4. ENVIRONMENTAL CONSEQUENCES

4.1 IMPACTS OF THE PROPOSED ACTION

Potential impacts resulting from the proposed action are presented in five sections: (1) impacts to Paducah Site area resources, (2) potential impacts to human health from an onsite accident, (3) impacts resulting from off-site transportation, (4) impacts resulting from on-site treatment, and (5) impacts from DMSA characterization.

4.1.1 Resource Impacts

The following sections present potential impacts to Paducah Site and area resources resulting from proposed waste disposition activities.

4.1.1.1 Land use

Waste Storage. In the proposed action, waste would continue to be stored in the current locations. This would result in no changes in land use.

Waste Treatment. Waste treatment would be performed at Bldg. C-752-A. This building is now used for industrial purposes, and the proposed action would not change this classification. The proposed action and the implementation of treatment technologies different from those now being performed would result in a minor modification to the current use for this building. This building is currently being used for other waste treatment activities that have been covered under separate analysis.

Building C-746-A is the proposed location for physical volume reduction of waste. This building is currently being used for this purpose, so no change in use would occur.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed/permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. Supporting activities are currently being performed at the site and take place within the Paducah Site boundaries. The continuation of these activities would have no impact on land use.

4.1.1.2 Geology and seismicity

Waste Storage. Under the proposed action, waste would continue to be stored in the current locations. Continuation of normal operations would result in no impacts to the site geology. Storage accidents, such as a spill, would likely not have an impact on the site geology due to mitigative measure that are in place, such as dikes and spill controls. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impact is still estimated to be minor.

Impacts resulting from a seismological event are addressed in Sect. 4.1.2.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario for waste treatment would affect the site geology. Waste treatment would be performed at an existing building; therefore, no new excavation for construction is anticipated. Treatment accidents, such as a release during treatment, would likely not have an impact on the site geology due to mitigative measures that are in place, such as dikes and spill controls. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impacts are still estimated to be minor and the probability of an accident is small.

Impacts from seismic events are addressed under Sect. 4.1.2.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts resulting from disposal are anticipated at the Paducah Site.

Accidents related to transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries, which currently do not involve geological disturbance, would have no impact on the site geology. However, should an accident occur that contaminates the soil, a small portion of the geology may be disturbed during spill cleanup should the area need to be excavated. Under this scenario, the impacts are still estimated to be minor, since probability of an accident is small.

4.1.1.3 Soils and prime farmland

No prime farmlands are located within the Paducah Site boundary where waste disposition activities are proposed to occur. Therefore, impacts to prime farmlands are not anticipated from any waste disposition activity. The following discussion focuses on impacts to local soils only.

Waste Storage. Under the proposed action, waste would continue to be stored in the current locations. Continuation of normal operations would result in no impacts to the site soils. Storage accidents, such as a contaminant spill, would have minimal impact on soils due to mitigative measures that are in place, such as dikes and spill controls.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario described in Sect. 4.1.4 for on-site waste treatment would notably affect the site soils. Waste treatment would be performed at an existing building that is equipped with spill controls such as nonporous floors and dikes. Accidents, such as a release during treatment, would have minimal impact on the site soils due to the mitigative measures that were previously mentioned. Treatment facilities would have pertinent permits to control treatment processes.

Impacts to soils from activities related to wastes shipment off-site for treatment are addressed under Sect. 4.1.3.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Accidents related to transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries would have no impact on the site soils. Accidents, such as a contaminant spill, would have minimal impact on soils due to mitigative measures that are in place, such as dikes and spill controls.

4.1.1.4 Water and water quality

Waste Storage. Normal waste storage operations should not result in the release of constituents at concentrations that would exceed water quality standards or other benchmarks. Long-term impacts to water quality would be beneficial after implementation of the proposed action because much of the on-site wastes would be removed from the site or repackaged and stored. When the current waste inventories are reduced or repackaged, potential releases of contaminants into the surface water are reduced, beneficially impacting the water quality.

Accident impacts to water quality from the reasonable worst-case, on-site accident scenario (earthquake) involving radionuclides are described in detail in Appendix C. Water quality in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River could be adversely impacted in the short term because of the low pH of the waste and radiation exposure. However, the high flow volume of the Ohio River, averaged at 315,000 ft^3/sec (USGS 2001), would result in quick dilution of contaminants when the spill reached the river. No chemical or radionuclide contaminants would occur in the Ohio River at high enough concentrations to have adverse impacts to water quality according to the accident analysis. Thus, the earthquake scenario is likely to cause harm to water quality in creeks draining into the Ohio River, but Ohio River water quality should not be adversely impacted.

Waste Treatment. Although wastewater would be treated and released to existing outfalls, the treated water would meet the waste requirements for the on-site WWTP, so the water is not expected to exceed KPDES permit limits. No new contaminants are expected to be introduced to the WWTP, because the wastes described are consistent with waste historically produced at the site. Since the Paducah Site waste inventory would be maintained within the Paducah Site fence, potential impacts resulting from normal operations and treatment would be the same as for waste storage. See previous discussion for potential impacts to water resources in the area.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, permitted and/or licensed facilities. These facilities were constructed with controls to contain the contamination within the facility. No impacts are anticipated at the Paducah Site.

Supporting Activities. The performance of supporting activities would potentially release the same waste constituents to the same water resources as discussed above in the waste storage section. No impacts are anticipated.

4.1.1.5 Groundwater, floodplains, and wetlands

No wetlands or floodplains are located within the Paducah Site boundary where waste disposition activities would occur. Therefore, no impacts to wetlands or floodplains are anticipated from any waste disposition activity. The following discussion focuses on groundwater impacts only.

Waste Storage. Continuation of normal waste storage operations would result in no impacts to the site groundwater. Storage accidents, such as spills, would have minimal impact on the groundwater due to mitigative measures that are in place, such as dikes and spill controls, and due to an estimated small release during the accident.

Waste Treatment. Neither normal operations nor a reasonable worst-case accident scenario for waste treatment would affect groundwater resources. Waste treatment would be performed at an existing building that is equipped with spill controls such as nonporous floors and dikes that would lower the risk of groundwater contamination. Accidents, such as a release during treatment, would have minimal impact on the groundwater due to these mitigative measures and to the estimated small release volume during an accident.

Impacts to groundwater related to wastes being transported for treatment are addressed under Sect. 4.1.3.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. These facilities were constructed with controls to contain the contamination within the facility; therefore, no impacts are anticipated at the Paducah Site.

Groundwater impacts related to accidents during transport of the waste to the disposal facility are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations and continuation of supporting activities within the Paducah Site boundaries would have no impact on groundwater. Accidents that may occur during the performance of supporting activities would not have notable impact on groundwater due to mitigative measures and to the estimated small release during an accident.

4.1.1.6 Ecological resources

Normal operational activities associated with the proposed action would not adversely impact site vegetation or wildlife species at the Paducah Site. Accidents could result in some impacts to vegetation and wildlife resources in the area of occurrence. The indirect impacts from accidents to these resources could be derived from the movement of contamination through groundwater or surface water to these receptors. However, with the implementation of routine mitigative measures such as spill controls, the impacts are estimated to be minimal.

Aquatic Biota

Waste Storage. Under normal operations, waste storage impacts to aquatic biota from the proposed action should be negligible, because the on-site storage of wastes should not result in the release of constituents at concentrations that would be harmful to aquatic biota. Long-term impacts to aquatic biota would be beneficial after implementation of the proposed action, because much of the on-site waste would be removed from the site, reducing the amount stored on-site. When the current waste inventories are reduced, the potential exposure of aquatic biota is reduced, benefiting the biota.

The accident scenario description and impacts to aquatic biota from the reasonable worst-case accident (earthquake) scenario involving radionuclides are described in detail in Appendix C. As shown in Appendix C, Table C.1, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would suffer minor impacts resulting from the caustic nature of the waste. Radiation exposure could be of an acute nature.

Accident impacts to aquatic biota from the reasonable worst-case accident scenario (earthquake) involving nonradionuclides are described in Appendix C. As shown in Appendix C, Table C.2, PCBs are the only constituents whose ratio of concentration to toxicity benchmark (2.08) exceeds 1, indicating that PCBs could pose minor, short-term adverse impacts to aquatic biota, as well as in Bayou and Little Bayou creeks near the Kentucky bank of the Ohio River.

Waste Treatment. Short-term impacts to aquatic biota from the proposed action should be negligible, because the normal operation of on-site waste treatment should not result in the release of constituents at concentrations that would be harmful to aquatic biota. Although wastewater would be treated, the treated water would meet the waste requirements for the on-site WWTP. No notable adverse impacts resulting from the WWTP have been observed. Therefore, no negative impacts are expected to result form the additional treatment activities.

Long-term impacts to aquatic biota would be beneficial after implementation of the proposed action, because much of the on-site waste would be treated, resulting in a more stable waste form. When the current waste inventories are reduced, the potential exposure of aquatic biota is reduced.

Accident impacts to aquatic biota from the worst-case accident scenario (earthquake) are described in detail in Appendix C. The impacts are similar to the waste storage activity analysis because the waste constituents, receptors, and scenarios are the same. However, realistically, these impacts would be smaller, since the volume of waste defined for treatment is smaller than the waste storage volume. See discussion under the waste storage activity.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. The normal operations and accident impacts are identical to the waste storage activity analysis because the waste constituents, receptors, and scenarios are the same. See discussion under the waste storage activity. Accident impacts to aquatic biota from supporting activities under the worst-case accident scenario involving radionuclides are described in detail in Appendix C.

Terrestrial Biota

Waste Storage. Short-term waste storage impacts to terrestrial biota from normal operations of the proposed storage activity should be negligible because the repackaging and on-site maintenance of wastes should not result in the release of constituents at concentrations that would be harmful to the biota.

