IV. Proposed MOX Fuel Irradiation Program

Under the mixed oxide (MOX) fuel approach being considered in the Surplus Plutonium Disposition Environmental Impact Statement *(SPD EIS), three reactor sites with a total of six reactors are now being considered for MOX fuel irradiation. The proposed action under the MOX approach is to use these reactors to irradiate MOX fuel. The cores of these reactors will be partially fueled (i.e., up to 40 percent) with MOX fuel and the MOX fuel will run through a normal fuel cycle. This section provides a description of the affected environment around the three proposed reactor sites. It will be included in the SPD Final EIS as Section 3.7.*

3.7 REACTOR SITES FOR MOX FUEL IRRADIATION

3.7.1 Catawba Units 1 and 2 Site Overview

The Catawba nuclear power plant occupies 158 ha (391 acres) in York County, South Carolina, 9.3 km (5.8 mi) north-northwest of Rock Hill, South Carolina, and 16.9 km (10.5 mi) west-southwest of Charlotte, North Carolina (see Figure 3.7–1). The site is on a peninsula bounded by Beaver Dam Creek to the north, Big Allison Creek to the south, Lake Wylie to the east, and private property to the west (Duke Power 1997:2-3). Lake Wylie has a surfaçe area of 5,040 ha (12,455 acres), a shoreline of approximately 523 km (325 mi), and a volume of 3.46×10^8 m^3 (281,900 acre-ft). The towns of Mount Holly and Belmont, North Carolina, take their raw water supplies from Lake Wylie. The communities of Chester, Fort Lawn, Fort Mill, Great Falls, Lancaster, Mitford, Riverview, and Rock Hill, South Carolina, obtain at least a portion of their municipal water supplies from the Catawba River within 80 km (50 mi) downstream from the site (Duke Power 1997:2-41, table 2-52).

In 1997, the plant employed 1,232 persons (DOE 1999). The Catawba reactors are operated by Duke Power Company. The operating licenses (Nos. NPF–35 and NPF–52) for Units 1 and 2 were granted in 1985 and 1986 and expire in 2024 and 2026, respectively (NRC 1991:vol. 1, 2-2; 1997). The population within an 80-km (50-mi) radius of these reactors is estimated to be 1,656,093 (Duke Power 1997:table 2-13).

Reactor cooling is accomplished using mechanical draft cooling towers, with water obtained from Lake Wylie (Duke Power 1997). During normal operations of Catawba, cooling water is pumped from the Beaver Dam Creek arm of Lake Wylie at a rate of 266,680 million l/yr (70,450 million gal/yr) and returned to Big Allison Creek at a rate of 172,902 million l/yr (45,676 million gal/yr). The net difference in water (93,779 million l/yr [24,774 million gal/yr]) is due to evaporation in the cooling towers (DOE 1999).

New (unirradiated) fuel assemblies are dry stored in racks located in the two New Fuel Storage Buildings. Each New Fuel Storage Building is designed to accommodate 98 fuel assemblies (a total of 196 assemblies). Spent (irradiated) fuel assemblies are stored in two spent fuel pools in the two fuel buildings. The spent fuel storage pools have a total capacity of 2,836 assemblies (Duke Power 1997:9-3–9-6). Security at the site is provided in accordance with U.S. Nuclear Regulatory Commission (NRC) regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–413 and 50–414.

3.7.1.1 Air Quality

Catawba is within the Metropolitan Charlotte, North Carolina, Air Quality Control Region (AQCR) #167. None of the areas within the site or York County are designated as nonattainment areas with respect to the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (EPA 1998a).

