EXHIBIT 3

AUG 13 1991

Docket No: 70-143
License No. SNM-124

Nuclear Fuel Services, Inc.
ATTN: Dr. Donald Paine, Vice President
Safety & Regulatory Management
P. O. Box 337, MS 123
Erwin, Tennessee 37650

Gentlemen:

Enclosed are copies of the Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) prepared to support the renewal of Materials License No. SNM-124. The FONSI, which has been forwarded to the Office of the Federal Register for publication, also contains a Notice of Opportunity for Hearing in accordance with Subpart L of 10 CFR Part 2.

Sincerely,

Original Signed By:

Virginia L. Tharpe
Uranium Fuel Section
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety, NMSS

Enclosures:
1. FONSI dtd 08/09/91
2. EA dtd 08/09/91

Distribution w/encls.

Docket 70-143	NRC File Center	PDR	NMSS R/F	IMUF R/F
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U.S. NUCLEAR REGULATORY COMMISSION
FINDING OF NO SIGNIFICANT IMPACT AND NOTICE OF OPPORTUNITY FOR A HEARING
RENEWAL OF SPECIAL NUCLEAR MATERIAL LICENSE NO. SNM-124
NUCLEAR FUEL SERVICES, INC.
ERWIN, TENNESSEE
DOCKET NO. 70-143

The U.S. Nuclear Regulatory Commission (the Commission) is considering the renewal of Special Nuclear Material License No. SNM-124 for the continued operation of Nuclear Fuel Services, Inc. (NFS) located in Erwin, Tennessee.

SUMMARY OF THE ENVIRONMENTAL ASSESSMENT

Identification of the Proposed Action: The proposed action is the renewal of the license necessary for NFS to continue operations. Principal operations include the processing of high-enriched UF_6 (> 90 percent U-235) into a classified fuel product and processing scrap materials to recover uranium. In addition, NFS develops other nuclear fuels containing enriched uranium and operates a facility for washing used low-enriched UF_6 cylinders from other licensees. A variety of radiological and nonradiological gaseous, liquid, and solid wastes are generated. After treatment, some of the wastes are released to the environment.

The Need For The Proposed Action: The NFS plant produces nuclear reactor fuel for the [redacted] The demand for fuel will remain to meet the needs of the [redacted]. Denial of the license renewal for the NFS Erwin Plant is an alternative available to the NRC but would require that similar activities be undertaken at another site.

Environmental Impacts of the Proposed Action: The main plant ventilation system collects air from most high-enriched uranium operations. Gaseous streams from individual process facilities are routed to this system through additional high-efficiency particulate air (HEPA) filters and scrubbers when necessary. Packed-bed scrubbers using scrubber solutions of potassium hydroxide, aluminum nitrate, or ammonium hydroxide are used in several buildings for treating air prior to discharge. After treatment, the gaseous effluents within the main plant ventilation system are discharged through a common stack. Approximately 90 percent of the plant's radioactive stack effluents are discharged through the main plant stack; the remaining gaseous effluents are released through short stacks or roof vents. The bulk of the aqueous process waste is piped to the Waste Water Treatment Facility. The liquid is treated on a batch basis and discharged to the Nolichucky River via a direct pipeline. Organic wash water, Process Development Laboratory waste water, and restroom and shower output are discharged to the sewer system which goes directly to the City of Erwin - Publicly Owned Treatment Works.

NFS conducts a comprehensive effluent and environmental monitoring program 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 NFS program includes sampling the liquid and gaseous discharges, ambient air stations, surface water, soil, sediment, vegetation, and ground water.

Radiological impacts of the plant were assessed using the radioactive effluent data for 1984. Data for 1984 was used because this is the year with the highest release since a major ventilation upgrade. Based on data from a monitoring station located in the vicinity of the nearest residence, 62 percent of the uranium was class Y lung solubility, and 38 percent was class D. The main process stack accounted for 89 percent of the airborne release, and 11 percent was released from building vents. The doses from airborne emissions were calculated for the nearest actual residence (250 m south of the plant). The atmospheric dispersion factors at this location are 2.5 E-4 s/m^3 for ground level release and less than 8.3 E-8 s/m^3 for the stack release. It was assumed that the individual spends 80 percent of the time at the residence location and that 10 percent of the food consumed is produced there. Doses are 50-year dose commitments (total dose to a reference organ, resulting from 1 year of intake, that will accrue during a 50-year period). The highest dose received from airborne effluents would be 10 mrems/year to the lungs. Doses to the total-body, kidneys, and bone are 2.2, 0.22, and 1.2 mrems/y, respectively. This dose is below the 25 mrem/y limit imposed by the NRC license (which is consistent with the criteria in 40 CFR 190 and 40 CFR 61). Maximum individual doses to the nearest resident from airborne and liquid effluents are 2.3 mrem/yr for the total body dose, 10 mrem to the lungs, and 2.8 mrem to the bone. Normal operation of the plant has resulted in maximum annual doses at the nearest residence that are below the limit of 25 mrem/y.

For the population dose due to airborne releases, the highest collective dose was to the lungs (80 person-rem). The total-body dose of 14.5 person-rem may be compared to a dose of 1.3 E+5 person-rem which the population would receive from annual background radiation. The population doses from liquid effluents were estimated for the town of Jonesboro, which draws its drinking water from the Nolichucky River. These doses were 0.1 and 3.2 person-rem for total body and bone, respectively. Calculations were based on the conservative assumption that uranium concentrations in the river at Jonesboro are the same as those measured downstream from NFS.

Conclusion: The staff concludes that the environmental impacts associated with the proposed license renewal for continued operation of NFS are expected to be insignificant. To evaluate future impacts, NFS will continue the environmental monitoring program. The staff concludes that there will be no significant impacts associated with the proposed action. The staff does recommend, however, that NFS: (1) establish a routine ground water monitoring program for the two burial grounds and submit the program for NRC approval; (2) establish an effective monitoring system for leakage detection for the underground storage tanks and submit the plan for NRC approval; (3) determine if there are residents within 1600 m (1 mile) of the site in the northwest quadrant, and if so, place an ambient monitoring station at the nearest residence in that area to collect continuous air samples for environmental air sample analysis; and (4) inform the NRC within 30 days if the State-permitting agency revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit for the discharge of liquid effluents.

Alternatives to the Proposed Action: Alternatives to the proposed action include complete denial of NFS's renewal application. Not granting a license renewal for the facility would cause NFS to cease fuel processing at this site. This alternative has not been considered because issues of public health and safety have been resolved. The only benefits to be gained by nonrenewal would be the cessation of the minor environmental impacts from operation of the NFS site. Because the nuclear fuel is a necessary product for the U.S. Naval Reactor Program, denial of a license for NFS would result in the transfer of the fuel production and associated environmental impacts to an alternative site.

Agencies and Persons Consulted: Staff utilized the environmental report dated July 1984; the revised applications dated August 11, 1989, October 15, 1990, and May 15, 1991; and additional information dated November 20, 1984, February 8, and April 1, 1985, February 19, 1986, June 2, and November 17, 1989, January 19, October 15, and December 28, 1990, and May 15, 1991. Discussions were held with the Tennessee Department of Health and Environment.

Finding of No Significant Impact: The Commission has prepared an Environmental Assessment related to the renewal of Special Nuclear Material License No. SNM-124. On the basis of this assessment, the Commission has concluded that environmental impacts that would be created by the proposed licensing action would not be significant and do not warrant the preparation of an Environmental Impact Statement. Accordingly, it has been determined that a Finding of No Significant Impact is appropriate.

The Environmental Assessment and the above documents related to this proposed action are available for public inspection and copying at the Commission's Public Document Room at the Gelman Building, 2120 L Street NW., Washington, DC.

OPPORTUNITY FOR A HEARING

Any person whose interest may be affected by the issuance of this amendment may file a request for a hearing. Any request for a hearing must be filed with the Office of the Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days of the publication of this notice in the Federal Register; be served on the NRC staff (Executive Director for Operations, One White Flint North, 11555 Rockville Pike, Rockville, MD 20852); on the licensee (Nuclear Fuel Services, Inc., P. O. Box 337, MS123, Erwin, TN 37650) and must comply with the requirements for requesting a hearing set forth in the Commission's regulation, 10 CFR Part 2, Subpart L, "Informal Hearing Procedures for Adjudications in Materials Licensing Proceedings."

These requirements, which the requestor must describe in detail, are:

1. The interest of the requestor in the proceeding;

2. How that interest may be affected by the results of the proceeding, including the reasons why the requestor should be permitted a hearing;

3. The requestor's areas of concern about the licensing activity that is the subject matter of the proceeding; and

4. The circumstances establishing that the request of hearing is timely, that is, filed within 30 days of the date of this notice.

In addressing how the requestor's interest may be affected by the proceeding, the request should describe the nature of the requestor's right under the Atomic Energy Act of 1954, as amended, to be made a party to the proceeding; the nature and extent of the requestor's property, financial, or other (i.e., health, safety) interest in the proceeding; and the possible effect of any order that may be entered in the proceeding upon the requestor's interest.

Dated at Rockville, Maryland, this 9th day of August, 1991.

FOR THE NUCLEAR REGULATORY COMMISSION

Original Signed By:

Charles J. Haughney, Chief
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety, NMSS

no legal objection

OFC: IMUF:	IMUF:	IMUF:	OGC:	IMSB:
NAME: MHorn:mh:	VLTharpe:	GHBidinger:	RLF.	CJHaughney:
DATE: 7/23/91:	7/23/91:	8/6/91:	8/8/91:	8/9/91:

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ENVIRONMENTAL ASSESSMENT

FOR RENEWAL OF

SPECIAL NUCLEAR MATERIAL
LICENSE NO. SNM-124

NUCLEAR FUEL SERVICES, INC., ERWIN PLANT

ERWIN, TENNESSEE

DOCKET NO. 70-143

AUGUST 1991

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Division of Industrial and Medical Nuclear Safety
Washington, D.C.

ABSTRACT

This Environmental Assessment contains an assessment of the environmental impact associated with the renewal of the license to operate the Nuclear Fuel Services, Inc. (NFS) Erwin Plant, pursuant to the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51 (10 CFR Part 51), as amended, of the Nuclear Regulatory Commission regulations. This assessment examines the environmental impacts, environmental consequences and mitigating actions, and environmental and economic benefits and costs associated with plant operation. Land use and terrestrial and aquatic ecological impacts will be small. No operational impacts to historic and archeological sites are anticipated. The effects of routine operations should not jeopardize any populations of endangered or threatened species. No significant impacts are anticipated from normal operational releases of radioactivity. The risk of radiation exposure associated with accidental release of radioactivity is very low. Socioeconomic impacts of the project are anticipated to be minimal.

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LIST OF FACTORS FOR CONVERSION OF ENGLISH UNITS TO THE INTERNATIONAL SYSTEM OF UNITS (SI)

The following table gives the factors used in this document for the conversion of conventional English units to the equivalent International System of Units (SI) now being adopted worldwide or conventional metric units. The conversion factors have been obtained from the Standard for Metric Practice published by the American Society for Testing and Materials. They are used to four-digit accuracy, because most of the values in this document are not known to any more exactness. After conversion, the SI values have been rounded to reflect an accuracy sufficient for the requirements of this document. Most of the values are given in SI units with the equivalent English unit following within parentheses.

Conversion of English Units to SI Units

To convert from	to	multiply by
acres	hectares (ha)	0.4047
feet (ft)	meters (m)	0.3048
cubic feet (ft^3)	cubic meters (m^3)	0.02832
gallons (gal)	cubic meters (m^3)	0.003785
gallons (gal)	liters (L)	3.79
gal/min	liters/s (L/s)	0.06309
inches (in)	centimeters (cm)	2.54
miles (statute)	kilometers (km)	1.609
square mile ($miles^2$)	square kilometers (km^2)	2.590
pounds (lb)	kilograms (kg)	0.4536

*American Society for Testing and Materials, Standard E-380, Standard for Metric Practice, February 1980.

ACRONYMS

AMAD	activity median aerodynamic diameter
AMSL	above mean sea level
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BOD	biological oxygen demand
CEQ	Council on Environmental Policy
CFR	Code of Federal Regulations
DOE	Department of Energy (U.S.)
DOP	dioctyl phthalate
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
HEPA	high efficiency particulate air
HEU	high-enriched uranium
LEU	low-enriched uranium
LLD	lower limit of detection
MMI	Modified Mercalli Intensity
MPC	maximum possible concentration
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services, Inc.
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
SNM	Special Nuclear Material
TDS	total dissolved solids
TLD	thermoluminescent dosimeter
TLV	threshold limit value
WWTF	waste water treatment facility

1. PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

The Nuclear Fuel Services, Inc. (NFS), Erwin Plant at Erwin, Tennessee, uses UF_6 to produce nuclear fuel containing either highly or slightly enriched uranium, develops other nuclear fuels from uranium and/or thorium, processes scrap material to recover the uranium content, and maintains (or will decommission) facilities previously used for handling plutonium.

In response to an application by NFS for renewal of Special Nuclear Material (SNM) License No. SNM-124, the U.S. Nuclear Regulatory Commission (NRC), with the technical assistance of the Oak Ridge National Laboratory (ORNL), prepared this environmental assessment (EA) pursuant to NRC regulations (in Title 10 of the Code of Federal Regulations, 10 CFR Part 51), which implement requirements of the National Environmental Policy Act (NEPA) of 1969 (P.L. 91-190). 10 CFR Part 51 also reflects the Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508) for implementing NEPA.

10 CFR Sections 51.14 and 51.30 define "environmental assessment" as follows:

1. An environmental assessment is a concise public document, for which the NRC is responsible, that serves to

   - briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a finding of no significant impact,

   - aid the NRC's compliance with NEPA when no EIS is necessary, and

   - facilitate preparation of an EIS when one is necessary.

2. An environmental assessment shall include brief discussions of the need for the proposed action, of alternatives as required by Section 102(2)(E) of NEPA, and of the environmental impacts of the proposed action and alternatives. It shall also identify agencies and persons consulted.

The NFS facility at Erwin has been in operation since 1958. An Environmental Impact Appraisal (EIA) related to plant operations was issued by the NRC in January 1978 (NRC 1978). This EA provides a review of the past 10 years of operation and an analysis of impacts.

Since the EIA was issued in 1978, no significant modifications to the nuclear fuel production process have been made; however, several environmentally related changes have been made to the NFS Plant and its operations. These changes, which are discussed in Chapters 2 and 4, include the following:

1. A new ventilation system has been installed that, among other things, combines gaseous effluents from all of the highly enriched uranium processing and laboratory areas and discharges them from a single, elevated [33-m (109-ft) high] stack.

2. Additional liquid waste storage capacity was installed at the Waste Water Treatment Facility. Consequently, plant discharges to the unlined ponds were terminated.

3. A program has been implemented to monitor radioactivity in the ambient air on site and at nearby areas.

4. Approximately 3,370 m^3 (119,000 ft^3) of contaminated soil has been removed from an area immediately north-northwest of the site (from the former stream bed of Banner Spring Branch) and placed in a mound on NFS property. The mound will be stabilized and monitored until final disposition is determined.

5. A ground-water monitoring program was implemented to define the hydrological and geological characteristics of the area in the vicinity of the ponds.

6. A new drainage system has been constructed that directs all plant runoff into Banner Spring Branch. Sluice gates were installed in the drainage pathways to allow greater containment in the event of spills.

7. The liquid waste from the laundry facility and Building 105 Laboratory are now directed to the onsite waste treatment facility.

Additionally, NFS plans to construct a new scrap plant. Operation of the plant will be covered by a future licensing action.

1.2 SUMMARY OF THE PROPOSED ACTION

The proposed action is renewal of License No. SNM-124 which is necessary for NFS to continue existing operations at the Erwin Plant. Principal operations include the processing of high enriched UF_6 (>90% ^{235}U) into a classified fuel product and processing scrap materials, containing either low- or high-enriched uranium, to recover uranium. In addition, NFS develops other nuclear fuels containing high-enriched uranium and operates a facility for washing used low-enriched UF_6 cylinders from other licensees. A variety of radiological and nonradiological gaseous, liquid, and solid wastes are generated. After treatment, some of the wastes are released to the environment.

NFS is also decontaminating and decommissioning a facility that was used to fabricate plutonium fuel. Similarly, formerly used ^{233}U processing facilities have been decontaminated. Under the existing license, NFS is not allowed to receive additional quantities of plutonium or ^{233}U, except as standards and calibration sources. Source materials (natural and depleted uranium and thorium) are licensed and controlled by the State of Tennessee.

1.3 NEED FOR THE PROPOSED ACTION

The NFS plant produces nuclear reactor fuel for the [redacted]. The demand for fuel will remain to meet the needs of the [redacted] Denial of the license renewal for the NFS Erwin Plant is an alternative available to the NRC but would require that similar activities be undertaken at another site. Thus, this alternative would be considered only if issues of public health and safety at the Erwin site cannot be resolved to the satisfaction of the NRC.

1.4 THE SCOPING PROCESS

The previous appraisal of NFS operations (NRC 1978) documented that impacts were small. Based on a review of recent monitoring data and the applicant's environmental report supporting the license renewal application, no significant environmental effects from the plant are anticipated. The staff, therefore, determined that a formal scoping process associated with this assessment was unnecessary. This document presents the staff's detailed review of environmental impacts associated with the operation of the NFS facility. In conducting the present assessment of the proposed action, the staff reviewed the applicant's environmental report, toured the site and surrounding area (November 14 and 15, 1984), and met with the applicant to discuss facility operations and to obtain additional information. NFS subsequently submitted formal responses to additional environmental questions discussed during the staff's site visit (NFS 1985). On November 14, 1984, the staff met with representatives of the following Tennessee State agencies:

Department of Health and Environment

- Division of Air Pollution Control
- Division of Water Management
- Division of Solid and Hazardous Waste Management

The staff again met with the applicant on February 20-24, 1989. NFS submitted additional information on June 2, 1989, and October 15, 1990, and submitted a revised application on August 11, 1989, October 15, 1990, and May 15, 1991.

The staff also used information from other sources as referenced to assist in the evaluation.

The limited environmental impacts from current operation of the NFS facility result primarily from releases of (1) radioactive gases to the atmosphere and (2) radioactively contaminated liquids to the nearby Nolichucky River. These releases and nonradioactive emissions and effluents have been monitored and documented. Because onsite burial of low level radioactive solid waste (discontinued in 1981) and ponding of radioactive liquid wastes (discontinued in 1980) may be causing some contamination of local ground water, ground water on the site is monitored for contamination.

The proposed license renewal for NFS does not involve a change in scope or level of activity beyond that previously appraised (NRC 1978); therefore, the staff determined that the principal topics to be addressed in this environmental assessment should include control of pollutant releases, environmental monitoring procedures, and the current environmental impact of operation and potential accidents. The site, environment, plant operations, and magnitude of environmental impacts on specific environmental resources will be described.

REFERENCES FOR SECTION 1

NFS (Nuclear Fuel Services, Inc.). 1984. "Environmental Report, Erwin Plant," Erwin, Tennessee. July.

NFS (Nuclear Fuel Services, Inc.). 1985. Letter with Attachment Containing NFS Responses to NRC Site Visit Questions from R. L. Ideker, NFS, to S. D. Wyngarden, NRC, Docket No. 70-143. February 8.

NFS (Nuclear Fuel Services, Inc.). 1989a. Letter with Attachment Containing Environmental Information Update for NFS License Renewal Action From B. E. Knight, NFS, to M. Horn, NRC, Docket No. 70-143. June 2.

NFS (Nuclear Fuel Services, Inc.). 1989b. Revised License Application. August 11.

NFS (Nuclear Fuel Services, Inc.). 1990. Letter with Attachment Containing NFS Responses to NRC Questions and Revised Pages to the License Application from D. Paine, NFS, to C. J. Haughney, NRC, Docket No. 70-143. October 15.

NFS (Nuclear Fuel Services, Inc.). 1991. Letter with Attachment Containing NFS Responses to NRC Questions and Revised Pages to the License Application from D. Paine, NFS, to C. J. Haughney, NRC, Docket No. 70-143. May 15.

NRC (U.S. Nuclear Regulatory Commission). 1978. "Environmental Impact Appraisal, Nuclear Fuel Services, Inc., Erwin Plant." Docket No. 70-143. January.

2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

2.1 THE ALTERNATIVE OF NO LICENSE RENEWAL

Not granting a license renewal for the facility would cause NFS to cease fuel processing at this site. This alternative has not been considered because issues of public health and safety have been resolved (Section 4). The only benefits to be gained by nonrenewal would be the cessation of the minor environmental impacts described in Section 4. Because the nuclear fuel is a necessary product for the U.S. Naval Reactor Program, denial of a license for NFS would result in the transfer of the fuel production and associated environmental impacts to an alternative site.

2.2 THE ALTERNATIVE OF LICENSE RENEWAL

License renewal, which is the proposed action, would result in the continued operation of the NFS facility essentially as it has been operated during the current license period. A description of the current operation and the waste confinement and effluent control follows.

2.2.1 Description of the Current Operation

The primary NFS operation converts high-enriched UF_6 into a classified product used in the fabrication of nuclear fuel. The classified production procedures are unique to the [redacted] In addition, NFS is involved in research on, 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; and operation of a chemistry lab. Some work done in the past with thorium and plutonium is briefly described here, but principal attention in the following sections is given to processes currently being used.

An aerial view of the NFS site and its relationship to the adjacent residential area are shown in Figure 2.1. The physical layout of the 23.4-ha (57.8-acre) site is shown in Figures 2.2 and 2.3. The facility consists of numerous small buildings located within a chain-link security fence. The administration building and the guard house are made of local brick; the process buildings are predominantly cement block, painted white. Metal "Butler" buildings are used for storage of equipment and supplies. Retention ponds, formerly used for liquid wastes, are also located within the security fence immediately northeast of the facility buildings (Figure 2.2). The burial grounds that were used for radioactive solid wastes are outside the security fence north of the retention ponds but inside a chain-link fence (Figure 2.2). There are also two burial trenches located largely inside the west security fence on railroad property near the northwest corner of the plant. The contaminated soil pile shown in Figure 2.2 is discussed in Section 2.2.2.5.

Figure 2.1. Aerial view of the NFS site at Erwin, Tennessee, October 6, 1979.
Source: supplied by Nuclear Fuel Services, Inc.

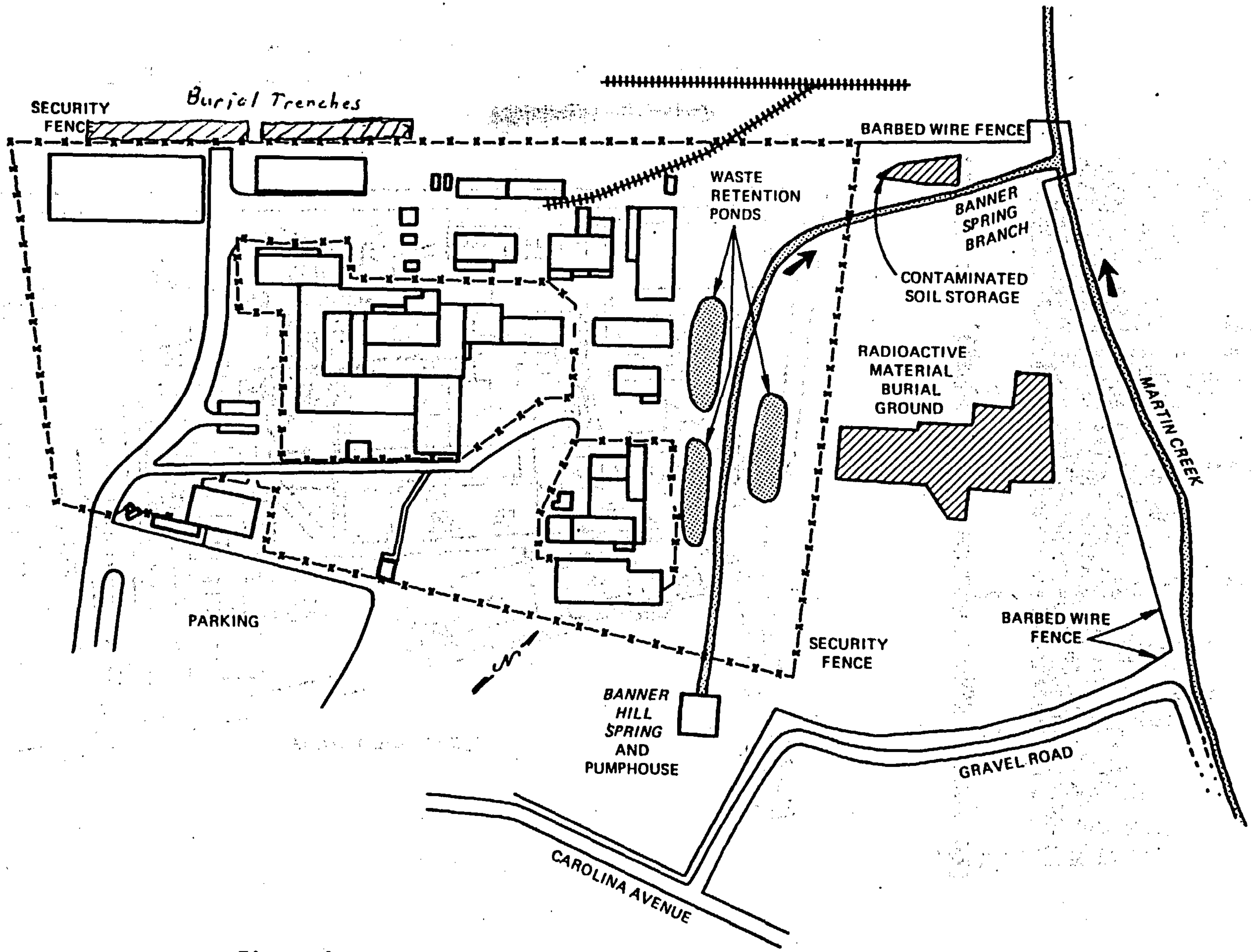

Figure 2.2. General layout of the NFS site.
Source: Oak Ridge National Laboratory
Drawing No. ES-6133 R.

Figure 2.3 Redacted

The average employment on the day shift (Monday through Friday) is 390 persons, and the average evening, midnight, and weekend shift employment is 96 persons per shift. Approximately 700 persons are employed as NFS employees or contract guard personnel.

Processing buildings and most other buildings are numbered and named (Figure 2.3); the names are associated with the processes performed. Effluent monitoring data for each building are summarized in Section 4.1.

2.2.1.1 Warehouse Facilities

[redacted] The warehouse facilities and shops include Buildings [redacted], [redacted], [redacted] and [redacted] and parts of Buildings [redacted], [redacted], and [redacted]. Stable or radioactive chemicals are stored in these buildings so as to prevent releases to the environs. As a general principle, double containment is provided for storage of radioactive materials. The only waste from these buildings is sanitary sewage and solids. The sewage is sampled for alpha contamination before it is released to the city sewer. Solid wastes are packaged for burial off site or are incinerated on site as described in Section 2.2.1.12.

2.2.1.2 Materials Staging and MEDIC Facility, Building 350

Building 350 houses the medical offices, an emergency decontamination and shelter facility, in vivo counting, offices, and shipping and receiving staging area.

2.2.1.3 Plutonium Fuel Fabrication and ^{233}U Processing, Buildings [redacted] (A,B,C) and 110 (C,D)

Reactor fuel elements containing a mixture of uranium and plutonium had been fabricated in Buildings [redacted] and [redacted] but fabrication of these fuel elements was discontinued in 1972. Laboratories were located in 110C and the north half of 110D. Decommissioning plans for these facilities have been in the making since about that time. Actual decommissioning had been delayed because a place to dispose of the plutonium contamination had not been identified. Although disposal in a commercial burial ground is prohibited, greater than class C wastes will be accepted for disposal at a Department of Energy (DOE) site. NFS has received approval to decommission the plutonium facilities. The plutonium decommissioning plan was approved by Amendment No. 55 dated June 20, 1989.

Facilities for processing ^{233}U were operated in Buildings [redacted], and [redacted] NFS states that these facilities have been decontaminated so that radioactivity levels attributable to ^{233}U are less than limits for a controlled area as specified in License Amendment No. 5 (NFS 1982a). Removable equipment was disposed of at the licensed radioactive waste burial facilities at Barnwell, South Carolina. Building [redacted] is currently used for activities involving uranium.

2.2.1.4 High-Enriched Uranium Scrap Recovery (Building 233) and Storage (Buildings 220 and 230)

High-enriched uranium (HEU) fuel that does not meet specifications and various scrap materials generated in the fabrication of HEU fuel are processed in Building 233 to reclaim the uranium. The final product may be recycled to onsite fuel processing facilities or shipped off site. Building 230 and part of Building 220 are storage areas for HEU fuel scrap. The three attached buildings are also known as the 200 Complex.

Liquid effluents generated in the recovery process are sampled for uranium before transfer to the Waste Water Treatment Facility (WWTF). Gaseous effluents from the process and building ventilation from the 200 Complex are treated by high-efficiency particulate air (HEPA) filters and/or by scrubbers and are discharged to the main stack.

2.2.1.5 Service Building, Building 100

Building 100 contains change rooms, lunch rooms, the plant first aid station, the NRC resident inspector's office, and laundry facilities. There are no gaseous effluents other than normal building air that is sampled routinely for worker protection and dryer exhaust vents that are sampled continuously for radioactivity. The only liquid effluents are laundry waste and sanitary sewage. Sanitary sewage is routed to the main sewer pipe where it is sampled. Laundry waste is collected and sampled before routing to the waste treatment system. (Section 2.2.2.3).

2.2.1.6 Ceramics Building, Building 110

The ceramics building contained a processing facility that has been decontaminated as described in Section 2.2.1.3. Fuel rods containing enriched uranium, uranium-233, thorium, or uranium-thorium blends were also fabricated in this facility.

Currently, area 110A contains a solid waste reduction process (for HEU-bearing materials) and several laboratories, most of which are no longer in operation. The 110D area houses a functioning Non-Destructive Assay (NDA) lab. There are no liquid effluents from this building other than sanitary sewage which is routed to the main sanitary sewer. Gaseous emissions are passed through single or double HEPA filters and include that generated by the waste reduction (compaction) process, the NDA lab hood, and building air.

2.2.1.7 Respirator Facility, Building 104

Building 104 houses the respirator facility. This includes the respirator laundry; inspection, testing, and quality asssurance; fit-test facility; and offices.

2.2.1.8 Chemical Building, Building 111

Three process lines have operated in the chemical building. The one for scrap material containing low-enriched uranium (LEU) is used to recover the uranium. The other two were for thorium dioxide powder and thorium metal pellets. Process waste water is collected and pumped to the WWTF (Section 2.2.2.3) for processing.

2.2.1.9 Administration and Laboratory

Buildings [redacted], [redacted], and [redacted], and part of Building [redacted] house offices and computer facilities that generate no effluents other than sanitary sewage and wastepaper that is disposed of onsite. Laboratory facilities are located in Building 105 (Sections "B", C", and "D"). Liquid wastes from the laboratories are processed in the waste treatment system. Gaseous effluents from the analytical laboratories housed in Building [redacted] are discharged via the [redacted] Complex ventilation system and main stack.

2.2.1.10 Metals Building, Building [redacted]

Before 1974, the metals building was used to produce uranium metal, uranium tetrafluoride, and thorium metal but is currently used only for cleaning UF_6 cylinders with the process illustrated in Figure 2.4. Cylinders that have been used to transport low-enriched UF_6 are washed free of uranium and are air dried. Gaseous emissions from cylinder cleaning and building ventilation are treated by a packed-bed scrubber before they are discharged through a roof vent. Waste liquids are sampled, transferred to Building 111 for uranium recovery, and then routed to the WWTF. The cleaned cylinders are shipped off the site.

2.2.1.11 Pilot Plant, Building [redacted]

The pilot plant was used for process research and development but not for actual production work. Hoods, dryboxes, and muffle furnaces have been used with both HEU and LEU. Process air and building exhaust air are filtered through high efficiency particulate air (HEPA) filters before being discharged through a roof vent. Liquid effluents are sent to the WWTF.

2.2.1.12 HEU Fuel Fabrication, [redacted] Complex

Buildings [redacted] and [redacted] comprise the 300 Complex where the principal product of the NFS facility is produced. High-enriched UF_6 is converted in a series of steps into a classified nuclear fuel product. Process steps involving UF_6 are vented through a venturi scrubber for uranium recovery. Process steps where 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 HEPA filters. Gaseous effluents from these devices are discharged into the 300 Complex ventilation system (Figure 2.5).

Process steps have leak collection equipment and procedures for liquid spills. Waste water from leakage and scrubbers is collected, sampled, and routed to Building 233 for uranium recovery or to the WWTF.

2.2.1.13 Developmental Fuel Production, Building [redacted]

The facility uses HEU to produce a classified product. The process streams involve either wet or dry systems, and work stations are enclosed in dry-boxes or hooded areas for pollution control and employee safety. Inadvertent losses from each station where dry systems are involved are passed through HEPA filters. Losses from process stations that use wet systems are

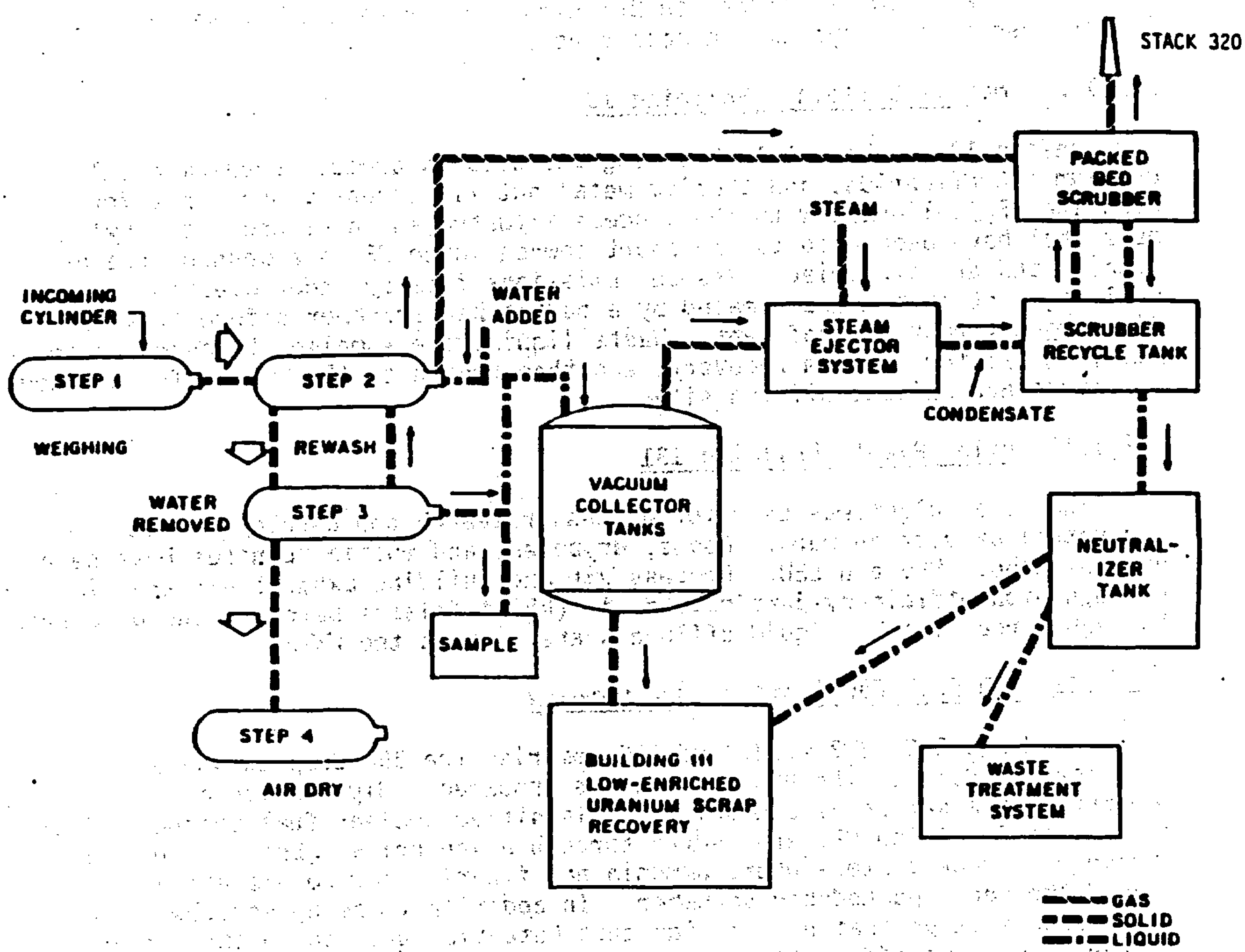

Figure 2.4. Uranium hexafluoride cylinder wash, Building 130.
Source: NFS 1984a.

