Appendix B

Risk Assessment Information

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Summary of Post-Remediation Risk Status at the Weldon Spring Site

Baseline risk assessments addressing both human health and ecological risks were performed as part of the remedial investigation phase of the remedial investigation/feasibility study processes conducted. A limited assessment was performed for the Quarry Bulk Waste Operable Unit (OU) consistent with the focused scope of the remedial investigation/feasibility study conducted. These risk assessments are documented in the baseline risk assessment reports that have been prepared for the four operable units of the Weldon Spring Site (DOE 1990, 1992, 1997, 1998). The assessments provided information regarding actual and potential risks to human health and the environment posed by the site areas addressed in each of the operable units. The information was then used to determine whether a current or potential threat to human health or the environment exists that warranted consideration of a remedial action.

The risk assessment performed to support the removal action conducted at the Southeast Drainage is presented in the Engineering Evaluation/Cost Analysis report prepared for the drainage (DOE 1996). An assessment was also prepared for the contaminated culverts under County Highway D (Frog Pond culverts) (ANL 2000).

After remediation of the former Chemical Plant and vicinity properties, a post-cleanup risk assessment (DOE 2002) was performed to determine residual risk levels for the various soil areas remediated. A similar assessment was also performed after the removal action was completed for the Southeast Drainage (ANL 1999). Information from the post-remediation reports and from the baseline risk assessment reports (for areas that did not undergo remediation) was used to determine the need for and the nature of institutional controls to protect human health and the environment.

B1.0 Risk Assessment Methodology

B1.1 Human Health

Potential risks posed by exposure to site-related radiation and chemicals were assessed using methods developed by EPA and other agencies (EPA 1989b). Although exposure to ionizing radiation can result in cancer, serious genetic effects, and other detrimental health effects, the predominant health concern associated with radioactive contaminants at the Weldon Spring Site (which are primarily alpha-emitting radionuclides) is the induction of cancer. The radiological health risks evaluated were limited to this concern. This approach is consistent with EPA guidance, which notes that, in general, the risk of cancer is limiting and may be used as the sole basis for assessing the radiation-related human health risks for a site contaminated with radionuclides (EPA 1989b). For exposure to site chemicals, cancer and noncancer endpoints were evaluated consistently with EPA guidance (EPA 1989b).

Potential human health risks were estimated with reference to current and likely foreseeable future land use. Risk assessments conducted for the Weldon Spring Site have been performed by DOE in consultation with EPA and the state of Missouri and conform to procedures recommended by both agencies.

The EPA risk assessment process as implemented at the Weldon Spring Site consists of four primary steps. Recognition and careful consideration of the uncertainties associated with each of the four steps presented below is an important component of the risk assessment process.

Data Collection and Hazard Assessment—Site-related hazards or contaminants of concern are identified.

Exposure Assessment—An estimate is made as to the nature and magnitude of potential exposures associated with the site. Exposure scenarios, exposure pathways, potential receptors, exposure concentrations, and intakes are postulated or estimated. An exposure pathway is considered complete only if all the following elements are present: presence of a contaminated medium (e.g., drinking water, soil), presence of a person or ecological receptor at the location where the contaminated medium exists, and opportunity for the person or ecological receptor to come in contact with the contaminated medium.

Toxicity Assessment—Toxicity of the contaminants of concern are evaluated, and appropriate toxicity values for quantifying the potential health effects of the contaminants of concern are identified; these values have been developed by EPA for conducting risk assessments at CERCLA sites.

Risk Characterization—Potential cancer and noncancer risks are quantified. For cancer risks, EPA has established an acceptable risk range of 1 in 1 million to 1 in 10,000 (EPA 1990). This means that contaminant concentrations at a site that could result in increasing a person's chances of developing cancer by 1 chance in 1 million to 1 chance in 10,000 (in addition to this person's chances of developing cancer from other causes) would be considered acceptable. The quantitative measure of noncarcinogenic health effects is the hazard index. EPA has defined a hazard index greater than 1 as indicating possible adverse noncarcinogenic health effects.

Table B−1 presents a summary of the exposure scenarios, scenario assumptions, and intake parameters used in the various risk assessments performed for the site.