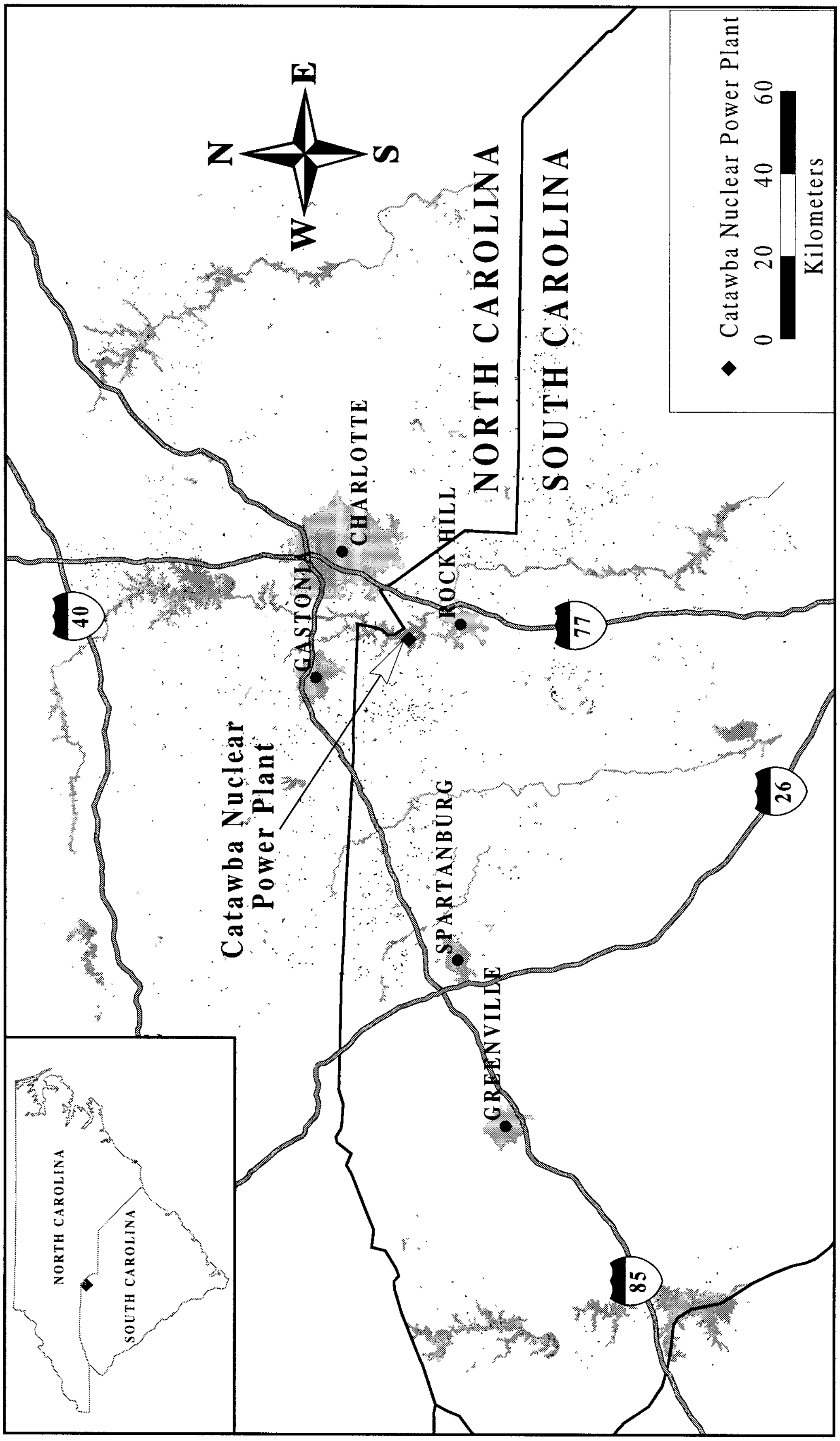

Figure 3.7–1. Catawba Nuclear Power Plant, South Carolina

Sources of criteria air pollutants from Catawba include five emergency diesel generators, a safe shutdown facility generator, and miscellaneous equipment such as trucks and forklifts. Table 3.7–1 provides a summary of criteria pollutant concentrations from operations of Catawba. The concentrations resulting from operations are well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

Table 3.7–1. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From Catawba Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)	Catawba ($\mu g/m^3$)
Carbon monoxide	8 hours	10,000	978
	1 hour	40,000	1,400
Nitrogen dioxide	Annual	100	3.26
PM_{10}	Annual	50	0.02
	24 hours	150	65.9
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0418
	24 hours	365	26.9
	3 hours	1,300	60.4

[a] No data is available with which to assess $PM_{2.5}$ concentrations.
Key: NAAQS, National Ambient Air Quality Standards.
Note: Based on 1994–1995 emissions data for diesel generators.
Source: Modeled concentrations based on DOE 1999; EPA 1997.

3.7.1.2 Waste Management

Table 3.7–2 presents the 5-year average annual waste generation rates for Catawba.

Table 3.7–2. Annual Waste Generation for Catawba (m^3)

Waste Type	Generation Rate
LLW	50
Mixed LLW	0.6[a]
Hazardous waste	29[a]
Nonhazardous waste	
Liquid	60,794[b]
Solid	909[a]

[a] Values converted from kilograms assuming a waste density such that 1 m^3 = 1,000 kg.
[b] Assuming sanitary wastewater is generated at the same rate 365 days per year.
Key: LLW, low-level waste.
Source: DOE 1999.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the steam generator blowdown system, ventilation unit condensate system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, and laundry drains. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the National Pollutant Discharge Elimination System (NPDES) permit. If liquids are determined to be radioactively contaminated, they are treated by filtration, evaporation, or mixing and settling, or are sent to the demineralizers, before being discharged. Continuous radiation monitoring is provided for treated liquid waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Duke Power 1997:11-9–11-27).

