Effects

The population impacts for No Action Alternatives 1A and 1B are presented in Table 5-78. For No Action Alternative 1A, the total number of accidents, injuries, and fatalities over the entire shipping campaign were estimated to be 5, 4 and 0.3, respectively. Similarly, for No Action Alternative 1B, the accidents, injuries, and fatalities were estimated to be 13, 12, and 1, respectively. Also presented in Table 5-78 are the pollution-related health effects.

Table 5-78
Population Impacts from Truck Transportation for No Action Alternative 1

Category	No Action Alternative 1A	No Action Alternative 1B
Nonradiological Impacts		
Number of Accidents	5	13
Number of Injuries	4	12
Number of Fatalities	0.3	1
Pollution Health Effects (fatalities)	0.03	0.07
Accident-Free Radiological Impacts (LCFs)		
Occupational	0.02	0.07
Nonoccupational		
Stops	0.4	0.8
Sharing Route	0.02	0.05
Along Route	0.01	0.02
Nonoccupational (LCFs) - Total	0.4	0.9
Aggregate Radiological Population Impacts for Truck Transportation Accidents (LCFs)		
CH-TRU Waste	5.6E-3	0.02
RH-TRU Waste	1.2E-3	1.2E-3
Total CH-TRU and RH-TRU Waste	6.8E-3	0.02

5.5.8.3 Accident-Free Radiological Impacts from Truck Transportation

The method used to calculate the accident-free radiological impacts under No Action Alternatives 1A and 1B was based on the consolidation of waste at the treatment sites. Table 5-78 presents a summary of the accident-free radiological impacts under No Action Alternatives 1A and 1B.

5.5.8.4 Radiological Impacts from Truck Transportation Accidents

Two types of analyses were conducted for SEIS-II radiological impacts due to accidents. The first estimated impacts over the entire shipping campaign, and the second estimated impacts from four bounding case accidents. For the first analysis, the impacts were estimated based on the number of shipments and the eight accident severity categories presented in RADTRAN. For No Action Alternatives 1A and 1B, the radiological impacts from accidents summed over all shipments are presented in Table 5-78.

For the bounding case accidents, it was estimated that the impacts would be the same as those reported for truck transportation under the Proposed Action (see Section 5.1.8.4). The analyses were based on an assumption that only one TRUPACT-II or RH-72B would be breached in a bounding case accident. Though the waste would be treated thermally under No Action Alternatives 1A and 1B, the treatment would not occur until after the transportation.

5.5.8.5 Hazardous Chemical Impacts from Severe Truck Transportation Accidents

As reported previously in Section 5.1.8.5, exposures to hazardous chemical releases from a severe truck transportation accident would present negligible impacts to the exposed population.

5.5.8.6 Impacts from Rail Transportation

Table 5-79 presents a summary of the transportation impacts for both regular and dedicated rail under No Action Alternatives 1A and 1B. The rail transportation impacts were estimated by adjusting the transportation impacts for truck shipments as described in Section 5.2.8.6 and Appendix E.

Table 5-79
Impacts of Rail Transportation for No Action Alternative 1

Impact Category	No Action Alternative 1A	No Action Alternative 1B
Aggregate Traffic Related Fatalities		
Regular Rail	0.2	0.5
Dedicated Rail	2.8	7
Aggregate Accident-Free Radiological Impacts (LCFs)		
Occupational	8.6E-4	3.7E-3
Nonoccupational		
Stops	0.05	0.09
Sharing Route	2.3E-4	4.6E-4
Along Route	0.02	0.04
Nonoccupational - Total	0.07	0.1
Aggregate Radiological Population Impacts for Rail Transportation Accidents (LCFs)		
CH-TRU Waste	5.6E-3	0.02
RH-TRU Waste	1.2E-3	1.2E-3
Total CH-TRU and RH-TRU Waste	6.8E-3	0.02

Radiological accident impacts from shipping by rail summed over all shipments for No Action Alternatives 1A and 1B are presented in Table 5-79 along with traffic-related fatalities and accident-free radiological impacts.

The impacts from bounding case accidents were estimated to be the same as those reported for Action Alternative 1 rail accident analyses, where it was assumed that two TRUPACT-IIs or RH-72Bs would be breached in an accident. The greatest impact was found when a conservative inventory was assumed, 32 LCFs in the population and a 0.12 probability of an LCF to the MEI.

5.5.9 Human Health Impacts from Waste Treatment and Storage Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from waste treatment and 100 years of managed storage under No Action Alternatives 1A and 1B. The estimates include the impacts from overpacking CH-TRU waste storage containers every 20 years. There would be no disposal of waste at WIPP under this alternative.

No Action Alternative 1 eliminates the risk from PCB-commingled TRU waste at the three sites known to store such waste: 242 cubic meters (8,550 cubic feet) at Hanford, 461 cubic meters (16,300 cubic feet) at INEEL, and 19 cubic meters (670 cubic feet) at Mound. Under No Action Alternative 1, PCBs in the waste would be destroyed during treatment.

Impacts from waste treatment were adjusted from those presented in the WM PEIS; a description of these adjustments is provided in Appendix B. Like Action Alternatives 2A and 2B, No Action Alternatives 1A and 1B include thermal treatment of the Total Inventory. The VOCs in the waste would be destroyed during thermal treatment, and heavy metals would be immobilized. Therefore, no routine releases of hazardous chemicals would occur in the subsequent waste storage operations. Thermal treatment also concentrates the waste and radionuclides into a smaller, denser volume. Denser waste matrices tend to decrease surface dose rates because of more self-absorption of the external radiation emitted by radionuclides in the waste. Worker radiological impacts reflect the impact of these factors. Appendix F provides additional information on the methods used to determine the impacts presented in this section.

5.5.9.1 Public

Impacts to the populations and to the MEIs under No Action Alternatives 1A and 1B are presented in this section; results are presented in Table 5-80. Impacts from waste treatment and managed storage operations are presented separately to show their relative impact contribution. Waste treatment and storage would take place at six DOE sites under No Action Alternative 1A and at four sites under No Action Alternative 1B. Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of all treatment sites and all lag storage sites. The impacts to the MEIs from waste treatment and managed storage operations are presented for the highest individual waste treatment and storage sites. See Chapter 3 for additional information on where treatment and managed storage would occur under the subalternatives of No Action Alternative 1.

Waste Treatment

Radiological impacts to the public from waste treatment would be 2.4 and 2.3 LCFs under No Action Alternatives 1A and 1B, respectively. No cancer incidence would be expected in the total population from hazardous chemical exposure, with 3×10^{-7} cancers expected under both subalternatives. For radiological impacts, the MEI with the greatest impact would be at RFETS under No Action Alternative 1A (3×10^{-5} probability of an LCF) and at Hanford under No Action Alternative 1B (5×10^{-5} probability of an LCF). Impacts from hazardous chemicals in CH-TRU waste would not exceed a 2×10^{-11} probability of a cancer incidence at any site. No noncarcinogenic health effects are predicted. The maximum HIs for the MEI would be 2×10^{-8} (under No Action Alternative 1A) and 5×10^{-9} (under No Action Alternative 1B), and no health effect is predicted unless the HI is 1 or higher.

Long-Term Managed Storage

Only radiological impacts would result from long-term managed storage because VOCs would be removed by thermal treatment under No Action Alternative 1. No LCFs would be expected in the total population around the storage sites under any of the alternatives, with 1×10^{-3} and 7×10^{-4} LCFs expected under No Action Alternatives 1A and 1B, respectively. The MEI with the greatest impact would be at LANL for No Action Alternative 1A (2×10^{-7} probability of an LCF) and at ORNL for No Action Alternative 1B (2×10^{-9} probability of an LCF). No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

Table 5-80
Lifetime Human Health Impacts to the Public from Waste Treatment and Storage Operations for No Action Alternatives 1A and 1B

Category	Waste Treatment Impacts		Storage Operations Impacts	
	Radiological (LCF) [a]	**Hazardous Chemicals (Cancer Incidence)**	**Radiological (LCF)** [a]	**Hazardous Chemicals (Cancer Incidence)**
MEI [b, c]				
Basic Inventory				
1A CH-TRU Waste	3E-5 (R)	3E-13 (L)	2E-7 (L)	0
1B CH-TRU Waste	2E-5 (H)	3E-13 (I)	5E-9 (S)	0
RH-TRU Waste	4E-7 (O)	1E-11 (O)	1E-9 (O)	0
1A Total Waste	3E-5 (R)	1E-11 (O)	2E-7 (L)	0
1B Total Waste	2E-5 (H)	1E-11 (O)	5E-9 (S)	0
Total Inventory				
1A CH-TRU Waste	3E-5 (R)	5E-13 (I)	2E-7 (L)	0
1B CH-TRU Waste	5E-5 (H)	6E-13 (I)	1E-9 (S)	0
RH-TRU Waste	6E-7 (O)	2E-11 (O)	2E-9 (O)	0
1A Total Waste	3E-5 (R)	2E-11 (O)	2E-7 (L)	0
1B Total Waste	5E-5 (H)	2E-11 (O)	2E-9 (O)	0
Population [b]				
Basic Inventory				
1A CH-TRU Waste	2.2	5E-9	7E-4	0
1B CH-TRU Waste	1.1	2E-9	4E-4	0
RH-TRU Waste	0.02	2E-7	3E-5	0
1A Total Waste	2.2	2E-7	7E-4	0
1B Total Waste	1.1	2E-7	4E-4	0
Total Inventory				
1A CH-TRU Waste	2.3	9E-9	1E-3	0
1B CH-TRU Waste	2.3	4E-9	6E-4	0
RH-TRU Waste	0.02	3E-7	5E-5	0
1A Total Waste	2.4	3E-7	1E-3	0
1B Total Waste	2.3	3E-7	7E-4	0
Aggregate Total				
1A	2.4	3E-7	3E-3	0
1B	2.3	3E-7	2E-3	0

[a] The probability of an LCF occurring to the MEI, and the number of LCFs in the population.
[b] The MEI and populations evaluated for treatment and storage operations impacts are different.
[c] H = Hanford, L = LANL, O = ORNL, R = RFETS, S = SRS, I = INEEL

The aggregate total indicated in Table 5-80 refers to the impacts to the public expected over a 100-year operational period under No Action Alternative 1. The estimates reflect the impacts under the management of the Total Inventory of CH- and RH-TRU waste. No LCFs (3×10^{-3} LCFs) would be expected over the several generations exposed to the small potential routine releases of radioactive materials under incident-free operations.

5.5.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under No Action Alternatives 1A and 1B are presented in this section; results are presented in Table 5-81. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, storage, or handling of waste. Impacts from waste treatment and long-term managed storage are presented separately to show the relative contributions of these activities.

Noninvolved worker population impacts were estimated as the total for all treatment sites and all managed storage facilities. The impacts to the maximally exposed noninvolved worker from waste treatment and managed storage are presented for the highest individual waste treatment sites.

Table 5-81
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment and Storage Operations for No Action Alternative 1

	Waste Treatment Impacts		Storage Operations Impacts	
Category	Radiological (LCF) [a]	Hazardous Chemical (Cancer Incidence)	Radiological (LCF) [a]	Hazardous Chemical (Cancer Incidence)
Maximally Exposed Noninvolved Worker [b, c]				
Basic Inventory				
1A CH-TRU Waste	5E-5 (R)	1E-12 (I)	8E-7 (S)	0
1B CH-TRU Waste	7E-5 (H)	2E-12 (I)	8E-7 (S)	0
RH-TRU Waste	3E-7 (O)	6E-11 (O)	1E-8 (O)	0
1A Total Waste	5E-5 (R)	6E-11 (O)	8E-7 (S)	0
1B Total Waste	7E-5 (H)	6E-11 (O)	8E-7 (S)	0
Total Inventory				
1A CH-TRU Waste	5E-5 (R)	4E-12 (I)	1E-6 (S)	0
1B CH-TRU Waste	2E-4 (H)	4E-12 (I)	1E-6 (S)	0
RH-TRU Waste	5E-7 (O)	1E-10 (O)	2E-8 (O)	0
1A Total Waste	5E-5 (R)	1E-10 (O)	1E-6 (S)	0
1B Total Waste	2E-4 (H)	1E-10 (O)	1E-6 (S)	0
Population [b]				
Basic Inventory				
1A CH-TRU Waste	0.09	3E-9	0.02	0
1B CH-TRU Waste	0.06	2E-9	0.02	0
RH-TRU Waste	4E-4	7E-8	2E-4	0
1A Total Waste	0.09	7E-8	0.02	0
1B Total Waste	0.06	7E-8	0.02	0
Total Inventory				
1A CH-TRU Waste	0.1	7E-9	0.02	0
1B CH-TRU Waste	0.1	6E-9	0.02	0
RH-TRU Waste	6E-4	1E-7	2E-4	0
1A Total Waste	0.1	1E-7	0.02	0
1B Total Waste	0.1	1E-7	0.02	0
Aggregate Total				
1A	0.1	1E-7	0.06	0
1B	0.1	1E-7	0.06	0

[a] The probability of an LCF occurring to the maximally exposed noninvolved worker, and the number of LCFs in the population.
[b] The MEI and populations evaluated for treatment and storage operations impacts are different.
[c] H= Hanford, I = INEEL, L = LANL, O = ORNL, R = RFETS, S = SRS

Waste Treatment

No radiation-related LCFs would be expected in the total noninvolved worker population at the waste treatment sites, with 0.1 LCFs under both subalternatives. No cancer incidence would be expected in the total noninvolved worker population from hazardous chemical exposure, with a 1×10^{-7} probability of a cancer incidence under both of the subalternatives. The maximally exposed noninvolved worker for radiological impacts would be at RFETS under No Action Alternative 1A (5×10^{-5} probability of an LCF) and at Hanford under No Action Alternative 1B (2×10^{-4} probability of an LCF). Impacts would not exceed a 1×10^{-10} probability of cancer incidence at any site. No noncarcinogenic health effects are predicted. The maximum HIs for the maximally exposed noninvolved worker would be 2×10^{-7} (under No Action Alternative 1A) and 1×10^{-7} (under No Action Alternative 1B), and no health effect is predicted unless the HI is 1 or higher.