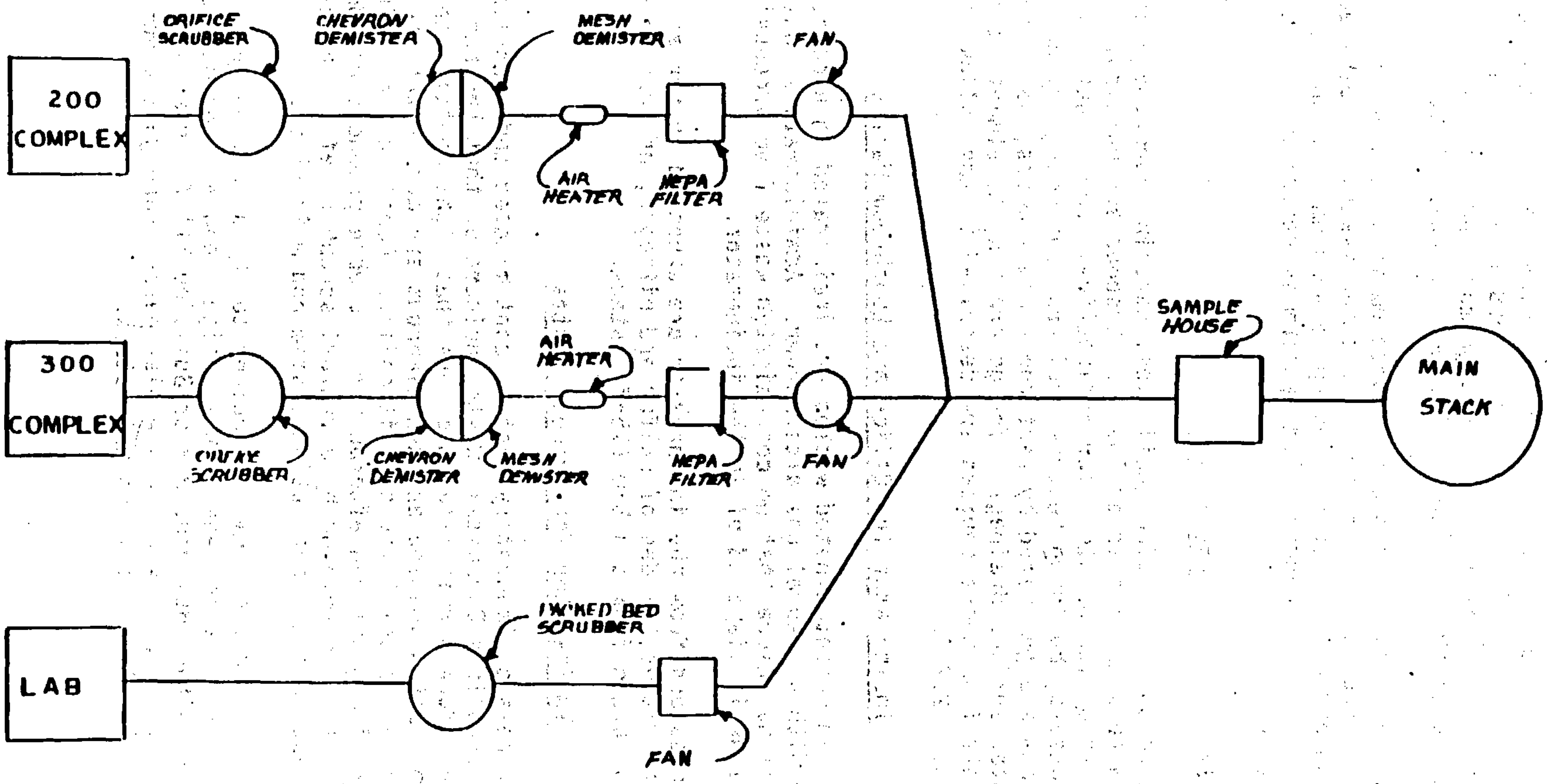

Figure 2.5. Main plant process ventilation system flow diagram. Source: NFS 1984a.

passed through a horizontal, wet, packed-bed scrubber. The gaseous effluent from the scrubber is heated and then mixed with the gaseous discharge from the dry gas HEPA filters. The combined gaseous effluents and building ventilation air are then passed through more HEPA filters before they are discharged to the environment through the main stack.

Liquid effluent containing uranium is processed through an evaporation system. Condensate from the evaporation system is combined with a scrubber solution and other liquids, having no uranium, and then is sampled and routed to the WWTF. The concentrated uranium is recycled through the processing facilities.

2.2.1.14 Auxiliary Facilities

Like the processing facilities, certain support equipment also generates gaseous and liquid effluents. Gaseous and particulate emissions are generated by incinerators for radioactively contaminated and uncontaminated solid wastes, building heaters, boilers, and emergency generators. Liquid effluents are generated by rest rooms and showers, water-cooling loops, and rainwater surface drainage. The generation, treatment, and disposal of the effluents from these sources are described in the following paragraphs and in Section 2.2.2.

- Incinerator for Office and Lunchroom Wastes

Solid uncontaminated wastes are incinerated in a commercial-type incinerator with a natural gas afterburner. Administrative controls and frequent inspections ensure that no contaminated waste from processing or laboratory operations is disposed of in the incinerator.

Emissions from the incinerator are expected to contain small quantities of particulates, oxides of sulfur and nitrogen, and carbon monoxide; they are discharged from a 4.5-m (15-ft) stack.

- Incinerator for Process Wastes

Process or laboratory wastes, contaminated and uncontaminated, are incinerated in a Combustall Waste Incinerator that has been modified to greatly reduce particulate emissions that might contain small quantities of uranium. Batch loading and ash cleanout are done after each incineration to preclude any possibility of criticality. Complete combustion is ensured by the use of a gas-fired afterburner. Soluble products of combustion and particulates are removed by a venturi scrubber before the effluent is routed to the 300 Complex ventilation system and main stack.

Ash is removed from the incinerator by a suction system and is transferred to a container where it is weighed and assayed before it is transferred to either Building 233 or Building 111 for uranium recovery. Exhausts from the transfer operation are also passed through the scrubber and to the main ventilation system and main stack.

- Emergency Generators

Three diesel-powered emergency generators are available to generate electricity for criticality alarms, security equipment, and some ventilation equipment during power outages. These generators operate only during infrequent power outages and testing. Although generator emissions can be expected to contain particulates, carbon monoxide, oxides of sulfur and nitrogen, and hydrocarbons, the small quantities released are not expected to adversely affect the air quality in the area.

- Decon Facility

The decon facility, which is housed in the west end of Building 304, is used to clean, segregate, and compacts contaminated solid wastes generated by plant operations. The cleaning is accomplished by freon washing, vibratory finishing, and electropolishing. Liquid wastes produced in the decon facility include NaOH solution and phosphoric acid. The NaOH solution is either reprocessed or solidified and sent off site for burial. The phosphoric acid solution is solidified and sent off site for burial.

- Building and Process Heat

Process steam is provided by three boilers that use natural gas; however, No. 2 diesel oil will be used if natural gas is unavailable or uneconomical. Although they have not been measured, total emissions were computed using fuel consumption data and average emission factors for similar small boilers (Environmental Protection Agency 1972). The estimates are given in Table 2.1. In addition to these boilers, some small oil- or gas-fired units provide building heat in the processing buildings.

2.2.2 Waste Confinement and Effluent Control

Waste confinement and effluent control for each facility are based on an understanding of the probable gaseous and liquid effluents. This section summarizes the methods for their control.

2.2.2.1 Gaseous Emissions

The various control devices used to remove radioactive particulates and chemicals from gaseous effluents are described here briefly.

The main plant process ventilation system (Figure 2.5) collects air from essentially all HEU operations, which consist of those in the [redacted] Complex (Buildings [redacted] and [redacted]), in the [redacted] Complex (Buildings [redacted] and [redacted]), and in labs in Buildings 301 and 105. Gaseous streams from individual process facilities within the 200 and 300 Complexes (e.g., glove boxes, hoods, furnaces) are routed to the system through additional HEPA filters and scrubbers when necessary.

The HEPA filters are rated at 99.7 percent efficient for removal of 0.3μ dioctyl phthalate (DOP) particles. In some cases, two or three HEPA filters are connected in series to provide increased removal efficiency and to ensure that no releases occur during a filter change or if one filter fails. The HEPA filters are tested by the manufacturer and certified as to their efficiency.

Table 2.1. Emissions from heating plant.

Contaminant	Emission rate (kg/year)[a]	Emission rate (lb/year)[a]	Concentration ($\mu g/m^3$)[b]
	With oil		
Particulates	3,015	1,368	6,707
Sulfur dioxide	5,708	2,589	12,698
Sulfur trioxide	80	36	178
Carbon monoxide	40.2	18.2	89
Hydrocarbons	603	274	1,341
Oxides of nitrogen	16,080	7,294	35,771
Aldehydes (as HCHO)	402	182	894
	With natural gas		
Particulates	450	204	8.1
Carbon monoxide	15	6.8	0.3
Oxides of sulfur (as SO_2)	10	5	0.2
Hydrocarbons (as CH)	100	45	1.8
Oxides of nitrogen (as NO_2)	300	140	5.4
Aldehydes (as HCHO)	8	140	0.1
Organics	18	8	0.3

[a]Based on 790,000 liters (210,000 gal) oil or 700,000 m^3 (25.2×10^6 ft^3) gas, and emission factors obtained from EPA (1972).

[b]Concentrations in micrograms per cubic meter are based on estimated volumes of combustible air required.

Source: NFS 1984a.

The building air in the [redacted] and [redacted] Complexes is passed through 30 percent efficient ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) prefilters and 80 percent efficient ASHRAE filters, and about 90 percent of it is recycled. The remaining air is discharged to the main ventilation system. Packed-bed scrubbers using scrubber solutions of potassium hydroxide, aluminum nitrate, or ammonium hydroxide are used in several buildings for treating air prior to discharge.

After treatment, the gaseous effluents within the main plant ventilation system are discharged through a common stack (Stack 416). This stack is approximately 33 m (109 ft) high. The ventilation system has been operating since 1983, and approximately 90 percent of the plant's radioactive stack effluents are discharged through the main plant stack. The remaining gaseous effluents are released through short stacks or roof vents.

Table 2.2 summarizes some physical characteristics of all the process stacks and release points. Effluent data is provided in Section 4.1.

2.2.2.2 Liquid Waste Retention

There are three underground waste retention tanks; two have a 23-m^3 (6,000-gal) capacity and one has a 0.43-m^3 (140-gal) capacity. In addition, numerous aboveground waste tanks are used. All aboveground waste tanks are diked to contain leaks or spills.

The 0.43-m^3 retention tank is made of stainless steel and is filled with borosilicate raschig rings to eliminate possibility of nuclear criticality. This tank is buried within Building 233 near the east side and serves as an emergency collection system in case of a spill or rupture in any of the solvent-extraction columns located within the building. If the tank is used, it would be emptied and the contents would be reprocessed as soon as practicable in the Building [redacted] uranium waste recovery system.

The two other underground retention tanks are located adjacent to Buildings 105 and 303. These fiberglass tanks are used to collect uranium-bearing process wastes for sampling before reprocessing or release to the WWTF.

2.2.2.3 Liquid Effluents

- Process Wastes

The bulk of the aqueous process waste is piped to the WWTF. The general process at the WWTF includes adjustment of the pH of waste water on a batch basis with caustic soda (NaOH), followed by precipitation and removal of fluoride ions by the addition of lime slurry [$Ca(OH)_2$]. Subsequently, dissolved ammonia is removed by air stripping when the ambient air temperature is above 5°C (40°F) or by adding elemental chlorine for breakpoint chlorination when either the ambient temperature is below 5°C (40°F) or the air stripping is inefficient. After the ammonia is removed, the pH is adjusted to discharge values (6 to 9), and the waste water is discharged to the Nolichucky River via a direct pipeline. The average daily discharge is approximately 12,000 gallons. The process flow diagram for this facility is shown in Figure 2.6.

Table 2.2 Physical characteristics of NFS process stacks and wall fans.

Stack	Building	Effective diameter (m)	Height (m)	Gas exit velocity (m/s)	Potential contaminants	Control devices
27	234	0.41 x 0.45	7.6	5.23	Pu	HEPA
28	234	0.45 x 0.71	7.6	6.21	Pu	HEPA
29	234	0.17 x 0.30	8.6	3.17	Pu	HEPA
224	234	0.17 x 0.03	9.1	4.96	Pu	HEPA
376	301[a]	0.61	9.0	8.26	HEU	HEPA
103	110	0.35 x 0.41	4.0	8.09	Pu	HEPA
104	110	0.35 x 0.41	4.0	7.56	Pu	HEPA
278	111	0.15	7.0	16.9	LEU	Scrubber
287	111	0.41	12.0	10.8	LEU	Scrubber
320	130	0.23	9.0	4.65	LEU	Scrubber
354	110	0.30	6.0	4.28	HEU	HEPA
185	131	0.20	6.0	5.35	HEU	HEPA
416	300/200/105	1.52	33	11.57	HEU	Scrubber, HEPA
333	110	0.25	5.0	8.35	HEU	HEPA
332	120	0.20	6.0	13.18	HEU	HEPA
421	100	0.30	Horizontal vent.	15.3	HEU	None
W Wall Fan #1	111		4.5	2.03	LEU	None
W Wall Fan #2	111		4.5	2.03	LEU	None
N Wall Fan	111		4.5	1.08	LEU	None
S Wall Fan	111		3.0	0.04	LEU	None

[a]The exhaust from Building 301 is expected to be routed to the main ventilation system discharge through stack 416 (NFS 1982b).

Source: NFS 1984a.

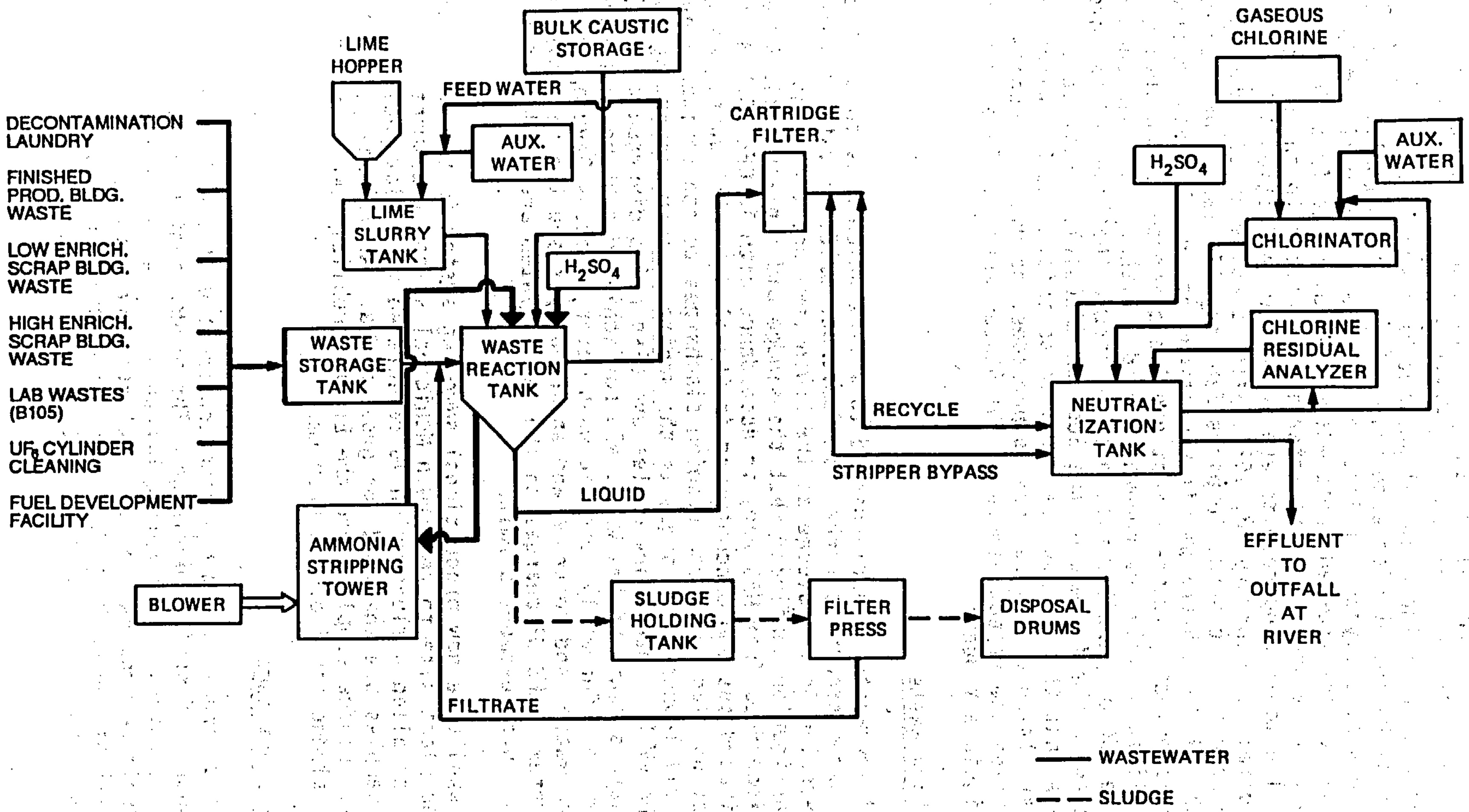

Figure 2.6. Waste Water Treatment Facility flow diagram.
Source: Oak Ridge National Laboratory
Drawing No. ES-6137.

Each batch going through the WWTF is analyzed for gross alpha and gross beta radioactivity before it is discharged. A monthly composite sample is analyzed for isotopes of uranium. The chemical parameters prescribed in the State of Tennessee National Pollutant Discharge Elimination System (NPDES) permit (Appendix B) are also analyzed, at least on the frequency specified in the permits. Samples of the treated waste water are collected from the final neutralization tank before the waste water is discharged to the Nolichucky River (Figure 2.7). The monitoring results are presented in Section 4.1. NFS received its new NPDES permit on February 28, 1991, after a November 29, 1990, public hearing on the permit. The permit expires February 27, 1996. NFS has committed to informing the NRC when NPDES permit violations occur. To show compliance with the Clean Water Act, licensees must provide evidence of continuing Section 401(a)(1) certification into the renewal period. Although NFS has committed to informing the NRC of permit violations, to insure that the NRC is informed of any changes in the effectiveness of the Section 401(a)(1) certification, the staff recommends that the licensee be required to inform the NRC within 30 days if the State-permitting agency revokes, supersedes, conditions, modifies or otherwise nullifies the effectiveness of the State-issued NPDES permit for the discharge of liquid effluents.

- Sanitary Waste

Plant sanitary wastes are discharged to a line which goes to the City of Erwin publicly owned treatment works. In September 1986, elevated levels of uranium were detected in the sludge at the Erwin sewerage treatment plant. The subsequent investigation confirmed that the sludge did contain enriched uranium. Although the discharges from NFS were in accordance with 10 CFR 20.303, the uranium precipitated out and concentrated in the sludge. NFS subsequently developed an Action Plan to reduce uranium discharges to the sanitary sewer. NFS eliminated all laundry discharges to the sanitary sewer, diverting the discharge to the WWTF. Laboratory wastes are also being diverted to the WWTF. By diverting waste streams to the WWTF, NFS has achieved a 98 percent reduction to the sewer system. Currently, organic wash water, Process Development Laboratory waste water, and restroom and shower output are the only discharges to the sewer system. NFS discharges to the sewer system are conducted in accordance with a pretreatment permit.

NFS has installed a new proportional sampling system in the sewer line leading from the plant site to the Erwin Municipal sewage treatment facility. They have also installed a flume which is calibrated to a flow measurement device. Daily samples are analyzed for gross alpha. Additionally, NFS has agreed to collect sludge samples from the Erwin - Publicly Owned Treatment Works and analyze the sludge for isotopic uranium.

- Surface Drainage

A new plant drainage system has been constructed at the NFS Erwin site for the control of surface drainage. The predominant flow is to the north where runoff enters Banner Spring Branch at three points within the fenced area. Drainage from east of the protected area (the parking lot and the hill northeast of the parking lot) enters the branch near the security fence downstream of the pumphouse (Figure 2.2). Subsequently, the flow

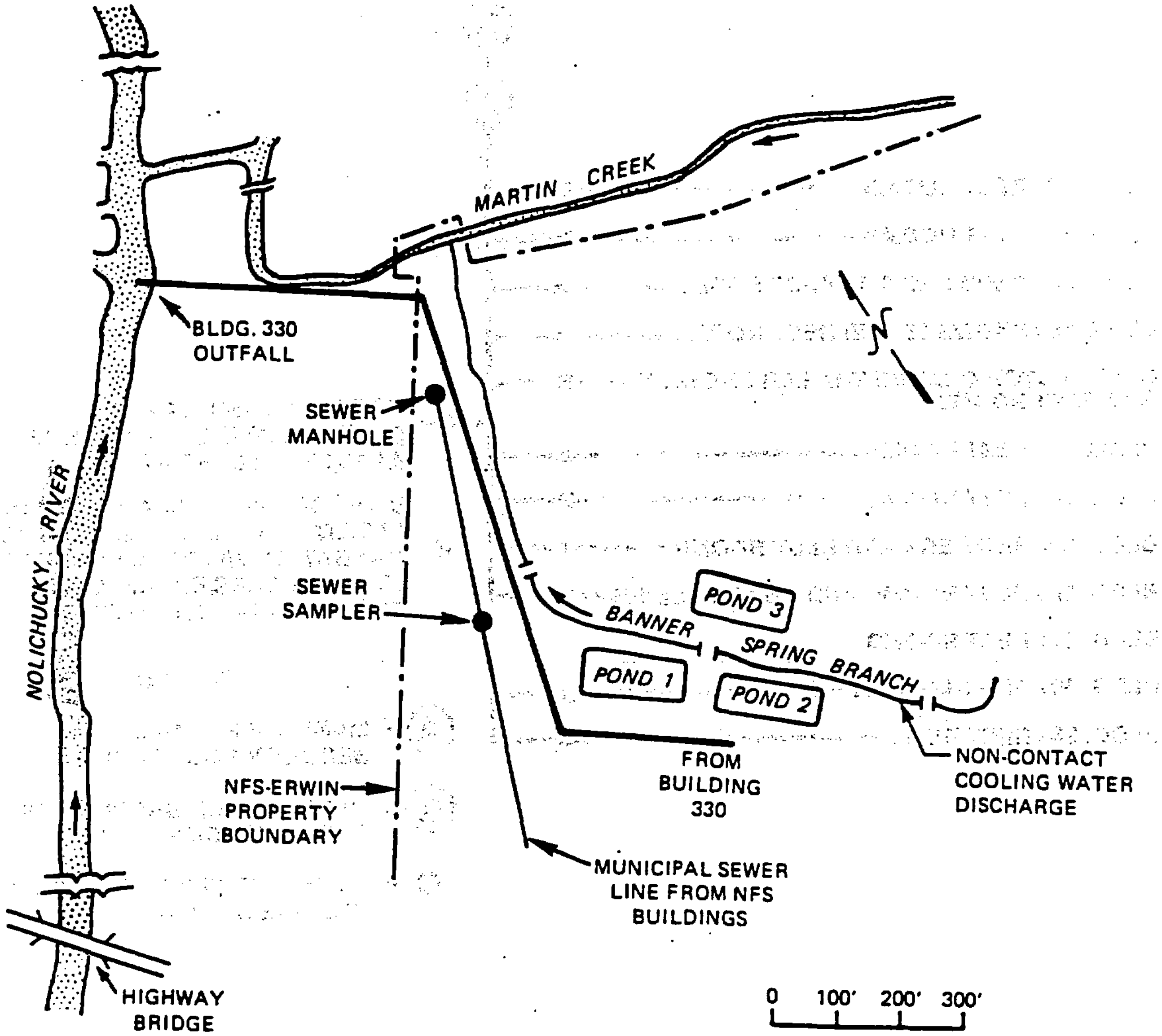

Figure 2.7. Liquid effluent release locations.
Source: Oak Ridge National Laboratory
Drawing No. ES-6136.

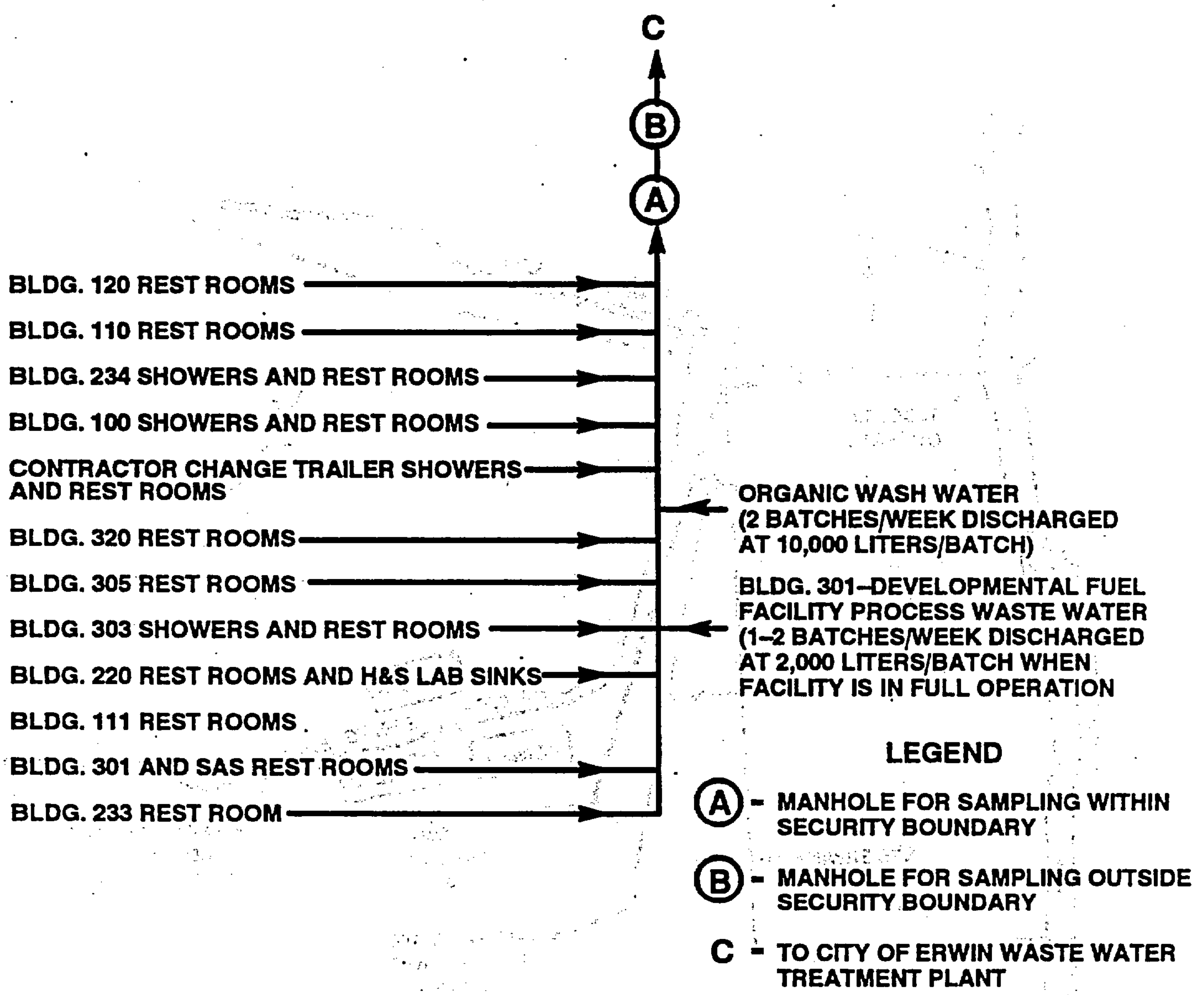

Figure 2.8. Inputs to the sanitary waste stream from the NFS Erwin Plant. Source: NFS 1986b.

enters Martin Creek, North Indian Creek, and then the Nolichucky River. Sluice gates located along each onsite flow path upstream from the discharge point can stop discharge into the Banner Spring Branch should a spill of hazardous material occur. This would enable cleanup of that area without the release of the contaminant to the environment.

- Previous Process Waste Treatment

Before 1977, treatment of liquid process waste consisted of pH adjustment and settling in unlined retention ponds (Figure 2.7). The effluent was then discharged to Banner Spring Branch, which flows into Martin Creek and then to North Indian Creek and the Nolichucky River. The effluent met existing water quality criteria with respect to radiological contaminants but did not meet water quality criteria for ammonia, nitrates, and fluorides.

The total volume of sediment in the ponds is approximately 86,000 cubic feet. Individual pond sediment volumes are reported as 42,000, 22,000, and 22,000 cubic feet in ponds 1, 2, and 3 respectively. The predominate radiological contaminants are isotopes of uranium and thorium. Table 2.3 provides the estimated concentrations of radionuclides in sediments from each pond.

Detailed characterization studies have been performed on the ponds. Additionally, NFS has conducted an extensive hydrogeological characterization study around the pond area as part of the closure plan for the ponds (Amendment 48). NFS has submitted a decommissioning plan for the ponds (NFS 1989). This plan was reviewed apart from the license renewal and is not dicussed in this document. The plan was approved by Amendment No. 62 on July 30, 1991.

2.2.2.4 Solid Waste Retention: Burial Grounds

All solid wastes contaminated with uranium are currently packaged for burial at a licensed waste disposal site.

Before 1981, NFS buried radioactive wastes at the site; however, new regulations (10 CFR Part 20) in 1981 prevented further burial. The burial ground location is shown in Figure 2.2. Two types of pits were used for wastes containing uranium or thorium. Small pits (70-1 through 70-11, Table 2.4) contain packaged uranium or thorium-contaminated wastes. Wastes in these pits are packaged in plastic-lined buckets or plastic bottles. The larger pits contain unpackaged, clean, or low-level uranium or thorium contaminated wastes. Waste in the large pits consists mainly of uncontaminated shipping containers, uncontaminated ash, low-level contaminated laboratory waste, and other miscellaneous items.

Before May 1970, regulations allowed up to 50 mCi of $^{234/235}U$ per pit. Each pit used after May 1970, when the regulations changed, contains 10 μCi or less of ^{235}U. The estimated quantities of radioactive material in each pit are shown in Table 2.4. All burial pits are covered and marked on all four corners with 6-inch-square, reinforced-concrete posts with metal end plates stamped for identification. Several ground water monitoring wells were drilled near the burial grounds to detect any seepage of radioactive material.

Table 2.3
Radionuclide Concentrations In
NFS Pond Sediment
(pCi/g dry)

Nuclide	Pond 1	Pond 2	Pond 3	Weighted Average *
U-238	1870	1220	3750	2178
Th-234	1870	1220	3750	2178
Pa-234m	1870	1220	3750	2178
U-234	21028	5301	9904	14315
Th-230	1288	848	2203	1407
Ra-226	21	7	37	22
U-235	404	211	625	411
Th-231	404	211	625	411
Th-232	4430	4600	8530	5498
Ra-228	3650	3850	7260	4603
Ac-228	3650	3850	7260	4603
Th-228	3400	3480	6340	4155
Ra-224	3400	3480	6340	4155
Rn-220	3400	3480	6340	4155
Po-216	3400	3480	6340	4155
Pb-212	3520	3420	6380	4210
Bi-212	3520	3420	6380	4210
Tl-208	1180	1270	2270	1475
Po-212	2180	2230	4060	2663
Pu-238	42	2.6	13	25
Pu-239	435	27	131	257
Pu-240	148	9	44	87
Pu-241	1490	91	448	880
Pu-242	0	0	0	0
Am-241	229	14	69	135

*Average is weighted based on sediment volume contained in each pond.

Source: NFS 1989.

A second burial area was located in two trenches outside the security fence, near the northwest corner of the plant. These trenches are actually on property belonging to the Clinchfield Railroad. These burial trenches were utilized in 1969; however, much of the buried material was later exhumed, decontaminated, and sold as clean scrap. The burial area is grass covered and

Table 2.4. Summary of radioactive waste burial at the NFS site at Erwin, Tennessee.

Pit No.	Closure date	Quantity	Nuclides	Mass	Description
Large pits					
66-1	December 1966	65.4 mCi	U-93% enriched	96 g	Mostly noncombustible trash
			Dep U	86.2 Kg	
			Thorium	126.0 Kg	
67-1	November 1967	68.4 mCi	U-93% enriched	357 g	Combustibles
			Dep U	33 g	
			Thorium	131 Kg	
68-1	No date	35.4 mCi	Dep U	117.6 Kg	
			Thorium	63.1 Kg	
69-1		(0)			
69-2		(0)			
69-3	July	30.0 mCi	Thorium	271.2 Kg	Trash
			Enriched U	0.5 g	
69-4	June	98.0 mCi	Thorium	400 Kg	283 m^3 (10,000 ft^3) of trash and 12 drums
			U-235	0.6 g	
69-5	July	0.04 mCi	U-235	1 g	Contaminated trailer
69-6	October	2.5 mCi	Dep U	2.3 g	
			U-235	53.4 g	
			U-233	<1 g	
			Pu-239	1 µg	
			Thorium	600 g	
69-12	December 1969	0.2 mCi	U-238	129 g	
			U-235	3 g	
			Thorium	160 g	
Small pits					
70-1	June 1970	3.8 mCi	U-97% enriched	491 g	
70-2	March 1970	2.7 mCi	U-97% enriched	34.7 g	
70-3	March 1970	48.7 mCi	U-97% enriched	629 g	
70-4	March 1970	50 mCi	U-70% enriched	2201 g	Bottles and 19 L (5-gal) cans
70-5	March 1970	49.1 mCi	U-88% enriched	629 g	
			U-20% enriched	3195 g	
			U-20% enriched	600 g	
			U-52% enriched	42 g	
70-6	April 1970	53.31 mCi	U-93% enriched	108.6 g	
			U-76.38% enriched	704 g	
			U-52% enriched	1551 g	
			U-20% enriched	50 g	
			U-16% enriched	56 g	
70-8	April 1970	49.28 mCi	U-238	15557 g	
			U-235	1289 g	
70-9	April 1970	2.6 µCi	Dep U	11 g	
70-10	May 1970	76.3 mCi	U-97% enriched	1.244 g	
			93% press cake	867 g	
70-11	May 1970	87 mCi	93%-U enriched	1046.8 g	
Large pits					
71,72-1	August 1973	0.228 mCi	97%-U enriched	0.003 g	
		2.76 mCi	Dep U	11.35 Kg	
73,74-1	May 1977	1.747 µCi	U-235	22.831 mg	
			U-235-5%	4 mg	
			U-235-93%	106 mg	
75-2	May 1975	6.5 µCi	Enriched U	4.87 g	
75-3	May 1975	9.2 µCi	Enriched U	6.88 g	
75-4	May 1975	3 µCi	Enriched U	2.29 g	
76,75, 74,73-1	1977	6.2 µCi	U-93% enriched	22.831 mg	
			U-5% enriched	4 mg	
			U-93% enriched	101 mg	

Source: NFS 1984a.

relatively level, with the trench covering slightly mounded and a shallow depression (drainage ditch) immediately northwest of the trenches. A new security fence is being erected approximately 30 feet outside of the existing fence. The burial pits will be within the isolation zone between the fences, except for a small portion which would extend just beyond the new fence.

NFS also buried nonradioactive solid wastes onsite until 1984. These wastes consisted of incinerator ash, packaging materials, construction debris, and the like. The most recent wastes were buried in three trenches [each approximately 45 m (150 ft) long, 6 to 7 m (20 to 25 ft) wide, and 1 to 1.3 m (3 to 4 ft) deep] directly east of the radioactive waste burial pits.

In 1987, Oak Ridge Associated Universities (ORAU) conducted a radiological characterization study of the burial grounds (ORAU, 1987). Radiological measurements identified no evidence of offsite subsurface migration or ground water contamination from the sites. Several conditions were identified which increase the potential of water infiltration and future subsurface migration. Additionally, areas of surface and near surface contamination were present on the burial areas. NFS has sealed boreholes, removed trees on or near the burial ground, removed contaminated soil, compacted and contoured the area for positive drainage and erosion control, established a vegetative cover, added the area to the environmental monitoring program (vegetation, soil, and air monitoring), and erected a fence to eliminate access by the general public. These improvements were part of the burial ground enhancement project (NFS 1990a, 1990b).

2.2.2.5 Contaminated Soil Removal and Storage

In the early years of operation of the NFS facility, Banner Spring Branch followed a westward course beyond the site boundary into the railroad right-of-way before turning northward to Martin Creek. Subsequently, NFS altered the course of Banner Spring Branch so the stream was totally on the site, as shown in Figure 2.2. The original stream course on the railroad right-of-way was subsequently found to be contaminated above an acceptable level. In compliance with License Amendment No. 8 (NRC 1980) approving the NFS General Soil Decontamination Plan, about 3,300 m^3 (119,000 ft^3) of contaminated soil was removed from the railroad property and placed in a mound within the site (NFS 1984b), as shown on Figure 2.2. NFS is committed to stabilizing the soil mound to minimize erosion and possible contamination of Banner Spring Branch.

2.3 DECOMMISSIONING

All major material licensees have been required to submit a general decommissioning plan to be put into effect at the end of plant life. This plan describes how the facilities and grounds will be decontaminated so that they can be released for unrestricted use. The plan identifies and discusses the major factors that influence the cost of decontaminating the facilities and grounds and provides a cost estimate for these activities. In the past, the decommissioning plan and a corporate commitment to provide funds for this effort were incorporated as conditions of the license.

On March 16, 1978, such conditions pertaining to the general facilities and grounds were incorporated into License No. SNM-124. At the same time, license conditions were added that required decontamination and decommissioning of the plutonium and ^{233}U facilities within an agreed upon schedule. As stated in Section 2.2.1.2, the ^{233}U facilities have been decontaminated, and NFS states that remaining contamination attributable to ^{233}U is less than the specified limits for decommissioning.

The NRC published the final rule on general requirements for decommissioning nuclear facilities on June 27, 1990 (FR 53-24018). These regulations set forth technical and financial criteria for decommissioning. NFS operations are subject to the new requirements. As a requirement to receive a 10-year renewal, NFS will be required to submit the decommissioning funding plan within 2 years of the renewal.

2.4 SAFEGUARDS

Current safeguards requirements are set forth in 10 CFR Parts 70 and 73. The regulations in Part 70 provide for material accounting and control requirements with respect to facility organization, material control arrangements, accountability measurements, statistical controls, inventory methods, shipping and receiving procedures, material storage practices, records and reports, and management control.

10 CFR Part 73 provides requirements for the physical security and protection of fixed sites and for nuclear material in transit. Physical security requirements for protecting formula quantities of strategic SNM include (1) establishing and training a security organization with armed guards, (2) installing physical barriers, and (3) establishing security response and safeguards contingency plans.

