3.4.4 WATER RESOURCES

Surface Water. The most prominent hydrologic feature at SRS is the Savannah River bordering the site for 32 km (19.9 mi) to the southwest (Figure 3.4.4–1). Six major streams flow through SRS to the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs Creek has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one tributary, Indian Grave Branch; and Steel Creek has one tributary, Myers Branch. Surface waters in the vicinity of F- and H-Areas flow into Upper Three Runs Creek and Fourmile Branch. Shallow groundwater in the vicinity recharges both Upper Three Runs Creek and Fourmile Branch (SR DOE 1995e:3-8).

The SRS facility withdraws surface water from the Savannah River mainly for industrial water cooling purposes. A small quantity is also removed for drinking water supplies. In 1994, 140.4 billion l/yr or 37.1 BGY was supplied from the Savannah River (SRS 1995a:1). Most of the water that is withdrawn is returned to the Savannah River through its onsite tributaries. Streams, especially Fourmile Branch, that received discharges from reactors in the past, are still recovering from scouring or erosion impacts. The average flow of the Savannah River is 282 m^3/s (9,959 ft^3/s). The lowest recorded flow, 152 m^3/s (5,368 ft^3/s), occurred during a drought period from 1985 to 1988 (SR DOE 1990a:3-18). The proposed HEU facility could affect the Fourmile Branch drainage basin, which also receives effluents from C-, F-, and H-Areas; however, Pen Branch also could receive discharges. The minimum flow of Fourmile Branch is 0.16 m^3/s (5.8 ft^3/s).

Average annual treated sanitary discharge volume to the Savannah River is about 2 million l/day (528,000 gallons per day [GPD]), which is about 50 percent of the new centralized sanitary wastewater treatment capacity. Wastewater from the treatment plant is discharged to Fourmile Branch. The F/H Effluent Treatment Facility treats industrial wastewater in F- and H-Areas, where the HEU blending facility will be located. The treated wastewater stream is released to Upper Three Runs Creek. The design capacity of Effluent Treatment Facility is approximately 600 million l/yr (159 MGY); however, the maximum permitted treatment capacity for the Effluent Treatment Facility is about 400 million l/yr (105 MGY). Currently, the Effluent Treatment Facility treats approximately 16 million l/yr (4.22 MGY).

The Savannah River also supplies potable water to several municipalities (SR DOE 1995e:3-8). Upstream from SRS, the Savannah River supplies domestic and industrial water needs to Augusta, Georgia; and North Augusta, South Carolina. The river also receives sewage treatment plant effluent from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and, as described above, from a variety of SRS operations via onsite stream discharges. Approximately 203 km (126 mi) downstream from SRS, the river supplies domestic and industrial water needs for the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia, and for Beaufort and Jasper Counties in South Carolina.

There are two man-made water bodies on SRS: L-Lake, which discharges to Steel Creek, and Par Pond, which empties into Lower Three Runs Creek. There are approximately 190 Carolina bays scattered throughout the site. Carolina bays are naturally occurring closed depressions that may hold water. There are no direct discharges to the bays; however, some do receive stormwater runoff.

The proposed HEU blending facility is to be located in either F- or H-Canyon, which is located outside of the 100-year floodplain (see Figure 3.4.4–2). Sitewide information concerning 500-year floodplains at SRS is not available. [Text deleted.]

Surface Water Quality. In the vicinity of SRS, the Savannah River and onsite streams are classified as fresh water suitable for the following: primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control; fishing and the survival and propagation of a balanced indigenous and aquatic community of fauna and flora; and industrial and agricultural uses (SC DHEC 1992a:29). Table 3.4.4–1 lists the surface water monitoring results for 1993 for the Savannah River downstream of SRS. No parameters exceeded the South Carolina Water Quality Criteria for the Savannah River. However, iron and manganese do exceed the National Secondary Drinking Water

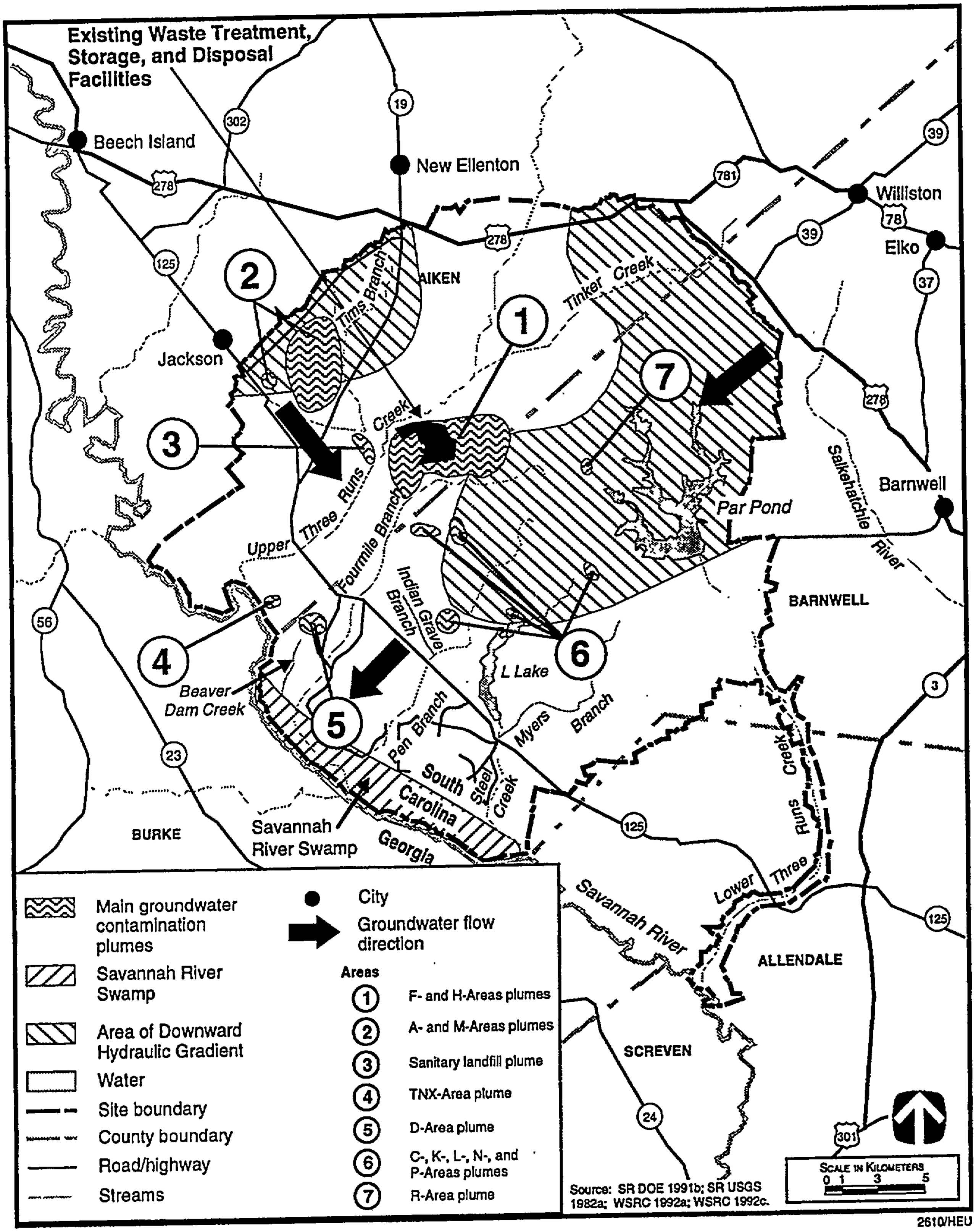


Figure 3.4.4–1. Surface Water Features and Groundwater Contamination Areas at Savannah River Site.

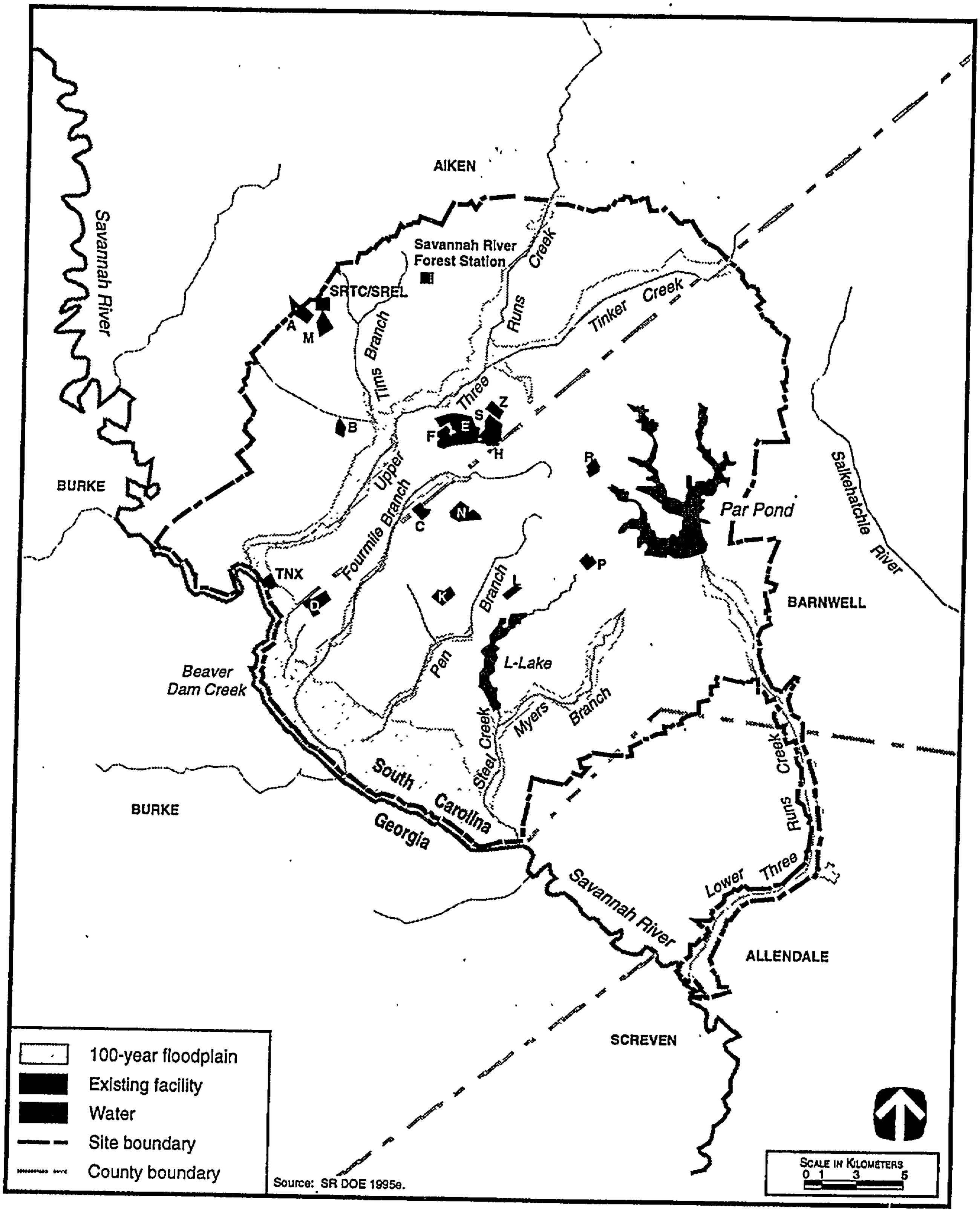


Figure 3.4.4–2. 100-Year Floodplain and Major Stream Systems at Savannah River Site.

Table 3.4.4–1. Summary of Surface Water Quality Monitoring at Savannah River Site

Parameter	Unit of Measure	Water Quality Criteria[a]	Water Body Concentration Receiving Water: Savannah River, 1993 High	Low
Alkalinity	mg/l	NA	24	13
Alpha (gross)	pCi/l	15[b]	0.51	-0.2[c]
Aluminum	mg/l	0.05 to 0.2[d]	0.838	0.182
Ammonia nitrogen	mg/l	NA	0.11	0.02
Beta (gross)	pCi/l	50[e]	3.41	0.9
Calcium	mg/l	NA	5.09	3.25
Chemical oxygen demand	mg/l	NA	ND	ND
Chromium	mg/l	0.1[b]	ND	ND
Conductivity	µohms/cm	NA	106	54
Dissolved oxygen	mg/l	>5[f]	10.5	6.2
Iron	mg/l	0.3[d]	1.15	0.516
Lead	mg/l	0.015[d, f]	0.003	ND
Magnesium	mg/l	NA	1.34	1.11
Manganese	mg/l	0.05[d, f]	0.064	0.04
Nitrogen (as NO_2/NO_3)	mg/l	NA	0.31	0.18
pH	pH units	6.5 to 8.5[f]	6.7	6
Phosphate (P)	mg/l	NA	ND	ND
Plutonium-238	pCi/l	1.6[g]	0.001	-0.001[c]
Plutonium-239	pCi/l	1.2[g]	0.001	0.0009
Sodium	mg/l	NA	12.7	5.28
Strontium-89, 90	pCi/l	8[b]	0.24	0.0017
Sulfate	mg/l	250[d]	9	4
Suspended solids	mg/l	NA	16	5
Temperature	°C	32.2[f]	25.7	9.1
Total dissolved solids	mg/l	500[d]	90	49
Tritium	pCi/l	20,000[b]	5,690	-147[c]
Turbidity	turbidity unit	1 to 5[d]	28	3.6
Zinc	mg/l	5[d]	0.012	ND

[a] For comparison only, except for parameters which have South Carolina Water Quality Criteria.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] A negative number represents concentration below upstream background values.
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[f] South Carolina State Water Quality Criteria.
[g] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem/yr; however, because the drinking water maximum contaminant level is based on 4 mrem/yr, the number listed is 4 percent of the Derived Concentration Guides.

Note: All nonradiological data from station R-10, downstream of SRS; all radiological data from station R-38 (below Vogtle); NA=not applicable; ND=none detected; mg=milligrams, pCi=picocuries; µohms/cm=microohms per centimeter.

Source: WSRC 1994d; WSRC 1994f.

Regulations. The exceedance would only affect the aesthetics of the water, but would not change any health effects.

In addition to water quality monitoring, SRS conducts monitoring to ensure compliance with NPDES permit limits. SRS has two NPDES permits that cover 81 outfalls as part of the permit requirements and one general stormwater discharge permit that covers 48 outfalls. In 1993, the major releases of radionuclides to surface waters were 12,700 (curies [Ci]) of tritium, 0.477 Ci of strontium-89 and -90, and 0.246 Ci of cesium-137, resulting in less than 2 percent of EPA and DOE standards for public water supplies and less than 0.2 percent of the DOE dose standard from all pathways. Of the 8,000 analyses performed at the industrial outfalls in 1993, 10 exceeded permit limits, 99.9 percent of the analyses were in compliance with the SRS NPDES permit (SR DOE 1995e:3-10). Noncompliances were noted for pH, and total suspended solids with one noncompliance each for oil and grease and biological oxygen demand. In all cases, either corrective actions or an administrative review were taken to prevent future noncompliances (WSRC 1994d:4-75).

Surface Water Rights and Permits. Surface water rights for the Savannah River are determined by the Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water availability for downstream users.

Groundwater. Several aquifer system naming schemes have been used at SRS. For this document, the most shallow aquifer will be called the water table. The water table is supported by the leaky "green clay" aquitard, which confines the Congaree aquifer. Below the Congaree aquifer is the leaky Ellenton aquitard, which contains the Cretaceous (or also, previously, the Tuscaloosa) aquifer. In general at SRS, groundwater flows slowly toward streams and swamps and into the Savannah River at rates ranging from centimeters to several hundred meters per year. The depth to which the onsite streams cut into the soils controls the horizontal movement of groundwater. The valleys of the smaller perennial streams allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (that is, Upper Three Runs Creek) drain formations of intermediate depth, and the valley of the Savannah River drains deep formations.

Groundwater flow at some locations on the site (that is, F-, H- and certain sections of K-Areas) is upward from the lower to the upper sediments (Figure 3.4.4–1). In other areas, including A-, M-, L-, and P-Areas, groundwater flow is downward. Horizontal groundwater flow occurs at M-Area (to the west–northwest in the shallow aquifer and subsequent flow to the south toward Upper Three Runs Creek in the intermediate aquifer), K-Area disassembly basin (toward Pen Branch and L-Lake), P-Area disassembly basin (toward Steel Creek), F-Canyon Building (toward Upper Three Runs Creek and Fourmile Branch), and H-Canyon Building (toward Upper Three Runs Creek and its tributaries).

The Cretaceous aquifer is an abundant and important water resource for the SRS region. Some of the local cities (for example, Aiken) also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region gets its water from the Congaree or water table. All groundwater at SRS is classified by EPA as a Class II water source. Depth to groundwater ranges from at or near the ground surface (near streams) to approximately 46 m (150 ft) below the ground surface.

Groundwater Quality. Groundwater data have been obtained from SRS monitoring wells for the past several years. Groundwater quality at SRS ranges from excellent (soft and slightly acidic) to below EPA drinking water standards on several constituents in the vicinity of some waste sites. Industrial solvents, metals, tritium, and other constituents used or generated at SRS have contaminated the shallow aquifers beneath 5 to 10 percent of SRS (SR DOE 1995e:3-10). These aquifers are not used for SRS operations and drinking water; however, they do discharge to site streams and eventually to the Savannah River. Most contaminated groundwater at SRS flows beneath a few facilities; contaminants reflect the operations and chemical processes performed at those facilities. At F- and H-Areas, contaminants in the groundwater include tritium and other radionuclides, metals, nitrates, and chlorinated and volatile organics. Area plumes are shown in Figure 3.4.4–1. At A- and M-Areas, contamination includes chlorinated volatile organics, radionuclides, metals, and nitrates. At the reactors (K-, L-, and P-Areas), tritium, other radionuclides, and lead are in the groundwater (SR DOE 1995e:3-11). At D-Area, contaminants include VOC, chromium, sulfate, and tritium; and at the TNX-Area, volatile organic compounds, lead, nitrate, and uranium are present.

Radioactive constituents (tritium, cesium-137, iodine-131, ruthenium-106, and strontium-89 and -90) above drinking water standards have occurred in F-Area monitoring wells. Studies of flow directions, infiltration rates, and operating history indicate that this contamination is from an isolated incident that occurred more than 35 years ago (SR DOE 1995e:3-11). Groundwater contamination found beneath H-Canyon reflects the widespread use of tritium in H-Area. The tritium is not directly from H-Canyon activities, but rather results from past use of the nearby H-Area seepage basins with subsequent transport beneath the canyon. Results of groundwater quality measurements from two monitoring wells located in the H-Canyon area and comparison with standards or criteria for selected groundwater quality parameters are presented in Table 3.4.4–2.

Groundwater Availability, Use, and Rights. Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County are from the Cretaceous aquifer. Domestic water supplies are primarily from the Congaree aquifer and the water table. In Barnwell and Allendale Counties, the Congaree aquifer supplies some municipal users. At SRS, most groundwater production is from the Cretaceous aquifer, with a few wells pumping from the Congaree aquifer. Every major operating area at SRS has groundwater wells; total groundwater production from these wells is approximately 13,249 million l/yr (3,500 MGY), which is similar to the volume pumped for industrial and municipal production within 16 km (9.9 mi) of the site (SRS 1995a:1).

Groundwater rights in South Carolina are traditionally associated with the absolute ownership rule. Originating in English common-law doctrine, the owners of land overlying a groundwater resource are allowed to withdraw from their wells all the water they wish for whatever purpose they desire. The water withdrawn can be used for any purpose on or off the owner's land (VDL 1990a:725). However, the *Water Use Reporting and Coordination Act* requires all users of 379,000 l (100,000 gal) or more per day

Table 3.4.4–2. Summary of Groundwater Quality Monitoring at Savannah River Site, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Characterization Well No. HAA-4B	Characterization Well No. HCA-4C
Alpha (gross)	pCi/l	15[b]	2.1	-0.5[c]
Barium	mg/l	2[b]	0.0397	0.0695
Beta (nonvolatile)	pCi/l	50[d]	0.2	0.7
Chloride	mg/l	250[e]	2.69	1.75
Iron	mg/l	0.3[f]	0.004	0.0057
Lead	mg/l	0.015[b]	0.003	0.003
Manganese	mg/l	0.05[f]	0.002	0.0052
Nitrate	mg/l	10[b]	0.333	0.74
pH	pH units	6.5-8.5[f]	8.1	9.03
Phenols	mg/l	22[d]	0.005	0.005
Sulfate	mg/l	250[f]	2.54	3.08
Total dissolved solids	mg/l	500[f]	132	39
Total organic halogens	mg/l	NA	0.005	0.0072
Total phosphates	mg/l	NA	0.05	0.462
Tritium	pCi/l	20,000[b]	6,300	1,600

[a] For comparison only.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] A negative number represents concentrations below upstream background values.

[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[e] National Secondary Drinking Water Regulations (40 CFR 143).

[f] South Carolina State Water Quality Criteria.

Note: NA=not applicable; mg=milligrams; pCi=picocuries.

Source: SRS 1995a:11.

(138.3 million l/yr or 36.4 MGY) of water to report their withdrawal rates to the South Carolina Water Resources Commission. SRS groundwater use exceeds this amount, and SRS reports its withdrawal rates to the commission.

3.4.5 GEOLOGY AND SOILS

Geology. The SRS facility lies in the Aiken Plateau portion of the Upper Atlantic Coastal Plain southeast of the Fall Line, a major physiographic and structural feature that separates the Piedmont and the Atlantic Coastal Plain in southeastern South Carolina. The plateau is highly dissected, with narrow, steep-sided valleys separated by broad, flat areas.

In the immediate region of SRS, there are no known capable faults within the definition of 10 CFR 100. Subsurface mapping and sëismic surveys suggest the presence of six faults beneath SRS: Pen Branch, Steel Creek, Advanced Tactical Training Area, Crackerneck, Ellenton, and Upper Three Runs Faults. The closest of these to the H-Canyon Area is the Upper Three Runs Fault. The Steel Creek Fault, which passes through L–Area, and the Pen Branch Fault, which passes through K-Area, are the closest faults to the areas that store nuclear materials (SR DOE 1995e:3-4); however, there is no evidence of movement within the last 38 million years along this fault.

Since SRS lies within Seismic Zone 2, moderate damage could occur as a result of earthquakes (Figure 3.3.5–1). Since 1985, only three earthquakes, all less than Richter magnitude 3.2 (Table 3.3.5–1), have occurred within the immediate vicinity of SRS (two within the SRS boundary and one located 16.1 km [10 mi] east of the city of Aiken). None of these earthquakes produced any damage at SRS. Historically, there have been two large earthquakes within 300 km (186 mi) of SRS. The largest of these two, the Charleston earthquake of 1886, had an estimated Richter magnitude of 7.5. The SRS area experienced an estimated peak horizontal acceleration of 0.1 gravity (SR DOE 1995e:3-7). Earthquakes capable of producing structural damage to any buildings are not likely to occur in the vicinity of SRS because SRS design basis for earthquakes is 0.2 gravity, which is twice as much as the historical earthquake horizontal acceleration (SR DOE 1995e:3-4). There is no volcanic hazard at SRS. The area has not experienced volcanism within the last 230 million years.

Soils. The soils at the HEU facility are mainly sands and sandy loams. The somewhat excessively drained soils have a thick, sandy surface layer that extends to a depth of 203 cm (80 in) or more in some areas. Many of the soils are subject to slight to moderate water and wind erosion, flooding, ponding, and cutbank caving (SR USDA 1990a:17-25). Several soil units that cover approximately 17 percent of the SRS plant property have been designated as prime farmland. All the soils have low shrink-swell potential and have slight water and wind erosion. The H–Canyon area lies on the upland soils of Fuquay-Blanton-Dothan Soil Association. This soil unit has been designated as prime farmland, but the area is not presently under cultivation. The soils at SRS are considered acceptable for standard construction techniques.

3.4.6 BIOTIC RESOURCES

Biotic resources at SRS include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion focuses first on SRS as a whole and then on the area of the proposed activities. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Most of SRS has remained undeveloped since it was established in 1950. Only about 5 percent of the site is occupied by DOE facilities. Five major plant communities have been identified at SRS. Of these, the largest is the loblolly, longleaf, and slash pine community that covers approximately 65 percent of SRS. This community type, as well as the upland hardwood and scrub oak community, occurs primarily in upland areas. Swamp forests and bottomland hardwood forests are found along the Savannah River and the numerous streams that traverse SRS. More than 1,300 species and varieties of vascular plants have been identified on the site (DOE 1992e:4-126; DOE 1995p:4-47).

Because of the variety of plant communities on the site, as well as the region's mild climate, SRS supports a diverse and abundant wildlife including 54 mammal species, 213 bird species, 58 reptile species, and 43 amphibian species. Common species at SRS include the slimy salamander, eastern box turtle, Carolina chickadee, common crow, eastern cottontail, and gray fox (DOE 1992e:4-128; WSRC 1993b:3-5, 3-39). A number of game animals are found on SRS; however, only the whitetail deer and feral hog are hunted onsite (DOE 1992e:4-128). Raptors, such as Cooper's hawk and black vulture, and carnivores, such as the gray fox and raccoon, are ecologically important groups on SRS. A variety of migratory birds have been found at SRS. Migratory birds, their nests, and eggs, are protected by the *Migratory Bird Treaty Act.* Eagles are similarly protected by the *Bald and Golden Eagle Protection Act.*

Wetlands. The SRS facility has extensive, widely distributed wetlands, comprising approximately 19,800 ha (49,000 acres). Most are associated with floodplains, streams, and impoundments. Wetlands on the site may be divided into the following categories: bottomland hardwoods, cypress-tupelo, scrub-shrub, emergent, and open water. The most extensive wetland type on SRS is swamp forest associated with the Savannah River floodplain. Approximately 3,800 ha (9,400 acres) of these wetlands are found on SRS. Past releases of cooling water effluent into site streams and the Savannah River swamp have resulted in shifts in plant community composition. Changes have included replacement of bald cypress by scrub-shrub and emergent vegetation in the swamp and reduction in bottomland forests along streams (DOE 1992e:4-130; WSRC 1989e:3-4).

Carolina bays, a type of wetland unique to the southeastern United States, are also found on SRS. Approximately 190 Carolina bays have been identified at SRS. These shallow depressions occur on interstream areas of SRS and range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests (SR NERP 1989a:9).

Aquatic Resources. Aquatic habitat on SRS includes artificial ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 artificial impoundments located throughout the site that mainly support populations of bass and sunfish (SRS 1992a:8). Fewer than 10 percent of the Carolina bays on SRS have permanent fish populations. Species present in these bays include redfin pickerel, mud sunfish, lake chubsucker, and mosquitofish (SR NERP 1983a:15; SR NERP 1989a:37). Par Pond and L-Lake support similar fish populations including largemouth bass, black crappie, and various species of pan fish (SRS 1992a:8). Recreational fishing is not allowed on SRS.

The Savannah River is used for both commercial and sport fishing. Important commercial species are American shad, hickory shad, and striped bass; all are anadromous. The most important warm-water game fish species of the Savannah River are bass, pickerel, crappie, bream, and catfish. In the past, water intake structures for C- and K-Reactors and the D-Area powerhouse caused annual estimated entrainment of approximately 10 percent of the fish eggs and larvae passing the intake canals during the spawning season. In addition, estimated impingement losses were approximately 7,600 fish per year (SR DOE 1987b:3-31, C-61).

Threatened and Endangered Species. Sixty-one Federal- and State-listed threatened, endangered, and other special status species have been identified on and in the vicinity of SRS (Appendix D, Table D.1–3). The appendix indicates that 57 of these species have records of occurrence on SRS. Twelve of these are Federal- and/or State-listed threatened or endangered species. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on SRS. The smooth coneflower is the only listed endangered plant species found on SRS. Two colonies exist on SRS, but suitable habitat for this species occurs throughout the site. Bald eagles nest near Par Pond and L-Lake and forage on these reservoirs. Wood storks forage in the Savannah River swamp and the lower reaches of Steel Creek, Pen Branch, Beaver Creek Dam, and Fourmile Branch. Red-cockaded woodpeckers inhabit open pine forests with mature trees (older than 70 years for nesting and 30 years for foraging). Peregrine falcons have been reported in the past as rare winter visitors on SRS. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River swamp. The shortnose sturgeon spawns in the Savannah River both up and downstream of SRS. This fish has not been collected in the tributaries of the Savannah River that drain SRS (SR DOE 1995b:3-44). The State-listed Rafinesque's big-eared bat and Appalachian Bewick's wren occur on SRS. [Text deleted.]

F- and H-Areas contain no habitat for any of the Federal-listed threatened or endangered species found on SRS. Red-cockaded woodpeckers nest in old growth pine trees, and there are no suitable nesting sites in the vicinity of F- or H-Area. Smooth coneflower also is not found in F- or H-Area. The

Southern bald eagle and the wood stork feed and nest near wetlands, streams, and reservoirs, and thus would not be attracted to the highly disturbed F- or H-Area. Shortnose sturgeon, typically residents of large coastal rivers and estuaries, have never been collected in Fourmile Branch or any of the tributaries of the Savannah River that drains SRS (DOE 1995p:4-51).

3.4.7 CULTURAL RESOURCES

Prehistoric Resources. Prehistoric site types on SRS consist of villages, base camps, limited-activity sites, quarries, and workshops. An extensive archaeological survey program began at SRS in 1974 and includes numerous field studies such as reconnaissance surveys, shovel test transects, and intensive site testing and excavation. More than 60 percent of SRS has received some level of cultural resource evaluation. Over 1,000 sites have been identified at SRS. Of these, over 800 prehistoric sites or sites with prehistoric components have been identified; however, fewer than 8 percent have been evaluated for eligibility to the NRHP. To date, 67 prehistoric and historic sites are considered potentially eligible for listing on the NRHP. Cultural resources surveys have been conducted within F- and H-Areas, and some prehistoric material has been found a few miles from H-Canyon. Some prehistoric sites that may be NRHP-eligible have been identified within F- and H-Areas. Most of H-Area has been disturbed through grading and construction. No NRHP sites are within the facility.

A Programmatic Agreement was signed by the DOE Savannah River Operations Office, the South Carolina State Historic Preservation Officer, and the Advisory Council on Historic Preservation on August 24, 1990. Its purpose is to ensure that appropriate measures are taken to inventory, evaluate, protect, and enhance archaeological sites on SRS. In addition, an Archaeological Resource Management Plan for SRS is in place.

Historic Resources. Types of historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, and commercial building locations. Approximately 400 historic sites or sites with historic components have been identified within SRS; approximately 10 percent have been evaluated for NRHP nomination.

Most historic structures were demolished during the initial establishment of SRS in 1951. Two 1951 buildings are currently in use. [Text deleted.]

Native American Resources. Native American groups with traditional ties to the area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. At different times, each of these groups was encouraged by the English to settle in the area to provide protection from the French, Spanish, or other Native American groups. Main villages of both the Cherokee and Creek groups were located southwest and northwest of SRS, and both groups may have used the area for hunting and gathering activities. During the 1830s, most of the remaining Native Americans residing in the region were relocated to the Oklahoma Territory as part of the Trail of Tears.

Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and areas containing traditional plants used for religious ceremonies. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the *American Indian Religious Freedom Act* within the central Savannah River Valley; however, no specific sites at SRS have been identified. The Yuchi Tribal Organization, the National Council of the Muskogee Creek, the Indian People's Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of the Cherokees have expressed concerns for sensitive Native American resources at SRS. The Yuchi and the Muskogee Creek expressed concern for areas containing several plants traditionally used in ceremonies (SR DOE 1991e:19,21).

Paleontological Resources. Paleontological materials at SRS include fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. All paleontological materials from SRS are marine invertebrate deposits and, with the exception of the giant oysters, are relatively common fossils and are widespread; therefore, the assemblages have relatively low research potential.

3.4.8 SOCIOECONOMICS

Socioeconomic characteristics described for SRS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 15 counties around SRS in the States of South Carolina and Georgia (Appendix F, Table F.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a six-county area in which 90.1 percent of all SRS employees reside. These counties include Aiken County (51.9 percent), Allendale County (1.1 percent), Bamberg County (1.7 percent), and Barnwell County (7.3 percent) in the State of South Carolina; and Columbia County (10.6 percent) and Richmond County (17.5 percent) in the State of Georgia (Appendix F, Table F.1–3). Supporting data are presented in Appendix F.

Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force in the REA increased 21.4 percent to the 1990 level of 248,239. In 1994, unemployment in the REA was 6.7 percent, which was approximately 0.4 and 1.5 percent higher than South Carolina and Georgia, respectively. The region's per capita income of $17,212 in 1993 was approximately 2.1 percent greater than South Carolina's per capita income of $16,861 and 10.6 percent lower than Georgia's per capita income of $19,249. Employment and regional economy statistics and projections for the proposed action period for the SRS REA are given in Appendix F, Table F.1–7 and summarized in Figure 3.4.8–1.

In 1993, as shown in Figure 3.4.8–1, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (16 percent) and the two States. Service sector employment in the region (22 percent of total employment) represented a 3 percent smaller share of the regional economy than in the economy of Georgia and was similar to that of South Carolina. The manufacturing sector's share of the economy was similar in the REA (21 percent) and South Carolina (20 percent), but represented a 6 percent larger share of the economy than in Georgia (15 percent).

[Text deleted.]

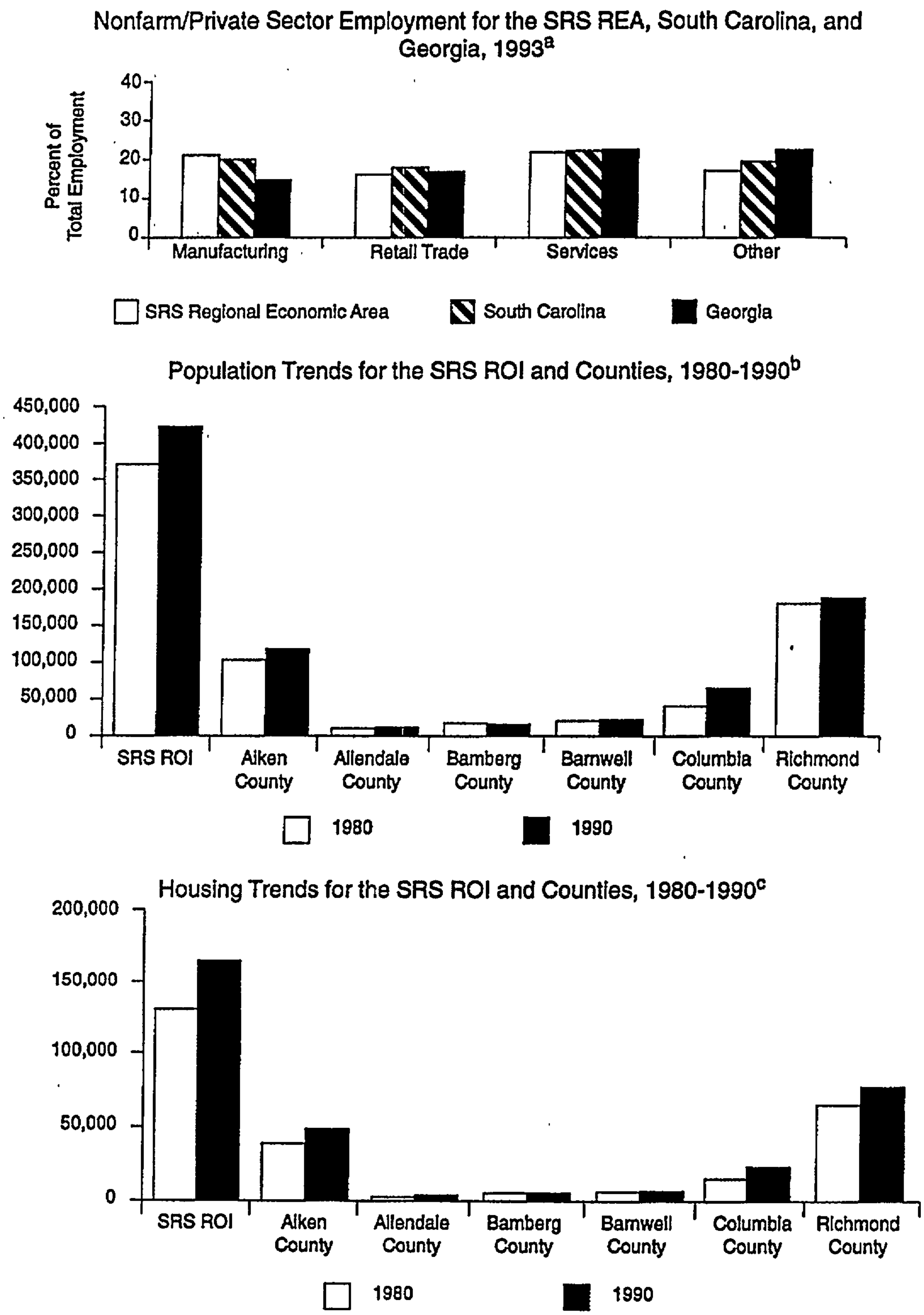
Population and Housing. In 1992, the ROI population totaled 453,824. From 1980 to 1990, the ROI population increased by 13.2 percent, compared to 18.6 percent for Georgia and 11.7 percent for South Carolina. Within the ROI, Columbia County experienced the largest increase at 65 percent, while Bamberg County's population decreased by 6.7 percent. Population trends are summarized in Figure 3.4.8–1. [Text deleted.]

The number of housing units in the ROI increased by 23.8 percent between 1980 and 1990, totaling 168,803 units in the latter year. The percent increase was comparable to South Carolina but 6 percent smaller than in Georgia. The 1990 homeowner vacancy rate in the ROI, 2.2 percent, was similar to those experienced by South Carolina and Georgia. The rental vacancy rate for the ROI counties, nearly 10 percent, was approximately 2 percent less than the rental vacancy rates for both states. (A full presentation of population and housing statistics and projections is provided in Appendix F, Tables F.1–11 and F.1–15, respectively.)

Community Services. Education, public safety, and health care characteristics will be used to assess the level of community service in the SRS ROI. Figure 3.4.8–2 presents school district characteristics for the SRS ROI. Figure 3.4.8–3 presents public safety and health care characteristics.

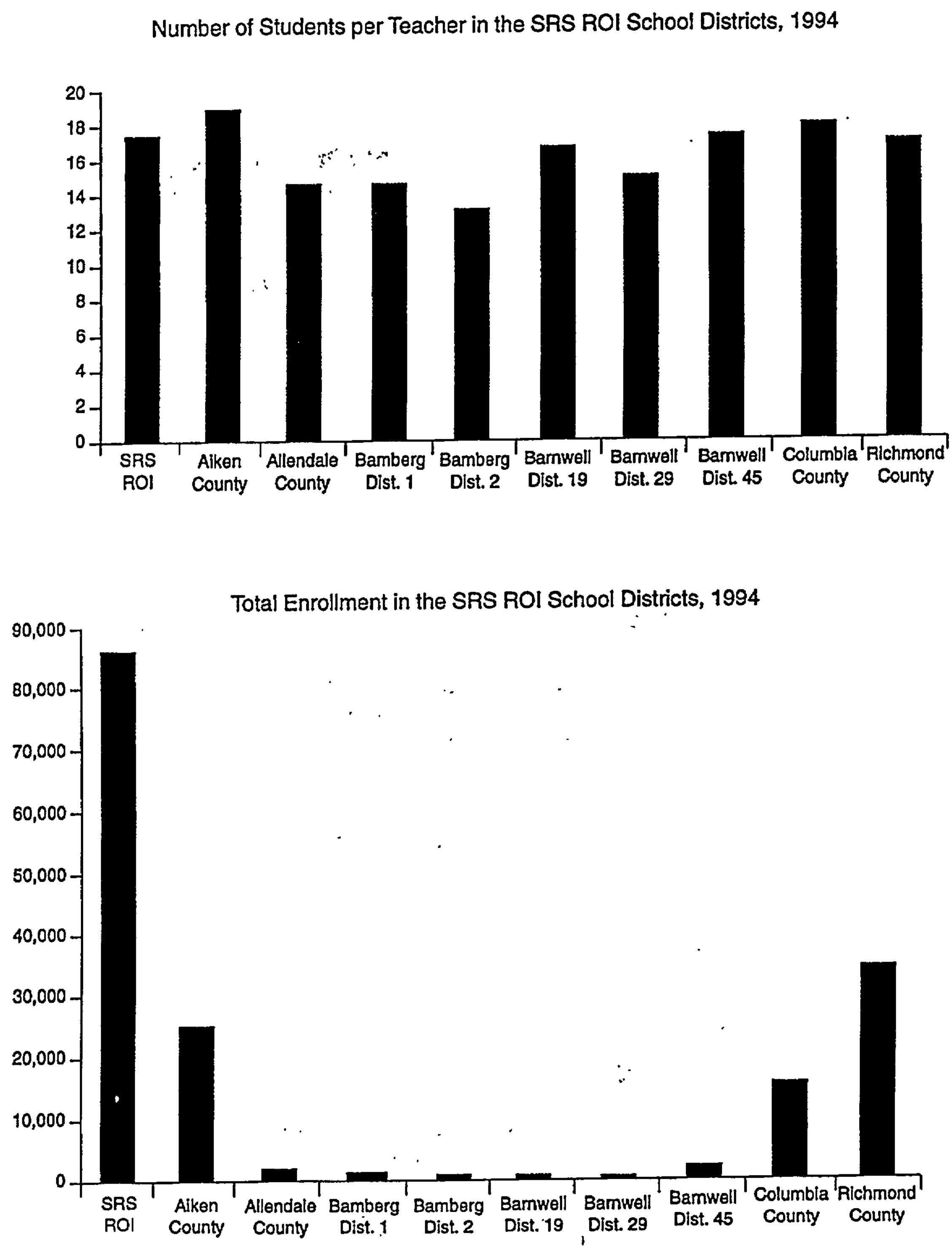
Education. In 1994, nine school districts provided public education services and facilities in the SRS ROI. As shown in Figure 3.4.8–2, these school districts ranged in enrollment size from 1,017 students in District 29 (located in Barnwell County) to 34,907 students in the Richmond County School District. The average students-to-teacher ratio for the ROI was 17.5:1. The Aiken County School District had the highest ratio at 19:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1993, a total of 924 sworn police officers served the six-county ROI. Richmond County employed the greatest number of sworn police officers (323), while the cities of Aiken and Augusta had the highest police officers-to-population ratios (3.7 officers per 1,000 persons). The average ROI sworn police officers-to-population ratio was 2



[a] DOC 1995a.
[b] Census 1983b; Census 1983c; Census 1993c; Census 1993e.
[c] Census 1982c; Census 1982j; Census 1991a; Census 1991b.

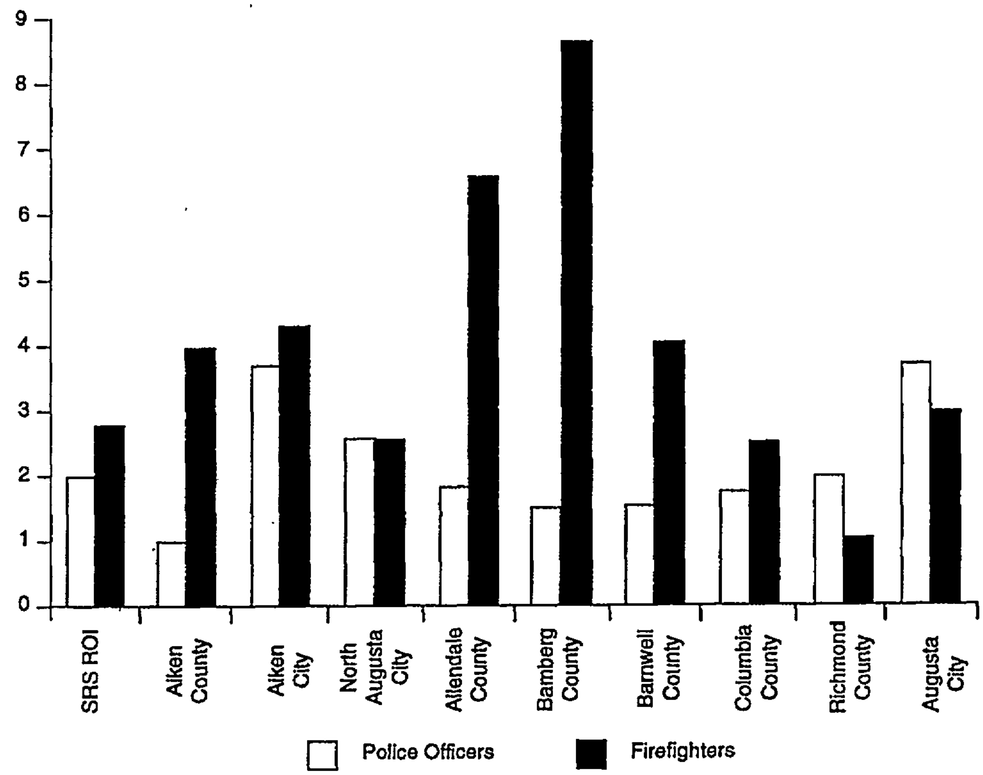
Figure 3.4.8–1. Economy, Population, and Housing for the Savannah River Site Regional Economic Area and Region of Influence.



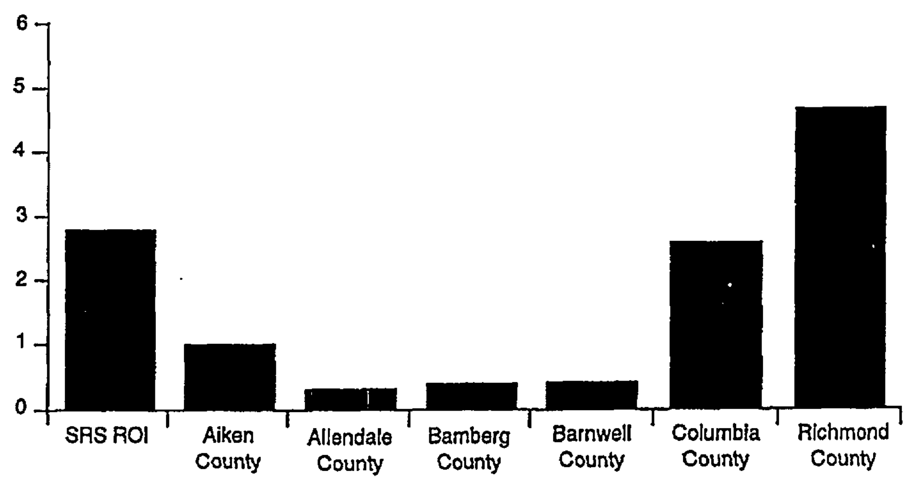
Source: SR School 1995a.

Figure 3.4.8–2. School District Characteristics for the Savannah River Site Region of Influence.

Number of Sworn Police Officers (1993) and Firefighters (1995) per 1,000 Persons in the SRS ROI[a]



Number of Physicians per 1,000 Persons in the SRS ROI, 1993[b]



[a] Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a; SR Fire 1995a.
[b] AMA 1994a; Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Figure 3.4.8–3. Public Safety and Health Care Characteristics for the Savannah River Site Region of Influence.

officers per 1,000 persons. Figure 3.4.8–3 compares police force strengths across the ROI.

Fire protection services in the SRS ROI were provided by 1,363 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Bamberg County (8.7 firefighters per 1,000 persons) as indicated in Figure 3.4.8–3. Aiken County had the greatest number of active firefighters (375). The average firefighters-to-population ratio in the ROI was 2.9 per 1,000 persons.

Health Care. There were eight hospitals serving the six-county ROI in 1993. All eight hospitals were operating at below capacity, with hospital occupancy rates ranging from 29.4 percent in Allendale County to 64.8 percent in Richmond County.

In 1993, a total of 1,325 physicians served the ROI with the majority (979) located in Richmond County. Figure 3.4.8–3 shows that the physicians-to-population ratio ranged from 0.3 physicians per 1,000 persons in Allendale County to 4.8 physicians per 1,000 persons in Richmond County. The average ROI physicians-to-population ratio was 2.9 physicians per 1,000 persons.

Local Transportation. U.S. and State Routes provide access between SRS and metropolitan areas as illustrated in Figure 3.4–1. SR-19, north of the site, provides access to New Ellenton and Aiken, South Carolina. West of the site, SR-125 provides access to Augusta. U.S. 278, located northwest of the site, provides access to the East Coast and Augusta.

Several routes provide direct access to SRS. From the northwest and north, access is provided by SR-125 and SR-19, respectively. Both highways are open to through traffic. From the northeast, SR-39 and SR-781 pass inside the SRS boundary. Access from the east is by SR-64 and from the southeast by SR-125. Public access is provided by U.S. 278, SR-125, and SR-19, but only SRS employees are permitted access to the site on the other routes. There are no road improvement projects under construction or planned in the near future in Barnwell and Aiken Counties that would affect SRS access (SC DOT 1995a:1). There is no local public transportation directly serving SRS. Rail service in the ROI is provided by NS and CSX Transportation. SRS has provided rail access via Robbins Station on the CSX Transportation line. In addition, SRS maintains 103 km (64 mi) of onsite track for internal uses. Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation (SRS 1995a:12). Columbia Metropolitan Airport, in the city of Columbia, and Bush Field, in the city of Augusta, receive jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located in the ROI (DOT 1992a).

3.4.9 Public and Occupational Health

Radiation Environment. All residents in the vicinity of SRS are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of SRS are shown in Table 3.4.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Table 3.4.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	29
External terrestrial radiation	29
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	363

[a] NCRP 1987a; WSRC 1994d. Value for radon is an average for the United States.

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. The radionuclides and quantities released from SRS operations in 1993 are listed in the *Savannah River Site Environmental Report for 1993* (WSRC-TR-94-075).

The releases listed in the 1993 report were used in the development of the reference environment's radiological releases at SRS for the public and occupational health segments within Section 4.3. The doses to the public resulting from these releases fall within radiological limits and are small in comparison to background radiation (DOE Order 5400.5). Table 3.4.9–2 presents the doses to the public resulting from releases at SRS.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix E), the fatal cancer risk to the MEI of the public due to radiological releases from SRS operations in 1993 is estimated to be approximately $1.6x10^{-7}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of SRS operations is less than 2 chances in 10 million. (It may take several years from the time of exposure to radiation for cancer to manifest.)

Based on the same risk estimator, $1.1x10^{-2}$ excess fatal cancers were estimated from normal operations in 1993 to the population living within 80 km (50 mi) of SRS. This number can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1993 in the population living within 80 km (50 mi) of SRS was 1,240. This number of expected fatal cancers is much higher than the estimated $1.1x10^{-2}$ fatal cancers that could result from SRS operations in 1993.

Workers at SRS receive the same dose as the general public from background radiation, but receive an additional dose from working in the facilities. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Appendix E), the number of excess fatal cancers to SRS workers from operations in 1992 is estimated to be 0.14. Table 3.4.9–3 includes the average, maximum, and total occupational doses to SRS workers from operations in 1993.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report for 1993* (WSRC-TR-94-075). The concentrations of radioactivity in various environmental media (for

Table 3.4.9–2. Doses to the General Public From Normal Operations at Savannah River Site, 1993 (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[c]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.18	4	0.14	100	0.32
Population within 80 km[d] (person-rem)	None	20	None	1.5	100	21.5
Average individual within 80 km[e] (mrem)	None	$3.2x10^{-2}$	None	$2.4x10^{-3}$	None	$3.5x10^{-2}$

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] WSRC 1994d.

[c] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of SRS to the Atlantic Ocean.

[d] In 1993, this population was approximately 620,100.

[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Table 3.4.9–3. Doses to the Onsite Worker From Normal Operations at Savannah River Site, 1993 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	17.9
Maximally exposed worker (mrem)	5,000	3,000
Total workers (person-rem)	None	350

[a] 10 CFR 835. DOE's goal is to maintain radiological exposures ALARA.

[b] DOE 1993n:7. The number of badged workers in 1992 was approximately 19,500.

example, air, water, soil) in the site region (onsite and offsite) are also presented in this reference.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Sections 3.4.3 and 3.4.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at SRS via inhalation of air containing pollutants released to the atmosphere by SRS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.4.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to SRS workers during normal operation may include those from inhalation of the workplace atmosphere, drinking SRS potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SRS workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*) ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm; therefore, worker health conditions at SRS are expected to be substantially better than required by the standards.

Health Effects Studies. Two epidemiologic studies on the general population in communities within 80 km (50 mi) of SRS resulted in three publications (ED 1982a:135-152; JAMA 1991a:1403-1407; NIH Publication 90-874, July 1990). One study (JAMA 1991a; 1403-1407; NIH Publication 90-874) found no evidence of excess cancer mortality; whereas, the other study (ED 1982a:135-152) reported an excess in leukemia and lung cancer deaths along with other statistically nonsignificant excess deaths.

An excess in leukemia deaths has been reported among hourly workers at SRS. A more detailed description of the studies and findings reviewed is included in Appendix E, Section E.4.3.

Accident History. From 1974 through 1988, there were 13 inadvertent tritium releases from the tritium facilities at SRS. These releases have been traced to aging equipment in the tritium processing facility and are one of the reasons contributing to the construction of a replacement tritium facility at SRS. Detailed descriptions and studies of these incidents and their consequences to the offsite population have been documented by SRS. The most significant occurred in 1981, 1984, and 1985, when 32,934, 43,800, and 19,403 Ci, respectively, of tritiated water vapor were released (WSRC 1991a:41). In the period from 1989 through 1992, there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of these recent releases occurred in 1992 when 12,000 Ci of tritium were released (WSRC 1993a:11-260).

Emergency Preparedness. Each DOE site has established an emergency management program. These programs have been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management programs incorporate activities associated with emergency planning, preparedness, and response.

The emergency preparedness facility at SRS provides overall direction and control for onsite responses to emergencies and coordinates with Federal, State, and local agencies and officials on the technical aspects of the emergency.

The SRS emergency operations facility consists of several centers, described below, that provide distinct emergency response support functions.

- The SRS operations center coordinates the initial response to all SRS emergencies and is equipped to function as the heart of SRS's emergency response communications network.

- The technical support center provides command and control of emergency response activities for the affected facility or operational area.

- The emergency operations center provides command and control of emergency response activities for SRS locations outside of the affected area.

- The security management center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the emergency operations center.

- The dose assessment center is responsible for assessing the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

3.4.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory and ongoing waste management activities for SRS. DOE is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed upon milestones. These agreements have been reviewed to ensure that proposed actions are allowable under the terms of the agreement.

The EPA has placed SRS on the National Priorities List and has identified approximately 150 potential operable units. In accordance with CERCLA, DOE entered into an FFCA with EPA and the State on January 15, 1993, to coordinate cleanup activities at SRS under one comprehensive strategy. The FFCA combines the RCRA Facility Investigation Program Plan with a CERCLA cleanup program entitled *RCRA Facility Investigation Remedial Investigation Program Plan.*

[Text deleted.] SRS has a waste minimization program that is improving the liquid and solid waste generation, treatment, and storage practices. A disciplined approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach has reduced the generation of TRU waste (48 percent), LLW (13 percent), mixed waste (96 percent), and hazardous waste (58 percent) (DOE 1993e:I-18). Table 3.4.10–1 presents a summary of waste management at SRS for 1993. A discussion of the waste management activities at SRS follows. SRS manages the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous.