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite licensed treatment and disposal facilities. Radioactive solid waste may include evaporator concentrates, spent demineralizer resins, spent filters, laboratory wastes, rags, gloves, boots, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Treatment on the site may include dewatering and compaction, or solidification using a contractor-supplied mobile unit. Materials that are compressible are placed in 208-l (55-gal) drums for compaction. Spent radioactive filter cartridges are packaged in either 114-l (30-gal) or 208-l (55-gal) drums. Packaged wastes are stored in the filter cartridge storage bunker, low-activity-waste storage room, high-activity-waste storage room, solidification area, and waste shipping area before being shipped to an offsite treatment or disposal facility (Duke Power 1997:11-53–11-61).

The small quantities of mixed low-level waste (LLW) and hazardous waste generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is treated in the onsite sanitary wastewater treatment facility and then discharged to Lake Wylie (SCDHEC 1997:6).

3.7.1.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of Catawba are shown in Table 3.7–3. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3.7–4. These doses fall within regulatory limits and are small when compared with background exposure.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancers per person-rem) to the public, the latent cancer fatality (LCF) risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 1.7×10^{-8}. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of normal reactor operations is about 1 chance in 60 million.

Table 3.7–3. Sources of Radiation Exposure to Individuals in the Vicinity Unrelated to Catawba Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Table 3.7–4. Radiological Impacts on the Public From Operations of Catawba in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	5	0.045	3	0.11	25	0.16
Population within 80 km (person-rem)[b]	None	4.0	None	4.3	None	8.3

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for the maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.
[b] Population used: 1,656,093; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997.
Source: DOE 1999; Duke Power 1997:tables 2-13, 11-12, and 11-15.

Based on the same risk estimator, 0.0042 excess LCFs are projected among the population living within 80 km (50 mi) of Catawba in 1997. For perspective, 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 population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of Catawba was about 3,300. This number of expected fatal cancers is much higher than the estimated 0.0042 LCFs that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public; however, they receive an additional dose from normal operations of the reactors. Table 3.7–5 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancers per person-rem) among workers, the number of LCFs to reactor workers from 1997 normal operations is estimated to be 0.11.

3.7.1.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole

Table 3.7–5. Radiological Impacts on Involved Workers From Operations of Catawba in 1997

Number of badged workers[a]	420
Total dose (person-rem/yr)	265
Annual latent fatal cancers	0.11
Average worker dose (mrem/yr)	78
Annual risk of latent fatal cancer	3.1×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.
Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.
Source: DOE 1999.

in the potentially affected area. In the case of Catawba, the potentially affected area includes parts of North Carolina and South Carolina.

The potentially affected area around Catawba is defined by a circle with an 80-km (50-mi) radius centered at these reactors (lat. 35°03′05″ N, long. 81°04′10″ W). The total population residing within that area in 1990 was 1,519,392. The proportion of the population that was considered minority was 20.7 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages of the States of North Carolina and South Carolina were 25.0 and 31.5, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 19.0 percent of the total population. Asians and Hispanics contributed about 0.7 percent, and Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 159,596 persons (10.5 percent of the total population) residing within the potentially affected area around Catawba reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold and that the figures for North Carolina and South Carolina were 13.0 and 15.4 percent, respectively (DOC 1992).

3.7.2 McGuire Units 1 and 2 Site Overview

The McGuire nuclear power plant occupies 12,000 ha (30,000 acres) in northwestern Mecklenburg County, North Carolina, 27.4 km (17 mi) northwest of Charlotte, North Carolina (see Figure 3.7–2). The site is bounded to the west by the Catawba River and to the north by Lake Norman. Surrounding land is generally rural nonfarmland. Lake Norman, with a surface area of 13,156 ha (32,510 acres), a volume of 1,349 million m^3 (1,093,600 acre-ft) and a shoreline of 837 km (520 mi), stretches 54.7 km (34 mi) from Cowans Ford Dam to the tailrace of Lookout Lake. The Charlotte municipal water intake is 18 km (11.2 mi) downstream from the site (Duke Power 1996:2-3, 2-27, 2-28). In addition, the communities of Belmont, Gastonia, and Mount Holly, North Carolina, and Chester, Fort Lawn, Fort Mill, Lancaster, Mitford, Riverview, and Rock Hill, South Carolina, obtain at least a portion of their municipal water supplies from the Catawba River within 80 km (50 mi) downstream from the site (Duke Power 1997:2-41, table 2-52).