Impacts to terrestrial biota from the worst-case accident scenario (earthquake), along with soil concentrations, screening benchmarks, and results for individual radionuclides, are shown in Appendix C, Table C.1. The scenario for chronic radionuclide exposure indicates that in even this worst-case accident scenario, long-term radiation effects to soil biota would be negligible. As shown in Appendix C, Table C.2, two organics (PCBs and 1,2,4-trichlorobenzene) and two inorganics (cadmium and chromium) have modeled concentrations that would likely pose minor adverse impacts to soil biota if the worst-case spill accident occurred. However, these impacts would be reduced by the use of mitigative controls such as dikes, spill control measures, and cleanup.

Waste Treatment. Short-term waste treatment impacts to terrestrial biota from normal operations of the proposed action should be negligible because the repackaging and on-site treatment of wastes should not result in the release of constituents in concentrations that would be harmful to the biota.

Impacts resulting from radiological and nonradiological accidents would be identical to those discussed under waste storage because the same wastes would be released through the same scenarios to the same resources. See the waste storage section for discussion.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. Under normal operations of the proposed action, all of the wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, no impacts are anticipated at the Paducah Site.

Supporting Activities. Short-term impacts to terrestrial biota from activities executed to support waste management storage activity should be negligible because the maintenance of wastes should not result in the release of constituents at concentrations that would be harmful to the biota.

Impacts resulting from radiological and nonradiological accidents would be identical to those discussed under waste storage. This is true because the same wastes would be released through the same scenarios to the same resources. See the waste storage section for discussion.

4.1.1.7 Threatened and Endangered Species

No threatened or endangered species occur within the Paducah Site fence where the proposed action would take place. However, five species have been identified in the vicinity surrounding the site.

Indiana Bat. There is poor to fair summer habitat for the Indiana bat along portions of Bayou Creek to the west of the Paducah Site. The FWS (Barclay 1999) had several recommendations to protect the bats' habitat and food supply: (1) control erosion and maintain water quality in all streams, (2) minimize removal of mature riparian and upland forest; (3) create an equal amount of maternity or foraging habitat, should such habitat be lost; and (4) perform periodic inspections to ensure the protection of any habitat and the success of any mitigation.

No proposed operations or hypothesized accidents have been identified that would affect potential Indiana bat roosting or foraging habitat.

Mussel Species. Bayou Creek enters the Ohio River about 8 km (5 miles) downstream of the Paducah Site. Under normal operating conditions, any small quantities of PCBs released to a KPDES Outfall would not adversely affect the creeks or be expected to reach the Ohio River. However, if a highly unlikely or incredible accident were to occur, wastes might reach the Ohio River. During a flooding rainfall (which occurred less than once in 25 years), Bayou Creek, Little Bayou Creek, and the Ohio River would be flooded and sediments would move downstream. This would be a negligible addition to the concentration of contaminants already present in Ohio River sediments. This additional quantity of contaminants would be well within the measured variability of concentrations in river sediments. The addition of contaminants in the Ohio River would quickly (in minutes) pass mussel beds during flood conditions as sediments were moved rapidly downstream. An accidental release of contaminants would be extremely small and too brief to increase concentrations in the mussel species.

4.1.1.8 Noise

Waste Storage. Continuation of normal storage operations would result in no increase in the noise level of the area.

Waste Treatment. The proposed on-site waste treatment process does not include the use of large machinery, other than trucks for waste transport, or other noisy equipment. Therefore, the noise level is not anticipated to increase due to treatment activities.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site. Impacts to the noise environment from activities related to wastes being shipped for treatment are addressed under Sect. 4.1.3.

Waste Disposal. Under normal operations of the proposed action, all of the waste is proposed to be disposed off-site at existing, licensed/permitted facilities. Noise impacts related to transport of the wastes to the disposal facilities are addressed under Sect. 4.1.3.

Supporting Activities. The normal operations of supporting activities within the Paducah Site boundaries would have no impact on the noise level at the site. Operation of trucks and drum-handling machinery, such as forklifts, and physical volume reduction machines, such as chippers and crushers, would occur. However, these activities currently take place at the site; therefore, no increase in the current noise level is anticipated.

4.1.1.9 Cultural, archaeological, and Native American resources

No cultural, archaeological, or Native American resources are identified where waste storage, treatment, or supporting waste disposition activities are proposed to occur. Therefore, no impacts to these resources are anticipated from any waste disposition activity.

4.1.1.10 Air quality

Waste Storage. Emissions of criteria pollutants are the primary concern from area (nonpoint) sources such as waste packaging/sorting and storage areas. No notable emissions of criteria air pollutants are expected from the routine packaging, handling, and storage activities of existing or future generated waste at the Paducah Site. All waste streams that are repackaged or stored would be in a stable configuration, so that minimal air emissions would occur. Liquid and volatile materials would be packaged in a manner that would avoid spillage or release to the atmosphere. Proper containers for the waste would be selected to ensure that emissions to the atmosphere during storage would be minimized. In addition, inspections would be conducted on a regular basis to ensure that there are no container breaches that could cause emissions into the air.

Waste Treatment. Particulates and dust would be the primary criteria pollutants emitted during movement of waste to on-site and off-site treatment facilities. All treatment activities would be conducted at existing facilities, so there would be no impacts from construction or site disturbance. The wastes proposed for on-site treatment would be processed by technologies, such as solidification, that historically have not produced notable air emissions. High-efficiency particulate air (HEPA) filters that would be located in the building would screen out a high percentage of airborne contaminants resulting from treatment. These facility controls result in no anticipated ambient air impacts at the Paducah Site. For further discussion of potential on-site treatment accident emissions, see Sect. 4.1.4.

Wastewater treatment techniques would be used to remove contaminants from aqueous waste streams that are suitable for on-site discharge through the permitted wastewater treatment system. Minimal air emissions would be expected from the wastewater treatment system since these proposed processes are not a notable source of air pollutants.

Under the proposed action, a portion of the wastes is proposed for off-site treatment at existing, licensed, and/or permitted facilities. This would result in no anticipated impacts at the Paducah Site.

Waste Disposal. The pollutants that would be emitted by transportation vehicles during waste movement to disposal facilities include nitrogen oxides, carbon monoxide, volatile organic compounds, particulates, and fugitive road dust emissions. Impacts on air quality from the exhaust emissions of the vehicles used to transport wastes from the Paducah Site would be very small, because only a few vehicles and a small number of daily or weekly trips would be involved. Transportation would impact the ambient air quality for a small segment of the general public for only a short period of time as the waste was being transported to a treatment and/or disposal location. The roads that would be used for transportation would be paved, with the possible exception of access roads at a treatment, storage, and disposal facility; therefore, fugitive road dust emissions would be limited and temporary. Overall, air quality impacts associated with transportation activities would be small, localized, and temporary. See Sect. 4.1.3 for more detailed air quality analysis.

All wastes are proposed to be disposed off-site at existing, licensed/permitted facilities. Therefore, non-transportation related disposal impacts are not anticipated at the Paducah Site.

Supporting Activities. Air emissions associated with supporting activities would be a combination of potential impacts discussed in previous sections on waste storage and waste treatment. Refer to these sections for further information.

4.1.1.11 Socioeconomics and environmental justice

The processing and repackaging of affected wastes for shipment are expected to result in an increase of 30 full-time-equivalent jobs per year. Transportation employment would similarly create 15 or fewer full-time-equivalent jobs. An increase of 45 total jobs would represent less than a 1% change from 1997 employment in McCracken County, which does not constitute a notable impact. Because the actual employment impact is likely to be smaller and would be spread over additional counties, there would be no notable economic impact from the proposed action. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the treatments considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site. However, these groups would be subject to the same negligible impacts as the general population.

Socioeconomic impacts and environmental justice issues regarding waste transport are addressed in Sect. 4.1.3.

4.1.2 On-Site Accident Analysis and Human Health Impacts

An analysis has been performed to evaluate the potential consequences and risks of accidents affecting the PCB, LLW, MLLW, and TRU wastes currently stored at the Paducah Site. For evaluation purposes, all wastes are estimated to be treated and disposed over a 10-year period. In this option, wastes may be shipped off-site for treatment and/or disposal following on-site treatment, if required.

Accidents have been postulated and the consequences and risks evaluated. The types of accidents considered included natural phenomena, process accidents such as vehicle impacts and dropped waste packages, and industrial accidents. Consequences included radiological exposure, toxic chemical exposure, and industrial hazards leading to injuries and fatalities.

The methodology, waste characterization, and a summary of the analysis of accidents affecting the alternative are discussed in the following sections. Calculations that derive the accident analysis are presented in Appendix G.

4.1.2.1 Methodology

The estimated accident consequences were based on the inventories and material characteristics of the wastes stored on the Paducah Site. Methods used to evaluate the importance of the potential adverse effects from postulated accidents are listed in Appendix G.

4.1.2.2 Waste characterization

The wastes stored on the Paducah Site consist of PCB-containing capacitors and nearly empty transformers, LLW, MLLW, and TRU waste. The packaged wastes (excluding the capacitors and transformers) include approximately 600 m^3 (21,189 ft^3) of liquids, 350 m^3 (12,360 ft^3) of solid combustible wastes, and 10,700 m^3 (377,867 ft^3) of noncombustible solid wastes.

4.1.2.3 Accident evaluation for the proposed action

In the proposed action, the wastes are stored pending on-site treatment, on-site disposal, or shipment off-site for treatment or disposal. The types of activity associated with these actions include storage of waste containers, mechanical handling of steel waste containers, and opening of waste containers under controlled conditions to allow treatment (e.g., solidification of liquids, grouting). The general approach to the analysis described in Appendix G is to postulate accidents that have the potential to breach the steel waste containers and release the contents. Once the contents are released, the accidents are postulated to suspend a fraction of the wastes in the air or surface water. The suspended wastes are then transported to individuals and populations. The dose consequences to these individuals and populations are evaluated assuming no mitigation (i.e., no evacuation or sheltering).