High-Level Waste. Liquid HLW at SRS is comprised of many waste streams generated during the recovery and purification of TRU products and unburned fissile materials from spent reactor fuel elements. These wastes are separated according to waste form, radionuclide, and heat content; and transferred to underground tanks in the F- and H-Area Tank Farms. Processes used to treat liquid HLW include separation, evaporation, and ion exchange. Evaporation produces a cesium-contaminated condensate. Cesium-137 is removed from the condensate, resulting in a low-level waste stream that is treated in the Effluent Treatment Facility. The remaining high-level waste stream salts are precipitated, and some can be decontaminated. The decontaminated salt solution is sent with residues from the Effluent Treatment Facility to the Defense Waste Processing Z–Area Saltstone Facility where it is mixed with a blend of cement, flyash, and blast furnace slag to form grout. The grout is pumped into disposal vaults where it hardens for permanent disposal as LLW. The remaining high-level salt and sludge will be permanently immobilized as a glass solid cast in stainless steel canisters at the Defense Waste Processing Facility Vitrification Plant. The stainless steel canisters will be welded closed, decontaminated to DOT standards, and temporarily stored onsite for eventual transport to a permanent Federal repository for disposal. Future HLW generation could result from the processing and stabilization of spent fuel for long-term storage as a result of 60 FR 28680 (amended by 61 FR 9441, March 8, 1996), and from remediation or materials recovery activities performed in F- and H-Canyons.

Transuranic Waste. Under the FFCA on RCRA Land Disposal Restrictions signed by EPA and DOE on March 13, 1991, SRS is required to prepare TRU waste for shipment. [Text deleted.] SRS will begin discussions with the State of South Carolina Department of Health and Environmental Control on alternative treatment options in January 1998 if the Secretary of Energy does not decide to operate the Waste Isolation Pilot Plant by that time. If a delayed opening date for the Waste Isolation Pilot Plant is determined, DOE will propose modifications to the SRS site treatment plan for approval by the State of South Carolina. Status of the Waste Isolation Pilot Plant readiness schedule will be included in the updates. Certified TRU waste is stored on TRU waste storage pads until it can be shipped to a TRU waste disposal facility. Should additional treatment be necessary for disposal at the Waste Isolation Pilot Plant, SRS would develop the appropriate treatment capability. All TRU waste currently generated is stored in containers on aboveground pads.

The Experimental TRU Waste Assay/Certification Facility began operations in 1986 to certify newly generated TRU waste. It since has been shut down. A new TRU Waste Characterization/Certification facility is planned that would provide extensive containerized waste processing and certification capabilities. The facility is needed to prepare TRU waste for treatment and to certify TRU waste for shipment to the Waste Isolation Pilot Plant. Drums certified for shipment to the Waste Isolation Pilot Plant are placed in interim storage on concrete pads in E–Area. Buried and stored wastes containing concentrations of transuranic nuclides between 10 and 100 nanocuries per gram (nCi/g) (referred to as alpha-contaminated LLW) is managed like TRU waste because its physical and chemical properties are similar, and because similar procedures will be used to determine its final disposition. Because all of the TRU waste placed on the aboveground pads prior to January 1990 is suspected of having hazardous constituents, RCRA Part B permit application has been submitted for the TRU waste storage pads and the Experimental TRU Waste Assay Certification Facility. The waste is currently being stored under RCRA interim status.

Low-Level Waste. The bulk of liquid LLW is aqueous process waste including effluent cooling water, decontaminated salt solutions, purge water, water from irradiated fuel and target storage basins, distillate from the evaporation of waste streams, and surface water runoff from areas where there is a potential for contamination. Liquids are processed to remove and solidify the radioactive constituents and the decontaminated liquids are discharged within

Table 3.4.10–1. Waste Management at Savannah River Site

Waste Category	1993 Generation (m^3)	Treatment		Storage		Disposal	
		Method	Capacity (m^3/yr)	Method	Capacity (m^3)	Method	Capacity (m^3)
High-Level							
Liquid	1,561	Settle, separate, and evaporate	53,700	F- & H-Area Tank Farm	133,000	None[a]	None
Solid	None[b]	Vitrification	18,800	Air-cooled, shielded facility	4,572 HLW canisters	To repository	NA
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	391	None	None	Pads and buildings	14,600	None (Federal repository in the future)	None
Low-Level							
Liquid	None	Adsorption, evaporation, filtration, neutralization, and saltstone	104,000	Ponds and tanks (awaiting processing)	NA	NA	NA
Solid	14,100	Compaction	52,000	NA	NA	Trench and caissons	2,578,000
Mixed Low-Level							
Liquid	115	Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, and evaporation	889,000	RCRA permit Bldgs. E, 600, 700, M-Area Liquid Effluent Treatment Facility	11,500	None	None
Solid	18	None	NA	RCRA permit Bldg. 600	1,990	None	None
Hazardous							
Liquid	None	None	None	DOT containers	Included in solid	Offsite	NA
Solid	74	None	None	DOT containers	860	Offsite	NA

Table 3.4.10–1. *Waste Management at Savannah River Site—Continued*

Waste Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Nonhazardous (Sanitary)							
Liquid	700,000[c]	Filter, settle, strip	994,000	Flowing ponds	NA	Permitted discharge	Varies by each permitted outfall
Solid	6,670	Compaction	Expandable, as required	NA	NA	Landfill (onsite and offsite)	Expandable, as required
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary

[a] Treatment removes the high-level constituents (salt and sludge) from the liquids; the salt and sludge are vitrified.

[b] Facility started operation in 1995.

[c] 1991 data.

Note: NA=not applicable; DOT=Department of Transportation.

Source: DOE 1995kk; SR DOE 1993c; SR DOE 1994b; SR DOE 1994c; SR DOE 1995b; SR DOE 1995c; SR MMES 1993a; SRS 1995a:1; WSRC 1995a.

standards established by the regulatory permit. Solid LLW includes operating plant and laboratory waste, contaminated equipment, reactor and reactor fuel hardware, spent lithium-aluminum targets, and spent deionizer resin from reactor coolant treatment. Solid LLW is separated by radiation levels into low and intermediate categories. Solid LLW that radiates less than 200 mrem/hr at 5 cm (2 in) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm (2 in), it is considered intermediate activity waste. The disposal method for solid LLW is disposal in earthen trenches and concrete vaults. Saltstone generated in the solidification of decontaminated salts extracted from HLW is disposed of as LLW in separate vaults, and is the highest volume of LLW disposed of at SRS. Disposal facilities are projected to meet solid LLW storage and disposal requirements (for example LLW from offsite DOE facilities such as Pinellas) for the next 20 years.

Mixed Low-Level Waste. The FFCA, signed by EPA and DOE on March 13, 1991, addresses SRS compliance with RCRA land disposal restrictions pertaining to past, ongoing, and future generation of mixed LLW (mostly solvents, dioxin, and California list wastes contaminated with tritium). SRS is allowed to continue to operate, generate, and store mixed waste subject to land disposal restrictions; in return, SRS will report to EPA the characterization of all solid waste streams disposed of in land disposal units at SRS and has submitted its waste minimization plan to EPA for review. Schedules for measures to provide compliance through construction of the Consolidated Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility are included in the FFCA.

The Consolidated Incineration Facility will treat mixed LLW and liquid hazardous waste. The hazardous waste/mixed waste disposal vaults are scheduled to be available in 2002. Mixed waste will be in interim storage in the E–Area waste disposal facility and in two buildings in G–Area until completion of the Consolidation Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility. The FFCA of 1992 required DOE facilities storing mixed waste to develop site treatment plans and to submit the plans for approval. The FFCA formed the basis for the SRS *Proposed Site Treatment Plan.*

Hazardous Waste. Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at SRS. All hazardous wastes are stored onsite in Department of Transportation-approved containers in RCRA-permitted facilities in three RCRA-permitted hazardous waste storage buildings and on three interim status storage pads in B– and N–Areas. Most of the waste is shipped offsite to commercial RCRA-permitted treatment and disposal facilities using Department of Transportation-certified transporters. Eight to nine percent of the hazardous waste (organic liquids, sludge, and debris) will be incinerated in the Consolidated Incineration Facility. Hazardous chemicals are stripped from aqueous liquids collected during groundwater monitoring in the M–Area Air Stripper, with the treated wastewater discharged in accordance with NPDES criteria.

Nonhazardous Waste. In 1994 the centralization and upgrading of the sanitary wastewater collection and treatment systems at SRS were completed. The program included the replacement of 14 of 20 aging treatment facilities scattered across the site with a new 3,977 m^3/day (1.05 MGD) central treatment facility and connecting them with a new 29 km (18 mi) primary sanitary collection system. The 29 km (18 mi) collection system intercepts wastewater at points prior to discharge into old sanitary wastewater treatment facilities. The new central treatment facility treats sanitary wastewater by the extended aeration activated sludge process utilizing the oxidation ditch method. The treatment facility separates the wastewater into two forms, clarified effluent and sludge. The liquid effluent is further treated by non-chemical methods of ultraviolet light disinfection to meet NPDES discharge limitations. The sludge goes through a volume reduction process to reduce pathogen levels to meet proposed land application criteria (40 CFR 503). The remaining existing sanitary wastewater treatment facilities are being upgraded as necessary to meet demands by replacing existing chlorination treatment systems with non-chemical ultraviolet light disinfection systems to meet NPDES limitation. [Text deleted.] SRS-generated municipal solid waste is sent to a permitted offsite disposal facility. DOE is evaluating a proposal to [Text deleted.] participate in an interagency effort to establish a regional solid waste management center at SRS. SRS addressed the offsite shipments in *Environmental Assessment for the Transportation and Disposal of Savannah River Site Generated Municipal Solid Waste at an Off-Site Disposal Facility* (DOE/EA-0989, August 1994) and described the environmental impacts of a regional center in *Environmental Assessment for the Construction and Operation of the Three Rivers Authority Waste Management Center at the Savannah River Site* (DOE/EA-1079, October 1995).

3.5 BABCOCK & WILCOX FACILITY, LYNCHBURG, VIRGINIA

The B&W NNFD was established in 1956. B&W is an operating company of McDermott, Inc., a subsidiary of McDermott International, Inc. It occupies approximately 212 ha (524 acres), approximately 8 km (5 mi) east of Lynchburg, Virginia. B&W NNFD operations primarily support the U.S. Navy propulsion program by fabricating unirradiated HEU into complete core assemblies for nuclear reactor fuel components, including fuel loading and subsequent refueling of ship reactors. They also provide fuel for Government and university research reactors. NNFD also performs recovery of scrap uranium. The location of the B&W site and its vicinity is shown in Figure 3.5–1.

The following sections describe the affected environment at B&W for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management.

3.5.1 LAND RESOURCES

Land Use. The B&W facility is located in the northeastern portion of Campbell County in central Virginia (Figure 3.5–1). The site is bordered by an oxbow of the James River along the north, east, and west site boundaries. The region is characterized by mixed land use consisting of small farms (crop and pasture) interspersed with large tracts of forested land. The Internet Foundry, which manufactures light machine parts of iron and steel, is 0.4 km (0.25 mi) from the southern boundary of the site. Other industrial activities are located within 4.8 km (3 mi) of the site, with the major industries in the general area near or within the city of Lynchburg (BW NRC 1991a:43).

There are three major classifications of land at the B&W site: agricultural/meadow (approximately 47 percent), undeveloped forest (approximately 48 percent), and industrial (approximately 5 percent) (BW NRC 1991a:44). Generalized land uses at the B&W site and its vicinity are presented in Figure 3.5.1–1. Three facilities are located at B&W: NNFD, Lynchburg Technology Center, and the Commercial Nuclear Fuel Plant (CNFP), which is owned by B&W Fuel Company, a conglomerate of French companies that includes Framatome (BW NRC 1991a:30). NNFD is located in the center of the site within an approximately 13.2-ha (32.6-acre) fenced area. The main manufacturing complex is contained in a separately fenced, approximately 8-ha (19-acre), area (see Figure 3.5.1–2 for B&W facility map). Bays 12A, 13A, and 14A of the NNFD facility would be the principal bays used for recovery and blending operations. There is no prime agricultural land on the site (BW USDA 1979a). The closest residence is approximately 1,100 m (3,610 ft) west-southwest from the NNFD stacks (BW NRC 1991a:73).

There are no formal public recreational facilities located on B&W; however, a softball field is available for the use of plant workers. Minimal swimming, boating, and other shoreline activities occur along the James River south of Lynchburg. While several small-scale recreational facilities (for example, playgrounds and athletic fields) are in the immediate vicinity of B&W, there are no prime or generally recognized recreational destination sites within the immediate area (BW 1974a:2-2-6).

Visual Resources. The landscape of B&W is characterized as gently rolling land dominated by a hill located approximately at the center of the property. The site also includes a large area of relatively flat floodplain adjacent to the James River. Mt. Athos, with an elevation of approximately 271 m (890 ft) above mean sea level, is the highest point near the site. The vegetation at B&W is predominately deciduous forest mixed with coniferous species (oak-hickory-pine). The undeveloped portions of the site consist of second-growth forests and grasslands, with a portion of the forest occurring within the James River floodplain. Wetlands are associated with the James River (BW NRC 1991a:56,59).

The visual character of B&W facilities may be described by individual facility. NNFD is contained within a fenced area. Manufacturing operations and support areas, office space, and a liquid waste treatment facility occupy a footprint of approximately 60,850 square meters (m^2) (655,000 square feet [ft^2]) (BW NRC 1991a:40). The NNFD main facility and parking lot remain brightly lit throughout the night. The Lynchburg Technology Center is located adjacent to NNFD and

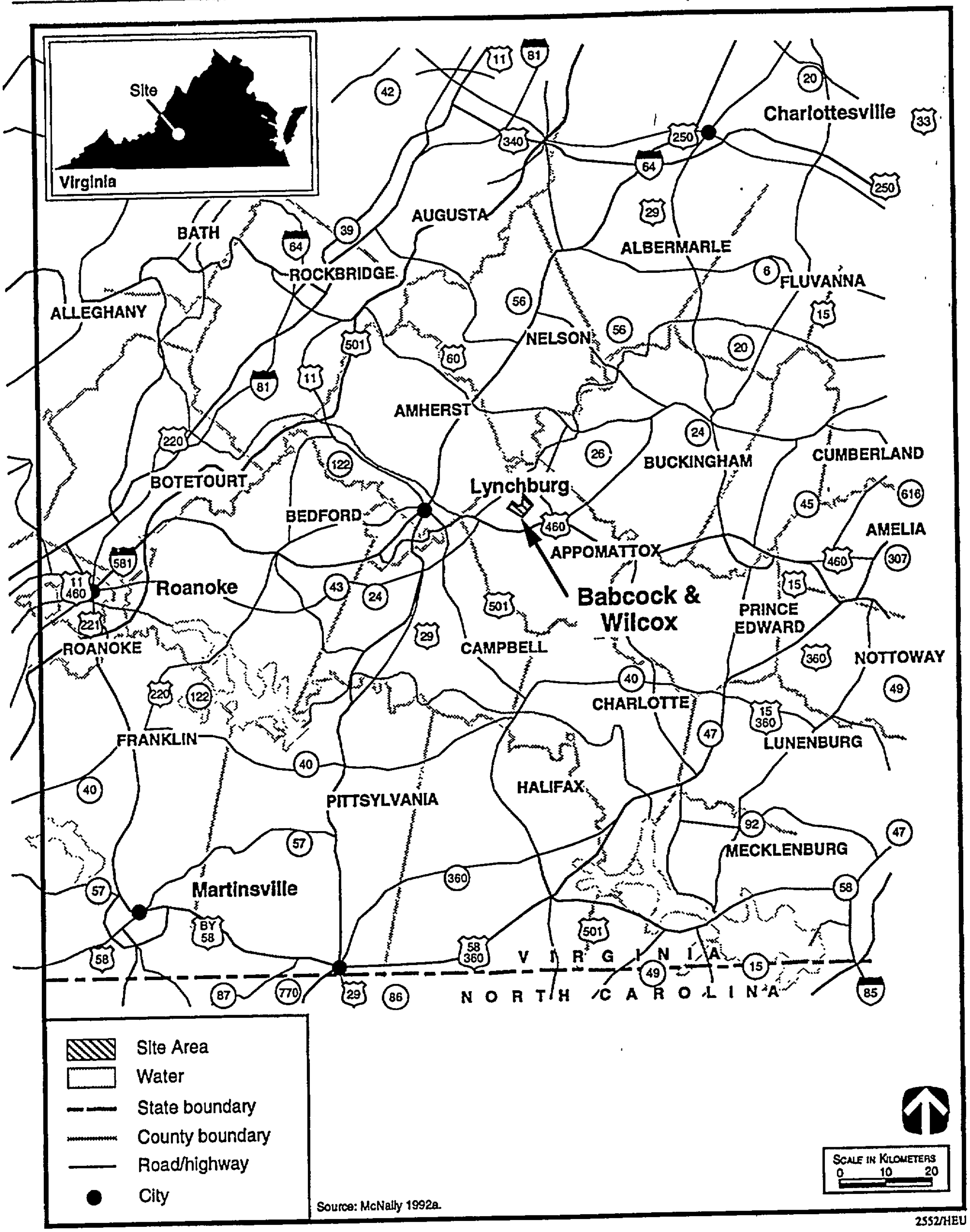


Figure 3.5–1. Babcock & Wilcox Site, Virginia, and Region.

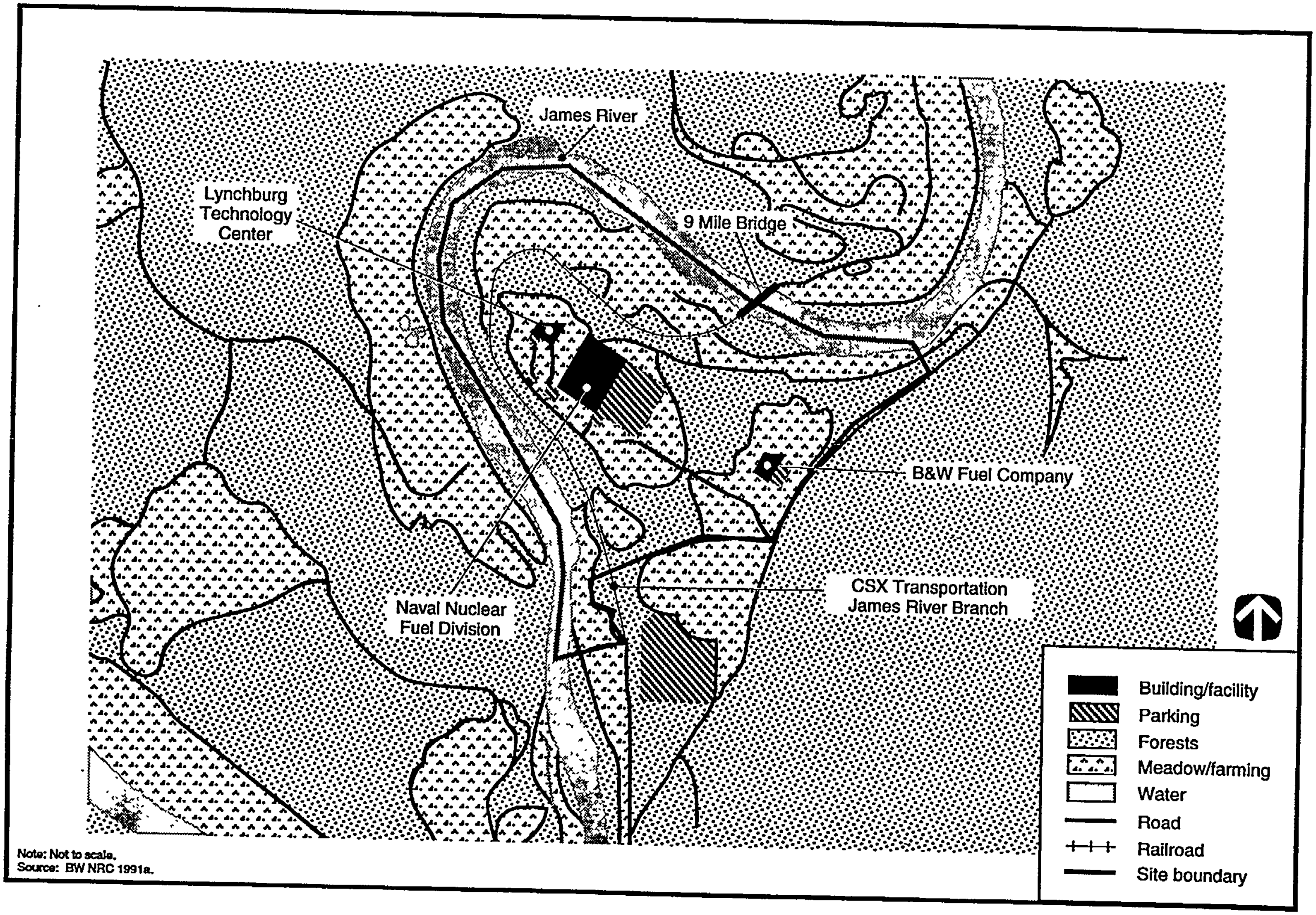


Figure 3.5.1–1. Generalized Land Uses at the Babcock & Wilcox Site and Vicinity.

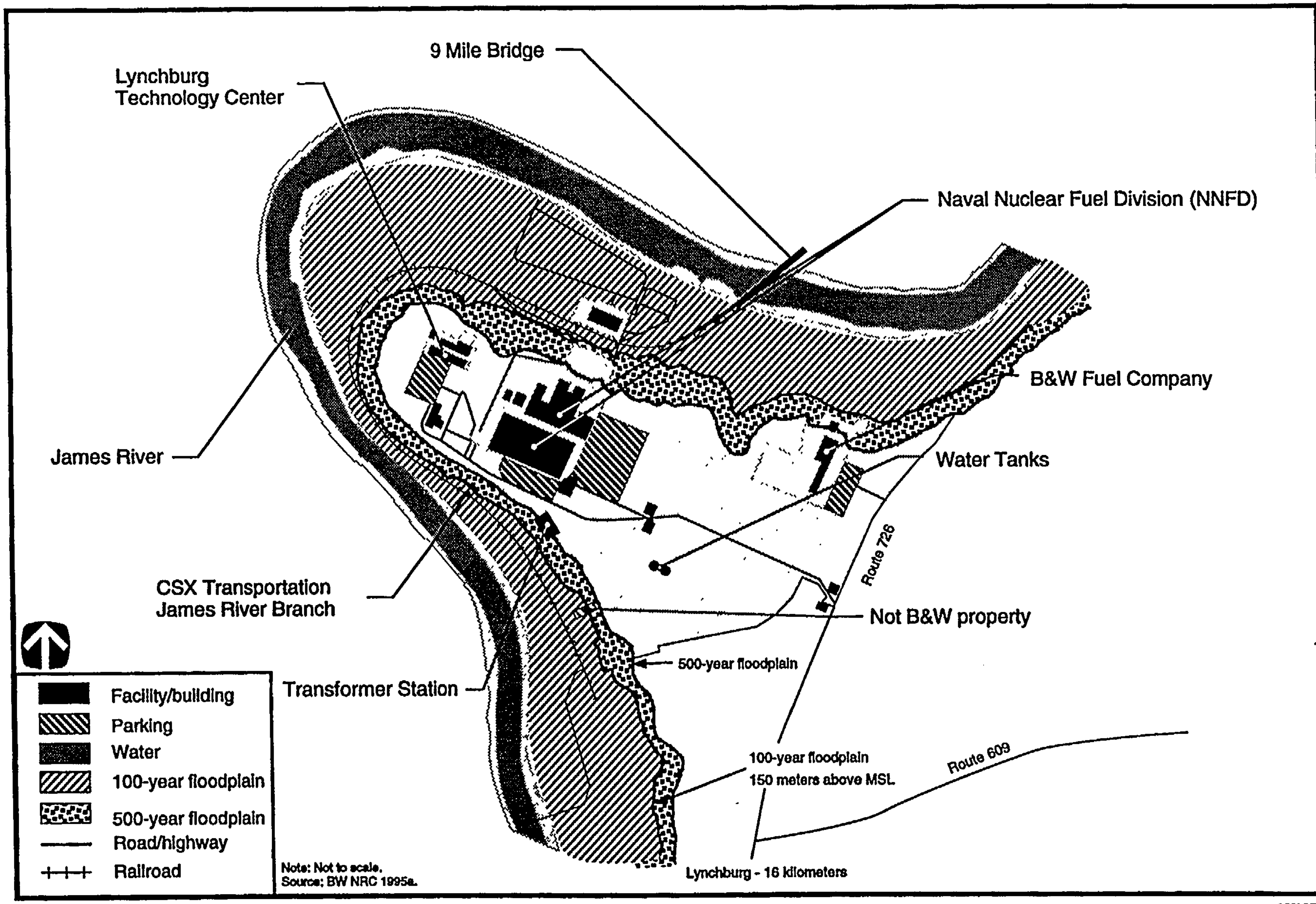


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Figure 3.5.1–2. Primary Facilities at the Babcock & Wilcox Site.

is similar in appearance. The facility footprint is approximately 10,500 m^2 (113,000 ft^2), with the structures varying from one to three stories in height. The *Environmental Report for the Babcock & Wilcox Commercial Nuclear Fuel Plant, Lynchburg, Virginia* (BAW-1412, December 1974) describes the area associated with the CNFP as landscaped and maintained to present a park-like appearance. The main plant building is a windowless, metal-paneled structure with a light tan and white, baked enamel finish. The footprint of the main plant building and machine shop wing is approximately 4,030 m^2 (43,400 ft^2) and has an average roof height of 7.3 m (24 ft). Support facilities are of metal construction. The plant site is surrounded by a 1.8-m (5.9-ft) chain-link security fence.

The visual landscape consists of rural character with farmland and woodland use. The city of Lynchburg is the nearest and largest population center. Offsite views of B&W facilities are greatly limited due to hilly terrain, forested areas, and limited access; however, agricultural and forested lands on the opposite side of the James River may be in view of the site. From U.S. 460, SR-726 provides the only access to the site. B&W facilities are not visible from U.S. 460 and are visible for only a short distance from SR-726 due to a hill that blocks the view of NNFD and the Lynchburg Technology Center. SR-726 ends in a private logging road approximately 3 km (1.9 mi) beyond the CNFP facility (BW 1974a:3-1-1).

3.5.2 SITE INFRASTRUCTURE

Site Description. The proposed action would add process equipment in existing buildings used by NNFD. This division is collocated with CNFP (B&W Fuel Company) and the Lynchburg Technology Center on B&W. The three functions on B&W's property are separately regulated by NRC. The laboratory supports NNFD operations, and NNFD processes sanitary waste and LLW for the laboratory.

The primary mission of NNFD is the fabrication of highly enriched nuclear fuel elements and assembly of these elements into complete reactor cores for the U.S. Navy. Other activities include fabrication of elements or cores for research and testing activities, research related to manufacturing of fuel elements, recovery of uranium from scrap materials, and recovery of uranium from fuel elements. The fuel manufacturing process includes classified techniques that are unique to the Naval Reactor Program.

Fuel elements are manufactured and assembled in two steel-frame buildings that have a total floor area of 46,400 m^2 (500,000 ft^2). Enriched uranium is processed into fuel elements and then assembled into complete reactor cores. Support activities, conducted in separate buildings, include fuel recovery, recovery of scrape zirconium and copper, waste compaction, waste processing, and research related to the recovery of uranium. The locations of these buildings are shown in Figure 3.5.2–1.

Incoming materials include HEU; zirconium, copper, nitric, and hydrofluoric acids; aluminum nitrate; aluminum; fuel oil; cutting oil; water; and natural gas. Exit streams include: product fuel elements and assemblies; recovered metals; and gaseous, liquid, and solid waste streams.

The B&W facility can be reached from SR-726 which connects with SR-609 and U.S. 460. U.S. 460 is a major link between the Roanoke/Lynchburg area and the eastern portion of the State. NNFD is also serviced by a spur of CSX Transportation that runs through the B&W property.

Environmental Regulatory Setting. The NNFD facility of B&W is regulated by NRC, who issued a 10-year license renewal to B&W in 1991. NRC provides compliance with CEQ regulations (40 CFR 1500-1508) by preparing an EA in support of the license issuance. While NNFD operates in compliance with its license, NRC regulates on the basis of the reduction of emissions of radionuclides to a level of as low as reasonably achievable (ALARA).

Radioactive material is released to the atmosphere through 27 stacks at NNFD and 2 stacks at Lynchburg Technology Center. While the weighted average release falls within the limits of 10 CFR 20 for concentration at an unrestricted area, NRC had concerns about untreated stack effluents, and so recommended the reduction of radionuclide emissions as part of the most recent license renewal conditions.

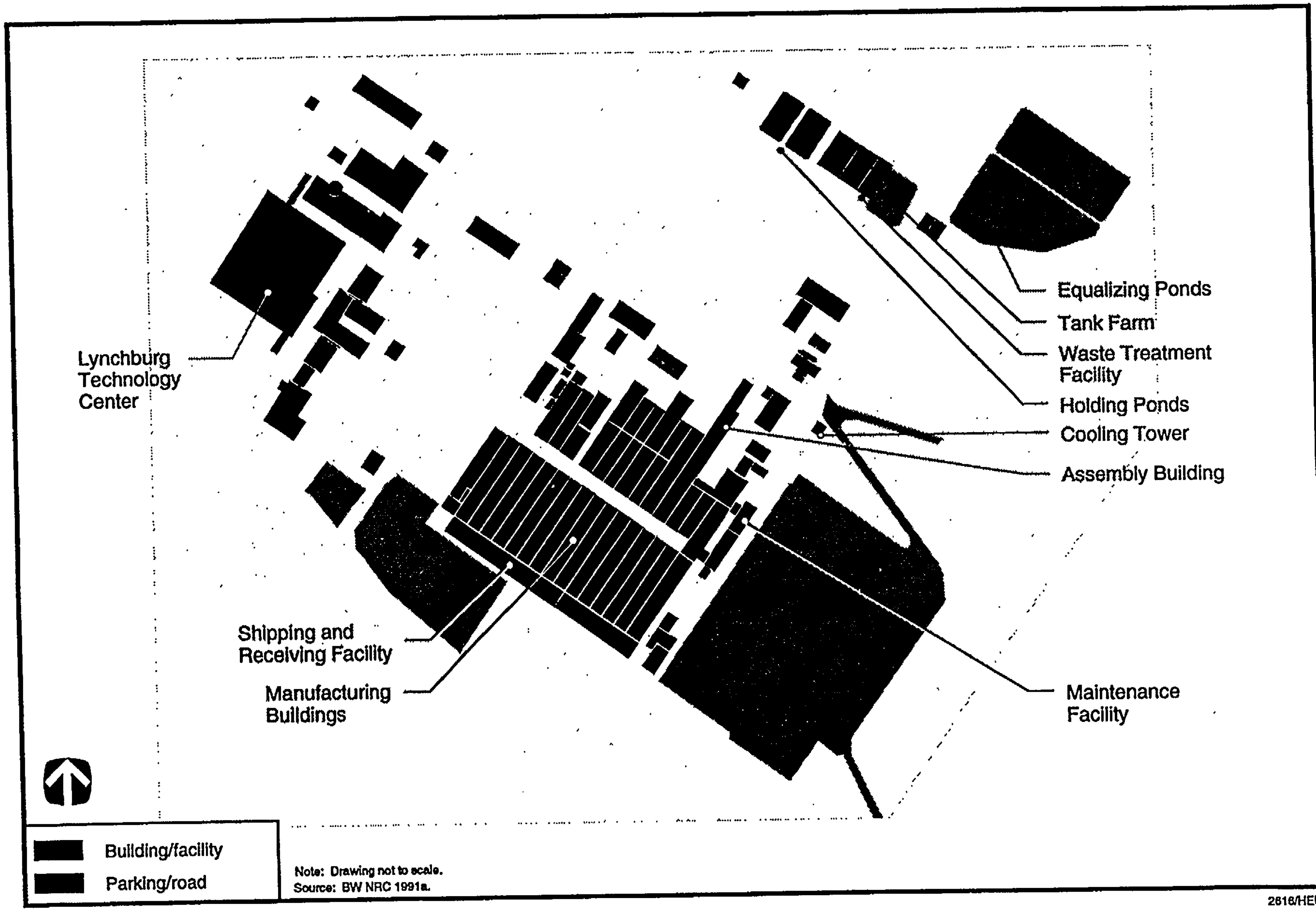


Figure 3.5.2–1. Building Locations at the Babcock & Wilcox Site.

Liquids discharged from NNFD enter the James River through three NPDES-permitted outfalls. The effluent is monitored to ensure compliance with provisions of the permit, which in turn ensure compliance with the *Clean Water Act* (CWA) and 10 CFR 20 for radionuclide content for discharge to unrestricted areas. In addition, NRC requires the facility to demonstrate compliance with the CWA and recommends that the licensee notify NRC within 30 days if the State of Virginia revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit. In addition, the licensee must notify NRC within 30 days of any violation of permit.

[Text deleted.] The Commonwealth of Virginia Department of Environmental Quality classified an NNFD pickling process as an etching process. The Virginia Department of Environmental Quality's classification resulted in the filter cake generated from the neutralization of the pickle acid as an F006 listed waste. This classification retroactively affected the onsite landfills and the disposal of a portion of the filter cake that was generated after the determination. F006 filter cake initially was also determined to be contaminated with very low levels of special nuclear material and therefore was classified as a mixed waste.

The B&W facility has identified and successfully implemented a disposal strategy for the filter cake solids generated after the Virginia Department of Environmental Quality classification. The material in the onsite landfills is being addressed with NRC and the EPA. B&W initiated an aggressive program of pollution prevention and waste minimization that effectively eliminated the generation of mixed waste. Legacy mixed waste generated by B&W NNFD is being addressed under an agreement with the Virginia Department of Environmental Quality. Low-level radioactive, hazardous, and solid nonhazardous wastes are staged onsite for shipment to offsite disposal facilities. The Virginia Department of Environmental Quality provides monitoring for compliance with RCRA regulations.

Pollution Prevention. Pollution prevention at NNFD is mandated by statutes, regulations, and governmental agency directives. The NNFD pollution prevention program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible in accordance with regulatory requirements. A comprehensive effluent and environmental monitoring program is conducted onsite to measure progress toward pollution prevention goals and to ensure compliance with appropriate environmental protection standards and to provide, where possible, site-specific data to assist in the prediction of environmental impacts.

Baseline Characteristics. The Naval Nuclear Fuel Division contains extensive production, research, and waste processing capabilities. To support current missions and functions, an infrastructure exists as shown in Table 3.5.2–1. The site is accessed by CSX Transportation and SR-726, which is 3.2 km (2 mi) from U.S. 460.

Table 3.5.2–1. Babcock & Wilcox Naval Nuclear Fuel Division Baseline Characteristics

Current Characteristics	Value
Land	
Area (ha)	212[a]
Roads (km)	<1
Railroads (km)	0.305
Electrical	
Energy consumption (MWh/yr)	64,700
Peak load (MWe)	14.3
Fuel	
Natural gas (m^3/yr)	2,850,000
Diesel/oil (l/yr)	470,000
Coal (t/yr)	0
Steam	
Generation (kg/hr)	1,460
Water Usage (l/yr)	195,000,000

[a] Although the total size of the B&W site is 212 ha, the NNFD portion of the site is 7.7 ha.

Note: MWh=megawatt hour; MWe=megawatt electric.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a.

3.5.3 Air Quality and Noise

The following describes existing air quality, including a review of the meteorology and climatology, in the vicinity of B&W. More detailed discussions of air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.6.

Meteorology and Climatology. The climate of the area surrounding B&W is influenced by cold and dry polar continental air masses in the winter and humid gulf maritime air masses in the summer. Extremes in weather conditions in the area are rare.

The average annual temperature at B&W is 13.3 °C (55.9 °F); the average daily minimum temperature is -4.1 °C (24.7 °F) in January; and the average daily maximum temperature is 30 °C (86 °F) in July. The average annual precipitation is approximately 104 cm (40.9 in). The monthly precipitation rates are nearly uniform throughout the year except for a slightly higher rate during the summer months. Prevailing wind directions at B&W are predominantly from the southwest, with a mean speed of 3.4 m/s (7.7 mph) (NOAA 1994b:3). Additional information related to meteorology and climatology at B&W is presented in Appendix C, Section C.1.6.

Ambient Air Quality. The B&W facility is located in Campbell County, in the Central Virginia Intrastate AQCR. As of January 1995, the areas within this AQCR were designated as in attainment with respect to NAAQS (40 CFR 81.347). Applicable NAAQS and Virginia State ambient air quality standards are presented in Appendix C, Section C.1.3.

One PSD Class I area can be found in the vicinity of B&W. This area, James River Face National Wilderness Area, is located approximately 40 km (24.9 mi) northwest of B&W. Since the promulgation of regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emissions source at B&W.

Tables 3.5.3–1 and 3.5.3–2 present the baseline ambient air concentrations for criteria and toxic/hazardous pollutants at B&W, respectively. As shown in the tables, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise Conditions. The noise environment near B&W is typical of a rural location with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4, B-5). Major noise emission sources within B&W include various industrial facilities, equipment, and machines. The primary source of noise at the site boundary and at residences near roads is expected to be traffic. During peak hours, the plant traffic may be a major contributor to traffic noise levels in the area. At the site boundary, some noise on site may be audible above the background sound levels. The impact of onsite noise sources has not been documented.

The Commonwealth of Virginia has not yet established noise regulations that specify acceptable community noise levels that would be applicable to B&W. Campbell County has established a maximum sound level limit of 65 dBA, which is applicable at a property boundary of the receiving land for the hours 10 p.m. to 6 a.m., but it is not applicable to construction and industrial activities.

3.5.4 WATER RESOURCES

Surface Water. The major surface water body in the immediate vicinity of B&W is the James River, which borders the site on three sides. Northern Campbell County is drained by the James River and its primary tributaries: Blackwater Creek, Opossum Creek, Beaver Creek, and Archer Creek. The James River flows generally southeast from the Valley and Ridge Province to the Atlantic Ocean. Just east of Lynchburg, the river makes an abrupt turn northeastward following the zone of faulted rocks for about 64 km (39.8 mi), then resumes its southeasterly course across the Piedmont Province. The annual average flow of the James River at the site is estimated to be about 107 m^3/s (3,800 ft^3/s) (BW 1974a:2-5-3). The minimal flow rate of the James River is 12.7 m^3/s (448 ft^3/s). The natural surface water body in the vicinity of the B&W facility is shown in Figure 3.5.1–2.

[Figure deleted.]

The B&W facility withdraws water from the James River and treats it before distribution to the various users. Total water supplied from the James River is approximately 735 million l/yr (194 MGY) with a withdrawal design capacity of approximately 1,193 million l/yr (315 MGY) (BW NRC 1995a:3). A recycled water system is also used at the facility to provide water for noncontact cooling, firefighting, sanitary sewage, and other uses that do not require high-purity water. The system receives make-up water from the James River. The recycled water system has become contaminated with low levels of radioactive material (uranium). The major source of

Table 3.5.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at the Babcock & Wilcox Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	Concentration at B&W Boundary (μg/m³)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a]	4	<1
	1 hour	40,000[a]	13.1	<1
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3.5	3.5
Particulate matter (PM_{10})	Annual	50[a]	0.02	<1
	24 hours	150[a]	0.16	<1
Sulfur dioxide (SO_2)	Annual	80[a]	0.34	<1
	24 hours	365[a]	2.28	<1
	3 hours	1,300[a]	11.8	<1
Mandated by Virginia				
Total suspended particulates (TSP)	Annual	60[c]	0.03	<1
	24 hours	150[c]	0.22	<1

[a] Federal standard.
[b] No emissions from existing sources.
[c] State standard or guideline.
Note: Ozone, as a criteria pollutant, was not evaluated since it is not directly emitted or monitored by the candidate sites.
Source: 40 CFR 50; VA APCB 1993a; VA DEQ 1995b.

Table 3.5.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants From Existing Sources at the Babcock & Wilcox Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] (μg/m³)	Concentration at B&W Boundary (μg/m³)	Percent of Regulations or Guidelines
Copper compounds	Annual	2	0.04	2
	1 hour	50	4.65	9.3
Nitric acid	Annual	10.4	0.04	0.4
	1 hour	250	4.55	1.8
Sulfuric acid	Annual	2	0.01	0.5
	1 hour	75	1.13	1.5
Trichloroethylene	Annual	538	2.44	0.5
	1 hour	13,425	313.6	2.3

[a] State standard or guideline.
Source: BW EPA 1995a; VA APCB 1993a.

the uranium contamination is believed to be fallout from recovery stack emissions and the subsequent drainage of rainwater from the roof areas that entered the recycle system in stormwater used for make-up at that time. Currently, an action plan to remedy the contamination problem has been implemented (BW NRC 1991a:5).

The U.S. Department of Housing and Urban Development has conducted flood studies along the James River. The northwest, north, and northeast property boundaries of B&W lie within the 100-year floodplain of the James River (Figure 3.5.1–2). The James River has flooded the plant site 11 times between the years 1771 and 1985. The 1795 flood had the highest flood stage and was measured at 160 m (525 ft) above mean sea level at Lynchburg and estimated at 151 m (495 ft) above mean sea level at the site. The largest most recent flood occurred in 1985, with a flood stage of 150 m (492 ft) above mean sea level at the site (BW NRC 1991a:43). Upstream flood control facilities have been designed to reduce the probability that the largest historic flood stages will be exceeded. The U.S. Army Corps of Engineers has developed flood criteria for a maximum probable flood and a standard project flood for the James River. According to these criteria, maximum probable flood and standard project flood discharges would produce a discharge rate of 10,700 m^3/s (378,000 ft^3/s) and a flood stage of 153 m (502 ft) above mean sea level at the site. The 500-year flood is estimated to have a discharge of 8,200 m^3/s (290,000 ft^3/s) and a stage of 152 m (499 ft) above mean sea level at the site (BW 1974a:2-5-4).

Surface Water Quality. The James River has been designated a Class A river at the site by the Virginia Department of Environmental Quality–Water Division (formerly known as the Virginia State Water Control Board). Classification A requires that the water must be generally satisfactory for use as public or municipal water supply and for secondary contact recreation, propagation of fish and aquatic life, and other beneficial uses. Several communities, including the city of Lynchburg, use the James River as their primary source of drinking water. The major water consumers downstream from the plant are Scottsville and Richmond (approximately 100 and 200 km [62 and 120 mi], respectively, in distance) (BW 1974a:2-5-6).

The B&W facility has three outfalls regulated by its NPDES permit. Effluents from the sanitary, radioactive and nonradioactive pickle acid treatment plants, and the Imhoff System have been combined to Outfall 001 (BW NRC 1995a:21). Discharges from Outfall 001 are discharged through a diffuser located in the middle of the river to allow mixing with James River water and to mitigate any potential impacts. Effluents from the stormwater overflowing the noncontact cooling tower and recycle reservoir are discharged through Outfall 002. The overflows from the noncontact cooling water system and the stormwater pond are discharged through Outfall 003. All three outfalls from the site discharge into the James River at a rate of approximately 65 million l/yr (17 MGY) (BW NRC 1991a:50). The parameters regulated by the NPDES permit are identified in Table 3.5.4–1, which lists the surface water monitoring results for the James River. Between 1989 and 1993, the NPDES permit was noncompliant two times at B&W: one for fecal coliform and one for fluoride (BW NRC 1995a:3).

Surface water samples are collected semiannually at six locations throughout the site by NNFD. The samples are analyzed for alpha activity and total uranium content. The action level for surface water are 15 picocuries per liter (pCi/l). The levels of uranium in surface water is well below action level, indicating that there has been minimal impact from operations (BW NRC 1991a:23).

Surface Water Rights and Permits. Surface water rights and allocations for the Commonwealth of Virginia are determined by the common law Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water for downstream users, and the water must be used for beneficial purposes. Virginia statutory laws direct the Virginia Department of Environmental Quality–Water Division to formulate State water resources policies and regulations that maintain the quality of the State's waters.

In December 1981, the Virginia State Water Control Board adopted Regulation II, which became effective March 1, 1982. This regulation requires the reporting of withdrawals of surface or groundwater when the daily average rate exceeds 0.038 million l/day (0.01 MGD) during any single full month of the year; excluded are withdrawals for crop irrigation,

Table 3.5.4–1. Summary of Surface Water Quality Monitoring at the Babcock & Wilcox Site

	Receiving Water: James River, 1993		
Parameter	**Unit of Measure**	**Water Quality Criteria**[a]	**Average Water Body Concentration**[b]
Arsenic	mg/l	0.05[c]	0.003
Beryllium	mg/l	0.004[c]	0.001
Biological oxygen demand	mg/l	NA	2
Cadmium	mg/l	0.006[c]	0.006
Chemical oxygen demand	mg/l	NA	12
Chromium	mg/l	0.1[c, d]	0.009
Chloride	mg/l	250[e]	15
Copper	mg/l	1.3[c, d]	0.0012
Fluoride	mg/l	4[c, d]	0.13
Lead	mg/l	0.015[c, d]	0.008
Manganese	mg/l	0.05[e]	0.073
Nickel	mg/l	0.1[c]	0.012
Nitrate as nitrogen	mg/l	10[c]	0.015
Nitrite as nitrogen	mg/l	0.025[f]	0.316
pH	pH units	6-9[d]	7.75
Selenium	mg/l	0.05[c]	0.001
Sulfate	mg/l	250[e]	22
Thallium	mg/l	NA	0.001
Zinc	mg/l	5[e]	0.02

[a] For comparison only.
[b] Results from the 6-21-93 sampling effort.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] Virginia Surface Water Quality Standards (VR 680-21-01.2B).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] Virginia Groundwater Quality Standard (VR 680-21-04).
Note: NA=not applicable.
Source: VA DEQ 1993a.

withdrawals of saline surface waters, withdrawals from mines or quarries for the sole purpose of dewatering, withdrawals for the sole purpose of hydroelectric power generation, and withdrawals by Federal agencies. Also exempt from the regulatory mechanisms are users who do not withdraw their water but obtain it from other users.

Groundwater. Metamorphic rocks of the Evington Group occupy the main portion of the B&W site. These rocks have very little porosity and are practically impermeable. Since these rocks generally slope in a northerly direction toward the James River, the main groundwater body (confined or unconfined) also follows the surfaces of the impervious layers. Because the thin layer of topsoil is underlain by impermeable cohesive soils such as silt and clay, runoff that penetrates into the topsoil is blocked by the cohesive soils and forms an unconfined groundwater source. The main portion of groundwater under the property is found in confined aquifers (BW 1974a:2-5-8). Although metamorphic rocks are usually poor aquifers, the wells on the B&W property produce adequate amounts of groundwater. Upper aquifer groundwater levels determined in a site survey range from 151 to 144 m (495 to 472 ft) above mean sea level. The higher levels are observed at the center of the site, and the lower levels are observed near the riverbank. The measured levels are all above the normal river elevation (BW NRC 1991a:53). The aquifer is recharged from the rainwater that falls in the B&W drainage basin.

Groundwater Quality. Groundwater is monitored quarterly by B&W's Environmental Engineering at 24 monitoring wells for pH, fluoride, nitrate, VOCs, and radioactivity. B&W's Environmental Engineering monitors for potential releases and tracks three trichloroethylene plumes under an EPA RCRA consent order. Annual sampling for primary and secondary metals is also conducted at these wells. In addition, sampling of the seven groundwater supply wells is also conducted for pH and radioactivity. Table 3.5.4–2 shows groundwater quality for selected groundwater monitoring wells. The action level for radioactivity in groundwater is 15 pCi/l, well in excess of observed levels (not shown in Table 3.5.4–2), indicating that the facility operations have not affected radiological quality of the groundwater. Levels reported for some primary and secondary metals are below maximum contaminant levels defined as primary drinking water standards. However, most exceed State groundwater contaminate levels.

[Text deleted.] The three groundwater plumes are contaminated with trichloroethylene (TCE), tetrachloroethylene (PCE), and related degradation constituents above the drinking water limit of

Table 3.5.4–2. Summary of Groundwater Quality Monitoring at the Babcock & Wilcox Site

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	FEP–3[b]	FEP–1[c]
Aluminum	mg/l	0.05-0.2[d]	155.075	3.5375
Cadmium	mg/l	0.006[e]	0.01635	0.016
Chromium	mg/l	0.1[e, f]	0.238	0.0356
Copper	mg/l	1.3[e, f]	0.55825	0.04
Cyanide	mg/l	0.2[e]	0.005	0.005
Fluoride	mg/l	1.4[f]	1.6925	2.15
Foaming agents	mg/l	0.05[f]	0.0725	0.23
Lead	mg/l	0.015[e, f]	0.1	0.026
Nitrogen	mg/l	0.025[f]	1.415	1.07
Nitrate as nitrogen	mg/l	10[e, f]	1	802.5
Nitrite as nitrogen	mg/l	0.025[f]	0.064	0.58
pH	pH units	5.5-8.5[f]	6.8	6.5
Silver	mg/l	0.1[d]	0.0169	0.0139
Sodium	mg/l	270[f]	12.075	1,764.625
Total organic carbon	mg/l	10[f]	8.285	3.7613
Total toxic organics	mg/l	2.13[f]	0.01	0.01
Zinc	mg/l	5[d]	0.66825	0.04713

[a] For comparison only, except for parameters with Virginia groundwater standards.
[b] FEP–3 monitors background water quality upgradient to the Final Effluent Ponds (FEP). Data represent the average of groundwater monitoring for 1993.
[c] Well is located downgradient of the Final Effluent Ponds. The number shown is an average value.
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] National Primary Drinking Water Regulations (40 CFR 141).
[f] Virginia Groundwater Quality Standards (VR 680-21-04).
Source: BW 1994a.

0.005 parts per million (ppm) (BW NRC 1995a:32). The largest plume, 28 ha (70 acres), is located beneath the NNFD plant and has an average concentration of 0.1 ppm for TCE. The second plume is located beneath the CNFP, and is approximately 10 ha (25 acres) with an average concentration of 0.01 ppm for TCE. The third plume is located on the western portion of the site where the former uranium recovery building was buried. The plume has an average concentration of 0.1 ppm for TCE and 0.1 ppm for PCE and is approximately 2 ha (5 acres) (BW NRC 1995a:32). The plumes are each migrating toward the James River, where dilution and evaporation reduce contaminant concentrations to acceptable levels (BW NRC 1991a:23-27). Upon EPA Region III approval of the Remedial Feasibility Investigation (RFI) report, B&W will proceed with the corrective measures study, where alternatives for corrective action will be evaluated (BW NRC 1995a:32).

Groundwater Availability, Use, and Rights. Approximately 165 million l/yr (43.6 MGY) of groundwater are obtained for potable and industrial process applications (BW 1996a:1). The groundwater is pumped from seven wells located in the northeast portion of the facility at an average rate of 322 l/minute (85 gal/minute), with a maximum capacity of 492 l/minute (130 gal/minute) (BW NRC 1995a:6). Groundwater without prior treatment is used as potable water and is routed to wastewater treatment following use. Groundwater used as process water is treated prior to use and is routed to wastewater treatment following use (BW NRC 1991a:5).

Groundwater rights in Virginia are traditionally associated with the American or Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others. Furthermore, the owner's use of groundwater for off-lying land may be unreasonable and therefore unlawful if the withdrawals for the off-lying land impair a neighbor's groundwater usage (VDL 1990a:725).

3.5.5 GEOLOGY AND SOILS

Geology. The B&W facility lies in the western region of the Piedmont metamorphic physiographic province, which is characterized by complex folding and faulting (BW USDA 1977a:118). The Piedmont Plateau, a landform of gently rolling to rolling topography, is underlain mainly by metamorphic rock formations and, to a lesser extent, by sedimentary and igneous rock formations. The surficial geology is composed of Quaternary-age alluvium below the 150-m (500-ft) contour elevation and Quaternary or older terrace gravels at higher elevations up to the base of Mt. Athos (BW NRC 1995a:25).

At B&W, metamorphic rocks (muscovite, schist, and phyllite) of the Candler Formation are exposed west of SR-726. East of SR-726, bedrock under the site is the metamorphic graphitic schist member of the overlying Archer Creek Formation. Both the Candler and Archer Creek Formations are part of the Evington Group of rock, which consists of tight isoclinal folds that have been faulted by high-angle reverse faults as a result of the James River Synclinorium regional structure (BW NRC 1991a:53).

Babcock & Wilcox lies within Seismic Zone 1, indicating that minor damage could occur as a result of earthquakes (Figure 3.3.5–1). Since the Virginia earthquake of 1758, 121 earthquakes with epicenters in Virginia have been reported. The largest earthquake occurred in 1897, 161 km (100 mi) west of B&W; it has been estimated that it had a modified Mercalli intensity of V to VI (Table 3.3.5–1) at the site and an intensity of VIII at the epicenter. In 1875, an earthquake with a modified Mercalli intensity of VII occurred 81 km (50.3 mi) east-northeast of the site. No earthquake activity has occurred at the site with intensities greater than the 1875 or 1897 occurrences (BW NRC 1991a:56). A maximum horizontal ground surface acceleration of 0.1 gravity at B&W is estimated to result from an earthquake that could occur once every 2,000 years (BW 1996a:1). The facilities at B&W that would be used were designed and constructed to meet the target performance to withstand an earthquake with an acceleration of 0.1 gravity (BW 1996a:1).

Soils. Most of the soil cover at B&W is formed by weathered products of the metamorphic rock formations and, to a lesser extent, by sedimentary and igneous rocks of the Piedmont Plateau. The Cullen-Wilkes Soil Association, found at the B&W site, is generally characterized as deep and moderately deep, well-drained, gently sloping to steep, and a predominantly clayey subsoil is found primarily in upland areas (BW USDA 1977a:4). This association accounts for approximately 25 percent of the area of Campbell County. It is specifically composed of 43-percent Cullen soils, 17-percent Wilkes soils, and 40-percent less extensive soils (BW NRC 1991a:56). The soils at B&W are considered acceptable for standard construction techniques.

Soil samples are collected semiannually by NNFD at 14 locations throughout the site and analyzed for alpha activity and total uranium content. B&W has continuously monitored the levels of uranium in the site's sediment and soils over the past 13 years. These results have been reported to the NRC. The NRC in the B&W EA dated June 1995 and FONSI published in the *Federal Register* (60 FR 46630, September 7, 1995) concluded that the environmental impacts associated with proposed license renewal for continued operation of B&W's NNFD/Lynchburg Technology Center facility are insignificant (BW 1996a:1). The action level identified for sediment and soil with the exception of the hot equalization pond sediment is 10 pCi/g. The action level for the radioactive equalization pond sediment is 500 pCi/g. Levels of uranium in selected sediments and soil are significant fractions of the action levels (BW NRC 1991a:23). An action plan was implemented in 1993 and 1994 to remedy the contamination problem related to fallout from recovery stack emissions and the subsequent drainage from the roof. Fallout from the recovery stack is no longer an issue because recovery scrubber system modifications and improvements were made. All potentially contaminated effluents have been routed through treatment systems through permitted discharge points.