In 1997, the plant employed 1,238 persons (DOE 1999). The McGuire reactors are operated by Duke Power Company. The operating licenses (Nos. NPF–9 and NPF–17) for these reactors were granted in 1981 and 1983, and expire in 2021 and 2023, respectively (NRC 1991:vol. 1, 2-2; 1997). The population within an 80-km

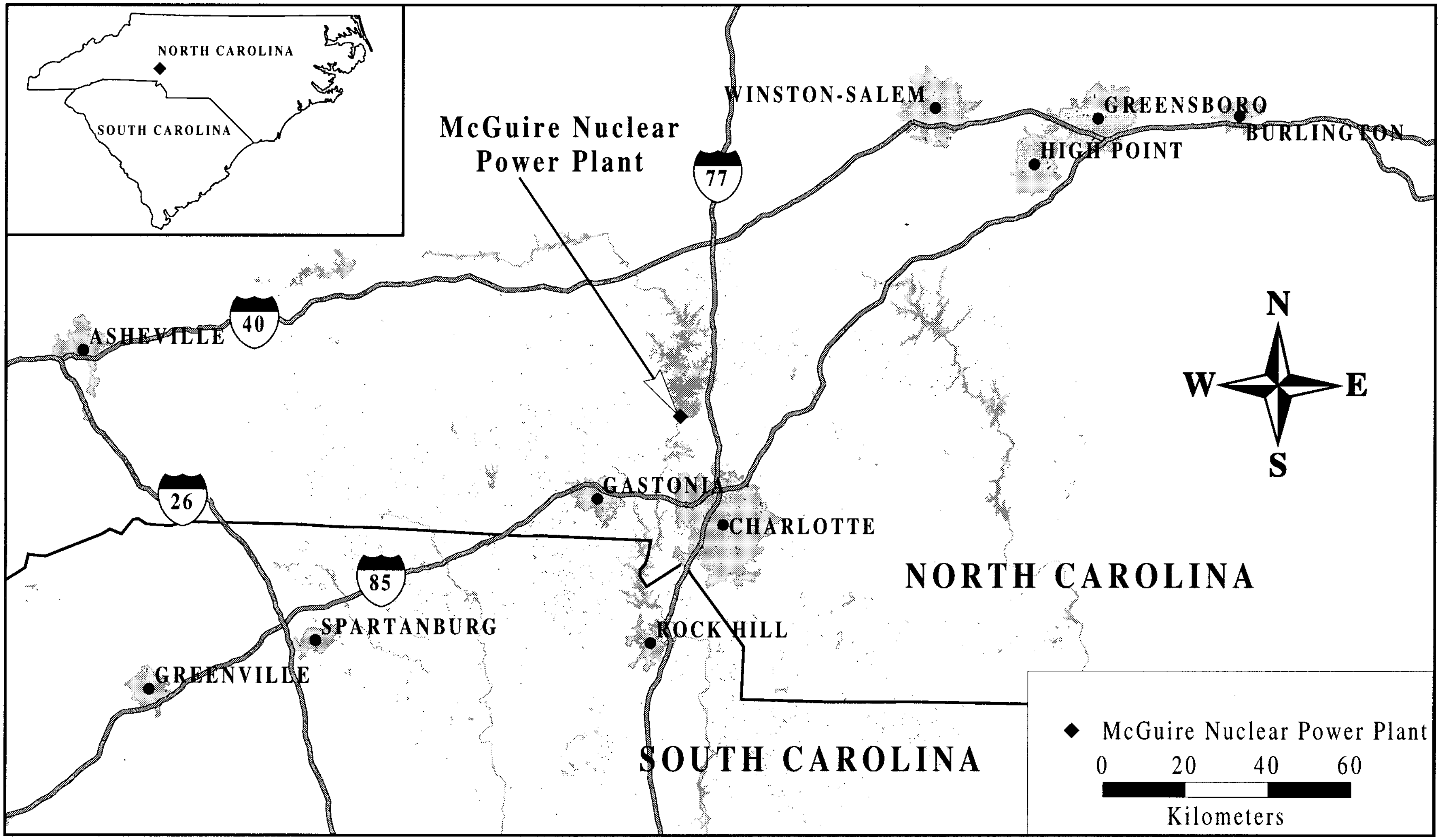

Figure 3.7–2. McGuire Nuclear Power Plant, North Carolina

(50-mi) radius of these reactors is estimated to be 2,140,720 (Duke Power 1996:table 2-1). Reactor cooling is accomplished using a once-through cooling system. Cooling water is withdrawn from Lake Norman at a rate of 3,512,969 million l/yr (928,031 million gal/yr) and discharged back into Lake Norman at a rate of 3,483,283 million l/yr (920,189 million gal/yr). The net difference in water (29,685 million l/yr [7,842 million gal/yr]) is due to evaporation (DOE 1999).