Five accidents were identified as having the potential to breach the waste containers:

- Evaluation-basis earthquake (EBE)
- Large aircraft impact and fire
- General aviation impact and fire
- Ground vehicle impact/mishandling
- Ground vehicle impact and fire

Accident Selection. The following accidents are postulated for evaluation:

- The earthquake scenario affects all stored containers. The EBE is a major earthquake of 0.8 gs at bedrock, or lithified rock. The earthquake scenario used to evaluate the Paducah Site facilities has a ground surface acceleration, which DOE has estimated equates to approximately 0.5-0.6 gs. An event of this caliber is judged capable of toppling stacked drums and possibly ST-90 containers. A fraction of these toppled containers is postulated to partially fail.

- The large aircraft impact accident, if it occurred, would affect a large number of containers. In addition to mechanical damage, the released fuel could ignite the combustible wastes. The likelihood, however, of a direct impact of a large aircraft into the stored wastes is extremely small and is judged not credible based on comparisons of the aircraft impact frequencies affecting the large Paducah Site buildings. Based on the extremely low likelihood of this accident and on the fact that the consequences are judged comparable to the much more likely EBE, the large aircraft accident is not considered further.

- In contrast to the large aircraft impact accident, general aviation (small aircraft) impacts are more likely. Although the number of boxes affected would be small with respect to the earthquake, the consequences might be notable if a container were affected that had high-radionuclide-concentration, combustible wastes. As shown in Table 1.1, however, the radionuclide and toxic metal concentrations in combustible wastes are negligible with respect to other constituents. The mechanical damage to other waste forms would be comparable to the more likely vehicle impact and mishandling accidents. Based on the limited source terms and the low probability of the event, general aviation impact accidents are not considered further.

- As in the case of the small aircraft impact, a ground vehicle accident could breach one or more containers and possibly initiate a fuel fire. In general, the effects of a fire are not notable for most waste packages and vehicle impacts. However, the impact and fire accident could be postulated to breach the nearly empty PCB-containing transformers. In addition, mechanical impact accidents could release a limited quantity of high-activity wastes with a higher frequency than the EBE, and they are analyzed for this reason.

Two of these accidents, large aircraft impact and general aviation impact, were ruled out as unlikely occurrence (Appendix G). As a result, three bounding accidents have been selected for the evaluation of the proposed action: an EBE, a vehicle impact/container mishandling accident, and a vehicle impact accident and fire affecting a PCB-containing transformer. Accident selection is described in detail in Appendix G.

4.1.2.4 Waste characterization and storage configuration

The physical and radiological characteristics of the four waste streams are listed in Table 1.1. The transformers and capacitors provide containment for the PCB oils within them. The listed mass is of the entire set of transformers and capacitors, including the steel containers and the contained PCB oil. Individual capacitors each contain approximately 2 gal of PCB oil. The transformers are drained but can contain up to 10% of their total capacity of PCB oil.

The waste stream volumes of packaged wastes are directly estimated quantities. The waste stream masses are based on an estimated average density of similar wastes, 1 g/cc for liquids and soft solids and 2 g/cc for all other solids. For each isotope in the waste stream, the total isotopic activity is computed as the product of the total waste stream mass and the mean isotopic activity density. This isotopic activity is then converted to an equivalent activity of uranium and summed over all isotopes in each waste stream. Similarly, the mass of each listed toxic metal is computed based on the waste stream mass and an estimated concentration of 5,000 ppm for each metal. The mass of each metal is converted to an equivalent mass of chromium for each metal and summed over each metal in the waste stream.

The transformers are large steel shells containing the PCB oil. No additional packaging is estimated. Packaged wastes would be stored in steel containers ranging from 55-gal drums to sea-land containers. Since the larger containers, however, are difficult to topple and breach, all packaged wastes are estimated conservatively to be contained in 55-gal drums and stacked two high in a square array.

Four drums are estimated to be mounted on 1.2- × 1.2-m (4- × 4-ft) pallets in double rows and stacked two containers high. To permit access to each container, a 5-m (16-ft) aisle is estimated between each double row. Assuming an approximately square array, an array of 180 × 180 m (590 × 590 ft) is required to store the estimated 56,600 drums.

Some wastes are expected to be treated on-site or shipped off-site prior to the completion of the proposed action. For purposes of this analysis, however, all wastes are estimated to be at risk of accidental release and dispersion over the entire 10-year processing period.

4.1.2.5 Analysis of the EBE accident

A detailed analysis of the EBE accident is presented in Appendix G. Following is a summary of that analysis.

In the event of a major earthquake, the horizontal ground acceleration is estimated to be capable of creating differential movement between the top and bottom box layers, resulting in drums being toppled into the aisles. It is estimated that 10% of the entire upper layer of drums (2800 boxes) topple and fail. The 10% estimate is based on an evaluation of stacked 55-gal drums during seismic events (Hand 1998).

Results of Radiological Dose Computations. Results from the Appendix G computations for the effects of radiological dose resulting from an EBE are presented in Tables 4.1 and 4.2. Two source terms were considered during the computations: the airborne source term (AST) in which radioactivity is released to, and dispersed by, the air; and the liquid source term (LST) in which radiologically contaminated liquids are released to, and dispersed by, surface water.

Table 4.1. Airborne source term risks

Receptor	Distance from area	Risk (expected fatalities)
MIW/MUW	At edge	1.5×10^{-8}
MEI	1,580 m	9.5×10^{-10}
Population	General	7.5×10^{-9}

MEI = maximally exposed individual
MIW = maximally exposed involved worker
MUW = maximally exposed uninvolved worker

Table 4.2. Liquid source term risks

Receptor	Risk (expected fatalities)
MEI	4.5×10^{-11}

MEI = maximally exposed individual

The AST has the potential for widespread dissemination of radioactivity. Therefore, four receptors were evaluated:

- the maximally exposed individual (MEI),
- the maximally exposed involved worker (MIW),
- the maximally exposed uninvolved worker (MUW), and
- the general population.

The impact of the LST would be less pervasive. Therefore, the computations considered only the MEI.

In summary, the computed risks (expected fatalities) from radiological dose resulting from an EBE accident are negligible (Tables 4.1 and 4.2).

Results of Toxic Metals Exposure Computations. Effects of exposure to toxic metals were considered. As stated in Appendix G, no toxic metals are known to be in the liquid waste streams being considered in this EA. Therefore, only the AST was considered in Appendix G. The results of the computations demonstrate that the concentration of toxic metals in the AST resulting from an EBE would be negligible compared to the most conservative benchmark for human exposure.

4.1.2.6 Analysis of the vehicle impact accident

During the proposed action, vehicles such as forklifts occasionally would be used to reposition waste containers. Impacts with drums resulting in breach are estimated to occur at a rate of one per year. Thus, it is estimated that one or more drums would be breached. For the wastes stored at the Paducah Site however, 87% of all radioactivity occurs in the single drum of ThF_4, and an additional 4% occurs in the 24 drums of TRU waste. The risks of accidents involving these wastes bound the risks of other waste streams.

The computations for analyzing the vehicle mishap/mishandling accident in Appendix G evaluated the risks (expected fatalities) resulting from rupturing the ThF_4 drum or any of the 24 drums containing TRU waste. This analysis takes into account the estimated accident frequency and the probability that the damaged drum would be either the ThF_4 drum or 1 of the 24 TRU waste drums out of a total of 56,000 drums. Other assumptions for the computations are presented in Appendix G. The results of the computations, presented in Table 4.3, show that the risk of the vehicle mishap/mishandling accident is negligible but slightly greater than for the EBE. However, it was assumed for the EBE computations that the ThF_4 drum would not be placed in a vulnerable position and would not be ruptured during the EBE. If, instead, the ThF_4 drum had been assumed to be placed in a vulnerable position for the EBE analysis, the results would have been similar to those for the vehicle mishap/mishandling computations.

Table 4.3. Vehicle impact accident risks

Contaminant	Receptor	Risk (expected fatalities)
ThF_4	MUW	7.9×10^{-8}
	MEI	1.1×10^{-9}
	Population	2.3×10^{-9}
TRU	MUW	1.7×10^{-8}
	MEI	2.4×10^{-10}
	Population	5.2×10^{-10}

MEI = maximally exposed individual
MUW = maximally exposed uninvolved worker
TRU = transuranic

4.1.2.7 Analysis of the vehicle impact/mishandling and fire accident

In addition to releases of radionuclides during a vehicle impact/mishandling accident, it is also possible that a PCB-containing transformer could be ruptured with ensuing combustion of the PCB oil. PCB combustion results in the release of several toxic substances. Essentially all of the chlorine (Aroclor 1254 is 54% chlorine) is stripped and released as hydrochloric acid (HCl). Also during combustion, approximately 1% of the PCB forms a pyrolyzed mixture of PCB, dioxins, and furans, also know as PCB soot.

Concentrations of HCl and PCB soot arising from a PCB fire were calculated in Appendix G. When compared to benchmarks (Table 4.4) neither the calculated HCl nor PCB soot occur in concentrations that would create adverse health effects to the MUW or MEI. The calculated concentration of HCl is 20% of the Emergency Response Planning Guideline—Level 2. The calculated concentration of PCB soot is 37% of the "no observed adverse effect level."