The NRC's regulations in 10 CFR Parts 70 and 73, described briefly above, are applied in the reviews of individual license applications. License conditions are tailored to fit the particular type of plant or facility involved.

The licensee has an approved material control and accounting plan and an approved physical security plan that meet the current requirements. The staff concludes, therefore, that the safeguards-related environmental impact of the proposed action is insignificant.

2.5 STAFF EVALUATION OF THE PROPOSED ACTION AND ALTERNATIVES

The staff has determined that the various operations at the NFS Erwin Plant are performed in a manner that protects both the public and the environment from unusual or adverse impacts. The licensee has incorporated suggested changes to the environmental program. These changes will enhance NFS's monitoring program. Additionally, the following recommendations are made to further improve NFS's environmental program:

1. Within 90 days, NFS should establish a routine ground water monitoring program for the two burial grounds and submit the program for NRC approval.

2. Within 90 days, NFS should establish an effective monitoring system for leakage detection for the underground storage tanks and submit the plan for NRC approval.

3. Within 30 days, NFS should determine if there are residents within 1600m (1 mile) of the site in the northwest quadrant, and if so, place an ambient monitoring station at the nearest residence in that area to collect continuous air samples for environmental air sample analysis. This station may be deleted after 2 years if the criteria in Section 5.2.1 of the license application are met.

4. NFS should inform the NRC within 30 days if the State-permitting agency revokes, supersedes, conditions, modifies, or otherwise nullifies the effectiveness of the State-issued NPDES permit for the discharge of liquid effluents.

Upon issuance of the license, these recommendations will be imposed as license conditions.

REFERENCES FOR SECTION 2

EPA (Environmental Protection Agency). 1972. "Air Pollution Emission Factors." PG209559. Washington, D.C.

NFS (Nuclear Fuel Services, Inc.). 1976. "Environmental Information Report on the Nuclear Fuel Services, Inc., Operation at Erwin, Tennessee" (part of license renewal application). January.

NFS (Nuclear Fuel Services, Inc.). 1982a. Letter with attachment from Richard L. Ideker, NFS, to R. G. Page, NRC, Docket 70-143. December 20.

NFS (Nuclear Fuel Services, Inc.). 1982b. Letter with attachment from C. J. Michel, NFS, to R. G. Page, NRC, Docket 70-143. August 5.

NFS (Nuclear Fuel Services, Inc.). 1983. Letter from F. K. Guinn, NFS, to W. T. Crow, NRC, Docket 70-143. June 3.

NFS (Nuclear Fuel Services, Inc.). 1984a. "Environmental Report, Erwin Plant, Erwin, Tennessee." July.

NFS (Nuclear Fuel Services, Inc.). 1984b. Letter with attachment from R. L. Ideker, NFS, to R. G. Page, NRC, Docket-70-143. November 20.

NFS (Nuclear Fuel Services, Inc.). 1985. Letter with attachment containing NFS responses to NRC site visit questions from R. L. Ideker, NFS, to Stephen D. Wyngarden, NRC, Docket 70-143. February 8.

NFS (Nuclear Fuel Services, Inc.). 1986a. Letter from J. R. Clark, NFS, to J. P. Stohr, NRC, Docket No. 70-143. May 28.

NFS (Nuclear Fuel Services, Inc.). 1986b. Letter from B. E. Knight, NFS, to E. Y. Shum, NRC, Docket 70-143. February 19.

NFS (Nuclear Fuel Services, Inc.). 1989. Letter with attachment from J. A. Long, NFS, to NRC, Docket 70-143. November 17.

NFS (Nuclear Fuel Services, Inc.). 1990a. Letter with attachment from A. M. Maxin, NFS, to G. L. Sjoblom, NRC, Docket 70-143. January 19.

NFS (Nuclear Fuel Services, Inc.). 1990b. Letter with attachment from D. Paine, NFS, to C. J. Haughney, NRC, Docket 70-143. December 28.

NFS (Nuclear Fuel Services, Inc.). 1991. Letter with attachments from D. Paine, NFS, to C. J. Haughney, NRC, Docket 70-143. May 15.

NRC (Nuclear Regulatory Commission). 1980. Letter from R. G. Page, NRC, to C. J. Michel, NFS, detailing Amendment No. 8 to License SNM-124. Docket 70-143. August 15.

ORAU (Oak Ridge Associated Universities). 1987. Radiological Characterization Onsite Waste Burial Areas Nuclear Fuel Services, Inc., Erwin, Tennessee. September.

3. AFFECTED ENVIRONMENT

3.1 SITE DESCRIPTION

The NFS Erwin Plant is located in Unicoi County in northeastern Tennessee (Figure 3.1). The plant is approximately 0.9 km (0.56 mile) southwest of the city limits of Erwin and is immediately northwest of the unincorporated community of Banner Hill. The plant site occupies 23.4 ha (57.8 acres) of relatively level land in a long, narrow mountain valley (Indian Creek Valley) oriented in a southwest-to-northeast direction. The valley is bounded on both sides by the Appalachian Mountains, which rise to elevations of 900 to 1500 m (3,000 to 5,000 ft) within several kilometers of the site. The developed portion of the site is about 9 m (30 ft) in elevation above the nearest point on the Nolichucky River [0.3 km (0.2 mile) northwest of the plant].

The site is surrounded mostly by privately owned property and is bounded in part by Carolina Avenue to the southeast, the Clinchfield Railroad right-of-way to the northwest, and Martin Creek to the northeast (Figure 2.2). More than half of the site is occupied by plant buildings and associated building grounds, parking lots, outdoor storage areas, settling ponds, and solid waste burial grounds. There are also small wooded areas and open fields on the site.

3.2 CLIMATOLOGY AND METEOROLOGY

3.2.1 Climatology

The climate of the Erwin vicinity is characterized by warm, humid summers and relatively mild winters. Temperatures at higher elevations in the surrounding mountains are lower. 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 Erwin area has a relatively high annual precipitation of 117 to 137 cm (46 to 54 in.) (NFS 1984, State of Tennessee 1983, NOAA 1978). The greatest precipitation occurs in the late winter and early spring during widespread storms; a secondary maximum occurs in midsummer in association with local thunderstorm and shower activities. Yearly snowfall is 25 to 38 cm (10 to 15 in.). Average temperatures range from 24°C (75°F) in July to 2°C (36°F) in January; the annual average is 13°C (56°F). Winds are predominantly from the southwest, averaging 8 km/h (5 miles/h). The length of the growing season between killing frosts averages 180 days.

3.2.2 Winds, Tornadoes, and Storms

Severe storms are infrequent in the Erwin region, which is east of the center of tornado activity, south of most blizzard conditions, and too far

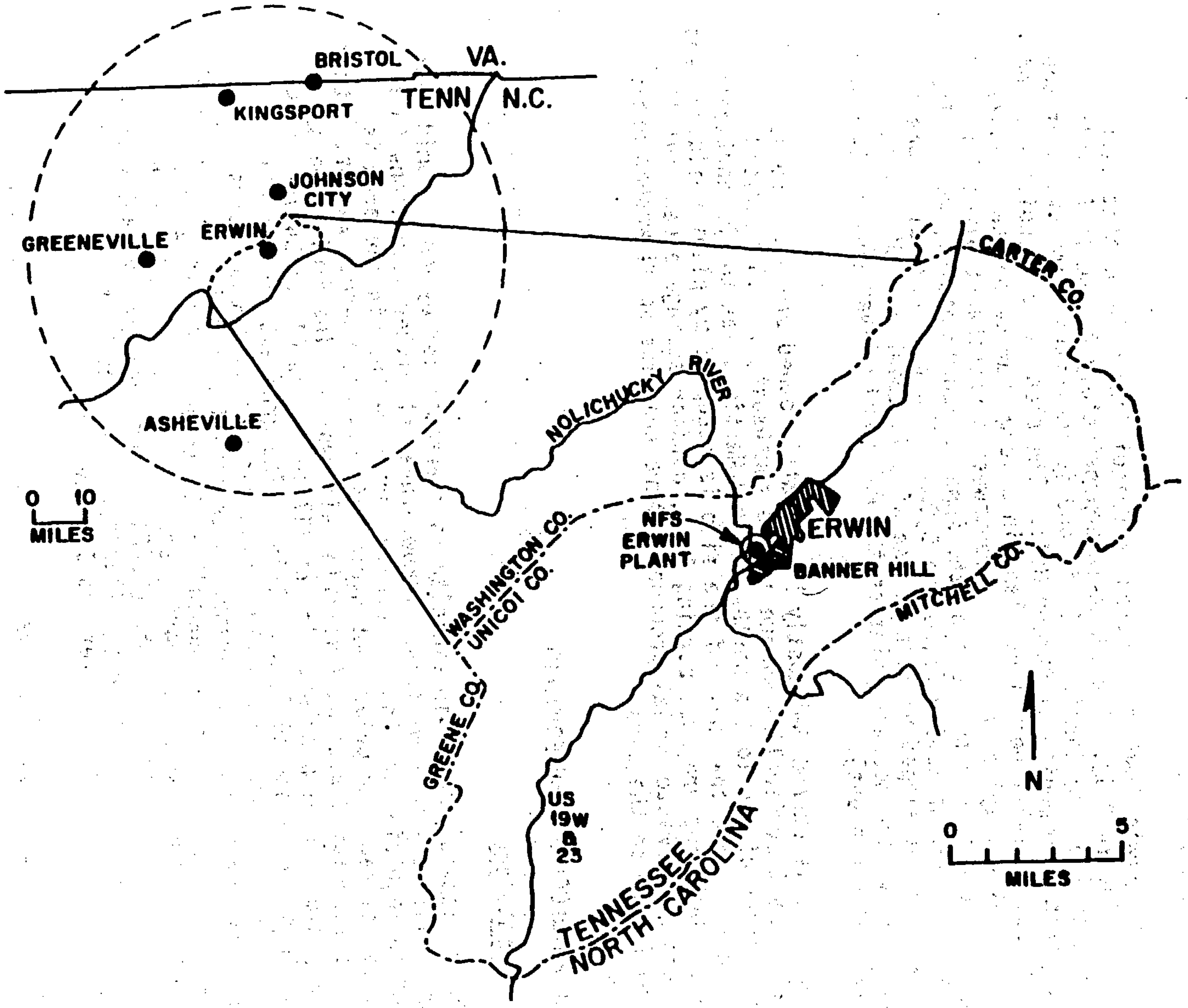

Figure 3.1. Location map of the NFS site at Erwin, Tennessee.
Source: NFS 1984.

inland to be often affected by hurricanes (NOAA 1978). Maximum sustained winds (at the nearest airport, Tri-City Airport near Kingsport) include a 80 km/h (50 mile/h) wind in 1951 and a 64 km/h (40 mile/h) wind in August 1962 (NRC 1978, NFS 1984). Only one tornado has been recorded in Unicoi County since 1950.

3.2.3 Meteorology

The onsite meteorological data for wind speed and direction are obtained from a Bendix Corporation Aerovane Transmitter and recorded on a Bendix Stripchart Recorder. The strip charts are analyzed and converted into wind roses and frequency distribution charts. The wind rose for the Erwin site is shown in Figure 3.2. As shown in this figure, the wind emanates from a generally southern quadrant (S 68°W to S 22°E) about 60 percent of the time and from the north to north-northwest about 20 percent of the time. The average wind speed is about 6.4 km/h (4 miles/h) in both principal wind directions. Winds rarely exceed 30 km/h (19 miles/h). Atmospheric dispersion factors (χ/Q) have been calculated (NRC 1983 and 1984) on an annual basis at downwind distances up to 80 km (50 miles) in 16 compass directions. The calculations were made using (1) a Gaussian plume model described in NUREG/CR-2919 (NRC 1982), (2) wind speed and direction data from the Erwin site for October 1979 to September 1981, and (3) atmospheric stability frequencies typical of the topography of the site (NRC 1983). Dispersion factors were obtained for both ground-level (Table 3.1) and elevated (Table 3.2) discharge points because approximately 11 percent of the uranium contamination is released from ground-level vents or short stacks (subject to building wake effects) and 89 percent from the elevated (33-m) main process stack. The largest depositions from ground-level releases (Table 3.1) occur on the agricultural property between the railroad and the Nolichucky River north to northwest of the NFS site (Figure 2.1). The annual average χ/Q at the nearest residence (Section 3.3) from ground-level releases is 2.5×10^{-4} s/m^3 (NRC 1983). The largest deposition from the main process stack occurs about 800 m (0.5 mile) northwest of the stack (NRC 1984). This is a wooded hillside on the other side of the Nolichucky River where there are few or no residents. The largest deposition from the stack in a residential area occurs about 0.8 to 1.2 km (0.5 to 0.75 mile) in a northeast direction; a slightly smaller deposition occurs south and southeast of the stack (Table 3.2).

3.2.4 Air Quality

Unicoi County is located within the Eastern Tennessee-Southwestern Virginia Air Quality Control Region. Air quality in Unicoi County meets the national and state standards (Table 3.3) for particulate matter, sulfur dioxide, and carbon monoxide but violates standards for ozone and nitrogen dioxide, as does air quality throughout Tennessee (40 CFR Part 81, revised July 1984). The status of lead and fluoride (HF) in the air in the Erwin area is not reported. However, the pollution controls at NFS should ensure that any HF in the plant air would be converted to particulate matter and mostly collected in filters and scrubbers. There is no reported use of lead by NFS, so any lead in the ambient atmosphere would arise from other activities.

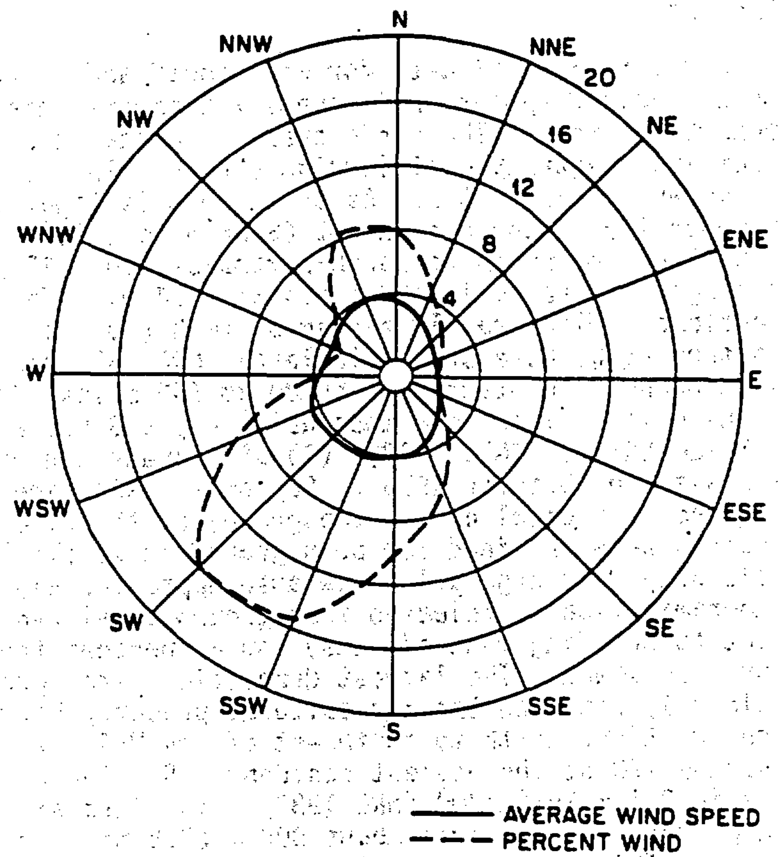

Figure 3.2. Frequency of wind direction and (percent) average wind speeds (miles/h) for the period of June 29, 1979, to December 31, 1983. Source: NFS 1984.

Table 3.1. Annual average atmospheric dispersion factors (χ/Q in s/m^3) by distance and direction from ground-level emissions at the NFS site.

Direction from site	Distance (miles)						
	0.25	0.5	0.75	1.0	2.0	3.0	4.0
S [a]	1.130×10^{-4}	3.396×10^{-5}	1.642×10^{-5}	1.003×10^{-5}	2.169×10^{-6}	1.151×10^{-6}	7.385×10^{-7}
SSW	1.315×10^{-4}	3.961×10^{-5}	1.915×10^{-5}	1.170×10^{-5}	3.807×10^{-6}	2.024×10^{-6}	1.301×10^{-6}
SW	1.481×10^{-4}	4.476×10^{-5}	2.164×10^{-5}	1.323×10^{-5}	4.316×10^{-6}	2.299×10^{-6}	1.480×10^{-6}
WSW	9.308×10^{-5}	2.814×10^{-5}	1.360×10^{-5}	8.320×10^{-6}	2.715×10^{-6}	1.447×10^{-6}	9.320×10^{-7}
W	7.868×10^{-5}	2.378×10^{-5}	1.149×10^{-5}	7.029×10^{-6}	2.293×10^{-6}	1.222×10^{-6}	7.870×10^{-7}
WNW	1.193×10^{-4}	3.608×10^{-5}	1.744×10^{-5}	1.067×10^{-5}	3.482×10^{-6}	1.856×10^{-6}	1.196×10^{-6}
NW	2.042×10^{-4}	6.177×10^{-5}	2.985×10^{-5}	1.826×10^{-5}	5.963×10^{-6}	3.180×10^{-6}	2.049×10^{-6}
NNW	1.428×10^{-3}	4.310×10^{-4}	2.083×10^{-4}	1.274×10^{-4}	4.151×10^{-5}	2.210×10^{-5}	1.422×10^{-5}
N	3.234×10^{-4}	9.755×10^{-5}	4.716×10^{-5}	2.883×10^{-5}	9.388×10^{-6}	4.995×10^{-6}	3.213×10^{-6}
NNE	4.208×10^{-4}	1.269×10^{-4}	6.135×10^{-5}	3.750×10^{-5}	1.221×10^{-5}	6.494×10^{-6}	4.177×10^{-6}
NE	2.917×10^{-4}	8.789×10^{-5}	4.249×10^{-5}	2.597×10^{-5}	8.448×10^{-6}	4.491×10^{-6}	2.888×10^{-6}
ENE	1.122×10^{-4}	3.376×10^{-5}	1.633×10^{-5}	9.975×10^{-6}	3.241×10^{-6}	1.721×10^{-6}	1.106×10^{-6}
E	6.707×10^{-5}	2.019×10^{-5}	9.761×10^{-6}	5.964×10^{-6}	1.939×10^{-6}	1.030×10^{-6}	6.619×10^{-7}
ESE	3.895×10^{-5}	1.172×10^{-5}	5.665×10^{-6}	3.461×10^{-6}	1.124×10^{-6}	5.965×10^{-7}	3.831×10^{-7}
SE	5.462×10^{-5}	1.641×10^{-5}	7.932×10^{-6}	4.845×10^{-6}	1.571×10^{-6}	8.332×10^{-7}	5.347×10^{-7}
SSE	9.759×10^{-5}	2.323×10^{-5}	1.123×10^{-5}	6.857×10^{-6}	2.216×10^{-6}	1.172×10^{-6}	7.505×10^{-7}

Direction from site	Distance (miles)					
	5.0	10.0	20.0	30.0	40.0	50.0
S	5.249×10^{-7}	1.838×10^{-7}	6.391×10^{-8}	3.413×10^{-8}	2.171×10^{-8}	1.519×10^{-8}
SSW	9.258×10^{-7}	2.169×10^{-7}	7.571×10^{-8}	4.052×10^{-8}	2.580×10^{-8}	1.807×10^{-8}
SW	1.055×10^{-6}	3.721×10^{-7}	1.304×10^{-7}	6.994×10^{-8}	4.461×10^{-8}	3.128×10^{-8}
WSW	6.642×10^{-7}	2.346×10^{-7}	8.227×10^{-8}	4.415×10^{-8}	2.817×10^{-8}	1.976×10^{-8}
W	5.608×10^{-7}	1.980×10^{-7}	6.938×10^{-8}	3.722×10^{-8}	2.374×10^{-8}	1.665×10^{-8}
WNW	8.524×10^{-7}	3.012×10^{-7}	1.057×10^{-7}	5.674×10^{-8}	3.621×10^{-8}	2.540×10^{-8}
NW	1.460×10^{-6}	5.163×10^{-7}	1.812×10^{-7}	9.730×10^{-8}	6.210×10^{-8}	4.357×10^{-8}
NNW	1.013×10^{-5}	3.570×10^{-6}	1.249×10^{-6}	6.695×10^{-7}	4.268×10^{-7}	2.991×10^{-7}
N	2.287×10^{-6}	8.051×10^{-7}	2.814×10^{-7}	1.507×10^{-7}	9.602×10^{-8}	6.727×10^{-8}
NNE	2.973×10^{-6}	1.046×10^{-6}	3.656×10^{-7}	1.958×10^{-7}	1.247×10^{-7}	8.739×10^{-8}
NE	2.055×10^{-6}	7.223×10^{-7}	2.521×10^{-7}	1.349×10^{-7}	8.591×10^{-8}	6.017×10^{-8}
ENE	7.864×10^{-7}	2.760×10^{-7}	9.616×10^{-8}	6.142×10^{-8}	3.273×10^{-8}	2.291×10^{-8}
E	4.708×10^{-7}	1.653×10^{-7}	5.761×10^{-8}	3.081×10^{-8}	1.961×10^{-8}	1.373×10^{-9}
ESE	2.724×10^{-7}	9.550×10^{-8}	3.326×10^{-8}	1.778×10^{-8}	1.132×10^{-8}	7.921×10^{-9}
SE	3.799×10^{-7}	1.330×10^{-7}	4.623×10^{-8}	2.469×10^{-8}	1.570×10^{-8}	1.098×10^{-8}
SSE	5.234×10^{-7}	1.854×10^{-7}	6.410×10^{-8}	3.413×10^{-8}	2.166×10^{-8}	1.513×10^{-8}

[a]The calculated χ/Q at the nearest actual residence about 0.155 mile south of the plant is 2.5×10^{-4} s/m^3.

Source: NRC 1983.

Table 3.2. Annual average atmospheric dispersion factors (χ/Q in s/m^3) by distance and direction from elevated (108 ft) stack emissions at the NFS site.

Direction from site	Distance (miles) 0.25	0.5	0.75	1.0	2.0	3.0	4.0
S [a]	2.107×10^{-7}	2.179×10^{-6}	5.303×10^{-6}	3.658×10^{-6}	1.068×10^{-6}	6.616×10^{-7}	4.678×10^{-7}
SSW	9.384×10^{-8}	1.017×10^{-6}	1.545×10^{-6}	1.736×10^{-6}	1.677×10^{-6}	1.084×10^{-6}	7.847×10^{-7}
SW	2.861×10^{-8}	7.638×10^{-8}	3.516×10^{-7}	7.229×10^{-7}	1.703×10^{-6}	1.143×10^{-6}	8.441×10^{-7}
WSW	1.116×10^{-8}	1.753×10^{-8}	4.889×10^{-8}	4.113×10^{-6}	2.483×10^{-6}	1.328×10^{-6}	8.581×10^{-7}
W	4.118×10^{-9}	2.050×10^{-5}	1.017×10^{-5}	6.190×10^{-6}	2.014×10^{-6}	1.075×10^{-6}	6.939×10^{-7}
WNW	9.480×10^{-9}	3.087×10^{-5}	1.527×10^{-5}	9.289×10^{-6}	3.022×10^{-6}	1.613×10^{-6}	1.041×10^{-6}
NW	3.031×10^{-8}	5.294×10^{-5}	2.535×10^{-5}	1.552×10^{-5}	5.124×10^{-6}	2.752×10^{-6}	1.781×10^{-6}
NNW	3.785×10^{-7}	3.363×10^{-6}	4.544×10^{-6}	4.968×10^{-6}	4.610×10^{-6}	3.932×10^{-6}	3.358×10^{-6}
N	1.276×10^{-7}	2.230×10^{-5}	3.704×10^{-7}	4.968×10^{-6}	4.610×10^{-6}	3.932×10^{-6}	3.358×10^{-6}
NNE	2.131×10^{-7}	3.498×10^{-7}	5.525×10^{-7}	6.923×10^{-7}	1.121×10^{-5}	6.040×10^{-6}	3.927×10^{-6}
NE	2.581×10^{-7}	2.326×10^{-5}	1.396×10^{-5}	1.034×10^{-5}	4.845×10^{-6}	2.987×10^{-6}	2.094×10^{-6}
ENE	2.002×10^{-7}	7.711×10^{-7}	9.652×10^{-7}	1.001×10^{-6}	2.895×10^{-6}	1.554×10^{-6}	1.009×10^{-6}
E	7.741×10^{-8}	3.041×10^{-7}	5.290×10^{-7}	6.669×10^{-7}	1.727×10^{-6}	9.281×10^{-7}	6.024×10^{-7}
ESE	1.468×10^{-7}	6.656×10^{-7}	9.994×10^{-7}	1.062×10^{-6}	5.202×10^{-7}	3.286×10^{-7}	2.350×10^{-7}
SE	6.363×10^{-7}	4.470×10^{-6}	2.535×10^{-6}	1.745×10^{-6}	7.632×10^{-7}	4.722×10^{-7}	3.338×10^{-7}
SSE	7.385×10^{-7}	4.510×10^{-6}	3.062×10^{-6}	2.217×10^{-6}	9.871×10^{-7}	6.123×10^{-7}	4.349×10^{-7}

Direction from site	Distance (miles) 5.0	10.0	20.0	30.0	40.0	50.0
S	3.552×10^{-7}	1.452×10^{-7}	5.464×10^{-8}	2.980×10^{-8}	1.918×10^{-8}	1.343×10^{-8}
SSW	6.047×10^{-7}	1.700×10^{-7}	6.493×10^{-8}	3.558×10^{-8}	2.296×10^{-8}	1.623×10^{-8}
SW	6.582×10^{-7}	2.844×10^{-7}	1.098×10^{-7}	6.036×10^{-8}	3.899×10^{-8}	2.757×10^{-8}
WSW	6.136×10^{-7}	2.197×10^{-7}	7.877×10^{-8}	4.305×10^{-8}	2.792×10^{-8}	1.988×10^{-8}
W	4.955×10^{-7}	1.766×10^{-7}	6.287×10^{-8}	3.417×10^{-8}	2.205×10^{-8}	1.564×10^{-8}
WNW	7.431×10^{-7}	2.647×10^{-7}	9.414×10^{-8}	5.112×10^{-8}	3.296×10^{-8}	2.335×10^{-8}
NW	1.275×10^{-6}	4.560×10^{-7}	1.626×10^{-7}	8.843×10^{-8}	5.708×10^{-8}	4.047×10^{-8}
NNW	2.901×10^{-6}	1.652×10^{-6}	8.320×10^{-7}	5.376×10^{-7}	3.888×10^{-7}	2.997×10^{-7}
N	2.097×10^{-6}	7.539×10^{-7}	2.704×10^{-7}	1.476×10^{-7}	9.567×10^{-8}	6.808×10^{-8}
NNE	2.820×10^{-6}	1.020×10^{-6}	3.681×10^{-7}	2.019×10^{-7}	1.314×10^{-7}	9.380×10^{-8}
NE	1.577×10^{-6}	6.260×10^{-7}	2.274×10^{-7}	1.212×10^{-7}	7.678×10^{-8}	5.349×10^{-8}
ENE	7.234×10^{-7}	2.611×10^{-7}	9.399×10^{-8}	5.142×10^{-8}	3.336×10^{-8}	2.377×10^{-8}
E	4.323×10^{-7}	1.562×10^{-7}	5.624×10^{-8}	3.077×10^{-8}	1.997×10^{-8}	1.422×10^{-8}
ESE	1.797×10^{-7}	7.465×10^{-8}	2.834×10^{-8}	1.551×10^{-8}	9.997×10^{-9}	7.060×10^{-9}
SE	2.534×10^{-7}	1.035×10^{-7}	3.888×10^{-8}	2.118×10^{-8}	1.361×10^{-8}	9.590×10^{-9}
SSE	3.320×10^{-7}	1.400×10^{-7}	5.634×10^{-8}	3.267×10^{-8}	2.209×10^{-8}	1.624×10^{-8}

[a]The calculated χ/Q at the nearest actual residence about 0.155 mile south of the plant is 8.3×10^{-8} s/m^3.

Source: NRC 1984.

Table 3.3. Tennessee and Federal primary standards for ambient air quality.

Contaminants	Concentration (μg/m³)	Averaging interval
Sulfur dioxide	80 365a	annual 24 hours
Carbon monoxide	10,000 40,000	8 hours 1 hour
Ozone	235[a]	1 hour
Nitrogen dioxide	100	annual
Lead	1.5	Calendar quarter
Particulate matter	75 260[a]	annual 24 hours
Fluorides[b]	1.2 1.6 2.9 3.7	30 days 7 days 24 hours 12 hours

[a]The value given is not to be exceeded more than once per year.

[b]Fluorides expressed as HF; State standards only.

Source: "Environmental Reporter," Bureau of National Affairs (BNA), Inc., Washington, D.C., April 19, 1985.

3.3 DEMOGRAPHY

An estimate of the 1980 population within 80 km (50 miles) of the NFS plant is given in Table 3.4 for each of the 160 segments defined by 16 radial (compass) directions and 10 radial distances. The population in each circular zone (annulus) is represented as column totals in Table 3.4. The total population within 80 km (50 miles) of the site is 921,439.

The population within 8 km (5 miles) of NFS is about 10,000, mostly in the city of Erwin and adjacent communities to the northeast, east, and south. The nearest residents are located in the Banner Hill community immediately south and east of the plant site. The nearest individual residents are about 0.25 km (0.16 mile) south of the facility's main stack.

The city of Erwin provides the major commercial and industrial employment base for Unicoi County, which has a population of about 16,400. Washington County (population 84,200), including Johnson City, which is about 27 km (17 miles) north of NFS, also provides a major source of employment for

Table 3.4. Incremental 1980 population estimates by sectors within 80 km (50 miles) of the NFS site at Erwin, Tennessee.

	Miles[a]									
Sector	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	27	167	306	224	223	807	2858	4585	53439	25668
SSW	0	12	65	88	51	566	2066	10072	56865	34176
SW	0	12	65	40	45	541	1024	2710	3311	11704
WSW	0	7	30	35	45	621	1483	3118	4599	17905
W	0	3	16	45	65	1204	6815	22635	6696	41254
WNW	0	0	21	72	111	727	4764	6522	14452	11323
NW	2	10	93	85	123	1225	3702	5703	9712	6029
NNW	3	96	123	86	112	1677	5803	34723	36519	5657
N	14	261	235	148	133	2931	20778	30630	17242	6766
NNE	87	391	338	236	203	2559	54040	15311	63351	13783
NE	126	311	386	342	211	1162	20959	10055	5619	10220
ENE	205	438	307	360	221	807	4445	3427	6715	8198
E	141	640	150	80	113	621	2429	7604	7857	21154
ESE	79	319	47	51	52	311	3041	5790	2128	22673
SE	133	371	103	50	51	235	3132	8119	16133	23667
SSE	47	396	310	121	116	136	4592	2185	8298	6134
All sectors[b]	864	3440	2603	2063	1875	16130	141931	173186	313036	266311

Total population, 0-50 miles: 921,439

[a]Kilometers = miles x 1.6.

[b]Values in columns may not add up to listed total because of rounding of individual values within the computer matrix.

Source: Oak Ridge National Laboratory.

residents of the Erwin area. The 700 employees of NFS (Section 2.2.1) represent only 2 percent of the estimated potential workers in Unicoi and Washington Counties.

3.4 LAND

3.4.1 Site Area

About 60 percent of the 23.4-ha (57.8-acre) site is or has been used for activities associated with the nuclear materials operations licensed by the NRC and is occupied by buildings, building grounds, waste ponds, solid waste burial grounds, and a parking lot (Figure 2.1, Table 3.5). The remainder of the site includes woods, brushland, shrub swamp, and open fields.

Table 3.5. Land uses on the NFS site.

Area	Percent of site (approx.)	Area (approx.)	
		hectares	acres
Buildings and grounds	33	7.7	19.1
Waste ponds and solid waste burial grounds	20	4.7	11.6
Parking lot	7	1.6	4.0
Open fields	29	6.8	16.8
Woods, brush, and shrub swamp	11	2.6	6.4
Total	100	23.4	57.9

Source: NFS 1984.

3.4.2 Adjacent Area

The area adjacent to the Erwin facility consists primarily of residential, industrial, and commercial areas, although a small amount of agricultural land lies to the northwest (Figure 3.3, Table 3.6). Within the mountain valley containing the site (Section 3.1), developed areas predominate to the northeast, and agricultural lands predominate to the southwest. The mountainous areas adjoining the valley consist of extensive forests of the Cherokee National Forest.

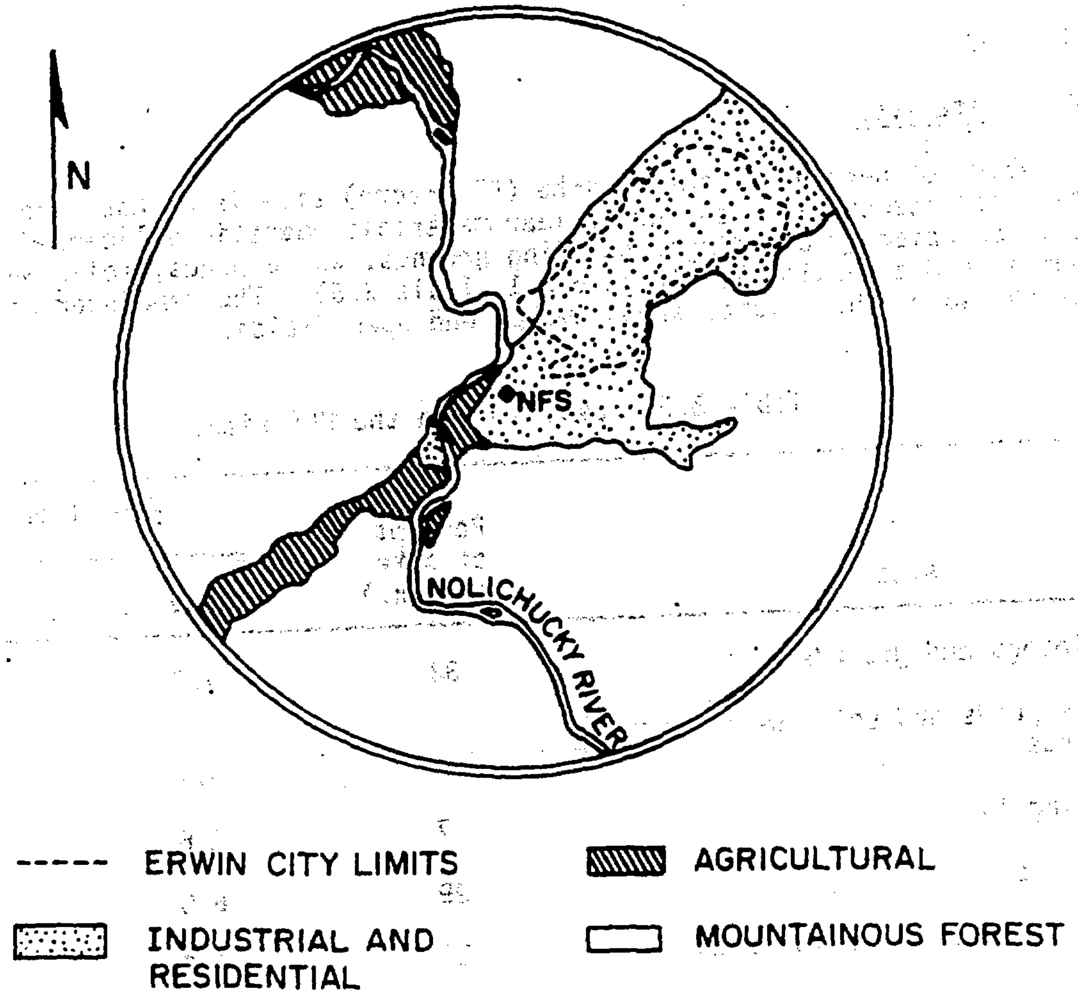

Figure 3.3. Land uses within 4.8 km (3 miles) of the NFS Erwin Plant. Source: NFS 1984.

Table 3.6. Land uses within 4.8 km (3 miles) of the NFS Erwin Plant.

Land Use	Percent of total area (7323 ha or 18,096 acres)
Residential	13.8
Commercial	1.1
Industrial	4.4
Farms, suburban homes	7.2
Mountainous forest land	73.5
Total	100.0

Source: NFS 1977.

The U.S. Soil Conservation Service has estimated that there are 132 ha (325 acres) of prime and unique farmland within 4.8 km (3 miles) of the NFS plant (NFS 1977). Important crops include tobacco, hay, corn, tomatoes, and strawberries. Many residents in the area have gardens and grow a variety of fruits and vegetables including summer squash, green beans, tomatoes, okra, sweet corn, and others. In the area, beef, swine, and dairy productions are low.

3.4.3 Historic Significance of Area

The Clarksville Iron Furnace is the only historic site in Unicoi County listed on the National Register of Historic Places (DOI 1979-1983). It is located west of Erwin off Tennessee Highway 107 in the Cherokee National Forest and is owned by the U.S. Forest Service. No archaeological sites are listed in the National Register of Historic Places for Unicoi County.

3.4.4 Floodplains and Wetlands

The Erwin site is located on the floodplain of the Nolichucky River where the greatest recorded flood elevation was 501 m (1,644 ft) above mean sea level (AMSL) before the Erwin Plant was built (NFS 1984). Elevations of the building floors are between 500 and 510 m (1,640 and 1,660 ft) AMSL. The construction of a highway [501 m (1,644 ft) AMSL] 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 serious flood on the Nolichucky River in November 1977 (92 percent of the greatest recorded flow) did not result in the flooding of any buildings on the site.