3.5.6 BIOTIC RESOURCES

Biotic resources at B&W include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each resource area, the discussion describes B&W as a whole. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Plant communities at B&W are characteristic of intermountain regions of central and southern Appalachia. Natural climax vegetation in the region is classified as oak-hickory-pine forest. Common species include white oak, post oak, hickory, and pine.

Approximately 48 percent of the site is second-growth forest and 47 percent is maintained as grassy areas. Approximately 5 percent has been developed. A portion of the forested area lies in the floodplain, adjacent to the James River (BW NRC 1991a:44).

There are approximately 24 species of mammals, 160 species of birds, 19 species of reptiles, and 17 species of amphibians expected to occur in the Lynchburg area. Economically important species in the vicinity of the site include big game mammals (for example, whitetail deer and black bear); small game mammals (for example, eastern gray squirrel and eastern cottontail); furbearers (for example, raccoon, mink, river otter, red fox, and beaver); upland game birds (for example, wild turkey, northern bobwhite, and mourning dove); and several species of waterfowl (BW NRC 1991a:59).

Wetlands. The B&W site contains several small areas of wetlands. An abandoned sewage lagoon and a fire pond and its associated wetland habitats are located near the B&W Fuel Company along with an area of wetlands associated with the river floodplain (BW NRC 1991a:50). Surface drainage at NNFD runs into one small onsite creek. Minor wetland habitats are associated with this drainage system.

Aquatic Resources. Aquatic habitats on or adjacent to B&W range from the nearby James River to several small artificial impoundments. The aquatic biota of the James River in the vicinity of B&W is characteristic of a moderately polluted flowing river. The benthic community of the James River near the site consists of both flowing and backwater areas. Fish common to the James River and found in the vicinity of B&W primarily include American shad, striped bass, common carp, and a variety of perch (BW NRC 1991a:59). These species have both commercial and recreational value.

Threatened and Endangered Species. Thirty-one Federal- and State-listed threatened, endangered, and other special status species that potentially occur on or in the vicinity of B&W are presented in Appendix D, Table D.1–4. The occurrence of these species on B&W is currently unknown. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on B&W. Federal- and State-listed threatened and endangered species that may be present at B&W include the bald eagle, peregrine falcon, Indiana bat, Virginia big-eared bat, and eastern cougar (BW NRC 1991a:59). There are no species of rare or endangered fish or mollusks known to occur in the James River in the vicinity of the site.

3.5.7 CULTURAL RESOURCES

Prehistoric Resources. Two prehistoric archaeological sites have been identified within the boundary of B&W. One site yielded historic kaolin pipestems and prehistoric stone tool manufacturing waste material; the other can be dated to the Archaic Period (ca. 8000-1000 B.C.). None of these sites is eligible for the NRHP. Prehistoric groups that lived during this time period were mobile hunters and gatherers who collected wild plants and hunted wild animals, such as white-tail deer or rabbit. The kaolin pipestem fragments are historic and probably date to the 18th century A.D. Other prehistoric resources that may exist within B&W include limited-activity hunting camps, longer-term multipurpose occupation camps, and stone tool manufacturing locations.

Historic Resources. No NRHP historic archaeological sites are located at the B&W site. Two nearby sites, the Mansion Truss Bridge, which crosses the James River to the north of B&W, and Mt. Athos, which is located east of the site on Mt. Athos, are on the NRHP. The Mt. Athos site includes the ruins of the manor house of Buffalo Lick Plantation. The house was built in 1796 by Colonel William J. Lewis. The plantation area includes gravesites, a tobacco barn, and stone cisterns. The mansion itself was destroyed by fire in 1876.

Remains of the Kanawha Canal still exist on the property and are located north of the railroad tracks and the facility structures. This canal was constructed during the early 19th century and played a role in the rural economy, transporting agricultural goods such as tobacco and wheat. During the Civil War, the canal was used by the Confederacy to transport war materials. Approximately six additional historic sites that date to the 19th century have been identified on the property. The historic component of the site previously described indicates remains of a circa 18th-century visit or occupation by European-Americans.

Native American Resources. Native Americans have lived in the Piedmont area and along the James River for thousands of years. In the early 17th century, a number of tribes that spoke Siouan dialects, including the Manahoacs, Monacans, Occaneechis, and Saponis, lived in the Piedmont region. These groups participated in a loose confederacy and can be referred to generally as Monacans. They were described by both Captain John Smith and by John Lederer in the early and late 17th century. They were hunter-gatherers of wild animals and plants, practiced agriculture, and lived in villages and hamlets. Five Monacan villages were identified on a 1607 map drawn by Captain John Smith. One of these villages was located near present-day Wingina, downstream from the site on the James River, approximately 56 km (34.8 mi) northeast of B&W.

Although most of these people were either removed, died, or left the area in the 18th and 19th centuries, the descendents of those who remained still live in the area. In 1833, Piedmont Indians purchased 162 ha (400 acres) of land on Bear Mountain in Amherst County, some 25 km (15.5 mi) north of B&W. The Monacan Indian Tribe in Amherst County is officially recognized by the State of Virginia, and most Monacans live in Amherst County and in Lynchburg. No Native American resources have been identified within B&W.

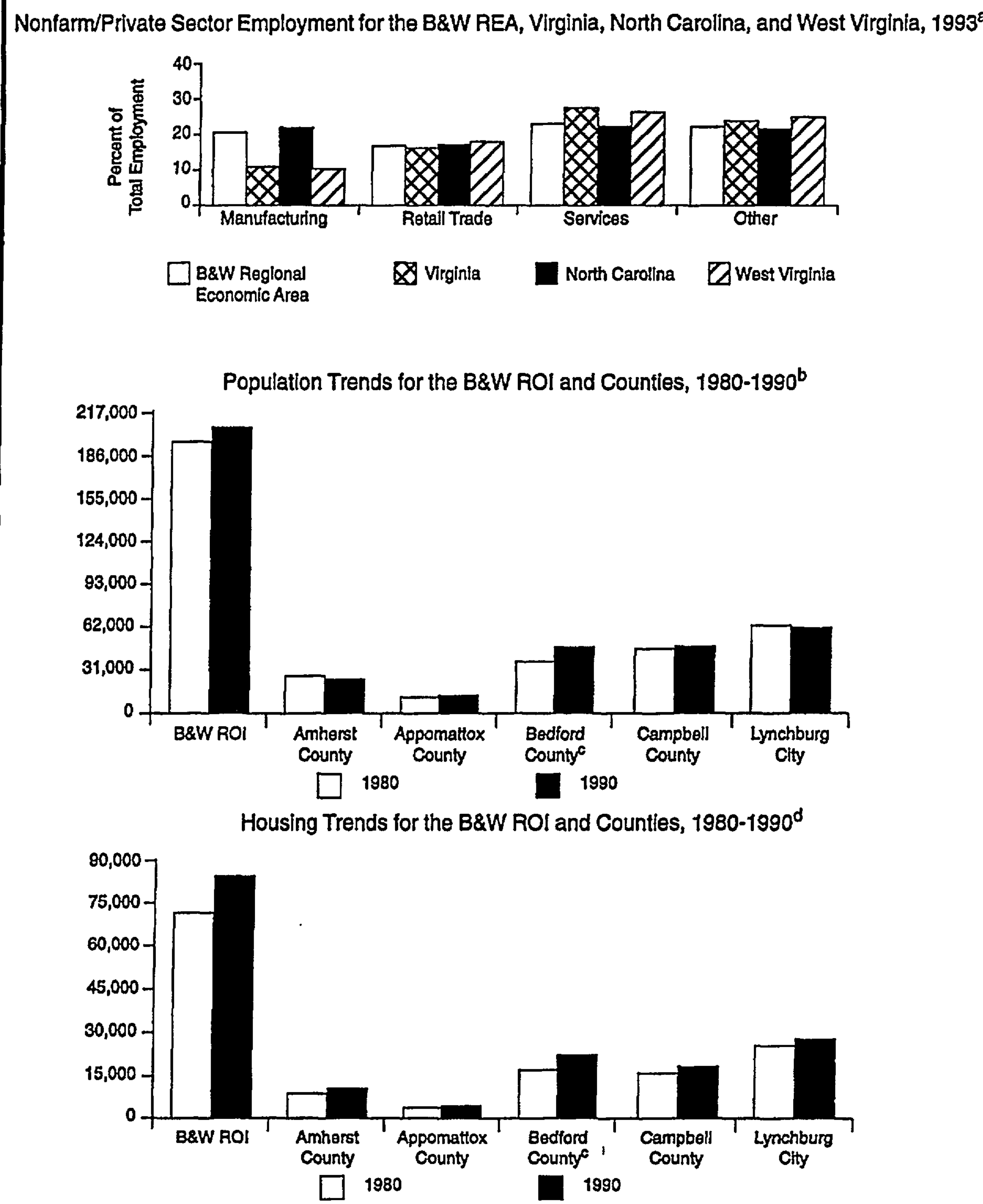
Paleontological Resources. The stratigraphy of the B&W landscape consists of two formations, the Candler Formation and the Archer Creek Formation, as described in Section 3.5.5. Outcrops of metamorphic rocks (muscovite, schist, and phylite) are located west of the main facility road. No surveys or excavations of paleontological resources have been conducted at B&W facilities because the probability of identification of significant or rare resources is low.

3.5.8 SOCIOECONOMICS

Socioeconomic characteristics described for B&W include employment, regional economy, population, housing, community services, and local transportation. Employment and regional economy statistics are presented for the REA that encompasses 18 counties around B&W in the States of Virginia, North Carolina, and West Virginia (Appendix F, Table F.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area located in Virginia (including the independent city of Lynchburg) where 91 percent of all B&W employees reside: Amherst County (11.9 percent), Appomattox County (9.6 percent), Bedford County (14.1 percent), Campbell County (18.5 percent), and Lynchburg (36.9 percent) (Appendix F, Table F.1–4). Supporting data are presented in Appendix F.

Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force increased 16.7 percent to the 1990 level of 382,857. In 1994 unemployment for the REA was 4.9 percent, comparable to Virginia's unemployment rate, but 0.5 percent higher than North Carolina's, and 4 percent lower than West Virginia's. The region's per capita income of $17,552 in 1993 was approximately 19 percent lower than the per capita income of $21,653 for Virginia, 6 percent lower than the per capita income of $18,670 in North Carolina, and 8.3 percent higher than the per capita income of $16,200 for West Virginia. Employment and regional economy statistics and projections for the proposed action period for the B&W REA are given in Appendix F, Table F.1–8 and selected statistics are summarized in Figure 3.5.8–1.

In 1993, as shown in Figure 3.5.8–1, manufacturing accounted for 21 percent of the region's total employment. By comparison, the manufacturing sector makes up 11, 11, and 21 percent, respectively, of Virginia's, West Virginia's, and North Carolina's total employment. The service sector provided 24 percent of the region's employment. The percent was similar to North Carolina but less than the percentage in Virginia (28 percent) and West Virginia (26 percent). The retail trade sector comprised 17 percent



[a] DOC 1995a.
[b] Census 1983r; Census 1993g.
[c] Bedford City included in Bedford County total.
[d] Census 1982k; Census 1991u.

Figure 3.5.8–1. Economy, Population, and Housing for the Babcock & Wilcox Site Regional Economic Area and Region of Influence.

of the region's total employment, a percentage comparable to the retail sector's contribution to North Carolina's economy, but slightly lower than the contribution to the economies of Virginia and West Virginia.

[Text deleted.]

Population and Housing. In 1992, the ROI population totaled 210,935. From 1980 to 1990, the ROI population increased by 5.2 percent, a rate that was significantly less than the approximately 16-percent population growth for Virginia. Within the ROI, Bedford County experienced the greatest population increase, 31 percent, while Amherst County's population decreased by 1.9 percent. Population trends are summarized in Figure 3.5.8–1.

[Text deleted.]

The percent increase in total housing units in the ROI between 1980 and 1990, 16 percent, was nearly 8 percent less than the increase in total housing units for the entire State. In 1990, the estimated total number of housing units in the ROI was 84,018. The 1990 ROI homeowner and rental vacancy rates were 1.5 percent and 7.2 percent, respectively. These rates were comparable to the Statewide rates. (A full presentation of population and housing statistics and projections are provided in Appendix F, Tables F.1–12 and F.1–16, respectively.)

Community Services. Education, public safety, and health care characteristics are used to assess the level of community service in the B&W ROI. Figure 3.5.8–2 summarizes public school district statistics for the B&W ROI, and Figure 3.5.8–3 summarizes public safety and health care services.

Education. During 1994, five school districts provided public education services in the B&W ROI. As seen in Figure 3.5.8–2, these school districts ranged in enrollment size from 2,332 students in the Appomattox County School District to 9,489 students in the Bedford County School District (includes Bedford City). The average students-to-teacher ratio for the ROI was 14.2:1. The Bedford County School District had the highest ratio at 15.4:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to residents of the ROI. In 1993, a total of 348 sworn police officers served the four-county area. Lynchburg employed the largest number of police officers (134), and also had the highest officers-to-population ratio (2 officers per 1,000 persons). The average ROI officers-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.5.8–3 presents police force strengths in the ROI.

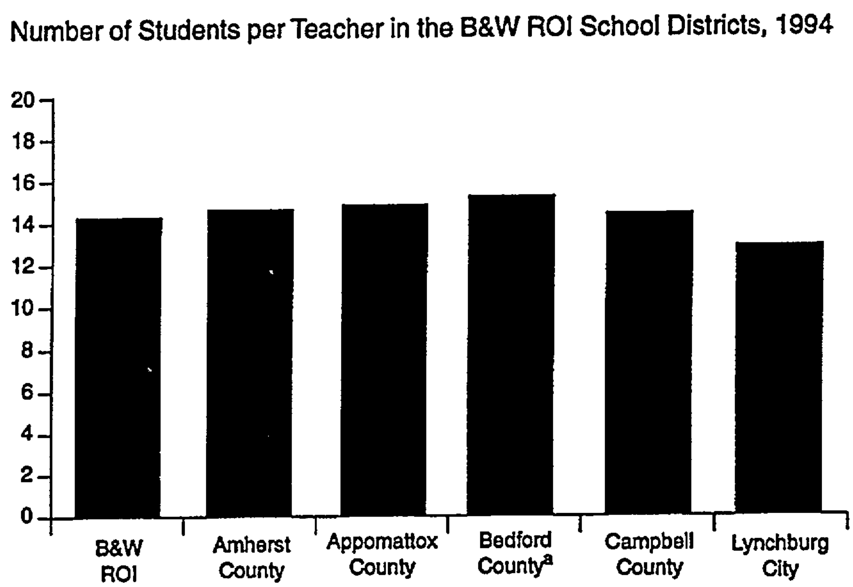
Firefighting protection services in the ROI were provided by 960 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Bedford County, 6 firefighters per 1,000 persons, as indicated in Figure 3.5.8–3 (includes Bedford City firefighters). Bedford County had the greatest number of active firefighters (343). The average firefighters-to-population ratio in the ROI was 4.4 firefighters per 1,000 persons.

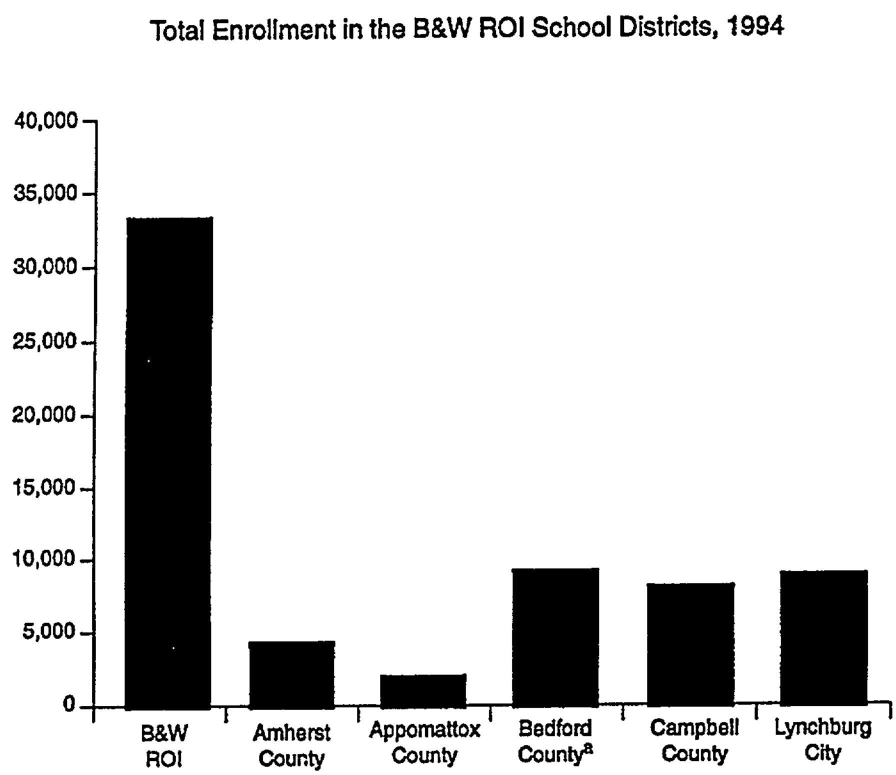
Health Care. There were three hospitals serving the four-county ROI in 1993. All three hospitals operated below capacity with hospital occupancy rates ranging from 40 percent in Bedford County to 72 percent in Campbell County.

There were 291 practicing physicians in the ROI during 1993, with the majority (229) practicing in Lynchburg. Figure 3.5.8–3 shows that the physicians-to-population ratio ranged from 0.2 physicians per 1,000 persons in Campbell County to 3.4 physicians per 1,000 persons in Lynchburg. The average ROI physicians-to-population ratio was 1.4 physicians per 1,000 persons.

Local Transportation. The B&W site is located approximately 8 km (5 mi) east of Lynchburg. U.S. highways and State Routes provide access between B&W and metropolitan areas (Figure 3.5–1). The east-west highway, U.S. 460, provides access to the cities of Roanoke and Farmville to the west and east, respectively. U.S. 460 East connects to U.S. 360, providing access to the city of Richmond. The north-south highway, U.S. 29, is located west of the facility providing access to the cities of Charlottesville to the northeast and Danville to the south.

Vehicular access to B&W is provided by SR-726, which connects with SR-609 and U.S. 460. No improvements to highways accessing the facility are currently underway or planned (VA DOT 1995a:1).



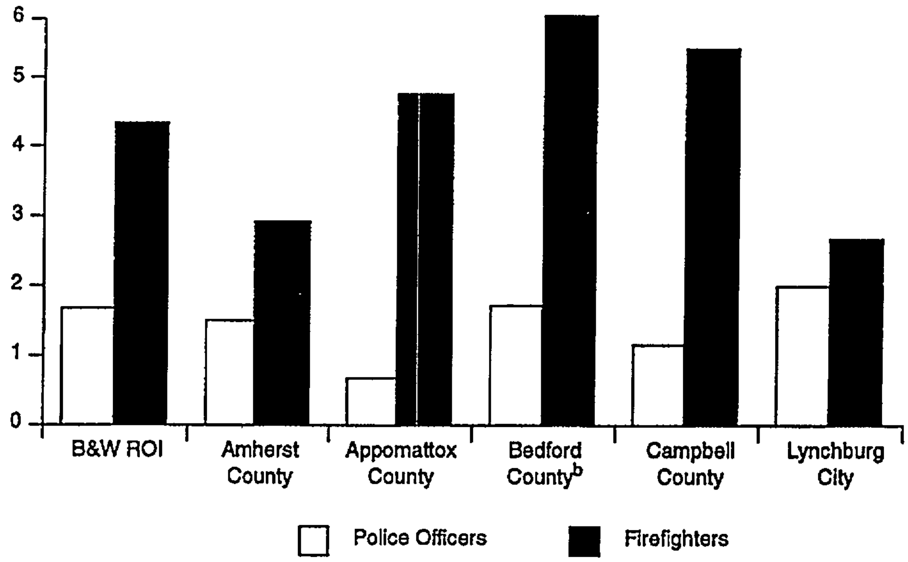


[a] Bedford City included in Bedford County total.

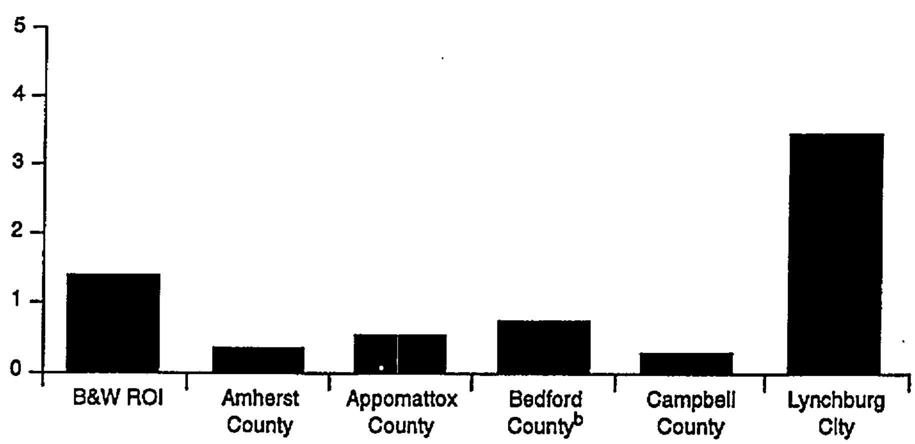
Source: BW School 1995a.

Figure 3.5.8–2. School District Characteristics for the Babcock & Wilcox Site Region of Influence.

Number of Sworn Police Officers (1993) and Firefighters (1995) per 1,000 Persons in the B&W ROI[a]



Number of Physicians per 1,000 Persons in the B&W ROI, 1993[c]



[a] BW Fire 1995a; Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a.
[b] Bedford City included in Bedford County total.
[c] AMA 1994a; Census 1993a; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j.
Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Figure 3.5.8–3. Public Safety and Health Care Characteristics for the Babcock & Wilcox Site Region of Influence.

There are no public transportation systems providing service to the site (LCC 1995a:1). Onsite rail transport for some materials is provided by a spur of CSX Transportation that runs through B&W. The facility is bordered by an oxbow of the James River on the north, east, and west. The James River is not used by the facility for transportation purposes. Lynchburg Municipal (Preston Glen) Airport in the city of Lynchburg provides jet passenger and cargo service for the region from major and national carriers (DOT 1992a).

3.5.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of NNFD are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of the B&W site are shown in Table 3.5.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Table 3.5.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Babcock & Wilcox Site Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	43
External terrestrial radiation	46
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	394

[a] BW NRC 1991a; NCRP 1987a. Value for radon is an average for the United States.

[Text deleted.]

Releases of radionuclides to the environment from B&W facility operations provide another source of radiation exposure to individuals in the vicinity of the site. These radionuclides and their representative associated release quantities for normal operations are presented in site-specific environmental reports. The doses to the public resulting from these releases and direct radiation fall within radiological limits and are small in comparison to background radiation. The doses to the public resulting from these releases and direct radiation are presented in Table 3.5.9–2. Furthermore, these radiological releases were used in the development of the reference environment's radiological releases at B&W for the public and occupational health segments within Section 4.3.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the fatal cancer risk to the MEI of the public, because of representative annual radiological releases from B&W facility operations, is estimated to be approximately 2.5×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of the B&W facility operations is less than three chances in 100 million. (It may take several years from the time of exposure for cancer to manifest.)

Based on the same risk estimator, 1.8×10^{-4} excess fatal cancers to the population living within 80 km (50 mi) of the B&W facility are estimated for a normal operating year. This number can be compared with the numbers of fatal cancers expected in this population from all causes. The average mortality rate associated with cancer for the entire U.S. population is presently 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur annually is 1,050 for the population living within 80 km (50 mi) of the B&W site. This number of expected fatal cancers is much higher than the estimated 1.8×10^{-4} fatal cancers that could result from present-day annual B&W facility operations.

Workers at the B&W site receive the same dose as the general public from background radiation, but they receive an additional dose from working at the facility. Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to B&W facility workers from operations in 1994 is estimated to be 7.2×10^{-3}. Table

Table 3.5.9–2. Representative Annual Doses to the General Public From Normal Operation of the Babcock & Wilcox Naval Nuclear Fuel Division and Commercial Nuclear Fuel Plant (committed effective dose equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Receptor	Standard[a]	Actual[b]	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	4.6×10^{-2}	4	4.0×10^{-3}	25	5.0×10^{-2}
Population within 80 km[c] (person-rem)	None	0.3	None	0.05	None	0.35
Average individual within 80 km[d] (mrem)	None	5.7×10^{-4}	None	9.5×10^{-5}	None	6.6×10^{-4}

[a] The standards for individuals are given in 40 CFR 61, 141, and 190. As discussed in these regulations, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 25 mrem/yr is the limit from all pathways combined.

[b] BW 1995b:1; BW NRC 1991a.

[c] In 1990, this population was approximately 525,000.

[d] Obtained by dividing the population dose by the number of people living within 80 km of the site.

3.5.9–3 presents the average, maximum, and total occupational doses to B&W facility workers from operations in 1994. These doses fall within radiological limits (10 CFR 20).

Table 3.5.9–3. Doses to the Onsite Worker From Normal Operation of the Babcock & Wilcox Naval Nuclear Fuel Division, 1994 (committed effective dose equivalent)

	Onsite Releases and Direct Radiation	
Receptor	Standard[a]	Actual[b]
Average worker (mrem)	None	10
Maximally exposed worker (mrem)	5,000	3,300
Total workers (person-rem)	None	18

[a] 10 CFR 20. NRC's goal is to maintain radiological exposure ALARA.

[b] BW 1995b:1; NRC 1995b. The number of badged workers in 1993 was approximately 1,800.

Chemical Environment. The background chemical environment important to human health consists of the following: atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in previous sections of this EIS, particularly Sections 3.5.3 and 3.5.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by B&W facility operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.5.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to B&W facility workers during normal operations may include those from the following: inhalation of the workplace atmosphere, drinking B&W site potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. B&W facility workers also are protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded.

Health Effects Studies. Data searches have been made for studies and/or information on the epidemiology in communities near the B&W site; however, no literature or database information has been identified. In addition, the Campbell County Health Department had no reports available. No epidemiologic information was available from the Campbell County Health Department, the Virginia State Office of Health Hazardous Control, or the Virginia State Department of Environmental Quality.

Accident History. The B&W site is a nuclear fuel manufacturing facility and is heavily inspected by Federal, State, and local agencies. Incidents over the last 10 years have included a few localized (onsite) minor chemical spills, all of which were cleaned up. There have been no reported incidents of radiological exposures or releases. There have been four reported incidents of occupational injuries that required treatment; all of the injuries were transient.

Emergency Preparedness. Sites that are licensed to operate by NRC are required to have extensive emergency preparedness programs, including plans and resources to deal with any emergency situation that may occur. Adequate resources must be available to protect the workers, the public, and the environment from unlikely hazards that may occur during a facility's lifetime.

3.5.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities at B&W NNFD. To meet the requirements of its current NRC license, NNFD ensures compliance with Federal and State regulations for water, air, and land disposal in addition to facility permits. Agencies responsible for enforcement and inspection at NNFD include NRC, the Virginia State Department of Environmental Quality, the Department of Health-Division of Radiological Health, the Air Pollution Control Board, and the Waste Management Control Board.

Wastes produced at this facility are categorized as low-level, mixed low-level, hazardous, and nonhazardous. Activities at NNFD that generate waste include uranium recovery, recovery of scrape zirconium and copper, waste compaction, waste processing, and research related to the recovery of uranium. Incoming materials to the facility include uranium, zirconium, copper, HEU, nitric acid, hydrofluoric acid, water, and natural gas. Exit streams from the facility include product fuel elements and assemblies; recovered metals; and gaseous, liquid, and solid waste.

The low-level, process, and sanitary liquid wastes produced are each treated in a different element of the waste treatment facility where they will result in an effluent suitable for environmental release. A discussion of the waste management activities at B&W is presented below:

High-Level Waste. The B&W site does not generate or manage HLW.

Transuranic Waste. The B&W site does not generate or manage TRU waste.

Low-Level Waste. Operations at B&W produce both liquid and solid LLW. Liquid LLW is produced in the manufacturing, recovery, and gaseous emission cleanup operations. Manufacturing process liquid waste includes acid pickling solution for metal parts, low level acid solutions from uranium dissolution, wash water from the laundry and personnel stations, analytical laboratory liquids, and scrubber water from the acid treatment operations. The total daily volume of these liquid wastes is 76 m^3 (20,000 gal) (BW NRC 1995a:8). Liquid LLW from recovery operations includes scrap dissolution liquids and scrubber solutions from gaseous emission control equipment. The total daily volume of liquid waste produced from recovery operations is approximately

57 m^3 (15,000 gal). Additionally, 3.8 m^3/day (1,000 gal/day) of LLW are produced from the NNFD Research Laboratory. This liquid waste stream is treated prior to release from the laboratory to comply with 10 CFR 20 requirements concerning release to an unrestricted area (BW NRC 1995a:10).

The LLW streams produced are treated in the liquid LLW treatment system. Treatment methods include acid neutralization, precipitation of metals, liquid clarification (using microfiltration system), and sludge filtration. This batch-mode system is designed to process 246 m^3/day (65,000 gal/day). The LLW stream from the NNFD Research Laboratory is transferred directly to the neutralization tank in batches of 3.8 m^3 (1,000 gal) (BW NRC 1995a:10). The liquid and sludge effluent separated in the clarifier are processed independently. After the complete treatment process, final dried solids are produced that have a uranium content of 6 milligrams (mg)/l (BW NRC 1995a:10). The solids are transferred to 208-l (55-gal) drums for offsite disposal at a licensed LLW disposal facility. Liquid effluents from the process undergo hot acid equalization and chlorination and are ultimately released into the James River in accordance with the NPDES permit (BW NRC 1995a:10).

Solid LLW results from manufacturing, liquid waste management, and incineration, and includes paper, small pieces of equipment, and miscellaneous trash. A fraction of the solid waste produced is incinerated and the remaining is packaged for offsite disposal. A supercompactor exists onsite that compacts 208-l (55-gal) drums containing LLW. During past operations at NNFD, the total solid LLW volume has been approximately 620 m^3/yr (22,000 ft^3/yr). [Text deleted.] Compaction reduces the solid LLW volume to approximately 283 m^3/yr (10,000 ft^3/yr) with an average radionuclide content of 118 becquerel per cubic centimeter (Bq/cm^3) (90 microcuries per cubic feet [μCi/ft^3]) (BW NRC 1995a:16).

Mixed Low-Level Waste. The Naval Nuclear Fuel Division processes uranium-containing F-listed solvents using distillation. The sludge bottoms from this process are categorized as mixed LLW. The mixed LLW is packaged and stored onsite at a dedicated facility (15.8 m^3 or 76 drums with a 55-gal capacity) until disposal becomes feasible (BW NRC 1995a:2-10). The volume of mixed LLW generated annually decreased from 28.3 m^3 to 14 m^3 (1,000 ft^3 to 500 ft^3) from 1990 to 1995 (BW NRC 1995a:16).

Hazardous Waste. Liquid hazardous waste is produced from acid pickling, metals cleaning, and emissions control operations at the rate of 151 m^3/day (40,000 gal/day) (BW NRC 1995a:10). Solid hazardous waste is produced through the liquid hazardous waste treatment operations. The primary methods for treating the liquid hazardous waste are acid neutralization, dissolved solids precipitation, liquid clarification, and sludge filtration. Liquid effluent from the treatment system is ultimately discharged to the James River in accordance with the facility's NPDES permit. Prior to 1990, the resulting sludge from the nonradioactive wastewater treatment system was buried in an onsite landfill. Currently, sludges from this process are packaged and disposed of offsite. [Text deleted.] These neutralization filter cake solids were categorized by the Virginia Department of Environmental Quality as an F–listed hazardous waste. The filter cake solids generated from the acid pickling operations are stored onsite for less than 90 days and processed at an offsite facility to render them nonhazardous.

Nonhazardous Waste. Process liquid waste is generated at the rate of 1,400 m^3 (370,000 gal) per day and is treated prior to release. Sanitary liquid waste is generated at the rate of 178 m^3/day (47,000 gal/day) and processed in a section of the waste treatment facility (BW NRC 1995a:10-13). The primary processes for this facility are size reduction, aeration, clarification, and chlorination, with a capacity of 606 m^3/day (160,000 gal/day) (BW NRC 1995a:2-11). As with the other treatment processes, the effluent is ultimately discharged into the James River in accordance with the facility's NPDES permit. Solid nonhazardous waste generated at the rate of 1,700 m^3/yr (60,010 ft^3/yr) includes miscellaneous trash and paper, classified paper, and scrap zirconium and copper (BW NRC 1995a:16). Approximately 455 t of paper are sold for offsite recovery each year. Scrap zirconium and copper are also recovered and sold for recycling. Miscellaneous trash is sorted, incinerated if appropriate, and packaged for offsite disposal at the Lynchburg Sanitary landfill.

3.6 NUCLEAR FUEL SERVICES, INC., ERWIN, TENNESSEE

The NFS facility has been in operation since 1958. It occupies 25.5 ha (63 acres) within the city limits of Erwin, Tennessee. The NFS plant produces nuclear reactor fuel for the U.S. Naval Reactor Program, processes scrap materials to recover uranium, and develops other nuclear fuels containing enriched uranium. The affected environment includes operations data for the processing of U.S. Naval Reactor Program material in 1994. The location of NFS and its vicinity is shown in Figure 3.6–1.

The following sections describe the affected environment at NFS for land resources, site infrastructure, air quality and noise, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, public and occupational health, and waste management.

3.6.1 LAND RESOURCES

Land Use. The NFS site is located in Unicoi County in the city of Erwin and immediately northwest of the unincorporated community of Banner Hill (Figure 3.6–1). The site is situated upon relatively level land in a long, narrow mountain valley (Indian Creek Valley). The valley is bounded on both sides by the Appalachian Mountains, which rise to elevations of 900 to 1,500 m (2,950 to 4,920 ft) within several kilometers of the site. Offsite land use within 4.8 km (3.0 mi) of NFS is shown in Figure 3.6.1–1. This total area of 7,320 ha (18,100 acres) consists primarily of residential (1,010 ha [2,500 acres] or 13.8 percent), industrial (322 ha [796 acres] or 4.4 percent), commercial uses (81 ha [200 acres] or 1.1 percent), agricultural/suburban residential (527 ha [1,300 acres] or 7.2 percent), and mountainous forest land (5,380 ha [13,300 acres] or 73.5 percent). The mountainous areas adjoining the valley consist of the Cherokee National Forest. The U.S. Natural Resources Conservation Service has estimated that there are 132 ha (326 acres) of prime and unique farmland within 4.8 km (3 mi) of the site (NF NRC 1991a:3-11). Although the soil conditions on a portion of the NFS site would meet prime farmland soil requirements, given the current site land use, the land would not be available for agricultural use; therefore, the U.S. Natural Resources Conservation Service has determined that no prime farmlands exist on the NFS site (NF USDA 1995a:1). About 60 percent of NFS is developed and occupied by buildings and associated grounds, parking lots, waste ponds, and solid waste burial grounds. The remainder of the site, approximately 40 percent, is undeveloped and includes open fields, brushland, shrub swamp, and woods (NF NRC 1991a:3-9). NFS is bounded in part by Banner Hill Road to the southeast, CSX Transportation to the northwest, and Martin Creek to the northeast (Figure 3.6.1–2). The nearest residences are located within the Banner Hill community immediately southeast of the site, with individual residences located approximately 250 m (820 ft) from the facility main stack (NF NRC 1991a:2-4,3-6).

The only recreational facility located within the NFS site is a softball field outside the secured area for NFS employee use. Nearby recreational opportunities center on water-based recreation. Recreational uses along the section between the origin and mouth of the Nolichucky River at Douglas Lake include swimming, rafting, boating, canoeing, picnicking, and other similar activities. Along the 24-km (14.9-mi) stretch of river downstream of NFS, recreational activities include canoeing, rafting, and using developed riverside recreational facilities, such as picnic tables and parks. Recreational fishing in the short stretch of Martin Creek near NFS is infrequent because limited access roads make it inaccessible to the public (NF NRC 1991a:3-15,3-16).

Visual Resources. The NFS landscape is characterized by relatively level topography. NFS lies within a valley oriented in a southwest-to-northeast direction. Although the original NFS site vegetation has been cleared, the predominant vegetation within the region is deciduous forest mixed with coniferous. The major forest types are the oak-hickory and oak-pine associations and the white pine (NF NRC 1991a:3-32).

The elevation of the developed portion of the site is about 9 m (29.5 ft) above the nearest point on the Nolichucky River. The visual character of the NFS site facilities may be described as consisting of numerous small buildings located within dual chain-link security fencing. The administration building and the guard house are constructed of local brick and the process buildings are predominantly cement block, painted white. Metal "Butler" buildings are

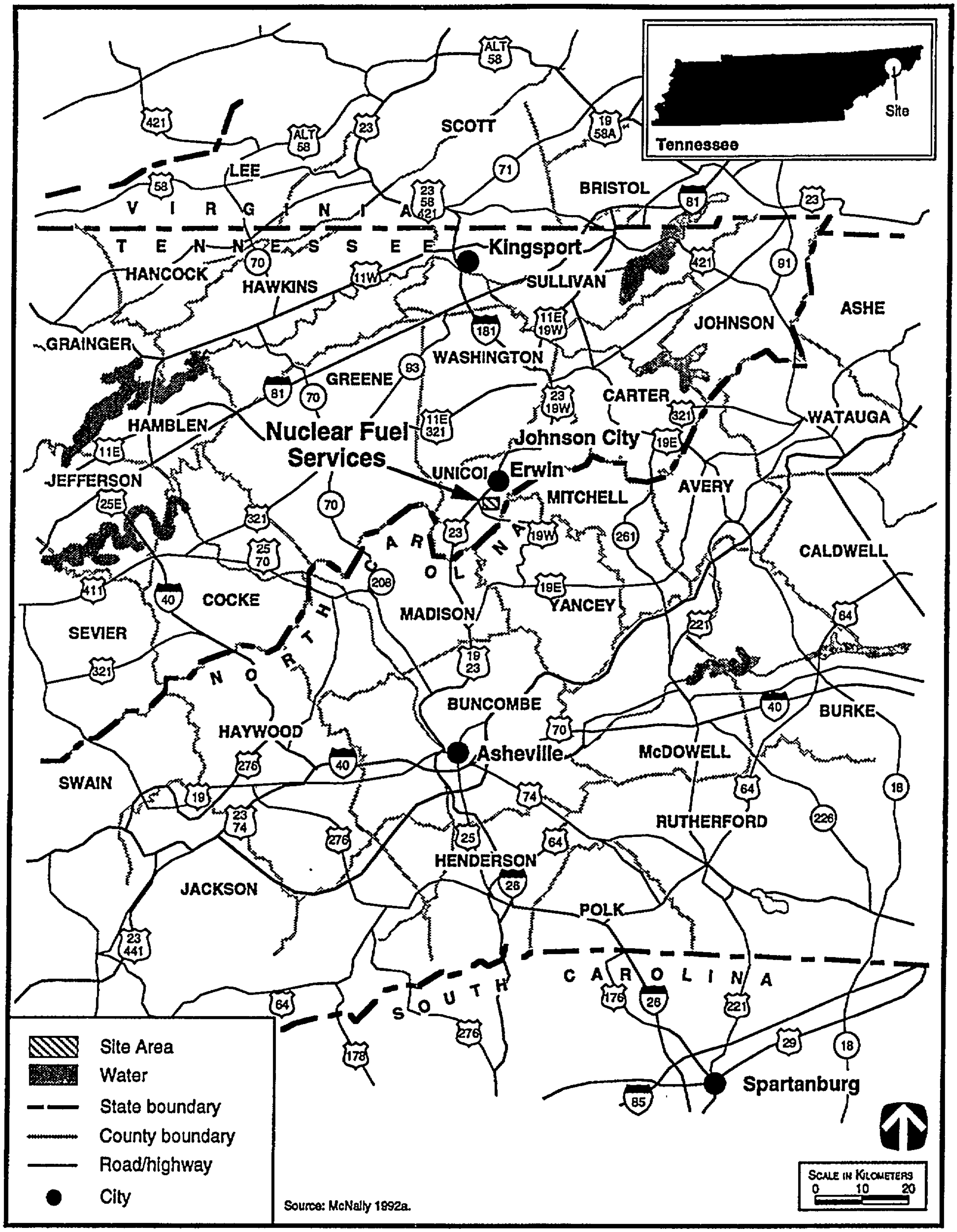


Figure 3.6–1. Nuclear Fuel Services Site, Tennessee, and Region.

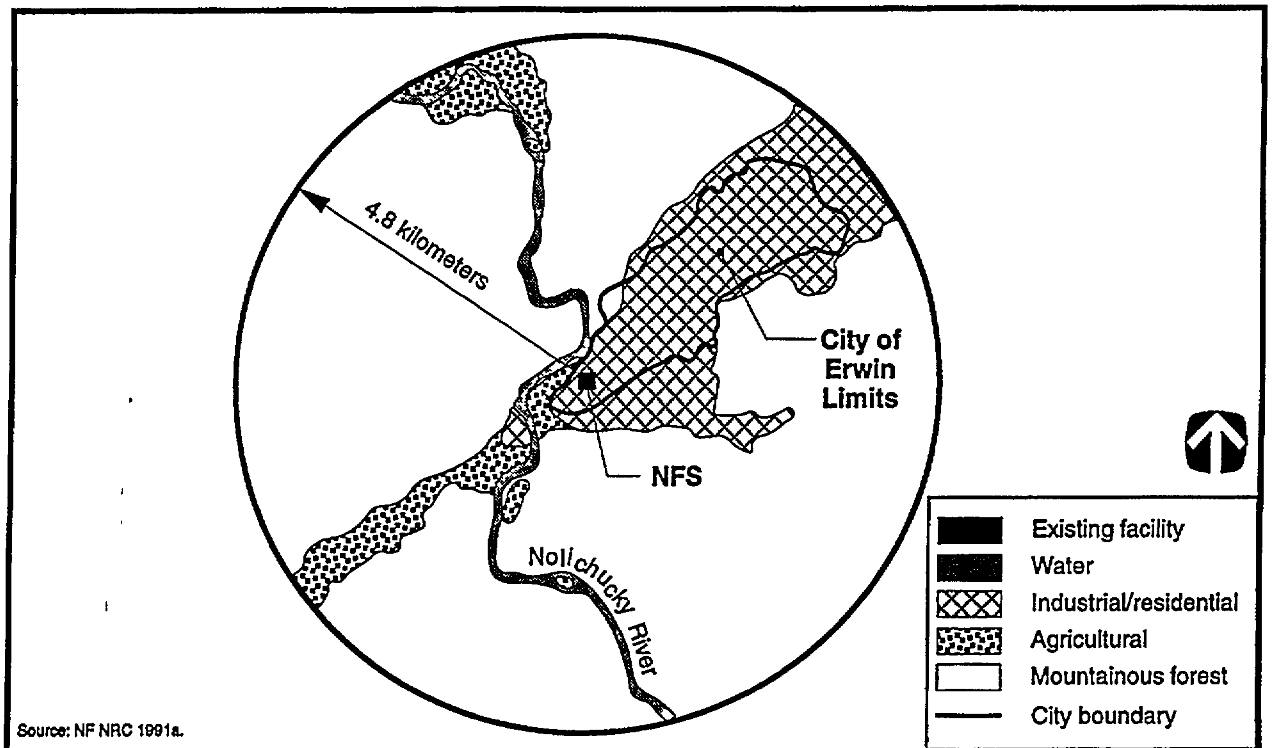


Figure 3.6.1–1. Generalized Land Use at Nuclear Fuel Services Site and Vicinity.

used for storage of equipment and supplies. The majority of the facilities are one to three levels. Retention ponds, radioactive solid waste burial grounds, and contaminated soil piles also are located within the perimeter fence (NF NRC 1991a:2-1).

The visual landscape consists of residential and industrial use. The city of Erwin is the closest population center and Johnson City, approximately 27 km (16.8 mi) north of the site, is the largest nearby population center (NF NRC 1991a:3-7). The facility and its perimeter are brightly lit at night and are highly visible to offsite lands due to the close proximity of development, particularly residential development along Carolina Avenue/Banner Hill Road.

3.6.2 Site Infrastructure

Site Description. The site is surrounded mostly by privately owned property and is bounded in part by Banner Hill Road to the southeast, CSX Transportation to the northwest, and Martin Creek to the northeast. About 60 percent of the site is or has been used for activities associated with the nuclear materials operations licensed by NRC, and is occupied by plant buildings, building grounds, outdoor storage areas, settling ponds, solid waste burial grounds, and a parking lot. The remainder of the site includes woods, brushland, shrub swamp, and open fields.

The primary mission of NFS operation is to convert HEU into a classified product used in the Naval Reactor Program. The classified production procedures are unique to the U.S. Naval Reactor Program. In addition, NFS is involved in research and development of improved manufacturing techniques, recovery and purification of scrap uranium, removal and/or recovery of material generated in manufacturing waste streams to prevent environmental degradation, operation of a chemistry lab, and decommissioning of unused facilities.

The facility consists of numerous small buildings within dual chain-link security fencing (Figure 3.6.1–2). Remediated retention ponds, formerly used for liquid waste, are also within the security fence immediately northeast of the facility buildings. Burial grounds that

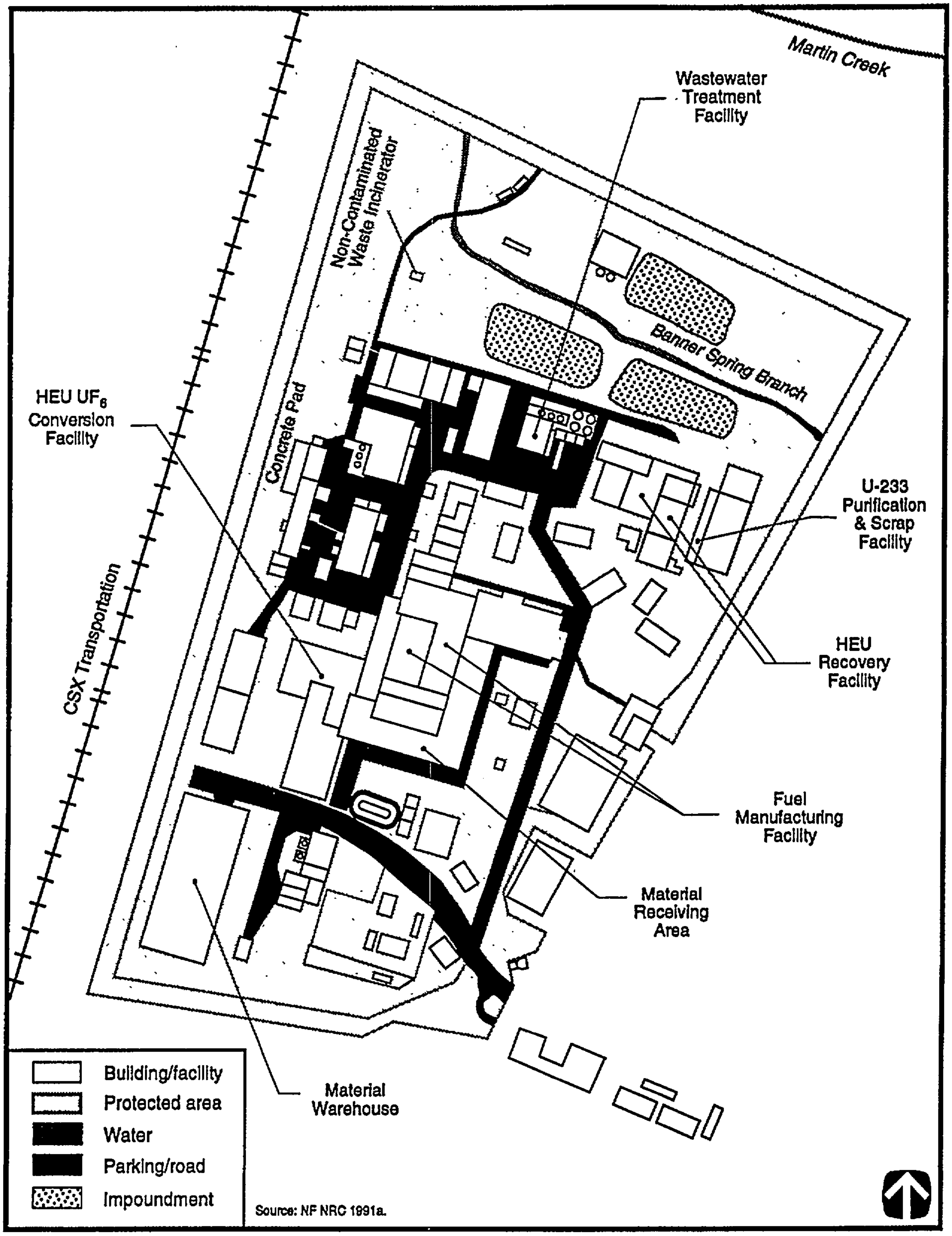


Figure 3.6.1–2. Building Locations at the Nuclear Fuel Services Site.

were used for radioactive solid waste are outside the security fence, north of the retention ponds, but inside a chain-link fence. The principal production area of NFS consists of several buildings where highly enriched UF_6 is converted in a series of steps into a classified nuclear fuel product. Process steps in which ammonia and fluoride may be present are vented through a packed-bed scrubber. In addition to being scrubbed, certain process steps that have a high dust potential are vented through high-efficient particulate air (HEPA) filters. Gaseous effluents from these devices are discharged into the 300-Complex ventilation system.

Nuclear Fuel Services has decommissioned buildings that once fabricated reactor fuel elements that contained a mixture of uranium and Pu. A Pu decommissioning plan for these buildings was approved in 1989, with decommissioning being completed in 1994.

Environmental Regulatory Setting. The NFS facility at Erwin, Tennessee, is regulated by NRC, who issued a 4-year license renewal to NFS in June 1992. NRC provides compliance with CEQ regulations (40 CFR 1500-1508) by issuing an EA and a FONSI of the license issuance (NF NRC 1991a:1-6). While the NFS facility operates in compliance with its license, NRC regulates on the basis of the reduction of emission of radionuclides to ALARA levels; therefore, it may request the reduction of emissions below the regulated level when such reductions can be reasonably achieved. A request for license renewal has been submitted by NFS since their license expires in June 1996. The NRC has placed NFS in a "timely renewal" which allows the site to continue operating until the NRC has completed a new EA and the licencing process.

A request for license renewal has been submitted by NFS since their license expires in June 1996. The NRC has placed them on a "timely renewal" status which allows the site to operate until the NRC has completed a new EA and the licensing process.

Radioactive material is released to the atmosphere through stacks at the NFS facility. The main plant stack discharges approximately 90 percent of the gaseous emissions, with the remaining emissions distributed through short stacks and roof vents. Nonradioactive air emissions are regulated by the TDEC-Division of Air Pollution Control. The site is in compliance with 10 CFR 20 for radionuclide emissions to unrestricted areas and with the *Clean Air Act* for hazardous and solid constituents.

Liquids discharged from NFS enter the Nolichucky River through a single NPDES-permitted outfall. Three other outfalls that do not empty into the Nolichucky are described in Section 3.6.4. The effluent is monitored to ensure compliance with 10 CFR 20 for radionuclide content discharged to unrestricted areas and for chemicals described in the NPDES permit. In addition, NRC requires the facility to demonstrate compliance with CWA and recommends that the licensee notify NRC within 30 days if the TDEC-Division of Water Pollution Control, revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit. In addition, the licensee must notify NRC within 30 days of any violation of the permit. NFS also samples sewage sent to the Erwin, Tennessee, Public Owned Treatment Works (POTW) and reports gross alpha activity, isotopic uranium concentrations, and flow rates. Sewage discharges have met 10 CFR 20.2003 (previously 10 CFR 20.303) limits for radionuclides, but in the past, uranium was concentrated in the treatment plant sludge. Since that time, NFS reduced the volume of uranium entering the sewer by 98 percent, and now treats most of its waste onsite.

Low-level, hazardous, and nonhazardous solid wastes are staged onsite for shipment to offsite disposal facilities. The TDEC-Divisions of Water Pollution Control and Solid Waste Management review NFS operation for compliance with CWA and RCRA regulations. Solid waste disposal practices are in compliance with all applicable regulations. Prior to 1977, process wastewater was allowed to settle in unlined ponds. These ponds have not been utilized since the late 1970s, and NFS has removed all sediment through its ongoing decommissioning efforts. This decommissioning plan was incorporated into NFS' NRC license by amendment. In addition, low-level and mixed low-level solid wastes were disposed of onsite. These burial sites have been partially remediated to prevent migration of hazardous and radiological constituents, and are monitored regularly. Decommissioning plans and the financial commitment to remediate these sites have been incorporated into NFS' license.

Pollution Prevention. Pollution prevention at NFS is mandated by various statutes, regulations, and governmental agency directives. The NFS pollution prevention program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible, in accordance with regulatory requirements. A comprehensive effluent and environmental monitoring program is conducted onsite to demonstrate compliance with appropriate environmental protection standards and to provide, where possible, site-specific data to assist in the prediction of environmental impacts. The site's environmental monitoring program monitors radiological releases; airborne discharges from stacks; and nonradiological pollution of surface water, groundwater, cooling water, soil, and vegetation.

Baseline Characteristics. NFS contains extensive production, research, and waste processing capabilities. To support current missions and functions, an infrastructure exists as shown in Table 3.6.2–1. The site is accessed by CSX Transportation, I-181, and I-81. The spur from CSX Transportation was removed, but replacement is planned for 1996.

Table 3.6.2–1. Nuclear Fuel Services Baseline Characteristics

Current Characteristics	Value
Land	
Area (ha)	25.5
Roads (km)	3
Railroad (km)	0
Electrical	
Energy consumption (MWh/yr)	21,800
Peak load (MWe)	3.5
Fuel	
Natural gas (m^3/yr)	12,900
Diesel/oil (l/yr)	36,000
Coal (t/yr)	0
Steam	
Generation (kg/hr)	6,260
Water Usage (l/yr)	57,000,000

Note: MWh=megawatt hour; MWe=megawatt electric.
Source: NF NRC 1991a; NFS 1995b:2.

3.6.3 AIR QUALITY AND NOISE

The following describes existing air quality, including a review of the meteorology and climatology, in the vicinity of the NFS site. More detailed discussions of the air quality methodologies, input data, and atmospheric dispersion characteristics are presented in Appendix C, Section C.1.7.