New (unirradiated) fuel assemblies are dry stored in racks located in the two New Fuel Storage Vaults. Each New Fuel Storage Vault is designed to accommodate 96 fuel assemblies (a total of 192 assemblies). Spent (irradiated) fuel assemblies are stored in two spent fuel pools in the two Auxiliary Buildings. The two spent fuel storage pools have a total capacity of 2,926 assemblies. New fuel can also be stored in the spent fuel pools (Duke Power 1996:9-3–9-8). Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–369 and 50–370.

3.7.2.1 Air Quality

McGuire is within the Metropolitan Charlotte AQCR #167. None of the areas within the site or Mecklenberg County are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1998b).

Sources of criteria air pollutants from McGuire include five emergency diesel generators, a safe shutdown facility generator, and miscellaneous equipment such as trucks and forklifts. Table 3.7–6 provides a summary of criteria pollutant concentrations from operations of McGuire. The concentrations resulting from operations are well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

Table 3.7–6. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From McGuire Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)	McGuire ($\mu g/m^3$)
Carbon monoxide	8 hours	10,000	1,060
	1 hour	40,000	1,510
Nitrogen dioxide	Annual	100	2.55
PM_{10}	Annual	50	0.0799
	24 hours	150	71.2
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0336
	24 hours	365	29.9
	3 hours	1,300	67.4

[a] No data is available with which to assess $PM_{2.5}$ concentrations.
Key: NAAQS, National Ambient Air Quality Standards.
Note: Based on 1994–1997 emissions data for diesel generators.
Source: Modeled concentrations based on DOE 1999; EPA 1997.

3.7.2.2 Waste Management

Table 3.7–7 presents the 5-year average annual waste generation rates for McGuire.

Table 3.7–7. Annual Waste Generation for McGuire (m^3)

Waste Type	Generation Rate
LLW	42.2
Mixed LLW	0.18[a]
Hazardous waste	28.6[a]
Nonhazardous waste	
Liquid	49,740[b]
Solid	1,136[a]

[a] Values converted from kilograms assuming a waste density such that 1 m^3 = 1,000 kg.
[b] Assuming sanitary wastewater is generated at the same rate 365 days per year.
Key: LLW, low-level waste.
Source: DOE 1999.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the steam generator blowdown system, ventilation unit condensate system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, and laundry drains. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the NPDES permit. If liquids are determined to be radioactively contaminated, they are treated by filtration, evaporation, or mixing and settling, or are sent to the demineralizers, before being discharged. Continuous radiation monitoring is provided for treated waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Duke Power 1996:11-9–11-26).

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite licensed treatment and disposal facilities. Radioactive solid waste may include evaporator concentrates, spent demineralizer resins, spent filters, laboratory wastes, contaminated oils, rags, gloves, boots, sweepings, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Treatment on the site may include dewatering, or solidification using a contractor-supplied mobile unit. Low-activity solid wastes, such as rags, clothing, and sweepings, are loaded directly into storage containers for shipment to an offsite treatment or disposal facility. Spent radioactive filter cartridges are packaged in drums or other waste containers, with spent resin solidified, if required. The disposal of slightly contaminated sludge from the wastewater treatment plant is carried out by landspreading the sludge on a site continguous to McGuire using a method approved by the State of North Carolina and NRC. Packaged wastes are stored in the filter storage bunker, solidified liner storage bunker, and the shielded storage bunker before being shipped to an offsite treatment or disposal facility (Duke Power 1996:11-49–11-56).

The small quantities of mixed LLW and hazardous waste generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is discharged to the Charlotte Mecklenburg Utility Department sanitary sewer system (Duke Power 1994).

3.7.2.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of McGuire are shown in Table 3.7–8. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Table 3.7–8. Sources of Radiation Exposure to Individuals in the Vicinity Unrelated to McGuire Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3.7–9. These doses fall within regulatory limits and are small when compared with background exposure.