Wetlands on the site include streams and shrub swamps (riverine and palustrine wetland types, respectively; Cowardin et al. 1979). The streams are Martin Creek, just outside the site's northeast boundary, and Banner Spring Branch, which flows through the site. These streams are described in more detail in Sections 3.5 and 3.7.2. A few small shrub swamps are located near Banner Spring. They are dominated by shrubs of various species and are less than a few hectares in size. No wetlands in the area have been considered for natural landmark status (Goodwin and Niering 1975, DOI 1983).

3.5 HYDROLOGY

3.5.1 Surface Water

The locations of three natural surface-water bodies (Banner Spring Branch, Martin Creek, and the Nolichucky River) in relation to the NFS Erwin Plant site are shown in Figure 2.9.

Banner Spring Branch, a small spring-fed stream approximately 0.5 to 1.0 m (1.5 to 3 ft) wide, lies entirely within the NFS site boundary. The spring is, however, owned by Erwin Utilities. The spring is not used by the city as a potable water source but could be. The spring and a pumphouse are screened and protected from access. The branch flows in a northerly direction at a rate of 0.01 to 0.02 m^3/s (0.45 to 0.67 cfs) and empties into Martin Creek at the site boundary. The stream is approximately 366 m (1,200 ft) from the spring source to the confluence with Martin Creek.

Martin Creek, which is fed by mountain springs, rain, and snow melt drainage from Martin Creek Hollow, runs nearly parallel to the northern property line of the site. The width of Martin Creek varies from 2.4 to 4.6 m (8 to 15 ft) and the depth from a few centimeters (inches) to pools of 0.9 to 1.2 m (3 to 4 ft). The flow of the creek varies seasonally from 0.06 to 0.3 m^3/s (2.2 to 11.1 cfs) (NFS 1984). Martin Creek crosses the NFS property for a short distance at the north corner of the site at the point where Banner Spring Branch joins the creek (Figures 2.2 and 2.9). Beyond the NFS site, the lower portion of Martin Creek parallels the fill for the Highway 19-23 bypass, which is parallel to the Nolichucky River. Martin Creek empties into North Indian Creek about 122 m (400 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, North Carolina, approximately river km 178 (river mile 111) above the Nolichucky's confluence with the French Broad River. The river flows westwardly from North Carolina and southwestwardly through Tennessee to join the French Broad River, whose watershed forms part of the upper Tennessee River basin. Approximately 163 km (101 miles) of the 178-km (111-mile) river are in Tennessee.

The Nolichucky River basin in Tennessee includes practically all of Green and Unicoi Counties, and parts of Hawkins, Hamblen, Jefferson, Washington, and Cocke Counties. The entire drainage area totals 4550 km^2

(1,756 miles^2), of which approximately 292u km^2 (1,126 miles^2) are in Tennessee and the remaining 1630 km^2 (630 miles^2) are in North Carolina.

The width of the Nolichucky River ranges from 30 to 60 m (100 to 200 ft) in the area of the NFS Erwin site. The average flow of the river for the 64-year period from 1920-1983 was 38.6 m^3/s (1363 cfs) at Embreeville [river km 143 (mile 89)] (USGS 1983), which is 5 km (3 miles) northwest of the site. The average 7d-10yr low flow of the river at the North Carolina-Tennessee border is 5 m^3/s (178 cfs) (NCDEM 1984). The maximum flow of record at Embreeville was 3400 m^3/s (120,000 cfs) on May 21, 1901 (USGS 1983). This is believed to be a 100-year flood. The minimum flow was 2.4 m^3/s (85 cfs) on September 8-9, 1925 (USGS 1983).

Although the river was rechanneled in the Erwin area during construction of the State Highway 19-23 bypass (June-July 1976), the average flows have remained approximately the same. The extreme flow since 1976 was 3,120 m^3/s (110,000 cfs) on November 6, 1977 (USGS 1983). The only effect of rechannelization on the NFS facility is the significant reduction in the probability of backwater flooding of the plant (NFS statement during site visit, November 14, 1984).

3.5.1.1 Water Quality

- Banner Spring Branch

The nonradiological water quality characteristics listed in Table 3.7 for Banner Spring Branch reflect the analysis by staff of the State of Tennessee of a grab sample of noncontact cooling water discharged to Banner Spring Branch (TDHE 1983). These values can be used as background data for comparison with the values from the NFS downstream monitoring program (Section 4.1.2).

The radiological water quality of Banner Spring Branch upstream of the discharge from the NFS plant (Section 4.1.2.1) is typical of background radioactivities for water resources.

- Martin Creek

The nonradiological water quality of Martin Creek has not been determined upstream of the NFS site. The quality of water in the creek upstream of the site is affected by passage of a sizeable portion of the flow through the Erwin Fish Hatchery. An upstream survey in 1977 by biologists from East Tennessee State University noted the presence of septic tank leakage into the creek; however, it was thought to have no noticeable influence on the character of the water (NFS 1984). The pH of the creek in 1977 was found to be 5.8, which is within the range characteristic of creeks in East Tennessee (NFS 1984).

The radiological water quality of Martin Creek upstream of the confluence with Banner Spring Branch (Section 4.1.2.1) is typical of background radioactivities for water resources.

Table 3.7. Summary of chemical and physical characteristics of 1983 water samples from the Nolichucky River upstream of the NFS discharge and from the Banner Spring Branch noncontact cooling water discharge.

Characteristics	Nolichucky River[a] sample collection dates		Banner[b] Spring Branch
	May 2	May 5	May 2
Temperature (°C)	17.0	14.5	23.3
mg/L (ppm)			
Dissolved oxygen	9.0	9.0	7.3
BOD	<1.0	<1.0	1
COD	<5.0	99.0	5
Suspended residue	2	19	2
Settleable residue	0.1	0.1	0.1
Total residue	60	57	103
Sulfates (SO_4)	<4	4	12
Total phosphate (P)	0.04	0.04	0.03
Total organic carbon	<1	<1	1
Ammonia (as N)	0.08	0.06	0.02
NO_3 and NO_2 (as N)	0.34	0.45	2.2
Sodium (Na)	2.0	1.4	4
Chloride (Cl)	1	1	2
Fluoride (F)	0.1	0.1	0.12
Potassium (K)	1.5	1.0	
Magnesium (Mg)	1.0	1.0	6.6
Iron (Fe)	0.7	1.0	0.23
Manganese (Mn)	7	18	1
µg/L (ppb)			
Nickel (Ni)	10	10	20
Mercury (Hg)	<0.2	<0.2	0.2
Lead (Pb)	<10	<10	10
Copper (Cu)	3	6	6
Arsenic (As)	<1	<1	1
Cadmium (Cd)	<1	<1	1
Zinc (Zn)	6	9	6
Barium (Ba)	<10	<10	10
Total chromium (Cr)	<1	<1	1
Cobalt (Co)	<10	<10	10
Silver (Ag)	<1	<1	20
Boron (B)	<200	<200	10
Molybdenum (Mo)	<10	<10	

Sources: [a]NFS 1984, Table 2.9.
[b]TDHE 1983.

• Nolichucky River

The water quality of the Nolichucky River continues to be influenced by runoff and silt from mica and feldspar tailings from earlier mineral mining at Spruce Pine, North Carolina. There are no gauging or water quality stations located on the Nolichucky River upstream of the NFS site. Table 3.7 shows the results of water quality samples taken upstream of the NFS discharge during May 1983 in conjunction with a 96-hour acute toxicity study of the NFS effluent (TDHE 1983).

Those water quality characteristics determined downstream, as part of the NFS monitoring program, are provided in Section 4.1.2.2.

3.5.1.2 Water Use

• Banner Spring Branch

Banner Spring Branch is classified for fish, recreation, irrigation, livestock watering, and wildlife use (TDHE 1983). Banner Hill Spring may be used in the future as a potable water supply for the Erwin City Water System. There is no recreational use of the spring or branch because they originate and terminate on the NFS property where public access is restricted.

Approximately 0.004 m^3/s (0.134 cfs) of water is used as industrial water for noncontact cooling for NFS operations. Approximately the same amount of cooling water is discharged to Banner Spring Branch (NFS 1984).

• Martin Creek

A State-operated fish hatchery (Erwin Trout Rearing Station) is located on Love Spring Branch, a tributary to Martin Creek, about 180 m (600 ft) upstream of the NFS site. Love Spring, which feeds Love Spring Branch, is the water source for the hatchery, which requires approximately 5.3×10^6 L/d (1.4×10^6 gal/d). The main portion of Martin Creek is used for recreational fishing, primarily downstream of the fish hatchery but upstream of the NFS site. Fishing in the short stretch of the creek near the site is infrequent because limited access roads make it inaccessible to the public. The creek is not classified as a trout stream by the State of Tennessee, nor is it used as a potable water source (NFS 1984). It is, however, classified for fishing, recreation, irrigation, livestock watering, and wildlife use (TDHE 1983).

• Nolichucky River

The Nolichucky River in the vicinity of the NFS discharge is classified for domestic, industrial, fishing, recreation, irrigation, livestock water, and wildlife use (TDHE 1983). The city of Jonesboro, 13 km (8 miles) downstream of the NFS site, is the nearest municipal user of water from the Nolichucky River [approximately 3×10^6 m^3 (8×10^5 gal) per day]. The only known crop irrigation occurs 16 to 24 km (10 to 15 miles) downstream of the NFS discharge to the Nolichucky River. Irrigation in the area is rare because the average annual rainfall (approximately 137 cm (54 in.) is generally adequate for crop production. Irrigation (usually overhead sprinklers) is used primarily in the spring and fall to reduce frost damage to crops (e.g., strawberries and tomatoes) and to extend the growing season and preserve the quality of tomato crops.

Recreational uses along the section between the origin and the mouth of the Nolichucky River at Douglas Lake include swimming, rafting, boating and canoeing, picnicking, and other similar activities. Along the 24-km (15 mile) stretch of river downstream of the NFS facility, recreational activities are canoeing and rafting and using developed riverside recreational facilities such as picnic tables and parks. A commercial canoe/raft outfitting business is located approximately 1.6 km (10 miles) downstream of the NFS site. Fishing in this reach of the Nolichucky River is primarily for warm-water fish such as bass, walleye, and catfish (NFS 1984).

3.5.2 Ground Water

Much of the characterization of ground water in Unicoi County is provided by DeBuchananne and Richardson (1956). For a detailed discussion of geology, the reader is referred to Section 3.6.

3.5.2.1 Ground-Water Regime

Shallow unconfined ground water is contained in the alluvium of the Nolichucky River and its tributaries and in residual soils developed on the Shady and Honaker Dolomites (Section 3.6). Alluvium and residual soils range up to 8 and 30 m (26 and 98 ft) thick, respectively.

Deeper ground water 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.

Many springs yielding large quantities of water are located in dolomitic rocks. Most of these springs are in the Shady and Honaker Dolomites. Some are located in the Rome Formation near the contact with the underlying Shady Dolomite.

Aquifer discharge and recharge takes 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.

3.5.2.2 Use

State-registered ground-water supplies within 8 km (5 miles) of the NFS Erwin site are shown in Figure 3.4. Their uses are indicated in Table 3.8.

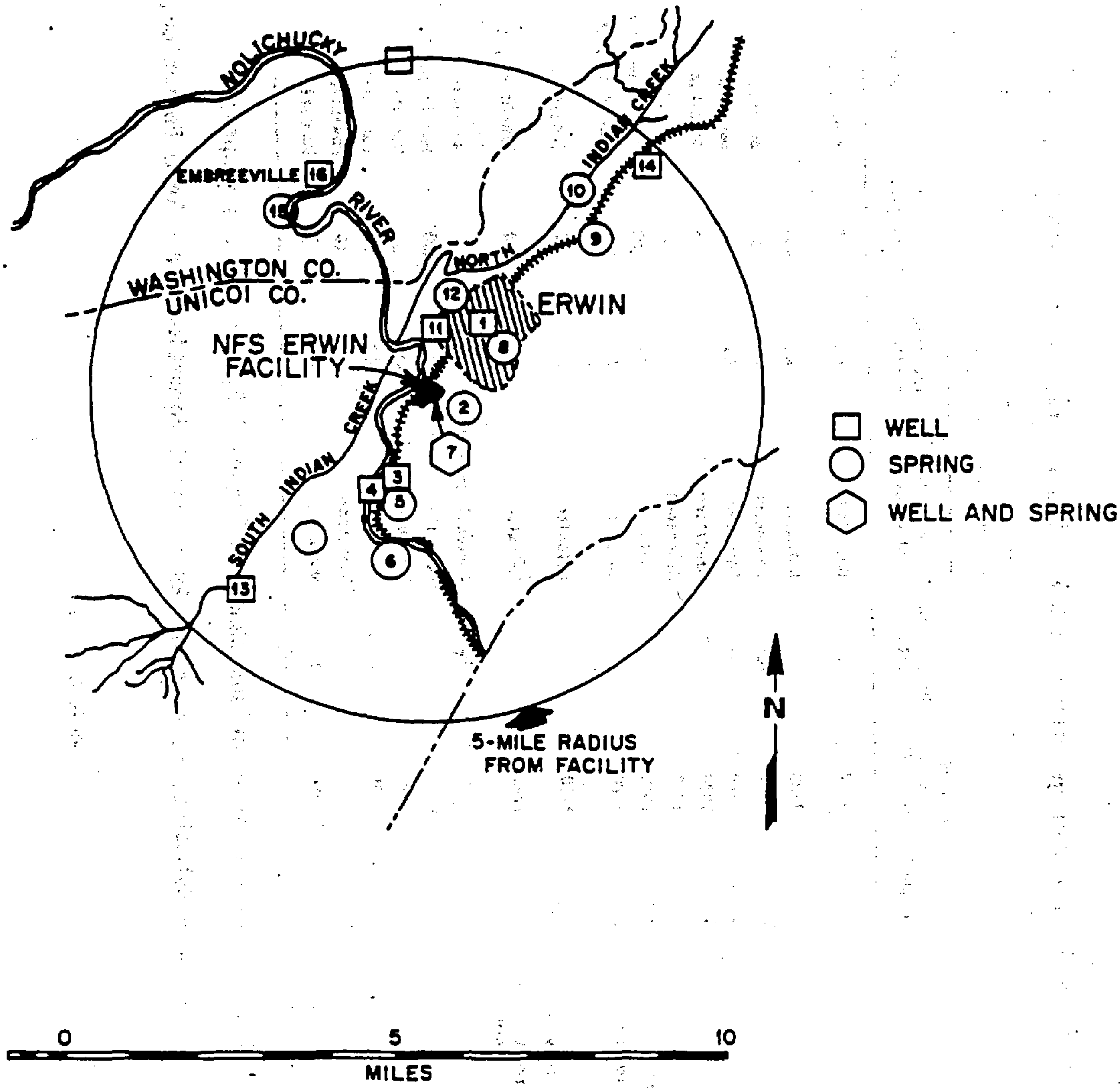

Figure 3.4. Springs and wells within an 8-km (5-mile) radius of the NFS Erwin Plant. Numbered locations are identified in Table 3.8. Source: NFS 1984.

Table 3.8. Surveyed wells and springs within an 8 km (5-mile) radius of the NFS Erwin Plant.

Well or spring no.[a]	Owner or name of spring or well	Topography[b]	Altitude above sea level (ft)	Well depth (ft)	Probable water-bearing bed: Character of material	Probable water-bearing bed: Geologic horizon[c]	Yield (gpm)	Use of water supply
1-w	Crystal Ice, Coal and Laundry Co.	V	1600	135	Dolomite	€hk	75	Industrial
2-s	Love Spring	V	1700		Dolomite	€s	500	
3-w	Grady Ledford	V	1760	122	Sandstone	€s	d	Domestic
4-w	Sam Tipton	S	1720	80	Sandstone	€s	d	Domestic
5-s	E. L. Lewis	S	1920		Sandstone	€s	5	Domestic
6-s	Unaka Springs	S	1720		Sandstone	€u	d	Domestic
7-s	Banner Hill Spring	V	1640		Shale	€r	300	Potential public supply
8-s	Erwin Water Department O'Brien Spring	S	1720		Dolomite	€s	640	Public supply
9-s	U.S. Dept. of the Interior Fish Hatchery	V	1760		Dolomite	€hk	916	Industrial
10-s	Erwin Water Department Anderson-McInturff Springs	S	1760		Dolomite	€hk	450	Public supply
11-w	Fess Radford	V	1340	30	Residual dolomite	€hk	d	Domestic
12-s	Birchfield Spring	V	1650		Dolomite	€s	2000	Public supply
13-w	Kelley Rice	V	1780	24	Residual dolomite	€s	d	Domestic
14-w	Charles Erwin	S	1900	323	Dolomite	€hk	d	Domestic[e]
15-s	Yates Spring	V	1620		Sandstone	€u	10	Domestic
16-w	W. B. Walker	V	1500	d	Shale	€h	3	Domestic

[a]Numbers of wells and springs correspond to locations shown in Figure 3.5; w = well, s = spring.
[b]V = Valley; S = Slope.
[c]€hk = Honaker Dolomite; €s = Shady Dolomite; €e = Erwin; €u = Unicoi Formation; €r = Rome Formation; €h = Hampton Formation.
[d]Not measured.
[e]Well supplies two houses.

Source: NFS 1984.

According to Howard Brown of Erwin Utilities, the municipal water supply is provided by five springs (O'Brien Spring, Birchfield Spring, and three springs collectively referred to as Anderson-McInturff Springs; locations 8, 12, and 10, respectively, in Figure 3.4). In July 1980, the average daily municipal water use was 7.8 million liters (2.1 million gallons). Maximum daily output in 1980 was 26 million liters (7 million gallons). Other systems served by Erwin Utilities include Temple Hill Utility District and Unicoi Water Utility District. About 10,000 people are served by Erwin Utilities. O'Brien and Birchfield Springs are located in the Shady Dolomite, and the Anderson-McInturff Springs are in the Honaker Dolomite. Erwin Utilities foresees the need to develop additional ground-water resources. In 1978, the Anderson-McInturff Springs were used only as a supplemental source of water. Today, however, these springs are supplying water for Erwin almost continuously.

Over the past few years, the discharge rates from municipally owned springs during the dry seasons have become a matter of concern. Dry season discharge currently is about one-half the discharge rate of the springs when they were first developed for municipal use. This is attributed to a gradual lowering of the Nolichucky River by mining its bed for gravel to be used in the construction industry. Lowering the alluvial water table directly affects the discharge from the springs.

Erwin Utilities is currently attempting to increase ground-water supplies by placing wells in service adjacent to existing springs. A 68-m (222-ft) well was completed adjacent to Birchfield Spring in 1984. This well is currently being pump-tested. When the well is pumped at a high discharge rate, the water becomes turbid. There is concern that production from the well may have to be curtailed to prevent bringing sediment to the surface and to reduce the potential for surface subsidence. There is also concern that a high production rate from the well may cause Birchfield Spring to cease flowing. At present, it is not known when, or if, this well can be placed in service. A second well was drilled at O'Brien Spring, but this well site was temporarily abandoned after the hole collapsed.

If these and other attempts to increase Erwin Utilities' water supply should fail, there may be renewed interest in using Banner Hill Spring for that purpose. Erwin Utilities already owns this spring and its use has been considered in the past.

Two fish hatcheries also use large quantities of ground water. They are: (1) the Erwin Trout Rearing Station, supplied by spring water emerging from the Shady Dolomite, and (2) the U.S. Department of the Interior Fish Hatchery, supplied by springs discharging from the Honaker Dolomite. Each of these hatcheries requires about 5.4 million liters per day (1.4 million gallons per day).

Smaller ground-water consumers in Unicoi County include Flag Pond Elementary School, Limestone Cove Campground, Rock Creek Recreation Area, Temple Hill Elementary School, Morrill Motors of Tennessee, and several domestic users identified in Table 3.8. Each of these facilities uses less than 19,000 liters (5,000 gallons) per day. Most of the domestic users produce small quantities of water from fractured sandstone or residual soils developed on dolomite.

Although there are no recorded users of the Quaternary alluvial aquifer, there is evidence of its use in the past. Two shallow, hand-dug wells existed on the site when NFS began operation. One of these, at the radioactive waste burial ground, is still in use for ground-water monitoring (location A on Figure 3.4). A local survey would be required to determine whether there are any present users of the aquifer.

3.5.2.3 Quality

DeBuchananne and Richardson (1956) provide ground-water quality data for Unicoi County for the winter 1947-48. Water quality at that time (before the NFS facility) was uniformly good. The principal dissolved constituents of the ground water were calcium, magnesium, carbonate, and bicarbonate, regardless of the production zone geology (Table 3.9). This reflects the regional influence of dolomitic host rocks on ground-water quality. Some nitrate was present (nil to 12 ppm), and total dissolved solids ranged from 90 to 189 ppm. There is no early record of well completions in Quaternary alluvium; hence, baseline ground-water quality in that unit is unknown.

More recent ground-water quality data for Erwin Utilities springs and wells are presented in Table 3.10. Ground-water quality is essentially unchanged from 1948 to the 1980s. At Banner Hill Spring (adjacent to the NFS facility), nitrate and TDS 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 kilometers downstream from the NFS facility.

3.6 GEOLOGY

This section describes physiography, stratigraphy, structure, foundation geology, mineral resources, and seismicity. These characteristics relate directly to foundation stability and ground-water resources.

3.6.1 Physiography and Geology

Most of Unicoi County (including Erwin and the NFS facility) lies in the Valley and Ridge Physiographic Province. This province consists of a series of northeast-trending valleys and ridges.

Cambrian strata dominate the Erwin region. Table 3.11 describes the lithology and thickness of Cambrian rocks in northeastern Tennessee. The valleys are underlain by the Honaker Dolomite (Ꞓhk), Rome Formation (Ꞓr), and Shady Dolomite (Ꞓs) (Figure 3.5), all of Cambrian age, and the Knox Formation (ꞒOk), which is of Cambrian and Ordovician age. The Honaker and Knox are mapped as a single unit (ꞒOhk) in Figure 3.5. The Rome is a dolomite at its contact with the underlying Shady but it grades upward into siltstone and sandstone. North Indian Creek and South Indian Creek flow along a broad flood plain within this outcrop band, which lies between the

Table 3.9. Analyses of ground water in Unicoi County (chemical constituents in parts per million).

Spring or well no.	Owner or name of spring or well	Geologic horizon	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na & K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C)
1W[a]	Crystal Ice, Coal and Laundry Co.	Єhk	12/23/47	11	15	4.3	4.0	0	62	3	5.5	2.8	90	55	119
2-S	Love Spring	Єs	12/23/47	18	17	7.5	4.0	0	86	4	5	0.5	103	75	148
3-W	Grady Ledford	Єs	3/9/48	10	22	11	6.6	0	130	3	3	0.8	124	100	206
4-S	Sam Tipton	Єs	3/0/48	8.0	15	5.7	7.3	0	58	3	7	10	108	61	153
5-S	E. L. Lewis	Єs	3/9/48	9.8			4.5	0	8	2	5	0.2		6	26
6-S	Unaka Springs	Єu	3/8/48	20	16	7.1	5.2	0	70	18	3	0.2	145	69	168
7-S	Banner Hill Spring	Єr	3/8/48	14	16	8.6	0.6	0	78	5	3	4.0	109	75	156
8-S	Erwin Water Department[b]	Єs	3/8/48	9.2	15	8.4	3.0	0	86	2	3	2.2	93	72	150
9-S	U.S. Dept. of Interior Fish Hatchery	Єhk	3/10/48	14	18	9.5	2.2	8	80	4	3	1.8	108	84	165
10-S	Erwin Water Department[c]	Єhk	3/8/48	16	16	8.8	2.9	0	86	4	4	2.8	103	76	154
11-W	Fess Radford	Єhk	3/8/48	18			5.8	0	14	7	4	4.0		15	65
12-S	Birchfield Spring	Єs	3/8/48	18	19	9.0	0.6	8	78	3	2	3.2	110	84	169

[a]Numbered wells (w) and springs (s) within 8 km of the NFS facility as identified in Figure 3.5.

[b]O'Brien Spring.

[c]Anderson-McInturff Springs.

Source: DeBuchananne and Richardson (1956).

Table 3.10. Ground-water quality data,[a] Erwin Utility District.

	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
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	0.03	0.05	0.05	0.03	0.06	<0.1
Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	0.28	0.86	1.02	0.26	0.81	<0.20
Lead	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	1.78	0.77	0.81	0.87	0.22	0.74
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hardness	88	49	85.7	81.8	80.0	
Chloride	5.3	3.5	4.5	4.7	5.7	3.0
Copper	0.03	0.026	0.013	0.011	0.052	0.023
Iron	0.05	0.011	0.011	0.005	0.023	0.268
Manganese	0.029	0.001	0.003	0.001	0.003	0.02
Sulfate	1.9	<0.2	2.8	<0.2	1.3	2.0
TDS	99	115	190	189	94	158
Zinc	0.009	0.018	0.055	0.02	0.068	0.013
Sodium	10.2	0.4	1.6	1.4	1.3	1.5
pH						7.20
Gross alpha (pCi/L)	0.4[c]				1.0[d]	0.6

[a]Units are mg/L except for pH and gross alpha.

[b]Municipal water mixed from O'Brien, Birchfield, and Anderson-McInturff Springs.

[c]Sampled 8/83.

[d]Sampled 2/84.

Source: Tennessee Dept. of Public Health Open-File.

Table 3.11. Generalized section of Cambrian formations in northeastern Tennessee.

Age	Formation (Map symbol)		Lithology	Thickness meters	Thickness feet
Lower Ordovician	Knox Dolomite €Ok		Gray to blue-gray limestone and dolomite, in part cherty; argillaceous seams in lower part	1200	4000
Upper Cambrian	Nolichucky Shale €n		Green calcareous and dolomitic shale, and shaly dolomite	30	100
Middle Cambrian	Honaker Dolomite €hk		Gray to blue-gray dolomite and limestone, with many silty and shaly laminae	600	2000
	Rome Formation €r		Red shale and siltstone, some green shale and some dolomite; residual clay contains some manganese deposits	360-550	1200-1800
	Shady Dolomite €s		Blue-gray dolomite, white dolomite, ribboned dolomite and limestone; residual clay contains many manganese deposits	270-360	900-1200
		Erwin Formation	White quartzite, greenish sandy shale and siltstone	360-460	1200-1500
Lower Cambrian	Chilhowee Group €bc	Hampton Formation	Dark-greenish argillaceous shale, sandy shale, and siltstone; some beds of arkosic quartzite	360-460	1200-1500
		Unicoi Formation	Arkosic quartzite, conglomerate, arkosic sandy shale and siltstone; some beds of amygdaloidal basalt	600-1500	2000-5000

Source: Modified after R. J. Ordway, "Geology of the Buffalo Mountain-Cherokee Mountain Area, Northeastern No. 9, Tennessee," Tennessee Department of Conservation and Commerce, Division of Geology, Report of Investigation No. Nashville, Tenn., 1969.

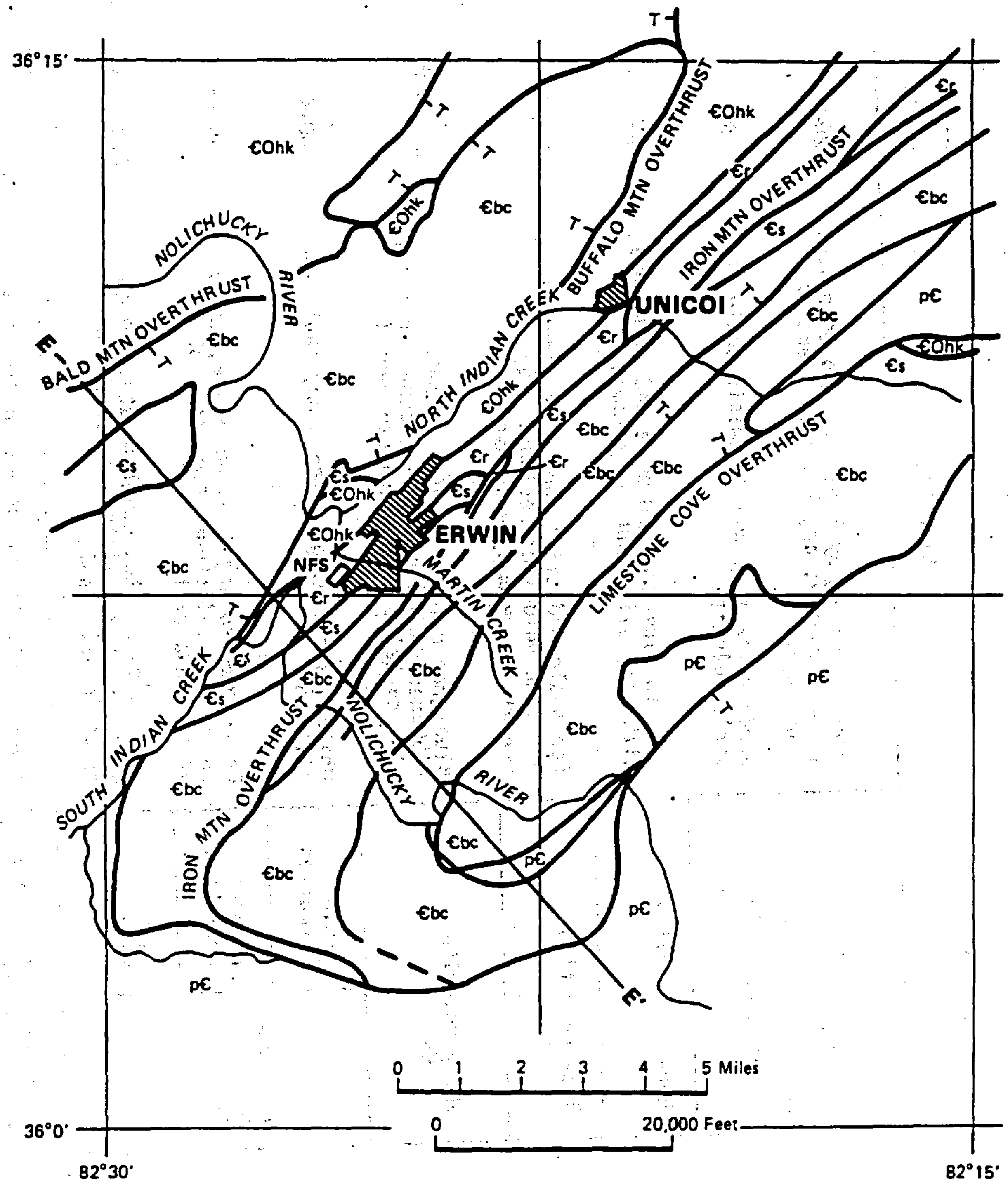

Figure 3.5. Geologic map of Erwin, Tennessee. Stratigraphic unit €Ohk represents undifferentiated Knox (€Ok) and Honaker (€hk) Dolomites (see Table 3.11).
Source: Oak Ridge National Laboratory, Drawing No. 85-10004lR.

Buffalo Mountain and Iron Mountain overthrusts. Ridges on either side of the valley are underlain by highly indurated clastic (shale, sandstone, and quartzite) rocks that comprise the basal Cambrian units (Ɛbc).

Rocks of the Blue Ridge Physiographic Province lie about 5 km (3.1 miles) southwest and southeast of Erwin. These are pre-Cambrian (pƐ) metamorphic and intrusive rocks that have been thrust over the basal Cambrian unit.

Structurally, the Erwin region is extremely complex. Figure 3.6 is a northwest-to-southeast structure section near the south side of Erwin, adjacent to the NFS facility. King et al. (1944) described the structure as a series of folded thrust faults with strata dipping steeply to the northwest. Locally, the bedding is vertical or overturned to the southeast. Rock cleavage (fractures) and low rank metamorphism are present.

Figure 3.7 is a more detailed geologic map of the Erwin area. It shows the position of the NFS facility on the Quaternary alluvium (Qal) of the Nolichucky River. Also shown are nearby springs in the Shady Dolomite (Unaka Springs and O'Brien Spring) and in the lower most (dolomite) Rome Formation near the contact with the Shady Dolomite (Banner Hill Spring).

The locations of thick residual soils (ƐGsr and Ɛsg) are also shown in Figure 3.7. In general, thick residual soils are restricted to the Shady Dolomite (Ɛsd) and the Honaker Dolomite (off the map to the northwest of North Indian Creek). Outcrops of these units are rare because of the residual soils. Soils are thin or absent over the Cambrian basal clastics and the Rome Formation.

3.6.2 Foundation Geology

At the NFS site, bedrock strata are highly indurated (consolidated), making firm foundations for buildings that rest directly on the strata or that are supported by column footings. Structures on spread footings are supported by unconsolidated alluvium from the floodplain and terraces of the Nolichucky River. Structures supported by alluvium are subject to differential settlement, depending on the character and distribution of the load and inhomogeneity of the sediments bearing the load. Most settlement has already taken place (the first 2 to 3 years after construction). Furthermore, total settlement is not expected to be large because unconsolidated sediments are thin and structures are not particularly heavy. Also, vibrations induced by operating machinery or by seismic events are not expected to be severe.

The NFS site is not likely to experience slope failure. Such failures are common in the mountainous terrain surrounding the site but not on the floodplain where slopes are flat. Structures are set back sufficiently from the Nolichucky River to avoid destabilization by erosion or slope failures along the river bank.

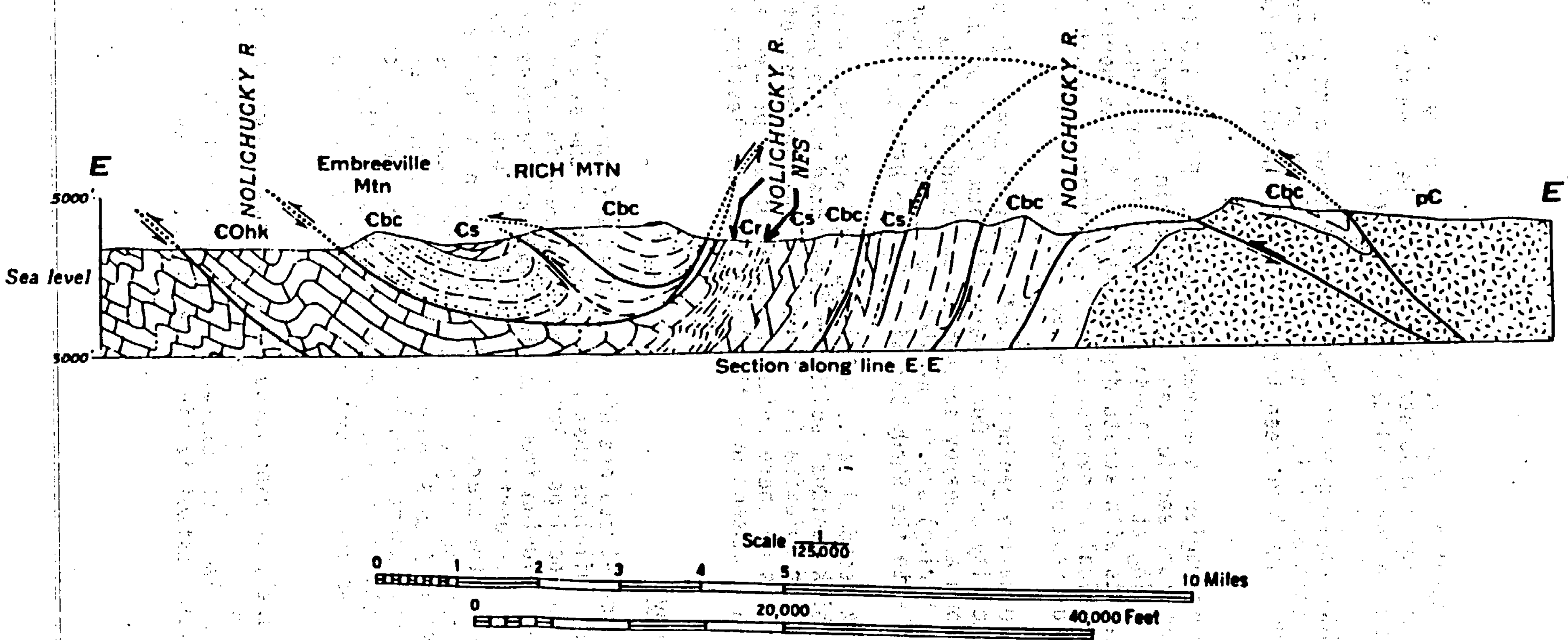

Figure 3.6. Geologic structure through Section E-E' in Figure 3.5. Stratigraphic unit €Ohk represents undifferentiated Knox (€Ok) and Honaker (€hk) Dolomites (see Table 3.11). Source: King et al. 1944.