Meteorology and Climatology. The climate in the vicinity of NFS is characterized by warm, humid summers and relatively mild winters. Cooler, drier weather in the area is usually associated with polar continental air masses, whereas warmer, wetter weather is associated with gulf maritime air masses.

The average annual temperature at NFS is 13.1 °C (55.5 °F); the average daily minimum temperature is -4.3 °C (24.3 °F) in January; and the average daily maximum temperature is 29.2 °C (84.6 °F) in July. The average annual precipitation is approximately 103 cm (40.7 in). Prevailing wind directions at NFS tend to follow the southwest to northeast orientation of the valley (NF NRC 1991a:3-1). The annual average windspeed is approximately 2.5 m/s (5.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at NFS is presented in Appendix C, Section C.1.7.

The NFS facility is located in Unicoi County, in the Eastern Tennessee-Southwestern Virginia Interstate AQCR. As of January 1995, the areas within this AQCR were designated as in attainment with respect to the NAAQS (40 CFR 81.343). Applicable NAAQS and Tennessee State Ambient Air Quality Standards are presented in Appendix C, Section C.1.3.

One PSD Class I area can be found in the vicinity of NFS. This area, Great Smoky Mountains National Park, is located approximately 75 km (46.6 mi) southwest of NFS. Since the promulgation of the PSD regulations (40 CFR 52.21) in 1977, no PSD permits have been required for any emission source at NFS.

The primary emission source of criteria pollutants at NFS is the heating plant. Other emission sources include chemical processes, vehicles, diesel-powered emergency generators, and incinerators (NF NRC 1991a:2-10). Appendix C, Section C.1.7 presents emissions of criteria and hazardous/toxic pollutants from NFS.

Tables 3.6.3–1 and 3.6.3–2 present the baseline ambient air concentrations for criteria and toxic/hazardous pollutants at NFS, respectively. As shown in the tables, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise Conditions. The noise environment near NFS is typical of a rural location with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4,B-5). Major noise emission sources within NFS include various industrial facilities, equipment, and machines. The primary source of noise at the site boundary and at residences near roads is expected to be traffic. During peak hours, the plant traffic may be a major contribution to traffic noise levels in the area. At the site boundary, some noise sources onsite may be audible above the background sound levels. The impact of onsite noise sources has not been documented. The State of Tennessee and Unicoi County have not established specific numerical environmental noise standards applicable to NFS..

3.6.4 WATER RESOURCES

Surface Water. There are four major surface water bodies in the immediate vicinity of the NFS Erwin Plant: Banner Spring Branch, North Indian Creek, Martin Creek, and the Nolichucky River (Figure 3.6.4–1). The Banner Spring Branch lies entirely within the site; North Indian Creek is located north of the site boundary; Martin Creek is just outside the site's north boundary; and the Nolichucky River is located west of the site boundary.

Banner Spring Branch is a small spring-fed stream that flows in a northerly direction at a rate of 0.01 to 0.02 m^3/s (0.35 to 0.71 ft^3/s) and empties into Martin Creek at the site boundary. The stream is approximately 366 m (1,200 ft) in length from the spring source to the confluence with Martin Creek. In the past, approximately 0.004 m^3/s (0.141 ft^3/s) of water was used as industrial water for noncontact cooling operations at NFS. When operational, noncontact cooling water was discharged back to this stream at a rate of 0.004 m^3/s or 0.141 ft^3/s (NF NRC 1991a:4-27). Other inputs to the stream from NFS include surface runoff and overflow. Martin Creek is fed from mountain springs, rain, and snow melt drainage from Martin Creek Hollow. The width varies from 2.4 to 4.6 m (7.9 to 15.1 ft) and the depth from a few inches to pools of 0.9 to 1.2 m (3 to 3.9 ft). The flow of the creek varies seasonally from 0.06 to 0.31 m^3/s (2.11 to 11.0 ft^3/s). Martin Creek empties into North Indian Creek approximately 1,220 m (4,000 ft) north of the NFS site, and North Indian Creek discharges into the Nolichucky River about 500 m (1,640 ft) downstream of the site.

The Nolichucky River is formed by the North Toe and Cane Rivers in Yancey and Mitchell Counties. The river flows west from North Carolina and southwest through Tennessee to join the French Broad River, whose watershed forms part of the upper Tennessee River Basin. The average flow of the river onsite is approximately 39 m^3/s (1,380 ft^3/s).

Currently, no surface water is being used on the site. Approximately 57 million l/yr (15 MGY) of water is are being supplied to the site from the city, which obtains its waters from springs located northeast of the site. In the past, the noncontact cooling loop utilized surface water at a rate of 0.004 m^3/s (0.141 ft^3/s). The Nolichucky River is used as a source of both agriculture and drinking water in the surrounding communities. The city of Jonesborough, located 13 km (8.1 mi) downstream of NFS, is the closest municipal user of water from the Nolichucky River.

The northern third of the NFS site, which contains the HEU recovery area, is located on the 100-year floodplain of the Nolichucky River, where the greatest recorded flood elevation was 501 m (1,643 ft) above mean sea level before NFS was built in 1956. The Tennessee Valley Authority has developed flood criteria for a maximum probable flood for the Nolichucky River. According to these criteria, maximum probable flood discharges would produce a discharge rate of 5,380 m^3/s (190,000 ft^3/s) and a flood stage of 501 m (1,644 ft) above mean sea level at the site. However, flood insurance rate maps and flood profiles published by the Federal Emergency Management Authority (FEMA) have determined the 100-year flood elevation at the site to be at 499.5 m (1,639 ft) above mean sea level (NF FEMA 1984a:20P). In addition, FEMA has estimated the 500-year floodplain to have a discharge of 4,899 m^3/s (173,000 ft^3/s) and a flood stage of

Table 3.6.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at the Nuclear Fuel Services Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	NFS Contribution (μg/m³)	Percent of Regulations or Guidelines
Carbon monoxide (CO)	8 hours	10,000[a]	1.97	<1
	1 hour	40,000[a]	2.52	<1
Lead (Pb)	Calendar Quarter	1.5[a]	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	0.62	<1
Particulate matter (PM_{10})	Annual	50[a]	0.03	<1
	24 hours	150[a]	0.21	<1
Sulfur dioxide (SO_2)	Annual	80[a]	0.02	<1
	24 hours	365[a]	0.15	<1
	3 hours	1,300[a]	0.35	<1
Mandated by Tennessee				
Total suspended particulates (TSP)	24 hours	150[c]	0.21	<1
Gaseous fluorides (as HF)	1 month	1.2[c]	0.02	1.7
	1 week	1.6[c]	<0.06[d]	<3.8
	24 hours	2.9[c]	0.06	2.1
	12 hours	3.7[c]	0.1	2.7
	8 hours	250[c]	0.11	0.04

[a] Federal standard.
[b] No emissions from existing sources.
[c] State standard or guideline.
[d] The ISCST2 code does not calculate weekly concentrations; therefore, the 24-hour concentration was used.
Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.
Source: 40 CFR 50; NF DEC nda; TN DEC 1994a; TN DHE 1991a.

Table 3.6.3–2. Estimated Concentrations of Toxic/Hazardous Pollutants From Existing Sources at the Nuclear Fuel Services Site

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] (μg/m³)	NFS Contribution (μg/m³)	Percent of Regulations or Guidelines
Ammonia	8 hours	1,700	129	7.6
Nitric acid	8 hours	520	3.3	0.6

[a] State standard.
Source: NF EPA 1994a; TN DHE 1991a.

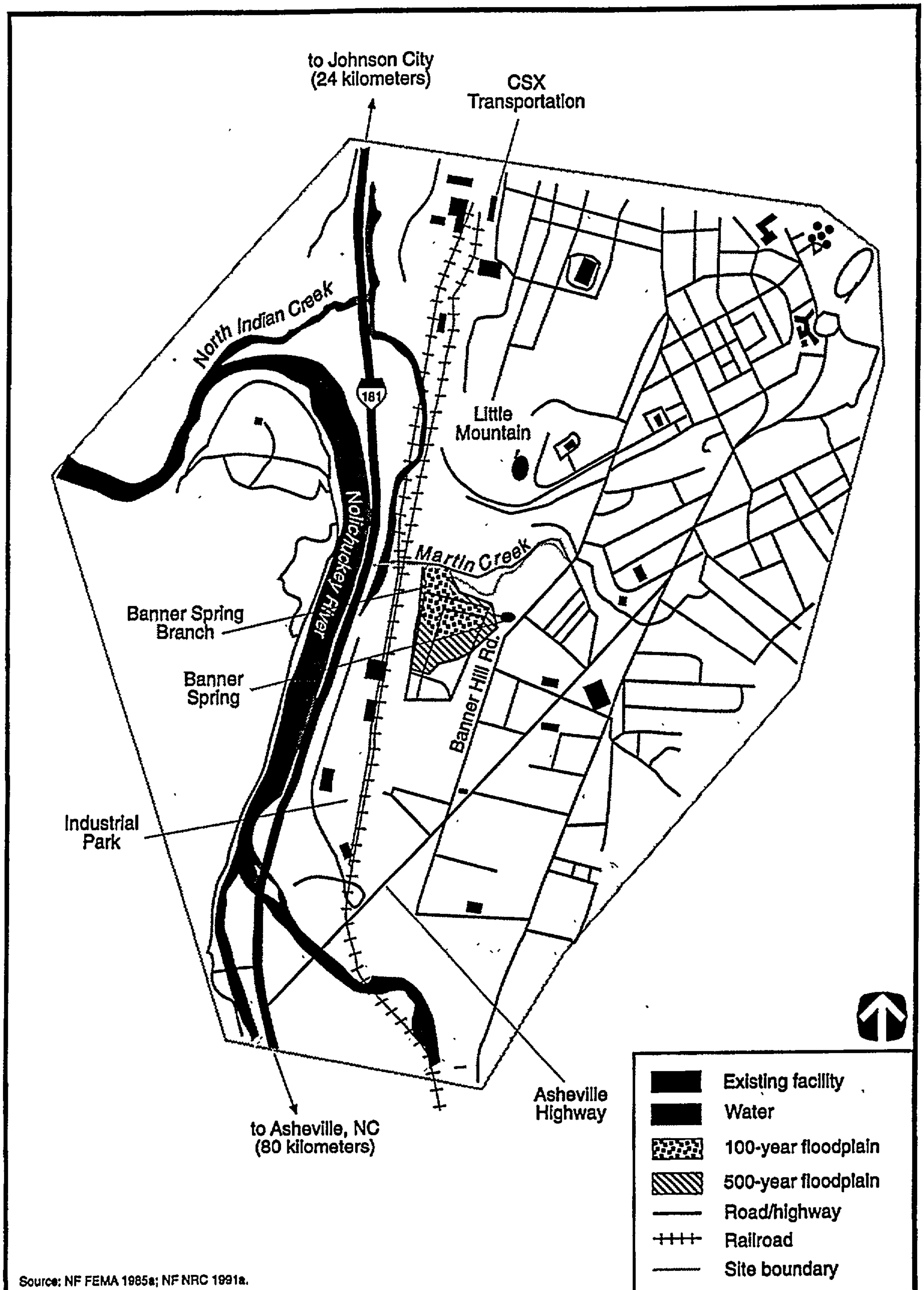


Figure 3.6.4–1. Surface Water Features and Location of 100- and 500-Year Floodplain Area at the Nuclear Fuel Services Site.

500 m (1,641 ft) above mean sea level at the site (NF FEMA 1984a:20P). Elevations of the building floors are between 500 and 510 m (1,640 to 1,670 ft) above mean sea level. The construction of the highway between the site and the river, the rechanneling of the river associated with the highway construction, and the rerouting of Martin Creek to enter the Nolichucky farther downstream from the site have slightly lowered the previously expected flood levels at the site. A significant flood (not reaching 100-year flood levels) on the Nolichucky River in November 1977 did not result in the flooding of any buildings on NFS; however, damage to homes, roads, and bridges was reported in the city of Erwin. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has Emergency Plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or because of accidental releases to surface water, the Jonesboro Water Treatment Plant closes off the water intake valves, so no contamination to the public water supply occurs.

Surface Water Quality. The streams and creeks of Tennessee are classified by the TDEC and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. Banner Spring Branch, Martin Creek, and the Nolichucky River are all classified for fish and aquatic life, livestock watering and wildlife, irrigation, and recreation. The Nolichucky River is also classified for domestic water supply.

Nuclear Fuel Services has four outfalls (001, 002, 003, and 004) regulated by NPDES permit, pretreatment permit, or stormwater NPDES permit. Approximately 18.9 million l/yr (5 MGY) of effluents from the wastewater treatment plant are discharged through Outfall 001 to the Nolichucky River. This outfall has the permitted capacity to discharge 38.6 million l/yr (10.2 MGY). Currently, no noncontact cooling water from the site is being discharged through Outfall 002 to Banner Spring Branch; however, when operational, this outfall has the capacity to discharge 0.004 m^3/s (0.141 ft^3/s). Approximately 38 million l/yr (10 MGY) of sanitary waste is discharged to Erwin Public Owned Treatment Works. This outfall has no permitted capacity. Stormwater is discharged to Banner Spring Branch through Outfall 004 and subsequently flows to Martin Creek, North Indian Creek, and then to the Nolichucky River. Sluice gates are in place along the flow path and could be closed should a spill occur.

The radiological water quality characteristics of Martin Creek are typical of background levels found in surface waters, and Banner Spring Branch is slightly higher than the background levels. The nonradiological water quality characteristics of Banner Spring Branch are typical of the area. The spring is monitored on a daily (Monday through Friday) basis downstream of the discharge for pH and flow. Ammonia, nitrate, fluoride, and mercury levels in the branch are analyzed weekly by NFS. With the exception of nitrate, all parameters analyzed are comparable to background levels and are within acceptable parameters for protection of water quality and aquatic life. The source of elevated nitrate in the branch may be from septic tanks or offsite fertilization of lawns and gardens east of Banner Hill Spring (NF NRC 1991a:4-27).

The nonradiological water quality of Martin Creek has not been determined upstream of the NFS site; however, the quality of the water in the creek has probably been affected by the flow through the Erwin Fish Hatchery located approximately 180 m (591 ft) upstream from NFS. The water quality of the Nolichucky River is influenced by runoff and silt from mica and feldspar tailings generated during previous mineral mining at Spruce Pine, North Carolina, located over 200 km (124 mi) to the east of NFS. No gauging or water quality stations are located upstream of NFS; however, samples were taken during the NFS effluent toxicity study and are provided in Table 3.6.4–1.

Surface Water Rights and Permits. The State of Tennessee's water rights laws are codified in the *Water Quality Control Act*. The water rights are similar to riparian rights in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would depend on intake location. Construction may require a 26 A permit from Tennessee Valley Authority, review by the Watts Bar Inter-Agency Working Group, a State Aquatic Resources Alteration Permit, or a U.S. Army Corps of Engineers permit to construct intake structures.

Table 3.6.4–1. Summary of Surface Water Quality Monitoring at the Nuclear Fuel Services Site

Parameter	Unit of Measure	Water Quality Criteria and Standard[a]	Nolichucky River[b]	Banner Spring Branch[c]
Ammonia	mg/l	NA	0.06	0.02
Arsenic	mg/l	0.05[d]	<0.001	0.001
Barium	mg/l	2[d]	<0.01	0.01
Bio oxygen demand	mg/l	NA	<1	1
Boron	mg/l	NA	<0.2	0.01
Cadmium	mg/l	0.006[d]	<0.001	0.001
Chemical oxygen demand	mg/l	NA	99	5
Chloride	mg/l	250[e]	1	2
Chromium	mg/l	0.05[f]	<0.001	0.001
Cobalt	mg/l	NA	<0.01	0.01
Copper	mg/l	1.3[d]	0.006	0.006
Dissolved oxygen	mg/l	NA	9	7.3
Fluoride	mg/l	4[d]	0.1	0.12
Iron	mg/l	0.3[e]	1	0.23
Lead	mg/l	0.015[d]	<0.01	0.01
Magnesium	mg/l	NA	1	6.6
Manganese	mg/l	0.05[e]	18	1
Mercury	mg/l	0.002[f]	<.0002	0.0002
Molybdenum	mg/l	NA	<0.01	
Nickel	mg/l	0.1[d]	0.01	0.02
Nitrate and Nitrite	mg/l	10[d]	0.45	2.2
Phosphate	mg/l	NA	0.04	0.03
Potassium	mg/l	NA	1	
Settleable residue	mg/l	NA	0.1	0.1
Silver	mg/l	0.1[e]	<0.001	0.02
Sodium	mg/l	NA	1.4	4
Sulfate	mg/l	250[e]	4	12
Suspended residue	mg/l	NA	19	2
Temperature	°C	NA	14.5	23.3
Total organic carbon	mg/l	NA	<1	1
Total residue	mg/l	NA	57	103
[Text deleted.]				
Zinc	mg/l	5[e]	<0.009	0.006

[a] For comparison only.

[b] Chemical and physical characteristics of 1983 water samples from the Nolichucky River upstream of the NFS discharge.

[c] Chemical and physical characteristics of 1983 waters samples from the Banner Spring Branch noncontact cooling water discharge.

[d] National Primary Drinking Water Regulation (40 CFR 141).

[e] National Secondary Drinking Water Regulation (40 CFR 143).

[f] Tennessee State Water Quality Standard.

Note: NA=not applicable.

Source: NF NRC 1991a.

Groundwater. Shallow unconfined groundwater at NFS is contained in the alluvium of the Nolichucky River and its tributaries and in residual soils developed on the Shady and Honaker Dolomites and Rome Formation (Section 3.6.5). Deeper groundwater is contained in solution cavities and fractures of the Shady and Honaker Dolomites and in fractures in the Rome Formation and the basal clastics.Only the dolomites are considered to be deep well sources of municipal and industrial water. In addition, numerous springs yielding large quantities of water are located in the dolomitic rocks of the Shady and Honaker Dolomites and in the Rome Formation near the contact with the underlying Shady Dolomite. Depth to groundwater varies from the ground level where the springs contact the surface to approximately 4.2 m (13.8 ft) at NFS.

Aquifer discharge and recharge take place readily through the alluvium of the Nolichucky River and its tributaries. The heterogeneous mixture of sand, gravel, and boulders in the alluvium is highly permeable, permitting rapid recharge to deeper aquifers through open solution cavities or fractures.

There are no Class I, sole-source aquifers that lie beneath NFS. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water, no groundwater is used for NFS operations. All water is supplied by the Erwin Public Utility System, which obtains water from springs and groundwater wells located northeast of the site. Approximately 57 million l/yr (15.1 MGY) of water is supplied to the site.

Groundwater Quality. Water quality in the area is generally good. The principal dissolved constituents of the groundwater are calcium, magnesium carbonate, and bicarbonate, regardless of the production zone geology. This reflects the regional influence of dolomitic host rocks on groundwater quality. Some nitrate was present (0 to 12 ppm), and total dissolved solids ranged from 90 to 189 ppm. There is no early record of well completions in the Quaternary alluvium; therefore, baseline groundwater quality in that unit is unknown.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to the settling ponds, beneath the buried holding tanks, and beneath the radioactive solid waste burial ground (NF NRC 1991a:4-32). There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. This area is the only documented offsite area of groundwater contamination. Banner Hill Spring is not presently contaminated; however, it is not known whether the Quaternary alluvium northeast of the site is contaminated. NFS currently analyzes groundwater samples for a number of nonradiological parameters on a routine basis. In the past, samples were analyzed for ammonia, nitrate, fluoride, mercury, and pH. As part of the hydrogeologic characterization for the pond decommissioning, groundwater samples were analyzed for general chemicals, heavy metals, radiochemicals, and organic chemicals. Samples collected near the ponds exhibit significant chemical contamination (NF NRC 1991a:4-29). NFS currently has 10 pump-and-treat wells in place in the ponds' vicinity and treats the groundwater prior to discharge to the sanitary sewer.

At Banner Hill Spring (on the NFS facility), nitrate and total dissolved solids were actually lower in 1980 than in 1948. Also, the gross alpha content was below that of Erwin Utilities municipal water supply and the Birchfield well located several thousand feet downstream from the NFS facility. Recent groundwater quality data for Erwin Utilities springs and wells are presented in Table 3.6.4–2.

Groundwater Availability, Use, and Rights. No groundwater is used onsite. All drinking water is obtained from the city of Erwin. Municipal drinking water supplies in the area are primarily taken from groundwater wells and from springs: O'Brien Spring, Birchfield Spring, and three springs collectively referred to as the Anderson-McInturff Spring located northeast of the site. Groundwater rights in Tennessee are traditionally associated with the Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others (VDL 1990a:725). Additionally, the owner's use of groundwater for off-lying land may be unreasonable, and therefore unlawful, if the withdrawals for the off-lying land impair a neighbor's water supply or usage.

Table 3.6.4–2. Summary of Groundwater Quality Monitoring at the Nuclear Fuel Services Site

Parameter	Unit of Measure	Water Quality Criteria and Standard[a]	Existing Conditions: Banner Hill Spring 12/80	O'Brien Spring 6/78	Birchfield Spring 6/78	Anderson-McInturff Springs 6/78	Composite[b] 8/78	Birchfield Well 8/84
Alpha (gross)	pCi/l	15[c]	0.4	NA	NA	NA	0.1	0.6
Arsenic	mg/l	0.05[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/l	2[c]	0.03	0.05	0.05	0.03	0.06	<0.1
Cadmium	mg/l	0.006[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride	mg/l	250[d]	5.3	3.5	4.5	4.7	5.7	3
Chromium	mg/l	0.05[e]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/l	1.3[c]	0.03	0.026	0.013	0.011	0.052	0.023
Fluoride	mg/l	4[c]	0.28	0.86	1.02	0.26	0.81	<0.2
Hardness	mg/l	NA	88	49	85.7	81.8	80	NA
Iron	mg/l	0.3[d]	0.05	0.011	0.011	0.005	0.023	0.268
Lead	mg/l	0.015[c]	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Manganese	mg/l	0.05[d]	0.029	0.001	0.003	0.001	0.003	0.02
Mercury	mg/l	0.002[e]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	mg/l	10[c]	1.78	0.77	0.81	0.87	0.22	0.74
pH	pH units	6.5-8.5[e]	NA	NA	NA	NA	NA	NA
Selenium	mg/l	0.05[c]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	mg/l	0.1[d]	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	mg/l	NA	10.2	0.4	1.6	1.4	1.3	1.5
Sulfate	mg/l	250[d]	1.9	<0.2	2.8	<0.2	1.3	2
Total dissolved solids	mg/l	500[d]	99	115	190	189	94	158
Zinc	mg/l	5[d]	0.009	0.018	0.055	0.02	0.068	0.013

[a] For comparison only.
[b] Municipal water mixed from O'Brien, Birchfield, and Anderson-McInturff Springs.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] Tennessee State Water Quality Standard.
Note: NA=not applicable.
Source: NF NRC 1991a.

3.6.5 GEOLOGY AND SOILS

Geology. The NFS site lies in the Valley and Ridge physiographic province of northeastern Tennessee. The stratigraphy of the area is very complex because much folding and faulting has occurred. The topography consists of a series of alternating valleys and ridges that have a northeast-southwest trend, with NFS occupying a valley. Three dolomite formations underlie the valley: the Shady, Knox, and Honaker Formations. They are associated with a large band of sandstone, siltstone, shale, dolomite, and limestone called the Rome Formation (NF USDA 1985a:1). Large areas of these formations are covered by deep soils found in colluvium from the adjacent mountains and alluvium from the larger streams. The present topography of the valleys is the result of stream erosion of the softer shales and limestones; the ridges are underlain by the more resistant shale, sandstone, and quartzite. Metamorphic and intrusive rocks of the Blue Ridge physiographic province lie southwest and southeast of NFS.

The NFS site lies in the moderately active Appalachian Tectonic Belt which is located in Seismic Zone 2, indicating that moderate damage could occur as a result of earthquakes (Figure 3.3.5–1). NFS is cut by many inactive faults formed during the late Paleozoic Era. There is no evidence of capable faults in the immediate area of NFS within the definition of 10 CFR 100; the nearest capable faults are located 100 km (62.1 mi) southwest and 200 km (124 mi) northeast of the site. Strong earthquakes over time originating in more active regions southwest of the site (New Madrid, Missouri, and Charleston, South Carolina) have been felt in eastern Tennessee, but no damage has been experienced at the site. A maximum horizontal ground surface acceleration of 0.18 gravity at NFS is estimated to result from an earthquake that could occur once every 2,000 years. The facilities at NFS that would be used for blending would meet the target performance to withstand an earthquake with an acceleration of 0.18 gravity (NFS 1996a:1).

Soils. The NFS facility lies on the Buncombe and Cotaco soil series. These soils consist of deep, moderately well-drained to excessively drained sandy and loamy soils on floodplains and terraces bordering stream channels (for example, Nolichucky River). These soils were formed in recent alluvium washed from mountainous areas and from soils underlain by quartzite, granite, and gneiss (NF USDA 1985a:47,49). Slopes range from 0 to 2 percent. Water and wind erosion (0.009 tons per acre-year) is low to moderate and shrink-swell potential is low. Permeability ranges from moderate to rapid, and available water capacity is low to high. The U.S. Department of Agriculture rates the Cotaco and the Buncombe soil series as having severe soil limitations and being poorly suited for construction because of the rapid permeability and the flood hazard (NF USDA 1985a:80).

At NFS, bedrock strata are consolidated, making firm foundations for buildings that lie directly on the strata or that are supported by footings; however, structures that are constructed on the unconsolidated alluvium from the floodplain and terraces of the Nolichucky River are subject to settlement during the first 2 to 3 years after construction (NF NRC 1991a:3-25,3-27).

The Cotaco soils that underlie the southwest portion of NFS have been designated by the U.S. Department of Agriculture as prime farmland, but the area is not presently under cultivation (NF USDA 1985a:29). The U.S. Department of Agriculture has estimated that there are 132 ha (326 acres) of prime and unique farmland within 5 km (3.1 mi) of the NFS plant (NF NRC 1991a:3-11). Important crops include tobacco, hay, corn, tomatoes, and strawberries.

Soil samples are collected quarterly from several locations on the site and analyzed for gross alpha radioactivity. Multi-year averages during 10 years (1979 to 1989) indicate that the alpha and beta activities are slightly elevated when compared to background samples; however, the samples are well below the limit of 30 pCi/g of enriched uranium for soil allowed for disposal with no restrictions on method of burial (NF NRC 1991a:4-21).

3.6.6 BIOTIC RESOURCES

Biotic resources at NFS include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion describes NFS as a whole. Scientific names of species identified in the text are presented in Appendix D.

Terrestrial Resources. Plant communities at NFS are characteristic of the intermountain regions of central and southern Appalachia. Major forest types in the Erwin area are oak-hickory, oak-pine, and white pine. Valley floors, mountains, and mountain coves have their individual characteristic vegetation types. The natural vegetation of NFS is a forest community dominated by red oak or white oak with subdominants including yellow poplar, hickories, other oaks, and some southern pine species (NF NRC 1991a:3-32). NFS lies within Indian Creek Valley. Plant communities consist of second growth forests and open grassy areas. Most of NFS is occupied by buildings, building grounds, and open fields. A limited area consists of woods, shrub, swamp, and brush; however, nearby mountainous areas are largely undisturbed and support extensive forest and wildlife resources.

The fauna of the Erwin region includes a large number of vertebrate species including 70 mammals, 140 birds, 35 reptiles, and 34 amphibians; however, most of these species would not be expected to occur in Indian Creek Valley because of extensive disturbance and lack of natural habitats. The woods, swamps, and brushy areas onsite or in the vicinity are likely to support more species. Common species include European starling, northern cardinal, mourning dove, Carolina chickadee, opossum, eastern cottontail, and house mouse. The most important game species of the region include whitetail deer, eastern gray squirrel, ruffed grouse, and wild turkey, which occur in the forests of the surrounding mountains but are not common onsite. Eastern cottontails, mourning doves, and northern bobwhites are present in most areas within Indian Creek Valley (NF NRC 1991a:3-34). Carnivores, such as the gray fox, and raptors, such as the red-tailed hawk, are ecologically important groups in the NFS vicinity.

Wetlands. Wetlands at NFS include streams and shrub swamps (riverine and palustrine wetland types, respectively). The streams include Martin Creek, just outside the site's northeast boundary, and Banner Spring Branch, which flows through the site. A small shrub swamp located near Banner Spring is less than 1 ha (2.47 acres) in size (NF NRC 1991a:3-11, 3-12).

Aquatic Resources. Aquatic habitat on or adjacent to NFS ranges from the Nolichucky River to several small streams. Banner Spring Branch is a small onsite stream that contains several species of minnows and some trout in its lower reaches. Martin Creek is typical of creeks in eastern Tennessee. The stream bed is composed of sand, pebbles, rocks, and some organic matter. A State-operated fish hatchery is located on a tributary to Martin Creek approximately 180 m (591 ft) upstream of NFS. The Nolichucky River in the Erwin vicinity contains a substrate of rocks, sand, boulders, and little aquatic moss. Riffles and large pools provide good smallmouth bass habitat. Other fish species present in the Nolichucky River include olive darters, catfish, largemouth and spotted bass, central stonerollers, and white crappie.

Threatened and Endangered Species. Twenty Federal- and State-listed threatened, endangered, and other special status species that potentially occur on and in the vicinity of NFS are presented in Appendix D, Table D.1–5. No Federal-listed threatened or endangered species are known to occur onsite. In addition, no Federal-listed aquatic species occur in the Nolichucky River, in the immediate vicinity, or downstream of NFS; however, the highfin carpsucker and sharphead darter, listed as species in need of management by the TDEC, are found in the Nolichucky River in the Erwin vicinity. Several plant species listed rare by the TDEC have been recorded in the vicinity of NFS (NF NRC 1991a:3-36, 3-37, C-1).

3.6.7 Cultural Resources

Prehistoric Resources. No cultural resources surveys or excavations have been conducted within NFS; therefore, no prehistoric archaeological sites have been identified within the facility. No NRHP sites are within the facility; however, because of its location along the floodplain of the Nolichucky River, there is the likelihood that some sites that are potentially eligible for inclusion on the NRHP may exist within the facility. These sites may include remains of short- or long-term occupations such as hearths, food storage pits, stone tools, or ceramic potsherds.

Historic Resources. No historic archaeological sites had been identified within NFS by 1996. One abandoned, deteriorated farmhouse is still standing. Some historic archaeological sites may exist, such as remains of residential structures or outbuildings and associated artifacts. No NRHP historic sites are located within the facility. There are two NRHP sites within Unicoi County. One is the Clarksville Iron Furnace on Tennessee State Highway 107 in the Cherokee National Forest, approximately 16 km (9.9 mi) west of the facility. The other is the Clinchfield Depot in Erwin. The depot was built in 1925 by the Carolina, Clinchfield, and Ohio Railroad.

Native American Resources. The Overhill Cherokee once lived in the vicinity of NFS. Most Overhill Cherokee villages were located along the Little Tennessee and Hiwassee Rivers, 128 km (79.5 mi) southwest of NFS, but they may have used the area for hunting and gathering activities. The Cherokee were allied with the British during the Revolutionary War. After the war, they remained in the region and became farmers and landowners. During the 1830s, most of the Cherokee were removed from this region to Oklahoma as part of the Trail of Tears. Some Native American resources may be located within the boundaries of NFS.

Paleontological Resources. The stratigraphy at NFS consists of siltstone, silty limestone, and shale with some sandstone. No paleontological surveys or excavations have been conducted at NFS, and no paleontological resources are known within the facility. Some invertebrate fossils may exist in the limestone and shale strata; however, these are probably common rather than rare or significant fossils. The probability of significant or rare paleontological resources existing at NFS is low.

3.6.8 SOCIOECONOMICS

Socioeconomic characteristics described for NFS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses nine counties around NFS in the States of Tennessee and Virginia. (Appendix F, Table F.1–1). As stated in Section 3.2, the geographic region comprising the REA is determined by Bureau of Economic Analysis and is based on economic links between communities in the region. Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area, located in the State of Tennessee, in which 91.7 percent of all NFS employees reside: Carter County (8.3 percent), Sullivan County (2.8 percent), Unicoi County (40.9 percent), and Washington County (39.7 percent) (Appendix F, Table F.1–5). It should be noted that there are no counties in North Carolina where significant numbers of NFS employees reside; therefore, neither the REA nor the ROI contain North Carolina jurisdictions. Supporting data are presented in Appendix F.

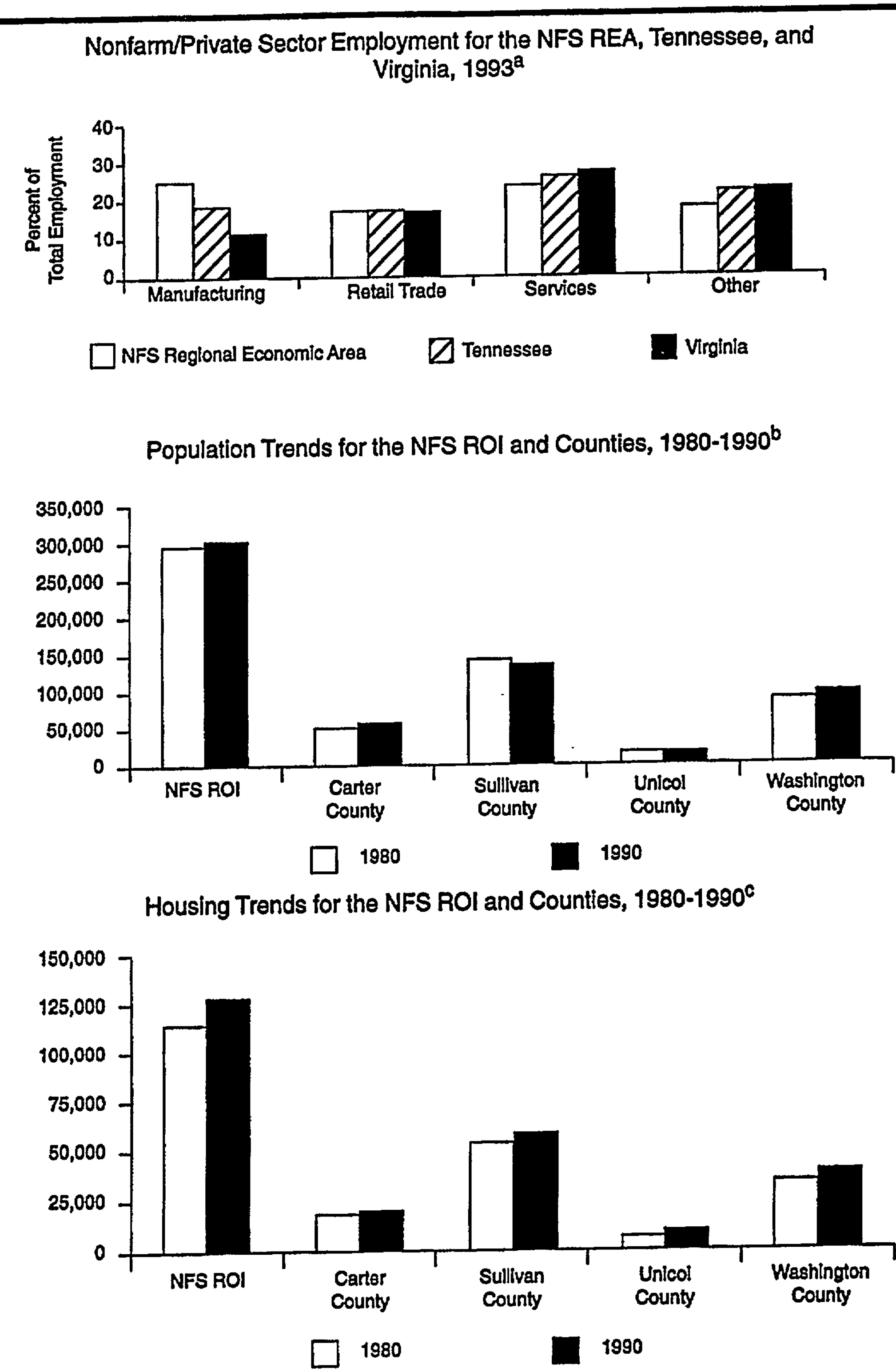
Regional Economy Characteristics. Between 1980 and 1990, the civilian labor force in the REA increased 10.6 percent to the 1990 level of 252,178. In 1994 unemployment in the REA was 5.9 percent, which was approximately 1 percent greater than both Tennessee and Virginia. The region's per capita income of $16,309 in 1993 was 11.5 and 24.7 percent less than the per capita incomes of $18,439 in Tennessee and $21,653 in Virginia, respectively. Employment and local economy statistics and projections for the proposed action period for the NFS REA are presented in Appendix F, Table F.1–9 and summarized in Figure 3.6.8–1.

In 1993, as shown in Figure 3.6.8–1, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (17 percent) and the two States. Manufacturing in the region (25 percent of total employment) represented a greater share of the economy than in the States of Tennessee (19 percent) and Virginia (11 percent). Services in the REA (22 percent) represented a 4 percent smaller share of the economy than in Tennessee and a 6 percent smaller share of the economy than in Virginia.

[Text deleted.]

Population and Housing. In 1992, the ROI population totaled 310,430. From 1980 to 1990, the ROI population increased by 1.6 percent compared to 6.2 percent for Tennessee. Within the ROI, Washington County experienced the largest increase at 4 percent, while Sullivan County's population decreased by 0.3 percent. Population trends are summarized in Figure 3.6.8–1. [Text deleted.]

The total number of housing units between 1980 and 1990 increased 12 percent, nearly 4 percent less than the increase in housing units for the entire State. In



[a] DOC 1995a.
[b] Census 1983q; Census 1993b.
[c] Census 1982d; Census 1991c.

Figure 3.6.8–1. Economy, Population, and Housing for the Nuclear Fuel Services Regional Economic Area and Region of Influence.

1990, the total number of housing units was 127,856. The 1990 homeowner vacancy rate in the ROI was 1.6 percent, which was similar to the vacancy rate for Tennessee. The rental vacancy rate for the ROI counties was 5.6 percent, approximately 4 percent less than the rental vacancy rate for the entire State. (A presentation of population and housing statistics and projections is presented in Appendix F, Tables F.1–13 and F.1–17, respectively.)

Community Services. Education, public safety, and health care characteristics are used to assess the level of community service in the NFS ROI.

Education. In 1994, eight school districts provided public education services and facilities in the NFS ROI. These school districts ranged in enrollment size from 2,547 students in the Elizabeth City School District to 14,550 students in the Sullivan County School District. The average students-to-teacher ratio for the ROI was 18:1. The Washington County School District had the highest ratio at 19.2:1. Figure 3.6.8–2 presents school district characteristics for the NFS ROI.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1993, a total of 542 sworn police officers served in the four-county area. Sullivan County employed the greatest number of sworn police officers (307) and had the highest officers-to-population ratio (2.1 officers per 1,000 persons). The average ROI officers-to-population ratio was 1.7 officers per 1,000 persons. Figure 3.6.8–3 presents police force strengths for the ROI.

Fire protection services in the NFS ROI were provided by 1,201 regular and volunteer firefighters in 1995. The fire department with the highest firefighters-to-population ratio is located in Sullivan County, with 4.6 firefighters per 1,000 persons. Sullivan County also employed the greatest number of firefighters (694). The firefighters-to-population ratio in the ROI was 3.7 firefighters per 1,000 persons. Figure 3.6.8–3 presents fire protection service characteristics for the ROI.

Health Care. There were eight hospitals serving the four-county ROI in 1993. All eight hospitals operated below capacity with hospital occupancy rates ranging from 31 percent in Carter County to 68 percent in Sullivan County.

There were 848 practicing physicians in the ROI during 1993, with most (415) practicing in Sullivan County. The physicians-to-population ratio ranged from 0.6 physicians per 1,000 persons in Carter and Unicoi Counties to 4.1 physicians per 1,000 persons in Washington County. The average ROI physicians-to-population ratio was 2.7 physicians per 1,000 persons. Figure 3.6.8–3 presents health care characteristics for the ROI.

Local Transportation. Interstate highways, U.S. highways, and State Routes provide access between NFS in Erwin, Tennessee, and metropolitan areas illustrated in Figure 3.6–1. The north-south highway, I-181, is located west of the facility and provides access to Johnson City, Tennessee. I-81 is northwest of NFS and connects to east-west highway SR-107, providing access to Greenville, Tennessee, via U.S. 321. Access to Asheville, North Carolina, is provided by north-south highway U.S. 19W/23, located to the south of NFS.

Vehicular access to NFS is provided by U.S. 19W/23. I-181 has been extended to the North Carolina State line. This should improve traffic conditions around Erwin. The expansion of I-181 does not currently interfere with local traffic near Erwin. There are no road projects planned in the near future that will affect access to NFS directly (TN DOT 1995a:1).

There are no public transportation systems providing service to the site. The site is accessed by CSX Transportation. The spur from CSX Transportation was removed, but replacement is planned for 1996. There is no access to NFS by navigable waterway.

The Tri-Cities Regional Airport, located north of Johnson City, is the nearest airport serving the region with major carriers providing passenger and cargo service (DOT 1992a).

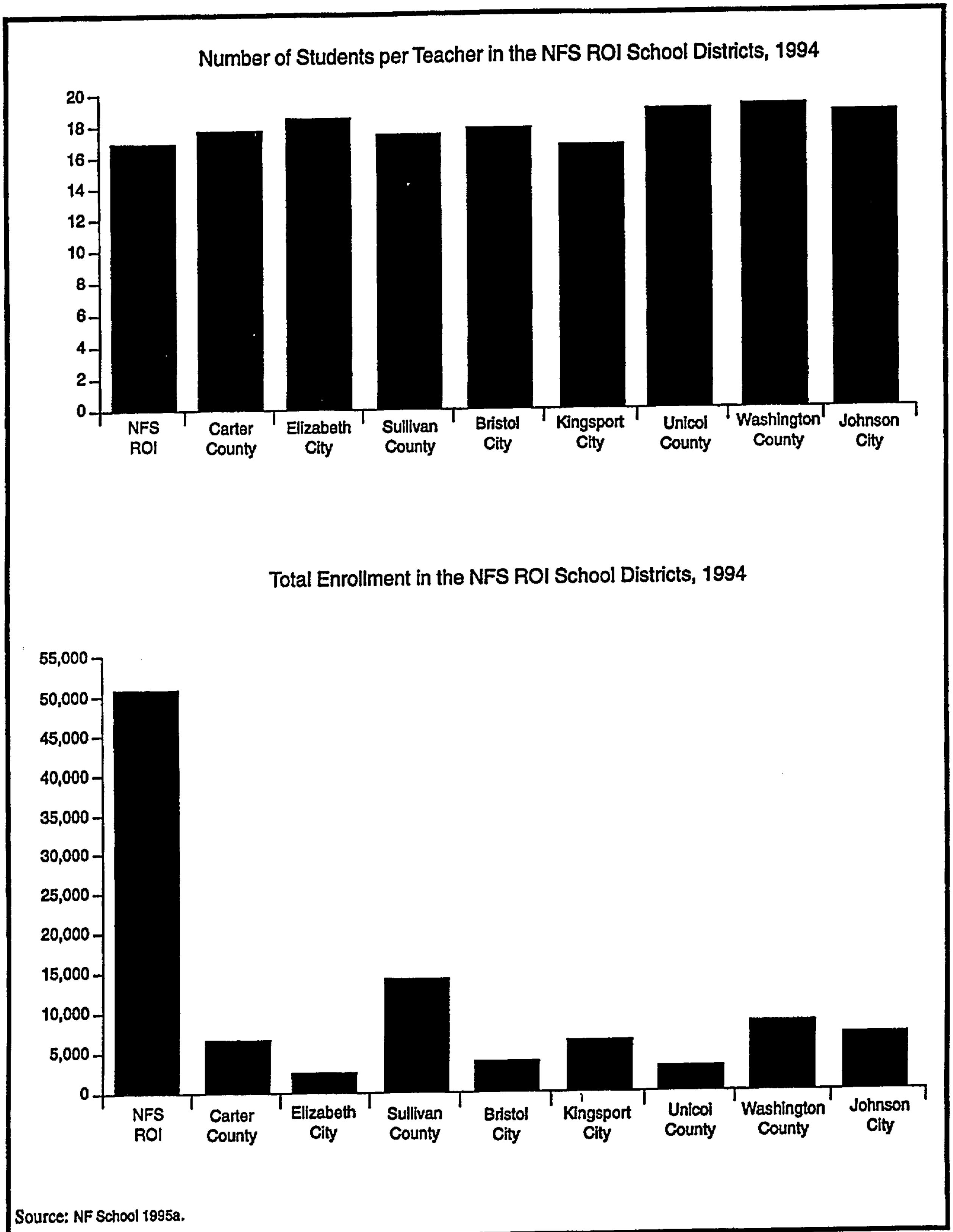
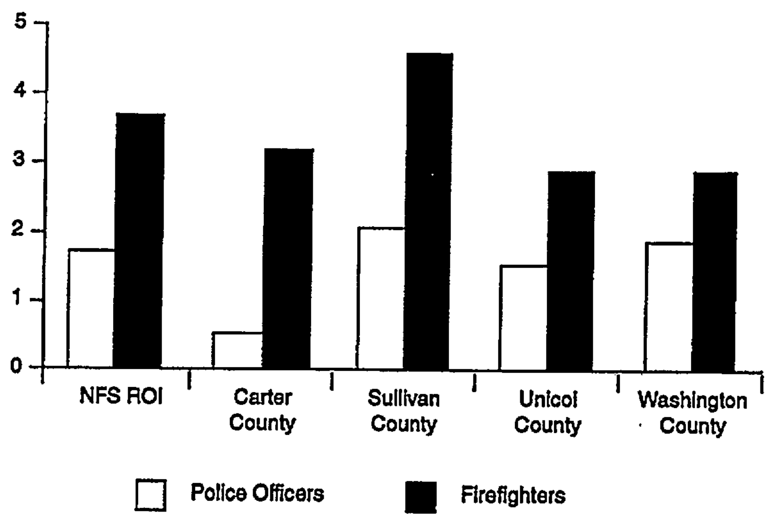
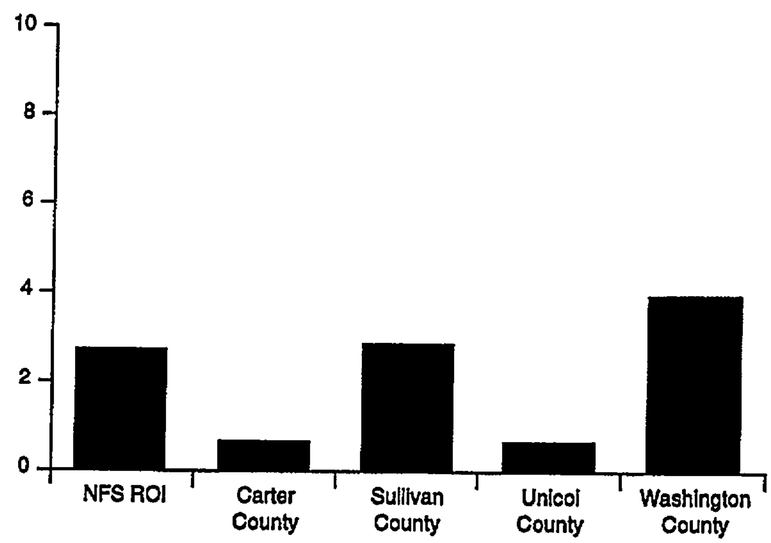


Figure 3.6.8–2. School District Characteristics for the Nuclear Fuel Services Region of Influence.

Number of Sworn Police Officers (1993) and Firefighters (1995) per 1,000 Persons in the NFS ROI[a]



Number of Physicians per 1,000 Persons in the NFS ROI, 1993[b]



[a] Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; DOJ 1994a; NF Fire 1995a.

[b] AMA 1994a; Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

Note: Except for ROI cities, city sworn officers and firefighters are included in the county totals. Kingsport Fire Department in Sullivan County and Limestone Cove Volunteer Fire Department in Unicoi County were excluded from the NFS ROI total because firefighter data were unobtainable.

Figure 3.6.8–3. Public Safety and Health Care Characteristics for the Nuclear Fuel Services Region of Influence.

3.6.9 PUBLIC AND OCCUPATIONAL HEALTH

Radiation Environment. All residents in the vicinity of the NFS facility are exposed to background radiation from a variety of natural and man-made sources. The major sources of background radiation exposure to individuals in the vicinity of NFS are shown in Table 3.6.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population.

Releases of radionuclides to the environment from NFS facility operations provide another source of radiation exposure to individuals in the vicinity of the site. These radionuclides and their representative associated release quantities for normal operations are presented in site-specific environmental reports. The doses to the public resulting from these releases and direct radiation are presented in Table 3.6.9–2. These doses fall within radiological limits and are small in comparison to background radiation.

Table 3.6.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nuclear Fuel Services Facility Operations

Source	Committed Effective Dose Equivalent (mrem/yr)[a]
Natural Background Radiation	
Cosmic radiation	45
External terrestrial radiation	70
Internal terrestrial radiation	25
Radon in homes (inhaled)	200
Other Background Radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	405

[a] NCRP 1987a; NF NRC 1991a. Value for radon is an average for the United States.

Furthermore, these radiological releases were used in the development of the reference environment's radiological releases at NFS for the public and occupational health segments within Section 4.3.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the fatal cancer risk to the MEI of the public due to representative annual radiological releases from NFS site operations is estimated to be approximately 1.6×10^{-8}. That is, the estimated probability of this person dying of cancer in the future from radiation exposure associated with 1 year of NFS operations is less than 2 chances in 100 million. (It may take several years from the time of exposure for cancer to manifest.)

Based on this same risk estimator, approximately 1.0×10^{-4} excess fatal cancers to the population living within 80 km (50 mi) of NFS are estimated from a normal operating year. This number can be compared with the numbers of fatal cancers expected in this population from all causes. The average mortality rate associated with cancer for the entire U.S. population is presently 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers from all causes expected to occur annually is 1,840 for the population living within 80 km (50 mi) of NFS. This number of expected fatal cancers is much higher than the estimated 1.0×10^{-4} fatal cancers that could result from present-day annual NFS facility operations.

Workers at NFS receive the same dose as the general public from background radiation, but receive an additional dose from working at the facility. These doses fall within radiological limits (10 CFR 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to NFS facility workers from operations in 1994 is estimated to be 6.5×10^{-3}. Table 3.6.9–3 presents the average, maximum, and total occupational doses to NFS facility workers from operations in 1994.

Chemical Environment. The background chemical environment important to human health consists of the following: the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example,

Table 3.6.9–2. Representative Doses to the General Public From Normal Operation of the Nuclear Fuel Services Fuel Fabrication Facilities, 1994 (committed effective dose equivalent)

Receptor	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual[b]	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	3.2×10^{-2}	4	9.0×10^{-4}	25	3.3×10^{-2}
Population within 80 km[c] (person-rem)	None	0.2	None	1.4×10^{-3}	None	0.2
Average individual within 80 km[d] (mrem)	None	2.2×10^{-4}	None	1.5×10^{-6}	None	2.2×10^{-4}

[a] The standards for individuals are given in 40 CFR 61, 141, and 190. As discussed in these regulations, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 25 mrem/yr is the limit from all pathways combined.

[b] NF NRC 1991a; NFS 1995b:1.

[c] In 1990, this population was approximately 921,400.

[d] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Table 3.6.9–3. Doses to the Onsite Worker From Normal Operation of the Nuclear Fuel Services Fuel Fabrication Facilities, 1994 (committed effective dose equivalent)

Receptor	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	50
Maximally exposed worker (mrem)	5,000	470[c]
Total workers (person-rem)	None	16.3

[a] 10 CFR 20. NRC's goal is to maintain radiological exposure ALARA.

[b] NFS 1995b:2; NRC 1995b. The number of badged workers in 1994 was approximately 325.

[c] NFS 1995b:2; NRC 1995b. From one-half year of operation.

surface waters during swimming and soil through direct contact, or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in previous sections of this EIS, particularly Sections 3.6.3 and 3.6.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (for example, air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by NFS facility operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous air pollutants and their applicable standards are presented in Section 3.6.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Appendix E, Section E.3.4.

Health impacts to NFS facility workers during normal operations may include inhalation of the workplace atmosphere, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to accurately summarize these impacts; however, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NFS facility workers also are protected by adherence to occupational standards that limit workplace atmospheric concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded.

Health Effects Studies. Data searches have been made for studies and/or information on the epidemiology in communities near the NFS site; however, no literature or database information has been identified. In addition, the Unicoi County Health Department had no reports available. The TDEC was requested to provide reports or information from epidemiologic studies conducted on area residents; the TDEC Epidemiology Program Office was not aware of any studies conducted by local or State personnel.

Database/literature searches have produced one study on kidney disease among plant workers, with guards, and local dairy farmers used as the comparison groups (NIOSH 1988a:1). NFS employees showed a higher prevalence of kidney stones than guards but lower than dairy workers. Although there was greater prevalence of urinary tract infections for workers at NFS than for the cohort groups, the authors did not link this finding to occupational hazards at NFS. Details of the study are presented in Appendix E, Section E.4.5.

Accident History. NFS is a nuclear fuel manufacturing facility and is heavily inspected by Federal, State, and local agencies. As such, NFS has maintained an exemplary record relating to strict compliance to all applicable regulations. NFS has never experienced a fatality resulting from work-related activities, nor has a criticality accident ever occurred at NFS. NFS has never been cited by the Occupational Safety and Health Administration (OSHA) or the Tennessee OSHA for any infraction, and within the past 7 years, NFS has had no reportable radiological over-exposures and no reportable offsite chemical releases.

Emergency Preparedness. Sites that are licensed to operate by NRC are required to have extensive emergency preparedness programs, including plans and resources to deal with any emergency situation that may occur. Adequate resources must be available to protect the workers, the public, and the environment from unlikely hazards that may occur during a facility's lifetime.

3.6.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities at NFS. NFS's waste management operations are in compliance with their NRC license; with Federal regulations for water, air, and land disposal; and with State of Tennessee and city of Erwin regulations.

All process waste is treated and discharged to the Nolichucky River through an NPDES-permitted outfall. The TDEC governs air pollution control, water pollution control, and solid and hazardous waste management at NFS. Hazardous and solid LLW are shipped offsite for disposal. NFS has disposed of LLW in the past in onsite burial grounds. Contaminated soil has been removed and placed in a controlled area on the site. Radiological measurements indicate no subsurface migration or groundwater contamination from previously used waste disposal sites (NF NRC 1991a:2-6). Waste management activities at NFS are discussed below.

High-Level Waste. NFS does not generate or manage HLW.

Transuranic Waste. Pu and mixed Pu-uranium fuel materials have been processed in the past; however, those facilities have been decontaminated. There is currently no TRU waste generation, though future decommissioning activities may produce some TRU waste from the removal of residual Pu contamination.