Long-Term Managed Storage

Only radiological impacts would result from managed storage because VOCs would be removed by thermal treatment. No LCFs would be expected in the total noninvolved worker population during the 35-year working lifetime assumed for workers at the managed storage sites (0.02 LCFs would be expected under both subalternatives). The maximally exposed noninvolved worker would be at SRS for both subalternatives; a 1 x 10^{-6} probability of an LCF was calculated. No noncarcinogenic health effects would occur because there would be no exposure to hazardous chemicals.

The aggregate total indicated in Table 5-81 refers to the impacts to the noninvolved worker population expected over the 100-year operational period under No Action Alternative 1. The estimates reflect the impacts under the management of the Total Inventory of CH- and RH-TRU waste. No LCFs (0.06 LCFs) would be expected over the several generations exposed to the small potential routine releases of gaseous radionuclides under incident-free operations.

5.5.9.3 Involved Workers

Potential impacts to involved workers from waste treatment and storage operations are presented in Table 5-82. Up to 1.7 and 1.3 LCFs could occur in involved worker populations from radiation exposure during waste treatment under No Action Alternatives 1A or 1B, respectively. No cancer incidence would be expected to occur from hazardous chemical exposure (6 x 10^{-5} cancers for No Action Alternative 1A and 9 x 10^{-5} cancers for No Action Alternative 1B), and no noncarcinogenic health effects would occur (maximum exposure index of 6 x 10^{-3}).

No impacts from radiation exposure would be expected from waste storage during the 100-year storage period evaluated (≤0.4 LCF) under either subalternative. All worker exposures to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Table 5-82
Lifetime Human Health Impacts to Involved Workers
from Waste Treatment and Storage Operations for No Action Alternative 1 [a]

Category	Waste Treatment Impacts		Storage Operations Impacts	
	Radiological (LCF)	Hazardous Chemicals (Cancer Incidence)	Radiological (LCF)	Hazardous Chemicals (Cancer Incidence)
Population				
Basic Inventory				
1A CH-TRU Waste	0.7	2E-5	0.09	0
1B CH-TRU Waste	0.5	4E-5	0.08	0
RH-TRU Waste	0.2	9E-6	≤0.09	0
1A Total Waste	0.9	3E-5	≤0.2	0
1B Total Waste	0.7	5E-5	≤0.2	0
Total Inventory				
1A CH-TRU Waste	1.4	5E-5	0.2	0
1B CH-TRU Waste	1.1	8E-5	0.2	0
RH-TRU Waste	0.3	1E-5	≤0.2	0
1A Total Waste	1.7	6E-5	≤0.4	0
1B Total Waste	1.3	9E-5	≤0.4	0
Aggregate Total				
1A	1.7	6E-5	≤1.1	0
1B	1.3	9E-5	≤1.1	0

[a] The workers considered for treatment impacts and storage impacts are different.

Different populations of involved workers would be involved in routine surveillance and monitoring activities and in waste overpacking operations. All sites were assumed to overpack 5 percent of the CH-TRU waste Total Inventory annually during the 100 years of storage evaluated. Each CH-TRU waste container would be overpacked every 20 years, although if this alternative were selected the Department would probably begin efforts to design longer lasting CH-TRU waste containers.

The impacts from CH-TRU waste would be from the external radiation dose received during waste container handling. Potential radiological impacts from inhalation of radioactive gases released from waste containers would be negligible. Involved worker impacts from storage activities were calculated by assuming waste handlers would spend 2 hours every workday at 1 meter (3.3 feet) from the CH-TRU waste containers and were assumed to be exposed over a 35-year career. Container dose rates were decay-corrected over 35 years. The first 35 years of packaging operations would be the period of greatest potential impact because radioactive decay would reduce the radioactivity of the waste over time. Table 5-83 shows how potential annual radiological impacts to involved worker populations would decrease over the storage period because of radioactive decay.

Overpacking of RH-TRU waste containers was not considered during the 100-year storage period because of the greater RH-TRU waste container integrity. Impacts from RH-TRU waste storage would be less because of remote RH-TRU waste handling and greater administrative controls for RH-TRU waste. Therefore, no specific RH-TRU waste storage impact estimates were made. Storage impacts under this alternative would be assessed in future site-wide or project-specific NEPA reviews.

The aggregate totals indicated in Table 5-82 refer to the impacts to the involved worker population expected over the 100-year operational period under No Action Alternatives 1A and 1B. Less than 1.1 LCFs would be expected in the several generations of involved workers exposed via external exposures from storage operations. The radiological impact estimates reflect the results of the aggregate impacts analyses presented in detail in Appendix F.

Table 5-83
Annual Involved Worker Population Impacts from CH-TRU Waste Overpacking Operations for No Action Alternatives 1A and 1B (LCFs)

Location	Worker Population	Years Since Operations Began					
		1	20	40	60	80	100
No Action Alternative 1A							
Hanford	14	9E-3	6E-3	4E-3	3E-3	2E-3	1E-3
INEEL	14	4E-3	3E-3	3E-3	3E-3	3E-3	3E-3
LANL	4	6E-4	6E-4	5E-4	5E-4	4E-4	4E-4
RFETS	1	3E-3	3E-3	2E-3	2E-3	2E-3	2E-3
SRS	2	1E-4	1E-4	1E-4	1E-4	9E-5	9E-5
No Action Alternative 1B							
Hanford	14	9E-3	6E-3	4E-3	3E-3	2E-3	1E-3
INEEL	19	7E-3	7E-3	6E-3	6E-3	6E-3	6E-3
SRS	2	1E-4	1E-4	1E-4	1E-4	9E-5	9E-5

5.5.10 Facility Accidents

This section describes potential impacts of facility accidents at the treatment sites from thermal treatment of waste and from indefinite waste storage after treatment under No Action Alternatives 1A and 1B. The difference between No Action Alternatives 1A and 1B is that no CH-TRU waste would be treated or stored at LANL and RFETS under No Action Alternative 1B. No waste would be disposed of under the two No Action Alternative 1 subalternatives; therefore, no WIPP disposal accidents were analyzed.

5.5.10.1 Waste Treatment Accidents

The impacts of waste treatment accidents under both No Action Alternative 1 subalternatives would be the same as those under Action Alternatives 2A and 2B (see Section 5.3.10.1). In both cases, the waste would be treated thermally at the same sites.

5.5.10.2 Waste Storage Accidents

Potential facility accident impacts under both No Action Alternative 1 subalternatives would be very similar to those presented in Section 5.3.10.2 for Action Alternatives 2A and 2B because stored waste would have been thermally treated. Because WIPP would not be an indefinite storage site under either No Action Alternative 1 subalternative some of the maximum values reported for the MEI in Section 5.3.10.2 would change. These differences are as follows:

- The maximum radiological impacts to the MEI from the drum puncture accident (Accident Scenario S1) would occur at LANL with an 8×10^{-9} probability of an LCF. Maximum impacts from the earthquake or other natural event (Accident Scenario S3) would also be at LANL, with a 4×10^{-3} probability of an LCF.

- The maximum heavy metal carcinogenic impacts to the MEI from the drum puncture accident (Accident Scenario S1) would occur at LANL, with a 1×10^{-16} probability of cancer. The maximum heavy metal carcinogenic impacts to the MEI from the earthquake or other natural event (Accident Scenario S3) would occur at Hanford, with a 1×10^{-9} probability of cancer.

Additional accident analysis information is presented in Appendix G.

As waste would be maintained in storage over long periods of time, the accident risk would be expected to change. Radioactive decay would reduce the amount of radioactivity in the waste. Impacts from a drum puncture (Accident Scenario S1) would be expected to decrease because of reduced radioactivity and overpacking reducing the potential amount of particulates spilled from the waste container in the event of a breach. Impacts from an earthquake (Accident Scenario S3) may decrease because of overpacking or may remain stable because of deterioration of the waste form over time. The deterioration may result in an increase in the amount of particulates released in the event that containers are breached.

5.5.11 Industrial Safety

Nine and seven fatalities would occur from industrial accidents during waste treatment at all treatment sites under No Action Alternatives 1A and 1B, respectively. These estimates were adjusted from the physical-hazard fatality estimates of the WM PEIS.

Under No Action Alternatives 1A and 1B, industrial safety impacts could occur as a result of decommissioning the WIPP site and from constructing and operating long-term TRU waste storage facilities at the treatment sites. Results are presented in Table 5-84. WIPP decommissioning activities would be the same as those discussed under the Proposed Action, except that activities would begin in 1998. In all likelihood, the initial work force would be smaller and the decommissioning period shorter, resulting in fewer injuries and illnesses. No fatalities would be projected.

Table 5-84
Industrial Safety Impacts from WIPP
Decommissioning and Site Storage for No Action Alternative 1

Years	Injury/Illness			Fatalities		
	Construction	**Operations**	**Total**	**Construction**	**Operations**	**Total**
WIPP Decommissioning 1998-2008	187	96	283	0.3	0.1	0.4
Indefinite Storage at Sites (packaging and monitoring for 100-year period)	124	213	337	0.2	0.2	0.4

Long-term storage impacts were evaluated for a 100-year period. It was assumed that CH-TRU waste storage facilities would be constructed. Waste would be moved to new facilities every 50 years. RH-TRU waste storage facilities would necessarily be more robust to provide therequired shielding and would be constructed only once during the period and would last 100 years. CH-TRU waste would be repackaged every 20 years (5 percent per year), while RH-TRU waste, stored in drums inside welded steel canisters, would not be repackaged during the 100-year period. Each year approximately 20 percent of the CH-TRU waste and 5 percent of the RH-TRU waste would be monitored in a manner requiring worker attention to individual containers (e.g., smearing the exterior of containers for contamination and checking lid seals or welds). These activities would be accomplished remotely for RH-TRU waste. No fatalities would occur during the 100-year storage period.

5.5.12 Long-Term Performance

Under No Action Alternatives 1A and 1B, TRU waste would continue to be generated and put into monitored, retrievable storage. There would be no shipment of waste to WIPP, and no long-term radiological or hazardous chemical impacts to the environment or human health would occur at the WIPP site. DOE would indefinitely maintain institutional control and provide long-term monitoring and maintenance of storage facilities. As a consequence, adverse health effects for the general public while DOE maintained control would be minimal, and the principal adverse effects, which also would be small, would be related to occupational activity at the facility. Health effects would continue at such levels for the indefinite future.

The Department realizes that loss of institutional control is a possibility for any long-term storage alternative. Therefore, an analysis of the potential impacts from long-term environmental release under No Action Alternative 1A and 1B was conducted. The analysis was similar to that presented in Appendix I for No Action Alternative 2; however, the waste form generated by the thermal treatment process would substantially reduce those potential impacts. Radionuclides and heavy metals would be incorporated into a more dense and durable waste form that would limit the release of waste into the accessible environment. It was assumed that the glass waste form uniformly reduced the infiltration release rate by a factor of 1×10^{-4}. This factor is based on studies conducted on the dissolution rate of glass waste forms and their effect on contaminant releases to the environment. VOCs would be removed in the treatment process and would not be present in emplaced waste. Once waste containers degrade, direct release from a thermally-treated waste form (e.g., metal slag or glass) would depend on the rate of corrosion and dissolution of metal or glass and natural forces responsible for erosion rather than leaching.

No radiological or hazardous chemical impacts to individuals or populations would be expected over 10,000 years. The number of aggregate LCFs for all sites over 10,000 years was estimated to be less than 8×10^{-4} LCFs for No Action Alternative 1A and 3×10^{-4} LCFs for No Action Alternative 1B for the Total Inventory.[1]

5.6 IMPACTS OF NO ACTION ALTERNATIVE 2

This section describes the environmental impacts associated with the implementation of No Action Alternative 2. If No Action Alternative 2 were implemented, WIPP would be closed, newly generated waste would be treated to planning-basis WAC, all other waste would be left as is, and all of the waste would remain at the sites where it is currently located or would be generated. A detailed description of No Action Alternative 2 is presented in Section 3.2.6.

5.6.1 Land Use and Management

Construction of treatment facilities under this alternative would be minimal. Only newly generated waste would be treated. All other waste would continue to be stored as it has been to date. Therefore, minimal land use impacts would be expected.

At WIPP, land use impacts under No Action Alternative 2 would be similar to those for WIPP under No Action Alternative 1, discussed in Section 5.5.1.