Table 3.7–9. Radiological Impacts on the Public From Operations of McGuire in 1997 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	5	0.033	3	0.065	25	0.098
Population within 80 km (person-rem)[b]	None	2.8	None	93	None	96

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.
[b] Population used: 2,140,720; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997.
Source: DOE 1999; Duke Power 1974:5.3-7, table 5.3.5-1; 1996:table 2-1.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancers per person-rem) to the public, the LCF risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 4.9×10^{-8}. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of normal reactor operations is about 1 chance in 20 million.

Based on the same risk estimator, 0.048 excess LCFs are projected among the population living within 80 km (50 mi) of McGuire in 1997. For perspective, 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 population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of McGuire was about 4,280. This number of expected fatal cancers is much higher than the estimated 0.048 LCFs that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public; however, they receive an additional dose from normal operations of the reactors. Table 3.7–10 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancers per person-rem) among workers, the number of LCFs to reactor workers from 1997 normal operations is estimated to be 0.20.

Table 3.7–10. Radiological Impacts on Involved Workers From Operations of McGuire in 1997

Number of badged workers[a]	3992
Total dose (person-rem/yr)	492
Annual latent fatal cancers	0.20
Average worker dose (mrem/yr)	123
Annual risk of latent fatal cancer	4.9×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.
Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.
Source: DOE 1999.

3.7.2.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of McGuire, the potentially affected area includes parts of North Carolina and South Carolina.

The potentially affected area around McGuire is defined by a circle with an 80-km (50-mi) radius centered at these reactors (lat. 35°25′59″ N, long. 80°56′55″ W). The total population residing within that area in 1990 was 1,738,966. The proportion of the population that was considered minority was 17.8 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages of the States of North and South Carolina were 25.0 and 31.5, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 15.9 percent of the total population. Hispanics and Asians contributed about 0.7 percent, and Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 170,956 persons (9.8 percent of the total population) residing within the potentially affected area around McGuire reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that the figures for North Carolina and South Carolina were 13.0 and 15.4 percent, respectively (DOC 1992).

3.7.3 North Anna Units 1 and 2 Site Overview

The North Anna nuclear power plant occupies 422 ha (1,043 acres) in Louisa County, Virginia, approximately 64.4 km (40 mi) north-northwest of Richmond, Virginia, and 113 km (70 mi) southwest of Washington, D.C. (see Figure 3.7–3). The largest community within 16 km (10 mi) of the site is the town of Mineral in Louisa County. The site is on a peninsula on the southern shore of Lake Anna. Lake Anna is approximately 27.4 km (17 mi) long, with a surface area of 5,260 ha (13,000 acres) and 322 km (200 mi) of shoreline. The reservoir contains approximately 380 billion l (100 billion gal) of water (Virginia Power 1998:2.1-1, 2.1-2).

In 1997, the plant employed 552 persons (DOE 1999). The North Anna reactors are operated by the Virginia Power Company. The operating licenses (Nos. NPF–4 and NPF–7) for these reactors were granted in 1978 and 1980, and expire in 2018 and 2020, respectively (NRC 1991:vol. 1, 2-2; 1997). It is estimated that the population within an 80-km (50-mi) radius of the reactor is 1,363,945 (Virginia Power 1998:2.1-21).

Reactor cooling is accomplished using a once-through cooling system with water obtained from Lake Anna (Virginia Power 1998:2.1-2). The rate of cooling water withdrawal is 5,565,000 million l/yr (1,470,000 million gal/yr), with all water returned to Lake Anna (DOE 1999). There are no known industrial users downstream from the site until some 97 km (60 mi) downstream at West Point, where a large pulp and paper manufacturing plant is located. There are no known potable water withdrawals along the entire stretch of the river downstream to West Point, where the river becomes brackish (Virginia Power 1998:2.4-3).

New (unirradiated) fuel assemblies are dry stored in the new fuel storage area of the fuel building. The new fuel storage area has a capacity of 126 fuel assemblies. Spent (irradiated) fuel assemblies are stored under water in the spent fuel pit in the fuel building. The spent fuel storage pit has a capacity of 1,737 fuel assemblies (Virginia Power 1998:9.1-1, 9.1-2). Dry cask storage is being developed and is expected to have a capacity of an additional 1,824 assemblies (NRC 1998). Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–338 and 50–339.

3.7.3.1 Air Quality

North Anna is within the Northeastern Virginia AQCR #224. None of the areas within the site or Louisa County are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1998c).