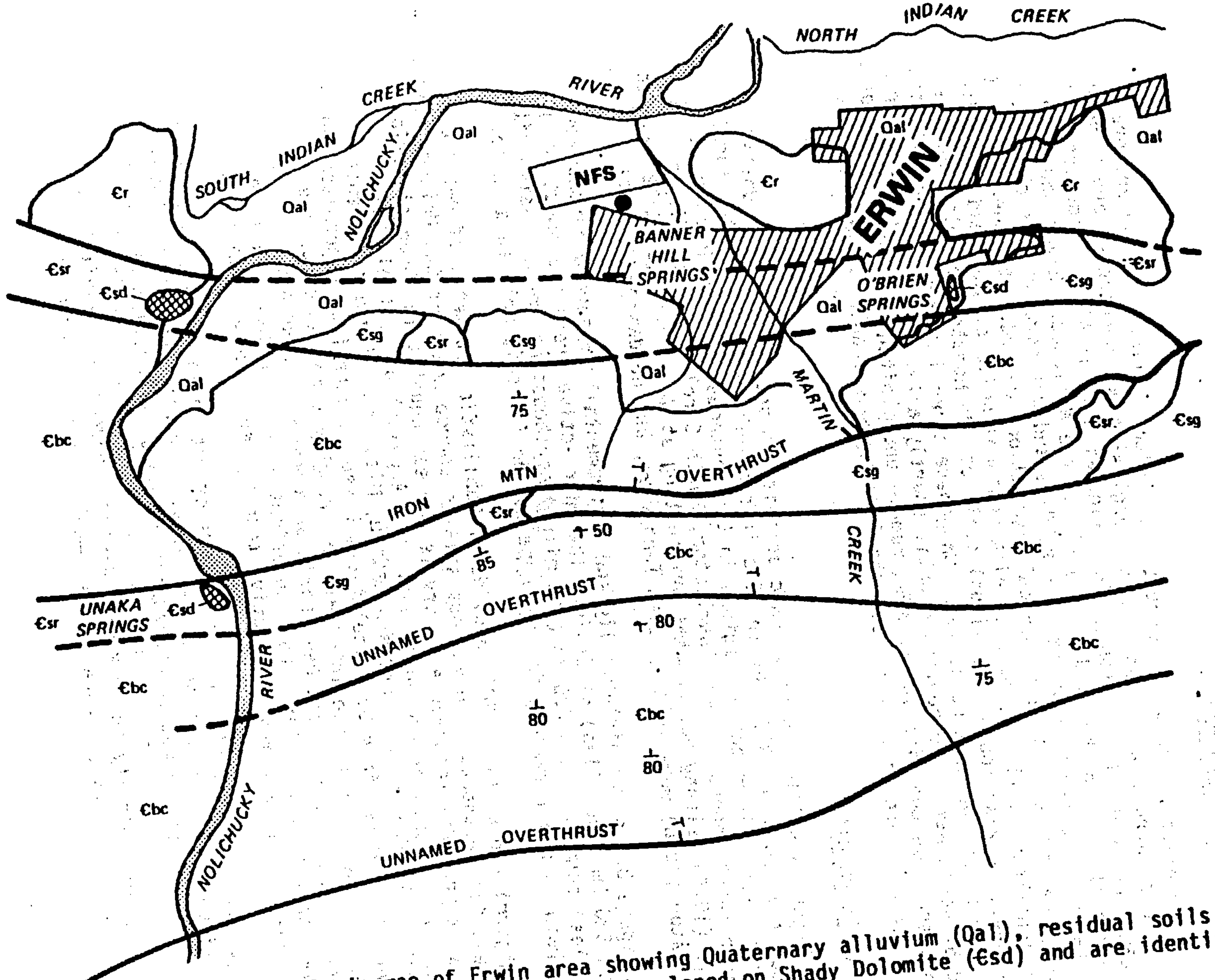

Figure 3.7. Detailed geologic map of Erwin area showing Quaternary alluvium (Qal), residual soils, and springs. The residual soils are developed on Shady Dolomite (€sd) and are identified as residual gravel (€sq) and residual soil (€sr).

3.6.3 Mineral Resources

The principal mineral resources of Unicoi County are sand and gravel for the construction industry, metallurgical grade manganese, and iron ore (DeBuchananne and Richardson, 1956., King et al., 1944). Extraction of sand and gravel from the bed and floodplain of the Nolichucky River and North Indian Creek began in earnest in the 1940s and was more or less continuous until the mid-1970s when large-scale operations ceased. Manganese deposits are contained mostly in the clay rich residual soils of the Shady Dolomite. Manganese is also found in residual soils of the Honaker Dolomite and the lower part of the Rome Formation. Manganese mines began producing near the end of World War I and continued until shortly after the end of World War II. Many manganese deposits in the area remain unexploited. Small iron ore deposits were mined before World War I but the industry was unable to sustain itself.

3.6.4 Seismicity

Figure 3.8 illustrates seismic activity in the southeastern United States from 1800 to 1972. Erwin lies in the moderately active Appalachian Tectonic Belt. More active regions in the southeast include New Madrid, Missouri-West Tennessee, and Charleston, South Carolina. According to Nuttli (1979), strong earthquakes originating at New Madrid (1811-12) and at Charleston (1886) were felt in east Tennessee, but no damage was done.

Figure 3.9 shows historically and instrumentally recorded earthquakes within 320 km (200 miles) of Erwin. The most active areas are about 100 km (62 miles) southwest and 200 km (125 miles) northeast of Erwin. Seismicity near Erwin is about average for the Appalachian Tectonic Belt as a whole.

Algermissen et al. (1982) provide probabilistic estimates of recurrence intervals for earthquakes in various seismic source zones of the United States. Table 3.12 provides recurrence intervals for earthquakes in three significant seismic source zones of the southeast: the Appalachian Tectonic Belt; Charleston, South Carolina; and New Madrid, Missouri. These recurrence intervals were determined by calculations based on data from Algermissen et al. (1982). Although recurrence intervals are roughly comparable for the Appalachian Tectonic Belt and New Madrid as a whole, the area of the former is 6.6 times that of the latter. For equivalent areas, the New Madrid seismic source zone is 5 to 7 times more active than the Appalachian Tectonic Belt.

Algermissen et al. (1982) also provide probabilistic estimates of mean value horizontal ground motions in rock at sites within the United States. Table 3.13 lists ground motion exceedance values as a function of return period for Erwin. There is a 100 percent probability that horizontal acceleration and velocity in rock will exceed 9 percent of gravitational acceleration and 6 cm/sec, respectively, at Erwin in a 50-year time interval.

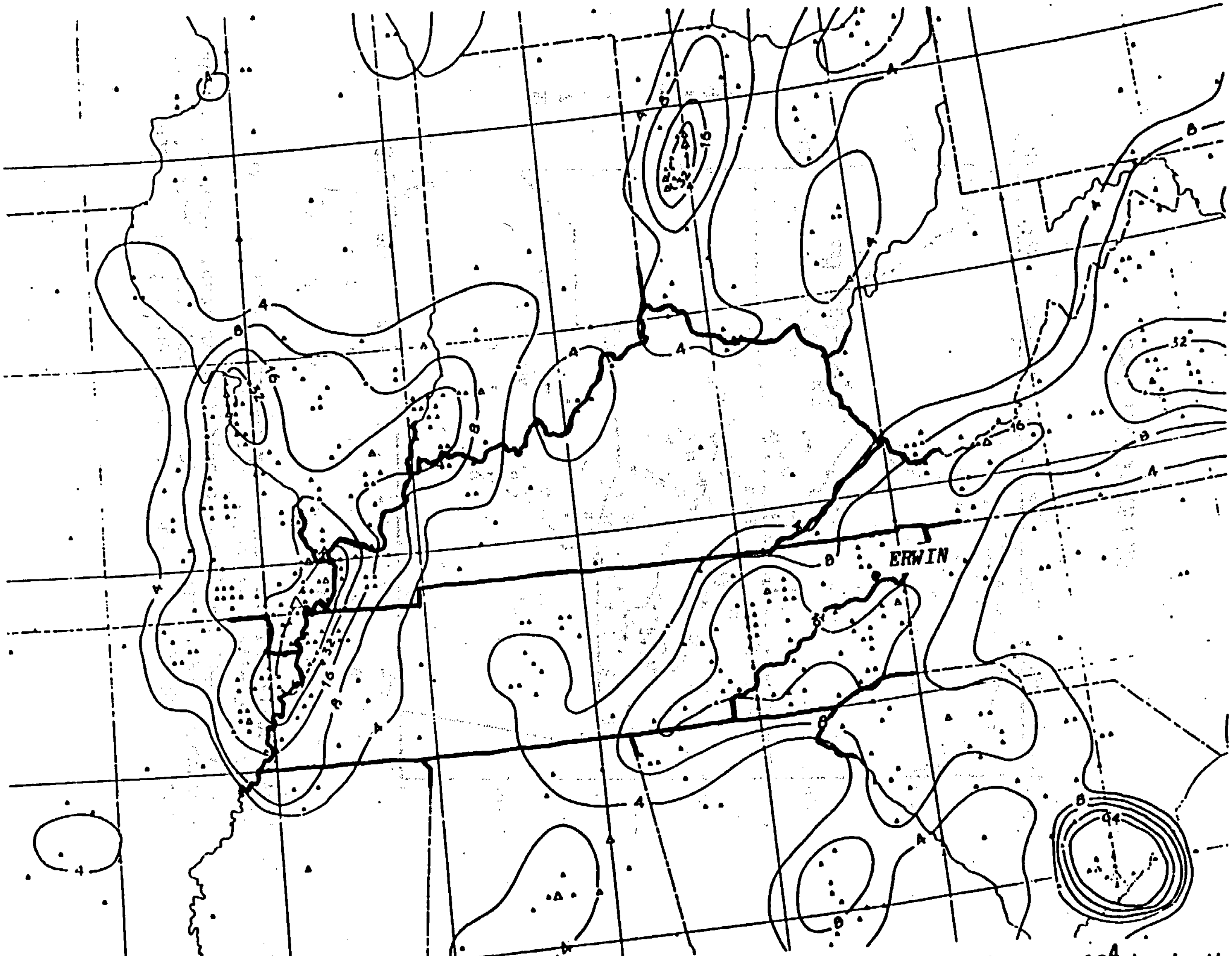

Figure 3.8. Number of earthquakes with a Modified Mercali Intensity of III or greater per 10^4 km in the east-central region from 1800-1972.
Source: Hadley and Devine 1974.

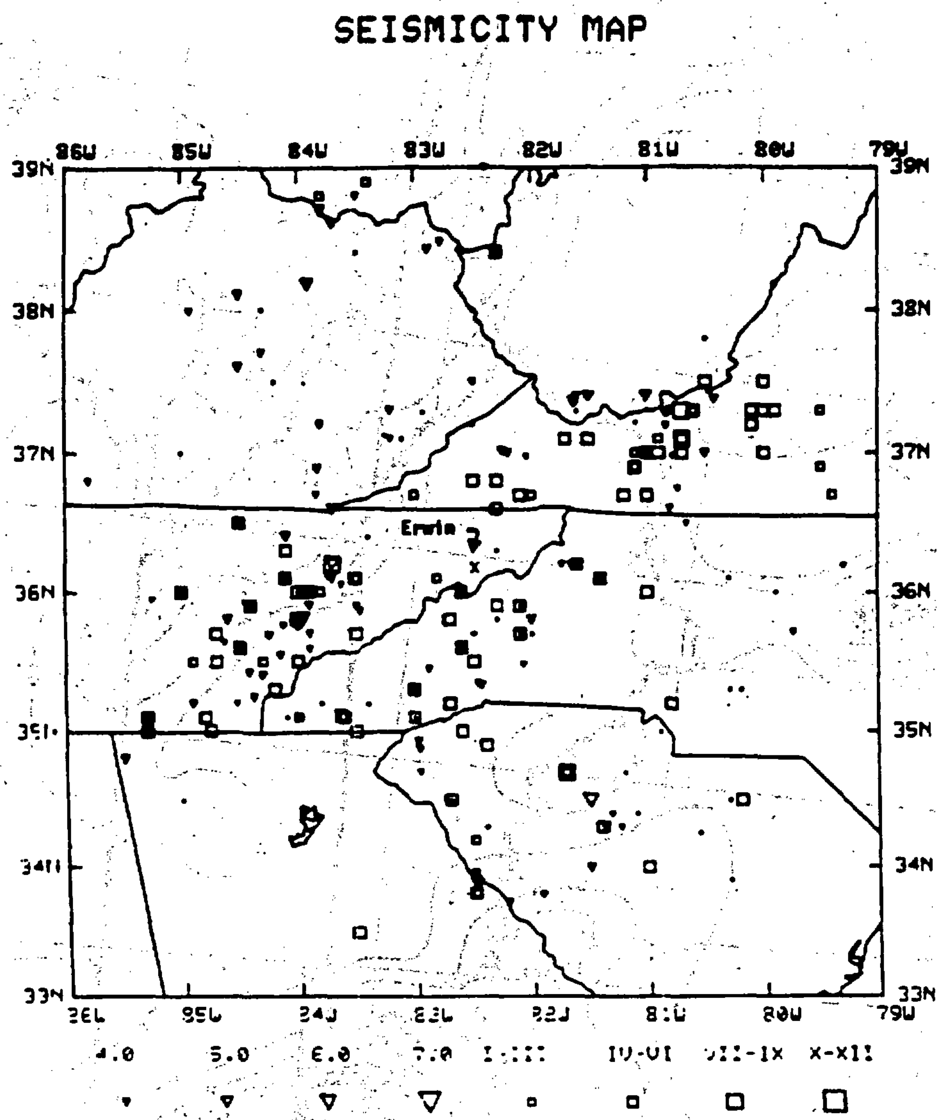

Figure 3.9. Historically and instrumentally recorded earthquakes within 320 km (200 miles) of Erwin, Tennessee.
Source: Computer printout provided by National Oceanographic and Atmospheric Administration. Boulder, Colorado. September 1984.
Source: Oak Ridge National Laboratory Drawing No. 85-10004.

Table 3.12. Earthquake recurrence intervals (years/10^4 km^2) as a function of MMI for selected seismic source zones.[a]

MMI	Seismic source zone: Appalachian Tectonic Belt	Charleston, SC	New Madrid, MO
V	36 (2.4)[b]	25 (5)	8 (3.5)
VI	110 (7.2)	79 (17)	23 (10)
VII	360 (24)	250 (53)	65 (28)
VIII	1,100[c] (72)	790[c] (170)	190 (83)
IX	3,600[c] (240)	2,500[c] (530)	540[c] (235)
X	11,000[c] (720)	7,900[c] (1,700)	1,600[c] (700)

[a]Based on data provided by Algermissen et al. (1982).

[b]The values in parentheses are the estimated recurrence intervals in years for the entire seismic source zone: 15.2, 5, and 2.3 x 10^4 km^2 for the Appalachian Tectonic Belt, Charleston, SC, and New Madrid, MO, respectively.

[c]Extrapolation beyond the historical data base.

Table 3.13. Estimated horizontal ground motion in rock at Erwin, Tennessee, exceeding given values for selected return periods.[a]

Horizontal ground motion	Return period (years)[b]: 95	475	2370
Acceleration (% gravity)	<4	9	19
Velocity (cm/sec)	2	6	13

[a]Modified from Algermissen et al. (1982).

[b]The probability of a given ground motion being exceeded during an interval of time equal to its return period is 63 percent. Return periods of 95, 475, and 2370 years correspond to 10 percent probabilities of exceedance for intervals of 10, 50, and 250 years, respectively.

The threshold of damage to poorly designed structures lies somewhere around Modified Mercalli Intensity (MMI) VI or VII (Table 3.14), which correspond roughly to horizontal accelerations of 6 percent of gravity and 12 percent of gravity. Damage from far-field earthquakes is likely to be associated with somewhat lower accelerations coupled with longer durations. The threshold of damage to well-designed structures may occur at substantially higher accelerations. Thus, the probability of major damage from an earthquake near Erwin is slight for an NFS plant life of less than 40 years.

Using deterministic seismic risk analysis (Krinitzsky and Marcuson 1983) forces one to deal with the possibility of a near-field earthquake at Erwin similar in intensity (MMI VIII) to the Giles County, Virginia, earthquake of 1897. Erwin, Tennessee, and Giles County, Virginia, are located in the same seismic source zone (Algermissen et al., 1982). According to Krinitzsky and Marcuson (1983), a near-field earthquake of this intensity would have a mean value horizontal ground acceleration of 23 percent of gravity and a standard deviation of 14 percent of gravity above the mean at a hard rock foundation site such as Erwin. However, according to Algermissen et al. (1982), a near-field (<25 km from Erwin) MMI VIII earthquake has a very low estimated recurrence interval (5,600 years) or about a 1 percent probability of occurrence in the next 50 years.

3.7 BIOTA

3.7.1 Terrestrial Biota

The NFS site lies within the Indian Creek Valley, whose original forests are now gone as a result of clearing for residential, commercial, industrial, and agricultural properties. Because they are disturbed and mostly nonforested, these areas surrounding the site as well as the site itself are unlikely to possess any particularly important native plant or animal resources. Most of the NFS site is occupied by buildings, building grounds, and open fields, and only several hectares consist of woods, shrub swamp, and brush. Biologists from East Tennessee State University surveyed the site in 1977 and found nothing of unique biotic value (NFS 1984). The nearby mountainous areas, however, are largely undisturbed and support extensive forest and wildlife resources.

Major forest types in the Erwin area are oak-hickory, oak-pine, and white pine (Eyre 1980). Valley floors, mountains, and mountain coves have their individual characteristic vegetation types. The potential natural vegetation of the NFS site, which lies in a valley floor, is a forest community dominated by red oak or white oak, with subdominants including yellow poplar, hickories, other oaks, and chestnut (Braun 1950). Southern pines are also expected to be constituents of the forest. At higher elevations, yellow poplar decreases and oak increases in relative abundance. Potential vegetation of mountain slopes is oak-pine or oak-hickory forest (oak-chestnut before the chestnut blight) with an ericaceous understory component, whereas that of coves resemble the more diverse mixed mesophytic forest region to the west and north (Braun 1950).

Table 3.14. MMI Scale of 1931.[a]

Intensity class	Effects of earthquake
V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken. A few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all: many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate damage in well-built ordinary structures; considerable damage in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motorcars.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings, with partial collapse; great damage in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb, great damage in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

[a]Scale abridged to show data on earthquakes of sufficient intensity to cause significant damage.

Source: S. T. Algermissen, "United States Earthquakes," U.S. Department of Commerce, U.S. Government Printing Office, Washington, D.C., 1968.

The fauna of the Erwin region includes a large number of vertebrate species: 14 species of frogs and toads, 20 salamander species, 20 snake species, 6 lizard species, 9 turtle species (Conant 1958); 70 mammal species (Simpson 1964); and 140 species of breeding birds (Cook 1969). However, most of these species would not be expected to occur at the site or in Indian Creek Valley because of the extensive disturbance and lack of natural habitats. The woods, swamps, and brushy areas on the site probably support many more animal species than the fields and developed areas. Animal species that occur on the site are common and relatively tolerant of disturbance (for example, starling, cardinal, mourning dove, Carolina chickadee, opossum, cottontail, and house mouse). The most important game species of the region (white-tailed deer, gray squirrel, ruffed grouse, wild turkey) occur in the forests of the mountains and are not common at the site. Cottontails, mourning doves, and bobwhite are present in most areas within Indian Creek Valley.

3.7.2 Aquatic Biota

- Banner Spring Branch

A 1977 survey conducted by East Tennessee State University for NFS found the major fauna within the spring (and presumably the associated branch) to be immature stages of Diptera (flies), Ephemeroptera (mayflies), and Trichoptera (caddisflies). Adults belonging to the orders Mecoptera (scorpion flies), Odonata (dragonflies and/or damselflies), and Plecoptera (stoneflies) were also observed around the stream margins. Vertebrates, mollusks, and crustaceans were absent, and only a sparse growth of diatoms was observed (NFS 1984).

The fact that the abundance and diversity of aquatic biota were found to be low was attributed to the small size of the stream (Section 3.5.1), the lack of microhabitat diversity, and the lack of organic matter (NFS 1984). Hynes (1970) states that small spring-fed streams are high in carbon dioxide content at their origin and, depending upon the geology, may be low in dissolved oxygen as well as nutrients. These factors may also contribute to the low abundance and diversity that were found in this branch.

Information obtained during the staff's site visit (November 14, 1984) indicates that the biota of Banner Spring Branch may be more diverse than the 1977 survey indicated. It was noted on the staff's site visit that trout are found in the lower reaches of the branch within the NFS fenced area and that there are species of minnows present in the branch. A number of small fish in the branch were killed in 1983 by an accidental thermal discharge into the branch. During one sampling period, flow measurements were not obtained because the sampling device was clogged with snails (NFS 1984).

- Martin Creek

Vertebrates observed in Martin Creek during the 1977 summary consisted of amphibians, fish, and one pair of mallard ducks with chicks (NFS 1977). One of the fish was a rainbow trout, believed to have escaped from the fish hatchery located 180 m (600 ft) upstream from where it was captured. The invertebrates were represented by five orders of insects, numerous crayfish, and one species of mollusk (periwinkle snail). Aquatic plants consisted of green algae, blue-green algae, and diatoms. The 1977 survey concluded that Martin Creek was typical of creeks in east Tennessee, possessing the usual and anticipated kinds of flora and fauna (NFS 1984). The stream bed is composed of sand, pebbles, and rocks mixed with some organic material, such as leaves and branches from dead trees (NFS 1984).

- Nolichucky River

Three biological surveys of the Nolichucky River in the 1950s between river km 143 and 154 (river miles 89 and 95.9) showed highly turbid water, considerable deposition of silt (Section 3.5.1), and a depauperate biological community (Ward 1960). The aquatic community consisted primarily of dipterans, oligochaete worms, a few mayflies and caddisflies, pulmonate snails, catfish, and a few bass. From 14 to 20 plant species were present. Most of these plant and animal species were tolerant of silt and organic pollution.

Because of both limited erosion control measures upstream and the time that has elapsed since mining occurred in the Spruce Pine, North Carolina area, the silt load and turbidity in the Nolichucky River have decreased (but have not been eliminated) to the point that the fauna and flora of the river are becoming more diverse. A survey of the benthic fauna upstream of Erwin near the Tennessee-North Carolina line (Poplar, North Carolina) found the richness of benthic taxa to be high (78 taxa) despite the fact that sedimentation was very heavy. The predominant taxa were dipterans (true flies), with ephemeropterans (mayflies) and trichopterans (caddisflies) also being abundant (NCDEM 1984).

Macroinvertebrate samples were taken both upstream and downstream of the NFS Outfall 001 to the Nolichucky River in May 1983 by the Tennessee Department of Health and Environment (TDHE 1983). Twenty-four taxa were collected at the upstream site and 19 taxa at the downstream site (NFS 1984), and more individuals were collected at the upstream site than at the downstream site (TDHE 1983). The substrate at the downstream site was sandy with bedrock, large rocks, and boulders, and no aquatic moss. At the upstream site, the substrate consisted of loose rock and boulders and little sand, with aquatic mosses present. The current at the upstream site was noticeably swifter than downstream (TDHE 1983). Pollution-intolerant species were found both upstream and downstream of the NFS discharge (see Section 4.1).

The Nolichucky River in the Erwin vicinity provides a very good smallmouth bass fishery. Percina squamata (olive darter), which inhabits deep riffles with boulder or bedrock substrates in large streams and rivers, has been collected downstream of Erwin at the Tn 107 bridge. Game fish species that can be found in the Nolichucky River in the vicinity include bass (spotted, largemouth, and smallmouth) and catfish (NRC 1978). Other fish species that can be found in the Nolichucky River are listed in Table 3.15.

Table 3.15. Fish species collected from fast-flowing water in the Nolichucky River in the vicinity of Erwin.

Percidae - Perch family	
Etheostoma acuticeps	sharphead darter
E. blennioides	greenside darter
E. chlorobranchium	greenfin darter
E. zonale	banded darter
E. camurum	bluebreast darter
Percina evides	gilt darter
P. squamata	olive darter
Cyprinidae - Minnow family	
Campostoma anomalum	stoneroller
Hybopsis insignis	blotched chub
Nocomis micropogon	river chub
Notropis galacturus	whitetail shiner
Phenacobius crassilabrum	fatlips minnow
Catostomidae - Sucker family	
Hypentelium nigricans	northern hog sucker
Moxostoma duquesnii	black redhorse
Ictaluridae - Freshwater catfish family	
Pylodictis olivaris	flathead catfish
Centrarchidae - Sunfish family	
Lepomis macrochirus	bluegill
Micropterus dolomiui	smallmouth bass
Pomoxis annularis	white crappie
Cottidae - Sculpin family	
Cottus bairdi	mottled sculpin
C. carolinae	banded sculpin

3.7.3 Endangered Species

The current or former geographic ranges of many threatened or endangered species include the Erwin area, as determined from the Federal list of such species (DOI 1984). The terrestrial animal species are listed in Table 3.16. None of these animal species are known to be near the Erwin Plant (Appendix C). Several plant species considered rare by the Tennessee Department of Conservation have been recorded in the vicinity of the NFS facility (Appendix C). However, none of these is afforded legal protection, and operation of the NFS facility should not affect these plants.

Table 3.16. Threatened and endangered terrestrial species possibly occurring in the Erwin area.

Reptiles and amphibians	Birds	Mammals
Tennessee cave salamander[a]	Peregrine falcon[b,c]	Gray bat[b,c]
Northern pine snake[a]	Bald eagle[b,c]	Indiana bat[b,c]
	Golden eagle[b]	Eastern cougar[b,c]
	Common raven[b]	River otter[a]
	Osprey[b]	
	Red-cockaded woodpecker[b,c]	
	Bachman's sparrow[b]	
	Black-crowned night heron[a]	
	Cooper's hawk[a]	
	Sharp-shinned hawk[a]	
	Marsh hawk[a]	
	Bewick's wren[a]	
	Grasshopper sparrow[a]	

[a]Listed as threatened by the State of Tennessee.

[b]Listed as endangered by the State of Tennessee.

[c]Listed as endangered by the U.S. Department of the Interior.

No Federally listed aquatic species occur in the Nolichucky River in the immediate vicinity or downstream of the NFS site. According to D. A. Etnier of the University of Tennessee, etheostoma acuticeps, the sharphead darter, will probably be listed by the State of Tennessee as threatened when the state list (1979) is updated. The species was not included in the 1979 listing because it was not known at that time to occur in Tennessee. This species appears to be fairly abundant in the fastwater areas of the Nolichucky River (Table 3.15) in the Erwin vicinity and downstream (TVA 1985). Carpiodes velifer, the highfin carpsucker, which is listed as a species of special concern by the Tennessee Department of Conservation, is also found in the Nolichucky River in the Erwin vicinity (Appendix C).

3.8 RADIOLOGICAL CHARACTERISTICS (BACKGROUND)

3.8.1 Total-Body Dose Rates

The total-body dose rate from natural background radiation in Tennessee averages 140 millirems/year (EPA 1972). Of this total, 70 millirems/year are from terrestrial radiation, 45 millirems/year from cosmic rays, and 25 millirems/year from internal radiation. This average dose rate compares favorably with 1979-1988 thermoluminescent dosimetry (TLD) measurements of ambient radiation (average about 78 millirems/year) at three offsite fixed monitoring stations around the Erwin plant (NFS 1984). For comparison, ambient radiation measurements obtained from nine other TLD stations, located along the NFS site perimeter, are presented in Section 4.1.2.

3.8.2 Soil, Vegetation, Air, Water, and Sediment Background Radiation

Background radiological characteristics typical of environmental media in the Erwin plant environs are given in Table 3.17.

Table 3.17. Characteristics of background radiation in the vicinity of the NFS Erwin Plant.

Location	Gross alpha radioactivity
Asheville Highway station[a]	
Ambient air	4.9×10^{-15} µCi/mL
Soil	1.4×10^{-6} µCi/g
Vegetation	5.6×10^{-7} µCi/g
Banner Spring Branch[b]	
Water	5.0×10^{-9} µCi/mL
Sediment	8.0×10^{-6} µCi/g
Martin Creek[b]	
Water	5.0×10^{-9} µCi/mL
Sediment	2.3×10^{-6} µCi/g
Nolichucky River[b]	
Water	2.0×10^{-9} µCi/mL
Sediment	2.4×10^{-6} µCi/g
Banner Hill Spring[c]	0.4×10^{-9} µCi/mL
Birchfield Well[d]	0.6×10^{-9} µCi/mL
Municipal water[e] well composite	1.0×10^{-9} µCi/mL

[a]Background station located 8 km SW of plant.

[b]Upstream stations.

[c]August 1983: see Table 3.10.

[d]August 1984: see Table 3.10.

[e]February 1984: see Table 3.10.

Source: NFS 1984 and Tennessee Department of Public Health open file.

REFERENCES FOR SECTION 3

Algermissen, S. T., D. M. Perkins, P. C. Thenhaus, S. L. Hanson, and B. L. Bender. 1982. "Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States," U.S. Geological Survey, Open-file Report 82-1033, Denver, Colorado.

BNA 1985. "Environmental Reporter," Bureau of National Affairs, Inc., Washington, D.C., April 19.

Braun, E. L. 1950. Deciduous Forests of Eastern North America. Free Press, New York. 596 pp.

Conant, R. 1958. A Field Guide to Reptiles and Amphibians. Houghton Mifflin Company, Boston, Massachusetts. 366 pp.

Cook, R. E. 1969. "Variation in Species Density of North American Birds," in Systematic Zoology, 18:63-84.

Cowardin, L. M., et al. 1979. "Classification of Wetlands and Deepwater Habitats of the United States," FWS/OBX-79/31, U.S. Fish and Wildlife Service.

DeBuchananne, G. D., and R. M. Richardson. 1956. "Ground Water Resources of East Tennessee," Tennessee Division of Geology, Bulletin 58, Nashville, Tennessee.

DOI (U.S. Department of the Interior). 1979-1983. National Register of Historic Places, Federal Register 44(26) (February 6, 1979), Part II; 45(54) (March 18, 1980), Part II: 46(22) (February 3, 1981); 47(22) (February 2, 1982); and 48(41) (March 1, 1983).

DOI (U.S. Department of the Interior). 1983. National Registry of Natural Landmarks, Federal Register 48:8682-8714, March 1.

DOI (U.S. Department of the Interior). 1984. "Endangered and Threatened Wildlife and Plants," 50 CFR 17.11 and 17.12, July.

EPA (U.S. Environmental Protection Agency). 1972. "Estimates of Ionizing Radiation Doses in the United States, 1960-2000." Office of Radiation Programs. Rockville, Maryland. ORP/CSD72-1.

Eyre, F. H. (ed.). 1980. Forest Cover Types of the United States and Canada. Society of American Foresters, Washington, D.C., 148 pp.

Goodwin, R. H., and W. A. Niering. 1975. Inland Wetlands of the United States. Evaluated as Potential Landmarks. National Park Service. Washington, D.C., 550 pp.

Hadley, J. B., and J. F. Devine. 1974. Seismo-tectonic Map of the Eastern United States, Map MF-620, U.S. Geological Survey, Washington, DC.

Hynes, H.B.N. 1970. <u>The Ecology of Running Water</u>, University of Toronto Press, Toronto, Canada.

King, P. B., H. W. Ferguson, L. C. Craig, and J. Rodgers. 1944. "Geology and Manganese Deposits of Northeastern Tennessee," Tennessee Division of Geology, Bulletin 52, Nashville, Tennessee.

Krinitzsky, E. L. and W. F. Marcuson. 1983. "Principles for Selecting Earthquake Motions in Engineering Design," Vol XX, Number 3, Association of Engineering Geologists.

NCDEM (North Carolina Division of Environmental Management). 1984. "Benthic Macroinvertebrate Ambient Network (BMAN) Data Review 1983." N.C. Div. Environ. Mgt., Dept. Nat. Resources and Community Dev., Raleigh, North Carolina. Report No. 84-12.

NFS (Nuclear Fuel Services, Inc.). 1977. "Responses to Environmental Information Report: NRC Questions of April 15, 1977," Erwin, Tennessee, May 31.

NFS (Nuclear Fuel Services, Inc.). 1984. "Environmental Report, Erwin Plant, Erwin, Tennessee," July.

NOAA (National Oceanic and Atmospheric Administration). 1978. <u>Climates of the States</u>. Vol. 1. Dale Research Company, Detroit, Michigan.

NRC (U.S. Nuclear Regulatory Commission). 1978. "Environmental Impact Appraisal of the Nuclear Fuel Services, Inc., Erwin Plant, Erwin, Tennessee. U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Div. of Fuel Cycle and Material Safety, Washington, D.C., January.

NRC (U.S. Nuclear Regulatory Commission). 1982. "Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, Final Report." NUREG/CR-2919. U.S. Nuclear Regulatory Commission, September.

NRC (U.S. Nuclear Regulatory Commission). 1983. "Dose Assessment of Airborne Releases from NFS-Erwin Fuel Facility--1972-1981." Prepared for Center for Disease Control, Atlanta, Georgia, by U.S. NRC, Region II, Atlanta, Georgia, May.

NRC (U.S. Nuclear Regulatory Commission). 1984. Memorandum to R. G. Page from William P. Gammill. "Re-calculation of annual average x/Q values for NFS-Erwin Fuel Facility," December 26.

Nuttli, O. W. 1979. "Seismicity of the Central United States," in Geological Society of America, <u>Reviews in Engineering Geology</u>, Volume IV.

Simpson, G. G. 1964. "Species Density of North American Recent Mammals," in <u>Systematic Zoology</u> 12:57-73.

State of Tennessee, Department of Economic and Community Development. 1983. "Tennessee Community Data for Erwin," July.

TDHE (Tennessee Department of Health and Environment). 1983. "Onsite 96-hour Flow-through Acute Toxicity Study, Nuclear Fuel Services, Inc., Erwin, Unicoi County, TN0002038, May 2-6, 1983." East Tennessee Regional Office, Dept. Health and Environ., Knoxville, Tennessee.

TVA 1985. Letter with attachment from J. C. Freeman, Jr., TVA, to V. R. Tolbert, Oak Ridge National Laboratory, February 19.

USGS (U.S. Geological Survey). 1983. "Water Resources Data for Tennessee, Water Year 1983," in "Water Data Report TN-83-1." U.S. Geological Survey, Reston, Virginia.

Ward, C. 1960. "The Fishes of the Nolichucky River: Special Report of the Tennessee Game and Fish Commission," GPO-915-001, U.S. Dept. of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED LICENSE RENEWAL

The following sections discuss the current environmental effects of operations at the NFS Erwin Plant and the effects expected if the NFS license is renewed. The analyses regarding air and water quality, land use, and ecological and radiological impacts were based primarily on data provided by the applicant (NFS 1983, 1984a, 1984b, 1984c, 1985a, 1985b, 1989a, 1989b, 1990, and 1991).

No significant modification of the procedures for nuclear fuel production have been made since an Environmental Impact Appraisal was issued by the NRC in January 1978 (NRC 1978). However, new pollution control equipment, including a new ventilation system, was installed and some operations were modified to reduce environmental impacts. These changes are factored into the analyses.

4.1 MONITORING PROGRAMS AND RESULTS

The applicant conducts a comprehensive effluent and environmental monitoring program 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 required monitoring program is presented in Table 4.1.

4.1.1 Effluent Monitoring Program

4.1.1.1 Radiological

- Gaseous

Stack and vent emissions are sampled at all points where radioactivity is released to the atmosphere. Each release point is provided with a particulate filter and a sample pump that operates continuously during facility use. Filters are exchanged and analyzed for radioactivity daily (Monday through Friday) for some release points. For more significant release points, filters are analyzed 7 days a week. Stack samples are collected isokinetically.

Tables 4.2 and 4.3 present stack and room ventilator effluent concentrations for the past several years. Nineteen room ventilators operated in both the 200 and 300 Complexes until the new plant ventilation system was installed in 1983. These release points have since been eliminated, and presently, there are no room air ventilators in HEU areas. Similarly, 26 separate discharge stacks were in operation from 1979 to 1983; however, with the installation of the new system, 11 of these stacks no longer exist.

In the early years shown in Table 4.3, the principal sources of radioactivity releases were the production glove boxes and hoods, the "wet" line hoods, the incinerator room, the dry box line, and the laboratory hoods and

Table 4.1. Environmental Radiological Monitoring Program.

Sample Point	Sample Type	Analysis/ Collection Frequency	Parameter	Action Level	Minimum Detectable Concentration
Air Monitoring					
Airborne Discharges Stacks	Continuous	Daily	Gross Alpha	>10E-12 uCi/ml (gross alpha - main stack) >50E-12 uCi/ml (gross alpha - other stacks)	1E-12 uCi/ml gross alpha
Ambient Air Stations	Continuous	Weekly	Gross Alpha	>5 x 10^{-15} uCi/ml Average concentration per quarter	3E-15 uCi/ml gross alpha
Surface Water					
Banner Spring Branch (Upstream)	Grab	Quarterly	Gross Alpha	3E-7 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Banner Spring Branch (Downstream)	Continuous	Daily (M-F)	Gross Alpha	3E-6 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Martin Creek (Upstream)	Grab	Quarterly	Gross Alpha	3E-7 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Martin Creek (Downstream)	Grab	Weekly	Gross Alpha	3E-6 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Nolichucky River (Upstream)	Grab	Quarterly	Gross Alpha	3E-7 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Nolichucky River (Downstream)	Grab	Quarterly	Gross Alpha	3E-6 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Process Water					
Waste Water Treatment Facility	Grab	1 per batch	Gross Alpha	>3E-5 uCi/ml (gross alpha)	1E-6 uCi/ml (gross alpha)
			Gross Beta	>2E-5 uCi/ml (gross beta)	1E-6 uCi/ml (gross beta)
Cooling Water	Grab	Weekly	Gross Alpha	>3E-7 uCi/ml (gross alpha)	3E-8 uCi/ml (gross alpha)
Sewer	Grab or Continuous*	Daily (M-F)	Gross Alpha	>8E-6 uCi/ml (gross alpha)	2E-7 uCi/ml (gross alpha)
Soil	Grab	Quarterly	Gross Alpha	>25E-6 uCi/gm (gross alpha)	5E-6 uCi/gm (gross alpha)
Silt/Sediment	Grab	Quarterly	Gross Alpha	>25E-6 uCi/gm (gross alpha)	5E-6 uCi/gm (gross alpha)
Vegetation	Grab	Quarterly	Gross Alpha	>25E-6 uCi/gm (gross Alpha)	5E-6 uCi/gm (gross alpha)

*A continuous sampler will be used except when sampler equipment failure, etc. preclude its operation. In such cases, a grab sample will be collected.

Table 4.2. Room air ventilator effluent concentrations of gross alpha radioactivity (μCi/mL x 10^{-12}).