B1.2 Ecological Risk Assessment

The ecological assessments conducted for the Weldon Spring Site addressed both aquatic biota and terrestrial wildlife, as appropriate for the four operable units (EPA 1989a and 1989c). For aquatic biota, the risk assessment included consideration of both exposure and effects. Biotic surveys of fish and invertebrate communities were performed. This method provided direct information on the status of the aquatic community inhabiting a spring (e.g., Burgermeister Spring) or a site surface water area (e.g., Femme Osage Slough) and the habitat quality of these spring water or surface water areas. Acute and chronic toxicity tests were also performed. The risk assessment for terrestrial wildlife modeled uptake of contaminants through a drinking water pathway.

Table B−1. Exposure Scenarios and Scenario Assumptions Presented in Risk Assessments for the Weldon Spring, Missouri, Site

Occurrence	Exposure Scenario	Scenario Assumptions and Intake Parameters	Comment/Reference
Chemical Plant soil	Site worker at former Chemical Plant[a]	Assumed 10 years of exposure for 200 days/year at 8 hours per day. Evaluated the ingestion, inhalation, and external gamma pathways.	Baseline Assessment Report (DOE 1992).
	Site trespasser at former Chemical Plant[a]	Assumed 10 years of exposure for 5 times a year for 1 hour each time. Evaluated the ingestion, inhalation, and external gamma pathways.	(same as above)
	Current/future recreational visitor[a]	Assumed 30 years of exposure for 20 times or days per year for 4 hours each time. Evaluated the ingestion, inhalation, and external gamma pathways.	(same as above)
	Hypothetical resident[b]	Assumed 30 years of exposure for 350 days per year. Evaluated the ingestion, inhalation (including radon) and external gamma pathway.	Post-Remediation Risk Assessment Report (DOE 2002)
Chemical Plant groundwater and springs (including Burgermeister Spring)	Current/future recreational visitor (assumed ingestion of spring water only)[a]	Assumed ingestion for 30 years at 20 visits per year consuming a cupful (200 mL) each time.	Baseline Risk Assessment Report (DOE 1997).
	Hypothetical resident (assumed ingestion of groundwater)[a]	Assumed ingestion for 30 years, 350 days/year at 2 L per day.	
Quarry Bulk Waste	Hypothetical passerby[a]	Evaluated the inhalation to radon pathway for an adult passing by 500 to 700 times per year for 5 to 10 years.	These scenarios were postulated to assess potential exposure to the bulk waste present at the time when the Quarry was fenced and closed to the public. Assessment presented in the Baseline Risk Evaluation Report (DOE 1990).
	Hypothetical trespasser[a]	Assumed to be 11 to 18 years old; trespassed 12 to 50 times a year for 2 to 4 hours each time for 5 to 10 years.	

Table B−1 (continued). Exposure Scenarios and Scenario Assumptions Presented in Risk Assessments for the Weldon Spring, Missouri, Site

Occurrence	Exposure Scenario	Scenario Assumptions and Intake Parameters	Comment/Reference
Residual Soil at Quarry Proper (soil that remained after bulk waste removal)	Recreational visitor[a]	Assumed ingestion, inhalation, external gamma pathways; 30 years of exposure, 20 visits per year.	Baseline Risk Assessment Report (DOE 1998).
Quarry Area soil	Recreational visitor[a]	Assumed ingestion, inhalation, external gamma pathways; 30 years of exposure, 20 visits per year.	(same as above)
Femme Osage Slough and Little Femme Osage Creek	Current/future recreational visitor[a]	Assumed ingestion of sediment, surface water, and fish.	(same as above)
	Hypothetical resident[c]	Assumed exposure to sediment and surface water via the ingestion and external gamma pathway.	Letter transmittal to DOE (ANL 2003).
Quarry groundwater	Hypothetical resident (assumed ingestion of groundwater)[a]	Assumed ingestion of groundwater for 30 years, 350 days/year at 2 L per day.	Baseline Risk Assessment Report (DOE 1998).
Southeast Drainage	Current/future recreational visitor/hunter[a]	Assumed 20 visits/year for 30 years; evaluated external gamma and ingestion pathways[d].	Southeast Drainage Engineering Evaluation/Cost Analysis (DOE 1996).
	Hypothetical child resident[a]	Assumed 90 days/year visits for 10 years; evaluated for external gamma and ingestion pathways[d].	
Frog Pond culverts	Utility construction worker[a]	Assumed exposure for 5 working days, 8 hours per day; evaluated external gamma, inhalation, and ingestion pathways.	Letter transmittal to DOE (ANL 2000).
	Recreational visitor[a]	Assumed exposure for 10 years, 10 days per year for 1 hour per day. Same pathways as that for construction worker.	