Table 4.4. Calculated concentrations of HCl and PCB soot resulting from a PCB fire compared to standard benchmarks

Substance	Calculated Concentration	Benchmark Concentration[a]
HCl	6.1 mg/m^3	30 mg/m^3
PCB soot	0.11 mg/m^3	0.3 mg/m^3 for 1 hour

[a] Benchmark for HCl is the Emergency response Planning Guideline—Level 2. For PCB soot it is the "no observed adverse affect level."
HC1 = hydrochloric acid
PCB = polychlorinated biphenyl

4.1.2.8 Analysis of industrial accidents

During the proposed action, it is estimated that the wastes are stored and monitored, transported to waste treatment locations on-site, and prepared for transportation off-site. It is estimated that these activities require 60 full-time equivalents or 120,000 person-h/year over the 10-year duration. Based on the 3.4×10^{-3}/200,000 person-h industrial fatality rate, 2.0×10^{-3} fatalities/year or 2.0×10^{-2} fatalities/ 10 years are expected.

4.1.3 Transportation Impacts

The proposed action would include shipment of heterogeneous LLW, MLLW, and TRU waste by truck, rail, or intermodal transport. LLW may be shipped only by truck and not by rail due to regulatory limits on the inventory of radionuclides.

4.1.3.1 Air quality

The Clean Air Act of 1970, Sect. 176 (c), requires EPA to establish rules to ensure that federal agency actions conform with state implementation plans (SIPs). These plans are designated to eliminate or reduce the severity and number of violations of the National Ambient Air Quality Standards (NAAQS). As a result, EPA promulgated the "General Conformity" rule (58 FR 63214-63259) in November 1993. This rule applies in areas considered "nonattainment" or "maintenance" for any of six criteria air pollutants (ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, particulate matter, and lead). A nonattainment area is one in which the air quality in an area exceeds the allowable NAAQS for one or more pollutants, while a maintenance area is one that has been redesignated from nonattainment to attainment. The general conformity rule covers direct and indirect emissions of criteria pollutants caused by federal actions and that exceed the threshold emissions levels shown in 40 *CFR* 93.153(b). Each affected state is required by Sect. 176(c) of the 1990 Clean Air Act amendments to devise a SIP, which is designed to achieve the NAAQS.

DOE has integrated the requirements of the general conformity rule with those of its NEPA process wherein, for actions not exempted, the total emissions from the proposed action are evaluated to determine when they are above de minimus thresholds and whether they are regionally important.

Since many of the representative transport routes are duplicative of routes assessed in the EA for transport of LLW from the Oak Ridge Reservation to off-site treatment and disposal facilities (DOE 2000b), the same analysis presented previously is given here. This analysis is provided as follows:

Nonattainment areas associated with each route:

- Nevada Test Site option: Las Vegas, Nevada.
- Clive, Utah, option: St. Louis, Missouri; Kansas City, Missouri-Kansas; and Salt Lake City, Utah.
- WCS (Andrews, Texas) option: Dallas-Fort Worth, Texas, area.
- Hanford option: St. Louis, Missouri; Kansas City, Missouri-Kansas; Ogden, Utah; and Boise, Idaho.
- For transport to commercial treatment facilities near Oak Ridge, there are no nonattainment areas. The Knoxville-Oak Ridge area is in an attainment region where criteria air pollutants do not exceed standards.

Air quality impacts from highway transport

The LLW transport EA (DOE 2000b) analyzed the maximum number of truck shipments that would occur in any one year: 835. It was expected that shipments would be spread evenly over the year; thus, the maximum in any 1 week would be 16, or 2 to 3 per day. All major nonattainment areas are associated with large metropolitan areas. Planned shipments of two to three per day maximum would not discernibly increase the daily rate of truck traffic for these metropolitan areas, and they are minimal compared with the daily rate of truck traffic in the areas. The Paducah Site anticipates making only 762 shipments per year. However, the Oak Ridge EA analysis provides a conservative result using an assumption of 835 per year.

In the brief Oak Ridge EA (DOE 2000b), analysis was undertaken to determine the impact of the proposed shipments relative to the threshold emission levels in nonattainment areas described by EPA in its air conformity regulations [40 *CFR* 93.153(b)(1)]. The EPA general conformity rule (58 FR 63214, November 30, 1993) requires federal agencies to prepare a written conformity analysis and determination for proposed activities only in those cases where total emissions of an activity exceed the threshold emission levels. Where it can be demonstrated that emissions from a proposed new activity fall below the thresholds, these emissions are considered to be de minimus and require no formal analysis.

The Oak Ridge EA (DOE 2000b) proposed routes were evaluated for maximum road miles proposed to be traveled for each criteria pollutant. Carbon monoxide, ozone, and particulate matter smaller than 10 micrometers (PM_{10}) were the criteria pollutants used. The maximum road miles traveled through a nonattainment area would be approximately 150 miles (includes return trip) through the Dallas-Fort Worth, Texas, area (Atlanta and St. Louis areas are nearly as large). This distance conservatively includes a return truck trip even though the return trip is not part of the Oak Ridge proposed action (no LLW on the truck), and it is likely that commercial vehicles would not return to Oak Ridge by the same route if they were able to contract a load for the return trip.

The EPA threshold for carbon monoxide for all nonattainment and maintenance areas is 200,000 lb (100 tons)/year for any new proposed activity. The EPA threshold for ozone (measured by its precursor, NO_x for "ozone attainment areas outside an ozone transport region" such as Dallas-Fort Worth) is 200,000 lb (100 tons)/year. The EPA threshold for PM_{10} for all moderate nonattainment areas is 200,000 lb (100 tons)/year for any new proposed activity. Emission factors for carbon monoxide and ozone for various motor vehicle types have been modeled for the year 1990 (Goel 1991). Emission factors for PM_{10} have been calculated using EPA's February 1995 model for that criteria pollutant. Heavy duty diesel-powered vehicles (HDDVs) are defined as any diesel-powered motor vehicle designated primarily for the transportation of property and rated at more than 8500 lb of gross vehicle weight. For HDDVs, including the standard commercial semitractor vehicles that would be used for pulling waste shipments, the average emission for carbon monoxide is estimated as 11.03 g/mile, while the NO_x (an ozone precursor) emission rate is 22.91 g/mile. Finally, the emission factor for PM_{10} is 14.87 g/mile.

Using a maximum of 835 shipments (truck round trips)/year, the carbon monoxide emission rate was estimated for the maximum distance traveled through a nonattainment area (Dallas-Fort Worth). This emission rate was approximately 3047 lb of carbon monoxide/year. This amount of emissions is below the threshold standard of 100 tons/year and is clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Using a maximum of 835 shipments/year (truck round trips), an ozone emission rate was established for the maximum distance traveled within a nonattainment area (Dallas-Fort Worth area). This emission rate was approximately 6313 lb of NO_x/year (NO_x is a precursor to ozone). This amount of emissions is below the threshold standard of 100 tons/year and clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Finally, using 835 shipments/year, a PM_{10} rule was established for the maximum distance within a nonattainment area (Dallas-Fort Worth). The emission rate was 4102 lb of PM_{10}/year. This amount is below the threshold standard of 100 tons/year and is clearly a de minimus amount. Therefore, the deduction is made that the Paducah Site's proposed action of 762 shipments per year would also be de minimus.

Because the Dallas-Fort Worth area example maximizes road miles traveled through a nonattainment area and also conservatively estimates emission factors, it is assumed that this example "bounds" the impacts within other nonattainment areas for the proposed action. Therefore, air emissions within all nonattainment areas along shipment routes are well below the EPA threshold emission levels, and thus require no formal conformity analysis.

4.1.3.2 Human Risk associated with truck transportation

This section discusses potential impacts associated with transporting the LLW, MLLW, and TRU waste in the following DOT- and RCRA-compliant shipping configurations[a]:

- **LLW:** The containers used for the transportation of LLW solids and liquids and the maximum load per shipment are as follows:

  — ST-90 boxes, 4 boxes/shipment;
  — 55-gal drums, 78 drums/shipment;
  — 85-gal drums, 40 drums/shipment;

[a] 762 shipments/(52 weeks/year) = 15 shipments/week. This makes the conservative assumption that each shipment takes 1 week to make a round-trip, so each shipment in a week requires a separate driver, and all shipments are made within a year. Actual shipment round-trips are likely to be shorter, reducing the number of drivers required. The number of shipments was taken from the waste stream table.

— B-25 boxes, 4 boxes/shipment; and
— tanker trucks.

- **MLLW:** The containers used for transportation of MLLW solids and liquids and the maximum load per shipment are as follows:

— 55-gal drums, 78 drums/shipment;
— 85-gal drums, 40 drums/shipment;
— B-12 boxes, 4 boxes/shipment; and
— tanker trucks.

- **TRU Waste:** The container used for transportation of TRU waste is 55-gal drums in one truck shipment. These drums will be overpacked in TRUPAC II or HALFPAC containers to met applicable protocols.

Radiological Impacts from normal Truck Transportation. The potential effects of transporting waste by highway from Paducah to each of the potential final destination sites described in Sect. 3.10 were evaluated for all three waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis.

The potential radiological effects of routinely transporting waste by highway from Paducah to each of the potential final destination sites described in Sect. 3.10 were estimated for all three waste subgroups on an annual basis during the major shipment year groupings, and on a total 10-year shipping campaign basis. Details of the evaluation are presented in Appendix H. Truck shipments to Andrews, Texas, Richland Washington, Mercury, Nevada, Clive, Utah, Oak Ridge [East Tennessee Technology Park (ETTP)], Tennessee, Oak Ridge (ORNL), Tennessee, and Oak Ridge Materials & Energy/Waste Control Specialists (MEWC), Tennessee, were evaluated for the probability of an latent cancer fatality (LCF) to the truck crew, the general population, and the MEI. The results of the evaluation are summarized below in Table 4.5, which shows the worst-case results from the seven evaluated truck routes. It turns out that the worst-case results for the truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada.