Vent No.	Bldg. No.	1979	1980	1981	1982	1983[a]
1	302	0.47	1.85	2.25	0.88	-
2	302	0.22	8.05	14.10	1.24	-
3	302	0.14	1.36	1.73	0.99	-
4	302	0.25	0.48	1.05	1.36	-
5	303	0.59	9.18	2.75	3.40	3.52[b]
6	303	0.20	0.74	1.44	4.55	2.28[b]
7	303	0.13	4.39	3.80	0.55	-
8	303	0.30	2.20	1.14	1.19	-
9	303	0.10	4.61	4.33	0.70	-
10	303	0.17	8.61	4.66	0.54	-
11	233	0.90	1.60	0.17	0.60	0.04[b]
12	233	0.22	1.08	0.46	1.73	-
13	233	0.43	1.33	3.26	0.43	-
14	302	0.40	23.54	27.34	11.10	-
15	302	0.17	2.34	2.27	11.14	-
16	302	0.30	2.94	10.58	20.25	-
17	302	0.21	1.33	3.73	2.77	-
18	302	0.06	1.13	2.30	2.65	-
19	233			0.38	4.28	0.20[b]
Wall vents	111	5.10	5.65	4.47	4.67	2.26[c]

[a]Most of the vents were decommissioned before January 1983.

[b]These vents were decommissioned during 1983. No room air ventilators exist in high-enriched uranium areas.

[c]This discharge is from a low-enriched uranium area.

Source: NFS 1984a.

Table 4.3

SUMMAY OF STACK EFFLUENT CONCENTRATIONS
(All units in μCi/ml E-12)

STACK NO.	BLDG. NO.	DESCRIPTION	1979 MAX.	1979 AVG.	1980 MAX.	1980 AVG.	1981 MAX.	1981 AVG.	1982 MAX.	1982 AVG.	1983 MAX.	1983 AVG.	1984 MAX.	1984 AVG.
Plutonium														
27	234A	Prod. Glove Box Line	1.7	0.2	1.2	0.1	4.3	0.1	0.5	0.1	1.2	0.1	1.9	0.06
28	234A	Room Cell Air	1.3	0.2	1.0	0.1	1.8	0.1	0.3	0.1	0.5	0.1	0.25	0.03
29	234A	Wet Cell Scrubber	2.7	0.2	1.5	0.1	6.4	0.1	0.5	0.1	0.4	0.1	0.68	0.05
224	234C	Glove boxes	4.1	0.6	2.9	0.2	0.9	0.1	1.2	0.1	0.6	0.04	0.52	0.02
36	234C	Purification cell	10.0		32.9	1.3	43.5	1.5	a					
51	234C	Purification dry boxes	5.7		87.4	1.7	a							
HEU														
185	131	Pilot plant dry boxes	38.8		26.6	0.7	524.0	1.1	5.0	0.4	2.3	0.2	3.7	0.12
207/358	302	Prod. gloves boxes and hoods	15513.4		4074.7	189.2	23000.0	212.3	335.0	23.9	a			
219	233	"Wet" line hoods	615.6		10172.0	27.2	11086.0	177.6	869.0	43.3	a			
253	233	Dry box line	63.9		200.9	9.6	19.8	1.2	25.0	1.2	a			
299	105	Spac Lab prep. dry box	26.4		a									
300	105	Phys. test dry boxes	18.5		a									
317	302	Incinerator room	4091.2		124.4	5.4	458.2	32.0	612.0	30.6	a			
332	120	Maintenance welding hood	87.9		216.7	1.6	11.9	0.4	2.3	0.4	6.4	0.2	0.6	10.06
333	110D	Spec Lab arc stand[b]	56.5		37.9	0.8	6.5	0.4	5.0	3.3	4.1	0.7	0.8	0.05
334	105	Lab hoods and glove boxes[c]			110.8	12.9	43.0	2.9	19.0	2.6	a			
337	105	Physical testing stand	21.0	1.2	a									
338	105	Physical testing lab	23.3	0.8	a									
16		Main process ventilation[c]									51.5	4.0	31.2	7.66
76	301	BEST facility[c]												
21	100	Laundry stack	2.3	1.2	7.6	2.6	3.7	2.0	2.3	1.8	1.8	0.8	2.1	0.2
LEU														
03	100		0.5	0.1	12.7	0.8	6.6	0.2	1.0	0.1	0.6	0.1	1.6	0.06
04	110		0.8	0.1	8.1	0.8	119.9	0.6	1.4	0.1	0.6	0.1	0.4	0.03
78	111		508.9	50.1	344.8	31.9	428.0	24.9	207.0	7.3	91.7	10.7	32.8	3.6
87	111		37.1	8.0	710.6	97.7	1436.8	72.8	128.4	12.7	24.5	2.9	98.9	9.1
20	130		11.3	0.9	d		117.7	1.5	1759.0	26.1	678.7	11.13	88.4	4.7
54	110	Trash compactor[c]					34.0	0.5	22.0	0.4	3.9	0.1	6.	

Decommissioned.
Spec Lab arc stand relocated to Building 105 during 1984. Stack #333 is NDA Standards Hood since mid 1984.
Installed during the year data appear.
Not in operation.
ource: NFS 1985a.

Table 4.3 (Continued)

SUMMARY OF STACK EFFLUENT CONCENTRATIONS
(All units in uCi/ml E-12)

STACK NO.	BLDG. NO.	DESCRIPTION	1985 MAX.	1985 AVG.	1986 MAX.	1986 AVG.	1987 MAX.	1987 AVG.	1988 MAX.	1988 AVG.	1989 MAX.	1989 AVG.
Plutonium												
27	234A	Prod. Glove Box Line	2.25	0.06	0.65	0.05	2.14	0.06	0.17	0.02	0.24	0.04
28	234A	Room Air Cell	2.69	0.05	4.77	0.12	0.28	0.05	1.04	0.06	0.18	0.03
29	234A	Wet Cell Scrubber	0.66	0.04	0.41	0.06	3.00	0.13	0.21	0.03	0.39	0.03
224	234A	Dissolution Glove Boxes	0.46	0.02	1.59	0.07	0.90	0.04	0.15	0.02	0.18	0.04
(1) 554	110	Room Air from CWB Lab	---	---	---	---	---	----	0.06	0.01	0.20	0.09
(7) 583	234	Pu Lab exhaust	---	---	---	---	---	---	----	----	0.01	0.04
HEU												
(2) 185	131	Prod. Dry Boxes	1.06	0.10	---	---	---	---	5.13	0.06	5.13	0.35
332	120	Maintenace Welding Hood	7.18	0.11	1.91	0.14	0.82	0.09	0.17	0.05	0.07	.07
333	110	Spec Lab Arc Stand	2.70	0.07	0.71	0.07	0.22	0.02	0.10	0.02	0.07	0.05
416		Main Process Ventilation	107.07	3.02	54.08	5.55	153.70	3.22	36.88	1.94	230.0	2.80
(3) 376	301	Ventiliation	23.53	1.17	9.82	1.22	14.83	0.56	5.10	0.34	3.74	0.24
(4) 573	302,303	Finishing Offgases	----	---	---	----	-----	----	95.87	3.86	3260.0	83.33
421	100	Laundry Exhausts	0.61	0.17	0.53	0.22	0.24	0.08	0.14	0.04	0.07	0.04
(5) 547	100	Laundry Exhausts	---	---	---	---	---	----	0.28	0.04	0.50	0.06
LEU												
103	110	Dry Boxes	0.78	0.04	0.68	0.04	0.70	0.15	0.24	0.04	0.72	0.05
104	110	Dry Boxes	0.62	0.04	0.32	0.04	0.19	0.05	0.40	0.04	1.46	0.12
(6) 278	111	Calciner Furnace	70.74	2.43	58.81	9.44	---	---	---	---	----	----
(6) 287	111	Main Vent Scrubber	136.46	8.17	79.78	3.62	---	---	---	---	---	----
320	130	Cylinder Wash Operation	113.25	5.95	22.77	3.19	31.67	3.70	171.19	4.30	0.30	0.09
354	110	Trash Compactor	1.80	0.10	3.01	0.12	0.26	0.04	0.14	0.02	0.22	0.31

(1) Stack No. 554 began operation during the second half of 1988.
(2) Stack No. 185 was not in operation in 1986 and 1987.
(3) Stack No. 376 began operation during the first half of 1985.
(4) Stack No. 573 began operation during the second half of 1988.
(5) New sampler began operation during the first half of 1988.
(6) Building 111 was shut down during 1987 and 1988.
(7) Exhaust No. 583 was started second half of 1989.

dry boxes. Subsequent improvements in process pollution control resulted in significant reduction in radioactivity concentrations in the effluents from some of these sources by 1982. In 1983, all of these discharges were to the main plant process ventilation system using additional pollution controls (Section 2.2.2.1) with subsequent discharge through the main stack (stack 416).

For most of the vents and stacks still in operation, there has been a general downward trend in concentration of radioactivity since 1979. The releases since 1983 from the wall vents and the stacks (Table 4.3) have generally been below the 10 CFR Part 20 limits for onsite concentrations, the average concentrations have all been below the limits. For offsite concentrations, after application of the appropriate atmospheric dispersion factor (Table 3.1), all releases have been below the limits in 10 CFR Part 20. The total annual releases for the years 1979-1989 from the main stack and from several remaining building vents are given in Table 4.4. These data are used in Section 4.2.5 to determine the maximum individual and population doses. In addition to transferring most of the radioactive discharges to the main process ventilation system (stack 416), NFS has also emphasized internal operational improvements that resulted in reducing total releases by more than 50 percent.

Table 4.4. Annual releases of uranium radioactivity (μCi) from stacks and building vents for the period 1979-1989.

Release point	1979	1980	1981	1982	1983	1984
Main process ventilation (stack 416)					4,100[a]	4,997
Building vents and low stacks	89,766	66,467	56,300	11,935	781	604
	1985	1986	1987	1988	1989	
Main process ventilation (stack 416)	2,140	4,000	2,090	1,490	2,700	
Building vents and low stacks	460	300	300	20	300	

[a]Stack 416 placed in operation in 1983.
Source: NFS 1985a, 1990.

- <u>Liquid</u>

The various liquid waste streams are monitored routinely. Process waste waters are discharged (Figure 4.1) on a batch basis from the Waste Water Treatment Facility (WWTF, Building 330) to the Nolichucky River (NPDES permit, Outfall 001). The Building 233 noncontact cooling water loop discharges to Banner Spring Branch (Outfall 002). Every batch of the WWTF liquids is sampled and analyzed for gross alpha and beta and total uranium content, and a monthly aliquot is analyzed for isotopic uranium, ^{99}Tc, ^{234}Th, and ^{234}Pa. The coolant water discharge sample is collected weekly and analyzed for gross alpha and beta content. Summary results of this monitoring over the period 1979-1989 are presented in Tables 4.5 and 4.6.

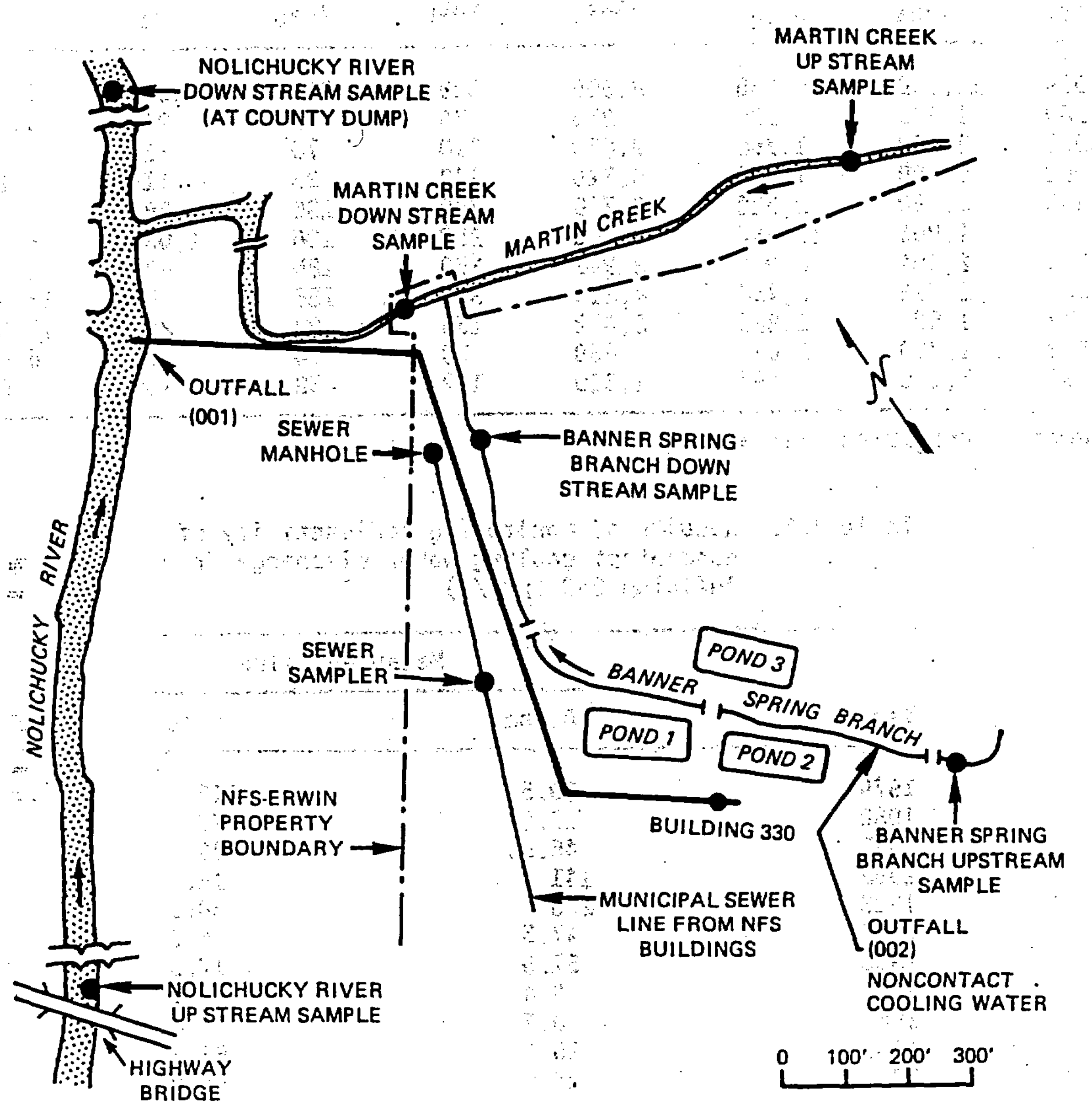

Figure 4.1. Surface water sampling locations in the vicinity of the NFS site, Erwin, Tennessee.
Source: Oak Ridge National Laboratory Drawing No. ES-6135R.

Table 4.5. Results (pCi/L) of monitoring WWTF process liquid effluent (1979-1989).

Year	Gross alpha	Gross beta	^{234}U	^{235}U	^{238}U	^{234}Th Pa	^{99}Tc
1979	18,500	6,050	18,500	590	340	1,530	10,400
1980	1,140	130	210	70	60	230	1,000
1981	3,810	1,790	3,650	110	70	110	2,080
1982	6,990	1,880	6,720	132	38	110	276
1983	5,400	2,520	7,700	280	136	286	1,830
1984	4,896	10,456	6,806	252	186	1,034	8,721
1985	2,454	8,044	3,947	350	185	472	4,818
1986	2,236	6,454	4,319	397	156	59	13,398
1987	1,824	8,811	2,412	150	84	292	18,523
1988	1,380	3,013	2,668	79	74	178	6,861
1989	1,508	7,494	1,320	127	68	140	815

Source: NFS 1984a, 1989a.

Table 4.6. Results of monitoring radioactivity of noncontact cooling water discharge from Building 233 (pCi/L).

	Measured value	
Year	Alpha	Beta
1979	29.5	115
1980	25.5	72.5
1981	45.5	33
1982	141	18.7
1983	205	30.5
1984	47.5	5.3
1985	57.5	17.5
1986	8.4	6.7
1987	0.7	2.7
1988	30.3	56.2
1989	35.9	58.2

Source: NFS 1984a, 1990.

The radioactivity concentrations in the effluent from the WWTF (Outfall 001) and from the Building 233 cooling water circuit (Outfall 002) are below the standards given in 10 CFR Part 20 for offsite locations. The radioactivity levels from the WWTF are substantially less than in 1979, but there was a generally increasing trend in the early 1980s since the lowest values were observed in 1980. The alpha contamination in the cooling water discharge steadily increased until 1983. The levels have decreased since 1983. It is unknown why the cooling water exhibited the elevated levels in 1982 and 1983.

The staff was concerned that the elevated levels indicated potential radioactive leakage into the cooling system. In response to the NRC concern, NFS has set an action level at 0.5 percent of the unrestricted area MPC for uranium. If the action level is exceeded, NFS will conduct an investigation into the cause for the exceedance.

Liquid discharges via the municipal sewer are sampled daily from a location inside the plant perimeter and are analyzed for gross alpha concentrations. The sampling results for the period 1979-1989 are summarized in Table 4.7.

Table 4.7. Annual average concentration of radioactivity discharged to the municipal sewer (pCi/L).

	Gross alpha	Gross beta	U-234	U-235	U-238	Total Pu	Total Th
1979	10,960	907	9,480	325	162	<8	25
1980	1,470	87	141	21	<10	<1	23
1981	2,180	230	872	31	32	3	1
1982	1,540	316	1,270	28	26	2	20
1983	691	102	1,110	33	19	1	17
1984	240	47	402	22	16	3	1
1985	194	49	212	32	16	1	3
1986	239	50	301	23	11	1	1
1987	126	45	276	15	16	3	9
1988	103	21	106	6	5	0	4
1989	120	37	217	19	17	1.5	6.9

Source: NFS 1984a, 1989a.

NFS has installed a new proportional sampler in the sewer line; grab samples are taken if the proportional sampler is inoperative. In addition, NFS has agreed to collect quarterly samples of sludge from the Erwin municipal sewage treatment facility. Samples will be analyzed for isotopic uranium.

Based on the average municipal waste flow from the facility of 72,500 m^3/year (Section 2.2.2.3), the total activity released by NFS to the municipal sewer in 1988 was less than 0.01 Ci, which is less than the 1-Ci annual limit specified in 10 CFR Part 20.303. NFS now diverts most of the liquid streams to the WWTF. The total activity released by NFS to the municipal sewer has significantly been reduced from the discharges of the early 1980s. The average concentrations of uranium, plutonium, and thorium in Table 4.7 are well below the lowest concentrations of 10 CFR Part 20.

Stormwater runoff was sampled from 1979-1983 at a drainage ditch along the railroad siding and in a surface storm drainage ditch. Sample results from the drainage ditch locations are shown in Table 4.8. Although these results are somewhat high compared to the effluent releases, they are still below the 10 CFR Part 20 concentrations. However, these drainage ditch results may not be indicative of radioactivity in any one stormwater runoff event because the samples were obtained from standing water in an area that probably contained contaminated soil (see Section 2.2.2.5). With the completion of the new plant stormwater drainage system in December 1983 (Section 2.2.2.3), these ditches no longer exist.

Table 4.8. Annual average concentrations of radioactivity in drainage ditches sampled from 1979-1983 (pCi/L).

Sampling location	Gross alpha	Gross beta	^{234}U	^{235}U	^{238}U	Total Pu	Total Th
Railroad Ditch							
1979	9,760	1,210	6,870	171	351	<2	31
1980	2,520	877	1,100	140	206	<1	<16
1981	4,580	499	4,100	97	47	1	2
1982	4,880	1,400	5,200	174	501	1	13
1983	218	33	470	29	28	0	26
Storm Drain							
1979	1,200	184	734	39	249	<2	35
1980	1,020	282	88	11	48	<1	<9
1981	782	243	494	20	147	0	3
1982	4,190	2,060	1,340	51	353	4	217
1983	4,240	1,680	2,230	127	736	2	256

Source: NFS 1984a.

4.1.1.2 Nonradiological

- Gaseous and Particulate

Fluoride releases to the atmosphere were monitored in 1981 before the new ventilation system was installed in 1983 (NFS 1985). The monitoring was discontinued (NFS 1984a) after the results indicated that ambient fluoride concentrations at the nearest site boundary were meeting Tennessee standards (Sections 3.2.4 and 4.2.1). The Tennessee Department of Health and Environment has issued permits for emissions to the atmosphere at about 20 release points on the NFS site and occasionally monitors for opacity and certain gaseous constituents at these release points. This monitoring has indicated that the NFS Erwin Plant is in compliance with all Federal and State air quality standards (Section 4.2.1).

• Liquid

The NPDES permit for effluent discharge from the NFS site is issued by the State of Tennessee (Appendix B). The plant effluent discharge to the Nolichucky River and to Banner Spring Branch (Figure 4.1) is monitored to ensure compliance with the permit. Table 4.9 contains a summary of the process and cooling water effluent monitoring data for the NFS plant. These discharges from NFS are generally in compliance with the NPDES permit (Appendix B). NFS has committed to notify the NRC of any violation of the NPDES permit. NFS received its new NPDES permit on February 28, 1991.

4.1.2 Environmental Monitoring Program

4.1.2.1 Radiological

• Ambient air

Environmental air sampling is conducted continuously at a minimum of six locations (Figure 4.2). All air filters are exchanged weekly and analyzed for gross alpha and beta radioactivity. In addition, composite samples from the station nearest the maximally exposed offsite individual is analyzed for isotopic uranium on a quarterly basis and for isotopic plutonium and thorium on an annual basis.

The annual average gross alpha radioactivity at the ambient air monitors for the years 1979 through 1989 is given in Table 4.10. Particle size and solubility in lungs of uranium in the samples collected on filters at the NFS parking lot entrance are shown in Table 4.11 for the period 1981 through 1989. The data shown in Tables 4.10 and 4.11 are used in Section 4.2.5 to calculate the potential radiological dose to individuals from ambient air samples for comparison with similar calculated doses using gaseous emission data in Table 4.4.

• Surface Water

Surface water samples are collected from upstream and downstream locations (Figure 4.1) in Banner Spring Branch, Martin Creek, and the Nolichucky River. Daily samples from Banner Spring Branch are analyzed for gross alpha. Nolichucky River water samples (upstream and downstream) are collected quarterly and analyzed for gross alpha. Split samples are sent to the State Department of Health and Environment for comparative analysis. The results of these analyses are summarized in Tables 4.12, 4.13, and 4.14.

The results of the surface water sample indicates that the concentrations of radioactivity downstream are well below the maximum permissible concentrations as specified in 10 CFR Part 20, Appendix B, Table II. Currently, the licensee is taking daily grab samples from Banner Spring Branch and Martin Creek. NFS has committed to collecting water samples from Banner Spring Branch on a continuous basis. Martin Creek samples will be a weekly grab sample. This will provide more accurate information for analyzing surface water release impacts.

Table 4.3.

Summary of nonradiological monitoring of process waste water and cooling water.[a]

Parameter	1979 AVG.	1979 MAX.	1980 AVG.	1980 MAX.	1981 AVG.	1981 MAX.	1982 AVG.	1982 MAX.	1983 AVG.	1983 MAX.
WWTF Discharge at Mile 94.6 - Nolichucky River Outfall 001										
Discharge Volume (m^3/day)	29.6	58.1	42.6	78.0	48.2	104.85	40.94	91.98	43.81	95.57
Total Suspended Solids (kg/day)[b]	40(1)	114	<1	4	<1	5	<1	5	<1	3
Ammonia (as N) (kg/day)	11(<1)	30(2)	NA	2(30)	NA	1.8(27)	NA	1.7(27)	NA	1.7(30)
Nitrates (as N) (kg/day)	8,810(198.5)	23,473(297.1)	NA	295	NA	297	NA	295	NA	296
Fluoride (kg/day)	15(<1)	29(1)	NA	2(29)	NA	1.5(28)	NA	1.3(29)	NA	1.6(30)
Boron (kg/day)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium (mg/L)	0.008	0.2	(<0.002)	(<0.010)	(<0.001)	(0.003)	(<0.01)	(0.009)	(<0.01)	(0.005)
Mercury (mg/L)	<0.002	0.039	(0.003)	(0.005)	(<0.001)	(0.005)	(<0.002)	(0.005)	(<0.001)	(0.005)
Settleable Solids (mg/L)	<0.2	0.6	(<0.2)	(0.5)	(<0.1)	(0.1)	(<0.1)	(0.1)	(<0.1)	(0.2)
Chlorine Residual (mg/L)	<0.06	2.0	NA	(1.0)	NA	(2.0)	NA	(1.2)	NA	1.4
pH - Standard Units (min. = 6.0)	7.1	8.3	NA	8.6	NA	9.9	NA	8.8	NA	8.8
Cooling Water Dishcarge to Banner Branch Ourfall 002										
Discharge Volume (m^3/day)	239.6	1,096.0	230.20	486.4	93.47	400.07	192.53	887.2	214.43	1,096.14
Discharge Temperature (°F)	67	88	69	97	81	100	74	99	83	146
pH - Standard Units (min. = 6.0)	Not required		NA	7.5	NA	7.4	NA	7.9	NA	7.6

[a]The National Pollutant Discharge Elimination System permit limits for these two waste outfalls are given in Appendix B.
[b]Value given within parentheses is average concentration in mg/L.
Source: NFS, 1984a, Table 5.2

Summary of Non-radiological
Monitoring of the Waste Water Treatment Facility
(Discharged at Mile 94.6 - Noli chucky River)
(Maximum Values)

	1984	1985	1986	1987	1988
Discharged Volume - M3/day	91.11	85.73	71.54	94.16	72.35
Total Suspended Solids - kg/day	2.24	1.50	2.00	1.92	1.65
Ammonia (as N) - kg/day (mg/l)	1.5(27.5)	1.45(23)	1.2(25.5)	1.07(27.5)	1.46(26.5)
Nitrates (as N) - kg/day	293.50	296.35	293.85	279.95	286.35
Fluoride - kg/day (mg/l)	1.35(23.5)	1.35(25.5)	1.35(25.5)	1.36(27)	1.30(26)
Settleable Solids - (ml/l)	0.25	0.20	0.10	0.20	0.15
Chlorine Residual - (mg/l)	1.60	1.30	0.33	1.12	1.38
pH - Standard Units (min. = 6.0)	8.55	8.60	8.65	8.75	8.50

Source: NFS, 1989a.

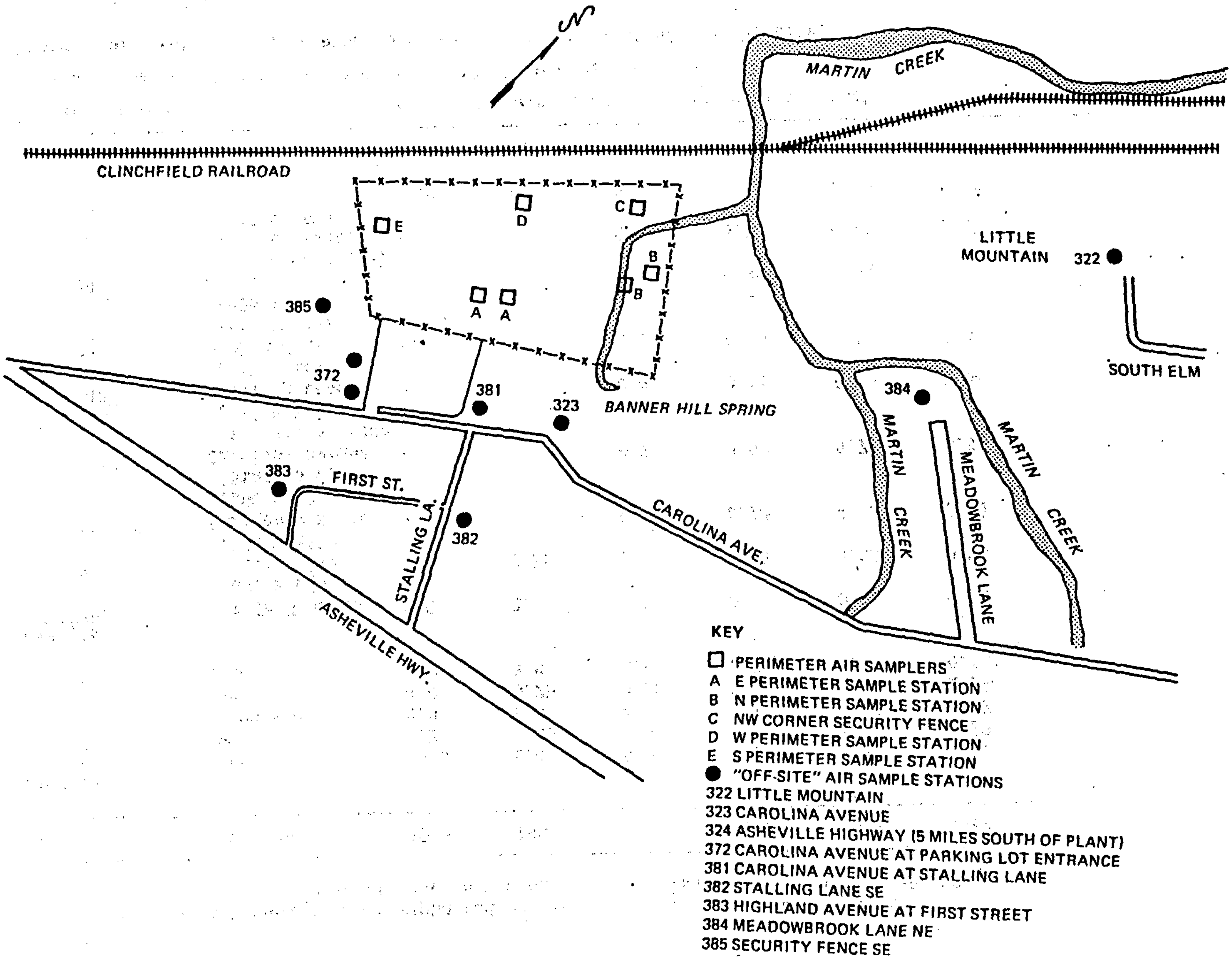

Figure 4.2. Location of perimeter and offsite air samplers at the NFS site, Erwin, Tennessee. Source: Oak Ridge National Laboratory Drawing No. 85-10043.

Table 4.10. Annual average gross alpha radioactivity (μCi/mL x 10^{-14}) in ambient air samples taken at five onsite and nine offsite locations from 1979-1989.[a]

Sample	Location	1979	1980	1981	1982	1983	1984
Perimeter							
A	East	15.8	5.4	4.0	1.5	1.42	0.54
B	Northeast	4.2	5.25	2.3	1.4	1.07	0.38
C	Northwest	4.0	6.0	4.0	2.15	1.76	0.72
D	West	4.0	5.25	3.25	2.4	2.32	1.19
E	South	3.0	3.0	1.4	0.7	0.87	0.41
Offsite							
322	Little Mountain (800 m NE)	2.6	2.1	1.8	0.45	0.48	0.31
323	Carolina Ave. (300 m ESE)	2.6	2.35	1.15	0.40	0.58	0.28
372[b]	Emergency House (280 m S) (Station B)	-	-	0.7[b]	0.70	0.75	0.35
381[b]	Carolina Avenue at Stalling Lane (215 m SE)	-	-	0.7	0.50	0.78	0.33
382[b]	Stalling Lane (315 m SE)	-	-	0.4	0.45	0.78	0.34
383[b]	Highland at First Street (405 m S)	-	-	0.6	0.45	0.58	0.34
384[b]	Meadowbrook Lane (540 m ENE)	-	-	0.4	0.85	0.51	0.16
385[b]	Security Fence (210 m SSW)	-	-	0.7	0.7	0.62	0.25
324[c]	Asheville Highway (8 km SW)	1.05	1.4	0.8	0.35	0.49	0.26

[a]Locations shown in Figure 4.2. Distance and direction are from the main stack.

[b]Six new samplers began operation during the second half of 1981.

[c]Background station located about 8 km (5 miles) southwest of the NFS site.

Source: NFS 1985a, 1990

Table 4.10. (Continued)

Sample	Location	1985	1986	1987	1988	1989
Perimeter						
	Northeast	0.88	0.84	0.46	0.34	0.26
	East	0.89	0.89	0.47	0.33	0.42
	South	0.77	0.79	0.32	0.25	0.46
	West	1.22	1.14	0.42	0.41	0.36
	Northwest	0.88	0.94	0.32	0.32	0.24
	East Northeast	--	--	--	0.32	0.42
Offsite						
	Little Mountain (800 m NE)	0.70	0.53	0.20	0.21	0.24
	Carolina Ave. (300 m ESE)	0.47	0.94	0.26	0.25	0.23
	Emergency House (280 m S) (Station B)	0.63	1.19	0.29	0.26	0.27
	Carolina Avenue at Stalling Lane (215 m SE)	0.58	0.87	0.28	0.27	0.27
	Stalling Lane (315 m SE)	0.65	0.76	0.29	0.33	0.25
	Highland at First Street (405 m S)	0.49	1.14	0.34	0.31	0.26
	Meadowbrook Lane (540 m ENE)	0.45	0.51	0.30	0.26	0.02
	Security Fence (210 m SSW)	0.76	0.79	0.28	0.28	0.29
(1)	Sewer Mound (300 m N)	--	--	--	0.25	0.33
	Asheville Highway (8 Km SW)	0.50	0.72	0.27	0.21	0.02

(1) New sampler began operation during the first half of 1988.

Table 4.11. Particle size and lung solubility of uranium from samples collected at the parking lot entrance (Sample No. 372).

Period	AMAD[a] (micro meters)	% Class D	% Class W	% Class Y
Jan-1981	1.9	26	0	74
Apr-1981	1.8	44	0	56
Jul-1981	2.0	39	0	61
Oct-1981	1.5	52	0	48
Jan-1982	2.0	39	0	61
Apr-1982	2.0	35	0	65
Jul-1982	2.0	43	0	57
Oct-1982	2.0	33	0	67
Jan-1983	2.4	35	0	65
Apr-1983	2.4	37	0	63
Jul-1983	1.5	54	0	46
Average[b]	2.0	40	0	60
Oct-1983	1.5	35	0	65
Jan-1984	1.8	20	0	80
Apr-1984	1.8	44	0	56
Jul-1984	1.1	33	0	67
Oct-1984	1.8	42	0	58
Jan-1985	1.5	30	0	70
Apr-1985	1.5	42	0	58
Jul-1985	1.9	47	0	53
Oct-1985	1.9	47	0	53
Jan-1986	1.1	45	0	55
Apr-1986	0.9	38	0	62
Jul-1986	0.9	46	0	54
Oct-1986	1.0	10	0	90
Jan-1987	2.6	23	0	77
Apr-1987	1.7	29	0	71
Jul-1987	1.0	52	0	48
Oct-1987	0.9	35	0	65
Jan-1988	1.5	47	0	53
Apr-1988	1.2	53	0	47
Jul-1988	1.3	62	0	38
Oct-1988	1.1	43	0	58
Jan-1989	1	26	0	74
Apr-1989	0.7	29	0	71
Jul-1989	0.7	38	0	62
Average[c]	1.35	38	0	62

[a]AMAD - Activity Median Aerodynamic Diameter.

[b]Average before ventilation upgrade.

[c]Average after ventilation upgrade.

- Ground Water

Until 1984, ground water monitoring consisted of sampling two wells. One of the wells is located between two 23,000-L (6,000-gallon) underground waste storage tanks north of Building 303 (Well B), and the other is located north of the burial ground at the north end of the plant property. Fourteen new wells were installed in early 1984 to obtain preliminary data on possible ground water contamination from the retention ponds and the waste burial ground. In 1988, NFS proposed an extensive hydrological characterization study around the pond area as part of a plan for the closure of the ponds and establishment of a long-term, plant-wide ground water monitoring program. This approach was approved in Amendment 48. NFS has committed to the same program in its license renewal application. The specific objectives include the determination of hydraulic gradients, aquifer hydraulic characteristics, soil density properties, and potential ground water flow alteration. This characterization program is still ongoing. On November 17, 1989, NFS submitted a decommissioning plan for the ponds. This plan was approved on July 30, 1991, as a separate action from the renewal application. Once the ponds are decommissioned, NFS has committed to submitting a plan for long-term site-wide routine ground water monitoring. This approach is acceptable for the pond area and areas impacted by the ponds. However, there are some areas around the site that should be included in a ground water monitoring program now. There are a number of wells located in and around the burial ground north of the ponds. Some of these wells have exhibited elevated levels of radioactivity. While part of the burial ground could be impacted by the contamination from the ponds, the burial ground should be part of the routine monitoring program. Additionally, the burial area located near the northwest corner of the plant should be included in the routine monitoring program. It is recommended that within 90 days of the license renewal NFS establish a routine ground water monitoring program to cover the burial ground north of the ponds and the burial area near the northwest corner of the plant.

Well B is positioned midway between the underground storage tanks, 1m (3 ft) from the outer wall of each tank. This well is terminated at the top of a concrete pad on which a 23-cm (0.75 ft) thick sand layer rests. The storage tanks were placed on top of the sand, whereas the well casing was perforated adjacent to the sand layer to allow water samples to be drawn from beneath the tank. The casing rises out of a bed of sand and gravel surrounding the underground storage tanks, but there is no cement collar around it. NFS has committed to collecting a weekly sample of the ground water collected from well B and analyzing the sample for gross alpha radioactivity. This well has exhibited elevated levels of uranium in the past; the nonradiological parameters such as ammonia and fluoride have also exhibited elevated levels, indicating some leakage occurred from past operations. As described above, well B has no cement collar around it; thus, surface water may get into the well and cause dilution of fluids that leak from the tanks. Because the past leakage of the tanks and the well construction may have destroyed the effectiveness of the ground water monitoring for leakage detection, it is recommended that within 90 days of the license renewal NFS develop a more effective monitoring system for leakage detection if the licensee plans to continue using the underground tanks. The licensee is encouraged to replace these tanks with above ground storage tanks to avoid potential ground water and subsurface soil contamination. The underground tank buried within Building 233 should also be included in the monitoring system for leakage detection.