[a]Exposure scenario evaluated for the baseline risk assessment.
[b]Exposure scenario evaluated for the post-remediation risk assessment.
[c]Data from baseline risk assessment (DOE 1998) reevaluated for hypothetical resident scenario.
[d]For calculating the external gamma doses, it was assumed that only 25 percent of the exposure time was spent in areas with elevated radionuclide concentrations because a receptor would be likely to move around the drainage.
Key: mL = milliliter, L = liter

B2.0 Baseline Risk Assessment Results

B2.1 Human Health

The baseline risk assessment performed for the former Chemical Plant soils, structures, surface water, and sludges at the raffinate pits indicates that elevated concentrations of site-related contaminants (both radioactive and chemical) could pose an unacceptable risk and a hazard index greater than 1 for the future recreational visitor scenario evaluated (DOE 1992).

Risk estimates for contaminated groundwater in the shallow aquifer beneath the Chemical Plant area indicate that some contaminants could pose an unacceptable risk if ingested at frequencies and amounts similar to those of residential use (DOE 1997).

Risk estimates for springs (including Burgermeister Spring) at the Chemical Plant indicate that site-related contaminant levels are within the acceptable risk range and below a hazard index of 1 for the current and future recreational visitor accessing the spring water (DOE 1997).

For the Southeast Drainage, risk estimates for a recreational visitor and hypothetical child resident scenario indicated that contaminant levels in spring water are within the acceptable risk range and below a hazard index of 1. However, radioactive contaminant levels in sediment at several locations posed a risk slightly greater than the acceptable range when evaluated using the hypothetical child resident scenario (DOE 1996). The hypothetical child resident was evaluated as the reasonably maximally exposed individual at the drainage. DOE consulted with EPA, the Missouri Department of Natural Resources, and the Missouri Department of Health in developing this scenario and its exposure assumptions for evaluating potential exposure to the contaminants in the drainage.

For the Quarry, residual soils at the Quarry proper, including those in the fractures, indicated that contaminant levels are within the acceptable risk range and below a hazard index of 1 for the recreational visitor scenario. Surface water, sediment, and fish samples from Femme Osage Slough also indicate that contaminant levels are within the acceptable risk range and below a hazard index of 1 for the recreational visitor scenario (DOE 1998).

Uranium in groundwater north of Femme Osage Slough poses a risk greater than the acceptable risk range for a hypothetical resident scenario. Site-related contaminants have not been detected at monitoring wells south of Femme Osage Slough (including those at the St. Charles County well field) (DOE 1998).

B2.2 Ecological Risk

At the former Chemical Plant, the area of most ecological concern was the four raffinate pits, largely due to chemicals (generally metals) in the ponded water and raffinate pit sludges. Although the industrial portion of the former Chemical Plant did not present good habitat for wildlife, the undeveloped areas supported fauna similar to that in the surrounding wildlife areas. Tissue concentrations in fish collected in Lakes 34, 35, and 36 in the Busch Wildlife Area indicated uranium concentrations at levels for which no adverse effects have been observed. Overall, there were no obvious adverse ecological impacts to area biota, with the possible

exception of the biota at the raffinate pits. Remedial action at the former Chemical Plant and raffinate pits has significantly reduced ecological risks in the area (DOE 1992).

Results of the biotic surveys, media toxicity testing, and contaminant uptake modeling for terrestrial wildlife indicate that current contaminant levels in surface water and sediment at Burgermeister Spring pose little or no risk to the aquatic and terrestrial biota of the area (DOE 1997).