5.6.2 Air Quality

Very limited treatment would be done under No Action Alternative 2. Only newly generated waste would be treated. All other waste would be left as it has been stored to date. Also, any treatment conducted would be to planning-basis WAC; no thermal or shred and grout treatment would be conducted. For TRU waste treatment, the only criteria pollutant postulated to exceed 10 percent of the applicable annual regulatory standard during operation of treatment facilities would be CO at RFETS (17 percent). No radiological, hazardous, or toxic air pollutants would exceed 10 percent of the applicable regulatory standard during normal accident-free treatment (DOE 1997). At WIPP, potential air quality impacts due to decommissioning activities under No Action Alternative 2 would be similar to those under No Action Alternative 1 described in Section 5.5.2.

5.6.3 Biological Resources

Because very limited treatment would be done under No Action Alternative 2 and because current storage facilities would be used, minimal biological impacts would be expected due to construction

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[1] People who might intrude upon the stored waste could receive radiation doses that would greatly exceed current regulatory limits.

and operation of treatment and storage facilities. Potential impacts on biological resources at WIPP under No Action Alternative 2 would be similar to those under No Action Alternatives 1A and 1B, described in Section 5.5.3.

5.6.4 Cultural Resources

Because very limited treatment would be done under this alternative, minimal cultural resource impacts, if any, would be expected. Also, no potential cultural resources impacts at WIPP would be expected under this alternative.

5.6.5 Noise

Potential noise impacts under No Action Alternative 2 would be negligible. No waste would be transported and only newly generated waste would be treated.

5.6.6 Water Resources and Infrastructure

Under No Action Alternative 2 there would be minimal incremental infrastructure impacts from water, wastewater, and power usage due to treatment to planning-basis WAC and storage. During decommissioning at WIPP, there would be a decreasing need and use of water, power, and wastewater systems and on-site transportation infrastructure. There would be no demand or use of these resources following decommissioning.

5.6.7 Socioeconomics

Estimated life-cycle costs and potential socioeconomic impacts for No Action Alternative 2 are presented in the following subsections.

5.6.7.1 Life-Cycle Costs

The life-cycle costs of No Action Alternative 2 are reported in Table 5-85. Under No Action Alternative 2, WIPP would not be used as a waste disposal site. Closure of the WIPP site would follow a 10-year period of decommissioning, beginning in 1998 and ending in 2008. There would be no waste transportation under No Action Alternative 2. Waste generator sites would treat and store CH-TRU and RH-TRU waste inventories for 35 years. Waste treatment operations at these sites cover only newly generated waste. Current waste management practices would continue. The total life-cycle costs of the No Action Alternative 2 would be $2.49 billion ($1.68 billion when discounted), reflecting life-cycle costs at the treatment sites and decommissioning costs at the WIPP site.

5.6.7.2 Economic Impacts

TRU waste treatment activities would support direct, indirect, and induced jobs. Under No Action Alternative 2, only the newly generated defense waste would be treated, and approximately 2,300 jobs would be supported throughout the ROIs of the ten major generator sites (ANL-E, Hanford, INEEL, LANL, LLNL, Mound, NTS, ORNL, RFETS, and SRS).

The economic impacts at the WIPP site would be the same as those for No Action Alternatives 1A and 1B, presented in Section 5.5.7.2.

Table 5-85
Life-Cycle Costs for No Action Alternative 2 (in millions of 1994 dollars) [a]

Cost Information	Basic Inventory			Total Discounted
	CH-TRU Waste	RH-TRU Waste	CH-TRU and RH-TRU Waste	CH-TRU and RH-TRU Waste
Treatment of Newly Generated Waste	880	380	1,260	700
Storage of all Waste	270	110	380	210
WIPP Decommissioning [b]	N/A	N/A	850	770
Total Life-Cycle Cost	1,150	490	2,490	1,680

[a] The methods and assumptions used to estimate the various cost components are described in Appendix D. Actual totals may differ due to rounding.

[b] The WIPP decommissioning cost of $850 million is applied to the total column only because it is not attributed to either CH-TRU or RH-TRU waste at the storage sites but must be considered in the life-cycle cost of this alternative.

N/A = Not Applicable

5.6.8 Transportation

No waste would be transported under No Action Alternative 2, so there would be no transportation impacts.

5.6.9 Human Health Impacts from Waste Treatment and Management Operations

This section presents human health impacts to the public, noninvolved workers, and involved workers from treatment of newly generated TRU waste to meet the planning-basis WAC and from continuation of current waste management practices (aboveground waste storage) under No Action Alternative 2. There would be no disposal of waste at WIPP under this alternative. Impacts from waste treatment were adjusted from those presented in the WM PEIS. A description of these adjustments is provided in Appendix B.

5.6.9.1 Public

Impacts to the populations and to the MEIs under No Action Alternative 2 are presented in this section; results are presented in Table 5-86. Impacts from treatment of newly generated waste and continued waste management/storage operations are presented separately to show their relative contribution to the total impact. Waste treatment and management/storage would take place at multiple DOE sites. Population impacts were estimated for those members of the public residing within 80 kilometers (50 miles) of all treatment sites and all management/storage sites. The impacts to the MEIs from waste treatment and waste management/storage operations are presented for the highest individual sites. See Chapter 3 for additional information on where treatment and management/storage would occur under No Action Alternative 2.

Waste Treatment

No LCFs (1×10^{-3} LCF) or cancer incidence (4×10^{-7} cancers) would be expected in the total population around the waste treatment sites. The MEI with the greatest impact would be at LANL for radiological impacts (8×10^{-8} probability of an LCF) and at ORNL for hazardous chemical impacts (2×10^{-11} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the MEI would be 8×10^{-11}, and no health effect is predicted unless the HI is 1 or higher.

Table 5-86
Lifetime Human Health Impacts to the Public
from Waste Treatment and Storage Operations Under No Action Alternative 2

	Waste Treatment Impacts		Storage Operations Impacts	
Category	**Radiological (LCF) [a]**	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF) [a]**	**Hazardous Chemical (Cancer Incidence)**
MEI [b, c]				
Basic Inventory				
CH-TRU Waste	8E-8 (L)	2E-12 (X)	2E-6 (O)	4E-8 (L)
RH-TRU Waste	1E-10 (L)	2E-11 (O)	2E-9 (O)	2E-8 (O)
Total Waste	8E-8 (L)	2E-11 (O)	2E-6 (O)	4E-8 (L)
Population [b]				
Basic Inventory				
CH-TRU Waste	1E-3	7E-8	0.01	2E-3
RH-TRU Waste	1E-6	4E-7	3E-5	3E-4
Total Waste	1E-3	4E-7	0.01	2E-3
Aggregate Total	1E-3	4E-7	0.01	2E-3

[a] The probability of an LCF occurring to the MEI, and the number of LCFs in the population.
[b] The MEI and populations considered for treatment impacts and storage impacts are different.
[c] L = LANL, O = ORNL, X = LLNL

Continued Management/Storage

No LCFs would be expected in the total population around the lag storage sites (1 x 10^{-2} LCF); no cancer incidence (2 x 10^{-3} cancers) would be expected in the total population from hazardous chemical exposure. The MEI with the greatest impact would be at ORNL for radiological impacts (2 x 10^{-6} probability of an LCF) and at LANL for hazardous chemical impacts (4 x 10^{-8} probability of a cancer incidence). No noncarcinogenic health effects would occur. The maximum HI for any MEI would be 4 x 10^{-4}.

The aggregate total indicated in Table 5-86 refers to the impacts to the public expected over the 100-year operational period under No Action Alternative 2. The estimates reflect the impacts under the management of the Total Inventory of CH- and RH-TRU waste. No LCFs (0.03 LCFs) or cancer incidence (6 x 10^{-3} cancers) would be expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous materials under incident-free operations.

5.6.9.2 Noninvolved Workers

Impacts to the noninvolved worker population and the maximally exposed noninvolved worker under No Action Alternative 2 are presented in this section; results are presented in Table 5-87. A noninvolved worker is an employee who works at a site but is not directly involved in the treatment, management, or storage of waste. Impacts from waste treatment and management/storage are presented separately to show the relative impact contribution of these activities. Waste treatment and management/storage would take place at multiple DOE sites. Noninvolved worker population impacts were estimated as the total for all treatment sites and all management/storage sites. The impacts to the maximally exposed noninvolved worker from waste treatment and management/storage are presented for the highest individual waste treatment sites.

Table 5-87
Lifetime Human Health Impacts to Noninvolved Workers from Waste Treatment and Storage Operations Under No Action Alternative 2

Category	Waste Treatment Impacts		Storage Operations Impacts	
	Radiological (LCF) [a]	Hazardous Chemical (Cancer Incidence)	Radiological (LCF) [a]	Hazardous Chemical (Cancer Incidence)
Maximally Exposed Noninvolved Worker [b, c]				
Basic Inventory				
CH-TRU Waste	4E-8 (L)	5E-12 (X)	8E-6 (O)	2E-7 (I)
RH-TRU Waste	5E-11 (L)	1E-10 (O)	3E-5 (O)	3E-8 (H)
Total Waste	4E-8 (L)	1E-10 (O)	4E-5 (O)	2E-7 (I)
Population [b]				
Basic Inventory				
CH-TRU Waste	8E-5	2E-8	0.04	4E-3
RH-TRU Waste	8E-8	1E-7	8E-5	5E-4
Total Waste	8E-5	1E-7	0.04	2E-3
Aggregate Total	8E-5	1E-7	0.04	2E-3

[a] The probability of an LCF occurring to the maximally exposed noninvolved worker, and the number of LCFs in the population.
[b] The noninvolved workers considered for treatment impacts and operations impacts are different.
[c] H = Hanford, I = INEEL, L = LANL, O = ORNL, X = LLNL

Waste Treatment

No LCFs (8 x 10^{-5} LCF) or cancer incidence (1 x 10^{-7} cancers) would be expected in the total noninvolved worker population at the waste treatment sites. The maximally exposed noninvolved worker would be at LANL for radiological impacts (4 x 10^{-8} probability of an LCF) and at ORNL for hazardous chemical impacts (1 x 10^{-10} probability of a cancer incidence). No noncarcinogenic health effects are predicted. The maximum HI for the maximally exposed noninvolved worker would be 8 x 10^{-10}, and no health effect is predicted unless the HI is 1 or higher.

Continued Management/Storage

No LCFs would be expected in the total noninvolved worker population at the management/storage sites (4 x 10^{-2} LCF); no cancer incidence (2 x 10^{-3} cancers) would be expected in the total noninvolved worker population from hazardous chemical exposure. The maximally exposed noninvolved worker would be at ORNL for radiological impacts (4 x 10^{-5} probability of an LCF) and at INEEL for hazardous chemical impacts (2 x 10^{-7} probability of a cancer incidence). No noncarcinogenic health effects would occur; the maximum HI for any maximally exposed noninvolved worker would be 1 x 10^{-3}.

The aggregate total indicated in Table 5-87 refers to the impacts to the noninvolved worker population expected over the 35-year operational period under No Action Alternative 2. No LCFs (0.1 LCFs) or cancer incidence (6 x 10^{-3} cancers) would be expected over the several generations that would be exposed to the small potential routine releases of radioactive or hazardous chemicals under incident-free operations.

5.6.9.3 Involved Workers

Potential impacts to involved workers from treatment of newly generated waste and storage operations under No Action Alternative 2 are presented in Table 5-88. No LCFs (0.4) would occur in the total involved worker population from radiation exposure during waste treatment. No cancer (8×10^{-6} cancers) would be expected from hazardous chemical exposure, and no noncarcinogenic health effects would occur (maximum exposure index of 5×10^{-5}). Less than 1 radiation-related LCF, and less than 0.04 cancers from hazardous chemical exposure would be expected in the involved worker population from continued waste management and storage operations. All worker exposures to radiation and hazardous chemicals would be controlled to ALARA levels. Administrative controls such as worker and area monitoring, rotation of workers to reduce exposures, and standard operating procedures would be used to limit exposures.

Table 5-88
Lifetime Human Health Impacts to Involved Workers
from Waste Treatment and Storage Under No Action Alternative 2

	Waste Treatment Impacts		Storage Operations Impacts	
Category	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**	**Radiological (LCF)**	**Hazardous Chemical (Cancer Incidence)**
Population				
Basic Inventory				
CH-TRU Waste	0.3	8E-7	0.5	0.02
RH-TRU Waste	0.02	7E-6	≤0.5	≤0.02
Total Waste	0.4	8E-6	≤1	≤0.04
Aggregate Total	0.4	8E-6	≤1	≤0.04

The impacts from CH-TRU waste would be from the external radiation dose received during waste container handling. Potential radiological impacts from inhalation of radioactive gases released from waste containers would be negligible. Involved worker impacts from storage activities were calculated by assuming waste handlers would spend 2 hours every workday at 1 meter (3.3 feet) from the CH-TRU waste containers and were assumed to be exposed over a 35-year career. Container dose rates were decay-corrected over 35 years. Impacts from RH-TRU waste storage would be less than those for CH-TRU waste storage because of remote RH-TRU waste handling and greater administrative controls for RH-TRU waste.

The aggregate total indicated in Table 5-88 refers to the impacts to the involved worker population at the storage sites expected over the 35-year period (for operations) under No Action Alternative 2. Storage worker population impact estimates indicate that less than 3 LCFs and less than 0.1 cancers are expected over the several generations of involved workers exposed externally or via inhalation of hazardous chemicals.