Table 4.5. Worst-case radiological impacts for truck shipments (to Mercury, NV)

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)[a]	LCF	Dose (person-rem)	LCF
Crew	6.1	2.4×10^{-3}	61	2.4×10^{-2}
Population[b]	2.4	1.2×10^{-3}	24	1.2×10^{-2}
MEI[c] (rem)	3.4	1.7×10^{-3}	3.4×10^{-4}	1.7×10^{-7}

[a]Person-rem represents the collective dose received by a group of workers or members of the public.
[b]Includes population dose receptors off-link and on-link.
[c]MEI latent cancer fatality represents the probability of a latent cancer fatality occurrence.
LCF = latent cancer fatality
MEI = maximally exposed individual

The estimated risks to the public are proportional to the total number of people potentially exposed to radiation while shipments are in transit. This potentially exposed population is estimated from population density categories and the distance traveled, as described in Sect. 3.10.1. The estimated risks to the public are based on a total dose across all persons within the potentially exposed population. The differences in estimated risks to the public between destinations are due to differences in the total number of potentially exposed people and do not reflect risks to an individual due to higher dose estimates.

The estimated risks to workers differ between destinations due to the distance of the destination from Paducah and to the radiological characteristics of the waste forms being transported. The estimated risks from radiation exposure for the trucking crew would be directly proportional to the number of miles traveled, the type of waste, and the number of shipments that were used to estimate the risks for each destination.

The MEI dose estimates demonstrate the relatively small dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the highway and would be exposed to every shipment of waste. Differences between the estimated risks to the MEI between waste subgroups were due to the differences in number of shipments between subgroups and to the differences in risk from the subgroup wastes themselves.

Cargo-Related Radiological Impacts During a Highway Accident. The probability of a highway accident occurring during waste transportation by truck was evaluated for each of the seven receiving locations. In addition, the radiological dose resulting from these accidents was calculated and the risk of LCFs to the general public were also calculated. The details of this analysis are presented in Appendix H, and the results are summarized below in Table 4.6. As summarized in Table 4.6, the worst-case calculated number is far less than 1 LCF (1.5×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 latent cancer fatality (2.5×10^{-3}).

Table 4.6. Cargo-related impacts resulting from truck transportation accidents

	Population risk[a]	
Destination	**Dose (person-rem)**	**Latent cancer fatalities**
Andrews, TX	0.07	3.5×10^{-5}
Hanford, WA	1.55	7.8×10^{-4}
Clive, UT	0.09	4.5×10^{-5}
Mercury, NV	3.0	1.5×10^{-3}
Oak Ridge (ETTP), TN	.02	1.0×10^{-5}
Oak Ridge (ORNL), TN	0.18	9.0×10^{-5}
Oak Ridge (MEWC) TN	0.02	1.0×10^{-5}
Total	**4.9**	$\mathbf{2.5 \times 10^{-3}}$

[a]Each population risk value is the product of the consequence (population dose or latent cancer fatalities) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

Vehicle-Related Impacts. Potential vehicle-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated in Appendix H. The results of the evaluation are summarized in Table 4.7. Impacts from vehicle-related accidents and emissions are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, vehicle-related impacts for these locations are calculated to be minimal.

Table 4.7. Estimated fatalities from truck emissions and accidents (vehicle-related impacts)

Destination[a]	Incidents		Latent fatalities from emissions[b]
	Accidents	Fatalities	
Andrews, TX	6.0×10^{-2}	3.1×10^{-3}	1.3×10^{-2}
Hanford, WA	9.0×10^{-3}	3.8×10^{-4}	2.1×10^{-3}
Clive, UT	7.3×10^{-1}	2.7×10^{-2}	1.6×10^{-1}
Mercury, NV	1.1	4.1×10^{-2}	2.6×10^{-1}
Oak Ridge (ETTP), TN	1.2×10^{-2}	6.8×10^{-4}	4.2×10^{-3}
Oak Ridge (ORNL), TN	5.4×10^{-4}	3.2×10^{-5}	2.0×10^{-4}
Oak Ridge (MEWC), TN	2.5×10^{-3}	1.4×10^{-4}	8.8×10^{-4}
TOTAL	**1.89**	**0.08**	**0.43**

[a]Accidents and fatalities are based on round-trip distance traveled.
[b]Calculated for travel through urban areas only.
ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

4.1.3.3 Human Risk associated with rail transportation

Radiological Impacts from normal Rail Transportation. The potential radiological effects of routinely transporting LLW, MLLW, and TRU waste by rail from Paducah to each of the potential final destination sites described in Sect. 3.10 were estimated for all three waste subgroups on an annual basis during the major shipment year groupings and on a total 10-year shipping campaign basis. Details of the evaluation are presented in Appendix H. Rail shipments to Hobbs, New Mexico, Hanford, Washington, Clive, Utah, Mercury Nevada, Oak Ridge (ETTP), Tennessee, Oak Ridge (ORNL), Tennessee, and Oak Ridge (MEWC), Tennessee, were evaluated for the probability of an LCF to the train crew, the general population, and the MEI. The results of the evaluation are summarized below in Table 4.8, which shows the worst-case results from the seven evaluated train routes. It turns out that the worst-case results for truck crew, general population, and MEI all occur during the shipment to Mercury, Nevada.

Table 4.8. Worst-case radiological impacts for rail shipments (to Mercury, Nevada)

Risk group	Annual impacts		Total for 10-year life cycle	
	Dose (person-rem)[a]	LCF	Dose (person-rem)	LCF
Crew	2.7	1.1×10^{-3}	27	1.1×10^{-2}
Population[b]	8.1	4.1×10^{-3}	81	4.1×10^{-2}
MEI[c] (rem)	7.3×10^{-5}	3.7×10^{-8}	7.3×10^{-4}	3.7×10^{-7}

[a]Person-rem represents the collective dose received by a group of workers or members of the public.
[b]Includes population dose receptors off-link and on-link.
[c]MEI LCF represents the probability of an LCF occurrence.
LCF = latent cancer fatality
MEI = maximally exposed individual

As with truck transportation, the estimated risks to the public are proportional to the total number of people potentially exposed to radiation while shipments are in transit. This potentially exposed population is estimated from population density categories and the distance traveled, as described in Sect. 3.10.1. The estimated risks to the public are based on a total dose across all persons within the potentially exposed population. The differences in estimated risks to the public between destinations are due to differences in the total number of potentially exposed people and do not reflect risks to an individual due to higher dose estimates.

The estimated risks to workers differ between destinations due to the distance of the destination from Paducah and to the radiological characteristics of the waste forms being transported. The estimated risks from radiation exposure for the rail crew would be directly proportional to the number of miles traveled, the type of waste, and the number of shipments that were used to estimate the risks for each destination.

The MEI dose estimates demonstrate the relatively small dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the railway and would be exposed to every shipment of waste. Differences between the estimated risks to the MEI between waste subgroups were due to the differences in number of shipments between subgroups and to the differences in risk from the subgroup wastes themselves.

Maximally Exposed Individual. The MEI dose estimates presented in Appendix H demonstrate the relatively low dose a single individual is likely to receive. The MEI dose estimates are also considered extremely conservative, since this individual is a hypothetical member of the public who lives 30 m (98 ft) from the railway and would be exposed to every shipment of waste.

Differences between the estimated risks to the MEI between waste subgroups were due to the differences in the number of shipments between subgroups and to the differences in risk from the subgroup waste itself. For example, the 10-year analysis period for shipment of waste to Oak Ridge (ORNL), Tennessee, results in an MEI dose of 4.4×10^{-6} rem. The MEI dose to the Las Vegas, Nevada destination for the 10-year period is 7.3×10^{-4}, and the resultant probability of an LCF is minimal at 3.7×10^{-7}.

Cargo-Related Radiological Impacts During a Rail Accident. The probability of a railroad accident occurring during waste transportation was evaluated for each of the seven receiving locations. In addition, the radiological dose resulting from these accidents was calculated and the risk of LCFs to the general public were also calculated. The details of this analysis are presented in Appendix H, and the results are summarized below in Table 4.9. As summarized in Table 4.9, the worst-case calculated number is far less than 1 latent cancer fatality (1.6×10^{-3}) for shipment to Mercury, Nevada. For the entire waste transportation campaign, the calculated value is still less than 1 LCF (2.8×10^{-3}). Calculated population risk for rail transportation is equivalent to that for transportation by truck (Table 4.6).

Table 4.9. Cargo-related impacts from rail transportation accidents

	Population risk[a]	
Destination	**Dose (person-rem)**	**LCF**
Hobbs, NM	0.07	3.5×10^{-5}
Hanford, WA	1.74	8.7×10^{-4}
Clive, UT	0.07	3.5×10^{-5}
Las Vegas, NV	3.2	1.6×10^{-3}
Oak Ridge (ETTP), TN	0.09	4.5×10^{-5}
Oak Ridge (ORNL), TN	0.4	2.0×10^{-4}
Oak Ridge (MEWC), TN	4.4×10^{-2}	2.2×10^{-5}
Total	**5.51**	$\mathbf{2.8 \times 10^{-3}}$

[a]Each population risk value is the product of the consequence (population dose or LCF) multiplied by the probability for a range of possible accidents.

ETTP = East Tennessee Technology Park
LCF = latent cancer fatality
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

Rail-Related Impacts. Potential rail-related impacts, including expected accidents, expected fatalities from accidents, and impacts from vehicle emissions were evaluated in Appendix H. The results of the evaluation are summarized in Table 4.10. Impacts from rail-related accidents and emissions are highest for the Mercury (Nevada Test Site), Nevada, and Clive (Envirocare), Utah, destinations because of the larger number of shipments and the total miles traveled to and from these destinations. However, all calculated values are much less than 1, indicating negligible impacts from rail-related accidents.