Sources of criteria air pollutants from North Anna include two auxiliary boilers, four emergency diesel generators, a station blackout generator, and miscellaneous equipment such as trucks and forklifts. Table 3.7–11 provides a summary of criteria pollutant concentrations from operations of North Anna. The concentrations resulting from operationsare well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

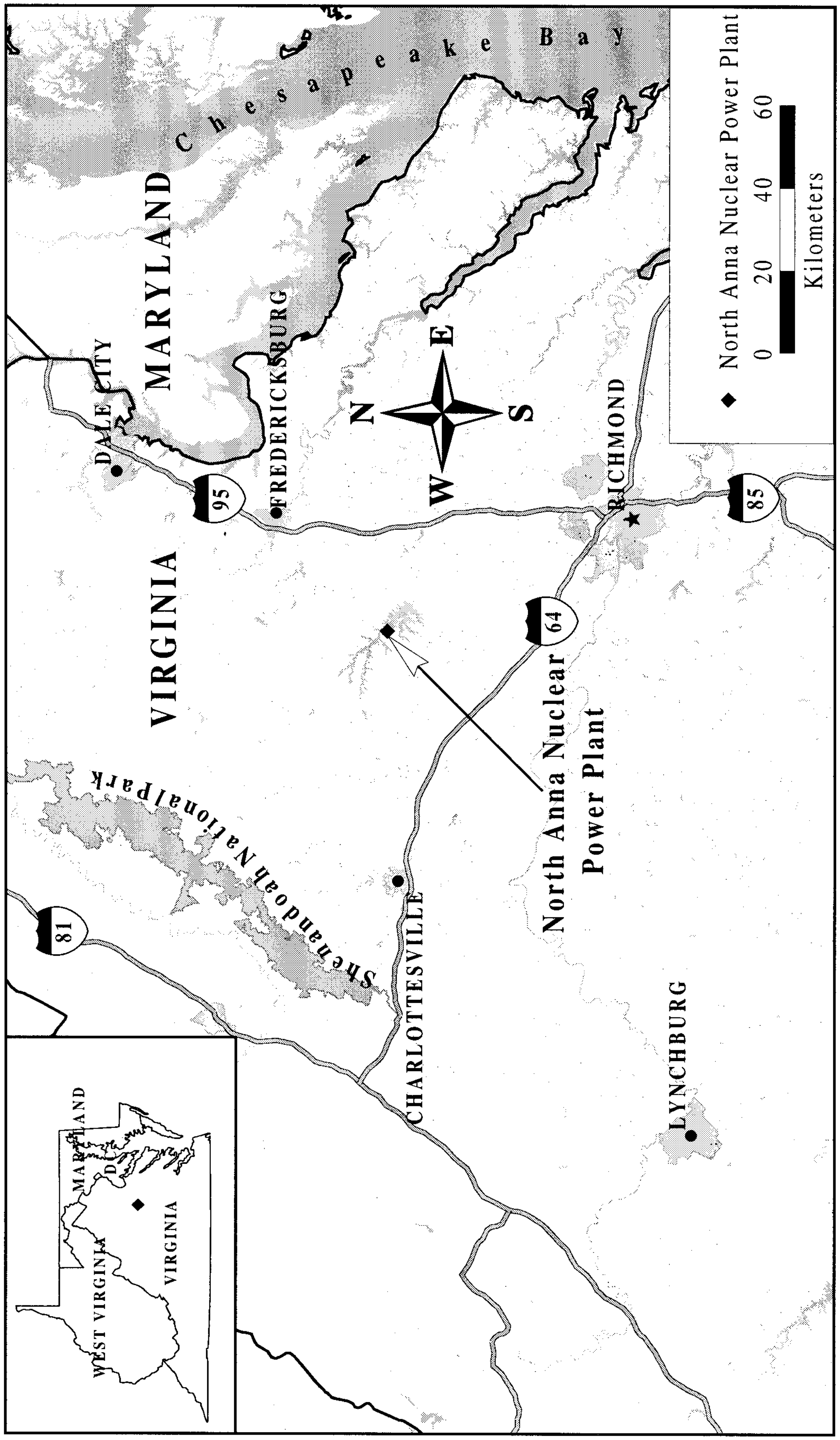

Figure 3.7–3. North Anna Nuclear Power Plant, Virginia

Table 3.7–11. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From North Anna Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS ($\mu g/m^3$)	North Anna ($\mu g/m^3$)
Carbon monoxide	8 hours	10,000	416
	1 hour	40,000	594
Nitrogen dioxide	Annual	100	0.00504
PM_{10}	Annual	50	0.00407
	24 hours	150	15.4
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0167
	24 hours	365	63
	3 hours	1,300	142

[a] No data is available with which to assess $PM_{2.5}$ concentrations.
Key: NAAQS, National Ambient Air Quality Standards.
Note: Based on 1997 emissions data for diesel generators.
Source: Modeled concentrations based on DOE 1999; EPA 1997.