5.6.10 Facility Accidents

Very limited treatment of waste would occur under No Action Alternative 2. Only newly generated waste would be treated, and that waste would be treated only to the planning-basis WAC. Also, no consolidation of waste would occur. Storage would be continued for an indefinite period of time. No waste would be disposed of at WIPP. WIPP disposal accidents, therefore, were not assessed for this alternative.

5.6.10.1 Waste Treatment Accidents

The impacts of waste treatment accidents under No Action Alternative 2 would be the same as those under the Proposed Action (see Section 5.1.10.1) because the small portion of waste that would be treated, would be treated to planning-basis WAC.

5.6.10.2 Waste Storage Accidents

Potential storage accident impacts under No Action Alternative 2 would be similar to those presented in Section 5.2.10.2 for Action Alternative 1 because that waste that would be treated at all would be treated to planning-basis WAC prior to storage. For that portion of the No Action Alternative 2 waste that would not be treated to planning-basis WAC, accident frequencies and potential impacts could be somewhat higher than those presented in Section 5.2.10.2.

5.6.11 Industrial Safety

At the waste generator sites less than one fatality (0.7) would occur from industrial accidents under No Action Alternative 2 during waste treatment at all generator sites. This result was estimated by adjusting the physical-hazard fatality estimate of the WM PEIS.

Under No Action Alternative 2, industrial safety impacts could occur as a result of decommissioning the WIPP site and from continued management of TRU waste at the generator-storage sites. Estimated impacts are presented in Table 5-89. WIPP decommissioning activities were assumed to be the same as discussed under the Proposed Action except that activities would begin in 1998. In all likelihood, the initial work force would be smaller and the decommissioning period shorter, resulting in fewer injuries and illnesses. No fatalities would be projected. Current waste practices were assumed to continue at the generator-storage sites for the 35-year operations period. No industrial fatalities were projected from continued waste storage at the sites.

Table 5-89
Industrial Safety Impacts from WIPP Decommissioning
and Site Waste Management Under No Action Alternative 2

Years	Injury/Illness			Fatalities		
	Construction	Operations	Total	Construction	Operations	Total
WIPP Decommissioning 1998-2008	187	96	283	0.3	0.1	0.4
Waste at Sites 1998-2033	N/A	190	190	N/A	0.2	0.2

N/A = Not Applicable

5.6.12 Long-Term Performance

No Action Alternative 2 was included among those alternatives considered in the FEIS and SEIS-I. The FEIS and SEIS-I analyzed the environmental consequences of No Action Alternative 2 under several different assumptions and conditions. In general, it was estimated that if DOE would provide effective monitoring and maintenance of storage facilities, adverse health effects for the general public would be quite small, and the principal adverse effects, also small, would be related to occupational activity at the facilities. These health effects would continue at such levels for the indefinite future under the hypothesis of DOE control.

However, if DOE were to lose institutional control of storage facilities, it was estimated that intruders could receive substantial radiation doses, a situation that could persist for the indefinite future. In addition, contaminants in TRU waste stored in shallow burial trenches and surface storage facilities would eventually be released and would persist in the surrounding environments at the treatment sites exposing on-site and off-site populations to chronic health impacts.

The ROD for the FEIS, published on January 28, 1981, determined as part of the basis for decision that the No Action Alternative was "unacceptable." This determination was made at the time because of the potential impacts of natural, low probability events and human intrusion at storage facilities after governmental control of the site is lost. In SEIS-I, a summary of the FEIS analysis was provided and the same conclusion was reached in its ROD, published on June 21, 1990.

The long-term impacts of continuing current TRU waste management practices and loss of institutional control were reexamined under No Action Alternative 2 for SEIS-II. The effect of human intrusion was reexamined because of the changed estimated volumes and inventories of future generated TRU waste (see Appendix A). This analysis also examined the long-term impacts

INTRUSION AT WIPP AND AT GENERATOR-STORAGE SITES

The intrusion scenarios and potential impacts for the WIPP repository evaluated under the Proposed Action and Action Alternatives 1, 2, and 3 are very different from those for the generator-storage sites evaluated under No Action Alternatives 1 and 2.

Intrusion into TRU waste at WIPP is limited by the repository’s 655-meter (2,150-foot) depth below the surface and remote location. The most likely direct intrusion scenario is penetration of the repository by hydrocarbon drilling. DOE has estimated the most likely number of intrusions into WIPP to be 5, with a probability of about 0.17 over a 10,000-year evaluation period. A limited amount of waste would be brought to the surface (less than 1 cubic meter) and would impact only a few members of the public directly associated with the drilling activity. This scenario, evaluated in SEIS-II, showed only a slight risk to the MEI. WIPP intrusion could result in the possibility of contamination migrating from the repository to the accessible environment through the borehole. Indirect intrusion, such as a well drilled for stock water (water in the vicinity of WIPP is not suitable for drinking or irrigation), would result in very low impacts to people eating stock exposed to this water.

In contrast, waste in surface facilities or shallow-buried storage would be easily accessible in the event of loss of institutional control, under the no action alternatives. There are multiple DOE sites that currently store TRU waste, some near population centers. Direct intrusion could occur through such common mechanisms as basement or building excavation, road building, pipeline or utility emplacement, scavenging, and casual intrusion. Indirect intrusion into contamination dispersed by any of the above activities or natural processes could be by gardening or farming activities. SEIS-II has evaluated potential impacts of intrusion and release of material under the no action alternatives. Under No Action Alternative 1, people who might intrude upon stored waste could receive radiation doses that would greatly exceed current regulatory limits. For waste in unconsolidated waste forms, evaluated under No Action Alternative 2, long-term and repeated intrusion activities could result in thousands of radiation-related LCFs over a 10,000-year evaluation period.

of environmental releases of contaminants from stored TRU waste at the major generator-storage sites. No TRU waste would be transported to WIPP and current WIPP operations would cease after a short decommissioning period. Thus, no long-term radiological or hazardous chemical impacts to the environment or human health would occur at the WIPP site under this alternative.

This section provides a summary of long-term impacts from stored TRU waste at the major generator-storage sites for 10,000 years following the loss of institutional control. The analysis of human health impacts estimated the impacts of TRU waste as a source of direct exposure and as a contaminant source for release to surface and subsurface exposure points in the environment. Scenarios analyzed included exposure to waterborne and airborne releases of contaminants from waste stored in shallow earth-covered trenches or covered by earthen berms and to waste stored in exposed surface pads or in surface enclosures and buildings.

Impacts to human health from waste intrusion and long-term environmental release were estimated using methods outlined in Appendix I and in a technical supporting document (Buck et al. 1997). This analysis focused on the impacts of waste at seven of the 10 major sites because the majority (99 percent) of the waste is stored at these sites. Estimates for RH-TRU waste impacts were only made at sites storing RH-TRU waste which are Hanford, INEEL, LANL, and ORNL. For buried waste, no estimates of impacts were made for either CH-TRU or RH-TRU waste at LLNL and RFETS because neither of these sites currently store waste in buried configurations.

Exposure scenarios evaluated included acute exposures to intruders and chronic exposures to settlers. These exposures were assumed to occur at the site of the original waste storage location, with little dispersion of contamination prior to exposure. Exposure scenarios evaluated for buried waste included an acute exposure of a driller intruder and the chronic exposure of a gardener who was assumed to subsequently settle at the drilling site. Exposure scenarios evaluated for surface-stored waste included the acute exposure of a scavenger intruder and the chronic exposure of a farm family settling on the site of the former waste storage area.

Impacts were also evaluated for the long-term environmental release of stored waste over 10,000 years. Evaluated were scenarios for chronic exposure of a MEI and the population living within 80 kilometers (50 miles) of the former waste storage sites. This individual and population could be exposed from releases from both buried and surface-stored waste. The MEI was assumed to be located 300 meters (980 feet) away from the waste storage site, in the direction of groundwater flow. The distribution of the off-site populations were assumed to be characteristic of current populations around the sites.

Descriptions of these exposure scenarios for intruders and settlers and long-term environmental releases are provided in AppendixI.

Impacts of Exposure Scenarios

With the loss of institutional control, individuals could come into direct contact or be inadvertently exposed to waste that had been stored in shallow burial or surface storage facilities. The following sections describe the impacts that could result from exposure to radionuclides and hazardous chemicals in CH-TRU and RH-TRU waste for exposure scenarios, where individuals were assumed to be exposed at the original storage locations. Individuals were assumed to be exposed immediately after the loss of institutional control, minimizing reduction of impact through radioactive decay.

Impacts from Exposure to Buried Waste

The driller scenario is one where an individual was assumed to drill a well at the site of the waste storage locations and be exposed over a 5-day work week to waste material brought to the land surface by the drilling process.

Radiological impacts to a hypothetical driller exposed acutely for 5 days (1 work week) from CH-TRU waste would range from a 1 x 10^{-6} to 5 x 10^{-6} probability of an LCF for the five sites with buried CH-TRU waste. Impacts to the driller from RH-TRU waste would range from a 1 x 10^{-6} to 3 x 10^{-5} probability of an LCF for the four sites with buried RH-TRU waste. Sites with the highest impacts would be INEEL and ORNL for CH-TRU waste and Hanford for RH-TRU waste. These results are presented in Table 5-90. Health impacts from hazardous chemicals would be significant. The RH-TRU waste concentration for lead could be up to 3,000 times the PEL.

The gardener scenario is one in which an individual was assumed to prepare a garden at the drilling site and grow produce in soil containing waste material brought to the surface by the drilling. This individual was assumed to ingest produce grown in the contaminated soil for a period of 30 years and be exposed while working in the garden.

Table 5-90
Radiological Impacts to Inadvertent Intruders Following Loss of Institutional Control for Seven Major Generator-Storage Sites (probability of an LCF)

	Hanford	INEEL	LLNL	LANL	ORNL	RFETS	SRS
CH-TRU Waste Impacts							
Buried Waste							
Driller (acute)	1E-6	5E-6	N/A	2E-6	5E-6	N/A	4E-6
Gardener (chronic)	0.01	0.01	N/A	0.02	0.01	N/A	0.06
Surface Waste							
Scavenger (acute)	2E-03	2E-03	6E-04	3E-03	3E-03	0.02	0.01
Family Farm (chronic)	0.6	0.8	0.2	1	1	1	1
RH-TRU Waste Impacts							
Buried Waste							
Driller (acute)	3E-5	5E-6	N/A	1E-6	3E-6	N/A	N/A
Gardener (chronic)	0.04	9E-3	N/A	4E-3	7E-3	N/A	N/A
Surface Waste							
Scavenger (acute)	0.01	2E-03	N/A	7E-04	1E-03	N/A	N/A
Family Farm (chronic)	1	1	N/A	0.3	1	N/A	N/A

N/A = Not Applicable

Radiological impacts to a hypothetical gardener would range from a 0.01 to 0.06 probability of an LCF for the five sites with buried CH-TRU waste. Impacts to the gardener from RH-TRU waste would range from a 4 x 10^{-3} to 0.04 probability of an LCF for the four sites with buried RH-TRU waste. Sites with the highest impacts would be SRS for CH-TRU waste and Hanford for RH-TRU waste. These results are also presented in Table 5-90. The hazard index for mercury and lead are 77 and 3,900, respectively, for the gardener for RH-TRU waste. The lead hazard index is 36 for CH-TRU waste.

Impacts from Exposure to Surface-Stored Waste

The scavenger scenario is one where an individual was assumed to come into direct contact with the TRU waste on the surface for a 24-hour period. This intruder was assumed to be exposed by inhalation of resuspended contamination, external radiation, and inadvertent ingestion of contaminated soil while at the site.

Radiological impacts to a hypothetical scavenger from CH-TRU waste would range from a 6×10^{-4} to 0.02 probability of an LCF; all seven sites would have surface-stored CH-TRU waste. Impacts to the scavenger from RH-TRU waste would range from a 7×10^{-4} to 0.01 probability of an LCF for the four sites with buried RH-TRU waste. Sites with the highest impacts would be RFETS for CH-TRU waste and Hanford for RH-TRU waste. These results are presented in Table 5-90. Significant impacts would be seen from heavy metals. The concentration of heavy metals ranges from 5 times to 1,400 times the PEL for CH-TRU waste and up to 160,000 times the PEL for RH-TRU waste.

The farmer scenario is one in which a hypothetical framer lives and farms on a plot of land at the location of the surface-stored waste. The waste was assumed to have degraded to a point where it was indistinguishable from the surrounding land and soil. The maximally exposed farmer was assumed to be exposed by ingestion of contaminated food crops grown in the contaminated soil, inhalation of resuspended contamination, external radiation, and inadvertent ingestion of contaminated soil. Under this scenario, the members of the family would receive very high radiation doses in the first year of farming. The probability of an LCF would range from 0.2 to 1 for CH-TRU waste, with three of the seven sites evaluated having a probability of 1 in the first year. The probability of an LCF would range from 0.3 to 1 for RH-TRU waste, with 3 of 4 sites having a probability of 1. These results are presented in Table 5-90. Noncarcinogenic effects such as radiation pneumenitis in the lungs could also occur. Health impacts from hazardous chemicals would be significant as well. The hazard index ranges from 10 to 100,000 for CH-TRU waste and up to 5,200,000 for RH-TRU waste.