Table 4.10. Estimated fatalities from rail-related accidents

	Incidence	
Destination[a]	**Accidents**	**Fatalities**
Hobbs, NM	4.2×10^{-3}	6.9×10^{-4}
Hanford, WA	9.8×10^{-4}	3.0×10^{-4}
Clive, UT	2.6×10^{-2}	8.6×10^{-3}
Las Vegas, NV	5.1×10^{-2}	1.5×10^{-2}
Oak Ridge (ETTP), TN	1.2×10^{-3}	2.8×10^{-4}
Oak Ridge (ORNL), TN	1.0×10^{-4}	2.3×10^{-5}
Oak Ridge (MEWC), TN	2.5×10^{-4}	5.7×10^{-5}
Total	**0.08**	**0.02**

[a]Accidents and fatalities are based on round-trip distance traveled.
ETTP = East Tennessee Technology Park
MEWC = Materials & Energy/Waste Control Specialists
ORNL = Oak Ridge National Laboratory

4.1.3.4 Socioeconomics and environmental justice

The processing and repackaging of affected wastes for shipment are expected to result in an increase of 30 full-time-equivalent jobs per year. Transportation employment would similarly create 15 or fewer full-time-equivalent jobs[a]. An increase of 45 total jobs would represent less than a 1% change from 1997 employment in McCracken County, which does not constitute a notable impact. Because the actual employment impact is likely to be smaller and would be spread over additional counties, there would be no notable economic impact from the proposed action.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the treatments considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site. For transportation alternatives, populations considered are those that live along the highways or rail lines where transport of packaged waste would occur (as described in Sect. 3.10) and people using the highways and/or stopping at rest stops. Individual access and use of public highways or rest stops that would be used by trucks shipping waste are not limited or restricted to any particular population group, economically disadvantaged or advantaged. Because it is expected that the percentage of minority or low-income households within the potentially exposed population would vary along the highway routes used for the proposed action, no disproportionate effects to those minority or low-income households located along the routes can be identified. These groups would be subject to the same negligible impacts as the general population.

[a] 762 shipments/(52 weeks/year) = 15 shipments/week. This makes the conservative assumption that each shipment takes 1 week to make a round-trip, so each shipment in a week requires a separate driver, and all shipments are made within a year. Actual shipment round-trips are likely to be shorter, reducing the number of drivers required. The number of shipments was taken from the waste stream table.

Most of the risk associated with incident-free transportation of waste by highway is the exposure of the public to radiation at rest stops, followed by exposure of truck crews. These exposures are put into perspective by comparison to a hypothetical MEI dose estimate (i.e., an individual who would be exposed to each shipment of waste). As discussed in Sect. 4.1.2, the MEI estimate is small compared to estimates of expected exposures from background radiation. The estimated risks of cancer resulting from vehicle emissions contributed by the waste transportation program are also anticipated to be low. Estimated risks resulting from transportation by rail are as low or lower than from highway transportation.

4.1.3.5 Natural Resource Impact

Accidents from truck and/or rail transport of wastes have the potential to impact national resources. Impacts could result from accidents that result in a waste container breach, leading to a waste spill. The introduction of contaminants into any natural resources (i.e., water, soils, wetlands, etc.) would result in short-term impacts to the receiving resource. The impacts are estimated to be short term due to cleanup efforts that would follow a spill. Impacts are also determined to be minor due to the utilization of mitigative measures exercised during waste transport. These measures, such as proper waste containerization and packaging, would decrease the amount of contamination spilled.

4.1.4 On-site Treatment Impacts

The following sections present potential impacts resulting from on-site treatment of a subset of the total waste volume on the Paducah Site.

4.1.4.1 Air Quality

Normal operation of the Waste Treatment Facility would not result in adverse impacts to the environment or to the health and safety of the public or workers. Normal airborne emissions of chemicals from the treatment processes would be treated to reduce concentrations to below permissible Clean Air Act environmental and worker exposure limits by HEPA filters before discharge from the facility enclosure, and subsequently, from Building C-752A. Workers inside the Treatment Facility would be protected from adverse effects of normal emissions of chemicals by the appropriate level of personal protective equipment (PPE). Solid (non-radioactive) wastes resulting from the Treatment Facility normal operation would be treated and/or packaged for subsequent offsite disposal, in accordance with Site Waste Management procedures, to preclude adverse impacts to the environment or public/worker health and safety.

The likelihood of accidents that may affect air quality are low due to the implementation of mitigative measures such as filters, process controls, and the proper training of treatment facility personnel. However, the airborne environmental consequence of an instantaneous release of nitric acid is evaluated in Appendix I. The evaluation shows a release of 500 gal of nitric acid would be in the form of a dispersion distance of 6.1 km (3.8 miles) to the Toxic Endpoint ["immediately dangerous to life or health" (IDLH) limit]. If the effect of the treatment facility enclosure is included in this scenario, the dispersion distance is reduced to 0.8 km (0.5 mile), which is within the nearest DOE property line. The unmitigated airborne environmental consequence of a small leak from the nitric acid storage container is a dispersion distance of 0.3 km (0.2 mile) to the Toxic Endpoint limit. The respirable impact of the alternative-case scenario on workers in the treatment facility wearing the minimum required level of personal protective equipment is an exposure to toxic chemicals at levels slightly above the IDLH limits. A release of airborne contamination from the rupture of a calcium hydroxide bag would produce lower consequences to potentially exposed workers.

4.1.4.2 Radiological consequences for on-site treatment of waste

Detailed analysis of radiological impacts to the public and to workers resulting from on-site treatment of LLW and TRU waste is contained in Appendix J. Table 4.11 summarizes the results by listing the projected health impacts to the public from routine operations of the on-site treatment facility.

The table indicates that impacts are not notable for the entire treatment process or for individual waste stream groups. The values in this table are conservative, since the dose calculations were based on atmospheric suspension of the entire radioactive quantities of each waste stream inside the treatment facility. This waste quantity was then estimated to be released to the environment via the facility high-efficiency particulate air filtration system that typically removes 99.999% of the radioactive contaminants. Actual dose from normal operations should be considerably less, since only a small fraction of the radioactive materials would become airborne during normal operations.

Table 4.11. Impacts on public health from normal operations of on-site treatment facility[a]

Waste group	Total dose: MEI[b] (mrem)	Total dose: Population (person-rem)	Population LCF[c]
Lab waste (439)	3.10×10^{-7}	2.92×10^{-4}	1.46×10^{-8}
Tc-99-contaminated waste (2802)	1.17×10^{-3}	3.28	1.64×10^{-4}
TRU waste—solids (444)	1.50×10^{-3}	1.42	7.11×10^{-5}
TRU waste—liquids (444)	2.48×10^{-3}	2.47	1.24×10^{-4}
Total	5.15×10^{-3}	7.17	3.59×10^{-4}

[a]Impacts are based on radioactive quantities for the waste streams listed here and identified in Table 1.1.
[b]MEI = Maximally exposed individual calculated to be approximately 1500 meters north of facility.
[c]LCF = Estimated number of latent cancer fatalities within the public from on-site treatment of projected waste quantities.
TRU = transuranic.

The results for the analysis of the impact to workers from an on-site treatment facility are summarized in Table 4.12. The table shows that the number of fatalities is calculated to be much less than one over the 3 to 4 months estimated to complete the on-site treatment.

Table 4.12. Impacts on workers from normal operations of on-site treatment facility

Workers	Impacts from operations
Average radiological dose to worker (rem)[a]	0.023
Total projected radiological dose to all rad workers (person-rem)[b]	0.34
Estimated number of latent cancer fatalities from total worker dose	1.4×10^{-4}

[a]Estimate of average dose to workers is based on the DOE average annual measurable total effective dose equivalent (TEDE = sum of internal and external dose) for waste processing/management facilities during 1997–1999 (DOE 2000c).
[b]Total projected worker dose calculated for an estimated 15 maximum radiological workers within the facility.
DOE = U.S. Department of Energy

The total radiation dose to the MEI of the general public for all Paducah Site operations has been estimated at 1 mrem/year (DOE 1999a), which is 1% of the radiation dose limit (100 mrem/year) set for the general public for operation of a DOE facility (DOE Order 5400.5). The external radiation dose for Paducah Site workers has ranged from 0 to 11 mrem/year in recent years (DOE 1999a). These doses are well below both the DOE administrative procedures dose limit (2000 mrem/year) and the regulatory limit of 5000 mrem/year (DOE 1999a; 10 *CFR* 835). The EPA limit is 15 mrem/year for an individual member of the public from all sources. All of these exposures are a very small fraction of the 360 mrem/year dose received by the general public and by workers from natural background and medical sources.

4.1.4.3 Socioeconomics and environmental justice

No census tracts near the site include a higher proportion of minorities than the national average. Some nearby tracts meet the definition of low-income populations, including two tracts in the north-northeast direction of the prevailing wind, but these are not the tracts closest to the Paducah Site. Impacts from noise, air emissions, radiological emissions, and accidents associated with waste treatment would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the workers affected in processing and repackaging are expected to be similar to historical exposures for Paducah Site operations overall.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects that their activities may have on minority and low-income populations. For the activities considered in this EA, populations considered are those that live within 80 km (50 mi) of the Paducah Site. However, these groups would be subject to the same negligible impacts as the general population.

4.1.5 DMSA Characterization

The following sections present potential impacts resulting from on-site characterization for DMSA wastes. Any potential impacts associated with postcharacterized DMSA waste transport or treatment are addressed in Sects. 4.1.3 and 4.1.4, respectively.

4.1.5.1 Impacts to the public from DMSA waste characterization normal operations

The DMSA waste comprises a large portion of the LLW and mixed waste quantities being considered in this EA. However, current quantities have not resulted in adverse impacts to the public and environment within the Paducah Site surrounding areas. The public access areas and the 50-mile radius surrounding the Paducah Site is monitored for radioactive emissions, and estimated doses to the public are reported in the Paducah Site Annual Environmental Report. DOE would continue to monitor impacts to the public and take appropriate actions to keep doses at minimal levels. Based on historical data, there have been no emissions or releases of DMSA wastes that have posed a hazard to the public or environment. However, as stated earlier, DOE has placed a high priority to characterize and dispose of DMSA waste on a previously agreed-upon schedule with state regulators.