The Quarry proper provides minimal suitable habitat for vegetation and wildlife and was not addressed in the ecological risk assessment. The media and areas of interest in terms of ecological risk are surface water and sediment in Femme Osage Slough and Little Femme Osage Creek. Results of the ecological risk assessment indicated that there are no risks to terrestrial wildlife receptors foraging in Femme Osage Slough or ingesting water from Little Femme Osage Creek. Biotic surveys indicated that the aquatic and terrestrial communities are typical of those expected to be in the area. Tissue analyses of small mammals and fish indicated uranium concentrations within the range for which no adverse effects have been observed. The levels of site-related contaminants in surface water and sediment in Femme Osage Slough and Little Femme Osage Creek present no risk to biota in the area (DOE 1998).

At the Southeast Drainage, surface water in the drainage does not pose risk to terrestrial biota drinking the water at the drainage. Surface water and sediment in the drainage pose minor risks to aquatic biota, and adverse effects would more likely result from the intermittent flow of surface water than from contamination in the drainage. Any ecological impacts would be localized within the drainage and would not have demonstrable effect on the ecological resources in the area. Removal of contaminated sediments has further reduced the low ecological risks that existed previously (DOE 1996).

B3.0 Residual Risk Summary

Table B−2 presents a summary of the human health risk status based on current conditions at the areas that constitute the Weldon Spring Site. The table is a compilation of risk results presented in post-remediation reports for remediated areas (e.g., the post-remediation risk assessment prepared for the former Chemical Plant soils, structures, and raffinate pits [DOE 2002]) and those presented in the baseline risk assessment reports for areas that did not undergo remediation, such as Femme Osage Slough, Burgermeister Spring, and Quarry groundwater. For the areas that were not remediated, DOE reviewed more recent data to determine whether risk results presented in the baseline risk assessments still reflect current conditions, and risk estimates were updated as needed.

The post-cleanup risk assessment performed for the Chemical Plant and vicinity properties (DOE 2002) incorporated all the soil data collected during the confirmation process. These data represent the levels of soil contaminants of concern that remain. The risk assessment considered each confirmation unit as separate one-half acre exposure units. The 95 percent upper confidence limit of the arithmetic mean of all samples collected for each confirmation unit was used as the exposure point concentration for calculating potential risk based on a hypothetical resident scenario. The ingestion, inhalation (including radon), and external gamma pathways were evaluated.

Table B−2. Summary of Residual Risk Status at the Weldon Spring, Missouri, Site

Site Area	Risk Status	Reference
Chemical Plant soil	Similar to background.[a]	DOE 2002
Vicinity property soil	Similar to background.[a]	DOE 2002
Chemical Plant groundwater	Greater than acceptable risk range and hazard index of 1 for a hypothetical resident scenario.[b]	DOE 1997
Burgermeister Spring	Within acceptable risk range for recreational visitor.[b]	DOE 1997
Quarry proper	Within acceptable risk range for recreational visitor.[b]	DOE 1998
Quarry area groundwater north of slough	Greater than acceptable risk range and hazard index of 1 due to uranium concentrations remaining.[b]	DOE 1998
Quarry area groundwater south of slough	Within acceptable risk range for resident scenario.[b]	DOE 1998
Femme Osage Slough and Little Femme Osage Creek	Within acceptable risk range for the recreational visitor[b] scenario. Within acceptable risk range for a hypothetical[c] resident scenario.	DOE 1998 ANL 2003
Southeast Drainage	Within acceptable risk range for recreational visitor and hypothetical child resident.[b]	DOE 1996
Frog Pond outlet/culverts	Within acceptable risk range for a utility construction worker and recreational visitor scenario.[b]	ANL 2000

[a]Risk status after remediation.
[b]Risk status at baseline risk assessment phase and still representative of current conditions.
[c]Data from baseline risk assessment (DOE 1998) reevaluated for hypothetical resident scenario.

For the Southeast Drainage, confirmation data that were collected for the locations remediated were also evaluated to determine the residual risk and the risk reduction that was achieved. The removal action performed has resulted in reducing potential risk posed by the drainage (ANL 1999).

Finally, data evaluated in the baseline risk assessment (DOE 1998) for Femme Osage Slough and Little Femme Osage Creek were re-evaluated to estimate potential risk using a hypothetical resident scenario. The evaluation in the baseline risk assessment was based on a recreational visitor scenario and was consistent with current and reasonable future land use. Results indicate that contaminant levels in the sediment and surface water are also within the acceptable risk range for the hypothetical resident scenario (ANL 2003).

B4.0 References

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