Impacts of Long-Term Environmental Release

For TRU waste stored in shallow burial trenches and surface storage facilities at generator-storage sites, contaminants would eventually be released to the surrounding environments after loss of institutional control. Contaminants within the buried or surface-stored waste would be leached and released to underlying soils and aquifer systems at depth. At most sites contaminants would eventually reach groundwater and migrate laterally to a downgradient receptor location. Contaminants might also eventually be discharged into nearby surface water bodies. Once in these surface-water systems, the public would be exposed to dilute concentrations of the contaminants in public water supplies.

Waste stored in surface facilities would also degrade and disperse contaminants in the environment by the processes of direct water and air erosion, deposition onto soils surrounding the site, and resuspension of contaminated soils in air. The surrounding populations would be exposed to these contaminants as they were redistributed into the environment by these cyclic and ongoing processes.

Radiological and chemical impacts were evaluated for MEIs and the populations surrounding seven major generator-storage sites (Hanford, INEEL, LANL, LLNL, ORNL, RFETS, and SRS).

Additional information is provided in Appendix I. Impacts to the MEI were evaluated for a groundwater exposure scenario and an air pathway exposure scenario. Under the groundwater exposure scenario, the MEI was assumed to be a member of a farm family living 300 meters (980 feet) downgradient of the waste storage areas at each of the sites. It was assumed that the family would engage in farming activities such as growing and consuming its own crops and livestock and would use contaminated groundwater as a source of drinking water and for watering the crops and animals. Under the air pathway exposure scenario the MEI was assumed to live at the point of maximum airborne contaminant concentration. This individual could be exposed via inhalation of resuspended contamination, ingestion of contaminated food crops grown in the contaminated soil, external exposure to the soil, and inadvertent ingestion of contaminated soil.

Impacts to off-site populations were also evaluated from long-term environmental releases to surface water and to air. For analyses of buried waste releases, all CH-TRU and RH-TRU waste was combined into a single waste disposal unit, and only the groundwater pathway was considered. For analyses of surface-stored waste releases, all CH-TRU and RH-TRU waste was combined into a single waste storage unit and was allowed to be released to all pathways.

Impacts to the MEIs for the maximum 70-year lifetime over 10,000 years of environmental release of contaminants are presented in Table 5-91 for the seven major generator-storage sites. Radiological impacts to the MEI would range from a 3 x 10^{-6} probability of an LCF at ORNL to a 4 x 10^{-3} probability of an LCF at INEEL. Carcinogenic hazardous chemical impacts to the MEI would range from a 1 x 10^{-7} probability of cancer incidence at LANL to a 5 x 10^{-3} probability of cancer incidence at INEEL. Noncarcinogenic hazardous chemical impacts were estimated using an HI and are presented in Table 5-92. No noncarcinogenic health effects would occur for an HI less than 1, and only at SRS, with an estimated HI of 2 for the MEI from ingestion of mercury in groundwater, would any noncarcinogenic impacts be expected.

Table 5-91
Maximum Lifetime MEI and Population Impacts for Seven Major Generator-Storage Sites Under No Action Alternative 2

Major Sites	Radiological Impacts		Chemical Carcinogenic Impacts	
	Lifetime LCF [a]	Dominant Pathway	Lifetime Cancer Incidence	Dominant Pathway
MEI Impacts				
Hanford	1E-04	Inhalation	2E-06	Groundwater Ingestion
INEEL	4E-03	Groundwater Ingestion	5E-03	Groundwater Ingestion
LANL	5E-05	Inhalation	1E-07	Resuspended Soil Ingestion
LLNL	7E-06	Inhalation	5E-06	Groundwater Ingestion
ORNL	3E-06	Groundwater Ingestion	6E-07	Groundwater Ingestion
RFETS	2E-03	Inhalation	3E-07	Groundwater Ingestion
SRS	7E-04	Groundwater Ingestion	4E-04	Groundwater Ingestion
Population Impacts				
Hanford	7E-04	Resuspended Soil Ingestion	2E-06	Surface Water Ingestion
INEEL	0.07	Inhalation	3E-06	Resuspended Soil Ingestion
LANL	0.08	Inhalation	2E-04	Resuspended Soil Ingestion
LLNL	0.02	Inhalation	3E-07	Resuspended Soil Ingestion
ORNL	4E-05	Inhalation	3E-07	Surface Water Ingestion
RFETS	7.1	Inhalation	3E-04	Resuspended Soil Ingestion
SRS	0.09	Inhalation	6E-05	Surface Water Ingestion

[a] Probability of an LCF for the MEIs; number of LCFs for the populations.

Table 5-92
Noncarcinogenic Hazardous Chemical Impacts to MEIs at Seven Major Generator-Storage Sites for No Action Alternative 2

Major Generator/Storage Sites	HI [a]	Key Chemical	Dominant Pathway
Hanford	0.2	Mercury	Groundwater Ingestion
INEEL	0.3	Carbon Tetrachloride	Groundwater Ingestion
LANL	2E-03	Mercury	Resuspended Soil Ingestion
LLNL	5E-04	Carbon Tetrachloride	Resuspended Soil Ingestion
ORNL	3E-04	Mercury	Groundwater Ingestion
RFETS	6E-05	Lead	Inhalation
SRS	1.5	Mercury	Groundwater Ingestion

[a] No noncarcinogenic impacts would occur for an HI less than 1.

Impacts to populations for the maximum 70-year lifetime over 10,000 years of environmental release of contaminants are also presented in Table 5-91 for the seven major generator-storage sites. Exposures from the air and groundwater to surface water pathways were included.

Radiological impacts to populations would range from 4 x 10^{-5} LCFs at ORNL to 7.1 LCFs at RFETS. Carcinogenic hazardous chemical impacts would range from 1 x 10^{-7} cancers at LLNL to 3 x 10^{-4} cancers at RFETS.

The aggregate number of LCFs that could occur in off-site populations around the seven sites over 10,000 years (approximately 142 70-year lifetimes) from release of the No Action Alternative 2 inventory was estimated. The aggregate number of LCFs for all sites was estimated to be 794 LCFs, with 98 percent of the estimated LCFs (781) occurring in the population around RFETS. In addition to the impact from release of the No Action Alternative 2 inventory, the number of aggregate LCFs at the seven sites was estimated for the Additional Inventory of Action Alternative 1 (see Tables 3-2 and 3-3) which would also remain in place at the sites under the No Action Alternative 2. An additional 13 aggregate LCFs were estimated to occur from release of the Additional Inventory. Release of the combined inventories would result in about 800 LCFs. Estimates of site-specific and total aggregate LCFs are presented in Table 5-93. The aggregate hazardous chemical impact over 10,000 years was estimated to be about 0.002 cancers. These

Table 5-93
Aggregate LCFs over 10,000 Years for Seven Major Generator-Storage Sites After Loss of Institutional Control for No Action Alternative 2

Site	Aggregate LCFs from Basic Inventory	Aggregate LCFs from Additional Inventory	Aggregate LCFs from Combined Inventory
Hanford	0.01	0.01	0.02
INEEL	3.8	7.7	11.4
LANL	8.5	5.6	14.1
LLNL	0.4	0	0.4
ORNL	6E-04	3E-04	9E-04
RFETS	781	0	781
SRS	0.3	0.1	0.4
Total	**794**	**13**	**807**

impacts were estimated based on current population distributions. These distributions may change substantially, creating the potential for significant increases over these estimates of aggregate LCFs.

5.7 RETRIEVAL AND RECOVERY

Waste "retrieval," as defined by the WIPP LWA, is "the removal of TRU waste and the container in which it has been retained, and any material contaminated by such waste from the underground repository at WIPP." For the purposes of analyses, SEIS-II distinguishes between waste "retrieval" and waste "recovery." Retrieval is the removal of intact (unbreached) waste containers. Retrieval is presumed to occur prior to the closure of WIPP before salt reconsolidation (rock creep) begins to crush CH-TRU waste drums and standard waste boxes or RH-TRU waste canisters. Waste "recovery" assumes that the waste containers would be breached through the process of salt reconsolidation and would include the removal of waste, waste containers, and any material contaminated by such waste. The analysis of waste removal at some future time is based on the following general assumptions: (1) the reason for removing the waste would be known; (2) the transportation mode, destination, and end use would be known; (3) waste removal would be based on future available technologies and future regulations.

The consequence analysis presented in the following subsections is intended to bound the impacts that could occur in the unlikely event that waste would need to be removed from the WIPP repository. If one or more panels of waste were removed after the panels had been closed but prior to repository closure, the impacts of waste removal would be proportional to the number of panel equivalents removed. In general, worker impacts would increase in proportion to the number of waste containers that have been breached.

5.7.1 Waste Retrieval

The retrieval of waste from WIPP prior to closure would conceptually be the reverse of the initial disposal. Because the facility would not have been closed, it was assumed that (1) the surface facilities, equipment, and shafts would be intact and operational, (2) access to the waste would be available via the access tunnels, (3) panel rooms would not have collapsed, and (4) the waste containers would be unbreached and intact. For this analysis, it was assumed that one panel of waste (17,560 cubic meters [620,000 cubic feet]) would be removed. This is equal to 10 percent of the Basic Inventory, the total of which is proposed for disposal in ten panel equivalents. If more than one panel were retrieved, the impacts would be proportional to the number of panel equivalents retrieved.

5.7.1.1 Operational Impacts of Waste Retrieval

Operational impacts of retrieving CH-TRU and RH-TRU waste from one panel-equivalent would be essentially the same as the impacts of emplacing that waste. Approximately 40 workers would be involved with removing the waste from the panel on a daily basis for a period of 2 years. The worker-population dose for this operation would not exceed 80 person-rem, based on WIPP administrative limits of 1 rem total effective dose equivalent (TEDE) per year, and would probably be much smaller. The number of LCFs in the worker population from this exposure would be about 0.03. The potential of cancer incidence from exposure to hazardous chemicals would be smaller, on the order of 5×10^{-6}. No noncarcinogenic effects from exposure to hazardous chemicals would be expected.

Impacts to the public and to noninvolved workers would be expected to be smaller, by at least an order of magnitude, than the values for WIPP operations under the Proposed Action (Tables 5-11 and 5-12). The estimated number of LCFs in the general population from radiation exposure was 3 x 10^{-5}, while cancer incidence from hazardous chemical exposure was about 2 x 10^{-6}. The MEI would have a 3 x 10^{-8} probability of an LCF from radiation exposure and about a 3 x 10^{-9} probability of a cancer incidence. The noninvolved worker population would have an estimated 4 x 10^{-5} LCF from radiation exposure and cancer incidence from hazardous chemical exposure would be about 1 x 10^{-5}. The maximally exposed noninvolved worker would have a 5 x 10^{-7} probability of an LCF from radiation exposure, and about a 1 x 10^{-8} probability of a cancer incidence. No noncarcinogenic health effects would be expected, with HIs not exceeding those under the Proposed Action and no larger than 6 x 10^{-5}.

5.7.1.2 Transportation Impacts of Waste Retrieval

Transportation impacts from the retrieval of one panel of waste would be the same for transporting the waste to WIPP for disposal. The impact of transporting waste is primarily based on the number of shipments required and the shipping destination distances. Because the amount of waste would be the same as originally disposed of, and the waste would be shipped back to the origination site, the number of shipments and shipping destinations would be the same, making the transportation impact the same. The estimated impacts of transporting one panel of TRU waste removed from WIPP to the waste origination site would be less than one vehicle-related fatality and less than one nonoccupational LCF (see Appendix E).

5.7.2 Waste Recovery

Recovery of waste from WIPP could occur during operations or after closure. Recovery after closure would require the sinking of new shafts and the excavation of new drifts. For this analysis it was assumed that standard mining techniques would be used until excessive contamination or radiation fields are encountered. In contaminated areas, currently available remote-controlled excavation equipment or equipment modified with off-the-shelf systems may be used. Where practical, waste removal operations and support operations, such as radiation and air quality monitoring, and geotechnical surveying, would be performed remotely. Contaminated and uncontaminated equipment and materials would be segregated, and maintenance operations would use separate ventilation systems.

Excavated waste materials would be placed in appropriately designed waste containers. The surfaces of the containers would be decontaminated, if necessary, prior to being transported aboveground. Aboveground facilities would include a control center where all remote operations would be coordinated and a decontamination area where waste containers would undergo additional decontamination if necessary. The waste containers would be staged aboveground for transportation to a pre-determined location or end use. A control center in the underground would provide the interface between the aboveground control center and underground operational activities.

The excavation and waste removal operations would be designed to reduce the amount of contamination and radiation exposure, and to allow limited human access for assessments, equipment retrieval, and equipment repairs. Operations would be designed to reduce direct human involvement to the extent practicable. Radiological work would be performed using standard industry practices and approved procedures.

Standard mining equipment would be used to sink the shafts and to excavate the drifts and support rooms. After the underground support areas have been completed, the waste would be removed. Reduced scale mining equipment would be used to remove the waste. A reduction in scale would enable the vehicles and supporting equipment to be remotely controlled and to handle waste materials not usually associated with mining activities. The CH-TRU and RH-TRU waste would be retrieved in separate operations. The RH-TRU waste would be removed as intact as possible. Because the RH-TRU waste poses a greater external radiation hazard, RH-TRU waste removal activities would require more rigorous measures to limit personnel exposure.

It is anticipated that a long time period would be needed to complete the removal of waste, but no time limit would be specified. The removal approach would minimize the overall hazards.