4.1.5.2 Accident analysis for impacts from DMSA waste characterization activities

The DMSA solids and liquids at the Paducah Site contain radiological as well as chemical hazards. The relatively large quantities of DMSA waste contain alpha, beta, and gamma-emitting radionuclides. This results in a potential to contribute important doses to workers if the waste is handled improperly. However, since the waste is stored in administratively controlled areas in approximately 160 locations, it is assumed that the entire contents would not be subject to likely accident scenarios. The DMSA waste would be found in well-defined limited quantities when undergoing characterization activities. The inspector would be fully trained and qualified to characterize DMSA waste, thereby minimizing the impacts from accident consequences.

Accident scenarios analyzed in previous sections include DMSA waste quantities. Refer to Sect. 4.1.3 for further discussion.

A portion of the DMSA waste may be located in non-RCRA/TSCA storage locations pending confirmation of type of waste. These wastes could result in health and safety impacts if they are not handled properly. Accidental releases to the environment via the atmospheric pathway or releases into effluent streams from DMSA solids and liquids could also result in minor impacts to the public and the environment. In order to minimize these accident-related impacts to workers, the public, and the environment, DOE has placed DMSA waste on a high priority for characterization, treatment, and disposal activities.

4.2 IMPACTS OF THE NO ACTION ALTERNATIVE

Under the No Action alternative, not only would current wastes not be removed from the site, but newly generated waste would be continually added to the current inventory. The probability of impacts would increase over time as volumes of waste increase and new storage facilities are constructed. The No Action alternative would also have ramifications related to regulatory noncompliance.

The No Action alternative is evaluated in detail in Appendix K. Following is a summary of the conclusions of Appendix K.

4.2.1 Resource Impacts

Under the No Action alternative, on-site storage of existing and newly generated waste would continue. No treatment or disposal activities would occur after expiration of existing CXs. The following sections discuss impacts resulting from the No Action alternative.

4.2.1.1 Land use

The No Action alternative would not affect land use classifications. However, new storage buildings would be required to store waste generated from ongoing operations through 2010 and beyond. NEPA analysis for new buildings would be performed as needed.

4.2.1.2 Geology

The No Action alternative would not affect site geology.

4.2.1.3 Soils and prime farmland

Prime farmland would not be affected.

4.2.1.4 Water and water quality

Evaluation of water and water quality in Appendix K shows that short-term and long-term impacts to surface water from the No Action alternative should be similar to those currently occurring from activities at the Paducah Site. This interpretation is based on the fact that the quality of water being discharged from the plant is not degrading.

Accident impacts to water quality from the worst-case on-site accident scenario (i.e., earthquake) involving radionuclides are the same as for the proposed action and are described in detail in Appendix C. Just as for the proposed action, calculations for the earthquake scenario show that there is likely to be harm done to water quality in creeks draining into the Ohio River as a result of exposure to radionuclides, but the Ohio River water quality should not be adversely impacted.

4.2.1.5 Ecological resources

The No Action alternative would not adversely affect any threatened or endangered species.

Aquatic Biota. Short- and long-term impacts to aquatic biota from the No Action alternative would be similar to those currently occurring from the Paducah Site activities. While there is some current evidence for toxicity to aquatic biota at one outfall (Appendix K), a plan for a toxicity reduction evaluation (TRE) has been submitted to state regulators for approval. The successful completion of the TRE should eliminate further toxicity.

Bioaccumulation studies for PCBs and mercury in fish show that concentrations are decreasing, which means that controls and remediation of sources have been effective. However, there is evidence of degradation in fish communities downstream of discharges from the Paducah Site, probably owing to high temperatures in the effluent or increases in sedimentation (Appendix K).

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C for the proposed action, and the impacts should be no different for the No Action alternative. Because of this, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be affected by the caustic nature of the waste. Radiation exposure would be of an acute nature.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are also described in Appendix C for the proposed action. Again, the impacts should be no different for the No Action Alternative. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota, according to the assumptions of the accident analysis.

Terrestrial Biota. Short- and long-term impacts to terrestrial biota from the No Action alternative should be similar to those currently occurring from the Paducah Site activities. Currently, there is some indication of impacts to terrestrial biota (Appendix K), deer and raccoon in particular, although the impacts appear to be minor and the ultimate causes and effects uncertain.

Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are the same as for the proposed action and are described in Appendix C. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible under the No Action alternative.

Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides under the proposed action are described in Appendix C. The impacts to terrestrial biota under the No Action alternative should be the same. As a result, nonradionuclides would likely pose adverse impacts to soil biota if the worst-case spill accident occurred under the No Action alternative.

4.2.1.6 Noise

Noise levels would be similar to those currently at the site.

4.2.1.7 Cultural and archaeological resources

The No Action alternative is not expected to adversely impact any known cultural or archaeological resources.

4.2.1.8 Air quality

The No Action alternative would result in the continuation of current DOE waste management activities. Under the No Action alternative, potential impacts resulting from on-site treatment, transport, and disposal would not apply. Other potential impacts are presented in Sect. 4.1.1 and would be identical to the proposed action.

4.2.1.9 Socioeconomics and environmental justice

Socioeconomic Impacts. The No Action alternative would result in no net change in employment and therefore would have no notable socioeconomic impact on the ROI.

Environmental Justice. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. For the No Action alternative considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site.

Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would continue at historical levels for the Paducah Site (Appendix K).

4.2.2 Radiological and Nonradiological Impacts

The No Action alternative would result in continued storage of LLW and TRU waste but would not address the long-term need for a final disposal plan. Potential impacts to the workers, public, and environmental resources are presented in this section.

4.2.2.1 Potential exposure of workers to radiological emissions

As described in Appendix K, worker doses under the No Action alternative would result in less than 1 LCF per waste type based on a worker population of 30 full-time employees. The estimated radiological doses are highly conservative because the calculations assumed that workers would spend the entire workday in the waste storage areas, which is not likely. The estimate presents an upper bounding level that is unlikely to be approached due to the "as low as reasonably achievable" approach practiced at the Paducah Site. Steps taken to keep worker exposures as low as possible include limiting the time employees spend in each storage area, monitoring all worker exposure to avoid exceeding established control limits, prohibiting storage of liquids in outdoor storage areas, ensuring proper maintenance of emergency equipment, and undertaking waste minimization efforts. However, if waste quantities increase beyond current foreseeable projections, then the subsequent radiological impacts would increase incrementally on a cumulative population basis.

4.2.2.2 Potential exposure of the public to radiological emissions

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. Radiation is minimized by time, distance, and shielding. Therefore it is unlikely that routine waste management activities would result in measurable quantities of radiation at the Paducah Site boundaries. A perimeter-monitoring program and warning system are in place around the Paducah Site boundaries and elsewhere to evaluate impacts from routine operations as well as emergency conditions. There are off-site regulatory limits that are adhered to by the Paducah Site as well. Environmental monitoring activities are conducted routinely and reported in the Annual Environmental Monitoring Report (DOE 1999a). This report has not indicated any adverse impact from the Paducah Site operations that include waste management activities. Therefore, it is unlikely that the No Action alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

4.2.2.3 Nonradiological risks to workers from the No Action alternative

Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year under the No Action alternative.

In addition, as waste inventories grow over time, additional storage facilities or expansion of current capacity would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction.

4.2.3 Accident Analysis

During the No Action alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time.

The transformers are estimated to remain in place within the process buildings and not be subject to the risks of vehicle impacts and fires. In the event of an accident, the combustion products of fires would be contained to the buildings, thus minimizing on-site and off-site consequences. Similar to the proposed action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the proposed action in Appendix G.

The EBE and vehicle impact/mishandling accidents were evaluated for the No Action alternative. Because the waste characteristics and the accident scenarios are the same as those evaluated for the proposed alternative, the accident consequences are identical to those computed and discussed in Sect. 4.1.1. However, while the frequency of the earthquake accident is the same for both alternatives, the frequency of vehicle impact/mishandling accidents is much lower due to the lower activity level. Based on the revised accident frequencies under the No Action alternative, expected fatalities are less than under the proposed action. However, because the institutional control period is assumed to be 100 years under the No Action alternative and is only 10 years under the proposed action, fatalities from the EBE increase by a factor of 10 under the No Action alternative. However, in both cases, the calculated number of expected fatalities remains negligible under the No Action alternative.

4.2.4 Comparison of Accident Risks

As discussed in Sects. 4.1 and 4.2, risks have been computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk was computed for the 100-year no-action institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4 container during the 10-year proposed action operating period. The risks are the same for both alternatives, but the proposed action has a shorter duration. These risks are minor.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period. Neither the risks nor the differences between them are considered notable.

4.2.5 Transportation Impacts

Under this alternative, no Paducah Site waste would be transported off-site after expiration of current CXS. Therefore, there are no transportation impacts associated with this alternative.

4.2.6 On-Site Treatment Impacts

Under this alternative no on-site treatment would occur. All wastes would be maintained in storage facilities. Therefore, no treatment impacts are associated with this alternative.

4.3 IMPACTS OF THE ENHANCED STORAGE ALTERNATIVE

Under the Enhanced Storage alternative, current wastes will remain at the site and would be stored in new or upgraded buildings designed to withstand the EBE. Newly generated waste would be continually added to the current inventory. The probability of impacts would increase slightly beyond those expected for the No Action alterative as volumes of waste increase and new/upgraded storage facilities are constructed. The Enhanced Storage alternative would also have ramifications related to regulatory noncompliance.

The Enhanced Storage alternative is a variation of the No Action alternative that is evaluated in detail in Appendix K. Following is qualitative evaluation of the Enhanced Storage alternative based on the conclusions in Appendix K.