Low-Level Waste. Liquid and solid LLW is generated at NFS. Liquid LLW is generated at the rate of 18,900 m^3/yr (5,000,000 gal/yr) and solid LLW is generated at the rate of 3,000 m^3/yr (106,000 ft^3/yr) (NFS 1995b:2). The bulk of liquid LLW is aqueous process waste. Liquid effluents are treated in the Waste Water Treatment Facility to remove the radioactive constituents, and the treated effluents are discharged within standards established by the State of Tennessee in the NPDES permits and 10 CFR 20. Liquid LLW process facilities have the capacity to treat 38,700 m^3/yr (10,000,000 gal/yr) of liquid waste (NFS 1995b:2). Solid LLW includes operating plant and laboratory waste, Waste Water Treatment Facility sludge, HEPA filters, and contaminated equipment. Solid LLW is shipped offsite for disposal.

Mixed Low-Level Waste. Mixed waste is generated at the rates of 0.45 m^3/yr (119 gal/yr) for liquids and 0.03 m^3/yr (1.05 ft^3/yr) for solids (NFS 1995b:2). Mixed waste is segregated, packaged, labeled, and managed in accordance with all applicable NRC, EPA, State, and Department of Transportation requirements. Mixed waste may be treated within 90 days of the accumulation start date in compliance with EPA and State of Tennessee regulations; however, if treatment is not feasible, the waste is stored in the NFS RCRA Part B-permitted storage facility until treatment capacity becomes available.

Hazardous Waste. Hazardous waste is segregated, packaged, labeled, and managed in accordance with all applicable EPA, State, and Department of Transportation regulations. The waste is moved to a 90-day storage facility prior to disposal at a permitted hazardous waste disposal facility. Twenty liters (5.3 gal) of liquid and 0.1 m^3 (4.0 ft^3) of solid hazardous waste are generated each year (NFS 1995b:2). [Text deleted.]

Nonhazardous Waste. Process wastewater is treated in the Waste Water Treatment Facility on a batch basis. Treatment includes pH adjustment, precipitation, air stripping, and chlorination. Each batch is analyzed for gross alpha and beta radioactivity before it is discharged to the Nolichucky River through a NPDES permit issued by the State of Tennessee. Thirty-seven thousand eight hundred cubic meters (10,000,000 gal) of liquid sanitary waste and 18,900 m^3 (5,000,000 gal) of liquid process waste are generated each year (NFS 1995b:2).

Sanitary waste is discharged to a sewer system that delivers it to the city of Erwin POTW. Current sanitary waste consists of groundwater treatment facilities effluent and restroom and shower output. A proportional sampling system in the line collects daily samples that are analyzed for gross alpha and beta contamination. Monthly composites of the daily samples are analyzed for uranium isotopes. There are 2,300 m^3 (81,000 ft^3) of solid nonhazardous wastes generated each year (NFS 1995b:2). Solid nonhazardous waste is packaged for offsite disposal.

Surface drainage is controlled and can be stopped along the drainage path in the event that hazardous constituents are detected in the flow. This allows for cleanup of hazardous constituents before the offsite release occurs.

Chapter 4
Environmental Consequences

4.1 METHODOLOGIES

The environmental impact assessment methodologies discussed in this section address the full range of natural and human resource and issue areas pertinent to the sites considered for the EIS alternatives. These resource areas are land resources, air quality and noise, water resources, geology and soils, biotic resources, cultural resources, and socioeconomics. Also included in the discussion are additional issue areas that are not specifically resources but are important to consider in assessing the environmental effects of the alternative blending processes. These issue areas are facilities operation/ site infrastructure, intersite transport of HEU and LEU (see Section 4.4), waste management, radiological and hazardous chemical effects during normal operation and accidents, and cumulative effects (see Section 4.6).

As part of the impact assessment process, the analysis includes mitigation measures that are part of the alternatives (for example, part of the facility or process) and provides mitigation measures for DOE facilities that could be used to reduce and minimize potential impacts as appropriate.

4.1.1 LAND RESOURCES

Land resource analysis involves an assessment of the patterns and densities of land use and visual resources. [Text deleted.] The potential for resource impacts are analyzed within the context of related Federal legislation and Executive orders.

Chapter 3 provides a description of land and visual resources for each site. Information was researched by data calls and facility site development/land-use plans, local zoning ordinances and comprehensive plans, and aerial photographs. Site-specific information published in recent NEPA documents is incorporated by reference where appropriate.

A baseline (no action) description of land resources is presented for each site. It discusses current and projected patterns and densities of land use and visual quality at these sites. No action information is assembled from any combination of existing NEPA documents, data calls, direct site contacts, and site visits. Key issues and public concerns pertaining to land resources provide a baseline to establish a framework for environmental consequences discussions.

An analysis of environmental consequences is performed to estimate the magnitude and extent of potential impacts to existing patterns and densities of land use from the alternatives under consideration. Land use analysis assesses the following: availability of adequate land area to operate an HEU building facility; compatibility of the facility with current and projected land use as designated by applicable plans, policies, and controls; potential impacts to prime and unique agricultural lands, wild and scenic rivers, public lands, and other environmentally sensitive lands; qualitative assessment of potential land-use changes in the locale caused by project-induced in-migration; and qualitative assessment of recreational lands lost or impacted. Potential changes to the existing facility layout that may impact land use are assessed.

Visual resource analysis classifies visual resources and assesses potential impacts to the visual environment that could result from the implementation of the alternatives. A methodology for visual resource assessment is based on the Bureau of Land Management VRM methodology. The existing landscape is assigned a VRM classification that ranges from one (a pristine area, including designated wilderness and wild and scenic rivers) to five (an area where the natural character of the landscape has been disturbed to the point that rehabilitation is necessary). [Text deleted.]

Visual resource impacts are assessed using the degree of visual contrast between the proposed facilities or activities and the existing landscape character as seen from viewpoints accessible to the public. Sensitivity levels of viewpoints, and viewpoints and visibility of the affected area are taken into consideration.

4.1.2 Site Infrastructure

Site infrastructure assessment evaluates the change in resource requirements imposed by the proposed alternatives at each site. Site infrastructure impacts are determined by comparing the infrastructure requirements of each alternative with each site's baseline (no action) requirements. Impact assessments focus on electrical power, road and rail networks, fuel requirements, water usage, and steam generation. Site-specific data information documents, site development plans, DOE planning documents, EISs, and EAs were used to determine site infrastructure conditions. Tables depicting current resource requirements and requirements needed at each site for each alternative are presented.

Chapter 3 presents baseline conditions at each site. For the DOE sites, ORR and SRS, the affected environments are the same as the no action alternatives. For the commercial sites B&W and NFS, the affected environments are the same as the no action alternatives, which are based on the most current site information available and their NRC-licensed activities. It is assumed that existing facilities would operate in compliance with their current licenses and permits.

4.1.3 Air Quality and Noise

Air Quality. The air quality assessment evaluates the consequences of criteria pollutants associated with each alternative at each site. Air quality impacts are evaluated within the context of EPA's Regulations on National Primary and Secondary Ambient Air Quality Standards (40 CFR 50), the 1990 *Clean Air Act*, National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61), and State-proposed or -adopted standards or guidelines. The assessment of radiological air emission impacts is discussed in the public and occupational health sections. Air quality concentrations from modeling current site emission rates are used to determine baseline concentrations of pollutants at each site. [Text deleted.]

This EIS presents the estimated impacts on air quality based on baseline air quality conditions at all sites and the projected impacts resulting from each of the alternatives. It compares the total concentrations to the most restrictive Federal or State ambient air quality standards and guidelines.

The modeling of site-specific emissions is performed in accordance with EPA's *Guideline on Air Quality Models (Revised)*, EPA-450/2-78-027R, July 1986. The EPA-recommended Industrial Source Complex Short-Term Model (Version 2) is the most appropriate model to perform the air dispersion modeling analysis for this EIS because it allows for the estimation of dispersion from a combination of point, area, and volume sources. More technical information can be found in EPA's *User's Guide for the Industrial Source Complex (ISC2) Dispersion Models*, EPA-450/4-92-008a, March 1992. For source characteristics that are not available, characteristics are assumed based on similar source configurations at sites employing similar processes.

Toxic air pollutants are addressed in both the air quality and noise sections and the public and occupational health sections for each of the candidate sites. In the air quality sections, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health sections, a health risk is calculated based upon chemical concentration and toxicity compared to the Reference Concentration for the public and the Permissible Exposure Level for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical method result in the different pollutants between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of these same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk, and therefore are presented in this analysis. The hazardous chemical pollutants used by these two disciplines to evaluate impacts will be different. Compliance to standards does not consider what health effects are expected nor the interaction between several chemicals that may together cause adverse health responses even if they separately are at below standard concentrations.

Noise. The onsite and offsite acoustical environments may be impacted during facility modification and operation. Generic noise sources that may affect nearby residents are briefly discussed for the no action baseline and each of the proposed alternatives.

A description of current conditions for DOE and commercial sites is provided. For each of the alternatives, a qualitative discussion of operation noise sources and the potential for onsite and offsite impacts is provided in the EIS. This discussion is prepared using information available on the potential types of noise sources.

Since most nontraffic noise associated with the operation of HEU facilities is located at a sufficient distance from offsite noise sensitive receptors, the contribution to the offsite noise level is expected to be small.

4.1.4 WATER RESOURCES

The assessment of potential impacts to water resources, which includes surface water, floodplains, and groundwater, addresses the following: 1) whether there is sufficient water available for the project and domestic consumption, 2) whether the water quality is degraded or will be further degraded, 3) whether the proposed actions challenge legislative or regulatory compliance, and 4) whether actions are threatened by flooding.

Surface Water Availability. Surface waters include rivers, streams, lakes, ponds, and reservoirs. An inventory of surface water resources in the project ROI, a description of areas in the ROI currently using surface water, general flow characteristics, reservoirs, and an identification of classifications applicable to the surface water is used to determine the affected environment at each site. Emphasis is placed on those water bodies potentially impacted during the facility modification or operation phases of the alternatives. Current potable and process water supplies and systems, water rights, agreements and allocations, and wastewater treatment facilities also are described as baseline.

For all the blending sites, the rate of water consumption associated with each alternative is compared with each site's baseline availability of water to determine potential effects on water supply. For all the blending sites, potential effects on the availability of water are determined if the proposed project: 1) increases withdrawals either by exceeding the current stream low flow, 2) decreases the stream flow rate to the point where downstream commitments cannot be met, or 3) violates existing water rights, agreements, allocations, or supply limits.

Surface Water Quality. [Text deleted.] The assessment of potential water quality impacts includes evaluation of the type (that is, wastewater effluent), rate, and concentration of potential discharge constituents. Parameters with the potential to further degrade existing water quality or that are in violation of existing NPDES permit limits are identified. Environmental consequences may result if: 1) the surface water flow rate is decreased to the point where the capacity of the stream to assimilate discharges is noticeably diminished, 2) the proposed increases in discharge cannot comply with NPDES permit limits on flow rates or specific constituent contributions, 3) the proposed increases in discharges contribute constituents to receiving waters already identified as exceeding applicable surface water quality criteria, or 4) the proposed increases in effluent cannot comply with pretreatment limits on flow rates or specific constituent contributions.

Floodplains. Floodplains include any lowlands that border a stream and encompass areas that may be covered by the stream's overflow during flood stages. As part of the affected environment discussion at each site, floodplains are identified from maps and environmental documents. Any facility within a 100-year floodplain or a critical action in a 500-year floodplain is considered an environmental consequence. The 500-year floodplain evaluation is of concern for activities determined to be critical actions for which even a slight chance of flooding would be intolerable.

Groundwater Availability. Groundwater includes water that occurs below the water table in saturated, nonconsolidated geologic material (sand or gravel) and in fractured and porous rock. Aquifers are saturated strata containing groundwater. Availability of groundwater will vary widely over the various sites because it is a function of both the hydraulic characteristics of the aquifers and the rate at which groundwater is withdrawn by other users.

[Text deleted.]

The potential effects to groundwater availability are assessed for each alternative at each candidate site by evaluating whether the proposed project: 1) increases groundwater withdrawals in areas already experiencing overdraft and other related problems (that is, land subsidence), 2) potentially decreases groundwater levels, causing a substantial depletion of the resource, 3) exceeds the water requirement allotment, water rights, or available supply limits, if present, or 4) reduces or ceases the flow of one or more major springs. Suitable mitigation measures to reduce impacts are identified and discussed.

Groundwater Quality. [Text deleted.] The potential groundwater quality environmental consequences are associated with pollutant discharges during facility modification and operation phases (that is, process wastes and sanitary wastes) and are examined for each site to determine if a direct input to groundwater occurs. The results of the groundwater quality projections are then compared to Federal and State groundwater quality standards, effluent limitations, and safe drinking water standards to assess the acceptability of each alternative. Parameters with the potential to further degrade existing groundwater quality are identified for each alternative.

4.1.5 Geology and Soils

The impact assessments for geology and soil resources identify resources that may be affected by the project and the presence of natural conditions that may affect the integrity and safety of the project. Geology resources include mineral resources (that is, energy resources such as coal, oil, and natural gas), unique geologic features, and geologic hazards (that is, earthquakes, faults, volcanoes, landslides, and land subsidence). Soil resources include natural earth materials in which plants grow (usually consisting of disintegrated rock, organic matter, and soluble salts), and prime and unique farmland. Several Federal, State, and local laws have been passed that protect geology and soil resources.

[Text deleted.]

A number of aspects of geology and soil resources are identified as potentially important in the EIS analyses for all sites. Unique or scenic topographic features may be impacted by project activities. Rock units, which may have scenic or other important values or contain mineral or energy resources, may have their condition or accessibility altered. Mineral and energy resources are evaluated from records of past production and reports assessing the potential for future exploitation.

Earthquake potential is evaluated from past events of effective peak velocity-related acceleration, by seismic zone, and by the location of capable faults. Areas of past mass movements and conditions favorable to mass movements, such as excessive slopes and the presence of water, are identified.

Soil units are evaluated for soil erosion potential and characteristics. Prime and unique farmlands that may limit facility operation are evaluated for each site using existing maps and records.

The impact assessments for each site involve locating geologic and soil features of concern and determining how many of those features would be influenced. Impacts of project activities are identified if, during operations, there is destruction or damage to important geological features and if erosion and the potential for subsidence or slope failure is increased. Impacts also are identified if a site is located within any prime or unique farmland or unique geological feature that would be subject to irreversible physical disturbance by the project. Potential operational activities conducted in areas prone to geologic or natural hazards (for example, landslides or earthquakes) are determined and presented. The geology and soil impacts are discussed qualitatively for each alternative, with the exception of presenting the amount of land that would be disturbed or affected during operation of the blending facilities. Mitigation measures to reduce potential impacts to or from geology and soil resources are identified and discussed.

4.1.6 Biotic Resources

The assessment of potential impacts to biological resources is performed for terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Each category has elements that are important from an ecological, recreational, scientific, and/or commercial standpoint. In addition, several laws specifically protect biological resources. Important legislation and Executive orders include, but are not limited to, the following: the *Endangered Species Act* of 1973; Section 404 permit requirements of CWA; the *Coastal Zone Management Act*, Wetlands Executive Order 11990; the *Migratory Bird Treaty Act;* and the *Fish and Wildlife Coordination Act.* Additional guidance is contained in CEQ's *Incorporating Biodiversity Considerations into Environmental Impact Analysis under NEPA* (January 1993).

Biological impacts are assessed by evaluating changes to the baseline environment (no action) that could result from action associated with each alternative. The baseline conditions at these sites are descriptive and qualitative in nature. Impacts resulting from facility modification or operational activities use the number of acres lost and/or the amount of water consumed or discharged as a basis for assessment. A summary comparison of the blending alternatives and their associated environmental consequences at each site also is provided. In addition, mitigation and monitoring strategies are discussed as appropriate.

Terrestrial Resources. Potential impacts to terrestrial resources include loss and disturbance of wildlife and wildlife habitats, as well as exposure of flora and fauna to air emissions. Two important considerations in assessing the impact of habitat loss are the presence and regional importance of affected habitats and the size of habitat area disturbed, temporarily or permanently.

Impacts on terrestrial plant communities resulting from project activities are evaluated by comparing regional vegetation data to proposed land requirements for both construction and operation. Impacts to wildlife are based to a large extent on plant community loss, which is closely related to wildlife habitat. The loss of important or sensitive species or habitats is more significant than the loss of species or habitats that are regionally abundant. This EIS evaluates disturbance, displacement, and loss of wildlife in accordance with the wildlife protection laws listed above.

Wetlands. Some potential impacts to wetlands are related to displacement of wetlands. Other impacts could be caused by activities outside of wetland areas (for example, soil erosion, siltation, and sedimentation). Operational impacts may occur from liquid emissions, from surface or groundwater withdrawals, or from the creation of new wetlands. Existing wetlands are described on a site-specific basis.

Impacts to wetlands resulting from proposed alternatives are addressed in a fashion similar to that for terrestrial plant communities. Impacts on wetlands are evaluated and compared to State and Federal regulations under the CWA.

Aquatic Resources. Impacts to aquatic resources depend on the nature of the water body and the aquatic life present. Impacts from loss of habitat, increased water demand, sedimentation, increased flows, and the introduction of waste heat and chemicals are evaluated as described for wetlands. Descriptions include streams, creeks, ponds, and nearby surface water that could be affected. Impacts resulting from operation are evaluated based on both short- and long-term impacts.

Threatened and Endangered Species. Impacts to threatened and endangered species, including critical habitat, are assessed. Information on species, areas of occurrence, and critical habitats are obtained from the U.S. Fish and Wildlife Service. Impacts are determined in a manner similar to that described for terrestrial and aquatic resources, since the sources of potential impacts are similar. Consultations with U.S. Fish and Wildlife Service, as well as State wildlife agencies, are conducted at the site-specific level as necessary. These consultations ensure that HEU blending activities would not adversely impact threatened and endangered species. Loss of biodiversity is assessed in accordance with guidelines from CEQ's *Incorporating Biodiversity Considerations into Environmental Impact Analysis under NEPA* (January 1993).

4.1.7 CULTURAL RESOURCES

The assessment of potential impacts to cultural and paleontological resources involves evaluation of the projected effects to prehistoric, historic, Native American, and paleontological resources. A description of the baseline (no action) environment based on the identification of resources within a potentially affected site is developed. This description is compiled using reports of previous cultural and paleontological resources studies and surveys. The potential impacts to these resources are discussed, based primarily on acreage disturbed or interference to viewsheds due to a specific alternative.

Prehistoric Resources. Prehistoric resources consist of the physical remnants of human activities that predate written records. They include, but are not limited to, chipped stone tools and the remains of hearths and structures.

Historic Resources. Historic resources consist of the physical remnants of human activities that post-date written records. They include, but are not limited to, residential and commercial structures and trails. In the United States, these are resources that date, in general, from 1492 onward.

Prehistoric and historic resources are primarily protected through the *National Historic Preservation Act* of 1966, the *Archaeological and Historic Preservation Act* of 1979, the *Archaeological Resources Protection Act* of 1979, and their implementing regulations. These laws and regulations establish procedures for the identification, evaluation, and protection of cultural resources.

The prehistoric and historic resources sections discuss how existing resources could be affected at each site. The discussion includes the acreage, if any, that could potentially be disturbed during the implementation of each alternative, the potential to reduce access to these areas, and the potential loss or destruction of these resources. Previous cultural resources studies, including surveys and excavations and the possible presence of sites that are on or are eligible for listing on the NRHP, also are discussed to provide a baseline environment for evaluation of each alternative's potential impacts. Consequences of the no action alternative are discussed. Potential mitigation measures are presented where applicable.

Native American Resources. Native American resources are sites and materials important to Native Americans for religious or heritage reasons. These include, but are not limited to, sacred spaces, cemeteries and burial grounds, and traditional plant gathering areas.

Native American resources are protected under the *American Indian Religious Freedom Act* of 1978 and the *Native American Graves Protection and Repatriation Act* of 1990. These laws and regulations establish procedures for the identification, evaluation, and protection of cultural resources. DOE's American Indian Policy is also considered.

The Native American resources section in the environmental consequences section follows the same format as the prehistoric and historic resources sections when discussing potential impacts. Impacts to Native American resources will be postulated if alternatives have the potential to affect sites important in the Native American physical universe or religion or to reduce access to sacred sites or traditional-use areas.

Paleontological Resources. Paleontological resources consist of the remains, impressions, and traces of plants or animals from a former geological age.

The paleontological resources section in the environmental consequences section follows the same format as the prehistoric, historic, and Native American resources sections in discussing potential impacts and mitigation methods. The potential loss or destruction of these resources that are scientifically important also is discussed.

4.1.8 SOCIOECONOMICS

Socioeconomic impact analysis assesses the environmental consequences of demographic and economic changes resulting from the implementation of each of the proposed alternatives. Increasing the level of activity at operational facilities could potentially burden existing community services and create additional demands on available housing stock. The primary determinants of community impacts are changes in the economic base and demographic composition usually associated with the in-migration of new workers. Assuming that total employment would rise from a proposed activity, and some of this increase could be associated with in-migration, the demand for local services could rise.

The new workers and their families would require public services (for example, schools and health care) and thus create conditions for an expansion of the economic base of the region. Whether this occurs would depend in part on the degree of excess capacity that may already exist. Potential impacts could occur in regions that cannot expand to accommodate new population growth if the demands of this growth are rapid or excessive.

Four sites, two commercial and two DOE facilities, have been identified as candidate sites for the proposed blending of HEU into LEU as UNH. Both commercial sites contain existing blending capabilities; therefore, no new construction would be required. Socioeconomic impacts from employment needs for the operational phase are assessed. The two commercial facilities are also evaluated as candidate sites for blending HEU into LEU as UF_6. Blending is assumed to take place in existing facilities and no new construction is required. Some additional workers are needed for the operational phase, and socioeconomic impacts are assessed. The ORR facility is also evaluated as a candidate site for blending HEU into LEU as molten metal. Socioeconomic impacts from operational employment needs are assessed in this document.

The use of either the commercial or DOE sites or both would require additional employment; therefore, potential impacts to surrounding communities are assessed. The study focuses on the potential impacts of additional workers on housing availability, health care services, education, public safety, and local transportation. Potential socioeconomic impacts are assessed for the geographic area that would be most affected, the ROI.

Changes to demographic and economic indicators of the REAs and ROIs are assessed by comparing baseline (no action) projections of the affected regions to estimates of project-induced impacts. Baseline projections for the project period are derived from population forecasts developed by Bureau of Economic Analysis.

Proposed project alternatives would require additional workers during operation phases. An analysis of the existing labor availability is performed to determine the number of workers that are needed to come from outside the region. In addition to jobs created directly by the proposed project alternatives, other job opportunities will be indirectly created within the region. These indirect jobs and income are measured by employing the most recent version of the Regional Input-Output Modeling System developed by Bureau of Economic Analysis. Population increases due to the in-migration of new workers and their families are assessed together with their effects on housing, community services, and local transportation.

Environmental Justice Assessment. The environmental justice analysis focuses on potential disproportionately high and adverse human health or environmental effects from the proposed alternatives to minority and low-income populations. The assessment is pursuant to Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, dated February 16,1994. EPA and DOE are in the process of developing implementation guidance concerning Executive Order 12898 and the approach taken in this EIS may differ somewhat from the guidance that is eventually issued and from the approach taken in other EISs. Selected demographic characteristics of region-of-influence (80 km [50 mi]) for each of the four candidate sites were generated from 1990 block level U.S. Census data. The analysis identified census tracts where minorities comprise 50 percent, or simple majority, of the total population in the census tracts, or where minorities comprise less than 50 percent but greater than 25 percent of the total population in the census tract. The analysis also identified low-income communities where 25 percent or more of the population is characterized as living in poverty (yearly income of less than $8,076 for a family of two). Impacts are assessed based on the analysis presented for each resource and issue area for each blending technology at each site. Any disproportionately high and adverse human health or environmental effects on minority and low-income populations are discussed.

4.1.9 Public and Occupational Health

The assessment of impacts to workers and the public for radiological releases from normal blending operations and facility accident conditions for each alternative is performed using the Hanford

Environmental Radiation Dosimetry Software System, Generation II (GENII) and MACCS computer codes, respectively. Impacts from facility accidents were originally estimated in the HEU Draft EIS using the GENII computer code. GENII is generally used and best suited for modeling impacts of radiological releases under normal operation of facilities because it handles a large number of radiological isotopes and accounts for the ingestion pathway. GENII was used with 50-percent meteorology (average meteorological conditions that would occur 50 percent of the time in any given period at the site) during the accident. It was assumed that the noninvolved worker is placed in the sector that yields the maximum dose calculated by GENII and is located 1,000 m (3,280 ft) away (or at the site boundary if less than 1,000 m [3,280 ft]) from the accident. Latent cancer fatalities were calculated by applying this dose to all noninvolved workers at a site. This was done to compensate for a lack of data regarding onsite worker distribution, but yields highly conservative results.

In response to public comments, DOE has revised its analyses to improve the realism in the calculation of noninvolved worker doses. Accidental releases of uranium were remodeled using the MACCS computer code with more detailed site-specific information to better estimate noninvolved worker cancer fatalities at each candidate site. MACCS is a widely used code that offers better capabilities than GENII in terms of modeling accident conditions. MACCS assumes, unlike GENII, that when an accident occurs, food production would be interdicted (no consumption of contaminated food). It uses actual (recorded onsite) meteorological conditions and statistically distributes population dose among sectors based on frequency of wind direction recorded over a 1-year period. MACCS also accounts for various site-specific protective measures such as evacuation sheltering and temporary relocation. All information required for MACCS were gathered including the worker distribution data for each site and incorporated into MACCS runs to obtain a more realistic estimate of potential worker accident consequences (see Appendix E for additional details).

Public Health Risks

The risks to the general public are determined in the following ways: 1) for present operations, doses presented in the most recent environmental or safety reports are used to calculate health risks, and 2) incremental radiological/chemical doses and respective subsequent risks for various blending operations are modeled using site-specific parameters.

The radiological and chemical effluents for the No Action Alternative are obtained from currently reported releases. For each of the other alternatives, radiological and chemical effluents are obtained from data reports specific to each blending process (further supplementary information is presented in Appendix E).

As discussed earlier, radiological impacts under normal operations are obtained using the GENII computer code. The assessment of incremental impacts to the MEI from blending alternatives at two DOE sites, Y–12 and SRS, and at one of the commercial sites, B&W, is directly performed using site-dependent factors such as meteorology and an assumed facility location on the site. Sufficient information exists for these sites for use in GENII to adequately represent ambient conditions (current conditions representing no action) and to calculate incremental increases in the MEI dose due to the proposed blending alternatives. However, for the assessment of impacts at the NFS site, a "calibration" factor (a benchmark ratio) is used to assess the incremental impacts to the MEI since all site-specific parameters required by GENII are not available. In this case, the "calibration" factor is established by dividing the no action dose reported in a recent NFS EA (NF NRC 1991a:4-34) by a corresponding GENII calculated no action dose (the GENII dose was calculated using the release terms in the EA). This benchmark ratio is used to adjust MEI doses calculated by GENII for each blending alternative.

For the calculation of incremental population doses for the two DOE sites, Y–12 and SRS, GENII is run using site-dependent factors such as meteorology, population distributions, agricultural production, and an assumed facility location. The incremental population doses for the two commercial sites, B&W and NFS, however, are calculated using a ratio obtained by dividing the dose to the population within 80 km (50 mi) by the MEI dose reported in the B&W EA (BW NRC 1995a: 73, 75) and NFS EA (NF NRC 1991a:4-34, 4-36), respectively. The incremental population dose for B&W and NFS for each blending alternative is then calculated by multiplying this ratio by the incremental dose to the MEI.

[Text deleted.]

The resulting doses are compared with regulatory limits and, for perspective, with background radiation levels in the area of the site. These doses then are converted into the projected number of fatal cancers using a risk estimator of 500 fatal cancers per 1,000,000 person-rem derived from data presented both in a report prepared by the National Research Council's Committees on the Biological Effects of Ionizing Radiations (BEIR V) and cited in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60), by the International Commission on Radiological Protection. The calculated health effects from each of the blending processes then are compared to those determined for the total site; the difference of the two yields a value that corresponds to a no action result. By presenting total site impacts, a conservative assumption that any blending operation can be performed concurrently with existing operations is maintained.

Hazardous and Toxic Chemical Consequences. Public health risks from hazardous chemical releases during normal operation at the respective DOE and commercial sites are assessed by essentially the same analytical approach using conservative assumptions. Engineering design for the facilities used to process HEU and/or store HEU or LEU includes the anticipated emissions of hazardous chemicals. From the emissions data, concentrations at the site boundary are assumed to represent the maximum that any member of the public will encounter; therefore, the site boundary concentrations are derived through modeling using the Industrial Source Complex Short-Term Model (Version 2) system recommended by EPA. The noncancer risks to the MEI of the public consist of hazard quotients (HQs) that compare chemical exposure levels to the Reference Concentration values published by EPA in the Integrated Risk Information System (IRIS). The lifetime cancer risk to the MEI is calculated from doses derived from modeled exposure level, using slope factors or unit risks for individual chemicals published in IRIS or the Health Effects Summary Tables, the yearly summary of EPA's regulatory toxicity data, including IRIS information. The hazard index (HI) values (that is, sum of HQs) and cancer risks are conservative because a single point at the site boundary is chosen for the calculations. The cancer risks are conservative due to the single point concentration and the position where the exposure is assumed. The conservatism of the cancer risk calculation is also due to the assumption that the MEI is exposed to the chemical over the individual's lifetime. The HI is independent of the cancer risk. If the HI is ≤ 1.0, all non-cancer exposure values meet OSHA standards. If the lifetime cancer risk is $\leq 1\times10^{-6}$ (40 CFR 300.430), the incidence of cancers from hazardous toxic chemicals cannot be distinguished from the cancer risk for an individual member of the general population.

Facility Accidents. [Text deleted.] The potential for and associated consequences of reasonably foreseeable accidents are assessed for the public for each alternative using the MACCS computer code. The potential impacts from events such as process-related accidents and a severe earthquake (the evaluation basis earthquake) are evaluated in terms of potential cancer fatalities that may result for the public from bounding scenarios. [Text deleted.] The evaluation basis earthquake is a severe earthquake, postulated for the purpose of evaluating consequences of mitigation and prevention system failures, and as such, it is analogous to a beyond design basis accident.

Three measures of accident consequences are presented. "Dose" is a measure of the amount of radiation received by the body. "Latent cancer fatalities per accident" is a measure of the health consequences of an accident if it occurs. It is the number of people that would be expected to die of cancer as a result of receiving that dose (which assumes that the postulated accident occurs). "Risk (cancer fatalities per year)" is a measure that reflects possible fatalities which considers both the probability that an event will occur and the consequences of that event. The numbers of latent cancer fatalities from the bounding scenarios are evaluated to provide an overall measure of accident impacts. The risk is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities to the public or increased likelihood of cancer fatality to the MEI).

The potential impacts from accidental releases of toxic chemicals to the public from these same bounding scenarios are evaluated in terms of immediately dangerous to life or health (IDLH) concentrations (NIOSH 1990a:4-5,116-117,126-127,160-161). These concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 min without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects. Concentrations to the public also are compared with Threshold Limit Values (TLV) for Short-Term (15-min) Exposure Limits (STEL) and Time (8-hr) Weighted Average (TWA) concentrations to workers (ACGIH 1992b:2-5,22-23,28-29). The latter represents the time-weighted average concentration for a normal 8-hr work-day and a 40-hr work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The former represents the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

Occupational Health Risks

Health risks are assessed for two types of workers. The first type is the involved worker who would be located inside a facility that is involved with the storage or disposition of HEU materials. The second type is the noninvolved worker who might be located somewhere else on the site but is not involved in the storage or disposition of HEU materials.

Radiological Impacts. Involved worker exposures are based on blending process dose measurements. The doses to noninvolved workers at each respective site are determined based on occupational dose histories; for these workers, impacts associated with each blending alternative are assumed to be negligible compared with those associated with their primary onsite activities.

The worker doses are converted into the number of projected fatal cancers using the risk estimator of 400 fatal cancers per 1,000,000 person-rem for doses less than 20 rem and dose rates less than 10 rad/hr (ICRP 1991a:70). This lower risk estimator, compared with that for members of the public, reflects the absence of children in the workforce.

Hazardous and Toxic Chemical Impacts. Since direct chemical monitoring data on worker exposure is not available for specific operations, the onsite worker is assumed to receive the maximum exposure any involved or noninvolved onsite person will receive. OSHA-regulated levels (that is, the Permissible Exposure Level) are applied to all hazardous chemicals that are released at the site. This includes both the process-specific releases as well as those that are a result of other site operations. All onsite exposures are assumed to occur at a distance of 100 m (330 ft) from a centralized point of release, which will yield a conservative concentration level for each chemical. The concentrations are derived through modeling using the Industrial Source Complex Short-Term Model (Version 2) model system recommended by EPA. The noncancer risks to the onsite worker consist of HQs that compare chemical exposure levels to the Permissible Exposure Level values established by OSHA. The HI for each alternative is the sum of all HQs for the alternative. The cancer risks to the onsite worker are calculated from doses derived from modeled exposure levels, using slope factors or unit risks for individual chemicals published in IRIS or Health Effects Summary Tables. The worker exposure is based on an 8-hour day and for 52 weeks of 40-hour duration (that is, 0.237 fractional year) and a lifetime exposure. The HI values and cancer risks are conservative because a single point at 100 m (330 ft) from a centralized source term is chosen for the calculations. The cancer risks are conservative due to the single point concentration and the position where the exposure is assumed. The cancer risks to the facility worker for each chemical are computed from the dose (converted from air concentrations) and the unit risk or slope factors to yield a probable risk. The risks are conservative because a single point at or near the maximum onsite concentration is selected for exposure of the facility worker. The conservatism of the cancer risk calculation is also due to the assumption that the worker is exposed to the chemicals over the individual's working lifetime of 40 years. Actual risks are lower than the estimated risks. As described for public health risks, this conservative approach is applied uniformly to workers at all sites. If the HI is ≤ 1.0, all non-cancer exposure values meet OSHA standards. If the lifetime cancer risk is ≤ $1x10^{-6}$ (40 CFR 300.430), the incidence of cancers from hazardous toxic chemicals cannot be distinguished from the cancer risk for a general individual member of the workforce. It should be noted that when the OSHA standards for HIs are exceeded and/or the cancer risk exceeds $1.0x10^{-6}$ a health concern does not necessarily exist and, indeed, may not exist. The model used to calculate HI and cancer risk in this EIS only establishes a baseline for comparison of alternatives among different sites. This baseline is then used to determine the extent by which each alternative adds or subtracts from the no action HI and cancer risk for workers at each site.

Facility Accidents. [Text deleted.] The potential impacts from accidents are evaluated in terms of potential cancer fatalities that may result for noninvolved workers from bounding scenarios explained previously under Public Health Risks. The risk of cancer fatalities from these bounding scenarios is also evaluated to provide an overall measure of accident impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities in the worker population).

The calculation for the dose to the noninvolved worker population is similar to the calculation for the dose to the general population within 80 km (50 mi) (described previously), except that a site-specific worker distribution is used. No credit was taken for short-term reactions such as evacuation or relocation. However, it was assumed that workers would be shielded from inhalation of the radioactive material for approximately half the time the radioactive plume would be present at the site. The noninvolved worker's breathing rate is taken as $2.7x10^{-4}$ m^3/s (0.01 ft^3/s) during immersion in the plume. It is also assumed that for healthy workers who are exposed to radioactivity of exposure rate less than 10 rad/hr or doses less than 20 rem, there would be 400 fatal cancers per 1,000,000 person-rem of exposure. For an exposure rate greater than 10 rad/hr or doses greater than 20 rem, there would be 800 fatal cancers per 1,000,000 person-rem of exposure.

The potential impacts from accidental releases of hazardous chemicals to noninvolved workers from these same bounding scenarios are evaluated in terms of IDLH concentrations (NIOSH 1990a:4-5,116-117,126-127,160-161). These concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (for example, severe eye irritation) or irreversible health effects. Concentrations also are compared with TLV for STEL and TWA concentrations to workers (ACGIH 1992b:2-5,22-23,28-29). The latter represents the time-weighted average concentration for a normal 8-hour work-day and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The former represents the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency.

In addition to the potential impacts to noninvolved workers, there are potential impacts to workers who could be located in the facilities. Quantitative statements of these impacts cannot be made until details are developed further in site-specific safety documentation, at which time the number and location of facility workers can be estimated to support accident impact analyses. Reference is made to an analysis of related facilities (OR DOE 1994d:6-26,6-27); its results are summarized as an indication of impacts to involved workers.

4.1.10 WASTE MANAGEMENT

The waste management analysis evaluates impacts of proposed alternatives on the existing and projected waste management activities at the candidate sites against the no action alternative at that site. The impact assessment addresses the waste types and waste volumes from the various blending processes at each site and compares them with the no action alternative.

The following categories of waste are analyzed: low-level, mixed low-level, hazardous, and nonhazardous waste. Wastes generated from environmental restoration programs are considered.

The waste management baseline information is extracted from annual site environmental reports; *The Integrated Data Base: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics-Annual Report*; the Waste Management Information System; the Mixed Waste Inventory Report; site treatment plans; site annual waste generation and minimization reports; site waste management plans; facility descriptions; process operation descriptions; and planning documents. Existing environmental agreements affecting emission, effluents, and waste streams also are examined to determine the requirements for each known site. A regulatory setting is developed for each site based on current Federal, State, regional, and local regulations and agreements.

This EIS assesses the environmental impacts associated with waste management for each proposed blending process. Waste generation and effluent (post-treatment) data are based on operating data for existing blending facilities and on estimates for new blending capabilities. The impact on waste management infrastructure and practice caused by waste streams for each blending process is evaluated. For the No Action (baseline) Alternative, waste generation data from the current affected environment are used.

For the purposes of analysis in this EIS, data from DOE's Integrated Data Base Program as shown in Tables 4.1.10–1 and 4.1.10–2 were used to calculate LLW disposal land usage for commercial and DOE disposal facilities, from 1990 through 1993. To determine a usage factor to use in the waste management impact analysis, SRS was selected, since the waste disposal facilities at ORNL accept only waste generated at ORNL, and not from K–25, Y–12, or from offsite. The SRS average value was rounded down to the nearest 100 cubic meters (that is, 8,600 m^3/ha [123,000 ft^3/acre]). Except for special conditions documented in Site Treatment Plans, in compliance with the *Federal Facility Compliance Act* of 1992, and subject to NEPA analysis and FFCA, DOE sites do not normally accept waste from other sites for disposal. NTS currently accepts waste from 15 generators with 9 more pending (7 submitting applications for approval and 2 awaiting DOE approval), for disposal of selected waste forms meeting NTS Waste Acceptance Criteria. No additional waste will be shipped to NTS until the completion of the NTS Sitewide EIS (or other applicable NEPA documentation, including the Waste Management PEIS) and in accordance with decisions in the associated ROD(s). For B&W and NFS, an average value of 20,000 m^3/ha (286,000 ft^3/acre) was calculated, assuming the waste would go to a commercial facility. The value used closely approximates usage at Barnwell, which is expected to remain operational through 2005 (DOE 1995kk:112,115). However, if necessary, the commercial facility at Richland, Washington, is also an option. It must be recognized that the specific site where wastes will be disposed is not a fixed issue. For this analysis, normal practice was assumed for the process waste, in that it is assumed to be disposed of in accordance with current practice (that is, the commercial sites would ship their waste offsite to a commercial facility, and the DOE sites would dispose of their waste onsite). At ORR, the proposed Class II LLW disposal facility was assumed to be utilized, with a usage factor of 3,300 m^3/ha (47,200 ft^3/acre) (OR DOE 1995e:1).

Table 4.1.10–1. Low-Level Waste Disposal Land Usage Factors for Commercial Sites

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ha)
	1993		
Barnwell, SC	701,368	36.6	19,163
Beatty, NV[a]	137,455	15.7	8,755
Richland, WA	355,051	11.9	29,836
	1992		
Barnwell, SC	684,223	34.7	19,718
Beatty, NV[a]	137,455	15.7	8,755
Richland, WA	349,763	11.9	29,392
	1991		
Barnwell, SC	660,705	29.8	22,171
Beatty, NV[a]	122,880	15.7	7,827
Richland, WA	338,042	11.9	28,407
	1990		
Barnwell, SC	638,337	29.8	21,421
Beatty, NV[a]	118,341	15.7	7,538
Richland, WA	326,170	7.8	41,817
	Average		
Barnwell, SC			20,618
Beatty, NV[a]			8,219
Richland, WA			32,363

[a] Stopped accepting LLW December 31, 1992.

Source: DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.

| *Table 4.1.10–2. Low-Level Waste Disposal Land Usage Factors for Department of Energy Sites*

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ha)
	1993		
Hanford	601,610	171.8	3,502
INEL	147,084	32.3	4,554
LANL	220,700	17.4	12,684
NTS	458,435	174.2	2,632
ORNL[a]	209,300	7	29,900
SRS	665,239	67.9	9,797
	1992		
Hanford	589,506	169.8	3,472
INEL	146,300	21.2	6,901
LANL	218,000	17.2	12,674
NTS	439,700	55	7,995
ORNL[a]	208,500	7	29,786
SRS	649,700	78.2	8,308
	1991		
Hanford	582,800	167.8	3,473
INEL	145,300	21.2	6,854
LANL	215,700	17.2	12,541
NTS	419,600	55	7,629
ORNL[a]	207,400	7	29,629
SRS	636,700	78.2	8,142
	1990		
Hanford	578,990	166.8	3,471
INEL	144,000	21.2	6,792
LANL	209,900	17	12,347
NTS	408,400	No data	No data
ORNL[a]	207,200	6	34,533
SRS	612,800	72.1	8,499
	Average		
Hanford			3,480
INEL			6,275
LANL			12,562
NTS			6,085
ORNL[a]			29,772
SRS			8,687

[a] Can only accept waste generated at ORNL. Cannot accept waste from Y–12 or K–25.

Source: DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.

4.2 NO ACTION ALTERNATIVE

To satisfy the requirements of NEPA, the No Action Alternative is presented as a baseline for comparison with the various action alternatives. Under no action, DOE would not dispose of surplus HEU. Surplus HEU is currently proposed to remain in storage primarily at DOE's Y–12 Plant and current operations at each of the proposed HEU blending sites would continue. The No Action Alternative establishes baseline characteristics necessary for the determination of environmental impacts for each of the candidate sites.

The interim storage, pending disposition (for up to 10 years) of surplus HEU at Y–12 (where most of the HEU is stored), is analyzed in the Y–12 EA. Impacts from interim storage are briefly summarized below.

Impacts of Interim Storage at the Y–12 Plant. Under the No Action Alternative, there are potential environmental impacts due to interim storage of HEU at the Y–12 Plant. The impacts to each resource during interim storage have been summarized below from the Y–12 EA, September 1994.

The Y–12 EA evaluates the continued receipt, prestorage processing, and interim storage of enriched uranium for up to 10 years in quantities that would exceed the historical maximum storage level. This EA states that eight facilities are currently used to store enriched uranium or process it for storage. These facilities would continue to be used for the interim storage of enriched uranium above the historical maximum storage level (OR DOE 1994d:3-4). No new facilities would need to be constructed to accomplish the proposed action of the Y–12 EA. Minor internal modifications would be required to provide enhanced security and additional storage capacity. Facilities and buildings within Y–12 that contain substantial quantities of enriched uranium have DOE-approved SARs, which are currently undergoing a Safety Analysis Report Update Program to meet requirements of new DOE orders.

Highly enriched uranium and LEU would be stored in vault-like cages, tube vaults, vaults, or modular storage vaults. LEU could be stored in other configurations such as drums stacked in warehouse storage areas depending upon the U-235 content of LEU. Within the storage configurations, HEU and LEU are stored in stainless or galvanized steel cylindrical containers. The criticality-safe containers are constructed to DOT specifications or are DOE-approved storage containers.

No construction or demolition of buildings is anticipated; therefore, archaeological, cultural, ecological resources, groundwater, and land use would not be affected. Wastewater discharge, domestic sewer discharge, or radionuclide discharge would not exceed applicable permit levels.

The release of contaminates into the atmosphere at the Y–12 site occurs as a result of plant operations, maintenance and waste management operations, and steam generation. Routine releases to the atmosphere would essentially be terminated when HEU is placed in storage. Therefore no additional impacts are anticipated to air quality while HEU is in interim storage.

The annual amounts of waste generated as a result of prestorage processing and storage are not expected to be higher than the 1993 quantities. This was because 1993 was the peak year for the disassembly of weapons systems at the Y–12 Plant which generated the highest rate of enriched uranium processing.

The annual doses for incident-free radiological exposure to workers and to the public were estimated to be well within the 1 rem (worker) and 10 mrem (public) maximum exposure limits. The annual collective dose from airborne releases due to Y–12 operations to all the involved workers and to the public within 80 km (50 mi) of ORR was estimated to be 12.9 person-rem and 12 person-rem, respectively. Under accident conditions, the average collective dose to the onsite worker population and the public was estimated to be highest under the solvent fire scenario, 7,100 person-rem and 100 person-rem, respectively. Potential radiological impacts as a result of the beyond design basis collapse postulated for Building 9212 was estimated to result from an extreme natural hazard (tornado or earthquake) or an airplane crash. The average collective dose to all the workers onsite at Y–12 and the public within 80 km (50 mi) was estimated to be 14,000 person-rem and 190 person-rem, respectively.

A bounding accident analysis was performed to determine the potential uranium toxicity exposures to the public (chemical risk). From the largest uranium release postulated, the concentration to the maximally exposed individual of the public was estimated to be 20 mg U/m^3. It was stated that there would be no discernible toxic effect for a 30-minute exposure below the level of concern value of 21 mg U/m^3 for acute exposures. Nitric acid and hydrofluoric acid also present hazard potential in the event of a release. The chemical accident scenario assumed that the entire tank of nitric acid is released. From this scenario, it was estimated that the maximally exposed member of the public would receive 25 mg/m^3 in the worst case which is just below the level of concern of 26 mg/m^3. A leak of anhydrous hydrofluoric acid into the air could be more dangerous. The scenario assumed that the entire hydrofluoric acid tank is released. This scenario predicted that 88 onsite personnel would be exposed to hydrofluoric acid concentrations exceeding one-tenth of the IDLH standard. Twenty-five of these 88 persons would be exposed to concentrations of hydrofluoric acid exceeding this standard. Mitigation measures such as hydrofluoric acid detectors and remote shutoff valves were installed to alert operators of a release, isolate a leak, and minimize the amount of hydrofluoric acid discharged.

4.2.1 Land Resources

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. Existing and planned land-use activities associated with these missions would continue at each of these sites and impacts to land use from these actions would be independent of and unaffected by the proposed action. The existing landscape characteristics would remain consistent with existing and proposed land uses under the No Action Alternative.

4.2.2 Site Infrastructure

Under the No Action Alternative, the existing and reasonably foreseeable activities described in Chapter 3 for each of the candidate sites would continue. Table 4.2.2–1 summarizes the baseline site infrastructure requirements for each candidate site. The existing site infrastructure has adequate capacity to support all of these no action requirements.

4.2.3 Air Quality and Noise

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing air quality and noise conditions. The concentration of criteria and toxic/hazardous pollutants resulting from the No Action Alternative are in compliance with applicable Federal and State air quality regulations and guidelines. Table 4.2.3–1 summarizes the baseline ambient concentrations of criteria pollutants from existing sources at each candidate site.

4.2.4 Water Resources

Surface Water. Under the No Action Alternative, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by

Table 4.2.2–1. Site Infrastructure Baseline Characteristics for the No Action Alternative

Site	Y-12	SRS	B&W	NFS
Land (ha, fenced)	328	80,130	212	25.5
Road (km)	42	230	<1	3
Railroad (km)	11	103	0.305	0
Electricity (MWh/yr)	420,500	659,000	64,700	21,800
Electric Peak Load (MWe)	62	130	14.3	3.5
Natural Gas (m^3/yr)	66,000,000	0	2,850,000	12,900
Diesel/oil (l/yr)	0	28,400,000	470,000	36,000
Coal (t/yr)	2,940	210,000	0	0
Steam Generation (kg/hr)	99,000	85,400	1,460	6,260
Water Usage (l/yr)	7,530,000,000	153,687,000,000	195,000,000	57,000,000

Note: MWh=megawatt hour; MWe=megawatt electric.

Source: Tables 3.3.2–2, 3.4.2–2, 3.5.2–1, and 3.6.2–1.

Table 4.2.3–1. Estimated Ambient Concentrations of Criteria Pollutants From Existing Sources at Each Candidate Site Boundary for the No Action Alternative

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	Y–12 (μg/m³)	SRS (μg/m³)	B&W (μg/m³)	NFS (μg/m³)
Carbon monoxide (CO)	8 hours	10,000[a]	5	22	4	1.97
	1 hour	40,000[a]	11	171	13.1	2.52
Lead (Pb)	Calendar Quarter	1.5[a]	0.05	0.0004	[b]	[b]
Nitrogen dioxide (NO_2)	Annual	100[a]	3	5.7	3.5	0.62
Particulate matter (PM_{10})	Annual	50[a]	1	3	0.02	0.03
	24 hours	150[a]	2	50.6	0.16	0.21
Sulfur dioxide (SO_2)	Annual	80[a]	2	14.5	0.34	0.02
	24 hours	365[a]	32	196	2.28	0.15
	3 hours	1,300[a]	80	823	11.8	0.35
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates (TSP)	Annual	60[c]	1[d]	12.6	0.03	0.03[d]
	24 hours	150[c]	2	47[d,e]	0.22	0.21
Gaseous fluorides (as HF)	1 month	0.8[c]	0.2	0.09	[b,d]	0.02
	1 week	1.6[c]	0.3	0.39	[b,d]	<0.06
	24 hours	2.9[c]	<0.6	1.04	[b,d]	0.06
	12 hours	3.7[c]	<0.6	1.99	[b,d]	0.1
	8 hours	250[c]	0.6	<2.99[d]	[b,d]	0.11

[a] Federal standard.
[b] No emissions from existing processes.
[c] State standard or guideline.
[d] No State standard.
[e] Based on maximum measured SRS ambient monitored data for 1985.
[Text deleted.]
Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations for Y–12 include other ORR operations.
Source: 40 CFR 50; DOE 1995i; NF DEC nda; SC DHEC 1992b; SR NUS 1991a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995a; WSRC 1994e.

the proposed action. Under the No Action Alternative, because of the reduced operating requirements of existing facilities at both ORR and SRS, surface water withdrawals are expected to decrease. Wastewater from the Y–12 Plant and SRS would continue to be discharged to NPDES-permitted site streams, although the volume discharged would decrease. As a result of reduction in discharges to site streams, water quality should improve. Under the No Action Alternative, current surface water withdrawal is expected to remain unchanged at B&W. Currently, no surface water is used at NFS.

Groundwater. Under the No Action Alternative, no additional impacts to groundwater resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by the proposed action. Under the No Action Alternative, existing missions at SRS and B&W that withdraw groundwater would be expected to continue. Currently no groundwater is used at ORR and NFS. All drinking water for NFS is obtained from the city of Erwin. Water quality data obtained from wells located near ORR and SRS indicate that water quality is above or bordering drinking water standards for a number of parameters. Under the No Action Alternative, current restoration programs would continue at ORR and SRS. Minimal impacts on groundwater quality are expected due to wastewater releases.

4.2.5 Geology and Soils

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing geologic and soil conditions. There would be no construction or demolition of buildings and no disturbance of the land beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be needed for storage. Because no new construction would occur beyond the effects of existing and future activities that are independent of the proposed action, the No Action Alternative would have no impact on the geological or soil resources at the four candidate sites. Any impacts to geology and soils from current missions would be independent of and unaffected by the No Action Alternative.

4.2.6 Biotic Resources

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing biotic conditions. There would be no construction or demolition of buildings, so there would be no loss of wildlife habitat beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be required for storage. Because no new construction would occur, the No Action Alternative would have no impact on biotic resources, including terrestrial and aquatic resources, wetlands, and threatened and endangered species at any of the candidate sites. Any impacts to biotic resources from current missions would be independent of and unaffected by the No Action Alternative.

4.2.7 Cultural Resources

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections in Chapter 3 are the existing cultural resources conditions. There would be no construction or demolition of buildings, so there would be no disturbance of the land beyond the effects of existing and future activities that are independent of the proposed action. Although it is currently proposed that Y–12 would continue to receive HEU for storage, existing facilities would be used and no new facilities would be required for storage. The No Action Alternative would have no impact on cultural resources, including prehistoric and historic resources, Native American resources, and paleontological resources at any of the candidate sites. The effects considered include those resulting directly from land disturbance during construction, visual intrusion on the settings or environmental context of historic structures, visual and audio intrusions on Native American sacred sites, reduced access to Native American traditional use areas, unauthorized artifact collection, and vandalism. Any impacts to cultural resources from current missions would be independent of and unaffected by the No Action Alternative.

4.2.8 Socioeconomics

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing socioeconomic conditions. Under the No Action Alternative, the worker population would not change at these sites; therefore, no environmental consequences are anticipated. The No Action Alternative assumes continuation of operations at the four candidate sites. Employment, local economy, population, housing, community services, and local transportation are the parameters used to assess the baseline characteristics. Table 4.2.8–1 summarizes the baseline conditions for these parameters for each candidate site.

4.2.9 Public and Occupational Health

Under the No Action Alternative, current missions at ORR, SRS, B&W, and NFS would continue. The baseline resources described in the affected environment sections of Chapter 3 are the existing normal operation and facility accident conditions.

Table 4.2.8–1. Socioeconomic Parameters Baseline Characteristics for the No Action Alternative

Site	ORR	SRS	B&W	NFS
Employment	15,273	19,208	1,846	325
Payroll (million $)	523	1,149[a]	80	13.2
Regional Economic Area				
Employment				
1995	462,900	243,800	321,400	253,800
2000	488,700	259,400	334,700	265,500
Unemployment (%)				
1994	4.9	6.7	4.9	5.9
Per capita income				
1995 ($)	18,200	17,800	18,000	16,800
2000 ($)	19,214	18,930	18,788	17,594
Region of Influence				
Population				
1995	519,300	477,600	219,900	322,600
2000	548,200	508,300	229,000	337,600
Housing units				
1995	222,000	189,400	90,500	135,700
2000	234,400	201,600	94,300	141,900
Students				
1995	83,400	88,200	34,200	52,500
2000	88,000	93,900	35,600	54,900
Teachers				
1995	5,140	5,060	2,400	2,920
2000	5,420	5,380	2,500	3,060
Police officers				
1995	792	956	358	556
2000	836	1,020	373	582
Firefighters				
1995	1,120	1,363	960	1,201
2000	1,180	1,450	1,000	1,260
Physicians				
1995	1,300	1,370	299	870
2000	1,380	1,460	312	910
Hospital occupancy (%)				
1995	73	66	70	61
2000	78	69	73	64

[a] Total payroll for 1992 is based on 1990 employee wage and 1992 total number of employees.