After the waste has been removed from the repository, the facility would be decommissioned in accordance with the regulatory requirements applicable at that time. Closure may include partial backfilling of the repository and support areas. The entire repository would not be backfilled, however. The intent would be to dispose of uncontaminated excavated salt and other materials removed from the underground during the initial mining operations. The shafts may be sealed; surface facilities would be decontaminated and decommissioned. All decontamination waste could be packaged and shipped in the same fashion as the waste removed.

The analysis for the recovery of waste after closure was based on the assumptions that (1) the repository has been closed for a period of time sufficient for total encapsulation of the waste and reconsolidation of the salt, (2) waste containers have been breached, and (3) waste characterization requirements and the process/equipment that meet these requirements are known and are based on regulations current at the time of removal.

A volume of 400,000 cubic meters (14 million cubic feet) of CH-TRU and RH-TRU waste was assumed to have been disposed of. This volume, which is the volume of waste disposed of under Action Alternative 3 (the maximum under any alternative), would be emplaced in 71 waste panels. To recover the disposed of waste, the materials that would be removed from the repository would include 3,370,000 cubic meters (119 million cubic feet) of contaminated material and 570,000 cubic meters (20 million cubic feet) of uncontaminated material. These volumes include uncontaminated materials from newly excavated repository shafts and access drifts and contaminated materials from the waste panel rooms and drifts, plus an additional 10 percent to include contaminated materials that may have penetrated into the disposal panel or drift floors or walls.

5.7.2.1 Operational Impacts of Waste Recovery

Operational impacts of recovering emplaced CH-TRU and RH-TRU waste from the entire repository 100 years after closure would be substantially greater than the impacts of emplacing the waste. In addition to excavation of waste, containers, and surrounding contaminated salt, there would be substantial effort involved in packaging the material for safe shipment. Packaging of recovered waste and contaminated salt was assumed to take place underground. It was assumed that engineered contamination controls, such as a HEPA-filtered ventilation system typical of DOE facilities that handle radioactive material, would be put into place. DOE believes that such controls would maintain releases and radiation exposures below the current regulatory levels. Therefore, all releases and radiation exposures to the public and workers were assumed to be limited to current regulatory standards, and the MEI would receive no more than 10 mrem per year, the

NESHAP limit for radionuclides in 40 CFR Part 61. Workers would be subject to the WIPP administrative dose limit of 1 rem per year.

The number of workers required for excavation and packaging activities was estimated to be about 100. The time period needed to remove the waste was estimated to be about the same as that required for emplacement, about 200 years, based on 5 years to excavate and package each panel containing CH-TRU and RH-TRU waste, and 2 years to excavate and package each panel containing only RH-TRU waste. Assuming a 35-year work period per worker, the accumulated worker-population dose over the entire 200-year recovery period would be 20,000 person-rem. The maximum accumulated LCFs in the involved worker population would be about 8. The accumulated potential of cancer incidence from exposure to hazardous chemicals would be smaller, on the order of 1×10^{-3}. No noncarcinogenic effects from exposure to hazardous chemicals would be expected.

The impact to the MEI receiving 10 mrem per year (the NESHAP radionuclide limit) would be approximately 1,000 times the calculated impact to the MEI from WIPP disposal operations under Action Alternative 3 (Tables 5-64 and 5-65). This ratio was used to estimate the potential impacts to the public and noninvolved workers from waste recovery, adjusting Action Alternative 3 impacts upward by a factor of 1,000. The estimated number of LCFs in the general population from radiation exposure would be 0.3, while cancer incidence from hazardous chemical exposure would be 0.02. The MEI would have a 3×10^{-4} probability of an LCF from radiation exposure, and about a 1×10^{-5} probability of a cancer incidence from exposure to hazardous chemicals. The noninvolved worker population would have an estimated 0.5 LCF from radiation exposure, and cancer incidence from hazardous chemical exposure would be about 0.09. The maximally exposed noninvolved worker would have a 3×10^{-4} probability of an LCF from radiation exposure, and about a 5×10^{-5} probability of a cancer incidence. No noncarcinogenic health effects would be expected, with the HIs not exceeding those under Action Alternative 3 and no larger than 1×10^{-3}.

5.7.2.2 Transportation Impacts of Waste Recovery

The transportation impacts of recovering the waste would be substantially greater than for its disposal because there would be a much greater volume of recovered waste (3.4 million cubic meters [121 million cubic feet]). It is assumed that the recovered waste would be transported to the treatment sites using the transportation consolidation described for Action Alternative 3. Because contaminated salt would be treated as waste, each generator site would receive more waste than it originally shipped for disposal.

The large volume of contaminated salt would increase the number of shipments by a factor of 8.5, increasing the transportation impact by approximately the same factor. This impact estimate is conservative because, in the time between disposal and recovery, the radionuclides with short half-lives would have decayed sufficiently to reduce accident-free radiological impacts to a large extent. Also, because much of the recovered waste would have a large salt component, the salt would provide shielding for the radioactive component. This self-shielding effect would further reduce accident-free impacts. The bounding accident impacts, however, would be about the same as that calculated for Action Alternative 3 (3 LCFs for CH-TRU waste average radionuclide concentration scenario) because the half-life of the alpha emitting radionuclides, which contribute most to internal dose, have relatively long half-lives. After 100 years, these radionuclides would not have decayed sufficiently enough to substantially reduce impacts. The maximum radiological populations impacts calculated to occur from nonoccupational accident-free exposures is estimated to be the same as Action Alternative 3 (15 LCFs). Vehicle-related traffic fatalities would increase to 185 due to a proportional increase in waste and transportation miles (see the related discussion in Appendix E for complete estimated transportation impacts).

5.8 ENVIRONMENTAL JUSTICE

DOE is in the process of developing environmental justice guidance, pursuant to Executive Order 12898. This guidance will be finalized after stakeholder comments, concerns, and opinions are received, reviewed, and incorporated, as appropriate.[1] The approach taken in this SEIS-II analysis may depart somewhat from the guidance that is eventually issued or from the approach taken in other documents. Information concerning minority populations for New Mexico as a whole is included in this section in response to public comments.

For purposes of this analysis, a high and adverse human health or environmental impact is a significant deleterious human health or environmental impact. A disproportionate impact to a minority or low-income population is one that substantially exceeds, or is likely to exceed, the same type of impact in the larger community. A disproportionately high and adverse human health or environmental impact would occur when the adverse human health or environmental effects are significant, and the risk or rate to a minority or low-income population from exposure (or multiple exposures) to the environmental or health hazard(s) substantially exceeds, or is likely to exceed, the risk or rate to the general population.

The SEIS-II environmental justice analysis for the vicinity of WIPP addresses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations within an 80-kilometer (50-mile) area of the WIPP site. The shaded areas in Figures 4-11 and 4-12 show the percentage of minority populations and low-income populations, respectively, in census blocks around the WIPP site. Minorities comprise about 36.8 percent of the population in the 80-kilometer (50-mile) area around WIPP, and low-income individuals about 21.5 percent of this population.

Approximately 38 percent of New Mexico’s population is Hispanic. Approximately 9 percent of New Mexico’s population is Native American.

The populations within an 80-kilometer (50-mile) area of the non-WIPP treatment sites are described in Chapter 4 of SEIS-II. SEIS-II also incorporates by reference the maps of the census tracts containing greater than 50 percent minority and low-income populations within the 80-kilometer (50-mile) area of treatment sites that are included in Appendix C of the WM PEIS. Of note for environmental justice assessments are LANL and SRS, where minorities constitute greater than 55 percent and 35 percent, respectively, of the total populations within the 80-kilometer (50-mile) area.

For treatment, potentially high and adverse human health effects could occur during normal, accident-free treatment operations at some treatment sites as a result of TRU waste management activities under the three Action Alternative 2 subalternatives. Several areas in the vicinity of WIPP contain a greater percentage of minorities than some other areas within the 80-kilometer (50-mile) area of WIPP and the population of the United States as a whole. It is possible, therefore, that adverse health impacts (estimate of 1 fatality) from routine or accident-free thermal

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[1] The Council on Environmental Quality has also developed draft “Guidance for Addressing Environmental Justice Under the National Environmental Policy Act.”

treatment of waste at WIPP under Action Alternative 2C would disproportionately affect the minority populations in the vicinity of WIPP. The prevailing winds at both SRS and LANL would direct treatment releases away from the concentrations of minority and low-income populations that exist around those sites.

At all treatment sites, treatment accidents would be unlikely so that accidents would not be expected to impact off-site populations; also, the impacts from treatment accidents would depend on meteorological conditions at the time of the accident. For these reasons, it is not likely that adverse environmental or human health impacts would disproportionately affect the minority or low-income populations at any of the treatment sites.

Potentially high and adverse impacts as defined above may occur as a result of waste transportation activities. Because all TRU waste would travel through New Mexico, residents of the State could be affected by transportation activities, although impacts would be spread throughout the transportation corridors. Routine truck transportation could cause between 3 (under the Proposed Action) and 15 (under Action Alternative 3) public fatalities over the life of the project from radiation exposure. These impacts are likely to be much lower because of conservative assumptions used in the analysis (e.g., assuming more stops than would actually occur). For the Proposed Action, less than 5 percent of the radiological impacts would be to those living along the highways. The ethnic and income distribution of travelers and workers at rest stops, where the impacts would primarily occur, would vary over time and by location. Thus, potential high and adverse impacts from routine transportation would not be likely to disproportionately affect minority or low-income populations.

Under the action alternatives, there could be from 5 (using truck transportation under the Proposed Action) to 264 fatalities (using dedicated rail under Action Alternative 3) from traumatic injuries sustained in accidents involving transportation vehicles. For truck transportation, accidents not involving a release of radioactivity are most likely to affect those traveling along the same route; for rail transportation, such accidents are most likely to affect those traveling near railroad crossings. Accidents would be random events that could occur on any segment of the transportation routes. Whether such travelers are minorities or low-income individuals cannot be predicted. Therefore, any high and adverse impacts from transportation accidents are not likely to disproportionately affect minority or low-income populations.

Severe transportation accidents that breach the transport package could result in up to 16 LCFs (from release of radioactive material) under any of the action alternatives. Accidents involving a release of radioactive material are most likely to affect residents and travelers along the transportation corridors, although the probability that an accident would involve a release of radioactive material is low (1.5×10^{-5} per accident). As noted above, accidents would be random events that could occur on any segment of the transportation routes. Whether the affected people would be minorities or low-income individuals cannot be predicted. Therefore, any high and adverse impacts from transportation accidents are not likely to disproportionately affect minority or low-income populations.

For disposal at WIPP, normal accident-free operations would not cause significant adverse human health or environmental impacts, and thus there would be no such impacts that could disproportionately affect minority or low-income populations. For disposal accidents, the most severe accident (the waste hoist failure) could cause up to 4 public fatalities for the Proposed Action and up to 24 fatalities for Action Alternative 3. However, the annual probability of this accident is 4.5 x 10^{-7}. Therefore, although possible, disproportionately high and adverse effects on minority or low-income populations would not be expected.

5.9 CUMULATIVE IMPACTS

This section focuses on the cumulative impacts that could result once the incremental impacts of the SEIS-II Proposed Action (its Preferred Alternative) and action alternatives are added to the impacts of other past, present, and reasonably foreseeable future actions. Throughout this section, the cumulative impacts discussion in the Final WM PEIS is incorporated by reference. This assessment of cumulative impacts also considers a number of other NEPA documents, including those listed in Table 5-94.

5.9.1 Cumulative Impacts in the Vicinity of WIPP

The WIPP site was withdrawn in the LWA for the purpose of TRU waste disposal and related activities, and DOE has no plans to dispose of other types of waste at WIPP nor to conduct any other type of activity there.

Future mining and drilling to extract mineral resources known to exist within the Land Withdrawal Boundary in the vicinity of WIPP would be prohibited by the LWA in the foreseeable future. Activity on two existing leases near the WIPP site would be allowed only if EPA found that such activity would not affect WIPP performance; otherwise, DOE would acquire those leases. The SEIS-II long-term performance assessment (presented both in this chapter and in Appendix H) takes into account the potential impacts of mining and drilling activities that might result after WIPP closure and the period of active institutional control.

DOE is also exploring the possibility of obtaining a Toxic Substances Control Act (TSCA) permit to dispose of the small amount (less than 700 cubic meters [25,000 cubic feet] as estimated in BIR-3) of PCB-commingled TRU waste without treatment. This waste was included in the CH-TRU waste Additional Inventory and was analyzed in SEIS-II.

DOE may propose to treat low-level alpha mixed waste at INEEL with a thermal process that would reduce the waste volume and concentrate TRU radionuclides. If DOE decides to use such a treatment process at INEEL, all or a portion of the resulting waste form could become CH-TRU waste after treatment. The thermally treated low-level alpha mixed waste would have characteristics similar to the other CH-TRU waste examined in the SEIS-II analyses, and disposal of this waste at WIPP would have impacts similar to the disposal of any other equivalent volume of CH-TRU waste. The volume of this waste is estimated to be about 27,000 cubic meters (930,000 cubic feet), which after treatment would occupy most of the projected unused CH-TRU waste disposal capacity of WIPP. While the CH-TRU waste capacity that was assumed to be emplaced for the SEIS-II Proposed Action (its Preferred Alternative) was adjusted up for the purpose of bounding the analyses to this disposal limit, the results of the analyses for the Proposed Action would have been essentially the same had the treated low-level mixed waste been included in the TRU waste inventory and assumed to take up the additional volume. Likewise, addition of this relatively small volume of treated TRU waste to the waste volumes examined under any of the SEIS-II action alternatives would not substantially affect the environmental impacts of disposal.