4.3.1 Resource Impacts

Under the Enhanced Storage alternative, on-site storage of existing and newly generated waste would continue. No treatment or disposal activities would occur after expiration of existing CXs under which limited treatment and disposal are currently being performed. The following sections discuss impacts resulting from the Enhanced Storage alternative.

4.3.1.1 Land use

The Enhanced Storage alternative would not affect land use classifications. However, new/upgraded storage buildings would be required to store waste generated from ongoing operations through 2010 and beyond. NEPA analysis for new/upgraded buildings would be performed as needed.

4.3.1.2 Geology

The Enhanced Storage alternative would not affect site geology.

4.3.1.3 Soils and prime farmland

Prime farmland would not be affected.

4.3.1.4 Water and water quality

Evaluation of water and water quality in Appendix K shows that short-term and long-term impacts to surface water from the No Action alternative should be similar to those currently occurring from activities at the Paducah Site. The Enhanced Storage alternative would not result in any additional short-term or long-term surface water impacts. This interpretation is based on the fact that the quality of water being discharged from the plant is not degrading.

Accident impacts to water quality from the worst-case on-site accident scenario (i.e., earthquake) involving radionuclides are likely to be less than those evaluated for the proposed action because the buildings would be designed and constructed to provide additional confinement for any materials that might be released in the EBE.

4.3.1.5 Ecological resources

The Enhanced Storage alternative would not adversely affect any threatened or endangered species.

Aquatic Biota. Short- and long-term impacts to aquatic biota from the Enhanced Storage alternative would be no greater than those currently occurring from the Paducah Site activities. While there is some current evidence for toxicity to aquatic biota at one outfall (Appendix K), a plan for a toxicity reduction evaluation (TRE) has been submitted to state regulators for approval. The successful completion of the TRE should eliminate further toxicity.

Bioaccumulation studies for PCBs and mercury in fish show that concentrations are decreasing, which means that controls and remediation of sources have been effective. However, there is evidence of degradation in fish communities downstream of discharges from the Paducah Site, probably owing to high temperatures in the effluent or increases in sedimentation (Appendix K). These conclusions would not be affected by the Enhanced Storage alternative.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving radionuclides are described in detail in Appendix C for the proposed action, and the impacts should be no greater for the Enhanced Storage alternative. Because of this, the earthquake scenario is highly unlikely to cause harm to aquatic biota in the Ohio River as a result of exposure to radionuclides. However, just as with the proposed action, aquatic receptors in Bayou and Little Bayou creeks and other water conveyances by which the waste would reach the Ohio River would likely be less affected under the Enhanced Storage alternative because less radioactive materials would escape from the storage facilities.

Accident impacts to aquatic biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides are also described in Appendix C for the proposed action. Again, the impacts should be no greater for the Enhanced Storage alternative. PCBs could pose adverse impacts to aquatic biota in the Ohio River, as well as in Bayou and Little Bayou creeks. None of the other nonradionuclide contaminants would reach high enough concentrations in the Ohio River to pose adverse impacts to aquatic biota, according to the assumptions of the accident analysis.

Terrestrial Biota. Short- and long-term impacts to terrestrial biota from the Enhanced Storage alternative should be no greater than those currently occurring from the Paducah Site activities. Currently, there is some indication of impacts to terrestrial biota (Appendix K), deer and raccoon in particular, although the impacts appear to be minor and the ultimate causes and effects uncertain.

Impacts to terrestrial biota from the modeled worst-case spill accident scenario (i.e., earthquake) are no greater than for the proposed action. Just as for the proposed action, long-term radiation effects to soil biota as the result of an earthquake would be negligible under the Enhanced Storage alternative.

Accident impacts to terrestrial biota from the worst-case accident scenario (i.e., earthquake) involving nonradionuclides under the proposed action are described in Appendix C. The impacts to terrestrial biota under the Enhanced Storage alternative should be less. Nonradionuclides would likely pose less impact to soil biota if the worst-case spill accident occurred under the Enhanced Storage alternative.

4.3.1.6 Noise

Noise levels would be similar to those currently at the site.

4.3.1.7 Cultural and archaeological resources

The Enhanced Storage alternative is not expected to adversely impact any known cultural or archaeological resources.

4.3.1.8 Air quality

The Enhanced Storage alternative would result in the continuation of current DOE waste management activities. Under the Enhanced Storage alternative, potential impacts resulting from on-site treatment, transport, and disposal would not apply. Other potential impacts are presented in Sect. 4.1.1 and would be no greater than those identified for the proposed action.

4.3.1.9 Socioeconomics and environmental justice

Socioeconomic Impacts. The Enhanced Storage alternative may result in a slight increase in employment due to construction and/or upgrades required for storage facilities. In addition, long-term surveillance and maintenance of facilities designed to withstand increased EBE loads might result in additional staff.

Environmental Justice. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. For the Enhanced Storage alternative considered in this EA, populations considered are those that live within 80 km (50 miles) of the Paducah Site.

Impacts from noise, air emissions, radiological emissions, and accidents would be low for both the residents closest to the site and the low-income communities. Exposures for the general public and the relevant workers would be no greater than those at historical levels for the Paducah Site (Appendix K).

4.3.2 Radiological and Nonradiological Impacts from the Enhanced Storage Alternative

The Enhanced Storage alternative would result in continued storage of LLW and TRU waste but would not address the long-term need for a final disposal plan. Potential impacts to the workers, public, and environmental resources are presented in this section.

4.3.2.1 Potential exposure of workers to radiological emissions

As described in Appendix K, worker doses under the No Action alternative would result in less than 1 LCF per waste type based on a worker population of 30 full-time employees. These doses would remain the same under the Enhanced Storage alternative because the work force required for storage facility workers would remain the same.

Additional workers might be required for building maintenance and surveillance activities for facilities that are designed to withstand increased EBE loads. However, these types of activities do not directly involve contact with stored materials and should not result in any additional exposures.

4.3.2.2 Potential exposure of the public to radiological emissions

The potential for public exposure to radiological emissions resulting from LLW and TRU waste management activities under the No Action alternative is limited at the Paducah Site. This potential would be further reduced under the Enhanced Storage alternative because the new/upgraded facilities would provide additional confinement to reduce the potential for radiological materials releases. Therefore, it is unlikely that the Enhanced Storage alternative would impact the public above current levels in terms of radiological impacts from continued storage of LLW and TRU waste.

4.3.2.3 Nonradiological risks to workers

Continued storage of LLW and TRU waste at the Paducah Site under the No Action alternative would increase safety risks to workers by requiring additional handling of the waste as maintenance and repackaging activities are needed. In addition, there would be routine monitoring activities in the storage locations that can present typical safety risks. These risks have been evaluated based on the average industrial accident rates for operations at similar industries. The estimated number of total recordable cases for the 30 workers associated with the No Action alternative would be 0.78 cases per year. The estimated lost workdays (LWDs) due to occupational illness or injury would be approximately 11 per year under the No Action alternative. These risks would remain the same under the Enhanced Storage alternative.

In addition, as waste inventories grow over time, additional storage facilities or upgrades of current facilities would be needed. This would require the use of heavy equipment and would introduce accident risks during facility construction.

4.3.3 Accident Analysis of the Enhanced Storage Alternative

During the No Action alternative, the packaged waste containers would be transported to an on-site location and stored. The containers would be inspected periodically to verify that the containers are intact and repaired if required. These containers would be subject to the same conditions as the stored containers in the proposed action. They would, however, be at risk for a longer period of time. These conclusions remain the same for the Enhanced Storage alternative.

The transformers would be moved to a new storage location under the Enhanced Storage alternative. Similar to the proposed action, accidents are postulated with the potential to breech the steel containers of the stored wastes and release the contents. The waste characteristics and the accident consequence methodology are the same as discussed for the proposed action in Appendix G and are the same for the Enhanced Storage alternative.

The EBE and vehicle impact/mishandling accidents were evaluated for the No Action alternative. The waste characteristics and the accident scenarios are the same for the Enhanced Storage alternative as those evaluated for the proposed alternative; however, the accident consequences would be expected to be less for the EBE because the enhanced storage facilities would provide additional confinement, thus reducing the amount of material released outside the building. The frequencies for both accidents remain the same as the No Action alternative.

4.3.4 Comparison of Accident Risks

As discussed in Sects. 4.1 and 4.2, risks have been computed for both process accidents and industrial accidents for the proposed action and the No Action alternatives. The highest radiological accident risk was 1.5×10^{-7} expected fatalities for the MIW/MUW at the edge of the waste storage area during and following an earthquake. This risk would be expected to be at least a factor of ten lower for the Enhanced Storage alternative because the buildings would provide additional confinement to reduce releases outside the facility. This risk would be computed for the 100-year no-action and enhanced storage institutional period. The second highest risk, 7.9×10^{-8} expected fatalities, was computed for the vehicle impact/mishandling accident impacting the ThF_4 container during the 10-year proposed action operating period. The risks are the same for all three alternatives, but the proposed action has a shorter duration. These risks are minor.

The industrial accident risks, while higher than the radiological accident risks, were small. The computed risk for the proposed action was 0.02 expected fatalities over the 10-year operating period. The corresponding industrial accident risk for the No Action alternative was 0.1 expected fatalities over the 100-year institutional control period and would be the same for the Enhanced Storage alternative. Neither the risks nor the differences between them are considered notable.

4.3.5 Transportation Impacts

Under this alternative, no Paducah Site waste would be transported off-site after expiration of current CXs. Therefore, there are no transportation impacts associated with this alternative.

4.3.6 On-Site Treatment Impacts

Under this alternative no on-site treatment would occur. All wastes would be maintained in storage facilities. Therefore, no treatment impacts are associated with this alternative.