Table 4.12. Annual average surface water alpha radioactivity in samples taken upstream and downstream of NFS discharges and in waste-retention ponds (pCi/L).

Location	1979	1980	1981	1982	1983
Banner Spring Branch (upstream)	14	13	3	4	5
Banner Spring Branch (downstream)	284	389	31	24	15
Martin Creek (upstream)	32	12	6	2	5
Martin Creek (downstream)	204	62	20	9	6
Nolichucky River (upstream)	72	9	3	4	2
Nolichucky River (downstream)	30	19	3	4	6
Pond 1	4,270	10,400	19,900	11,100	4,290
Pond 3	3,100	2,510	4,000	8,400	37,300

Location	1984	1985	1986	1987	1988	1989 Jan-Jun	1989 July-Dec
Banner Spring Branch (upstream)	1	3.5	26.5	4.7	4	3.0	3.1
Banner Spring Branch (downstream)	10	44.5	15.5	8.1	8.5	9.9	10.2
Martin Creek (upstream)	3.5	7	5.5	5.8	3.5	2.3	2.4
Martin Creek (downstream)	4	21	6.7	7.1	6.3	6.2	6.3
Nolichucky River (upstream)	15	3	0.4	6.7	3.1	3.3	3.4
Nolichucky River (downstream)	0.9	3	1.1	6.8	4	2.5	3.5

*Sampling of the settling ponds was discontinued before 1984.

Source: NFS 1984a, 1989a.

Table 4.13. Annual average surface water beta radioactivity in samples taken upstream and downstream of NFS discharges (pCi/L).

Location	1979	1980	1981	1982	1983
Banner Spring Branch (upstream)	60	40	20	3	3
Banner Spring Branch (downstream)	1,670	1,110	330	8	7
Martin Creek (upstream)	80	30	7	3	3
Martin Creek (downstream)	920	60	6	7	4
Nolichucky River (upstream)	60	10	6	3	1
Nolichucky River (downstream)	100	40	7	3	2

Source: NFS 1984a, 1990

Location	1984	1985	1986	1987	1988	1989
Banner Spring Branch (upstream)	0	0	7.5	8.7	10.2	7.1
Banner Spring Branch (downstream)	0	0.02	13.5	10.8	11.3	10.6
Martin Creek (upstream) at Carolina Ave	0	0	4.2	13.6	9.2	7.6
Martin Creek (downstream) at Banner Spring Mouth	--	--	--	7.35	9.7	5.5
Martin Creek (downstream)	0	0.01	13.7	9.15	11.4	8.5
Nolichucky River (upstream)	0	0	0.5	13.4	9.5	6.7
Nolichucky River (downstream)	0	0	2.2	14.5	10.2	7.7

Table 4.14. Annual average of isotopic radioactivity in surface water samples obtained downstream of NFS discharges[a] (pCi/L).

Sampling location	^{234}U	^{235}U	^{238}U	Total Pu	Total Th
Banner Spring Branch					
1979	101	5	8	<5	<11
1980	11	<2	<2	<1	<13
1981	30	2	1	0	<3
1982	60	1	2	0	<3
1983	69	2	5	0	9
1984	58	5	6	1	1
1985	35.2	4.2	3.5	6.8	0.7
1986	35.3	1.5	3.6	0.8	5.2
1987	28.3	1.6	6.4	0.6	0.9
1988	23.2	2.1	2.9	0.3	2.4
1989	43.3	4.0	5.6	0.2	6.7
Martin Creek					
1979	32	<2	6	<2	<8
1980	5	1	1	0	<4
1981	19	2	2	0	<1
1982	16	0	1	0	2
1983	61	2	3	0	10
1984	13	1	2	0	0
1985	26.1	1.9	2.6	0.5	1
1986	49.3	2	2.8	0.9	1.1
1987	28.3	1.6	6.4	0.6	0.9
1988	14.1	0.9	1.4	0.2	1.5
1989	15.8	1.4	1.4	0.2	4.3
Nolichucky River					
1979	<3	<4	<2	<1	<3
1980	<3	<1	<2	0	<2
1981	1	0	0	0	0
1982	3	0	1	0	1
1983	4	1	0	1	8
1984	1.3	0.1	0.1	1.2	0.5
1985	1.6	0.1	0.1	1.8	0.6
1986	0	0	0	0	1.2
1987	0.8	0.2	0.5	0.4	1.5
1988	1.3	0.3	0.5	0.1	4
1989	1.6	0.3	0.3	0.1	2.3

[a]Zero indicates less than 0.5 pCi/L.

Source: NFS 1984a, 1990.

- <u>Sediment</u>

Sediment samples are taken quarterly from upstream and downstream in Banner Spring Branch, Martin Creek, and the Nolichucky River. The top one-quarter inch of a square foot of sediment is analyzed for gross alpha. The annual average alpha concentrations, which are an indicator of uranium contamination from NFS operations, are given in Table 4.15.

A review of the stream sediment data in Table 4.15 indicates that the downstream sediments in Banner Spring Branch and Martin Creek do contain more radioactive contamination than the upstream sediments. If the alpha activity is assumed to be enriched uranium, several annual average values are in excess of the limit of 30 pCi of enriched uranium per gram of soil allowed for disposal with no restriction on the method of burial (NRC 1981). Therefore, the staff shall continue to require that the sediments of Banner Spring Branch and Martin Creek immediately downstream of the NFS site be monitored to serve as an indicator of potential unexpected radioactive release events and of long-term buildup of radioactivity that may require removal when the NFS facility is decommissioned. NFS no longer discharges process liquids to Banner Spring Branch; however, the ponds may discharge to the creek.

The alpha activity measurements for the Nolichucky River sediments do not indicate any consistent increase as a result of NFS operation. Considering the small flow and small amount of radioactivity discharged from the Waste Water Treatment Facility and the large dilution by the river, that result was not unexpected.

- <u>Soil and Vegetation</u>

Soil and vegetation samples will be collected quarterly at the Banner Hill Road and north NFS mound at the sewer locations near but downwind of the NFS site (Figure 4.2) and at the background station at an Asheville highway location about 8 km south of the plant. Samples are analyzed for gross alpha radioactivity. For the years 1979-1989 (Table 4.16), the data (NFS 1984a, 1989a, 1990) generally indicate that the alpha and beta activities in the soil at the Little Mountain and Carolina Avenue locations are slightly elevated when compared with the distant Asheville highway location; but there is not a similar trend in the activities in the vegetation samples. However, if all of the alpha activities are assumed to be uranium, they have been well below the limit of 30 pCi of enriched uranium per gram of soil allowed for disposal with no restriction of the method of burial (<u>Federal Register</u> December 2, 1982, p. 57446).

- Ambient Radiation

Twelve permanent thermoluminescent dosimeter (TLD) monitoring stations are located on and around the site (Figure 4.3). These dosimeters are exchanged and read quarterly to determine ambient radiation levels. The data in Table 4.17 indicate that the locations receiving consistently higher radiation levels from the NFS facility are principally along the controlled area fence around the NFS processing buildings. These include locations 7, 9, 10, 11, and 13. Location 11 may also be affected by radiation from one of the retention ponds. The sample locations beyond the controlled area security fence and locations 4 and 6 at the security fence do not exhibit a significant difference from the Asheville highway background station.

Table 4.15. Annual average alpha radioactivity in stream sediments and retention ponds (pCi/g or $\mu Ci/g \times 10^{-6}$).

Location/sample type	1979	1980	1981	1982	1983
Pond 3 (upper pond) sediment	3618.7	1518.0	4636.1	3248.28	6067.28
Pond 1 (lower pond) sediment	754.6	776.8	326.9	288.0	1213.0
Banner Spring Branch, upstream sediment	6.1	5.5	7.8	1.87	8.02
Banner Spring Branch, downstream sediment	61.0	19.8	52.3	18.88	48.20
Martin Creek, upstream sediment (Carolina Avenue)	10.2	4.4	8.2	1.91	2.30
Martin Creek, downstream sediment	3.0	7.1	13.2	9.49	35.14
Nolichucky River, upstream sediment	6.3	5.5	9.3	1.83	2.44
Nolichucky River, downstream sediment	13.5	4.7	4.0	1.42	2.26

Location/sample type	1984	1985	1986	1987	1988	1989
(1) Pond 3 (upper pond) sediment	24804.45	21578.86	15400.00	-----	-----	----
(1) Pond 2 pond/sediment	---	4248.35	310.00	-----	-----	----
(1) Pond 1 (lower pond) sediment	535.17	1020.94	350.00	-----	-----	----
Banner Spring Branch, upstream sediment	5.84	11.66	13.89	4.53	1.37	0.23
Banner Spring Branch, downstream sediment	99.55	346.72	137.00	151.37	64.39	15.16
Martin Creek, upstream sediment (Carolina Avenue)	2.36	3.90	2.83	2.61	1.12	0.5
Martin Creek, downstream sediment	30.70	20.80	28.65	27.67	14.32	3.4
Nolichucky River, upstream sediment	2.85	2.65	3.11	5.76	1.64	0.16
Nolichucky River, downstream sediment	1.46	8.56	2.75	4.24	1.63	0.15

(1) Sampling of ponds #1, #2, and #3 was discontinued during 1986.

Source: NFS 1984a, 1989a.

Table 4.16. Annual average radioactivity (pCi/g) in soil and vegetation at two locations[a] near the NFS site and at one distant background site.

Sample type and location	Alpha 1979	Alpha 1980	Alpha 1981	Alpha 1982	Alpha 1983	Beta 1979	Beta 1980	Beta 1981	Beta 1982	Beta 1983
Soil										
Asheville Highway (Approx. 8 km S)	16.5	5.7	5.7	2.13	1.36	27.4	14.7	12.7	3.20	2.61
Little Mtn. (Approx. 0.6 km N)	20.1	6.9	5.5	2.57	2.75	36.1	10.1	7.1	2.17	1.72
Carolina Ave. (Approx. 150 m E)	12.3	8.2	5.6	2.47	1.94	15.1	7.3	21.4	1.55	1.93
Vegetation										
Asheville Highway (Approx. 8 km S)	9.7	4.1	13.5	2.40	0.56	17.4	20.2	13.2	4.47	1.74
Little Mtn. (Approx. 0.6 km N)	7.4	3.4	9.9	1.24	0.81	10.3	9.4	11.3	3.13	2.79
Carolina Ave. (Approx. 150 m E)	9.7	4.6	10.0	1.98	0.72	12.4	17.7	12.4	4.17	2.65

[a]Distance and direction are from the plant boundary.
Source: NFS 1984a.

Sample type and location	Alpha 1984	Alpha 1985	Alpha 1986	Alpha 1987	Alpha 1988	Alpha 1989	Beta 1984	Beta 1985	Beta 1986	Beta 1987	Beta 1988	Beta 1989
Soil												
Asheville Highway (Approx. 8 km S)	1.76	4.62	2.79	5.29	2.64	0.28	0.31	2.17	1.05	5.02	2.20	0.3
Little Mtn. (Approx. 0.6 km N)	2.52	6.79	5.18	7.45	3.37	0.53	0.40	1.69	0.78	5.87	3.16	0.41
Carolina Ave. (Approx. 150 m E)	4.59	7.33	6.42	8.83	3.77	0.80	0.67	1.84	1.88	6.82	2.60	0.23
(1)Sewer Mound (Approx. 300 m N)	---	---	---	---	1.69	4.2	---	---	---	---	0.63	2.16
Vegetation												
Asheville Highway (Approx. 8 km S)	0.48	2.22	1.51	1.65	0.58	0.1	0.27	0.84	0.37	3.04	1.69	0.13
Little Mtn. (Approx. 0.6 km N)	0.37	2.36	1.43	1.14	0.60	0.15	0.14	0.42	0.17	2.75	1.60	0.13
Carolina Ave. (Approx. 150 m E)	0.19	2.13	1.79	1.77	0.70	0.08	0.04	1.31	0.30	2.88	1.60	0.15
Sewer Mound (Approx. 300 m N)	---	---	---	---	---	0.9	---	---	---	---	---	0.15

[a]Distance and direction are from the plant boundary.
(1) New sample location added during the first half of 1988.
Source: NFS 1984a, 1989a.

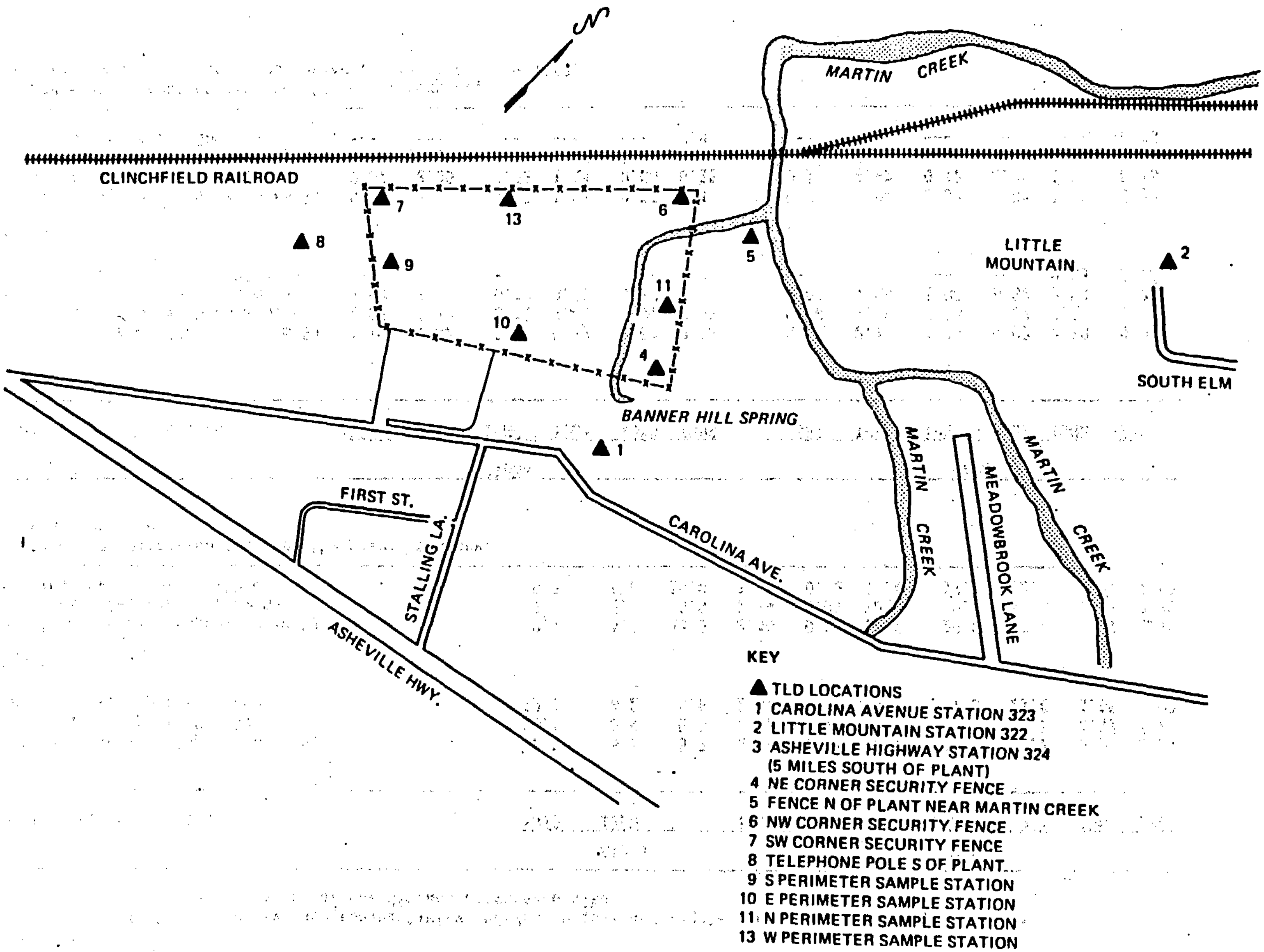

Figure 4.3 Location of perimeter and offsite TLD stations at the NFS site, Erwin, Tennessee. Source: Oak Ridge National Laboratory Drawing No. 85-10039.

Table 4.17. Annual average ambient radiation levels measured with TLDs near the NFS site and at an Asheville Highway background location.

Station no[a]	Location	1979	1980	1981	1982	1983
1	Carolina Avenue Sample Station 223	95[b]	95	25[b]	115	65[b]
2	Little Mountain Sample Station 322	145	85	35	95	105
3	Asheville Highway[c] Sample Station 324	165	95[b]	35	125	95
4	NE Corner Security Fence	145	95	25	15[d]	45[d]
5	Fence N of Plant near Confluence of Banner Spring Branch and Martin Creek	125[b]	45[b]	35	15[d]	45[d]
6	NW Corner Security Fence	165	55[d]	35	140[b]	95
7	SW Corner Security Fence	255	195	150	115[b]	195
8	Telephone Pole S of Plant	145	95	35	125	135
9	S Perimeter Sample Station	500	440	370	435	185[d]
10	E Perimeter Sample Station	155	105	35	115	105
11	N Perimeter Sample Station	175	105	35	135	105
13	W Perimeter Sample Station	250	250	135	205	145[b]

[a]As indicated on Figure 4.5.

[b]Based on three calendar quarters of data.

[c]Background sample located about 8 km (5 miles) southwest of the NFS site.

[d]Based on two calendar quarters of data.

[e]Based on less than four quarters of data.

Source: NFS 1984a, 1990.

Table 4.17 (Continued)

Station no[a]	Location	1984	1985	1986	1987	1988	1989
1	Carolina Avenue Sample Station 223	125	35	65	35	65	45[e]
2	Little Mountain Sample Station 322	115	35	65	35	65	25[e]
3	Asheville Highway[c] Sample Station 324	125	35	65	35	65	25[e]
4	NE Corner Security Fence	155	35	65	35	75	25[e]
5	Fence N of Plant near Confluence of Banner Spring Branch and Martin Creek	155	35	65	30[e]	65	65
6	NW Corner Security Fence	185	35	65	35	65	65
7	SW Corner Security Fence	195	35	65	35	45[e]	45[e]
8	Telephone Pole S of Plant	155	35	55	35	65	25[e]
9	S Perimeter Sample Station	295	35	85	55	55[e]	75
10	E Perimeter Sample Station	115	35	75	35	65[e]	65
11	N Perimeter Sample Station	125	35	85	35	165[e]	75
13	W Perimeter Sample Station	155	35	95	35	75	65

[a]As indicated on Figure 4.5.

[b]Based on three calendar quarters of data.

[c]Background sample located about 8 km (5 miles) southwest of the NFS site.

[d]Based on two calendar quarters of data.

[e]Based on less than four quarters of data.
Source: NFS 1984a, 1990.

4.1.2.2 Nonradiological

- Air, Soils, Vegetation, and Biota

Emissions of fluorides are covered only by Tennessee air quality criteria. Monitoring conducted by an NFS contractor in 1981 before the main process ventilation system was installed indicated that fluoride emissions were already in compliance with the criteria (NFS 1984a). According to NFS, occasional monitoring conducted more recently by the TDHE also indicated that the NFS facility is in compliance with fluoride criteria as well as other air quality criteria. Therefore, routine sampling of air, soil, vegetation, and biota for fluoride is not necessary.

- Surface Water

(a) Onsite Water

Noncontact cooling water is discharged at a rate of 0.004 m^3/s (0.134 cfs) to Banner Spring Branch, which flows through the site at a rate of 0.01 to 0.02 m^3/s (Section 3.5.1). Other inputs to the stream from NFS include surface runoff and overflow and probably seepage from the waste retention ponds. The pH, flow, and temperature of Banner Spring Branch are monitored on a weekly basis downstream of the discharge. Ammonia, nitrate, fluoride, and mercury levels in the branch are analyzed monthly; concentration of these elements and pH values are summarized in Table 4.18. The onsite waste retention (settling) ponds are sampled for pH (NFS 1984a). With the exception of nitrate, all parameters analyzed are comparable to values obtained offsite (see below) and are within acceptable levels for protection of water quality and aquatic life. In 1979 and 1987, levels of nitrate in Banner Spring Branch approached the limit (10 mg/L) for domestic water supply (health) (EPA 1976). Although levels in other years have not approached this level, they remain elevated above those levels found in Martin Creek and the Nolichucky River. The source of elevated nitrate in the branch may be from seepage from the onsite settling ponds (Section 3.5.2.2) or from septic tanks or offsite fertilization of lawns and gardens east of Banner Hill Spring.

(b) Offsite Water

Offsite monitoring is conducted by the applicant downstream of the discharge from Banner Spring Branch into Martin Creek and downstream of the effluent discharge (Outfall 001) into the Nolichucky River (Figure 4.1). Offsite samples taken on a monthly basis are analyzed for nitrate, ammonia, fluoride, and mercury and the pH is determined (NFS 1984a). A summary of some of the results of this monitoring program is shown in Table 4.18. There are no upstream samples taken by NFS that would facilitate comparison of chemical constituents and determination of possible contamination of the river by the plant discharge. The levels of monitored parameters in Table 4.18 are up to an order of magnitude higher than those reported by the Tennessee Department of Health and Environment (Table 3.7), but this appears to be because the applicant's analytical procedures were not as sensitive. However, the results in Table 4.18 for Martin Creek and the Nolichucky River are within Environmental Protection Agency limits for protection of water quality and aquatic life (EPA 1976).

Table 4.18. Summary of nonradiological monitoring of surface water (mg/L except pH).

Sampling location/date	pH	Ammonia	Nitrate	Fluoride	Mercury
Banner Spring Branch					
1979	7.7	1.2	9.8	1.4	<1.0
1980	7.6	1.1	3.7	1.2	<0.001
1981	7.7	<1.8	5.7	4.8	<0.001
1982	7.4	<1.7	<1.5	<1.9	<0.001
1983	7.7	<3.0	<4.2	<3.4	<0.001
1984	8.30	2.45	6.02	<1.6	<0.001
1985	7.25	1.00	4.58	<1.0	<0.001
1986	7.65	1.23	5.23	<1.0	<0.001
1987	7.90	1.00	9.65	<1.0	<0.001
1988	8.15	1.00	1.50	<1.0	<0.001
Martin Creek					
1979	7.6	1.2	1.1	1.3	<1.0
1980	7.6	1.2	1.6	1.0	<0.001
1981	8.1	1.7	<4.3	<1.7	<0.001
1982	7.3	<1.7	<1.0	<2.0	<0.001
1983	8.0	<3.0	<3.0	<3.0	<0.001
1984	8.50	1.90	2.60	<1.8	<0.001
1985	7.35	1.00	4.94	<1.0	<0.001
1986	7.40	1.43	2.70	<1.0	<0.001
1987	7.55	1.20	9.30	<1.0	<0.001
1988	7.60	1.00	1.20	<1.0	<0.001
Nolichucky River					
1979	7.4	<1.0	<1.0	<1.0	<1.001
1980	7.6	<1.0	0.7	<2.0	<0.001
1981	8.0	<1.0	0.5	<1.0	<0.001
1982	7.1	<1.0	<0.5	<1.0	<0.001
1983	7.3	<2.3	<1.2	<2.5	<0.001
1984	7.50	2.30	1.85	<2.0	<0.001
1985	7.05	1.00	1.70	<1.0	<0.001
1986	7.35	1.32	1.57	<1.0	<0.001
1987	7.05	1.00	3.05	<1.0	<0.001
1988	7.00	1.00	.95	<1.0	<0.001

Source: NFS 1984a, 1989a.

- Aquatic Biota

(a) Onsite Biota

There is no onsite monitoring of aquatic biota at the NFS Erwin site. Banner Spring Branch, which is wholly on the NFS site, is the source of and receives discharge of noncontact cooling water, runoff from surface drainage, and probably seepage from settling ponds. The results of the onsite surface water monitoring program are comparable to values obtained off the site and are within acceptable levels for protection of aquatic life; therefore, there should be no adverse effect on biota due to effluents in the branch. Consequently, there should be no need for monitoring onsite aquatic biota.

(b) Offsite Biota

There is no offsite monitoring of aquatic biota in the vicinity of the NFS Erwin site. Because effluent discharge from the NFS facility operations conforms to the NPDES permit limitations and because the volume of discharge is low compared to the flow of the river, there should be no impact on aquatic biota in the river and no need for an ongoing monitoring program.

- Ground Water

NFS is not currently required to analyze any ground water samples for non-radiological parameters. In the past, samples were analyzed for ammonia, nitrate, fluoride, mercury, and pH. As part of the hydrogeologic characterization for the pond decommissioning, ground water samples were analyzed for general chemicals, heavy metals, radiochemicals, and organic chemicals. Wells located near the ponds do exhibit significant chemical contamination. The chemical data supports the conclusion that the settling ponds are the major sources of ground-water contamination from operation of the NFS facility. As part of the site-wide ground water monitoring program, NFS should include nonradiological chemical parameters.

4.2 DIRECT EFFECTS AND THEIR SIGNIFICANCE

4.2.1 Air Quality Effects

At the NFS facility, emissions of nonradiological pollutants (SO_2, NO_x, CO, and particulates), subject to Federal and Tennessee air quality standards (Section 3.2.4), are relatively minor. About 20 release points for fluorides or other pollutants on the NFS site are covered by permits issued by the Tennessee Department of Health and Environment. Space heating is accomplished by combustion of natural gas, which is very clean burning (Table 2.1); fuel oil will be burned only if natural gas is unavailable. Three diesel-powered generators for emergency use operate only infrequently and on an annual basis release only minor amounts of pollutants subject to Federal and State standards. Two incinerators also release pollutants subject to these standards, but both have natural gas afterburners to ensure complete combustion (Section 2.2.1.12). The emissions from one, which is for radioactive wastes, are passed through a venturi scrubber to remove solubles and particulates and are then routed to the main ventilation system for further scrubbing and filtering.

Emissions of fluorides are covered only by Tennessee air quality criteria. Monitoring conducted by an NFS contractor in 1981 before installation of the main process ventilation system indicated that fluoride emissions were already in compliance with the criteria (NFS 1984a). According to NFS, more recent occasional monitoring by the TDHE also indicated that the NFS facility is in compliance with fluoride criteria as well as with other air quality criteria.

Substances not subject to the Federal and State standards are also emitted in small amounts that should have no significant environmental effect. Many of these substances are also typically emitted at many other types of industrial developments. These substances include inert, nontoxic gases (e.g., helium, argon, nitrogen), and various potentially hazardous substances and their reaction or combustion products. The potentially hazardous substances and the amounts used at NFS are given in Section 4.3.2.2. In addition, ammonia is emitted from the NFS facilities. Offsite ammonia concentrations are estimated to be no higher than 9 $\mu g/m^3$. The recommended threshold limit value (TLV) for humans in the workplace in the United States is 25 ppm (18,000 $\mu g/m^3$) (ACGIH 1982). The TLV is the concentration at which it is believed that nearly all workers may be repeatedly exposed day after day for a normal 8-hr workday and a 40-hr workweek without adverse effect. Although chronic exposure limits for the general public in populated areas have not been set or recommended for the western world, the Soviet Union has defined 0.3 ppm (200 $\mu g/m^3$) as the maximal allowable long-term concentration in populated areas (National Research Council 1979). The ammonia concentrations resulting from NFS Erwin operations are far below these recommended limits and should have no effect on humans or other biota.

4.2.2 Land Use Impacts

Land uses on the site are not expected to change significantly; the new scrap plant will be constructed in an area that is already dedicated for plant use. Off the site, there is virtually no potential for land use to be affected by continued operation. Emissions to the air do not significantly affect air quality (Section 4.2.1) and thus should not reduce the growth and productivity of agricultural crops or garden plants grown nearby (Section 3.4.2) or the value of such crops for consumption by humans or domestic livestock. Therefore, such land uses should continue unaffected. Prime farmlands, wetlands, and floodplains located in the vicinity (Section 3.4.2) will similarly not be affected. No historic sites are located near the plant (Section 3.4.3); hence, none will be affected. Of all substances emitted to the atmosphere, fluorides have the greatest potential to impact land use by adverse effects on agricultural crops, domestic animals, and wildlife (NAS 1971, MacLean et al., 1984, Shupe et al., 1984). On the NFS site, concentrations of fluorides in vegetation averaged 23 $\mu g/g$ in 18 samples collected in the spring and summer of 1984 (NFS 1985a). These concentrations are below the suggested tolerance levels for cattle (30 to 100 $\mu g/g$, EPA 1980a) and other domestic animals, which should, therefore, not be affected by NFS operations. The productivity of agricultural crops should also be unaffected, because concentrations of fluorides meet Tennessee Air Quality Standards (Section 4.2.1).

4.2.3 Impacts on Water

4.2.3.1 Surface Water

Liquid effluents from the waste treatment system and cooling water circuit are described in detail in Table 4.9. The temperature of the cooling water discharge is within the NPDES permit limitation and has no effect on water use.

The average total nitrogen in the Nolichucky River upstream of NFS, including organically combined nitrogen, ammonia, and nitrate, is 0.465 mg/L. Facility effluents may increase this level by as much as 0.082 mg/L. The majority of this increase is from nitrates (NFS 1984a). The staff used an average flow of 38 m^3/s and an average total nitrogen value of 300 kg/day for 1979-1988 values given in Table 4.9 to determine that the NFS effluent may increase the combined nitrogen level in the Nolichucky River by as much as 0.09 mg/L. This value, which does not appreciably differ from the change calculated by NFS (1984a), would not result in any adverse impact on the environment or users of the river water.

The background fluoride concentration in the Nolichucky River is 0.1 mg/L. The staff calculated the increase of fluoride in the river as the result of the NFS discharge to be approximately 5×10^{-4} mg/L. The concentration of fluoride in the river, including the contribution from NFS, is well below the normal fluoridation level (1 mg/L) (NRC 1978).

Levels of the monitored heavy metals in the NFS effluent (arsenic, cadmium, chromium, copper, lead, nickel, zinc, and silver) (NFS 1983, 1984b) are below U.S. EPA water quality criteria limitations (EPA 1976) and should not have an adverse effect on water quality in the Nolichucky River.

4.2.3.2 Ground Water Contamination

Currently, ground water contamination occurs in the Quaternary alluvium adjacent to the NFS facility's settling ponds, beneath the buried holding tanks (Well B) and beneath the radioactive solid waste burial ground. There is also slightly contaminated ground water beneath the Clinchfield Railroad right-of-way. This area is the only documented offsite area of ground water contamination. Banner Hill Spring is not presently contaminated but it is not known whether the Quaternary alluvium northeast of the site is contaminated. However, contamination beyond Martin Creek (the northeastern boundary of the NFS facility) is unlikely because ground water discharges to the creek and Banner Spring Branch during low surface flow and backs up toward the NFS facility during high flow. There are no known local downgradient wells in the Quaternary alluvium. If any such wells exist, it is unlikely that they are still in use because of the availability of municipal water from Erwin Utilities.

Banner Hill Spring has remained uncontaminated from 25 years of normal operations at the NFS facility. It should continue to be a viable ground water resource as long as local water wells do not draw down the aquifer that feeds it.

Erwin Utilities personnel have indicated that if Erwin Utilities eventually develops Banner Hill Spring, water will be diverted as it emerges at the surface. Erwin Utilities has no plans to develop a well at this site because of concern that pumping will produce a cone of depression, causing contaminated ground water to flow toward the production zone.

The settling ponds are the principal sources of ground water contamination at the NFS facility. They were installed as containment structures for process liquid wastes. Although some of the liquid evaporated, most of it seeped through the unlined floors and sidewalls of the ponds. Seepage rates were rather high because the ponds were created by excavating into alluvium of the Nolichucky River floodplain with the excavated material being used in the construction of dikes. NFS has submitted a decommissioning plan for the ponds that was approved by the NRC on July 30, 1991.

4.2.4 Ecological Effects

4.2.4.1 Terrestrial Ecology

No significant loss of plant communities and wildlife habitat will occur as a result of relicensing the Erwin facility. The new scrap plant will be constructed in an area that will not cause any loss of plant communities or wildlife habitat. Emissions to the atmosphere have little effect on air quality (Section 4.2.1) and should not adversely affect any vegetation or wildlife in the vicinity, including several plant species considered rare by the State of Tennessee (Section 3.7.3). In addition, because the immediate surroundings of the plant site lack significant native plant and animal resources and because the natural ecology is in a relatively disturbed condition as a result of agricultural and residential development (Section 3.7.1), there is little potential for the Erwin facility to have adverse ecological effect on wildlife or their habitats. Threatened or endangered wildlife do not occur near the plant (Section 3.7.3) and should thus not be jeopardized by continued operation of the facilities.

4.2.4.2 Aquatic Ecology

The only direct effect of discharge from the NFS facility on biota in Banner Spring Branch would be the result of site runoff and of thermal input from the Building 233 cooling water; no process water is discharged to Banner Spring Branch. Except for one incident in 1983 in which fish were killed in the branch by thermal input, cooling water discharge to Banner Spring Branch has been within NPDES limitations (Section 4.1.1.2 and Table 4.8). No incidences of ecological impact resulting from polluted site runoff have been reported.

As long as the nitrate concentrations in Banner Spring Branch (Table 4.17), which may result from seepage from the settling ponds (Section 3.5.2.2), do not exceed the EPA drinking water limitation of 10 mg/L, the staff does not expect adverse effects on aquatic biota.

The potential may exist for a slight increase in algal production in the Nolichucky River as the result of nitrate addition in the discharge (Outfall 001) of the Waste Water Treatment Facility (Section 4.2.3); however, because of the turbidity in the river, the light penetration is somewhat restricted and the increased growth should be minimal. The discharge from Outfall 001 has been in compliance with the NPDES permit limitations. In addition, the flow of the discharge to the Nolichucky River is low (0.01 to 0.02 m^3/s) relative to the average flow of the river (39 m^3/s), and the river is wide (30 to 60 m) in the area of the discharge. Thus, the chemical constituents in the discharge should disperse readily and should be indistinguishable from ambient levels in the river within 1 km downstream. There should be little, if any, effect on downstream aquatic biota. Because there is no process discharge to Banner Spring Branch and Martin Creek, no adverse effect on aquatic biota should occur in these water bodies.

4.2.5 Radiological Impacts

Radiological impacts of the Erwin Plant were assessed using both airborne isotopic effluent data and ambient air gross alpha monitoring data for 1984. Data for 1984 is used because this is the year with the highest release since the ventilation upgrade. Releases to the atmosphere were 5600.5 microcuries of uranium and 0.5 microcurie of plutonium. The radiological composition of the uranium was assumed to be 95.9 percent ^{234}U, 2.3 percent ^{235}U, 0.08 percent ^{236}U, and 1.7 percent ^{238}U. Based on data (Table 4.10) from ambient air monitoring station 372, located at the southern corner of the site (Figure 4.2) and in the vicinity of the nearest residence, 62 percent of the uranium was class Y lung solubility and 38 percent was class D (NFS 1985b). Table 4.3 shows that 89 percent of the airborne effluent was released from the main process stack (an elevated release) and 11 percent was released from building vents (a ground level release) in 1984. Atmospheric dispersion factors generated by the staff were used for the two release modes.

Doses to an individual and populations are 50-year dose commitments (that is, the total dose to a reference organ, resulting from 1 year of intake, that will accrue during a 50-year period). Estimates were also made of the dose to an infant younger than 1 year old living at the nearest residence.

Appendix A contains parameters and dose conversion factors used in this analysis.

4.2.5.1 Individual Doses

The doses from airborne radioactive emissions were calculated for the nearest actual residence (250 m south of the plant). The atmospheric dispersion factors (χ/Q) at this location are 2.5×10^{-4} s/m^3 for ground level release (Table 3.1) and less than 8.3×10^{-8} s/m^3 for the stack release (Table 3.2). It was assumed that the individual spends 80 percent of the time at the residence location and that 10 percent of the food consumed is produced there. The highest dose received from airborne effluents (Table 4.19) would be 10 millirems/year to the lungs. Doses to the total-body, kidneys, and bone are 2.2, 0.22, and 1.2 millirems/y, respectively. About 96 percent of these doses is due to ^{234}U, and inhalation is the major pathway of radiation exposure. More than 99 percent of these individual doses is due to ground level releases from the building vents.

The above calculations assume a normal adult, but the staff has also considered a critical individual (an infant of 0-1 years of age) at the nearest residence. The lung dose to an infant would be 1.9 times the adult dose

(Hoenes and Soldot 1977), equivalent to 19 millirem/y. This dose is about 76 percent of the 25 millirem/y limit imposed by the NRC license (which is consistent with the criteria in 40 CFR Part 190 applicable to the light-water reactor fuel cycle). Therefore, normal operation of the plant has resulted in maximum annual doses at the nearest residence that are below the limit of 25 millirem/y.

Ambient air monitoring results obtained from sample station 372, which is essentially across the street from the nearest residence, also were used to estimate radiation doses. Using 1984 air monitoring data (NFS 1985a), including gross alpha measurements, particle size, and lung solubility of particles, estimated doses to the nearest adult resident from airborne particles are about 29 percent lower than those given in Table 4.19 for model calculations based on airborne effluents. The lung dose for an adult would be about 7.1 millirem/y and for an infant about 13.5 millirem/y. Ambient air monitoring data from this location for the years 1981-1983 (NFS 1985a) indicate that doses from airborne particles would be about two times higher than in 1984. These higher doses would still be in compliance with the 25 millirem/y limits given in 40 CFR Part 61 for an adult resident. However, the lung dose to an infant may have been as high as 27 millirem/y.

The maximum atmospheric dispersion factor for stack release in the populated southeast quadrant is 4.51×10^{-6} s/m^3 (Table 3.2) at 800 m (0.5 mile) SSE from the NFS facilities. At this distance, the χ/Q for ground level release is 2.3×10^{-5} s/m^3 (Table 3.1). For these dispersion factors, the individual dose would be about one-fourth of the values attributed to air effluents in Table 4.19 (for adults about 2.5 millirem/y to the lungs), and the stack release would account for about 61 percent of the dose. Because the individual dose is much lower than for the nearest resident, no ambient air monitor is needed at this location.