Source: AHA 1994a; AMA 1994a; BW 1995b:1; BW Fire 1995a; BW School 1995a; Census 1991a; Census 1991b; Census 1991c; Census 1991u; Census 1993a; Census 1993b; Census 1993c; Census 1993e; Census 1993g; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOJ 1994a; NF Fire 1995a; NF School 1995a; NFS 1995b:2; OR Fire 1995a; OR Police 1995a; OR School 1995a; ORR 1991a:4; SR Fire 1995a; SR School 1995a; SRS 1991a:3.

Under the No Action Alternative during normal operations, both radiological and hazardous chemical releases to the environment as well as direct exposures would occur. Table 4.2.9–1 summarizes the baseline conditions for the resulting radiological doses and potential health effects to the public and workers. To put operational doses into perspective, the doses from natural background radiation also are included in Table 4.2.9–1. If normal operations at the four candidate sites were to continue, the resulting impacts would remain within the regulatory limits. The risks of adverse health effects to workers and the public would be small.

At ORR, the annual dose to the MEI of the public, including continued operation of the Y–12 interim

Table 4.2.9–1. Potential Radiological Impacts to Workers and the Public Resulting From Normal Operations Baseline Characteristics for the No Action Alternative

Receptor	ORR	SRS	B&W	NFS
Natural background radiation dose (mrem/yr)	295	298	329	340
Average worker (mrem/yr)	4	17.9	10	50
Fatal cancer risk for 20 years	3.2×10^{-5}	1.4×10^{-4}	8.0×10^{-5}	4.0×10^{-4}
Maximum worker exposure (mrem/yr)	2,000	3,000	3,300	470[a]
Maximally exposed member of public (mrem/yr)	2[b]	0.32	5.0×10^{-2}	3.3×10^{-2}
Fatal cancer risk for 20 years	2.0×10^{-5}	3.2×10^{-6}	5.0×10^{-7}	3.3×10^{-7}
Total worker dose (person-rem/yr)	68	216	18	16.3
Number of fatal cancers for 20 years	0.54	1.7	0.14	0.13
Total population dose (person-rem/yr)	28	21.5	0.35	0.2
Number of fatal cancers for 20 years	0.28	0.22	3.5×10^{-3}	2.0×10^{-3}

[a] Representative of one-half year.

[b] Representative of air and liquid media only; an additional 1 mrem/yr may be incurred due to direct exposure.

Source: BW 1995b:1; BW NRC 1991a; DOE 1993n:7; NF NRC 1991a; NFS 1995b:2; OR DOE 1994c; SRS 1995a:13; WSRC 1994d.

storage is 2.0 mrem. After 20 years of operation, the corresponding cumulative risk of fatal cancer to this individual is 2.0×10^{-5}. The annual population dose (within an 80-km [50-mi] radius of the site), including interim storage facilities at Y–12, would be 28 person-rem. After 20 years of operation, the corresponding cumulative number of fatal cancers in this population would be 0.28.

Hazardous chemical impacts to the public resulting from normal operation are presented in Table 4.2.9–2. The hazardous chemical impacts from all site operations are needed to estimate the total site impacts for the various alternatives. The noncancer adverse health effects expected and the risk of cancer due to the total chemical exposures are estimated for each site. Tables showing the toxic chemical effects and the exposure limits for each chemical are presented in Appendix E in Tables E.3.2–1 and E.3.3–1, respectively. The background chemical exposure levels are negligible for the sites analyzed because releases come primarily from site operations and not commercial industrial operations that are present in surrounding communities. The no action

Table 4.2.9–2. Potential Hazardous Chemical Impacts[a] to Workers and the Public Resulting From Normal Operations Baseline Characteristics for the No Action Alternative

Receptor	ORR	SRS	B&W	NFS
Maximally Exposed Individual				
Hazard index[b]	3.95×10^{-2}	5.16×10^{-3}	1.15×10^{-5}	9.55×10^{-2}
Cancer risk[c]	0	1.31×10^{-7}	1.68×10^{-8}	0
Onsite Worker				
Hazard index[d]	0.154	1.16	4.07×10^{-3}	7.57×10^{-3}
Cancer risk[e]	0	1.94×10^{-4}	3.94×10^{-5}	0

[a] Includes any background emissions that would be present at the site in the absence of site operations plus site emissions that exist at the present time.

[b] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[c] Cancer risk for MEI=(emissions of concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[d] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[e] Cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: NFS 1995b:2; OR MMES 1995i; SRS 1995a:2; SRS 1996a:1; VA DEQ 1995a.

level of exposures is used to calculate the noncancer and cancer risks for all sites. All supporting analyses are provided in Appendix E, Tables E.3.4–1 through E.3.4–4. [Text deleted.] The HIs for the public show that the hazardous chemical concentrations are within EPA's (Reference Concentrations) regulatory limits. The HIs for the workers at SRS indicate the potential for noncancer effects. At SRS and B&W, the cancer risks for the onsite worker are 1.94×10^{-2} and 3.94×10^{-5}, respectively.

Under the No Action Alternative, it is currently proposed that HEU would continue to be stored at the Y–12 Plant and other operations would continue at SRS, B&W, NFS, and the remainder of ORR. Potential accidents and their consequences have been addressed in site safety documentation prepared for existing facilities. The Y–12 EA (DOE/EA-0929, September 1994) addresses accident consequences for the interim storage of HEU at the Y–12 Plant. The potential radiological consequences to the involved worker range up to several thousand rem (fatal); up to 2 rem (9.0×10^{-4} increased likelihood of latent cancer fatality) to the noninvolved worker; up to 14 rem (7.0×10^{-3} latent cancer fatalities) to the maximally exposed individual; and up to 190 person-rem to the surrounding population. The maximum chemical accident consequences would be from a hydrogen fluoride leak. Evacuation level concentrations would be reached for a short distance outside the site boundary under most weather conditions for such an accident; fatalities could not be ruled out under limiting conditions. Since 1989, DOE has been engaged in a program to update SARs for the Y–12 Plant, as in some cases existing SARs did not reflect current standards. That effort is ongoing. Accident probability and consequences are dependent on the accident scenarios, which vary at these sites due to the type, form, amount, and processes, and the radiological and hazardous chemicals resident at the site. Under the No Action Alternative, the risk of accidents at these sites would be unchanged.

4.2.10 WASTE MANAGEMENT

Under the No Action Alternative, current and reasonably achievable missions at ORR, SRS, B&W, and NFS would continue. Under this alternative, it is currently proposed that surplus HEU continue to be stored at the Y–12 Plant. Under the No Action Alternative, waste management practices would continue. Under the No Action Alternative, all four sites would continue to manage low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.2.10–1 summarizes the baseline conditions for the waste types for each candidate site.

At the Y–12 Plant, solid LLW would continue to be stored until future disposal methods are determined. Mixed LLW would continue to be generated at Y–12 under the No Action Alternative during the treatment of nitrate waste from the purification/recycling of

Table 4.2.10–1. Annual Waste Generated Baseline Characteristics for the No Action Alternative

Waste Category	ORR	SRS	B&W	NFS
Low-Level				
Liquid (m^3)	2,576	0	50,005	18,900
Solid (m^3)	8,030	14,100	620	3,000
Mixed Low-Level				
Liquid (m^3)	84,210	115	0	<1
Solid (m^3)	960	18	14	<1
Hazardous				
Liquid (m^3)	32,640	Included in solid	55,115	<1
Solid (m^3)	1,434	74	0	<1
Nonhazardous				
Liquid (m^3)	1,743,000	700,000	576,160	56,700
Solid (m^3)	52,730	6,670	1,700	2,300

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2; OR LMES 1995b; SR DOE 1994c.

uranium and in the treatment of plating shop wastes. Mixed LLW would be managed in accordance with the *ORR Site Treatment Plan*, which complies with FFCA. The Y–12 Plant's hazardous waste treatment, storage, and disposal units would continue to operate in accordance with RCRA interim status requirements pending receipt of RCRA operating permits. Nonhazardous sanitary and nonradioactive process waste liquids would be treated in conventional sewage treatment plants. The resultant solids would be disposed of with solid nonhazardous waste in a permitted landfill sized to handle projected waste volumes. Asbestos and general refuse would continue to be managed in the Y–12 Plant Sanitary Landfill. Under the No Action Alternative, this landfill would also continue to accept nonradiological medical wastes that have been rendered noninfectious.

4.3 DISCUSSION OF SITE-SPECIFIC ANNUAL IMPACTS ASSOCIATED WITH BLENDING HIGHLY ENRICHED URANIUM TO LOW-ENRICHED URANIUM

The site-specific alternatives in this section consider blending surplus HEU to a suitable assay LEU for fabrication as fuel for commercial reactors or for disposal as waste. Most of the surplus HEU, whether commercial (130 t) or off-spec (40 t) material (described in Section 2.1.1), could be blended with suitable blendstock material to produce LEU for commercial use. There are two blending processes available for this purpose: blending HEU to LEU as UNH, and blending HEU to LEU as UF_6. Currently, the commercial fuel industry receives all LEU fuel feed as UF_6; however, since UNH crystals could also be used as fuel feed, the UNH blending process is considered reasonable for reactor fuel. The environmental consequences of the two processes, blend as UNH and blend as UF_6, are presented in Sections 4.3.1 and 4.3.2.

All of the surplus HEU including commercial (130 t), off-spec (40 t), and noncommercial (30 t), could be blended with blendstock material to produce LEU for disposal as waste. There are two blending processes available for this purpose: blending as UNH and blending as metal. For the reasons explained in Section 2.2.2, UNH and metal are not acceptable waste forms for disposal; therefore, LEU in UNH and metal form would be converted to U_3O_8 prior to being discarded as waste. The environmental consequences of the two processes, blend as UNH and blend as metal, are presented in Sections 4.3.3 and 4.3.4. The analyses in Section 4.3 describe annual impacts.

The following four sections discuss the environmental consequences of blending surplus HEU to either 4-percent or 0.9-percent LEU at each of the candidate sites. All four candidate sites have the capability to blend surplus HEU to 4-percent or 0.9-percent LEU as UNH. The two commercial sites may add the capability to blend surplus HEU to 4-percent LEU as UF_6 for commercial fuel. The Y-12 site has the capability to blend surplus HEU to 0.9-percent LEU as metal. UNH and metal blending facilities at Y–12 and SRS and UNH blending facilities at NFS are currently not operating. UF_6 conversion and blending facilities do not currently exist, but might be developed at B&W and NFS by the addition of new processing equipment to existing facilities.

The SRS site currently lacks the capability to solidify UNH material at enrichment levels higher than about 1 percent. (See Section 2.2.3.3.) Nonetheless, the environmental impacts from the solidification process have been included in this analysis for SRS as for the other sites so a valid comparison can be made among them. Development of a new UNH solidification facility at SRS (or offsite locations) might be proposed in the future by DOE, by a commercial entity, or by another Federal agency to whom off-spec LEU derived from surplus HEU might be sold or transferred pursuant to the *USEC Privatization Act* (Public Law 104-134, Section 3112(e)(1)).

Except as noted in the proceeding paragraph, none of the analyzed processes would necessitate construction of new facilities, require land disturbance, or affect the VRM classification of any of the candidate sites; consequently, no impacts to land resources, geology and soils, or cultural resources are anticipated. Any future construction at B&W or NFS would be a business decision, and is not proposed by DOE or necessitated by this proposed action or alternatives. No construction of a solidification facility at SRS is proposed at this time. If any such construction at any of the sites were proposed, it could involve land disturbance and associated impacts, such as minor air emissions. Additional NEPA review would be conducted as necessary for any such new construction, if it were proposed.

[Text deleted.]

4.3.1 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 4-PERCENT LOW-ENRICHED URANIUM AS URANYL NITRATE HEXAHYDRATE

The process would involve dissolving both surplus HEU and uranium blendstock in nitric acid, yielding UNH for further blending and conversion to UNH crystals or to uranium oxide as UO_2 as described in Section 2.2.2.1. This process could be performed at any or all of the four facilities.

Assessment of impacts of blending HEU to 4-percent LEU as UNH are based on an annual throughput of 10 t of impure, unalloyed 50-percent assay HEU metal to pure 4-percent assay UNH crystals with appropriate blendstock. The blendstock feed material used in this alternative is assumed to be pure U_3O_8 or metal.

4.3.1.1 Site Infrastructure

Operation of facilities to blend HEU to 4-percent LEU as UNH would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply.

Site infrastructure requirements are discussed in Section 2.2.2.1 and detailed in Table 4.3.1.1–1 for each candidate site; however, the discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities and the estimated UNH blending facility utility requirements, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications. The additional annual electrical service requirement represents a small percentage increase for the DOE sites (that is, less than 1 percent of the Y–12 Plant and SRS's annual consumption) with only a few percent increase in peak demand, as shown in Table 4.3.1.1–1. For commercial facilities, this increase is slightly higher, approximately 6 percent for B&W and over 18 percent for NFS. The increase in peak load is approximately 14 percent for B&W and 57 percent for NFS. The capacity at both the DOE and commercial sites is adequate to accommodate the blending facility's electrical service requirements without implementing any major modifications or constructing new transmission or distribution facilities.

The fuel and water requirements to support the blending facility represent relatively small fractions of current annual usage or existing capability at Y–12 and SRS. Natural gas is available and in use at all sites except for SRS where oil is the major fuel source. Annual fuel oil consumption at ORR is 416,000 l (110,000 gal); none of this is used at the Y–12 Plant. Coal-fired boilers are in use at both DOE sites for the production of process steam, whereas the commercial sites utilize either natural gas or oil depending upon availability and cost. The total fuel requirements, in terms of total fuel energy equivalent for the UNH conversion and blending facility, represent an increase of 0.6, 0.2, and 12 percent of current fuel consumption at ORR, SRS, and B&W, respectively. For NFS, the blending facility represents an increase of 742 percent of current fuel consumption because the facilities are less active than normal; however, based on fuel consumption data for building and process equipment (that is, 790,000 l [209,000 gal] of fuel oil), the fuel requirements for the UNH blending facilities would be about 36 percent of NFS's installed capacity. Annual raw water requirements to support blending facility operations are insignificant compared with current usage at ORR and SRS. For B&W and NFS, this requirement represents an increase of about 9.7 percent and 33.3 percent of current usage, respectively. The available water capacity at each site is adequate to satisfy the blending facility requirements under this alternative.

As a result of the extensive site infrastructure already existing at Y–12 and SRS, minimal effects in terms of the percentage increase in site infrastructure resource usage would result from the operation of the UNH conversion and blending facilities at either site. Site infrastructure resource requirements are well within the available capacity at both the Y–12 Plant and SRS. For B&W and NFS, the infrastructure resource requirements of the blending facility represent a more significant increase over current useage; however, the existing infrastructure is capable of accommodating the blending facility requirements with no significant adverse site infrastructure-related environmental effects being incurred.

4.3.1.2 Air Quality and Noise

Operation of facilities to blend HEU to 4-percent LEU as UNH would generate criteria and toxic/hazardous pollutants. Concentrations of these pollutants resulting from this alternative were estimated for each site and are presented in Table 4.3.1.2–1. The discussion of impacts on air quality and noise are presented for all the sites collectively.

Air Quality. Air pollutant emissions associated with the operation of the UNH blending facility consist of

Table 4.3.1.1–1. Annual Changes to Site Infrastructure for Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

	Access			Electrical		Fuel			Water	
Site	Area (ha)	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)	Natural Gas (m^3/yr)	Diesel/Oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
UNH facility	0	0	0	4,000	2	17,000	56,800	363	19	1
Y–12 baseline	328	42	11	420,500	62	66,000,000	0	2,940	7,530	99,000
Y–12 percent change	0	0	0	0.95	3.2	<0.1[a]	NA[b]	12	0.25	0.001
SRS baseline	80,130	230	103	659,000	130	0	28,400,000	210,000	153,687	85,400
SRS percent change	0	0	0	0.6	1.5	NA[c]	0.3[a]	0.17	0.012	0.001
B&W baseline	212	<1	0.305	64,700	14.3	2,850,000	470,000	0	195	1,460
B&W percent change	0	0	0	6.2	14	0.6	71.5[a]	NA[d]	9.7	0.07
NFS baseline	25.5	3	0	21,800	3.5	12,900[e]	36,000[e]	0	57	6,260
NFS percent change	0	0	0	18.4	57.1	132	933[a]	NA[d]	33.3	0.02

[a] Percent change includes required natural gas, oil, or coal energy equivalent.

[b] Natural gas is the primary fuel at Y–12, and all of the blending facility oil requirements have been converted to a natural gas energy equivalent; fuel oil (0.96 kg/l) is assumed to be 41,800 BTUs/kg or 40,128 BTUs/l and natural gas is assumed to be 35,315 BTUs/m^3 (that is, 56,800 l of fuel oil=64,515 m^3 of natural gas).

[c] Natural gas is not available at SRS and all of the blending facility process natural gas requirements would be supplied via liquid petroleum gas (LPG); these requirements have been converted to a fuel oil energy equivalent; the natural gas is assumed to be 35,315 BTUs/m^3, LPG is assumed to be 24,800 BTUs/l, and fuel oil is assumed to be 40,128 BTUs/l (that is, 17,000 m^3 of natural gas=24,200 l of LPG=14,900 l of fuel oil).

[d] Coal is not utilized at B&W-NNFD or NFS, and all of the blending facility coal derived energy requirements would be supplied via the fuel oil energy equivalent; the fuel oil energy content is assumed to be 40,128 BTUs/l, and for coal it is assumed to be 30.9 million BTUs/t, (363 t of coal=279,200 l of fuel oil).

[e] Values shown are based on current usage; typical annual consumption is estimated at approximately 790,000 l of fuel oil.

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: OR LMES 1995b; Tables 3.3.2–2, 3.4.2–2, 3.5.2–1, and 3.6.2–1.

criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants such as nitric acid used or generated in the blending process. These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The 24-hour concentration of sulfur dioxide (SO_2) at ORR is approximately 9 percent of the standard, which is the highest percent of a standard for the criteria pollutants at ORR. The UNH blending would contribute 8 and 53 percent to the 24-hour concentration of SO_2 and total suspended particulates (TSP) at ORR, respectively. The remaining criteria pollutant concentrations would be less than 55 percent of the respective standard.

The 3-hour concentration of SO_2 at SRS is approximately 63 percent of the standard, which is the highest percent of a standard for criteria pollutants at SRS. The UNH blending process would contribute less than 1 percent to the 3-hour concentration of SO_2 at SRS. The remaining criteria pollutant concentrations would be less than 63 percent of the respective standard.

The annual concentration of nitrogen dioxide (NO_2) at B&W was calculated to be approximately 3.5 percent of the annual NAAQS for NO_2. NO_2 is considered to be a primary emission at the site. The UNH blending process would contribute less than 1 percent to the annual concentration of NO_2 at the site. The addition of the blending emissions of NO_2 to those existing at B&W would increase the percent of the annual NAAQS for NO_2 only slightly. Criteria pollutant concentrations would be expected to remain in compliance with the NAAQS and State-mandated standards.

The primary source of criteria pollutants at NFS is from space heating, which is accomplished by combustion of natural gas. The annual concentration of NO_2 at NFS is approximately 0.6 percent of the standard, which is the highest percent of a standard for criteria pollutants at NFS. Monitoring performed at NFS by TDEC indicated that the facility is in compliance with Federal and State regulations and guidelines (NF NRC 1991a:4-30). Operation of the UNH blending facilities would add less than 0.1 percent to the annual concentration of NO_2, which would not be expected to change the compliance status of NFS.

Table 4.3.1.2–1 presents the estimated concentrations of criteria pollutants from blending HEU to 4-percent LEU as UNH. Table 4.3.1.2–2 presents the total concentrations of no action criteria pollutants plus blending HEU to 4-percent LEU as UNH at each site. During operation, impacts from the UNH blending facilities with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for each site.

Noise. Operation of the UNH blending facility in an existing building at each site would result in little or no change in the contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that any of the four facilities would require a maximum of 125 employees during operation, many of whom would be employees currently working at the site (OR LMES 1995b:20).

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

4.3.1.3 Water Resources

Environmental impacts associated with the operation of UNH conversion and blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.1 were used to assess impacts to surface water and groundwater. The discussion of impacts are provided for each site separately.

Oak Ridge Reservation

Surface Water. Operation of UNH blending facilities would require an additional 19 million l/yr (5.0 MGY) of water, mostly for process operations and steam generation and a lesser amount for potable water. This would be less than 1 percent of the Clinch River's average flow (132 m^3/s [4,661 ft^3/s]), and the

Table 4.3.1.2–1. Estimated Concentrations of Criteria Pollutants Based Upon Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	UNH Blending Alternative Concentration[a] Y–12 (μg/m³)	SRS (μg/m³)	B&W (μg/m³)	NFS (μg/m³)
Carbon monoxide (CO)	8 hours	10,000[b]	11.5	0.07	5.22	0.6
	1 hour	40,000[b]	53	0.14	16.96	0.77
Lead (Pb)	Calendar Quarter	1.5[b]	c	c	c	c
Nitrogen dioxide (NO_2)	Annual	100[b]	1.33	0.01	0.1	0.02
Particulate matter[d] (PM_{10})	Annual	50[b]	0.03	<0.01	0.02	<0.01
	24 hours	150[b]	0.37	<0.01	0.16	0.02
Sulfur dioxide (SO_2)	Annual	80[b]	2.46	0.02	0.27	0.04
	24 hours	365[b]	29.3	0.32	1.82	0.27
	3 hours	1,300[b]	161	0.71	9.41	0.64
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates[d] (TSP)	Annual	60[e]	6.74[f]	0.05	0.02	<0.01[f]
	24 hours	150[e]	80.16	0.88[f]	0.16	0.02
Gaseous fluorides (as HF)	1 month	0.8[e]	c	c	c, f	c
	1 week	1.6[e]	c	c	c, f	c
	24 hours	2.9[e]	c	c	c, f	c
	12 hours	3.7[e]	c	c	c, f	c
	8 hours	250[e]	c	c,f	c, f	c

[a] Model results.
[b] Federal standard.
[c] No emissions from this process.
[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.
[e] State standard or guideline.
[f] No State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: 40 CFR 50; OR LMES 1995b; SC DHEC 1992b; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b; WSRC 1994e.

Table 4.3.1.2–2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending (10 t/yr) Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	No Action Plus Blending Concentration[a] Y–12 (μg/m³)	SRS (μg/m³)	B&W (μg/m³)	NFS (μg/m³)
Carbon monoxide (CO)	8 hours	10,000[b]	16.51	22	9.22	2.57
	1 hour	40,000[b]	64	171	30.06	3.29
Lead (Pb)	Calendar Quarter	1.5[b]	0.05	0.0004	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	4.33	5.71	3.6	0.64
Particulate matter (PM_{10})	Annual	50[b]	1.03	3	0.04	0.03
	24 hours	150[b]	2.37	50.6	0.32	0.23
Sulfur dioxide (SO_2)	Annual	80[b]	4.46	14.5	0.61	0.06
	24 hours	365[b]	61.3	196	4.1	0.42
	3 hours	1,300[b]	241	824	21.21	0.99
Mandated by Tennessee, South Carolina, and Virginia						
Total suspended particulates (TSP)	Annual	60[d]	7.74[e]	12.65	0.05	0.04[e]
	24 hours	150[d]	82.16	47.88[e]	0.38	0.23
Gaseous fluorides (as HF)	1 month	0.8[d]	0.2	0.09	[c, e]	0.02
	1 week	1.6[d]	0.3	0.39	[c, e]	<0.06
	24 hours	2.9[d]	<0.6	1.04	[c, e]	0.06
	12 hours	3.7[d]	<0.6	1.99	[c, e]	0.1
	8 hours	250[d]	0.6	<2.99[e]	[c, e]	0.11

[a] Model results.

[b] Federal standard.

[c] No emissions from no action and this process.

[d] State standard or guideline.

[e] No State standard.

[Text deleted.]

Note: Ozone, as a criteria pollutant, is not directly emitted nor monitored by the candidate sites. Pollutant concentrations shown for Y–12 include other ORR operations.

Source: 40 CFR 50; DOE 1995i; NF DEC nda; OR LMES 1995b; SC DHEC 1992b; SR NUS 1991a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b; WSRC 1994e.

potable water usage would be within ORR's treatment capacity.

The liquid effluents from involved operations and sanitary wastewater discharges, would not contain radionuclides or hazardous chemicals. The wastewater generated from the operations would be conveyed to the Y–12 Central Pollution Control Facility or the Y–12 West End Treatment Facility for processing. The approximately 18.7 million l/yr (4.9 MGY) of additional treated wastewater would be discharged to East Fork Poplar Creek. Treated sanitary and process wastewater discharges (18.7 million l/yr [4.9 MGY]) released to East Fork Poplar Creek would not exceed 1 percent of the average flow (1.3 m³/s [45 ft³/s]) and therefore should not result in any downstream flow effects. Releases to the Clinch River would represent less than 1 percent of the average flow. All discharges would be monitored to comply with NPDES permit limits. The difference between the amount of water being used and the amount of water being discharged can be attributed to drift and evaporation in the cooling towers. Stormwater runoff from the main plant area would be collected in detention ponds, monitored, and, if acceptable, discharged to nearby streams. Stormwater runoff from outside the main plant area, except from those facilities that require onsite management controls by regulations (for example, sanitary treatment plants and landfills), would be discharged to nearby streams.

The Y–12 Plant is currently involved with remediation of East Fork Poplar Creek under CERCLA because East Fork Poplar Creek was contaminated by past releases from the Y–12 Plant. Significant cleanup activities are required onsite and offsite. Future NPDES permits would be obtained after review of the current water quality and how it is affected by discharges from Y–12. In addition, discharges from the treatment plants are required to meet all permit limits; therefore, no impacts to water quality are expected.

Domestic wastewater from the Y–12 Plant, including some sinks in process areas, is discharged to the sanitary sewer for treatment under an industrial user's permit. This permit allows the Y–12 Plant to discharge wastewater to be treated at the ORR wastewater treatment facility through two main sewage lines into the ORR sanitary sewer system in accordance with effluents limitations, monitoring requirements, and other conditions set forth in the permit. Radiological and nonradiological parameters are monitored for these sewer lines.

UNH blending facilities lie outside the 100- and 500-year floodplains.

Groundwater. No groundwater would be used at Y–12 given the plentiful surface water available; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of UNH blending facilities. Because there would be no direct discharge of process wastewater to ground or groundwater, and wastewater would be treated at either the Y–12 Central Pollution Control Facility or at the Y–12 West End Treatment Facility before being released to surface waters, no impacts on groundwater quality are expected. Groundwater contamination at ORR is the result of practices that have been discontinued. The Y–12 Plant has implemented a comprehensive groundwater monitoring plan to monitor groundwater flow, quality, and content by sampling groundwater monitoring wells across the facility. Water quality of the East Fork Poplar Creek would be protected by the extensive Y–12 efforts to protect water quality.

Savannah River Site

Surface Water. Surface water required for the operation of UNH blending facilities (19 million l/yr [5 MGY]) would be taken from the existing water supply system, which obtains water from the Savannah River and groundwater wells. These surface water withdrawals would represent less than 1 percent of the regulated minimum flow of the Savannah River (152 m^3/s [5,368 ft^3/s]), and would not be expected to affect downstream users. Use of the Savannah River would not be affected by consumptive use associated with the UNH blending facilities. Operation of UNH blending facilities under these conditions would not violate riparian rights (Section 3.4.4).

The major sources of liquid effluents from involved operations would be nonhazardous wastewater that would not contain radionuclides and chemicals. Fourmile Branch near F- and H-Canyons is an area of low instream flow and was determined by an SRS study to be acceptable for sanitary water discharges after treatment at the new Centralized Sanitary Wastewater Treatment Facility. The 18.7 million l/yr (4.9 MGY) would represent less than 1 percent of the minimum flow of Fourmile Branch and would not be expected to adversely impact stream hydrology. All discharges would be required to comply with NPDES permit limits. Stormwater runoff from the facility would be collected in detention ponds, monitored, and, if clean, discharged to nearby streams. Stormwater from outside the main plant area would be discharged to nearby streams.

The UNH blending would be accommodated in facilities located outside the 100-year floodplain of Fourmile Branch or Upper Three Runs Creek. Statewide information concerning 500-year floodplains at SRS is not available. However, the blending alternatives at SRS would not be likely to affect or be affected by the 500-year floodplain of either the Fourmile Branch or Upper Three Runs Creek because the F- and H-Canyons are located at an elevation of approximately 32.6 m (107 ft) and 64 m (210 ft) above these streams and at distances from these streams of 0.8 km (0.5 mi) and 1.5 km (0.94 mi), respectively. The maximum flow that has occurred on the Upper Three Runs Creek was in 1990, with a flow rate of about 58 m^3/s (2,040 ft^3/s). At that time, the creek reached an elevation of almost 30 m (98 ft) above mean sea level (SR USGS

1996a:1). The elevation of the buildings in F- and H-Canyons are located more than 62 m (203 ft) above the highest flow elevation of the Upper Three Runs Creek. The maximum flow that has occurred on the Fourmile Branch was in 1991 with a rate of approximately 5 m^3/s (186 ft^3/s), and an elevation about 6.1 m (199 ft) above mean sea level (SR USGS 1996a:1). Elevations of the buildings in F- and H-Areas are approximately 31 m (101 ft) higher than the maximum flow level than has occured.

Groundwater. Suitable groundwater from the deep aquifers at the site is abundant, and aquifer depletion is not a problem. Pumping from the deep aquifer to meet domestic, process, and other water uses has continued as needed since the early 1950s. This usage has not adversely affected water levels in the deep aquifer.

Normal operation of UNH conversion and blending facilities would not result in liquid effluent discharges to groundwater; thus, groundwater quality would not be directly affected by wastewater discharges.

SRS would continue to notify the South Carolina Water Resources Commission when groundwater pumping exceeds 379,000 l/day or 100,000 gal/day (138 million l/yr or 36.4 MGY).

Babcock & Wilcox

Surface Water. Water withdrawn from the James River for the UNH blending operation (19 million l/yr [5 MGY]) is less than 1 percent of the minimal flow rate of the river (12.7 m^3/s [448 ft^3/s]). The design capacity for withdrawal by the B&W facility is 1,193 million l/yr (315 MGY), and this additional amount would be 1.7 percent of the design capacity. To date, water withdrawn from the James River has had no adverse impact on the James River flow rate. The withdrawal rates associated with future operations are expected to be similar to or less than the historical flows; therefore, no adverse impacts to river flow are expected.

The aqueous process waste and sanitary wastewater is treated and then discharged to the James River through permitted outfalls. The additional 18.7 million l/yr (4.9 MGY) discharged to the river would represent an approximate 29-percent increase in the amount being treated (65 million l/yr [17 MGY]) and would represent less than 1 percent of the James River minimum flow rate (12.7 m^3/s [488 ft^3/s]). The difference in amounts between water usage and water discharge is attributed to drift and evaporation in the cooling towers.

Degradation of surface water quality is prevented by enforcement of release limits and monitoring programs mandated under the facility NPDES permit. Examination of the NPDES monthly reports indicates that Total Dissolved Solids (TDS) standards were violated in three instances.

The site has the potential for flooding if the James River experiences very high flows. The more vulnerable areas of the site are the wastewater treatment facility and the ponds that are at lower site elevations. A large flood for the site (10,000 m^3/s [353,000 ft^3/s]) would cover the two equalization ponds and could remove the sediment material and transport it downstream. Such a flood would not be expected to inundate the applicable UNH blending facility.

Groundwater. Potential groundwater impacts include drawdown of the water table in the vicinity of facility wells and degradation of groundwater quality due to uncontrolled leakage from the subsurface soils. B&W withdrawals of groundwater in the area of the James River are small in comparison to the capacity of the wells and groundwater system.

There are no discharges of wastewater that could result in groundwater contamination from proposed operations except for those ponds that are used to manage the flow rate of discharges into the James River. The groundwater does have low levels of TCE contamination from previous leaks that have been identified and eliminated. All but two of the underground tanks installed at the site have been removed, so the potential for accidental contamination of the groundwater is reduced. Remediation plans are being prepared for the cleanup of the TCE plume. The operation of UNH blending facilities is not expected to result directly in any impacts to the local groundwater.

Nuclear Fuel Services

Surface Water. Water required for the operation of UNH blending facilities (19 million l/yr [5 MGY]) would be taken from the existing water supply system, which obtains process water from the city of Erwin public utility system. The additional water required would represent about 33 percent of the current usage (57 million l/yr [15 MGY]) and would not be expected to affect other users.

Aqueous process waste is piped to the wastewater treatment facility, treated, and then discharged to the Nolichucky River by a direct pipeline. The additional discharge (0.9 million l/yr [0.23 MGY]) would represent an approximate 5-percent increase in the current discharge (18.9 million l/yr [5 MGY]). Total site discharges (19.8 million l/yr [5.2 MGY]) to the Nolichucky River would be 51 percent of the current permitted capacity (38.6 million l/yr [10.2 MGY]) and less than 1 percent of the river's average flow (39 m^3/s [1,380 ft^3/s]). Sanitary wastewater (17.8 million l/yr [4.7 MGY]) would be discharged to the city of Erwin treatment system. This will increase current sanitary wastewater discharges (38 million l/yr [10 MGY]) by approximately 47 percent. Total site sanitary wastewater discharges (55.8 million l/yr [14.7 MGY]) would not exceed the current permitted capacity (75.7 million l/yr [20 MGY]). There are no plans for noncontact cooling water to be discharged to Banner Spring Branch. Discharge is required to meet all NPDES permit limitations.

The site has the potential for being flooded if the Nolichucky River experiences very high flows. Elevations of the building floors are between 500 and 510 m (1,640 and 1,670 ft). The UNH blending would be accommodated at facilities in the 300 Area, located outside the 100- and 500-year floodplains. Based on the Flood Insurance Rate Map and the flood profiles, 100- and 500-year floodplain elevations at the NFS site are determined to be 499.5 m (1,639 ft) and 500 m (1,640 ft) above mean sea level, respectively. Facilities in the 300 Area have building floor elevations of approximately 500.5 m (1,642 ft) above mean sea level, which would be above the 100- and 500-year floodplain elevations. The more vulnerable areas of the site include the HEU recovery area, which contains the Highly Enriched Scrap Building, Highly Enriched Scrap Expansion, and Di-Process Storage facilities. The rechanneling of the Nolichucky, associated with the highway construction and rerouting of Martin Creek to enter the Nolichucky farther downstream, has lowered the previously expected flood levels at the site. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has emergency plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or any accidental releases to the surface water, the Jonesborough Water Treatment Plant closes off the water intake valves so no contamination to the public water supply occurs. In addition, the intake valves are monitored routinely for any water contamination problems. By having flood warning systems in place and emergency action plans, the public water supply can remain well protected from any potential contamination.

Groundwater. No groundwater would be used at NFS given the plentiful city water available; therefore, no impacts on groundwater levels are expected.

Groundwater quality would not be affected by the operation of UNH blending facilities, because there would be no direct discharges of process wastewater to groundwater. Wastewater would be treated prior to discharge to the Nolichucky River.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to NFS's settling ponds, beneath the buried holding tanks and beneath the radioactive solid waste burial ground. A pump-and-treat restoration program is in place to clean up the groundwater contamination. There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. There are no known local down-gradient wells in the Quaternary alluvium. Banner Hill Spring has remained uncontaminated from 25 years of normal operations at the NFS facility.

4.3.1.4 Biotic Resources

The operation of the UNH blending facilities at ORR, SRS, B&W, or NFS is not expected to have significant adverse impacts on biotic resources. Operation of the blending process would be accommodated within existing buildings. There would be no loss of habitat; therefore, there would be no impacts on wildlife. The increase of water intake or discharge to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

Impacts to wetlands would not occur since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.1.5 Socioeconomics

This section describes the potential socioeconomic effects resulting from operation of facilities for the blending of HEU to 4-percent LEU as UNH at ORR, SRS, B&W, or NFS. Any upgrades/modifications required at these facilities would be accomplished by the site's existing workforce, and no new jobs would be created; however, operation of the blending facilities at any of these sites would require additional employees, creating some minor economic benefits to the region.

Operation of the UNH blending facility would require 125 employees. Some workers needed for operation are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that all of the candidate sites would need 125 additional employees to blend HEU to LEU as UNH. The project would also create indirect jobs within the REAs ranging from 245 at SRS to 319 at ORR (Figure 4.3.1.5–1).

Available labor in each of the regions is sufficient to fill the new jobs created directly by the project and additional jobs created indirectly; therefore, it is unlikely that there would be any in-migration to these regions. Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROIs would be the same as for the No Action Alternative.

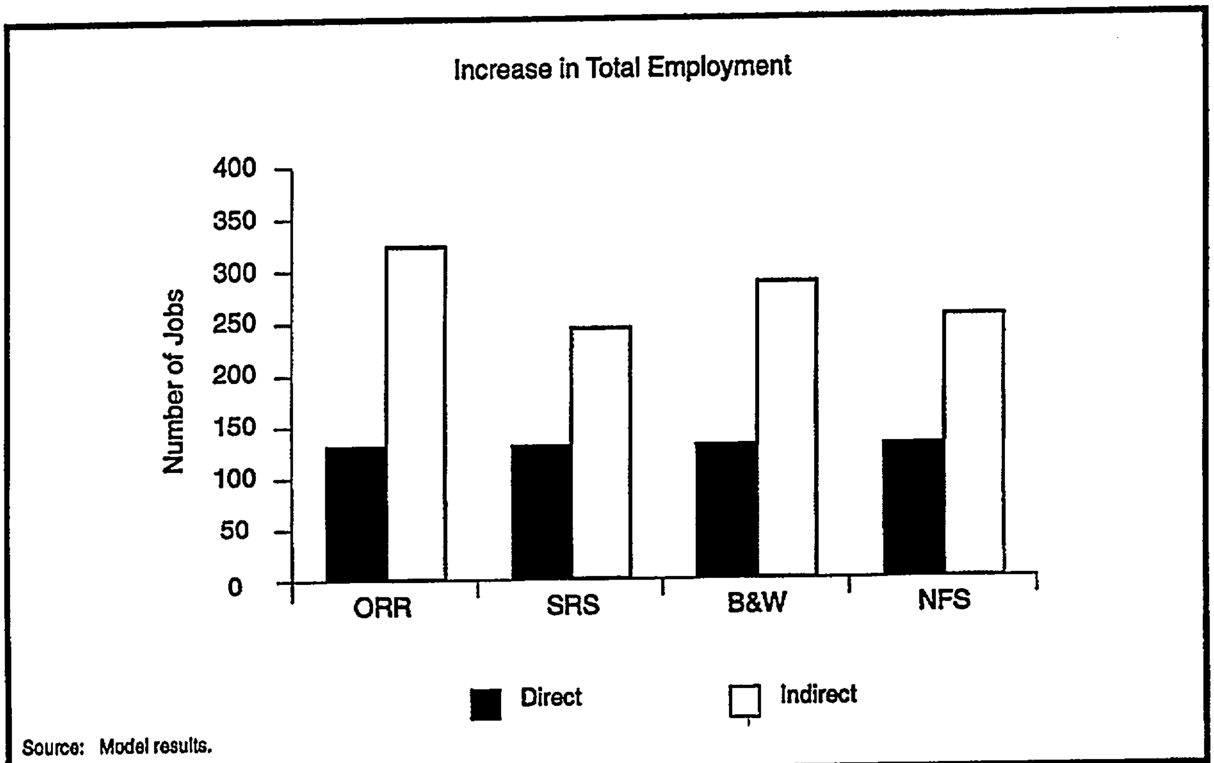


Figure 4.3.1.5–1. Increase in Total Project-Related Employment (Direct and Indirect) at Each Candidate Site Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

4.3.1.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or potential accidents for blending HEU to 4-percent LEU as UNH at the candidate sites. Summaries of the radiological impacts at each site to the public and to workers associated with normal operation are presented in Tables 4.3.1.6–1 and 4.3.1.6–2, respectively. Chemical impacts to these same groups are presented in Table 4.3.1.6–3, and accident impacts are presented in Table 4.3.1.6–4 through Table 4.3.1.6–7. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of UNH conversion and blending facilities at each of the sites are presented in Table 4.3.1.6–1. The impacts from total site operations, including the UNH conversion and blending facilities, are also given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, comparisons are made with natural background radiation. As shown in Table 4.3.1.6–1, the doses to the MEI of the public from annual total site operations are all within radiological limits and would range from 0.052 mrem at B&W to 2 mrem at ORR. The annual population doses (within 80 km [50 mi]) would range from 0.51 person-rem at B&W to 28.2 person-rem at ORR.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.1.6–2. The annual incremental dose to involved workers at the blending and conversion facility would be 90 mrem to the average worker and 11.3 person-rem to the entire facility workforce (DOE 1993n:7; NRC 1995b; OR LMES 1995b).

[Text deleted.] All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 4-percent LEU as UNH at ORR, SRS, B&W, and NFS are presented in Table 4.3.1.6–3. The increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites are shown, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site.

The incremental and total site HIs for the public MEI contributed by this alternative at all sites are less than 1.0, showing that all hazardous chemicals are at concentrations below EPA's Reference Concentrations. However, at SRS the total HI for the worker is 1.16 higher than the level for no potential noncancer effects. This level is due to the no action contribution at this site. The cancer risks to the MEI at all sites are low and not significantly different from those to the nonexposed public. The cancer risks for the worker are also low except at SRS and B&W where the total cancer risks are 1.94×10^{-4} and 3.94×10^{-5}, respectively. [Text deleted.]

The incremental and total site HIs for the onsite workers contributed by this alternative at all sites are all less than 1, showing that all hazardous chemical concentrations are below OSHA's regulatory health limits (Permissible Exposure Levels), except at SRS where the total HI is 1.16. The incremental cancer risks for workers are all less than 1.0×10^{-6} (RA 1994a:477-481). The total site worker cancer risks at SRS and B&W are above the level for potential noncancer effects. The cancer risks to the MEI at all sites, and the total risk for onsite workers at Y–12 and NFS should not exhibit differences from the general public from the onset of operation. For details of calculations used to derive HIs and cancer risks, refer to Appendix E.3.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact involved and noninvolved onsite workers and the offsite population. A set of accident scenarios were selected to represent bounding cases. In assessing the bounding accident scenarios for the UNH blending facilities, the following parameters were evaluated: 1) material at risk; 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events); 3) barriers to release; and 4) protective features of the facility.

Table 4.3.1.6–1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	ORR		SRS		B&W		NFS	
	Incremental	Total Site[a]	Incremental	Total Site[a]	Incremental	Total Site[a]	Incremental	Total Site[a]
Maximally Exposed Individual (Public)								
Dose from atmospheric release pathway[b] (mrem/yr)	3.9×10^{-2}	1.4	2.5×10^{-3}	0.18	1.9×10^{-3}	4.8×10^{-2}	0.14	0.17
Dose from total liquid release pathway[b] (mrem/yr)	0	0.6	0	0.14	0	4.0×10^{-3}	0	9.0×10^{-4}
Dose from atmospheric and liquid release pathways combined[b] (mrem/yr)	3.9×10^{-2}	2	2.5×10^{-3}	0.32	1.9×10^{-3}	5.2×10^{-2}	0.14	0.17
Percent of natural background[c]	1.3×10^{-2}	0.68	8.4×10^{-4}	0.11	5.8×10^{-4}	1.6×10^{-2}	4.1×10^{-2}	5.0×10^{-2}
Risk of fatal cancer per year of operation[d]	2.0×10^{-8}	1.0×10^{-6}	1.3×10^{-9}	1.6×10^{-7}	9.5×10^{-10}	2.6×10^{-8}	7.0×10^{-8}	8.5×10^{-8}
Population Within 80 km								
Dose from atmospheric release pathways[e] (person-rem/yr)	0.16	26.2	0.16	20.2	1.7×10^{-2}	0.44	1.2	1.5
Dose from total liquid release pathways[e] (person-rem/yr)	0	2	0	1.5	0	0.07	0	1.9×10^{-3}
Dose from atmospheric and liquid release pathways combined[e] (person-rem/yr)	0.16	28.2	0.16	21.7	1.7×10^{-2}	0.51	1.2	1.5
Percent of natural background[c]	5.2×10^{-5}	9.2×10^{-3}	7.5×10^{-5}	1.0×10^{-2}	7.0×10^{-6}	2.1×10^{-4}	2.8×10^{-4}	3.5×10^{-4}
Number of fatal cancers per year of operation[d]	8.0×10^{-5}	1.4×10^{-2}	8.0×10^{-5}	1.1×10^{-2}	8.5×10^{-6}	2.6×10^{-4}	6.0×10^{-4}	7.5×10^{-4}

[a] Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

[b] The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathway, 100 mrem/yr from all pathways combined for DOE sites: ORR and SRS and 25 mrem/yr from all pathways combined for NRC sites: B&W and NFS. Incremental radiological doses are different at each site because of site-specific characteristics such as meteorology, topography, distance to site boundary, etc.

[c] Annual natural background radiation levels: 1) ORR: the average individual receives 295 mrem; the population within 80 km receives 306,000 person-rem, 2) SRS: the average individual receives 298 mrem; the population within 80 km receives 213,000 person-rem, 3) B&W: the average individual receives 329 mrem; the population within 80 km receives 244,000 person-rem, 4) NFS: the average individual receives 340 mrem; the population within 80 km receives 429,000 person-rem.

[d] Representative of material processed at the rate of 10 t/yr.

[e] Proposed 10 CFR 834 (58 FR 16268) includes the requirement that the contractor who operates a DOE site notify DOE if the potential annual population dose exceeds 100 person-rem from all pathways combined.

Source: Appendix E.

Table 4.3.1.6–2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	ORR	SRS	B&W	NFS
Involved Workforce[a]				
Average worker				
Dose (mrem/yr)[b]	90	90	90	90
Risk of fatal cancers per year of site operation	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}
Total				
Dose (person-rem/yr)	11.3	11.3	11.3	11.3
Number of fatal cancers per year of site operation	4.5×10^{-3}	4.5×10^{-3}	4.5×10^{-3}	4.5×10^{-3}
Noninvolved Workforce[c]				
Average worker				
Dose (mrem/yr)[b]	4	18	10	50
Risk of fatal cancers per year of site operation	1.6×10^{-6}	7.2×10^{-6}	4.0×10^{-6}	2.0×10^{-5}
Total				
Dose (person-rem/yr)	68	216	16.7	16.3
Number of fatal cancers per year of site operation	2.7×10^{-2}	8.6×10^{-2}	6.7×10^{-3}	6.5×10^{-3}
Total Site Workforce[d]				
Dose (person-rem/yr)	79	227	28	28
Cumulative number of fatal cancers per year of site operation	3.2×10^{-2}	9.1×10^{-2}	1.1×10^{-2}	1.1×10^{-2}

[a] The in-plant (involved) worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 125.

[b] The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20 and 10 CFR 835).

[c] The noninvolved worker is a worker on site but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 16,875 at ORR; 12,000 at SRS; 1,675 at B&W; and 325 at NFS.

[d] The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 17,000 at ORR; 12,125 at SRS; 1,800 at B&W; and 450 at NFS.

Source: BW 1995b:1; DOE 1993n:7; NFS 1995b:2; NRC 1995b; OR LMES 1995b; SRS 1995a:13.

Table 4.3.1.6–3. Potential Hazardous Chemical Impacts to the Public and Workers Resulting From the Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

Receptor	Y–12		SRS		B&W		NFS	
	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]	Incremental[a]	Total Site[b]
Maximally Exposed Individual (Public)								
Hazard index[c]	3.84×10^{-4}	3.99×10^{-2}	4.26×10^{-5}	5.20×10^{-3}	1.38×10^{-6}	1.29×10^{-5}	2.02×10^{-3}	9.75×10^{-2}
Cancer risk[d]	1.21×10^{-15}	1.21×10^{-15}	1.35×10^{-16}	1.31×10^{-7}	4.37×10^{-18}	1.68×10^{-8}	6.37×10^{-15}	6.37×10^{-15}
Onsite Worker								
Hazard index[e]	1.26×10^{-3}	0.155	1.13×10^{-3}	1.16	4.68×10^{-4}	4.54×10^{-3}	6.42×10^{-4}	8.21×10^{-3}
Cancer risk[f]	2.75×10^{-14}	2.75×10^{-14}	2.47×10^{-14}	1.94×10^{-4}	1.03×10^{-14}	3.94×10^{-5}	1.41×10^{-14}	1.41×10^{-14}

[a] Incremental=contribution only from single activity at the site.

[b] Total=no action emissions plus activity incremental.

[c] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[d] Lifetime cancer risk for MEI=(emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[f] Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995b.

Table 4.3.1.6–4. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Y–12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	320
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	0.13
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	1.3×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	0.31
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	1.6×10^{-4}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	1.6×10^{-8}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	44
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	2.2×10^{-2}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	2.2×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–5. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Savannah River Site

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	2.3	8.5	70
Latent cancer fatalities per accident	9.3×10^{-4}	3.4×10^{-3}	2.8×10^{-2}
Risk (cancer fatalities per year)	9.3×10^{-7}	3.4×10^{-7}	2.8×10^{-6}
Maximally Exposed Individual			
Dose (rem)	6.6×10^{-5}	3.0×10^{-4}	1.9×10^{-3}
Latent cancer fatality per accident	3.3×10^{-8}	1.5×10^{-7}	9.6×10^{-7}
Risk (cancer fatality per year)	3.3×10^{-11}	1.5×10^{-11}	9.6×10^{-11}
Population Within 80 km (710,000 in 2010)			
Dose (person-rem)	0.37	0.33	11
Latent cancer fatalities per accident	1.8×10^{-4}	1.6×10^{-4}	5.3×10^{-3}
Risk (cancer fatalities per year)	1.8×10^{-7}	1.6×10^{-8}	5.3×10^{-7}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–6. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Babcock & Wilcox

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences[c]			
Noninvolved Workers			
Dose (person-rem)	24	80	760
Latent cancer fatalities per accident	$9.5x10^{-3}$	$3.2x10^{-2}$	0.3
Risk (cancer fatalities per year)	$9.5x10^{-6}$	$3.2x10^{-6}$	$3.0x10^{-5}$
Maximally Exposed Individual			
Dose (rem)	$1.2x10^{-2}$	$5.6x10^{-2}$	0.36
Latent cancer fatality per accident	$5.9x10^{-6}$	$2.8x10^{-5}$	$1.8x10^{-4}$
Risk (cancer fatality per year)	$5.9x10^{-9}$	$2.8x10^{-9}$	$1.8x10^{-8}$
Population Within 80 km (730,000 in 2010)			
Dose (person-rem)	0.9	1.9	26
Latent cancer fatalities per accident	$4.5x10^{-4}$	$9.3x10^{-4}$	$1.3x10^{-2}$
Risk (cancer fatalities per year)	$4.5x10^{-7}$	$9.3x10^{-8}$	$1.3x10^{-6}$

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences shown are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.1.6–7. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Nuclear Fuel Services

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	1.6	8.7	67
Latent cancer fatalities per accident	6.6×10^{-4}	3.5×10^{-3}	2.7×10^{-2}
Risk (cancer fatalities per year)	6.6×10^{-7}	3.5×10^{-7}	2.7×10^{-6}
Maximally Exposed Individual			
Dose (rem)	2.3×10^{-3}	1.4×10^{-2}	7.8×10^{-2}
Latent cancer fatality per accident	1.2×10^{-6}	6.9×10^{-6}	3.9×10^{-5}
Risk (cancer fatality per year)	1.2×10^{-9}	6.9×10^{-10}	3.9×10^{-9}
Population Within 80 km (1,260,000 in 2010)			
Dose (person-rem)	1.3	2.2	38
Latent cancer fatalities per accident	6.4×10^{-4}	1.1×10^{-3}	1.9×10^{-2}
Risk (cancer fatalities per year)	6.4×10^{-7}	1.1×10^{-7}	1.9×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix E.5.

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added in the form of water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions would occur prior to reaching a stable, subcritical condition and that all material releases would occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality would be 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.076 Ci of uranium isotopes (67 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are shown in Tables 4.3.1.6–4 through 4.3.1.6–7. The consequences shown in these tables for B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike Y–12, SRS, and NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The combined evaluation basis earthquake and earthquake-induced criticality accident release results in the highest consequences. The evaluation basis earthquake is conservatively assumed to cause both a criticality and a release of uranium material. The evaluation basis earthquake and the criticality are added together to show the range of consequences and risks at the candidate sites. If the evaluation basis earthquake were to occur, the estimated latent cancer fatalities in the general population within 80 km (50 mi) of each site would range from 5.5×10^{-3} at SRS to 2.4×10^{-2} at Y–12. For the MEI, there would be an increased likelihood of latent cancer fatality ranging from 1.1×10^{-6} at SRS to 2.1×10^{-4} at B&W. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of latent cancer fatalities in the worker population ranges from 3.1×10^{-2} at SRS and NFS to 0.33 at B&W. The accident risks, reflecting both the probability of the accident occurring and the consequences, are also shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 2.4×10^{-6}, 2.1×10^{-8}, and 3.3×10^{-5} per year, respectively.

For SRS the accident analysis was performed for the H-Area. If blending were to occur in the F-Area, doses from an accidental release would be similar to an accidental release in the H-Area. The dose to the MEI would be slightly larger due to the decreased distance of 9,646 m (31,649 ft) from F-Area to the site boundary. The dose to the offsite population within 80 km (50 mi) would be slightly smaller due to F-Area being further from the offsite population than H-Area. The dose to noninvolved workers would be smaller due to the smaller workforce in the F-Area. The dose to noninvolved workers in the processing area is the dominant portion of the dose to total site noninvolved workers. The dose to noninvolved workers not in the processing area would be a minimal effect due to the distance to other areas.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range up to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27).

The bounding chemical release accident is a spill from nitric acid (HNO_3) and sodium hydroxide (NaOH) storage tanks caused by the evaluation basis earthquake. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the tank pits such that the two chemicals mix; they would react with sufficient heat generation to result in the airborne release of 13,000 kg (28,700 lb) of unreacted HNO_3; for sufficiently large exposures this could result in irritation to the respiratory system, eyes, skin, and pulmonary edema. If this accident were to occur, the noninvolved worker could be exposed to concentrations in excess of the IDLH level (100 ppm) at Y–12 and B&W and in excess of the TLV-STEL level (4 ppm) at NFS and SRS. The MEI of the public could be exposed to concentrations in excess of the IDLH level at Y–12 and B&W (these levels dissipate below the IDLH level at 380 and 180 m [1,250 and 590 ft] downwind, respectively), in excess of the TLV-STEL level at NFS (36 m [120 ft] downwind of the IDLH level), and at levels less than the TLV-TWA level (2 ppm) at SRS (see Section 4.1.9 for a discussion of the significance of these levels).