3.7.3.2 Waste Management

Table 3.7–12 presents the 5-year average annual waste generation rates for North Anna.

Table 3.7–12. Annual Waste Generation for North Anna (m^3)

Waste Type	Generation Rate
LLW	236.6[a]
Mixed LLW	0
Hazardous waste	11.4
Nonhazardous waste	
Liquid	682
Solid	10,400

[a] Two-year average (1996–1997).
Key: LLW, low-level waste.
Source: DOE 1999.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the boron recovery system, steam generator blowdown system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, laundry drains, and spent resin flush system. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the NPDES permit. If liquids are determined to be radioactively contaminated, they are treated by the ion exchange filtration system or demineralizers to reduce contamination before being discharged. Continuous radiation monitoring is provided for treated liquid waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Virginia Power 1998:11.2-1, 11.2-2).

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite treatment and disposal facilities. Radioactive solid waste may include spent resin slurries, spent filter cartridges, rags, gloves, boots, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Contaminated solid materials resulting from station maintenance are stored in specified areas of the auxiliary building and the decontamination building. Materials that are compressible are placed in 208-l (55-gal) drums for compaction at the bailing facility. Compressible materials and other contaminated solid materials that are not placed in drums are placed in 6.1-m (20-ft) seavans for shipment to offsite licensed treatment and disposal facilities. Contaminated metallic materials and highly contaminated solid objects are placed inside disposable containers for shipment to a disposal facility (Virginia Power 1998:11.5-1–11.5-3).

The small quantities of mixed LLW and hazardous waste generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is treated in the onsite sanitary wastewater treatment facility and then discharged to Lake Anna (VADEQ 1997:9, 28).

3.7.3.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of North Anna are shown in Table 3.7–13. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Table 3.7–13. Sources of Radiation Exposure to Individuals in the Vicinity Unrelated to North Anna Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3.7–14. These doses fall within regulatory limits and are small when compared with background exposure.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancers per person-rem) to the public, the LCF risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 1.4×10^{-7}. That is, the estimated probability of this person

Table 3.7–14. Radiological Impacts on the Public From Operations of North Anna in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	5	6.1×10^{-4}	3	0.28	25	0.29
Population within 80 km (person-rem)[b]	None	6.0	None	9.0	None	15.0

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for the maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.
[b] Population used: 1,614,983; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997. Population doses were ratioed to reflect latest census data projections.
Source: DOE 1999; Virginia Power 1998:2.1-21, 11B-3, 11.3-13.

dying from cancer from radiation exposure from 1 year of normal reactor operations is about one chance in seven million.

Based on the same risk estimator, 0.0075 excess LCFs are projected among the population living within 80 km (50 mi) of North Anna In 1997. For perspective, 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 population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of North Anna was about 3,230. This number of expected fatal cancers is much higher than the estimated 0.0075 LCFs that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public, however, they receive an additional dose from normal operations of the reactors. Table 3.7–15 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancers per person-rem) among workers, the number of LCFs to reactor workers from 1997 normal operations is estimated to be 0.041.

Table 3.7–15. Radiological Impacts on Involved Workers From Operations of North Anna in 1997

Number of badged workers[a]	2,243
Total dose (person-rem/yr)	103
Annual latent fatal cancers	0.041
Average worker dose (mrem/yr)	46
Annual risk of latent fatal cancer	1.8×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.
Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.
Source: DOE 1999.

3.7.3.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of North Anna, the potentially affected area includes parts of Maryland and Virginia.

The potentially affected area around North Anna is defined by a circle with an 80-km (50-mi) radius centered around these reactors (lat. 38°03′37″ N, long. 77°47′24″ W). The total population residing within that area in 1990 was 1,286,156. The proportion of the population that was considered minority was 21.9 percent. The same census data show that the percentages of minorities for the contiguous United States was 24.1, and the percentage of the States of Maryland and Virginia were 30.4 and 24.0, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 18.9 percent of the total population. Asians contributed about 1.5 percent, and Hispanics, about 1.4 percent. Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 88,162 persons (6.9 percent of the total population) residing within the potentially affected area around North Anna reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that the figures for Maryland and Virginia were 8.3 and 10.3 percent, respectively (DOC 1992).

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