Table 5-94
Documents Describing Other Activities Included in the Cumulative Impact Analysis

Title	Applicable Sites
Final Environmental Impact Statement, Defense Waste Processing Facility	SRS
Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility	SRS
Savannah River Site Waste Management Final Environmental Impact Statement	SRS
Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley	West Valley Demonstration Project
Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington	Hanford
Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement	Hanford, INEEL, SRS
Storage and Disposition of Weapons-Usable Fissile Materials, Environmental Impact Statement	Hanford, INEEL, NTS, ORR, Pantex, SRS
Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement	LANL, SNL
Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement	LANL
Final Environmental Impact Statement for the Tank Waste Remediation System	Hanford
Plutonium Finishing Plant Stabilization Final Environmental Impact Statement	Hanford
Programmatic Environmental Impact Statement for Stockpile Stewardship and Management	LLNL, LANL, NTS, ORR, Pantex, SRS
The Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada	NTS
Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center	WVDP
Final F-Canyon Plutonium Solutions Environmental Impact Statement	SRS
Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee	ORR
Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling	INEEL, NTS, ORR, Pantex, SRS
Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada	NTS
Savannah River Site Waste Management Final Environmental Impact Statement	SRS
Final Environmental Impact Statement for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories	LLNL, SNL-CA
Disposition of Surplus Highly Enriched Uranium, Environmental Impact Statement	ORR, SRS
Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling	SRS
Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components	Pantex
Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan	Hanford
Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, Ohio Class and Los Angeles Class Naval Nuclear Plants	Hanford
Nonnuclear Consolidation Environmental Assessment	LANL, ORR, RFETS, SNL, SRS
Proposed 7-GeV Advanced Photon Source Environmental Assessment	ANL-E
Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories	SNL

DOE also is considering whether to classify some stabilized plutonium residues (with less than 20 percent plutonium by weight) as TRU waste. These residues are not usable for weapons and are stored primarily at Hanford, INEEL, LANL, LLNL, RFETS, and SRS. Residues with less than 20 percent plutonium by weight at RFETS were reported as TRU waste volumes in BIR-3, and the impacts of disposal of the RFETS residues were examined as part of the SEIS-II Proposed Action and the action alternatives. The Department will prepare additional site-specific NEPA analyses, as appropriate, concerning management and stabilization of the residues before decisions are made concerning disposal at WIPP.

Other DOE decisions may result in generation of TRU waste that could ultimately be destined for WIPP. The ROD for the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996e) has little impact on TRU waste generation potential. The ROD for the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996h) may potentially have a greater impact on TRU waste generation. The Department decided to pursue a dual strategy for disposing of excess weapons-usable plutonium that would immobilize some (and potentially all) of the inventory in a glass or ceramic material and allow the burning of some of the surplus plutonium as mixed oxide fuel in existing reactors, depending upon subsequent decisions. The Department is preparing a *Surplus Plutonium Disposition Environmental Impact Statement* (Notice Of Intent, May 22, 1997, 62 FR 28009). The disposition of surplus weapons-usable plutonium (a fissile material) could produce approximately 4,500 cubic meters (158,000 cubic feet) to 7,000 cubic meters (245,000 cubic feet) of additional TRU waste for disposal at WIPP.

5.9.2 Cumulative Transportation Impacts

The cumulative effects of transporting low-level, low-level mixed, high-level, hazardous, and TRU wastes are presented in the Final WM PEIS (DOE 1997). For the following discussion, the information in the Final WM PEIS, which examined 20 years of transportation for all waste types except high-level waste (for which 40 years of transportation was analyzed), has been incorporated and supplemented by information in SEIS-II (which examined 35 years of transportation).

The totals in the Final WM PEIS show that transporting all waste types between generator, treatment, storage, and disposal sites by truck would result in an aggregate total of between 12 fatalities (under one of the regionalized alternatives for TRU waste considered in the WM PEIS) and 69 fatalities (under the decentralized alternative for TRU waste considered in the WM PEIS). The total for the SEIS-II Proposed Action (over 35 years) would increase to about 15 fatalities for transportation of TRU waste by truck to WIPP. Approximately 6 of these 15 fatalities would result from radiation exposure, with the remainder due to injuries induced by physical trauma.

Cumulatively, transportation of all waste types by rail would result in 11 fatalities (for SEIS-II Action Alternative 1) to 15 fatalities (for SEIS-II Action Alternative 3). Rail transportation impacts were not examined for the SEIS-II Proposed Action. Transportation by rail would result in a reduction of both radiological and physical trauma impacts as compared to truck transportation.

If the potential impacts from other DOE and non-DOE transportation activities are included, approximately 175 radiation-related LCFs may occur in the general population and an additional 140 radiation-related LCFs may occur among workers from past, present, and reasonably foreseeable transportation activities (including transportation to WIPP) (DOE 1997).

5.9.3 Cumulative Impacts at Treatment Sites

The Final WM PEIS (DOE 1997) examined the impacts of storage and treatment of TRU waste at major storage or treatment sites and found the potential for TRU waste management activities to affect health or to exceed applicable air quality standards. It also found cumulative impacts as a result of combined activities at those sites. These cumulative impacts are presented in the Final WM PEIS.

The Final WM PEIS did not examine cumulative impacts at Mound. However, the bounding analysis in the *Environmental Assessment for Commercialization of the Mound Plant* (DOE 1994c) does not project the generation of any TRU waste or any impacts associated with TRU waste at Mound.

The cumulative impacts of the SEIS-II Proposed Action (Preferred Alternative) and Action Alternative 1 during the 10 years analyzed by the Final WM PEIS would be virtually identical to those of the Final WM PEIS preferred alternative. Those impacts are presented below. For SEIS-II Action Alternatives 2 and 3, treatment was assumed to begin after the 10-year period examined in the Final WM PEIS, because it would take an estimated 12 years to design, build, and obtain permits for the treatment facilities. Treatment, therefore, would not begin until after the 10-year period assessed in the Final WM PEIS.

For the cumulative impacts for time periods beyond the 10-year period, as examined below, the impacts from TRU waste (as noted in this chapter for a 35-year period) would be added to those impacts from other actions that are foreseeable or ongoing at that time. DOE has not attempted to predict the cumulative impacts beyond 10 years, because many of the actions that might contribute to those impacts are not reasonably foreseeable at this time. The following discussion focuses on human health impacts and presents the impacts of the Final WM PEIS preferred alternative. Other cumulative impacts due to construction and operation of storage and treatment facilities would also be similar or identical to those presented in the Final WM PEIS.

Hanford Site

No off-site public radiation cancer fatalities (0.14 LCF) and 11 worker radiation fatalities (11.1 LCFs) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at Hanford.

Idaho National Engineering and Environmental Laboratory

No off-site public radiation cancer fatalities (0 LCF) and 2 worker radiation fatalities (2.04 LCFs) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at INEEL.

Los Alamos National Laboratory

No off-site public radiation cancer fatalities (0 LCF) and 2 worker radiation fatalities (2.11 LCFs) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at LANL.

Nevada Test Site

No off-site public radiation cancer fatalities (0 LCF) and 3 worker radiation fatalities (2.87 LCFs) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at NTS.

Oak Ridge National Laboratory

No off-site public radiation cancer fatalities (0.23 LCF) and 2 worker radiation fatalities (1.6 LCF) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at ORNL.

Rocky Flats Environmental Technology Site

No off-site public radiation cancer fatalities (0 LCF) and no worker radiation fatalities (0 LCF) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at RFETS.

Savannah River Site

Approximately 1 off-site public radiation cancer fatality (1.48 LCF) and 8 worker radiation fatalities (8.0 LCF) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at SRS.

Lawrence Livermore National Laboratory

No off-site public radiation cancer fatalities (0.18 LCF) and no worker radiation fatalities (0.16 LCF) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at LLNL.

Argonne National Laboratory – East

No off-site public radiation cancer fatalities (0 LCF) and no worker fatalities (0 LCF) would result from ongoing operations, waste management activities, and other reasonably foreseeable future actions at ANL-E.

5.10 MITIGATION MEASURES

Analyses of potential environmental impacts in SEIS-II did not identify the need for any additional mitigation measures above those described in the FEIS (DOE 1980) and SEIS-I (DOE 1990). Most of the previously identified mitigation commitments have been fulfilled at WIPP for construction and predisposal phases or were intended to apply to underground tests at WIPP using TRU waste that never took place. DOE will reevaluate ongoing mitigation measures from the FEIS and SEIS-I and mitigation proposals for the disposal phase in light of SEIS-II analyses. Most of the following mitigation measures are included as part of each alternative and would be implemented by DOE to reduce potential impacts. DOE will specify the mitigation measures to be implemented for the action selected in the Record of Decision.

Air quality impacts may be mitigated by activities to reduce generation of criteria pollutants at WIPP, including the use of proper, low-contaminant fuels; paving heavily trafficked areas; and spraying water on dusty roads to minimize fugitive dust emissions. Similar measures may also be taken during decommissioning to minimize air quality impacts. The HEPA filtration systems are already in place and can be used to mitigate any potential releases of radionuclides from the WIPP waste handling facilities. The use of radiation monitors to activate HEPA filtration of underground exhaust air (a mitigation commitment made in SEIS-I) may be reevaluated.

Biological resource impacts would be mitigated by avoiding unnecessary damage to vegetation, wildlife, and soil by controlling traffic, minimizing the areas of disturbance, controlling runoff, and cleaning up spills. Any temporary facilities such as haul roads, stockpiles, and work areas may be restored by regarding, reseeding, and fencing as activities requiring these facilities are completed. Environmental monitoring is ongoing and could continue, as necessary, to provide early warning of affects on the biological environment so that specific mitigative measures could be developed and implemented. DOE plans to return decommissioned land used in the operation of WIPP to a stable ecological condition and maintain or enhance the ecological condition of wildlife habitat within the Land Withdrawal Area (DOE 1996a). Disturbed areas would be restored as soon as possible after decommissioning, using methods of soil replacement and revegetation conducive to soil stabilization and wildlife needs.

Cultural resource impacts could be mitigated by performing additional surveys of areas that could be disturbed by surface activities, including those during decommissioning. DOE would attempt to avoid potential cultural and historic sites to the extent possible; if avoidance is not possible, specific mitigation measures would likely be developed in consultation with the State Historic Preservation Office, the Advisory Council on Historic Preservation, and the BLM.

Some socioeconomic impact was mitigated when DOE eliminated the former “Control Zone IV” in the 1980's, releasing the area of this zone that was outside the current Land Withdrawal Boundary and making available an estimated 50 million tons of potash for mining and opening the area for oil and gas recovery. In the event that either of the no action alternatives were selected, DOE may mitigate impacts to the regional economy by staging worker layoffs over the course of the decommissioning period. DOE could also assist laid-off workers by offering such services as worker training and reeducation programs, and providing relocation services for finding jobs elsewhere in the DOE complex.

Transportation impacts would be mitigated in a variety of ways in addition to using approved routes and transportation packages. Transportation routes can be selected to meet federal and state regulations. Trucks (and rail cars) transporting TRU waste would be inspected and maintained on a regular basis. Drivers would be required to meet strict selection and training criteria. The TRANSCOM system would be used to monitor truck movement at all times when transporting waste to WIPP. Extensive emergency response capability exists and would be maintained at DOE, the trucking contractor, and in communities along the transportation routes to respond in the event of an accident. In addition, DOE will consider maintaining spill control equipment to protect the environment from fuel spills, should a transportation accident occur.

Human health impacts to the public and noninvolved worker may be mitigated by using HEPA filtration systems to reduce potential releases of radionuclides or heavy metals from the WIPP waste handling facilities. Worker safety programs are currently in place at WIPP and could continue, with particular emphasis on the physical hazards of underground operations. Mitigation measures for potential radiological impacts to involved workers include adhering to the ALARA philosophy, area and personnel monitoring, and using shielding and remote-handling equipment when handling high dose rate waste containers. Panel seals would be constructed to reduce operational exposures to VOCs emanating from emplaced waste.

The long-term performance of the repository could be enhanced by taking mitigation measures that include emplacing a chemical backfill with waste in the repository and using plugs and seals in the repository panels, access drifts, and shafts. The performance assessment calculations assumed the use of these mitigation measures. To protect the repository from inadvertent intrusion, hydrocarbon drilling and potash mining would continue to be limited by the BLM and DOE.

The need for specific mitigation measures at the treatment sites would be determined in NEPA reviews performed for the construction and operation of treatment facilities. For example, mitigation of human health impacts from atmospheric releases of radionuclides during treatment operations would be evaluated where treatment impacts warrant such mitigation.

5.11 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The LWA prohibits the extraction of mineral and hydrocarbon resources from the 41-square-kilometer (16-square-mile) Land Withdrawal Area during the period of WIPP disposal operations and for perpetuity. After decommissioning and permanent marking, the aboveground area of the WIPP site would be restored by contouring, grading, seeding, and other methods to return it to its natural condition.