The SRS Interim Management of Nuclear Materials EIS (SRS IMNM EIS) also considers facility accidents that are similar to those in this EIS (SR DOE 1995e:E-25). Some of the accident scenarios involving HEU presented in the SRS IMNM EIS would have more severe consequences than the accidents postulated in the HEU EIS. Table 4.3.1.6–8 presents a comparison between the two EISs for the noninvolved worker, the maximally exposed individual, and the population within 80 km (50 mi) for the accident scenario resulting in the highest consequences. The consequences differ in these two documents mainly due to different meteorological assumptions used in the accident analyses. The SRS IMNM EIS assumes very conservative meteorological conditions (extreme conditions that are not likely to be exceeded 99.5 percent of the time) whereas the analyses in this EIS use average meteorological conditions (that will likely occur 50 percent of the time). The SRS IMNM EIS described the potential variability attributable to differences in meteorological assumptions as follows:

> The modeling of the various accidents postulated for the facilities associated with the different alternatives assumed

Table 4.3.1.6–8. Comparison of Accident Results Between the Highly Enriched Uranium and the Savannah River Site Interim Management of Nuclear Materials Environmental Impact Statements

Accident Description	HEU EIS Evaluation Basis Earthquake Scenario	SRS IMNM EIS Severe Earthquake Scenario
Accident frequency (per year)	10^{-4}	2.0×10^{-4}
Consequence		
Noninvolved Worker		
Latent cancer fatality per accident	8.8×10^{-5}	2.2×10^{-2}
Risk (cancer fatality per year)	8.8×10^{-9}	4.4×10^{-6}
Maximally Exposed Individual		
Latent cancer fatality per accident	9.6×10^{-7}	6.3×10^{-4}
Risk (cancer fatality per year)	9.6×10^{-11}	1.3×10^{-7}
Population Within 80 km (710,000 in 2010)		
Latent cancer fatality per accident	5.3×10^{-3}	3.7
Risk (cancer fatalities per year)	5.3×10^{-7}	7.3×10^{-4}

Source: SR DOE 1995e; Table 4.3.1.6–4.

conservative (99.5 percentile) meteorological conditions (for example, direction and speed of the prevailing wind). Conservative meteorological conditions are those for which, for a given release, the concentration of radionuclides (and the resulting dose) at a fixed downwind location will not be exceeded 99.5 percent of the time. Usually, this means a highly stable-low wind speed weather condition where the wind provides only limited dilution of the material released. Use of these meteorological conditions result in consequences approximately three to four times higher for onsite workers and between 10 and 100 times higher for the offsite population than those that would occur during average (50 percentile) meteorological conditions (SR DOE 1995e: E-7).

Therefore, SRS IMNM EIS gives generally higher consequences due to the difference in material present and the conservative meteorological conditions assumed. In addition, SRS IMNM EIS used a site specific evaluation basis earthquake frequency of $2x10^{-4}$, whereas the HEU EIS used a generic accident frequency range of 10^{-3} to 10^{-5} appropriate for all four sites. Both the SRS IMNM EIS frequency of $2x10^{-4}$ and the HEU EIS frequency of 10^{-4} are within the accident frequency range. The Y–12 EA evaluated an earthquake with a $5.0x10^{-4}$ frequency also within the frequency range for the HEU EIS. These events (that is, earthquakes) are very rare. [Text deleted.] For the HEU EIS, the latent cancer fatalities following an evaluation basis earthquake are $8.8x10^{-5}$, $9.6x10^{-7}$, and $5.3x10^{-3}$ for the noninvolved worker, the MEI, and the population within 80 km (50 mi), respectively. For the SRS IMNM EIS, the latent cancer fatalities for the same earthquake are $2.2x10^{-2}$, $6.3x10^{-4}$, and 3.7. The differences between consequences for the noninvolved worker, the MEI, and the population within 80 km (50 mi) are a factor of 250, 660, and 700, respectively. This difference between the two EISs is mainly due to the assumptions employed for meteorological conditions and the source terms used in the analyses. The two analyses differ because the HEU EIS assumed a normal solution source term of 0.076 curies and the SRS IMNM EIS assumed a limiting solution source term of 1.17 curies which includes material in the facility unrelated to the blending activity. In addition to the differences between the consequences, the differences between the risks, which is the product of the consequence and the probability, are an additional factor of 2. These additional differences are due to the larger earthquake frequency that is assumed in the SRS IMNM EIS. The HEU EIS describes a spectrum of accidents for a specific material. For a wider range of accident scenarios at SRS, the SRS IMNM EIS should be consulted and the results evaluated in association with those presented in this EIS.

4.3.1.7 Waste Management

Operation of facilities required to blend surplus HEU to 4-percent LEU as UNH would affect current waste management activities at the candidate sites. There is no spent nuclear fuel, HLW, or TRU waste associated with the proposed conversion and blending. However, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the potential impacts on waste management activities at each candidate site resulting from blending HEU to 4-percent LEU as UNH.

As shown in Table 2.2.2.1–2, the blending process would result in generation of additional amounts of low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.3.1.7–1 provides the estimated sitewide waste generation resulting from the blending process. At each commercial facility considered for the blending process, the generation of wastes would be evaluated for ALARA principles. Table 2.2.2.1–2 also provides the resultant waste volume after treatment (effluent) using a reasonably foreseeable treatment scheme as outlined in Figures 4.3.1.7–1 to 4.3.1.7–3.Liquid LLW from decontamination would go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall.

Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Solids generated from decontamination processes would go through a uranium recovery process before being packaged for disposal. All other solid LLW would be

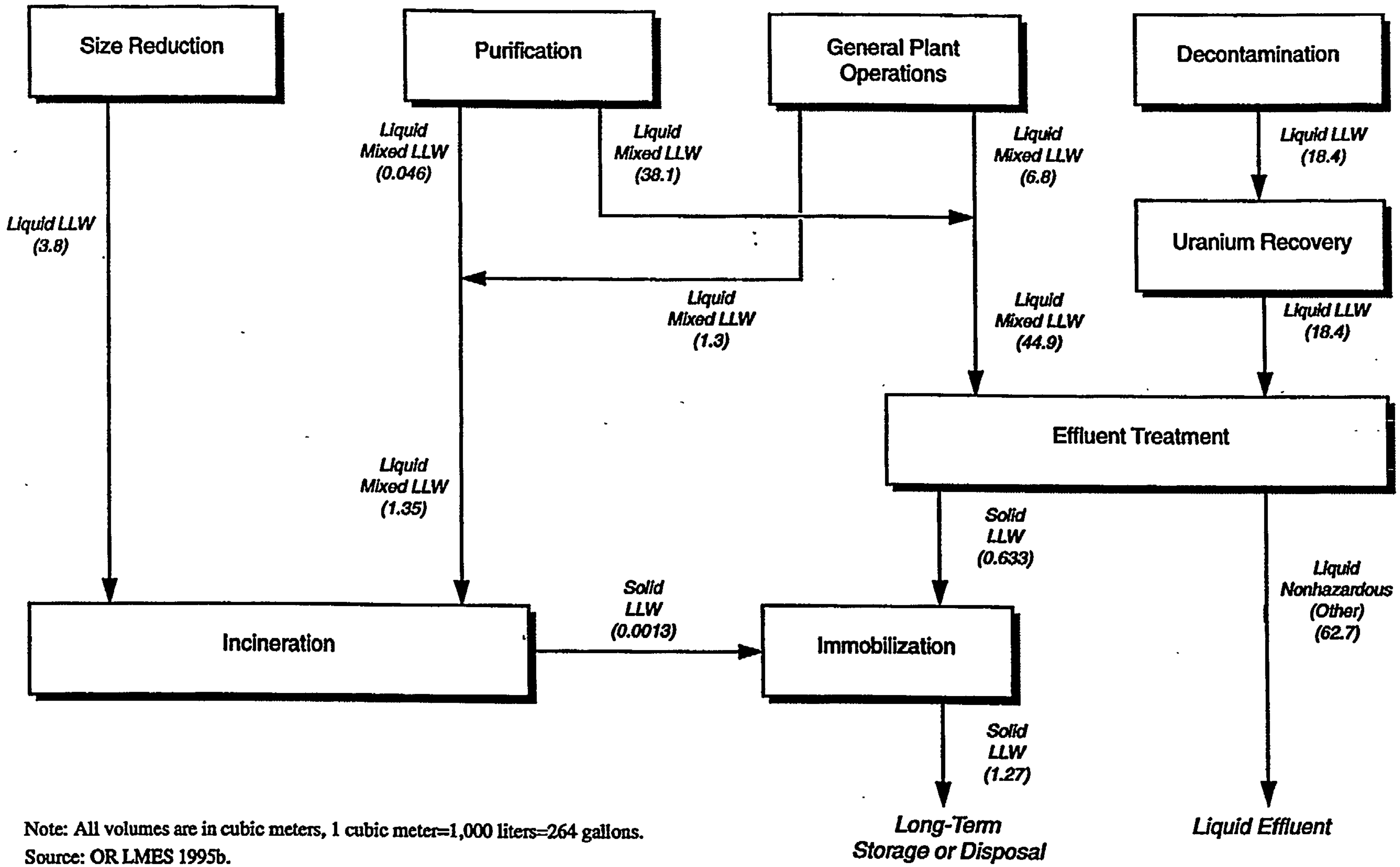
Table 4.3.1.7–1. Estimated Annual Generated Waste Volumes for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

	ORR[a]			SRS[b]			B&W			NFS		
	With UNH			With UNH			With UNH			With UNH		
Waste Category	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)	No Action (m^3)	Blending (m^3)	Increase (Percent)
Low-Level												
Liquid	2,576	2,598	<1	0	22	>100	50,005	50,027	<1	18,900	18,922	<1
Solid	8,030	8,106	<1	14,100	14,176	<1	620	696	12	3,000	3,076	3
Mixed Low-Level												
Liquid	84,210	84,256	<1	115	161	40	0	46	New	<1	46	>100
Solid	960	960	0	18	18	0	14	14	0	<1	<1	0
Hazardous												
Liquid	32,640	32,728	<1	Included in solid	88	–	55,115	55,203	<1	<1	89	>100
Solid	1,434	1,434	0	74	74	0	0	0	0	<1	<1	0
Nonhazardous												
Liquid	1,743,000	1,761,773	1	700,000	718,773	3	576,160	594,933	3	56,700	75,473	33
Solid	52,730	53,550	2	6,670	7,490	12	1,700	2,520	48	2,300	3,120	36

[a] 1993 Generation. Wastes at ORR are managed by a centralized waste management organization and not by individual sites; therefore, generation rates represent the sum of activities at K–25, ORNL, and Y–12.

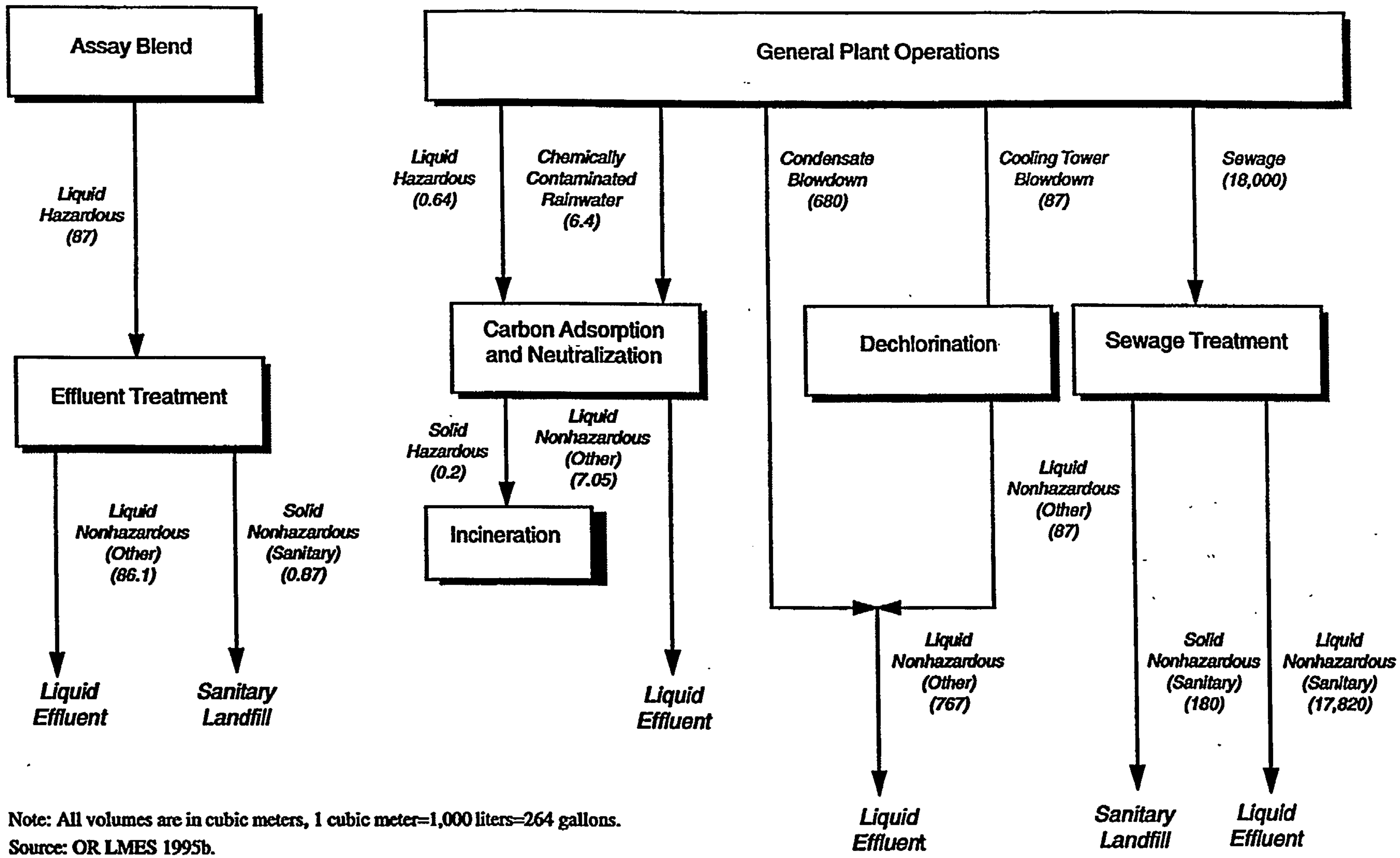
[b] 1993 Generation. Nonhazardous waste category is 1991 Generation.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NFS 1995b:2; NRC 1991a; OR LMES 1995b; Tables 3.3.10–1, 3.3.10–2, 3.3.10–3, and 3.4.10–1.



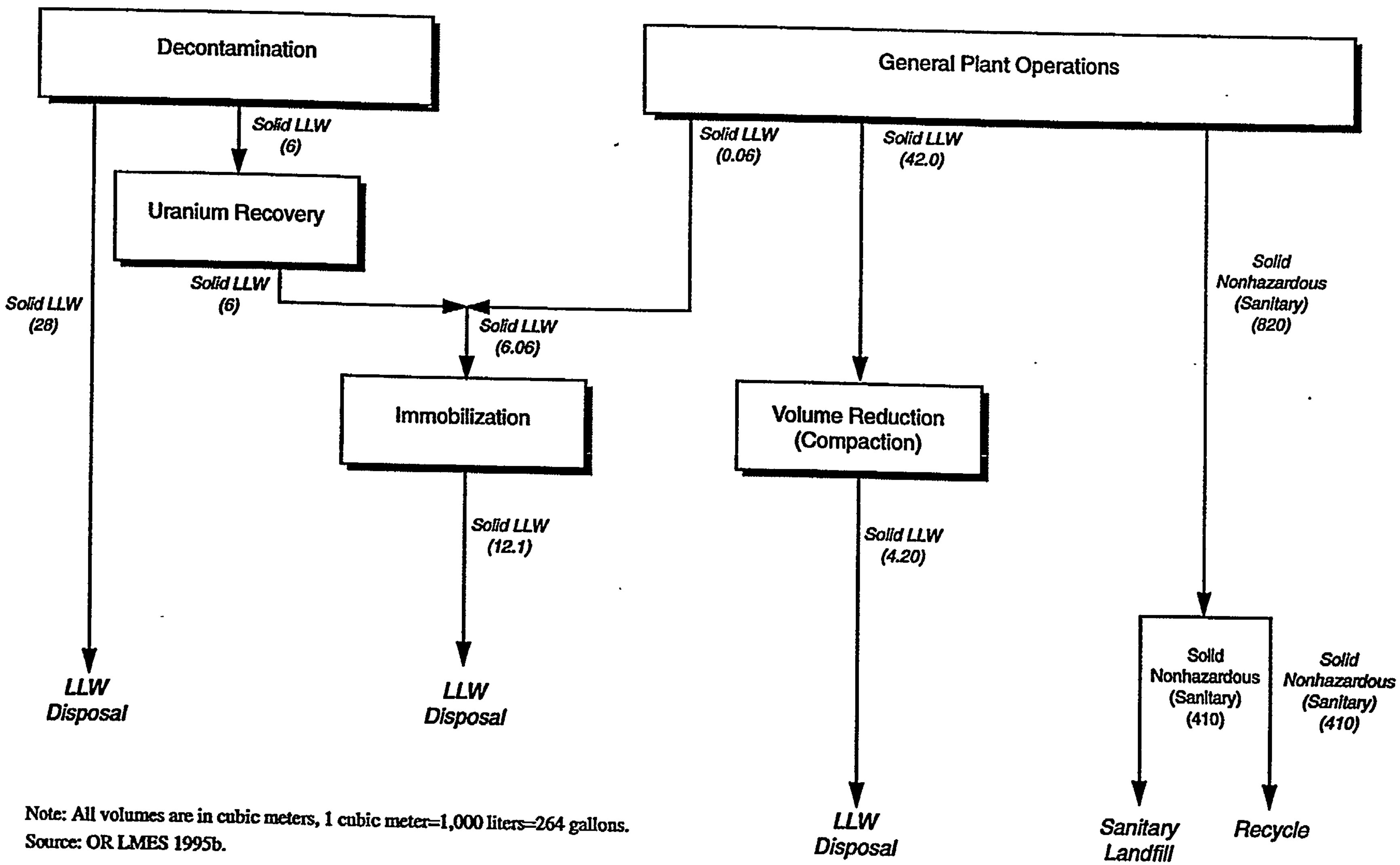
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–1. Radioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995b.

Figure 4.3.1.7–3. Solid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid mixed LLW consisting of spent solvents and lab waste would be incinerated, thus eliminating the hazardous constituent. The resultant ash would be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal and the treated effluent would be discharged through a permitted outfall. Other solid mixed LLW would consist of contaminated gloves and wipes. After compaction, they would be packaged for storage until a sufficient volume had accumulated for treatment in an onsite or offsite RCRA-permitted facility.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10–1 through 3.3.10–3. These tables indicate that liquid and solid LLW treatment facilities at ORR would not be greatly impacted due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by blending 10 t/yr of HEU that would eventually be transferred to the LLW disposal facility would be 46 m^3/yr (1,620 ft^3/yr). Assuming a usage factor of 3,300 m^3/ha (47,200 ft^3/acre) as developed in Section 4.1.10, this waste will require 0.014 ha/yr (0.034 acres/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3), which would require 0.24 ha (0.59 acre) for disposal. Adequate staging capacity also is available to incorporate the amount of solid mixed LLW from the treatment of the liquid mixed LLW. The onsite hazardous waste treatment facility has the capacity to accommodate the 1-percent increase in the amount of hazardous liquid waste produced by the blending process. This action would increase liquid sanitary waste generation to approximately 1,762,000 m^3/yr (465 MGY). The onsite facilities have a capacity of 4,930,000 m^3/yr (1,300 MGY), so the increase is within the facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

Savannah River Site. Current waste generation rates and treatment, storage, and disposal capacities are presented for SRS in Table 3.4.10–1. This table indicates that liquid and solid LLW treatment facilities at SRS would not be greatly impacted due to this action. The amount of liquid LLW generated per year by this action would be small compared to the amount of liquid LLW generated yearly at the site, and the onsite treatment facility has the capacity to accommodate the increase. There would be 46 m^3/yr (1,620 ft^3/yr) of solid LLW resulting from liquid and solid LLW treatment that would require staging and/or disposal. Assuming a usage factor of 8,600 m^3/ha (123,000 ft^3/acre) as presented in Section 4.1.10, the increase in the amount of solid LLW would require 0.005 ha/yr (0.012 acres/yr) in the onsite LLW disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3) which would require 0.09 ha (0.22 acre). The onsite mixed LLW treatment facility has the capacity to incorporate the increase in the amount of mixed LLW generated by the blending process. The storage capacity for mixed LLW at SRS is much greater than the yearly waste generation rate and would likely be able to handle this increase. Currently, the site incorporates liquid hazardous waste into the solid hazardous waste treatment system. There exists at SRS the capacity to treat 2,000 m^3/yr (528,000 gal/yr) of liquid hazardous waste; therefore, the increase would not burden existing systems. A 3-percent increase in the amount of liquid nonhazardous waste would result at SRS if this action were implemented. This increase would not burden onsite facilities. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated in the site's current recycling practices.

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23.7 MGY); therefore, B&W would be able to handle the 22 m^3/yr (5,810 gal/yr) increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 46 m^3/yr (1,620 ft^3/yr). This waste would be hauled offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre) as developed in Section 4.1.10, this waste would require 0.002 ha/yr (0.005 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3) which would require 0.039 ha (0.097 acre). The small amount of liquid mixed LLW generated would require some form of treatment. [Text deleted.] This waste can be treated in the existing LLW treatment facility at B&W. Currently, onsite treatment facilities process approximately 55,115 m^3 (14.6 million gal) of liquid hazardous waste. The increase in liquid hazardous waste generation of 88 m^3 (23,200 gal) should not burden this treatment system. The amount of liquid nonhazardous waste resulting from the blending process would increase by 3 percent over current operations. This could be accomplished in existing facilities that have a capacity of 2.5 times the combined requirement. B&W has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small and the onsite treatment facility would likely have the capacity to handle an increase of approximately 22 m^3/yr (5,810 gal/yr). This action will add 46 m^3 (1,620 ft^3) of solid LLW requiring staging and eventual disposal. This waste would be shipped offsite to a disposal facility. With a usage factor of 20,000 m^3/ha (286,000 ft^3/acre) as presented in Section 4.1.10, this waste would require 0.002 ha/yr (0.005 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 782 m^3 (27,600 ft^3), which would require 0.039 ha (0.097 acre). The small amount of liquid mixed LLW generated by this process would require some form of treatment. The liquid LLW treatment system could handle the increase in mixed LLW. [Text deleted.] The amount of liquid nonhazardous waste resulting from the blending process would increase from current operations. It would be discharged to the public treatment works with the rest of the nonhazardous liquid waste. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

4.3.2 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 4-PERCENT LOW-ENRICHED URANIUM AS URANIUM HEXAFLUORIDE

The process analyzed in this section involves converting surplus HEU to UF_6 and blending it in the gaseous form with natural or low-enriched UF_6 to obtain the desired enrichment level. There are no DOE or commercial facilities in the United States that have the capability to convert HEU to UF_6. However, for the reasons explained in Section 2.2.1, B&W and NFS are used as representative sites for this alternative.

Assessment of impacts of blending HEU to 4-percent LEU as UF_6 are based on an annual throughput of 10 t of impure alloyed 50-percent assay HEU metal to 4-percent assay UF_6 with LEU blendstock. The blendstock feed material used in this alternative is assumed to be pure UF_6.

4.3.2.1 Site Infrastructure

Operation of facilities to blend HEU to 4-percent LEU as UF_6 would potentially affect site infrastructure, mainly electrical power, fuel, and water/steam supply. Site infrastructure requirements are discussed in Section 2.2.2.3 and detailed in Table 4.3.2.1–1 for each site; however, the discussion of impacts on site infrastructure is presented for all the sites collectively.

Due to the use of existing facilities, and the estimated utility requirements for the UF_6 blending facility, there is no anticipated need for modifications to onsite or offsite road and rail access or right-of-way access corridors for such services as electrical transmission lines, natural gas and water supply pipelines, and telecommunications.

Annual electrical service requirements would result in approximately a 38-percent increase over the current annual usage at B&W and a 115-percent increase in annual consumption for NFS (This increase at NFS is due to its current unoperational state.) Peak load is estimated to increase by approximately 14 and 57 percent at B&W and NFS, respectively. Even with this increase, the capacity at both commercial facility sites would still be adequate to accommodate the blending facility's electrical service requirements without implementing any major modifications or constructing new transmission or distribution facilities.

Due to a decrease in processing requirements, the facilities at NFS are less active than normal; therefore, increases in resource requirements from the blending facility are orders of magnitude higher than current annual consumptive fuel use. Natural gas is the primary fuel in use at B&W with a significant fraction used in steam boilers to satisfy energy requirements of current operations. Similarly, NFS uses natural gas in boilers for building and process heat production. Fuel oil is used at both sites when natural gas is unavailable or uneconomical. The fuel requirements for the UF_6 conversion and blending facility represent an increase over current usage of 16.6 percent at B&W. For NFS, the blending facility represents an increase of 1,075 percent of current fuel consumption; however, based on fuel consumption data for NFS building and process equipment (790,000 l [209,000 gal] of fuel oil), the fuel requirement for the UF_6 blending facility would be about 65 percent of NFS's installed capacity. The annual raw water requirements for operation of the blending facility would result in about a 10.3 percent increase in current usage at B&W and a 35.1 percent increase at NFS. The available water capacity at each site is adequate to satisfy the blending facility requirements under this alternative.

The infrastructure resources at B&W and NFS are capable of accommodating the blending facility requirements without incurring any significant adverse environmental effects. No major modification or upgrade to these resources is expected due to development, operation, and decommissioning of the UF_6 blending facility at either site.

4.3.2.2 Air Quality and Noise

Operation of facilities to blend HEU to 4-percent LEU as UF_6 would generate criteria and toxic/hazardous pollutants that could potentially exceed Federal and State ambient air quality standards or guidelines. Concentrations of these pollutants resulting from this alternative were estimated for each site and are presented in Table 4.3.2.2–1.

Air Quality. Air pollutant emissions associated with the operation of the UF_6 blending facility consist of criteria pollutants from the operation of boilers to produce steam and toxic/hazardous pollutants used or generated in the blending process such as nitric acid.

Table 4.3.2.1–1. Changes to Site Infrastructure for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

	Access		Electrical		Fuel			Water	
Site	Road (km)	Rail (km)	Energy (MWh/yr)	Peak Load (MWe)	Natural Gas (m^3/yr)	Diesel/Oil (l/yr)	Coal (t/yr)	Water (million l/yr)	Steam (kg/hr)
UF_6 facility	0	0	25,000	2	21,200	56,800	545	20	1
B&W baseline	<1	0.305	64,700	14.3	2,850,000	470,000	0	195	1,460
B&W percent change	0	0	38.6	14	0.7	101[a]	NA[b]	10.3	0.07
NFS baseline	3	0	21,800	3.5	12,900[c]	36,000[c]	0	57	6,260
NFS percent change	0	0	115	57.1	165	1322[a]	NA[b]	35.1	0.02

[a] Percent change includes required coal energy equivalent.

[b] Coal is not utilized at B&W NNFD or NFS and all of the blending facility coal derived energy requirements would be supplied via the fuel oil energy equivalent; the fuel oil energy content is assumed to be 40,128 BTUs/l and for coal it is assumed to be 30.9 million BTUs/t (that is, 545 t of coal=419,185 l of fuel oil).

[c] Values shown are based on current usage; typical annual consumption is estimated at approximately 790,000 l of fuel oil, equivalent.

Note: NA=not applicable; MWh=megawatt hour; MWe=megawatt electric; BTU=British thermal unit.

Source: BW 1995b:1; NF NRC 1991a; NFS 1995b:2; OR LMES 1995a.

Table 4.3.2.2–1. Estimated Concentrations of Criteria Pollutants Based Upon Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines ($\mu g/m^3$)	UF_6 Blending Alternative Concentration[a] B&W ($\mu g/m^3$)	NFS ($\mu g/m^3$)
Carbon monoxide (CO)	8 hours	10,000[b]	5.43	0.62
	1 hour	40,000[b]	17.63	0.80
Lead (Pb)	Calendar Quarter	1.5[b]	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	0.14	0.03
Particulate matter[d] (PM_{10})	Annual	50[b]	0.03	<0.01
	24 hours	150[b]	0.19	0.03
Sulfur dioxide (SO_2)	Annual	80[b]	0.4	0.05
	24 hours	365[b]	2.74	0.4
	3 hours	1,300[b]	14.11	0.96
Mandated by Tennessee and Virginia				
Total suspended particulates[d] (TSP)	Annual	60[e]	0.03	< 0.01[f]
	24 hours	150[e]	0.19	0.03
Gaseous fluorides (as HF)	1 month	1.2[e]	trace[f, g]	trace[g]
	1 week	1.6[e]	trace[f, g]	trace[g]
	24 hours	2.9[e]	trace[f, g]	trace[g]
	12 hours	3.7[e]	trace[f, g]	trace[g]
	8 hours	250[e]	trace[f, g]	trace[g]

[a] Model results.
[b] Federal standard is the most restrictive standard.
[c] No emissions from this process.
[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.
[e] State standard or guideline.
[f] No State standard.
[g] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the candidate sites.

Source: 40 CFR 50; OR LMES 1995a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b.

These pollutants are controlled using liquid scrubbing prior to HEPA filtration to remove chemical vapors and particulates.

The annual concentration of NO_2 at B&W was calculated to be approximately 3.5 percent of the annual NAAQS for NO_2. NO_2 is considered to be a primary emission at the site. The UF_6 blending facility would contribute less than 1 percent to the annual concentration of NO_2 at B&W. Criteria pollutant concentrations would be expected to remain in compliance with the NAAQS and State-mandated standards.

The primary source of criteria pollutants at NFS is from space heating, which is accomplished by combustion of natural gas. The annual concentration of NO_2 at NFS is approximately 0.6 percent of the standard, which is the highest percent of a standard for criteria pollutants at NFS. Monitoring performed at NFS by TDEC indicated that the facility is in compliance with Federal and State regulations and guidelines (NF NRC 1991a:4-30). Operation of the UF_6 blending facility would add less than 0.1 percent of the annual concentration of NO_2, which would not be expected to change the compliance status of NFS.

Table 4.3.2.2–1 presents the estimated concentrations of criteria pollutants from blending HEU to 4-percent

LEU as UF_6. Table 4.3.2.2–2 presents the total concentrations of no action criteria pollutants plus blending at each site. During operation, impacts from the UF_6 blending facility with respect to the concentrations of criteria and toxic/hazardous air pollutants are expected to be within Federal and State regulations and guidelines for each site.

Noise. Operation of the UF_6 blending facility in an existing building at each site would result in little or no change in the contribution to noise levels at offsite receptors. Existing buildings are located at a sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Noise impacts associated with increased traffic on access routes would be small considering that either of the two facilities would require a maximum of 126 employees during operation (OR LMES 1995a:24), many of whom would be employees currently working at the site.

Potential measures to minimize noise impacts on workers include providing workers in noisy environments with appropriate hearing protection devices that meet OSHA standards. As required, noise

Table 4.3.2.2–2. Estimated Total Concentrations of Criteria Pollutants for No Action Plus Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines (μg/m³)	No Action Plus Blending Concentration[a] B&W (μg/m³)	No Action Plus Blending Concentration[a] NFS (μg/m³)
Carbon monoxide (CO)	8 hours	10,000[b]	9.43	2.59
	1 hour	40,000[b]	30.73	3.32
Lead (Pb)	Calendar Quarter	1.5[b]	[c]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	3.64	0.65
Particulate matter[d] (PM_{10})	Annual	50[b]	0.05	0.03
	24 hours	150[b]	0.35	0.24
Sulfur dioxide (SO_2)	Annual	80[b]	0.74	0.07
	24 hours	365[b]	5.02	0.55
	3 hours	1,300[b]	25.91	1.31
Mandated by Tennessee and Virginia				
Total suspended particulates[d] (TSP)	Annual	60[e]	0.06	0.04[f]
	24 hours	150[e]	0.41	0.24
Gaseous fluorides (as HF)	1 month	1.2[e]	trace[f,g]	0.02
	1 week	1.6[e]	trace[f,g]	<0.06
	24 hours	2.9[e]	trace[f,g]	0.06
	12 hours	3.7[e]	trace[f,g]	0.1
	8 hours	250[e]	trace[f,g]	0.11

[a] Model results.
[b] Federal standard.
[c] No emissions from no action or this process.
[d] It is conservatively assumed that PM_{10} concentrations are TSP concentrations.
[e] State standard or guideline.
[f] No State standard.
[g] Hydrofluorination is anticipated to be a closed system with scrubber filter exhaust system. Therefore, emission of gaseous fluorides is estimated to be a trace amount.
[Text deleted.]
Note: Ozone, as a criteria pollutant, is not emitted nor monitored by the candidate sites.
Source: 40 CFR 50; NF DEC nda; OR LMES 1995a; TN DEC 1994a; TN DHE 1991a; VA APCB 1993a; VA DEQ 1995b.

levels would be measured in worker areas, and a hearing protection program would be implemented.

4.3.2.3 Water Resources

Environmental impacts associated with the operation of UF_6 blending facilities would affect surface and groundwater resources. Water resource requirements and discharges provided in Section 2.2.2.3 were used in assessing impacts to surface water and groundwater. The discussion of impacts is provided for each site separately.

Babcock & Wilcox

Surface Water. Water withdrawn from the James River for the UF_6 blending operation (20 million l/yr [5.3 MGY]) would represent less than 1 percent of the minimal flow rate of the river (12.7 m^3/s [448 ft^3/s]) and approximately 1.7 percent of the design capacity of B&W (1,193 million l/yr [315 MGY]). To date, water withdrawn from the James River has had no adverse impacts on the river's flow rate. The withdrawal rates associated with future operations are expected to be similar to or less than the historical withdrawals; therefore, minimal flow impacts are expected.

The aqueous process waste and sanitary wastewater is treated and then discharged to the James River through permitted outfalls. The additional 19.1 million l/yr (5 MGY) discharged to the river would represent an approximate 29-percent increase in the amount being treated, 65 million l/yr (17 MGY), and less than 1 percent of the James River minimum flow rate (12.7 m^3/s [448 ft^3/s]). The difference in amounts between water usage and water discharge is attributed to drift and evaporation in the cooling towers.

Degradation of surface water quality is prevented by enforcement of release limits and monitoring programs mandated under the facility NPDES permit. Examination of the NPDES monthly reports indicated that TDS standards were violated in three instances.

The site has the potential for flooding if the James River experiences very high flows. The more vulnerable areas of the site are the wastewater treatment facility and the ponds that are at lower site elevations. A large flood for the site (10,000 m^3/s [353,000 ft^3/s]) would cover the two equalization ponds and could remove the sediment material and transport it downstream. Such a flood would not be expected to inundate the applicable UF_6 blending facility.

Groundwater. Potential groundwater impacts include drawdown of the water table in the vicinity of facility wells and degradation of groundwater quality due to uncontrolled leakage from the subsurface soils. B&W withdrawals of groundwater in the area of the James River are small in comparison to the capacity of the wells and groundwater system.

There are no discharges of wastewater that could result in groundwater contamination from proposed operations, except for those ponds that are used to manage the flow rate of discharges into the James River. The groundwater does have low levels of TCE contamination from previous leaks that have been identified and eliminated. All but two of the underground tanks installed at the site have been removed; therefore, the potential for accidental contamination of the groundwater is reduced. Remediation plans are being prepared for the cleanup of the TCE plume. The operation of UF_6 blending facilities is not expected to result in any direct impacts to the local groundwater.

Nuclear Fuel Services

Surface Water. Water required for the operation of UF_6 blending facilities (20 million l/yr [5.3 MGY]) would be taken from the existing water supply system, which obtains process water from the city of Erwin public utility system. The additional water required would represent about 35.1 percent of the current usage (57 million l/yr [15 MGY]) and would not be expected to affect other users.

The aqueous process waste is piped to the wastewater treatment facility, treated, and then discharged to the Nolichucky River by a direct pipeline. The additional discharge (1.3 million l/yr [0.34 MGY]) would represent an approximate 7-percent increase in the current average daily discharge (18.9 million l/yr [5 MGY]) or less than 1 percent of the average flow (39 m^3/s [1,380 ft^3/s]). The sanitary wastewater (17.8 million l/yr [4.7 MGY]) would be discharged to the city of Erwin wastewater treatment facility. This will increase current sanitary wastewater discharge (38 million l/yr [10 MGY]) by approximately 47 percent. Total site sanitary wastewater discharges (55.8 million l/yr [14.7 MGY]) would not exceed the current permitted capacity (75.7 million l/yr [20 MGY]). There are no plans to discharge noncontact cooling water to Banner Spring Branch. Discharges are required to meet all NPDES permit limitations.

The site has the potential for being flooded if the Nolichucky River experiences very high flow. Elevations of the building floors are between 500 and 510 m (1,640 and 1,670 ft). The UF_6 conversion and blending facility would not be accommodated at facilities in the 300 Area, located inside the 100- or 500-year floodplain. [Text deleted.] Based on the Flood Insurance Rate Map and the flood profiles, 100- and 500-year floodplain elevations at the NFS site are determined to be 499.5 m (1,639 ft) and 500 m (1,640 ft) above mean sea level, respectively. Facilities in the 300 Area have building floor elevations of approximately 500.5 (1,642 ft) above mean sea level, which would be above the 100- and 500-year flood elevations. Warning devices and systems are in place along the river to warn the public and the plant of the chance of possible flooding. The NFS site has emergency plans in place to contact the city of Jonesborough Water Treatment Facility as well as other local, State, and national committees, and inform them when any accidental releases from the plant have occurred. During flooding or because of accidental releases to the surface water, the Jonesborough Water Treatment Plant closes off the water intake valves, so no contamination to the public water supply occurs. The rechanneling of the Nolichucky associated with the highway construction and the rerouting of Martin Creek to enter the Nolichucky farther downstream have lowered the previously expected flood levels at the site.

Groundwater. No groundwater would be used at NFS given the plentiful city water available. Therefore, no impacts to groundwater levels are expected.

Groundwater quality would not be affected by the operation of UF_6 blending facilities, because there would be no direct discharges of process wastewater to groundwater. Wastewater would be treated prior to discharge to the Nolichucky River.

Currently, groundwater contamination occurs in the Quaternary alluvium adjacent to the NFS's settling ponds beneath the buried holding tanks and beneath the radioactive solid waste burial ground. A pump and treat restoration program is in place to clean up groundwater contamination. There is also slightly contaminated groundwater beneath the CSX Transportation right-of-way. There are no known local down-gradient wells in the Quaternary alluvium. Banner Hill Spring has remained uncontaminated from 25 years of normal operations at the NFS facility.

4.3.2.4 Biotic Resources

The operation of the UF_6 blending facilities at B&W or NFS is not expected to have significant adverse impacts on biotic resources. Operations would be accommodated within existing buildings. There would be no loss of habitat; therefore, no impacts on wildlife are anticipated. The increase of water intake or discharges to site streams would be minimal (less than 1 percent of stream flow rates), which would cause no impacts to aquatic resources.

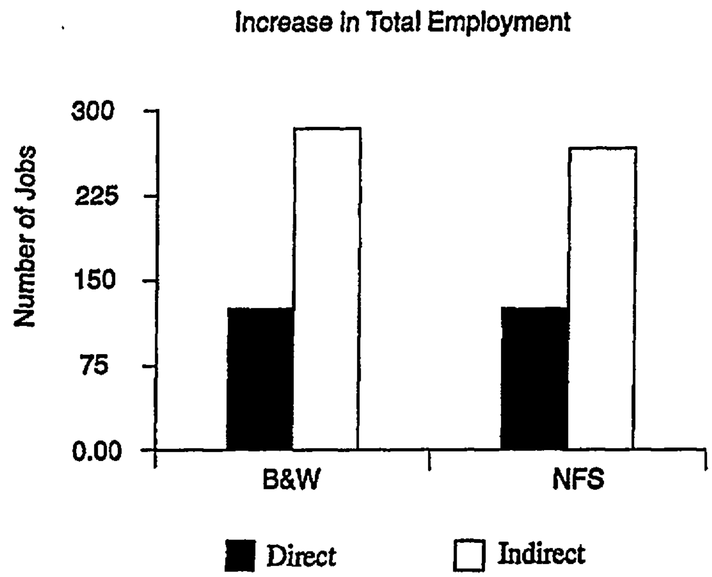
Impacts to wetlands would not occur, since these resources are not located in the proposed area of activities. No Federal- or State-listed threatened or endangered species would be affected.

4.3.2.5 Socioeconomics

This section describes the potential socioeconomic effects resulting from operation of facilities to blend HEU to 4-percent LEU as UF_6 at B&W or NFS. Any upgrades/modifications required at either facility would be accomplished by the site's existing workforce, and no new jobs would be created. However, operation of the blending facilities at either location would require additional employees creating some positive economic benefits to the region.

Operation of the UF_6 blending facility would require 126 employees. Some workers needed for operations are currently employed at these sites; however, to assess the maximum potential impact of this alternative, the analysis assumes that both candidate sites would need 126 additional employees to blend HEU to LEU as UF_6. The project would also create 285 and 253 indirect jobs within the B&W and NFS REAs, respectively (Figure 4.3.2.5–1). The regional unemployment rates would decrease from 4.9 to 4.8 percent at B&W and from 5.9 to 5.7 percent at NFS.

Available labor in both regions would be sufficient to fill the new jobs created directly by the project and additional indirect jobs. Therefore, it is unlikely that there would be any in-migration to the regions.



Source: Model results.

Figure 4.3.2.5–1. Increase in Total Project-Related Employment (Direct and Indirect) at Each Candidate Site Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.

Without any project-related in-migration, there would be no additional demands for housing units, community services, or transportation. The effects on housing and community services in the ROIs would be the same as for the No Action Alternative.

4.3.2.6 Public and Occupational Health

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or potential accidents for blending HEU to 4-percent LEU as UF_6 at the two commercial sites under consideration. Summaries of the radiological impacts to the public and workers associated with normal operation at each site are presented in Tables 4.3.2.6–1 and 4.3.2.6–2, respectively. Chemical impacts to these same groups are presented in Table 4.3.2.6–3, and accident impacts are presented in Tables 4.3.2.6–4 and 4.3.2.6–5. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. Incremental radiological impacts to the public resulting from normal operation of the UF_6 blending facilities at both sites are presented in Table 4.3.2.6–1.The impacts from total site operations, including the UF_6 blending facilities, are also given in the table. These impacts are provided to demonstrate compliance with applicable regulations governing total site operations. To put operational doses into perspective, comparisons are made with the doses from natural background radiation. As shown in Table 4.3.2.6–1, the doses to the MEI of the public from annual total site operations are all within radiological limits and would be 0.054 mrem at B&W and 0.28 mrem at NFS. The annual population doses within 80 km (50 mi) would be 0.52 person-rem at B&W and 2.6 person-rem at NFS.

Incremental and total site doses to onsite workers from normal operations are given in Table 4.3.2.6–2. The annual incremental dose to involved workers at the blending facility would be 115 mrem to the average worker and 14.5 person-rem to the entire facility workforce (NRC 1995b:A-9; OR LMES 1995a:24).

Table 4.3.2.6–1. Potential Radiological Impacts to the Public Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Receptor	B&W Incremental	B&W Total Site[a]	NFS Incremental	NFS Total Site[a]
Maximally Exposed Individual (Public)[b]				
From atmospheric release pathway (mrem/yr)[c]	3.5×10^{-3}	5.0×10^{-2}	0.25	0.28
From total liquid release pathway (mrem/yr)[c]	0	4.0×10^{-3}	0	9.0×10^{-4}
From atmospheric and liquid release pathways combined (mrem/yr)[c]	3.5×10^{-3}	5.4×10^{-2}	0.25	0.28
Percent of natural background[d]	1.1×10^{-3}	1.6×10^{-2}	7.4×10^{-2}	8.2×10^{-2}
Risk of fatal cancer per year of operation[e]	1.8×10^{-9}	2.7×10^{-8}	1.3×10^{-7}	1.4×10^{-7}
Population Within 80 km				
From atmospheric release pathways dose (person-rem/yr)	3.2×10^{-2}	0.45	2.3	2.6
From total liquid release pathways (person-rem/yr)	0	7.0×10^{-2}	0	1.9×10^{-3}
From atmospheric and liquid release pathways combined (person-rem/yr)	3.2×10^{-2}	0.52	2.3	2.6
Percent of natural background[d]	1.3×10^{-5}	2.1×10^{-4}	5.4×10^{-4}	6.1×10^{-4}
Number of fatal cancers per year of operation[e]	1.6×10^{-5}	2.6×10^{-4}	1.2×10^{-3}	1.3×10^{-3}

[a] Includes impacts from all site operations that are expected to continue during the interim of blending process operations (reference environment).

[b] The applicable radiological limits for an individual member of the public from total site operations are 10 mrem/yr from the air pathways, 4 mrem/yr from the drinking water pathways, and 25 mrem/yr from all pathways combined.

[c] Incremental radiological doses are different at each site because of site-specific characteristics such as meteorology, topography, distance to site boundary, etc.

[d] Annual natural background radiation levels: 1) B&W: the average individual receives 329 mrem; the population within 80 km receives 244,000 person-rem, and 2) NFS: the average individual receives 340 mrem; the population within 80 km receives 429,000 person-rem.

[e] Representative of material processed at the rate of 10 t/yr.

Source: Appendix E.

Table 4.3.2.6–2. Potential Radiological Impacts to Workers Resulting From Normal Operation of Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

Receptor	B&W	NFS
Involved Workforce[a]		
Average worker		
Dose (mrem/yr)[b]	115	115
Risk of fatal cancer per year of site operation	4.6×10^{-5}	4.6×10^{-5}
Total		
Dose (person-rem/yr)	14.5	14.5
Number of fatal cancers per year of site operation	5.8×10^{-3}	5.8×10^{-3}
Noninvolved Workforce[c]		
Average worker		
Dose (mrem/yr)[b]	10	50
Risk of fatal cancer per year of site operation	4.0×10^{-6}	2.0×10^{-5}
Total		
Dose (person-rem/yr)	16.7	16.3
Number of fatal cancers per year of site operation	6.7×10^{-3}	6.5×10^{-3}
Total Site Workforce[d]		
Dose (person-rem/yr)	31.2	30.8
Number of fatal cancers per year of site operation	1.2×10^{-2}	1.2×10^{-2}

[a] The involved worker is a worker associated with operations of the blending and conversion facilities. The estimated number of in-plant workers is 126. The average in-plant worker dose is estimated to be similar to that for UNH blending operations, with an additional 25 mrem/yr incurred from fluorination processes.

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

[c] The noninvolved worker is a worker onsite but not associated with operations of the blending and conversion facilities. The estimated number of noninvolved workers is 1,674 at B&W and 325 at NFS.

[d] The total site workforce is the summation of the in-plant worker impacts and the noninvolved worker impacts. The estimated number of workers in the total site workforce is 1,800 at B&W and 451 at NFS.

Source: BW 1995b:1; NFS 1995b:2; NRC 1995b; OR LMES 1995a.

[Text deleted.] All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 4-percent LEU as UF_6 at B&W and NFS are presented in Table 4.3.2.6–3. The table presents the increment of potential adverse noncancer health effects and cancer risks posed by this action at the various sites, followed by the total risk (that is, incremental risk plus no action contribution to risk) at each unique site.

The incremental and site total HIs for the public MEI contributed by this alternative are all less than 1.0 at B&W and NFS, and the cancer risks to the MEI of the public are below the value of 1.0×10^{-6} (RA 1994a: 477-481).

The incremental and site total HIs for the onsite workers contributed by this alternative are all less than 1.0 at B&W and NFS showing that all chemicals or combinations are below OSHA Permissible Exposure Levels. The incremental lifetime cancer risks for B&W and NFS, respectively, are below the value of 1.0×10^{-6}, but total site lifetime cancer risk exceeds this level for B&W. Since the HIs represent ratios between actual exposure levels to hazardous chemicals and their regulated levels, there is no time limit placed on the exposures. Likewise, the cancer risks to the MEI and onsite workers represent lifetime and working lifetime for the onsite individual. Therefore, the MEI and the onsite workers should not exhibit differences from the general public from the onset to the end of operations (with the exception noted). For details of the calculations used to derive the HIs and cancer risks, refer to Appendix E.3.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the conversion and blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility. The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the fluidized bed release and the filter fire

Table 4.3.2.6–3. Potential Hazardous Chemical Impacts to the Public and Workers at Various Sites Resulting From Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

	B&W		NFS	
Receptor	**Incremental [a]**	**Total Site[b]**	**Incremental[b]**	**Total Site[c]**
Maximally Exposed Individual (Public)				
Hazard index[c]	1.44×10^{-6}	1.29×10^{-5}	2.10×10^{-3}	9.76×10^{-2}
Cancer risk[d]	8.44×10^{-18}	1.68×10^{-8}	1.23×10^{-14}	1.23×10^{-14}
Worker Onsite				
Hazard index[e]	5.09×10^{-4}	4.58×10^{-3}	6.98×10^{-4}	8.27×10^{-3}
Cancer risk[f]	1.98×10^{-14}	3.94×10^{-5}	2.72×10^{-14}	2.72×10^{-14}

[a] Incremental=contribution only from single activity at the site.

[b] Total site includes any background emissions that would be present in the absence of site operations plus site emissions that exist at the present time.

[c] Hazard index for MEI=sum of individual hazard quotients (noncancer adverse health effects) for MEI.

[d] Lifetime cancer risk for MEI=emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Hazard index for workers=sum of individual hazard quotients (noncancer adverse health effects) for workers.

[f] Lifetime cancer risk for workers=(emissions for 8-hour) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

Source: OR LMES 1995a.

(with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake. Therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality, UF_6, and other release scenarios.

In a fluidized bed release, it is assumed that the high-temperature filters would be removed for replacement but the filter housing would be closed without new filters inside. The inventory of one bed is swept out by the nitrogen used to fluidize the bed. The quantity of material assumed to be released is 7.5 kg (16.5 lb) of HEU.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution would be damaged directly by seismic shaking and indirectly by falling debris. Safe spacing is lost and moderators added as water from the fire system or organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions would occur prior to reaching a stable, subcritical condition and that all material releases would occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality would be 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.061 Ci of uranium (76 percent of the activity is U-234).

In the UF_6 release, the evaluation basis earthquake causes equipment failures and a pressurized release of a UF_6 cylinder. Thirty percent of a cylinder containing LEU is assumed to be released into the atmosphere consistent with NRC's guidance presented in the *Nuclear Fuel Cycle Facility Accident Analysis Handbook* (NUREG-1320, May 1988). After the accident, it is estimated that there would be a release of 30 percent of the material to equalize the pressure inside and outside the cylinder. This is assumed to result in the release of 1,900 kg (4,100 lb) of 1.5-percent assay LEU as shown in Appendix E.5.2.2.

The accidents that release radioactivity and their consequences are shown in Tables 4.3.2.6–4 and 4.3.2.6–5. The consequences shown in these tables for B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The accident with the highest consequences is a UF_6 cylinder release. The evaluation basis earthquake is conservatively assumed to cause a criticality, a UF_6 cylinder release, and a release of uranium material. The evaluation basis earthquake, criticality, and UF_6 cylinder release are added together to show the range of consequences and risks at the candidate sites. If a UF_6 cylinder release were to occur, there would be an estimated 1 and 1.4 latent cancer fatalities in the general population within 80 km (50 mi) of B&W and NFS, respectively. For the MEI, there would be increased likelihood of latent cancer fatality of 1.9×10^{-2} and 3.0×10^{-3} at these two sites, respectively. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of fatalities in the worker population would be 30 and 2.5 respectively. The accident risks, reflecting both the probability of the accident occurring and the consequences, are also shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 1.4×10^{-4}, 1.9×10^{-6}, and 3.0×10^{-3} per year, respectively.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the blending facilities analyzed in this EIS. Potential radiological consequences to the involved worker range to several

Table 4.3.2.6–4. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride at Babcock & Wilcox

Accident Description	Fluid Bed	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario	UF_6 Cylinder Release
Accident frequency (per year)	10^{-3}[a]	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]	10^{-4}[b]
Consequences[c]					
Noninvolved Workers					
Dose (person-rem)	990	24	80	524	54,000
Latent cancer fatalities per accident	0.4	9.5×10^{-3}	3.2×10^{-2}	0.21	30
Risk (cancer fatalities per year)	4.0×10^{-4}	9.5×10^{-6}	3.2×10^{-6}	2.1×10^{-5}	3.0×10^{-3}
Maximally Exposed Individual					
Dose (rem)	0.49	1.2×10^{-2}	5.6×10^{-2}	0.25	26
Latent cancer fatality per accident	2.4×10^{-4}	5.9×10^{-6}	2.8×10^{-5}	1.3×10^{-4}	1.9×10^{-2}
Risk (cancer fatality per year)	2.4×10^{-7}	5.9×10^{-9}	2.8×10^{-9}	1.3×10^{-8}	1.9×10^{-6}
Population Within 80 km (730,000 in 2010)					
Dose (person-rem)	38	0.9	1.9	18	1,900
Latent cancer fatalities per accident	1.9×10^{-2}	4.5×10^{-4}	9.3×10^{-4}	9.1×10^{-3}	1
Risk (cancer fatalities per year)	1.9×10^{-5}	4.5×10^{-7}	9.3×10^{-8}	9.1×10^{-7}	1.0×10^{-4}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences shown are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.2.6–5. Accident Consequences and Risk of Major Accidents for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride at Nuclear Fuel Services

Accident Description	Fluid Bed	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario	UF_6 Cylinder Release
Accident frequency (per year)	10^{-3a}	10^{-3a}	10^{-4b}	10^{-4b}	10^{-4b}
Consequences					
Noninvolved Workers					
Dose (person-rem)	68	1.6	8.7	46	5,000
Latent cancer fatalities per accident	2.7×10^{-2}	6.6×10^{-4}	3.5×10^{-3}	1.8×10^{-2}	2.5
Risk (cancer fatalities per year)	2.7×10^{-5}	6.6×10^{-7}	3.5×10^{-7}	1.8×10^{-6}	2.5×10^{-4}
Maximally Exposed Individual					
Dose (rem)	9.7×10^{-2}	2.3×10^{-2}	1.4×10^{-2}	5.4×10^{-2}	5.7
Latent cancer fatality per accident	4.8×10^{-5}	1.2×10^{-6}	6.9×10^{-6}	2.7×10^{-5}	3.0×10^{-3}
Risk (cancer fatality per year)	4.8×10^{-8}	1.2×10^{-9}	6.9×10^{-10}	2.7×10^{-9}	3.0×10^{-7}
Population Within 80 km (1,260,000 in 2010)					
Dose (person-rem)	53	1.3	2.2	26	3,000
Latent cancer fatalities per accident	2.7×10^{-2}	6.4×10^{-4}	1.1×10^{-3}	1.3×10^{-2}	1.4
Risk (cancer fatalities per year)	2.7×10^{-5}	6.4×10^{-7}	1.1×10^{-7}	1.3×10^{-6}	1.4×10^{-4}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix B.5.

thousand rem in the case of a criticality. The combined evaluation basis earthquake, earthquake-induced criticality, and UF_6 cylinder release would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26, 6-27).