5.12 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The irreversible and irretrievable commitments of resources associated with the operation of WIPP have not changed substantially from those presented in Section 9 of the FEIS and Section 11 of SEIS-I. Land use for the salt storage pile is currently planned as 12 hectares (30 acres) rather than 24 hectares (60 acres). Although this area would be remediated when the WIPP site is closed, residual salt would probably make growth of any but salt-tolerant species unlikely. Retrieval or recovery activities, discussed in Section 5.7, would probably result in additional use of resources. Retrieval usage would probably equal normal operating uses for the period these activities were under way, while recovery activities would probably be greater than normal operating usage.

Use of diesel fuel for transportation of waste would be more than estimated previously. The FEIS estimate was about 380 cubic meters (100,000 gallons) per year, or about 9,460 cubic meters (2.5 million gallons) for the original WIPP operating period of 25 years. While annual fuel consumption would not be greatly different from the FEIS estimates, total fuel consumption would be 2 to 5 times higher under the Proposed Action.

5.13 CHANGES DUE TO OTHER TRU WASTE VOLUME ESTIMATES

Since the completion of the analyses in the Draft SEIS-II, DOE has continued to update the estimates of stored and to-be-generated TRU waste volumes at the various generator sites. In particular, the *National Transuranic Waste Management Plan* includes updated estimates of the stored and projected volumes of TRU waste at the generator sites. SEIS-II analyses are based on the TRU waste volumes published in BIR-3, although the updated *National Transuranic Waste Management Plan* estimates and associated impacts are also presented in SEIS-II (see Appendix J).

Overall, the *National Transuranic Waste Management Plan* has 5,662 cubic meters (199,951 cubic feet) more CH-TRU waste than the SEIS-II Basic Inventory (before adjustment to the

168,500 cubic meters [5,950,000 cubic feet] allowed by the LWA). This is an increase of 4 percent. *The National Transuranic Waste Management Plan* reports more than 30,000 cubic meters (1,059,000 cubic feet) less of RH-TRU waste than the SEIS-II Basic Inventory. This is a decrease of 86 percent.

The SEIS-II Proposed Action (the Preferred Alternative) presents impacts adjusted to the treatment and disposal of 168,500 cubic meters (5,950,000 cubic feet) of CH-TRU waste (the maximum allowed under the Land Withdrawal Act) and 7,080 cubic meters (250,000 cubic feet) of RH-TRU waste (the maximum allowed under the C & C Agreement with the State of New Mexico). Using the *National Transuranic Waste Management Plan* in the same manner, no change would occur in the impacts for the Proposed Action except for the elimination of impacts related to storage of excess RH-TRU waste. No excess RH-TRU waste, therefore, would be left at ORNL and Hanford.

For the generator-storage sites with significant changes in waste volumes, individual site impacts could vary to a greater extent than indicated by the differences in the total volumes noted above. Under Action Alternatives 1, 2, and 3 and for the individual sites, the following changes would be expected:

- Negligible changes to the impacts would be anticipated in areas of land use and management, biological resources, cultural resources, noise, water resources and infrastructure, long-term performance, or consequences of lag storage accidents. No change would be expected in consequences from treatment accidents or WIPP disposal accidents.

- Changes in the estimated impacts for human health, life-cycle costs (except transportation costs), air quality, industrial safety, and economics would be directly related to changes in CH-TRU and RH-TRU waste volumes. Site impacts would change, as presented in the "percent difference" columns of Table J-1 for CH-TRU waste and Table J-2 for RH-TRU waste. Unlike most other impact areas, CH-TRU waste is a much higher contributor to impacts for involved workers than is RH-TRU waste; therefore, large decreases in RH-TRU waste volumes would have little impact for involved workers. However, at WIPP, large decreases in the amount of RH-TRU waste volumes would reduce the operations time needed for excavation and emplacement, reducing industrial safety and economics impacts.

- Changes in transportation impacts, including costs, are directly related to the number of shipments, which is dependent upon the type of waste treatment. Tables J-4 and J-5 present detailed CH-TRU and RH-TRU waste shipment information for all sites under all alternatives using The National Transuranic Waste Management Plan volumes. Table J-6 (and Table 5-95 presented here) summarize the differences in shipments and the percentages of the total inventories between The National Transuranic Waste Management Plan and the Basic Inventory.

Overall, impacts would be slightly lower using data from *The National Transuranic Waste Management Plan* because, although CH-TRU waste volumes are slightly higher, the RH-TRU waste volumes are markedly lower (except for the impacts to the involved workers, as noted above). The difference is quite marked for transportation impacts because of the reduction of nearly 61,000 shipments of RH-TRU waste under Action Alternative 3 (see Table 5-95).

Table 5-95
Comparison of Shipments Between Alternatives Using *The National Transuranic Waste Management Plan* and Basic Inventory

Alternatives	Number of Shipments to WIPP for the Total Inventory NTRUWM Plan	BIR-3	Difference	Percentage of BIR-3 Shipments (NTRUWM/BIR-3)
Proposed Action				
CH-TRU Waste	27,988	29,766 [a]	-1,778	94%
RH-TRU Waste	7,626	7,957	-331	96%
Action Alternative 1				
CH-TRU Waste	41,027	41,003	24	100%
RH-TRU Waste	11,509	62,162	-50,653	19%
Action Alternative 2A				
CH-TRU Waste	43,749	42,775	974	102%
RH-TRU Waste	4,028	21,895	-17,867	18%
Action Alternative 2B				
CH-TRU Waste	43,750	42,774	976	102%
RH-TRU Waste	4,028	21,895	-17,867	18%
Action Alternative 2C				
CH-TRU Waste	43,431	41,206	2,225	105%
RH-TRU Waste	11,507	62,160	-50,653	19%
Action Alternative 3				
CH-TRU Waste	65,922	67,309	-1,387	98%
RH-TRU Waste	13,808	74,606	-60,798	19%

[a] RH-TRU waste volumes are adjusted to the limits of the C&C Agreement. CH-TRU waste volumes are adjusted to reflect the capacity allowed under the LWA taking into account the RH-TRU waste limits of the C&C Agreement.

Changes in volume-dependent impacts (for example, human health impacts) would be expected at some sites. The changes in impacts would be greatest at INEEL, a major generator, treatment, and potential consolidation site under all alternatives, where volume-dependent impacts could increase by about 124 percent. Impacts at RFETS would increase by about 50 percent and at SRS by less than 10 percent. Impacts at Hanford would decrease dramatically: approximately 50 percent from CH-TRU waste and 90 percent from RH-TRU waste. ORNL impacts, mainly from RH-TRU waste, would be about 60 percent lower. Impacts at LANL, the other key generator site, would also decrease by about 15 to 20 percent.

Additional information on how these impacts would change, as well as information on other waste volumes, is presented in Appendix J.

5.14 REFERENCES CITED IN CHAPTER 5

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CHAPTER 6
CONSULTATIONS AND PERMITS

This chapter discusses the results of consultations with various agencies during the preparation of the *Waste Isolation Pilot Plant* (WIPP) *Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS-II). This chapter also lists active, pending and potentially required permits for WIPP.

The National Environmental Policy Act (NEPA) requires that federal, state, and local agencies with jurisdiction or special expertise regarding environmental impacts be consulted and involved in the NEPA process. Agencies involved include those with authority to issue permits, licenses, and other regulatory approvals. Other agencies also include those responsible for protecting significant resources, such as endangered species or wetlands. All such agencies have been sent copies of this SEIS-II document.

The following governmental agencies were consulted.

- New Mexico Forestry Division, New Mexico Energy, Minerals, and Natural Resources Department, 408 Galisteo, Villagra Building, P.O. Box 1948, Santa Fe, NM 87504
  (Karen Lightfoot, 505-827-7865)

- U.S. Fish and Wildlife Service, U.S. Department of Interior, New Mexico Ecological Services State Office, 2105 Osuna Road NE, Albuquerque, NM 87113
  (Jennifer Fowler-Propst, State Supervisor, 505-761-4525)

- New Mexico Game and Fish Department, P.O. Box 25112, Santa Fe, NM 87504
  (Jerry Maracchini, Director, 505-827-9912)

These agencies were contacted in September 1995 in regards to federal- and state-listed endangered, threatened, proposed, and candidate plant species. The agencies responded with species lists (Sivinski and Lightfoot 1995, NMDG&F 1995, and USFWS 1995). Table 4-1 lists the species of special concern for the area surrounding the WIPP site.

Also required by NEPA is a list of permits that are active, pending, or potentially required before disposal can begin at WIPP. Table 6-1, which presents this information, begins on the next page. Other realty components that are constructed, maintained, and utilized by WIPP are referenced in the *WIPP Land Management Plan* (DOE 1996).

Table 6-2 lists DOE orders applicable to this EIS.

Table 6-1
Active, Pending, and Potentially Required Permits and Approvals for the Waste Isolation Pilot Plant Disposal Operations

Granting Agency [a]	Type of Permit or Approval	Status
U.S. Department of the Interior, BLM	Right-of-Way for Water Pipeline	Active
U.S. Department of the Interior, BLM	Right-of-Way for the North Access Road	Active
U.S. Department of the Interior, BLM	Right-of-Way for Railroad	Active
U.S. Department of the Interior, BLM	Right-of-Way for Dosimetry and Aerosol Sampling Sites	Active
U.S. Department of the Interior, BLM	Right-of-Way for Seven Subsidence Monuments	Active
U.S. Department of the Interior, BLM	Right-of-Way for Aerosol Sampling Site	Active
U.S. Department of the Interior, BLM	Right-of-Way for Ten Raptor Nesting Platforms	Active
U.S. Department of the Interior, BLM	Right-of-Way for Survey Monument Installation	Active
U.S. Department of the Interior, BLM	Free Use Permit for Caliche	Active
N.M. Environment Department	Operating Permit for two Backup Generators	Active
N.M. Environment Department	RCRA Part B Permit Application	Pending
N.M. Department of Game and Fish	Individual Banding	Active
N.M. Department of Game and Fish	Master Collecting	Active
N.M. Department of Game and Fish	Concurrence that WIPP disposal activities will have no significant impact on State-listed threatened or endangered species	Active
U.S. Department of the Interior, Fish and Wildlife Service	Master Personal Banding	Active
U.S. Department of the Interior, Fish and Wildlife Service	Concurrence that there are no Federally listed, threatened, proposed, or endangered species at WIPP	Active
U.S. Environmental Protection Agency	Notification of the presence of two Underground Storage Tanks	Active
U.S. Environment Protection Agency	N.M. NPDES Storm Water General Permit	Active
U.S. Environmental Protection Agency	Certification of Compliance with 40 CFR 194	Pending
U.S. Nuclear Regulatory Commission	Certificate of Compliance for the TRUPACT-II	Active
U.S. Nuclear Regulatory Commission	Certificate of Compliance for the RH-72B cask	Pending
N.M. Commissioner of Public Lands	Right-of-Way for High Volume Air Sampler	Active
N.M. State Engineer Office	H-19b1 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b2 well, permit to appropriate the under waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b3 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b4 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b5 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b6 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	H-19b7 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-1 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-2 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-3 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-4 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-5 well, permit to appropriate the underground waters of N.M. for monitoring ad characterization	Active
N.M. State Engineer Office	WQSP-6, well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	WQSP-7 well, permit to appropriate the underground waters of N.M. for monitoring and characterization	Active
N.M. State Engineer Office	Appropriation: Exhaust Shaft Exploratory Borehole	Active
N.M. State Engineer Office	Exploratory: Exhaust Shaft Exploratory Borehole	Active
N.M. State Engineer Office	H-14 and H-15 Test Wells	Active

[a] U.S. = United States, BLM = Bureau of Land Management, N.M. = New Mexico

Table 6-2
Laws and Regulations Relevant to the WIPP Disposal Phase

Primary Implementing Agency	Law or Regulation	
U.S. Department of Energy Orders	Order 451.1,	National Environmental Policy Act Compliance Program
	Order 5000.3B,	Occurrence Reporting and Processing of Operations Information
	Order 5400.1,	General Environmental Protection Program
	Order 5400.2A,	Environmental Compliance Issue Coordination
	Order 5400.3,	Hazardous and Radioactive Mixed Waste Program
	Order 5400.5,	Radiation Protection of the Public and the Environment
	Order 5480.1B,	Environmental Protection, Safety and Health Protection Program for DOE Operations
	Order 5480.21,	Unreviewed Safety Questions
	Order 5480.22,	Technical Safety Requirement
	Order 5480.23,	Nuclear Safety Analysis Reports
	Order 5480.24,	Nuclear Criticality Safety
	Order 5480.3B,	Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes
	Order 5480.4,	Environmental Protection, Safety, and Health Protection Standards
	Order 5480.9,	Construction Safety and Health Program
	Order 5480.10,	Contract Industrial Hygiene Program
	Order 5480.11,	Radiation Protection for Occupational Workers
	Order 5481.B,	Safety Analysis and Review System
	Order 5482.1B,	Environmental, Safety and Health Appraisal Program
	Order 5483.1A,	Occupational Safety and Health Program for DOE Contractor Employees at government-Owned Contractor-Operated Facilities
	Order 5484.1,	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
	Order 5500.3A,	Planning, and Preparedness for Operational Emergencies
	Order 5700.6C,	Quality Assurance
	Order 5820.2A,	Radioactive Waste Management
	Order 6430.1A,	General Design Criteria

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