The bounding chemical release accidents (caused by the evaluation basis earthquake) are a spill from HNO_3 and NaOH storage tanks, and the rupture of processing lines resulting in the emptying of the HF tank and a F_2 cylinder. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the HNO_3 and NaOH tank pits such that the two chemicals mix; they are assumed to react with sufficient heat generation to result in the airborne release of 2,600 kg (5,730 lb) of unreacted HNO_3; for sufficiently large exposures, this could result in irritation to the respiratory system, eyes, and skin and pulmonary edema. If this accident were to occur, the impact to the noninvolved worker could be exposure to concentrations in excess of the IDLH level (100 ppm) at B&W, and in excess of the TLV-STEL level (4 ppm) at NFS. The impact to the MEI of the public could be exposure to concentrations in excess of the TLV-STEL level at each site (280 and 160 m [920 and 530 ft] downwind of the IDLH level at B&W and NFS, respectively).

The HF and F_2 releases, (600 and 500 kg [1,320 and 1,100 lb], respectively), which cause similar health impacts as to HNO_3, could result in exposure to the noninvolved worker of concentrations in excess of the IDLH level (30 and 25 ppm, respectively) at B&W and in excess of the TLV-STEL level (6 and 2 ppm, respectively) at NFS. The public could be exposed to concentrations in excess of the TLV-STEL level at each site. (See Section 4.1.9 for a discussion of the significance of these levels.)

4.3.2.7 Waste Management

Operation of UF_6 blending facilities would increase waste generated at the candidate sites. There is no

Table 4.3.2.7–1. Estimated Annual Generated Waste Volumes for Blending 10 t/yr Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride

	B&W			NFS		
Waste Category	No Action (m^3)	With UF_6 Blending (m^3)	Increase (Percent)	No Action (m^3)	With UF_6 Blending (m^3)	Increase (Percent)
Low-Level						
Liquid	50,005	50,054	<1	18,900	18,949	<1
Solid	620	765	23	3,000	3,145	5
Mixed Low-Level						
Liquid	0	159	>100	<1	159	>100
Solid	14	14	0	<1	<1	0
Hazardous						
Liquid	55,115	55,121	<1	<1	6	>100
Solid	0	0	0	<1	<1	0
Nonhazardous						
Liquid	576,160	595,315	3	56,700	75,855	34
Solid	1,700	2,520	48	2,300	3,121	36

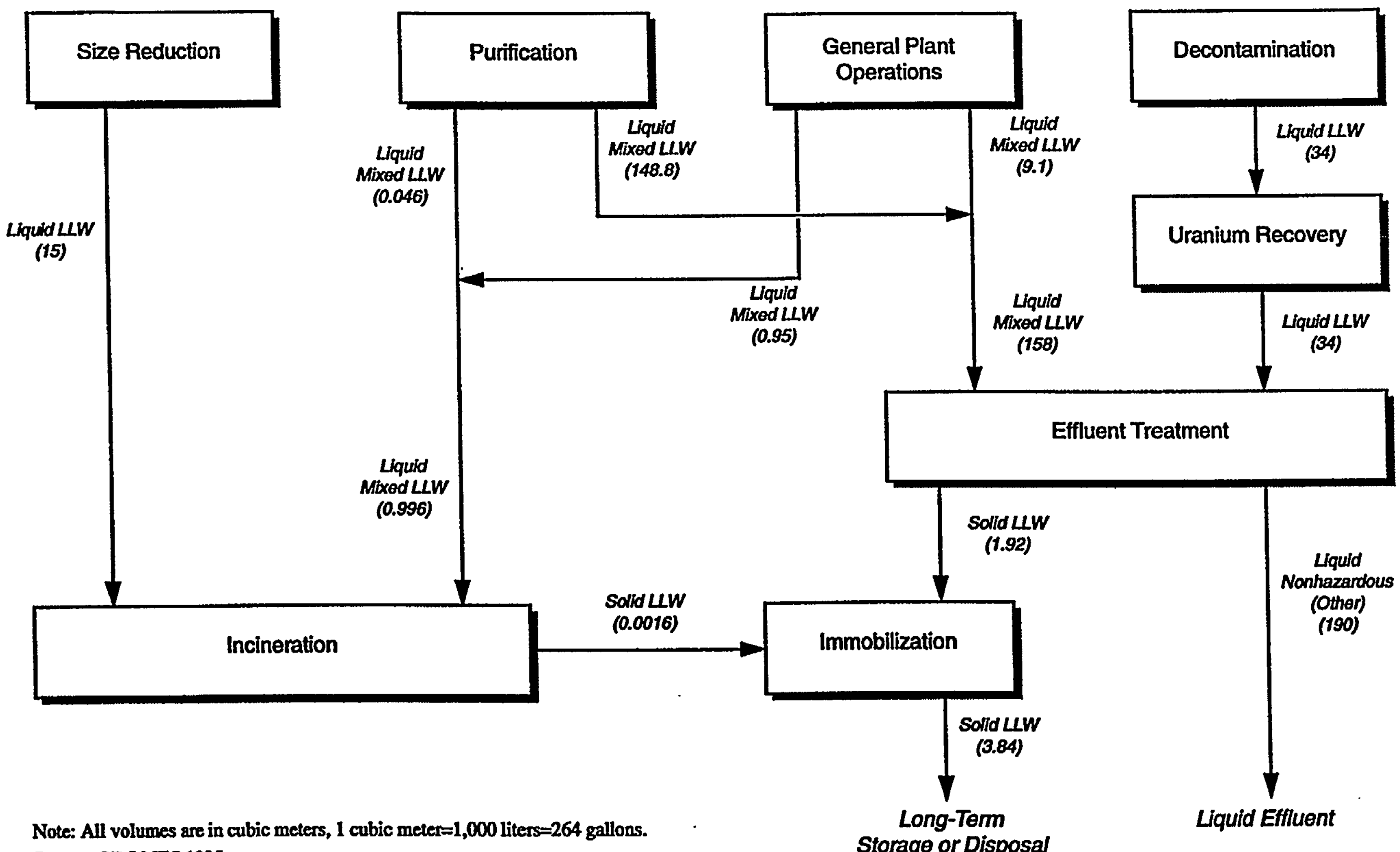
Source: BW 1995b:2; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2.; OR LMES 1995a.

spent nuclear fuel, HLW, or TRU waste associated with the proposed action. However, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the impacts on treatment, storage, and disposal facilities at each potential site resulting from the UF_6 blending.

The blending process would result in the generation of low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.3.2.7–1 provides the sitewide waste generation resulting from the blending process. At each facility considered for the blending process, the generation of wastes would be evaluated against ALARA principles. Table 2.2.2.3–2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures 4.3.2.7–1 to 4.3.2.7–3. Liquid LLW from decontamination would go through a uranium recovery process first. The liquid effluent then would go to a radioactive wastewater treatment facility. The resultant sludge would be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall.

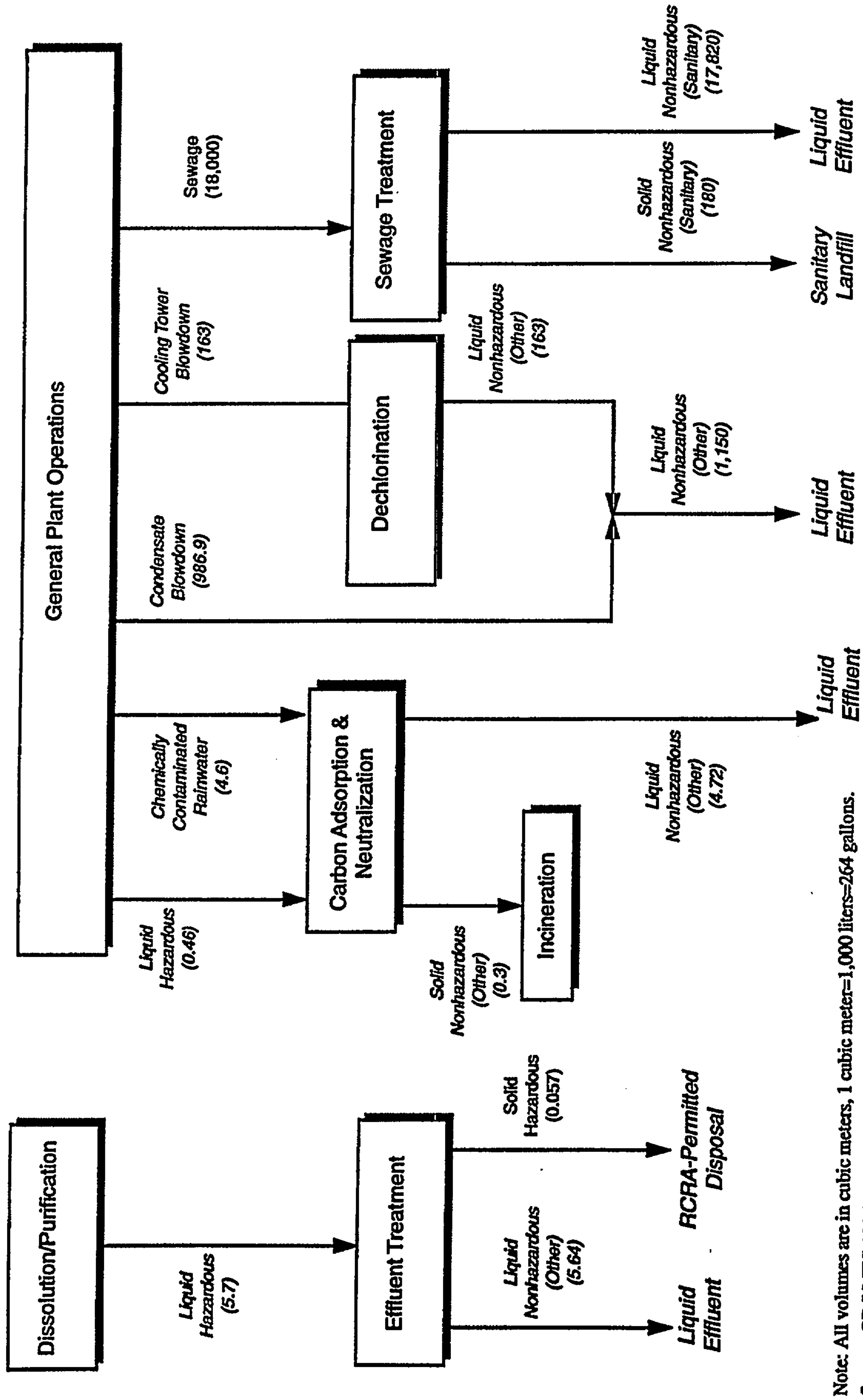
Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, contaminated calcium fluoride, spent sodium fluoride, sintered-metal filter cartridges, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontamination solids would go through a uranium recovery process before being packaged for disposal. All other solid LLW would be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. This solid LLW radiological content would include U-232, U-234, U-235, U-236 and U-238. Liquid mixed LLW consisting of spent solvents and lab waste would be incinerated, thus eliminating the hazardous constituent. The small amount of solid mixed LLW remaining would increase the amount to be disposed of offsite. The resultant ash would be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations would be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge would be immobilized for disposal and the treated effluent would be discharged through a permitted outfall.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air



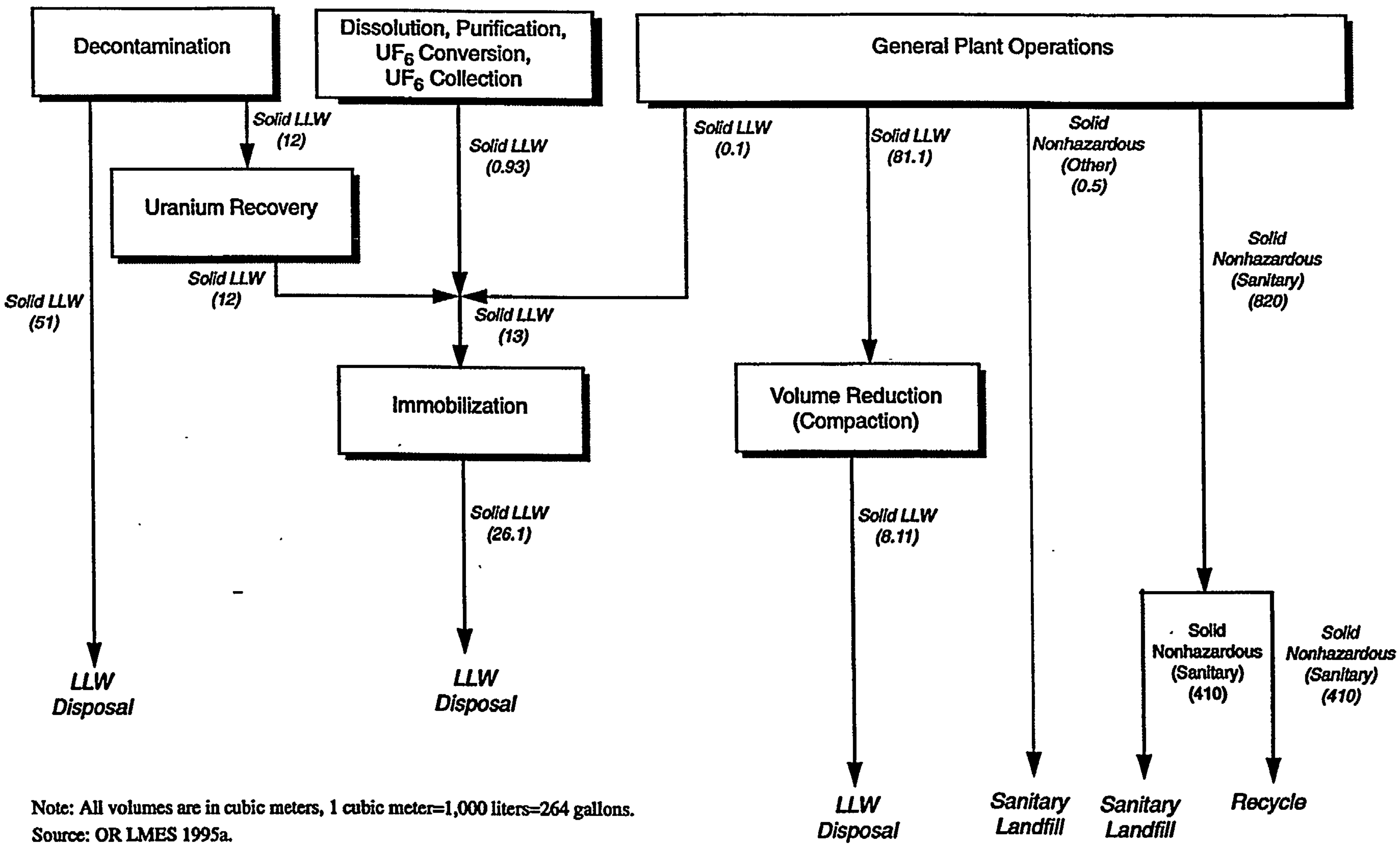
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–1. Radioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995a.

Figure 4.3.2.7–3. Solid Waste Management for Conversion and Blending 10 t/yr of Highly Enriched Uranium to 4-Percent Low-Enriched Uranium as Uranium Hexafluoride.

filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice. Solid and liquid nonhazardous wastes would be generated from the minor building modification activities associated with this blending alternative. Wastes generated during building modification would include concrete and steel construction waste materials and sanitary solids and wastewater. Any steel construction waste would be recycled as scrap material before completing building modification. The remaining nonhazardous wastes generated would be disposed of as part of the building modification project by the contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres).

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the total amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23,700,000 gal/yr); therefore, the facility would be able to handle the 159 m^3/yr (42,000 gal/yr) increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal for processing 10 t/yr HEU would be 89 m^3/yr (3,140 ft^3/yr). This waste would be hauled offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acres/yr) in a disposal facility. Solid LLW generated as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres). The small amount of liquid mixed LLW generated would require some form of treatment. This waste can be treated in the existing LLW treatment facility at B&W. Currently, onsite treatment facilities annually process approximately 55,300 m^3 (1,930,000 gal) of liquid hazardous waste. The increase in liquid hazardous waste generation of 6 m^3/yr (1,590 gal/yr) would not burden this treatment system. The amount of liquid sanitary waste resulting from the blending process would increase by 3 percent over current operations. This could be accommodated in existing facilities, which have a capacity 2.5 times the combined requirement. B&W has current recycling practices that could incorporate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small and the onsite treatment facility has the capacity to handle more than twice the combined volume, which would increase approximately 49 m^3/yr (1,730 ft^3/yr). This action will add 89 m^3/yr (3,140 ft^3/yr) of solid LLW requiring staging and eventual disposal. This waste would be shipped offsite to a disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acre/yr) in a disposal facility. After treatment, solid LLW to be disposed of as a result of processing the entire potentially commercially usable HEU (170 t) would be 1,510 m^3 (53,400 ft^3), which would require a total disposal area of 0.076 ha (0.19 acres). The small amount of liquid mixed LLW generated by this process could be accommodated in the LLW treatment facility at NFS. [Text deleted.] The liquid sanitary waste resulting from the blending process would be discharged to the public treatment works with the rest of the nonhazardous liquid waste. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

4.3.3 TECHNOLOGY AND SITE-SPECIFIC IMPACTS FOR BLENDING HIGHLY ENRICHED URANIUM TO 0.9-PERCENT LOW-ENRICHED URANIUM AS URANYL NITRATE HEXAHYDRATE

Blending surplus HEU to 0.9-percent LEU as UNH involves the same processes described in Section 4.3.1. A significantly smaller quantity of HEU (2.1 t/yr) can be blended annually in producing the 0.9-percent LEU (ratio of HEU to blendstock is 70 to 1) than 4-percent LEU (ratio of HEU to blendstock is 14 to 1). The only differences between blending to 0.9-percent and blending to 4-percent LEU are in the areas of public and occupational health, intersite transportation, and waste management. Specific differences are discussed in the appropriate sections that follow.

4.3.3.1 Site Infrastructure

As shown in Section 2.2.2.1, the annual site infrastructure resources consumed in implementing this blending process are equal to the blending of HEU to 4-percent LEU as UNH except for two resource areas: electricity and natural gas. Annual electricity requirements for blending to 0.9-percent LEU increase by 1,000 megawatt hour (MWh) and the natural gas requirements increase by 2,800 m^3. Site infrastructure resource requirements are the same as those shown in Table 4.3.1.1–1 except electricity requirements are 5,000 MWh/yr and natural gas requirements are 19,800 m^3/yr. The major difference in processing HEU to a waste product versus reactor fuel is in the elimination of the purification process requirements. The elimination of the purification process step results in no effect in the site infrastructure resources. Accordingly, the annual site infrastructure services required to implement this action, along with the associated environmental impacts, will be the same as that presented for the 4-percent LEU blending process described in Section 4.3.1.1.

4.3.3.2 Air Quality and Noise

Operation of facilities to blend HEU to 0.9-percent LEU as UNH would generate criteria and toxic/hazardous pollutants at ORR, SRS, B&W, and NFS. Annual air pollutant emissions resulting from this alternative would be equal to those associated with blending to 4-percent LEU as UNH; therefore, annual air and noise consequences of this alternative action would be the same as the consequences presented previously in Section 4.3.1.2.

4.3.3.3 Water Resources

Operational requirements and discharges for blending HEU to 0.9-percent LEU as UNH would be less than those associated with blending to 4-percent LEU; therefore, environmental consequences of this alternative action would be less than or similar to the consequences presented previously in Section 4.3.1.3.

4.3.3.4 Biotic Resources

Annual operational intake or discharges for blending HEU to 0.9-percent LEU as UNH would be equal to those associated with blending to 4-percent LEU as UNH; therefore, environmental consequences of this alternative action would be equal to the consequences presented previously in Section 4.3.1.4.

4.3.3.5 Socioeconomics

The potential socioeconomic impacts resulting from blending HEU to 0.9-percent LEU as UNH at ORR, SRS, B&W, or NFS would be equal to those associated with blending to 4-percent LEU as UNH, except would continue over a longer period of time. Upgrades to any one of these facilities would be accomplished by the site's existing workforce, and no new jobs would be created. [Text deleted.]

Operation of the proposed blending facility would require 125 employees, the same workforce requirement as for blending HEU to 4-percent LEU as UNH. The activities would generate some minor economic benefits to the affected region.

4.3.3.6 Public and Occupational Health

The radiological releases and their associated impacts resulting from potential accidents involving the HEU blending facility at any of the four sites under consideration would be similar to but not necessarily equal to those associated with blending to 4-percent LEU as UNH. This facility will blend HEU to 0.9-percent LEU in the form of UNH. Summaries of the radiological impacts to the public and workers associated with accidents are presented in Tables 4.3.3.6–1 through 4.3.3.6–4. (Further supplementary information is presented in Appendix E.)

Normal Operation

Radiological Impacts. [Text deleted.] In comparison to annual impacts for blending to 4-percent LEU as UNH, conveyed in Section 4.3.1.6, all annual impacts would be identical both to the public and to workers when blending to 0.9-percent LEU.

Hazardous Chemical Impacts. Hazardous chemical impacts to the public resulting from blending HEU to 0.9-percent LEU as UNH at Y–12, SRS, B&W, and NFS are equal to those presented in Table 4.3.1.6–3 for blending HEU to 4 percent because all incremental and total site HIs and cancer risks are identical.

Facility Accidents

A set of potential accidents has been postulated for which there may be releases of radioactivity and hazardous chemicals that could impact noninvolved onsite workers and the offsite population. A set of accident scenarios was selected to represent bounding cases. In assessing the bounding accident scenarios for the blending facility, the following parameters were evaluated: 1) material at risk, 2) energy sources (for example, fires, explosions, earthquakes, and process design-related events), 3) barriers to release, and 4) protective features of the facility.

Table 4.3.3.6–1. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Y–12

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	11	38	960
Latent cancer fatalities per accident	4.2×10^{-3}	1.5×10^{-2}	0.38
Risk (cancer fatalities per year)	4.2×10^{-6}	1.5×10^{-6}	3.8×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.0×10^{-2}	5.1×10^{-2}	0.94
Latent cancer fatality per accident	5.2×10^{-6}	2.6×10^{-5}	4.7×10^{-4}
Risk (cancer fatality per year)	5.2×10^{-9}	2.6×10^{-9}	4.7×10^{-8}
Population Within 80 km (1,040,000 in 2010)			
Dose (person-rem)	1.5	3	130
Latent cancer fatalities per accident	7.7×10^{-4}	1.5×10^{-3}	6.7×10^{-2}
Risk (cancer fatalities per year)	7.7×10^{-7}	1.5×10^{-7}	6.7×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

Table 4.3.3.6–2. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Savannah River Site

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences			
Noninvolved Workers			
Dose (person-rem)	2.3	8.5	210
Latent cancer fatalities per accident	9.3×10^{-4}	3.4×10^{-3}	8.4×10^{-2}
Risk (cancer fatalities per year)	9.3×10^{-7}	3.4×10^{-7}	8.4×10^{-6}
Maximally Exposed Individual			
Dose (rem)	6.6×10^{-5}	3.0×10^{-4}	5.8×10^{-3}
Latent cancer fatality per accident	3.3×10^{-8}	1.5×10^{-7}	2.9×10^{-6}
Risk (cancer fatality per year)	3.3×10^{-11}	1.5×10^{-11}	2.9×10^{-10}
Population Within 80 km (710,000 in 2010)			
Dose (person-rem)	0.37	0.33	32
Latent cancer fatalities per accident	1.8×10^{-4}	1.6×10^{-4}	1.6×10^{-2}
Risk (cancer fatalities per year)	1.8×10^{-7}	1.6×10^{-8}	1.6×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

Source: Results shown are derived from accident analyses; see Appendix E.5.

The accident scenarios that were considered included a tornado, straight winds, an aircraft crash, a truck crash, nuclear criticality, process-related accidents, and an evaluation basis earthquake. With the exception of the filter fire (with continuous exhaust flow), all of the accident scenarios that are considered potentially bounding can be initiated by the evaluation basis earthquake; therefore, it is concluded that the evaluation basis earthquake would result in the highest atmospheric release of radioactivity and hazardous chemicals. The evaluation basis earthquake is assumed to initiate the nuclear criticality and other release scenarios.

In a filter fire accident, it is assumed that a fire occurs that releases all the uranium in the bag filters, traps, and HEPA filters to the atmosphere in a matter of minutes. The quantity of material assumed to be released is 0.15 kg (0.33 lb) of HEU.

In an earthquake-induced criticality accident, it is assumed that storage racks containing multiple critical masses of uranium powder and uranyl nitrate solution are damaged directly by seismic shaking and indirectly by falling debris. Safe spacing between storage containers is lost and moderators from the fire suppression system are added as water or as organic solutions. This results in the possible formation of one or more critical assemblies. In an accidental criticality, it is assumed that 1.0×10^{19} fissions occur prior to reaching a stable, subcritical condition and that all material releases occur within a 2-hour period (NRC 1979b:3.34-4). The amount of radioactive material released as fission products created by the nuclear criticality is 46,000 Ci of krypton isotopes, 65,000 Ci of xenon isotopes, and 1,600 Ci of iodine isotopes.

In the evaluation basis earthquake accident scenario, it is assumed that the building collapses, resulting in ruptured containers, piping, and tanks releasing uranium solutions, water, toxic gases, flammable gases, and toxic and reactive liquids. This is assumed to result in the release of 0.19 Ci of uranium isotopes (54 percent of the activity is U-234).

The accidents that release radioactivity and their consequences are shown in Tables 4.3.3.6–1 through 4.3.3.6–4. The consequences shown in these tables for

Table 4.3.3.6–3. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Babcock & Wilcox

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3a}	10^{-4b}	10^{-4b}
Consequences[c]			
Noninvolved Workers			
Dose (person-rem)	24	80	2,300
Latent cancer fatalities per accident	9.5×10^{-3}	3.2×10^{-2}	0.91
Risk (cancer fatalities per year)	9.5×10^{-6}	3.2×10^{-6}	9.1×10^{-5}
Maximally Exposed Individual			
Dose (rem)	1.2×10^{-2}	5.6×10^{-2}	1.1
Latent cancer fatality per accident	5.9×10^{-6}	2.8×10^{-5}	5.4×10^{-4}
Risk (cancer fatality per year)	5.9×10^{-9}	2.8×10^{-9}	5.4×10^{-8}
Population Within 80 km (730,000 in 2010)			
Dose (person-rem)	0.9	1.9	79
Latent cancer fatalities per accident	4.5×10^{-4}	9.3×10^{-4}	3.9×10^{-2}
Risk (cancer fatalities per year)	4.5×10^{-7}	9.3×10^{-8}	3.9×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[c] Onsite meteorological data required for MACCS is not available. Therefore, consequences are based on the nearest meteorology data set, Roanoke Airport. The consequences corresponding to onsite meteorology would be approximately two to three times lower than the consequences indicated in this table. Further information is described in Appendix E.5.1.3.

Source: Results shown are derived from accident analyses; see Appendix E.5.

B&W are based on meteorological data for Roanoke Airport (which is located 93 km [61 mi] west of B&W, in an area of more adverse stability), since, unlike Y–12, SRS, and NFS, onsite meteorological data required for MACCS were not available (some meteorological parameters are not monitored at B&W). Therefore, as discussed in Appendix E, Section E.5.1.3, these consequences (as shown in the table) are expected to be approximately two to three times higher than anticipated at B&W under onsite meteorological conditions.

The combined evaluation basis earthquake and earthquake-induced criticality accident release results in the highest consequences. If the combined evaluation basis earthquake and earthquake-induced criticality were to occur, the estimated increase in latent cancer fatalities in the general population within 80 km (50 mi) of each site would range from 1.6×10^{-2} at SRS to 6.9×10^{-2} at Y–12. For the MEI, there would be an increased likelihood of latent cancer fatality ranging from 3.0×10^{-6} at SRS to 5.7×10^{-4} at B&W. Based on the spatial distribution of noninvolved workers located on the site, the estimated number of latent cancer fatalities ranges from 8.4×10^{-2} at NFS to 0.94 at B&W. The accident risks, reflecting both the probability of the accident occurring and the consequences, also are shown in the tables. For the general population, MEI, and noninvolved worker population, the fatal cancer risks range up to 6.9×10^{-6}, 5.7×10^{-8}, and 9.4×10^{-5} per year, respectively.

For SRS the accident analysis was performed for the H-Area. If blending were to occur in the F-Area, the doses from an accidental release would be similar to an accidental release in the H-Area. The dose to the MEI would be slightly larger due to the decreased distance of 9,646 m (31,649 ft) from F-Area to the site boundary. The dose to the offsite population within 80 km (50 mi) would be slightly smaller due to F-Area being farther from the offsite population than H-Area. The dose to the noninvolved workers would be smaller

Table 4.3.3.6–4. Accident Consequences and Risk of Major Accidents for Blending 2.1 t/yr Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate at Nuclear Fuel Services

Accident Description	Filter Fire	Earthquake Induced Criticality	Evaluation Basis Earthquake Scenario
Accident frequency (per year)	10^{-3}[a]	10^{-4}[b]	10^{-4}[b]
Consequences			
Noninvolved Workers			
Dose (person-rem)	1.6	8.7	200
Latent cancer fatalities per accident	6.6×10^{-4}	3.5×10^{-3}	8.0×10^{-2}
Risk (cancer fatalities per year)	6.6×10^{-7}	3.5×10^{-7}	8.0×10^{-6}
Maximally Exposed Individual			
Dose (rem)	2.3×10^{-3}	1.4×10^{-2}	0.23
Latent cancer fatality per accident	1.2×10^{-6}	6.9×10^{-6}	1.2×10^{-4}
Risk (cancer fatality per year)	1.2×10^{-9}	6.9×10^{-10}	1.2×10^{-8}
Population Within 80 km (1,260,000 in 2010)			
Dose (person-rem)	1.3	2.2	110
Latent cancer fatalities per accident	6.4×10^{-4}	1.1×10^{-3}	5.7×10^{-2}
Risk (cancer fatalities per year)	6.4×10^{-7}	1.1×10^{-7}	5.7×10^{-6}

[a] Accident annual frequency estimated in the range of 10^{-4} to 10^{-2}, 10^{-3} chosen for use in comparing alternatives.

[b] Accident annual frequency estimated in the range of 10^{-5} to 10^{-3}, 10^{-4} chosen for use in comparing alternatives. The probability or frequency of a criticality induced by an earthquake would be lower.

[Text deleted.]

Source: Results shown are derived from accident analyses; see Appendix E.5.

due to the smaller workforce in the F-Area. The dose to noninvolved workers in the processing area is the dominant portion of the dose to the total site noninvolved workers. The dose to noninvolved workers not in the processing area would be a minimal effect due to the distance to the other areas.

In addition to the potential impacts to noninvolved workers, there are potential impacts to involved workers, who are located in the facilities analyzed in this EIS. Potential radiological consequences to the involved worker range up to several thousand rem in the case of a criticality. The combined evaluation-basis earthquake and earthquake-induced criticality would probably result in fatal doses to the involved worker. Furthermore, fatalities to the involved workers would be expected as a result of the building collapse (from the earthquake) and the criticality (OR DOE 1994d:6-26,6-27).

The bounding chemical release accident is a spill from HNO_3 and NaOH storage tanks caused by the evaluation basis earthquake. The release point for these accidents is the same as for radiological accidents. The seismic event is assumed to compromise the structural integrity of the curbing around the tank pits such that the two chemicals mix; they would react with sufficient heat generation to result in the airborne release of 13,000 kg (28,700 lb) of unreacted nitric acid. For sufficiently large exposures this could result in irritation to the respiratory system, eyes, skin, and pulmonary edema. If this accident were to occur, the noninvolved worker could be exposed to concentrations in excess of the IDLH level (100 ppm) at Y–12 and B&W and in excess of the TLV-STEL level (4 ppm) at NFS and SRS. The MEI of the public could be exposed to concentrations in excess of the IDLH level at Y–12 and B&W (these levels dissipate below the IDLH level 380 and 180 m [1,250 and 591 ft] downwind, respectively), in excess of the TLV-STEL level at NFS (36 m [118 ft] downwind of the IDLH level), and at levels less than the TLV-TWA level (2 ppm) at SRS. (See Section 4.1.9 for a discussion of the significance of these levels.)

The SRS IMNM EIS also considers facility accidents that are related to those in this EIS. A comparison between the accident analysis in the SRS IMNM EIS and the HEU EIS is contained in Section 4.3.1.6.

4.3.3.7 Waste Management

The process of blending HEU as uranyl nitrate to 0.9-percent LEU for disposal as waste is bounded for this analysis by the throughput capacity of process facilities at Y–12, which assumes processing 8.4 t/yr of uranium-aluminum (U/Al) alloy, at 25 percent HEU. At a dilution ratio of 70 to 1, the resulting waste product would contain 149 t of LEU at 0.9 percent U-235 in a U/Al oxide mixture, resulting in approximately 177 t waste product for disposal.

There is no spent nuclear fuel, HLW, or TRU waste associated with blending to LLW as UNH; however, generation of low-level, mixed low-level, hazardous, and nonhazardous wastes would increase. This section summarizes the potential impacts on waste management activities at each site resulting from the blending of HEU to approximately 0.9-percent LEU as UNH crystals.

The blending process would result in an increased generation of low-level, mixed low-level, hazardous, and nonhazardous wastes, which are shown in Table 2.2.2.1–2. Table 4.3.3.7–1 provides the sitewide waste generation resulting from the blending process. At each facility considered for the blending process, the generation of wastes would be analyzed against ALARA principles. Table 2.2.2.1–2 also provides the resultant waste volume after treatment (effluent) using a proposed treatment scheme as outlined in Figures 4.3.3.7–1 to 4.3.3.7–3. Liquid LLW from decontamination could go through a uranium recovery process first. The liquid effluent would then go to a radioactive wastewater treatment facility. The resultant sludge could be immobilized for disposal as solid LLW and the treated effluent would be discharged through a permitted outfall. Solid LLW generated by the blending process would consist of lab wastes, decontamination solids, scrapped equipment, air sampling filters, HEPA filters, and miscellaneous contaminated solids. Decontaminated solids could go through a uranium recovery process before being packaged for disposal. All other solid LLW could be compacted and immobilized as appropriate to meet the waste acceptance criteria of an onsite or offsite LLW disposal facility. The solid LLW radiological content would include U-232, U-234, U-235, U-236, and U-238. Liquid mixed LLW consisting of spent solvents and lab waste could be incinerated, thus eliminating the hazardous constituent. The resultant ash could be immobilized and packaged for disposal as solid LLW. The sump collection wastes from general plant operations could be precipitated and filtered in a radioactive liquid waste treatment facility. The resultant sludge could be immobilized for disposal and the treated effluent could be discharged through a permitted outfall. Other solid mixed LLW would consist of contaminated gloves and wipes. After compaction, they could be packaged for storage until a sufficient volume had accumulated for disposal in an offsite RCRA-permitted facility.

Liquid hazardous waste consisting of liquid waste treatment excess/flush water and chemical spillage would be treated onsite by distillation, evaporation, neutralization, and ammonia removal. The treated effluent would be discharged through a permitted outfall. Liquid nonhazardous waste such as sewage wastewater would be treated and disposed of using current site practices and facilities. Solid nonhazardous waste would primarily consist of solid sanitary waste, trash, waste paper, scrap metal, air filters, personnel respirators, plastic bags, and gloves. Nonrecyclable portions of this waste would be disposed of in a permitted landfill per site practice.

The wastes quantified in Table 2.2.2.1–2 result only from the process of blending 2.1 t of HEU per year to 0.9-percent LEU as UNH. The end product from this process will be an LEU waste that may be staged temporarily at SRS or ORR in existing facilities until there is sufficient quantity for cost-effective shipment to the disposal site(s). The blending process of 2.1 t of HEU will result in 177 t of LEU waste per year. Assuming a loading of a 90-kg/55-gal (0.208 m^3) drum, it can be determined that this blending process will result in approximately 409 m^3 (14,400 ft^3) of LEU "end product" waste per year. In a DOE LLW disposal facility, this waste would require from 0.05 to 0.12 ha (0.12 to 0.31 acre) of space per year, based on usage factors for DOE facilities that range from 3,300 to 8,600 m^3/ha (47,200 to 123,000 ft^3/acre), respectively.

The following discussions for each site considered for this blending process present analyses for the wastes

Table 4.3.3.7–1. Estimated Annual Generated Waste Volumes for Blending 2.1 t/yr Highly Enriched Uranium as Uranyl Nitrate to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate

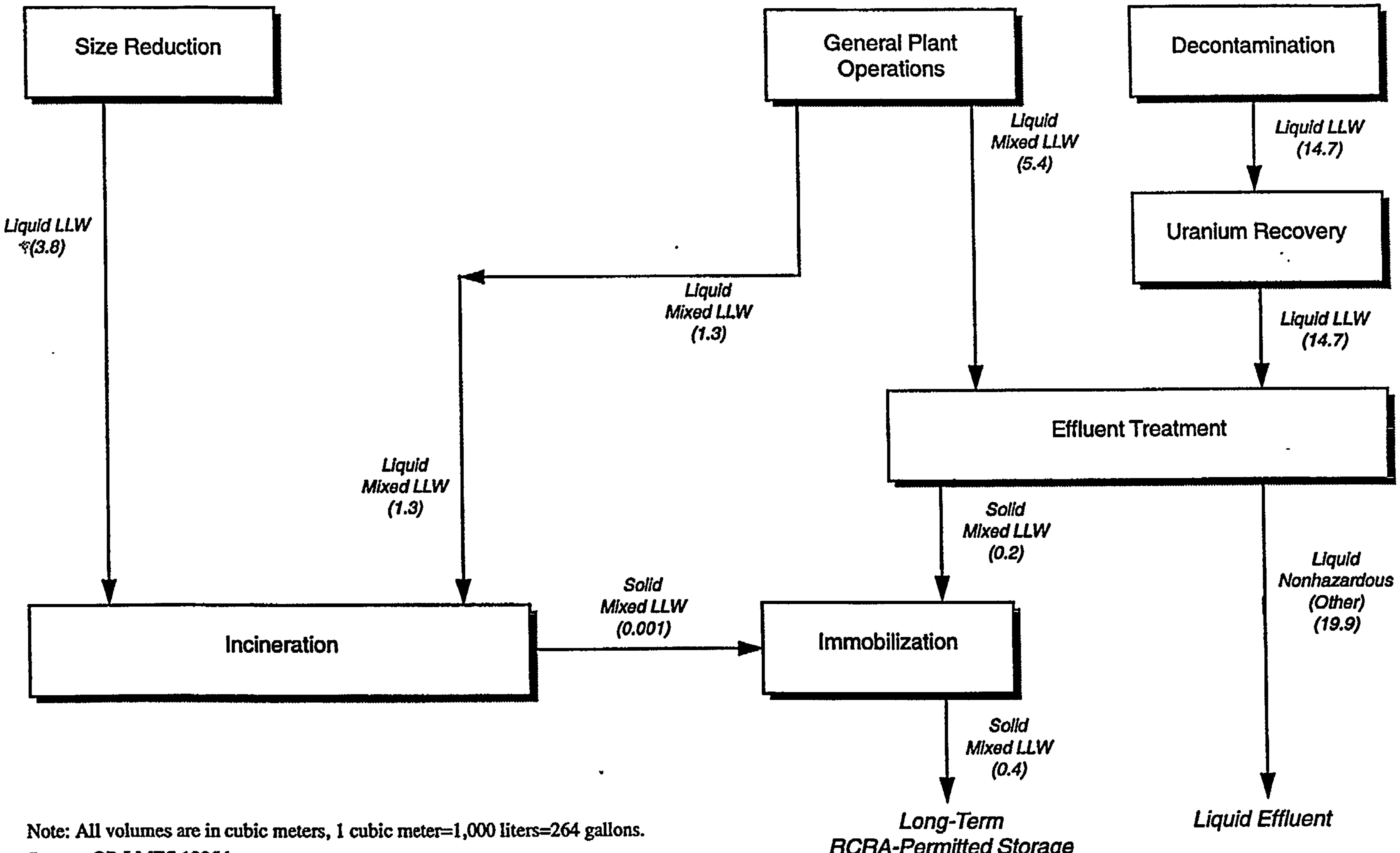
	ORR[a]			SRS[b]			B&W			NFS		
Waste Category	**No Action (m^3)**	**With UNH Blending (m^3)**	**Increase (Percent)**	**No Action (m^3)**	**With UNH Blending (m^3)**	**Increase (Percent)**	**No Action (m^3)**	**With UNH Blending (m^3)**	**Increase (Percent)**	**No Action (m^3)**	**With UNH Blending (m^3)**	**Increase (Percent)**
Low-Level												
Liquid	2,576	2,595	<1	0	19	>100	50,005	50,024	<1	18,900	18,919	<1
Solid	8,030	8,099	<1	14,100	14,169	<1	620	689	11	3,000	3,069	2
Mixed Low-Level												
Liquid	84,210	84,217	<1	115	122	6	0	7	>100	<1	7	>100
Solid	960	960	0	18	18	0	14	14	0	<1	<1	0
Hazardous												
Liquid	32,640	32,651	<1	Included in solid	11	NA	55,115	55,126	<1	<1	11	>100
Solid	1,434	1,434	0	74	74	0	0	0	0	<1	<1	0
Nonhazardous												
Liquid	1,743,000	1,761,763	1	700,000	718,763	3	576,160	594,893	3	56,700	75,463	33
Solid	52,730	53,550	2	6,670	7,490	12	1,700	2,520	48	2,300	3,120	36

[a] 1993 Generation. Generation rates represent sum of activities at K–25, ORNL, and Y–12.

[b] 1993 Generation. Nonhazardous waste category is 1991 Generation.

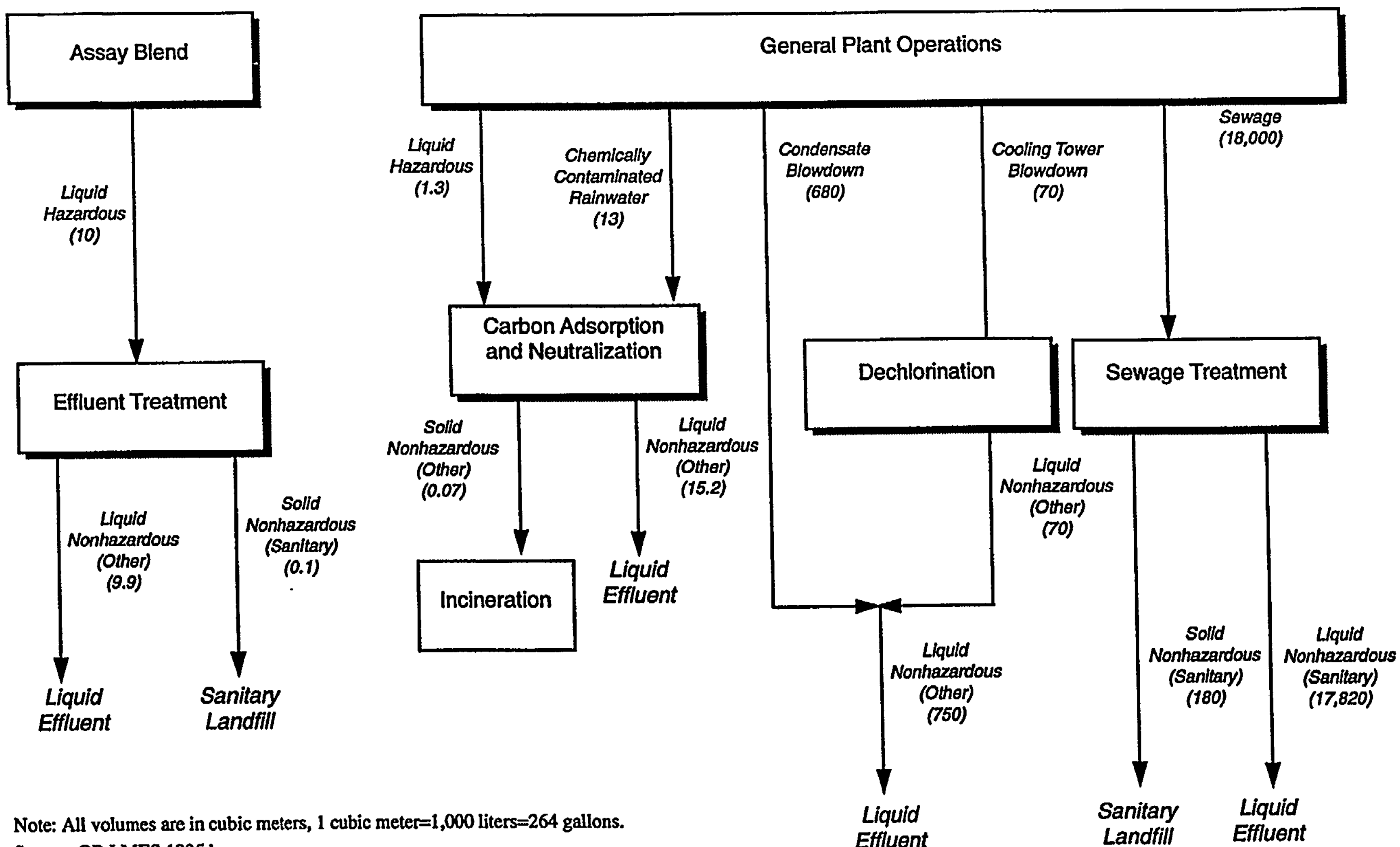
Note: NA=not applicable.

Source: BW 1995b:1; BW NRC 1991a; BW NRC 1995a; NF NRC 1991a; NFS 1995b:2; OR LMES 1995d, Tables 3.3.10–1, 3.3.10–2, 3.3.10–3, and 3.4.10–1.



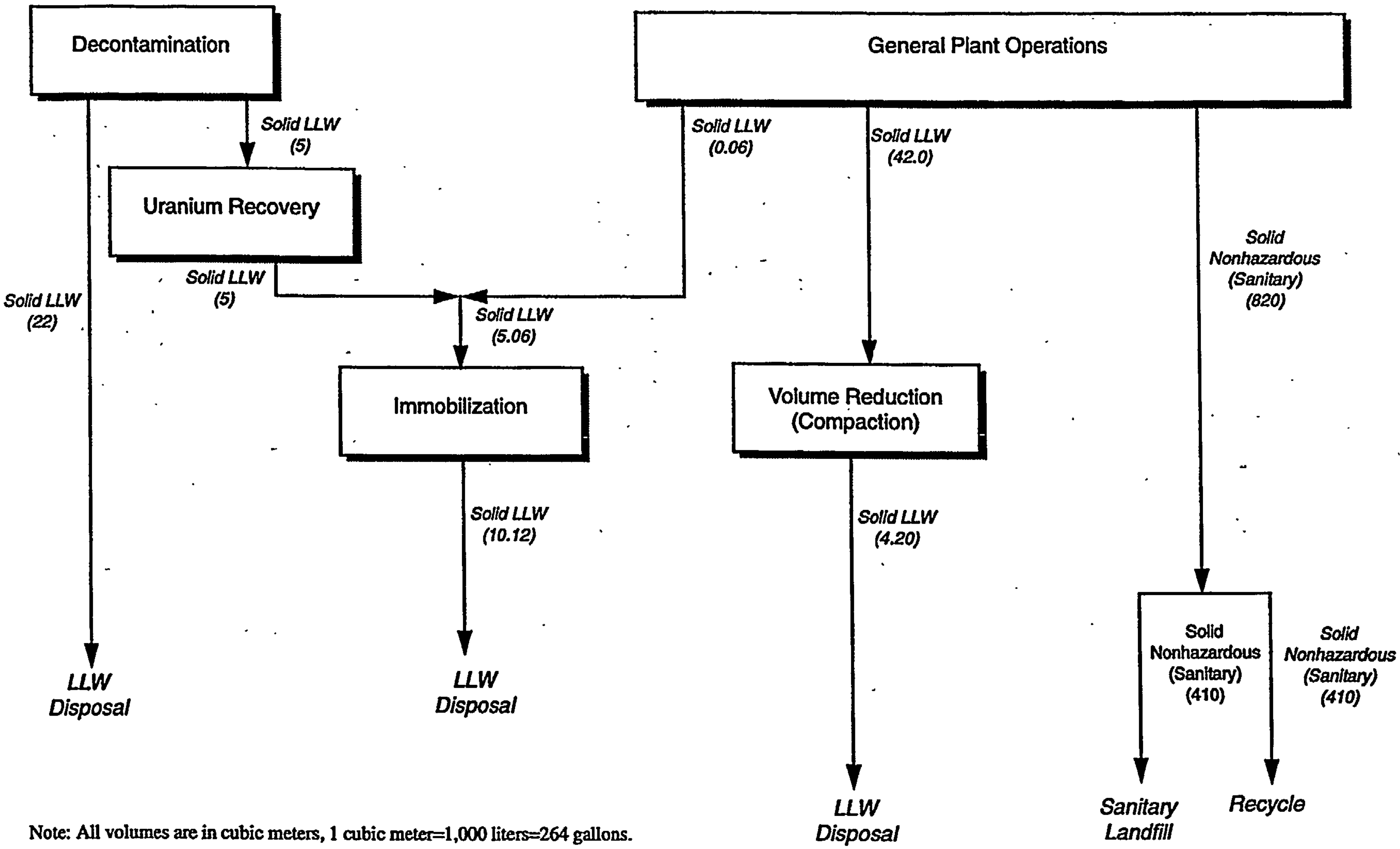
Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–1. Radioactive Liquid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–2. Nonradioactive Liquid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.



Note: All volumes are in cubic meters, 1 cubic meter=1,000 liters=264 gallons.
Source: OR LMES 1995d.

Figure 4.3.3.7–3. Solid Waste Management for Conversion and Blending 2.1 t/yr of Highly Enriched Uranium to 0.9-Percent Low-Enriched Uranium as Uranyl Nitrate Hexahydrate.

generated by the blending process and not the ultimate management of the waste end product. The annual and total quantities of LEU "end product" (as LLW) for disposal and transportation related to this LLW are discussed in section 4.4 and 4.5. Depending on the alternative, the total amount of HEU that would be potentially not commercially usable could vary between 30 t (15 percent of surplus inventory) and 200 t (100 percent of surplus inventory), as stated in Chapter 2. Multiple sites and blending processes would be used under all alternatives (except no action) for blending the entire surplus inventory to LLW, as explained in Chapter 2.

Oak Ridge Reservation. Current waste generation rates and treatment, storage, and disposal capacities are presented for ORR in Tables 3.3.10–1 through 3.3.10–3. These tables indicate that liquid and solid LLW treatment facilities at ORR would not be greatly affected due to this action. The liquid LLW treatment facility at ORR has the capacity to treat the increase in liquid LLW generated. Solid LLW generated at ORR would be compacted, smelted, and incinerated offsite and then stored onsite pending the completion of a proposed LLW Class II facility that is due to be operational in 2002. The amount of solid LLW generated by this action that would eventually be transferred to the LLW disposal facility would be 36 m^3/yr (1,271 ft^3/yr). Assuming a usage factor of 3,300 m^3/ha (OR DOE 1995e:1), this waste will require 0.01 ha/yr (0.28 acres/yr) in the new LLW Class II facility. The small increase in liquid mixed LLW could be handled by the onsite mixed LLW treatment facility. Adequate staging capacity is also available to incorporate the amount of solid mixed LLW from the treatment of the liquid mixed LLW. The onsite hazardous waste treatment facility has the capacity to accommodate the less than 1-percent increase in the amount of hazardous liquid waste produced by the blending process. This action would increase the liquid sanitary waste generation to 1,762,000 m^3/yr (465 MGY). The onsite facilities have a capacity of 4,930,000 m^3/yr (1,300 MGY), so the increase is within facility capacity. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated by the site's current recycling practices.

Savannah River Site. Current waste generation rates and treatment, storage, and disposal capacities are presented for SRS in Table 3.4.10–1. These tables indicate that liquid and solid LLW treatment facilities at SRS would not be greatly impacted due to this action. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site, and the onsite treatment facility has the capacity to accommodate the increase. There would be 36 m^3 (1,271 ft^3) of solid LLW generated per year resulting from liquid and solid LLW treatment that would require staging and/or disposal. Assuming a usage factor of 8,600 m^3/ha, the increase in the amount of solid LLW would require 0.004 ha/yr (0.01 acre/yr) in the onsite LLW disposal facility. The onsite mixed LLW treatment facility has the capacity to incorporate the less than 1-percent increase in the amount of mixed LLW generated by the blending process. Currently, the site incorporates liquid hazardous waste into the solid hazardous waste treatment system. The capacity exists to treat 2,000 m^3/yr (528,000 gal/yr) of liquid hazardous waste at SRS; therefore, the increase of 11 m^3/yr (2,900 gal/yr) will not burden existing systems. A 3-percent increase in the amount of liquid nonhazardous waste would result at SRS if this action were implemented. This increase would not burden onsite facilities. The increase in solid sanitary waste would not greatly reduce the design life of the onsite landfill. The nonhazardous recyclable solid wastes generated by this process could be easily accommodated by the site's current recycling practices.

Babcock & Wilcox. The B&W site has facilities for treating liquid LLW, hazardous waste, and sanitary waste. The amount of liquid LLW generated per year by this action is small compared with the amount of liquid LLW generated yearly at the site. The onsite treatment facility for liquid LLW at B&W has a capacity to treat approximately 89,800 m^3/yr (23,700,000 gal/yr); therefore, B&W would be able to handle the increase in liquid LLW generated (BW NRC 1991a:13). When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 36 m^3/yr (1,271 ft^3/yr). This waste would be hauled offsite to a licensed disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), this waste would require 0.002 ha/yr (0.0005 acre/yr) in a commercial licensed disposal facility. The small amount of liquid mixed LLW generated could be accommodated in the liquid LLW treatment facility. Currently, onsite treatment facilities process approximately 55,300 m^3 (14,600,000 gal) of liquid hazardous waste per year. The increase in liquid hazardous waste generation of 11 m^3 (2,900 gal/yr) should not burden this treatment system. The amount of liquid nonhazardous waste resulting from the blending process would increase by 29 percent over current operations. This could be accommodated in existing facilities, which have a capacity of 2.5 times the combined requirement. B&W has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.

Nuclear Fuel Services. The NFS site has facilities for treating LLW, hazardous waste, and process waste. The amount of liquid LLW generated per year by this action can be accommodated onsite in the LLW treatment facility that has a capacity of 38,700 m^3/yr. When this process is complete, the amount of solid LLW requiring staging and eventual disposal would be 36 m^3/yr (1,271 ft^3/yr). This waste would be shipped offsite to a licensed disposal facility. Assuming a usage factor of 20,000 m^3/ha (286,000 ft^3/acre), this waste would require 0.002 ha/yr (0.005 acre/yr) in a commercial licensed disposal facility. [Text deleted.] The amount of liquid nonhazardous waste resulting from the blending process would increase by 33 percent from current operations. The increase results in a combined effluent that is within the capacity of the POTW where it is processed. NFS has current recycling practices that could accommodate the increased amount of recyclable nonhazardous waste resulting from this action.