Table 4.19. Estimated maximum annual dose to the nearest resident.[a]

Pathway	Effective	Organ dose (millirem/year)		
		Lungs	Kidneys	Bone
Air effluents				
Direct irradiation	2.9×10^{-5}	2.3×10^{-5}	2.2×10^{-5}	3.6×10^{-5}
Immersion in air	7.9×10^{-8}	7.3×10^{-8}	6.8×10^{-8}	1.1×10^{-7}
Inhalation[b]	2.2	1.0×10^{1}	2.2×10^{-1}	1.1
Ingestion[c]	3.6×10^{-5}	2.1×10^{-6}	2.0×10^{-4}	9.4×10^{-2}
Liquid effluents				
Potable water	4.9×10^{-2}	2.9×10^{-3}	2.9×10^{-1}	1.3
Submersion	1.0×10^{-7}	5.8×10^{-8}	5.3×10^{-8}	1.0×10^{-7}
Aquatic food	1.3×10^{-2}	7.9×10^{-4}	7.9×10^{-2}	3.5×10^{-1}
Total	2.3	1.0×10^{1}	5.9×10^{-1}	2.8

[a] Resides 250 m south of the plant.
[b] Assumes 80 percent residence time.
[c] Assumes 10 percent of vegetables consumed are grown at residence.

A region of potential maximum radiological impact from combined stack and ground-level releases where the individual dose may exceed the dose to the nearest resident exists in the northwest quadrant up to 1600 m (1 mile) from the NFS facility. Table 3.4 indicates that 19 people reside in the northwest quadrant within 1600 m of the NFS site. Because Figure 2.1 does not show any residences between the site and the Nolichucky River, these residents apparently reside between 800 m and 1600 m (0.5 and 1 mile) of the site. This 800-m segment consists of a heavily wooded hillside on the other side of the Nolichucky River. At 800 m, the staff estimates that the individual dose may be as much as a factor of two higher than that calculated above for the nearest resident. The stack releases would contribute about 85 percent to the exposure. The staff recommends that NFS determine if there are residents within 1600 m (1 mile) of the site in the northwest quadrant, and if so, place an ambient air monitoring station at the nearest residence in that area to assist with an accurate determination of radiological impact.

The staff has reviewed the gross-alpha and isotopic analysis of the environmental air samples collected in past years and found that the isotopic analysis (performed on a semi-annual basis) provides a more accurate and reliable measurement for demonstration of the NRC's imposed 25 millirem/y dose limit for NFS routine operation. For future demonstration of compliance with the imposed dose limit, NFS has committed to composite the environmental air samples and analyze for isotopic uranium on a quarterly basis with an analytical sensitivity of at least 5×10^{-16} µCi/mL and for plutonium and thorium on an annual basis with the same analytical sensitivity. In addition, the gross alpha data and the isotopic data have been inconsistent in some aspects. At the staff's request, NFS has committed to a quality assurance program that incorporates elements of NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Program (Normal Operation) Effluent Streams and the Environment."

Maximum individual doses due to liquid effluents (Table 4.19) were estimated from reported radionuclide concentrations (Table 4.12) in the Nolichucky River downstream from the Erwin Plant. Doses due to ingestion of water (730 liters/y), fish (2 kilograms/y), and swimming in the river (1 percent of the year) were calculated. Dose to bone (1.7 millirem/y) was highest followed by doses of 0.06, 0.004, and 0.37 millirems/y to total-body, lungs, and kidneys, respectively. Ingestion of water was the primary pathway of exposure.

Maximum individual doses to the nearest resident from airborne and liquid effluents are given in Table 4.19. The total-body doses from all pathways (2.3 millirems/y) is about 9 percent of the 25 millirem/y limit established by the license. Dose to lungs of an adult is 40 percent and dose to lungs of an infant is 76 percent of the 25 millirem/y limit to organs other than thyroid.

On December 15, 1989, EPA published the "National Emission Standards for Hazardous Air Pollutants Radionuclides; Final Rule and Notice of Reconsideration." This rulemaking established emission standards for various source categories. EPA granted a reconsideration of the standards of 40 CFR Part 61, Subpart I, concerning emissions from facilities licensed by the NRC, thereby staying the implementation of the new regulation. Subpart I would limit emissions to the ambient air such that no member of the public would receive in any year an effective dose equivalent of 10 mrem/yr. Subpart I also contains reporting and recordkeeping requirements with which NFS will have to comply if the regulations are implemented by EPA.

4.2.5.2 Population Doses

Radiation doses to the 921,439 persons living within 50 miles of the Erwin Plant were estimated for airborne releases of radioactivity. The highest collective dose was to lungs (80 person-rem). Total-body, kidney, and bone doses were 14.5, 1.7, and 8.7 person-rem, respectively. The total body dose of 14.5 person-rem may be compared to a dose of 1.3×10^5 person-rem which the population would receive from annual background radiation. Most of the collective doses result from inhalation of ^{234}U.

Population doses from liquid effluents were estimated for the town of Jonesboro, which draws its drinking water from the Nolichucky River. These doses were 0.1, 0.7, and 3.2 person-rem for total-body, kidney, and bone, respectively. Calculations were based on the conservative assumption that uranium concentrations in the river at Jonesboro are the same as those measured (Table 4.12) downstream from the Erwin Plant.

4.3 INDIRECT EFFECTS AND THEIR SIGNIFICANCE

4.3.1 Socioeconomic Effects

As discussed in Section 3.3, employment at NFS comprises only 2 percent of the estimated potential workers in Unicoi and Washington Counties. Thus, neither continued operation or discontinuance would have a significant impact on socioeconomic conditions in the region. The economy of Erwin could be seriously affected if NFS terminated operation, but most laid-off workers would probably be incorporated into the regional work force.

4.3.2 Potential Effects of Accidents

Accidents that could occur at the NFS plant are both radiological and nonradiological in nature. Potentially harmful materials stored and the amount used annually at NFS are discussed in Section 4.3.2.2. With the exception of a criticality accident and the potential rupture of UF_6 cylinders, accidents within the NFS facilities are of comparable probability, nature, and magnitude with nonnuclear process operations using small quantities of chemicals. The radiological environmental impacts of the more probable postulated accidents are insignificant at this facility.

Accident severity is classified into three categories. Category 1 accidents are those most likely to occur during normal plant operations and have the least environmental impact of the three. Category 2 events, which would occur infrequently during the plant's operating life, could release concentrations of radiological and nonradiological pollutants to the onsite (and possible offsite) environment that would exceed normal effluent releases and could cause significant impacts if not controlled or mitigated. Category 3 accidents are those that are not expected to occur during the life of the plant but that could result in significant releases of radioactive or toxic pollutants to the onsite and offsite environment. NFS has analyzed the radiological (1984a,c) and nonradiological (1984a) consequences of several accident scenarios.

4.3.2.1 Radiological Impacts

Although several minor accidents are likely to happen during the life of the plant (e.g., a small leak in a pipeline or a small spill), most will not result in a significant release of uranium or plutonium to the environment. Therefore, the accident analysis in support of this assessment is limited to the consideration of two potentially severe, low-probability accidents that could result in the release of large quantities of radioactivity: a UF_6 release and criticality accident. The radiological consequences of a major fire and a transportation accident are also evaluated.

- UF_6 Release

UF_6 is stored in shipping cylinders inside a warehouse. UF_6 is a solid at ambient temperature (it sublimes at 132°F). Therefore, the possibility of an outdoor release of gaseous UF_6 is remote. If a cylinder of solid UF_6 were to fail for any reason, the UF_6 would vaporize very slowly. Because UF_6 reacts with atmospheric moisture to form uranyl fluoride (UO_2F_2), which is a non-volatile solid, such a leak would tend to be self-sealing. Therefore, the quantity of UF_6 released from a broken cylinder within the warehouse or outside during transfer to a process building would not contribute significantly to the plant's normal emissions, and the potential offsite consequences would not be a concern. Very little combustible material is stored in the warehouse, and the construction materials are not combustible. It is considered extremely remote that the UF_6 cylinders could be heated above the sublimation temperature within the warehouse. Therefore, rapid release of gaseous UF_6 in the warehouse is not considered as a potential accident in the staff's assessment.

UF_6 is heated and vaporized only inside buildings with appropriate ventilation controls. Although very unlikely, an accidental release of about 15 kg (approximate contents of one cylinder) of high-enriched uranium during vaporization was postulated as the maximum credible release. An accident of this magnitude occurred at NFS in May 1972 when a valve on a cylinder failed during vaporization, and UF_6 was released to the indoor air. About 40 percent of the HEU was later recovered inside the plant, and the balance was presumed to escape outside primarily through room ventilators. With the new plant ventilation system, such room ventilators in HEU areas no longer exist and if any released UF_6 exited the plant, it would be passed through the ventilation system and discharged through the main stack.

In this accident scenario, it is assumed that UF_6 is charged into the vaporization lines and, because of a failure of a water supply line for the mixing tee of the hydrolysis unit, the UF_6 is released directly into the ventilation system. This is a more conservative scenario than postulating a release into the building air, where UF_6 would be contained and condense onto indoor surfaces. To add further conservatism, it is assumed that the UF_6 release occurs simultaneously with a complete failure of ventilation system scrubbers and filters.

As the UF_6 passes through the ventilation system, it would react with water vapor to form hydrogen fluoride (HF) gas and UO_2F_2 particulates. Some of the UO_2F_2 will plate out in the ventilation lines. The staff assumes that 10 percent will plate out, although in reality, a larger portion would likely be captured by sticking to various surfaces. Some, however, would eventually be released through the main plant stack. In another smaller UF_6 release at NFS (on August 7, 1979), quantities released to the atmosphere increased rapidly to a maximum within 10 to 15 minutes and then slowly decreased as material circulated out of the process ventilation and out the stack. Most activity (60 to 80 percent) was released in 1 hour, although it took about 3 hours for all the activity to escape. For the staff assessment, the release is assumed to take place over 1 hour.

An atmospheric dispersion factor has been determined by the staff based on the following:

(1) an effective stack height of 21 m, based on a 33-m stack, a small amount of plume rise as a result of momentum (no plume buoyancy), and the local topography between the release point and the nearest residence

(2) a wind speed of 0.5 m/s, based on onsite meteorological measurements under stable conditions

(3) a Pasquill stability class of C, which results in the plume dropping to the ground at 250 m away and essentially maximizes the χ/Q

(4) credit given for plume meander caused by surface influences within the river valley.

Given these assumptions, the χ/Q at 250 m away (the distance from the main stack to the nearest residence) is 1.49×10^{-4} s/m^3. For comparison, the annual average χ/Q at this point for stack emissions is about 2×10^{-7} s/m^3.

Considering the above and assuming the wind is blowing in the right direction, average air concentrations at the nearest residence would be 0.56 mg/m^3 of uranium and 0.21 mg/m^3 of HF. Assuming a uranium enrichment of 95 percent, the radioactivity concentration would be 0.04 µCi/m^3. If an adult remained in the plume for an entire hour, there would be an intake of 0.51 mg of uranium. Observations from past accidents indicate that the highest uranium intake a person can receive over a short period without causing serious consequences from chemical toxicity is between 2 and 6 mg (NRPB 1980). The intake of 0.51 mg would be below levels recognized to cause transient kidney damage. The effective whole-body dose commitment would be 99 mrem (assuming all of the uranium is soluble ^{234}U with AMAD = 0.3µ). This is well below the EPA's protective action guide of 1 rem (EPA 1980b), which if exceeded as the result of a radiological accident, indicates that offsite emergency planning should be considered. The HF concentration in this accident scenario is about one-third of the associated uranium concentration, and it is assumed that all of the HF is released to the environment in 1 hour. Therefore, the calculated concentration of HF at the nearest resident would be about 0.21 mg/m^3. This concentration of HF is greater than the level where odor is detected (0.1 mg/m^3) but is well below 25 mg/m^3, which can cause respiratory discomfort if exposed to for several minutes (NAS 1971). The HF concentration is also far below the 100 mg/m^3 where exposures of one minute may result in severe respiratory discomfort and significant epidemiological impact (NAS 1971, CRC 1972).

• Criticality Accident

The effects of a postulated criticality accident have been considered, although the possibility of such an accident is remote. It has been hypothesized that a uranium solution is accidentally transferred into a vessel of unfavorable geometry in Building 233. The postulated criticality accident has the following nuclear characteristics (NRC Regulatory Guide 3.34, Revision 1) and physical assumptions:

(1) The accident results in 10^{19} fissions produced in a series of pulses within a supercritical liquid system over an 8-hr period.

(2) The accident releases only the volatile fission products produced by the above number of fissions. No radioactive decay is considered during transit of radionuclides to the nearest resident.

(3) Twenty-five percent of the halogens and 100 percent of the noble gases are released from the manufacturing building.

(4) No credit for removal of radionuclides is given for the existing filters, scrubber, or other installed controls.

(5) The accident is assumed to occur under adverse meteorological conditions (a C-type atmospheric stability and a wind speed of 1 m/s), with an atmospheric dispersion factor from the main stack at the nearest residence of 1.49×10^{-4} s/m^3.

The offsite consequences from this accident at the nearest residence are shown in Table 4.20. The whole-body dose commitment is within the recommended protective action guides (1 to 5 rem for total body and 5 to 25 rem for thyroid) given by the Environmental Protection Agency (EPA 1980). In addition, the prompt gamma and prompt neutron doses would probably be greatly reduced by shielding from building materials and intervening topographic features.

Table 4.20. Maximum 50-year dose commitment to the nearest resident from a criticality accident.[a,b]

Exposure type	Dose (rem) Total body	Thyroid
Airborne radioactivity	0.16	0.32
Prompt gamma	0.57	0.57
Prompt neutron	1.33	1.33
Total	2.06	2.22

[a]Nearest resident is 150 m (500 ft) from the accident site and 300 m (1000 ft) from the main stack.

[b]Accident parameters and calculations are based on information in NRC Regulatory Guide 3.34, Revision 1.

- Transportation Accidents

Transportation of enriched uranium is strictly regulated by the U.S. Department of Transportation (49 CFR Parts 170-179) and the NRC (10 CFR Part 71), and package design and specifications must be approved by NRC. Containers must be designed to withstand hypothetical accident conditions applied sequentially in an order specified in the regulations to determine the cumulative effect on the container being tested. Criteria include free drops, punctures, thermal stress, and water immersion tests. These tests, which are more severe than any expected transportation accidents, make the probability of release of contents or accidental criticality very small. In addition, to ensure that all packages are properly prepared for shipment, the applicant must establish, maintain, and execute a quality assurance program (10 CFR Part 71) that satisfies applicable criteria (10 CFR Part 50). The uranium is transported in dedicated vehicles specifically designed for the purpose of ensuring nuclear safety and material accountability and security.

The environmental effects of transportation accidents involving radioactive materials have been thoroughly analyzed and documented (AEC 1972 and 1974; NRC 1975 and 1977). These analyses show that the radiological risk from transportation accidents involving radioactive materials does not contribute appreciably to the accident consequences.

The probability of an accident occurring in transportation is small, about 10^{-6} per vehicle mile, and decreases with increased severity of the accident to an extremely small probability of about 10^{-13} per vehicle mile for extremely severe accidents (AEC 1972). The probability that the accident will be severe enough to release any of the material from the packaging containers is significantly lower than the probability of the accident. The probability that such an accident would result in measurable radiation exposure to the general public or environmental contamination is almost nonexistent.

4.3.2.2 Nonradiological Accidents

The NFS facility can be considered in the same class as any other manufacturing plant where significant quantities of nonradiological chemicals are processed. Quantities stored and usage of chemicals are shown in Table 4.21. The nonradiological accident categories are described below.

(1) Category 1. Category 1 accidents within the manufacturing building in the chemical processing area would be typified by minor liquid spills [0.04 m^3 (10 gal) or less] of acids and oils. A leak of this type would be cleaned up quickly and the spilled liquid would be transferred to the waste treatment facility. No environmental release would occur. Similarly, Category 1 leaks or spills [0.2 m^3 (50 gal) or less] external to manufacturing buildings would be quickly detected because of security and employee movement and would be contained within the first few inches of soil. Contamination would be removed and properly disposed.

(2) Category 2. Category 2 accidents occurring in the chemical storage areas outside the manufacturing building could result in complete or partial emptying of a bulk chemical storage tank. Such a release is considered very unlikely because storage vessels are designed using

Table 4.21. Storage and usage of potentially hazardous chemicals at the NFS Erwin Plant.

Type	Chemical	Average annual use	Maximum quantity stored	Average shipment size	Approximate number of shipments/yr
Compressed gas	Acetylene	7 cyl	[redacted]	2	4
Liquified gas	Hydrogen	10×10^6 ft^3	[redacted]	1.8×10^5 ft^3	57
Fuel	#2 diesel oil	199 gal	[redacted]	66 gal	3
	Natural gas	4.54×10^4 ft^3	[redacted]	--	Pipeline
	Lubricating oils	1000 gal	[redacted]	100 gal	10
	Gasoline	2000 gal	[redacted]	500 gal	4
	Propane	20,000 gal	[redacted]	2000 gal	10
Process chemicals	67% Nitric acid	43,000 gal	[redacted]	2600 gal	12
	Tributyl phosphate	594 gal	[redacted]	198	3
	AMSCO 125	2000 gal	[redacted]	500	4
	Hydrochloric acid	7000 gal	[redacted]	700 gal	9
	Ammonium hydroxide (25%)	4000 gal	[redacted]	700 gal	6
	Sodium hydroxide	1700 gal	[redacted]	425 gal	4
	Acetone	700 gal	[redacted]	175 gal	4
	Methyl alcohol	2700 gal	[redacted]	385 gal	7
	Detergent	2000 gal	[redacted]	1000 lb	2
	Sulfuric acid	534 gal	[redacted]	100 gal	5
	Hydrogen peroxide	11,500 gal	[redacted]	1500 gal	8
	Aluminum nitrate	3000 gal	[redacted]	2000 gal	2
	Phosphoric acid	396 gal	[redacted]	66 gal	6
Radioactive chemicals	Low enriched uranium	36,400 lb (16,500 kg)	[redacted]	3,100 lb (1,400 kg)	12
	High enriched uranium[a]		[redacted]		
	Plutonium	0	[redacted]	0	0

[a]Refers to a classified product

Source: NFS 1984a.

good engineering practices and are filled according to safe operating procedures. To experience a rupture or failure, some unforeseen catastrophic disaster would have to occur, or all current safety systems would have to deteriorate simultaneously. Nevertheless, the most conceivable release scenarios involve (1) exposure of the storage vessels to an intense, prolonged fire with subsequent release of vapors through pressure relief valves, and (2) tank rupture caused by a projectile from an adjacent explosion. All of the chemicals shown in Table 4.21 are stored within a paved, diked area that would prevent ground contamination and confine the spills to the plant drain systems, which can be isolated from offsite drainage by stop valves. Fuel oil released from a ruptured tank would also be confined within the site boundary because of a sluice valve on the drainage ditch that runs by the tank.

(3) Category 3. These accidents are catastrophic in magnitude and are not expected in the plant's lifetime. All are extremely unlikely; they would involve either container rupture, failure, explosion, fire, natural disaster, or an extremely improbable criticality-type accident.

Although the probability and effect of these types of occurrences cannot be precisely estimated, it does not appear that the probability is significantly different from that at other industrial - or chemical - processing facilities.

Fire is an unlikely event because combustible materials are restricted, and electrical and heating equipment are carefully maintained. Plant personnel would notice an incipient fire visually or they would be alerted by a fire detector, and the fire would be extinguished according to plan. As an example of such an improbable event, NFS postulated a fire in a plutonium-contaminated glove box in Building 234, which is not in use. Less than 350 g of residual plutonium would be fairly uniformly distributed over about 21,000 ft^2 of surface area. It is predicted that the fire would be of a slow-burning type and might destroy the first absolute filter but would not destroy the final bank. It is estimated that the short-term release of plutonium might increase a thousandfold, to about 10^{-5} µCi/second, but the long-term average would change very little. Potential consequences of container rupture and criticality accidents have been discussed previously.

4.3.3 Possible Conflicts Between the Proposed Action and the Objectives of Federal, Regional, State, and Local Plans and Policies

At this time, the staff is not aware of any conflict between the proposed action and the objectives of federal, regional, state, or local plans, policies, or controls for the action proposed as long as proper agencies are contacted, proper applications are submitted, and proper monitoring and mitigatory measures are taken to protect the environment and public health and safety.

4.3.4 Effects on Urban Quality, Historical and Cultural Resources, and Society

The environmental effects of the proposed license renewal action as discussed above are considered to be insignificant. The facility has not affected historical or cultural resources. The short-term societal effects during operation are and will be minimal, and there will be minimal effects after decommissioning and reclamation because the site then will be required to meet federal standards for unrestricted use.

REFERENCES FOR SECTION 4

ACGIH (American Conference of Governmental Industrial Hygienists). 1982. "Threshold Limit Values for Chemical Substances in Work Air Adopted by ACGIH for 1982." Cincinnati, Ohio.

AEC (U.S. Atomic Energy Commission). 1972. "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December.

AEC (U.S. Atomic Energy Commission). 1974. Directorate of Licensing, "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, Sect. E, Washington, D.C., April.

CRC (The Chemical Rubber Company). 1972. Handbook of Analytical Toxicology, Irving Sunshine (ed.). Cleveland, Ohio.

Deutsch, W. J., N. E. Bell, B. W. Mercer, R. J. Serne, J. W. Shade, and D. R. Tweeton. 1984. "Aquifer Restoration Techniques for In-site Leach Uranium Mines," U.S. Nuclear Regulatory Commission, NUREG/CR-3104, Washington, D.C.

EPA (Environmental Protection Agency). 1976. "Quality Criteria for Water," U.S. Environmental Protection Agency, EPA 440/9-76-023.

EPA (Environmental Protection Agency). 1980a. "Reviews of the Environmental Effects of Pollutants: IX. Fluoride." EPA-600/1-78-050. Cincinnati, Ohio.

EPA (Environmental Protection Agency). 1980b. "Manual of Protection Action Guides and Protective Actions for Nuclear Incidents," EPA-520/1-75-001 (Draft), June.

Hoenes, G. R., and J. K. Soldat. 1977. "Age-Specific Radiation Dose Commitment Factors for a One-Year Chronic Intake," NUREG-0172, Battelle Pacific Northwest Laboratories, November.

MacLean, D. C., D. C. McCune and R. E. Schneider. 1984. "Growth and Yield of Wheat and Sorghum After Sequential Exposures to Hydrogen Fluoride," in Environ. Pollut. Ser. A. 36:351-365.

NAS (National Academy of Sciences). 1971. "Fluorides," Committee on Biological Effects of Atmospheric Pollutants, Washington, D.C.

National Research Council. 1979. Ammonic, University Park Press, Baltimore, Maryland.

NFS (Nuclear Fuel Services, Inc.). 1983. "Quarterly Discharge Monitoring Report for NPDES Permit #TN0002038," April, July, September 1983 and January 1984.

NFS (Nuclear Fuel Services, Inc.). 1984a. "Environmental Report, Erwin Plant, Erwin, Tenn.," July.

NFS (Nuclear Fuel Services, Inc.). 1984b. "Quarterly Discharge Monitoring Report for NPDES Permit #TN0002038," April, July, September.

NFS (Nuclear Fuel Services, Inc.). 1984c. "Radiological Contingency Plan, Revision 1, 1983," letter from R. L. Ideker, NFS, to R. G. Page, NRC, February 3.

NFS (Nuclear Fuel Services, Inc.). 1985a. "NFS Responses to Environmental Questions," letter from R. L. Ideker, NFS, to S. D. Wyngarden, NRC, February 8.

NFS (Nuclear Fuel Services, Inc.). 1985b. "Ground Water Monitoring, 1984 Annual Survey, NFS-Erwin," April 1.

NFS (Nuclear Fuel Services, Inc.). 1989a. "Environmental Information Update," Letter from B. Knight, NFS, to M. Horn, NRC, June 2.

NFS (Nuclear Fuel Services, Inc.). 1989b. Revised License Application. August 11.

NFS (Nuclear Fuel Services, Inc.). 1990a. Letter wth Attachment Containing NFS Responses to NRC Questions and Revised Pages to the License Application from D. Paine, NFS, to C. J. Haughney, NRC, Docket No. 70-143. October 15.

NFS (Nuclear Fuel Services, Inc.). 1991. Letter with Attachments Containing NFS Responses to NRC Questions and Revised Pages to the License Application from D. Paine, NFS, to C. J. Haughney, NRC, Docket No. 70-143. May 15.

NRC (U.S. Nuclear Regulatory Commission). 1975. "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," NUREG-7538, Supplement 1, Washington, D.C., April.

NRC (U.S. Nuclear Regulatory Commission). 1977. "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," NUREG-0170, Vols 1 and 2, Washington, D.C., December.

NRC (U.S. Nuclear Regulatory Commission). 1978. Environmental Impact Appraisal of the Nuclear Fuel Services, Inc., Erwin Plant, Erwin, Tennessee," U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Div. of Fuel Cycle and Material Safety, Washington, D.C., January.

NRC (U.S. Nuclear Regulatory Commission). 1984. "Re-calculation of Annual Average χ/Q values for NFS-Erwin Fuel Facility," internal memorandum from W. P. Gammill to R. G. Page, December 26.

NRPB (National Radiological Protection Board). 1980. "Emergency Exposure Levels for Natural Uranium."

Shupe, J. L., A. E. Olson, H. B. Peterson, and J. B. Low. 1984. "Fluoride Toxicosis in Wild Ungulates," in J. Amer. Vet. Med. Assoc. 185:1295-1300.

Appendix A

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

Appendix A

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING RADIATION DOSE COMMITMENTS FROM THE RELEASE OF RADIONUCLIDES

A.1 METHODOLOGY AND ASSUMPTIONS FOR AIRBORNE RELEASES

A.1.1 Methodology

The radiation dose commitments resulting from the atmospheric releases of radionuclides are calculated using the AIRDOS-EPA computer code (Moore et al. 1979). The methodology is designed to estimate the radionuclide concentrations in air; rates of deposition on ground surfaces; ground-surface concentrations; intake rates via inhalation of air and ingestion of meat, milk, and fresh vegetables; and radiation doses to man from the airborne releases of radionuclides.

With the code, the highest estimated dose to an individual at the nearest residence and the doses to the population living within an 80-km (50-mile) radius of the plant site can be calculated. The doses may be summarized by radionuclide, exposure mode, or significant organ of the body. In addition, site-specific concentrations of radionuclides in the air obtained at or near the nearest resident property can be used to calculate the highest dose to an individual for comparison with the dose calculated from the atmosphere releases.

Many of the basic incremental parameters used in AIRDOS-EPA are conservative; that is, values are chosen to maximize intake by man. Many factors that would reduce the radiation dose, such as shielding provided by dwellings and time spent away from the reference location, are not considered. The residence time and portion of food produced and consumed at the nearest residence are specified in Sect. 4.2.5.

Meteorological dispersion factors, χ/Q, were estimated using the Gaussian plume model and diffusion coefficients for Pasquill-type turbulence (Slade 1968; Sangendorf 1974). Radionuclide concentrations in meat, milk, and vegetables consumed by man are estimated by coupling the output of the atmospheric transport models with the terrestrial food chain model in NRC Regulatory Guide 1.109 (NRC 1977a).

A.1.2 Radiation exposure pathways and dose conversion factors

Environmental transport links the source of release to the receptor by numerous exposure pathways. Figure A.1 is a diagram of the most important pathways that result in the exposure of man to radioactivity released to the environment. The resulting radiation exposures may be either external or internal. External exposures occur when the radiation source is outside the irradiated body, and internal exposures are those from radioactive materials within the irradiated body.

Factors for converting the radiation exposures to estimates of dose are calculated using the latest dosimetric criteria of the International Commission on Radiological Protection (ICRP) and other recognized authorities.

External dose conversion factors. Releases of radioactive gases and particulates to the atmosphere may result in external doses by exposure to and/or immersion in the plume and by exposure to contaminated land surfaces. The dose conversion factors are summarized by Kocher (1981), and those used in this report are shown in Table A.1.

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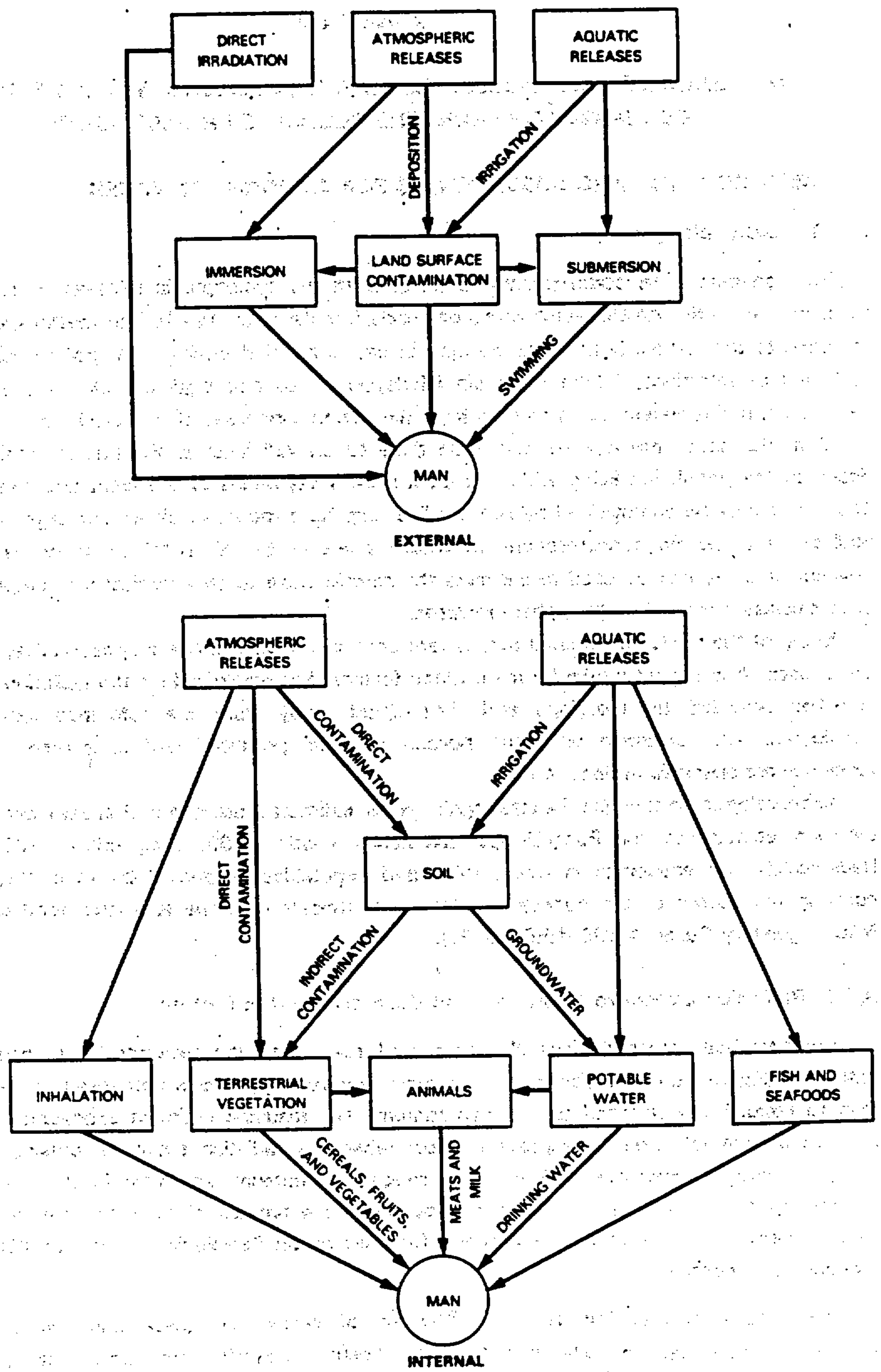

Fig. A.1. Pathways for exposure to man from releases of radioactive effluents.

Table A.1. Dose conversion factors for external exposure pathways

Radionuclide	Organ			
	Total body	Bone	Kidney	Lung
Exposure to ground surfaces (millirem/year per $\mu Ci/cm^2$)				
^{234}U	7.1×10^2	3.0×10^2	1.0×10^2	1.7×10^2
^{235}U	1.5×10^5	2.1×10^5	1.3×10^5	1.4×10^5
^{236}U	6.4×10^2	2.4×10^2	7.0×10^1	2.4×10^2
^{238}U	5.7×10^2	2.1×10^2	5.9×10^1	1.2×10^2
Immersion in air (millirem/year per $\mu Ci/cm^3$)				
^{234}U	6.8×10^5	7.1×10^5	3.7×10^5	4.1×10^5
^{235}U	6.8×10^8	9.4×10^8	5.9×10^8	6.3×10^8
^{236}U	5.3×10^5	5.4×10^5	2.6×10^5	3.0×10^5
^{238}U	4.6×10^5	4.5×10^5	2.2×10^5	2.5×10^5
Submersion in water (millirem/year per $\mu Ci/cm^3$)				
^{234}U	1.7×10^3	1.7×10^3	8.9×10^2	9.8×10^2
^{235}U	1.5×10^6	2.1×10^6	1.3×10^6	1.4×10^6
^{236}U	1.3×10^3	1.3×10^3	6.3×10^2	7.3×10^2
^{238}U	1.1×10^3	1.1×10^3	5.3×10^2	6.1×10^2

Source: D. C. Kocher, *Dose-Rate Conversion Factors for External Exposure to Photons and Electrons*, ORNL/NUREG-79, Oak Ridge National Laboratory, August 1981.

Internal dose conversion factors. Factors for converting internal radiation exposure to estimates of dose have been computed based on recent models (ICRP 1966; Eve 1966) and are summarized by Dunning et al. (1981). The dose conversion factors used in this report are presented in Tables A.2 and A.3. These factors are input data into the AIRDOS-EPA computer code, which is used to calculate the dose from inhaled and ingested radionuclides.

A.1.3 Radiation dose to the individual

Internal exposure continues as long as radioactive material remains in the body, which may be longer than the duration of the individual's residence in the contaminated environment. The best estimates of the internal dose resulting from an intake are obtained by integrating over the remaining lifetime of the exposed individual; such estimates are called "dose commitments." The remaining lifetime is assumed to be 50 years for an adult.

External doses are assumed to be annual doses. The dose rate above the contaminated land surface is estimated for a height of 1 m. Following the initial deposition of radionuclides, the potential for exposure of man may persist, depending on the influence of environmental

Table A.2. Dose conversion factors for inhalation exposure pathways[a] (AMAD[b] = 1.0 μm)

Radionuclide	Committed dose equivalent (rem/μCi)			
	Effective total body	Bone	Kidneys	Lungs
		Class D		
^{234}U	2.5	7.7×10^{1}	1.6×10^{1}	9.4×10^{-1}
^{235}U	2.1	6.9×10^{1}	1.5×10^{1}	8.5×10^{-1}
^{236}U	2.3	7.2×10^{1}	1.5×10^{1}	8.9×10^{-1}
^{238}U	2.1	6.8×10^{1}	1.5×10^{1}	8.3×10^{-1}
		Class Y		
^{234}U	1.1×10^{2}	7.9	1.7	5.4×10^{2}
^{235}U	9.9×10^{1}	7.2	1.5	4.8×10^{2}
^{236}U	1.0×10^{2}	7.5	1.6	5.1×10^{2}
^{238}U	9.8×10^{1}	7.1	1.5	4.8×10^{2}

[a]*Source:* D. E. Dunning et al., *Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities*, vol. 3, ORNL/NUREG/TM-190/V3, Oak Ridge National Laboratory, October 1981.

[b]AMAD = Activity median aerodynamic diameter.

Table A.3. Dose conversion factors for ingestion exposure pathways[a]

Radionuclide	Committed dose equivalent (rem/μCi)			
	Effective total body	Bone	Kidneys	Lungs
		Soluble		
^{234}U	2.6×10^{-1}	7.8	1.7	1.7×10^{-2}
^{235}U	2.2×10^{-1}	7.1	1.5	1.6×10^{-2}
^{236}U	2.4×10^{-1}	7.4	1.6	1.6×10^{-2}
^{238}U	2.2×10^{-1}	7.0	1.5	1.5×10^{-2}
		Insoluble		
^{234}U	2.5×10^{-2}	3.1×10^{-1}	6.7×10^{-2}	6.9×10^{-4}
^{235}U	2.4×10^{-2}	2.8×10^{-1}	6.1×10^{-2}	7.4×10^{-4}
^{236}U	2.4×10^{-2}	3.0×10^{-1}	6.3×10^{-2}	6.5×10^{-4}
^{238}U	2.2×10^{-2}	2.8×10^{-1}	6.0×10^{-2}	6.1×10^{-4}

[a]*Source:* D. E. Dunning et al., *Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities*, vol. 3, ORNL/NUREG/TM-190/V3, Oak Ridge National Laboratory, October 1981.

redistribution, long after the plume leaves the area. Concentrations of radionuclides at the point of deposition normally are reduced by infiltration of radionuclides into the soil, by loss of soil particles because of erosion, and by transport in surface water and in groundwater. When the effects of these processes cannot be quantified, a conservative estimate of the dose resulting from external exposure to a contaminated surface is obtained by assuming that the radionuclide concentrations are diminished by radioactive decay only.

The dose is estimated for individuals at the nearest site boundary or at the nearest residence. The intake parameters used for individual dose determination are shown in Table A.4 and then modified by site-specific estimates of food consumption in Sect. 4.2.5.

Table A.4. Intake parameters (adult)[a] used in lieu of site-specific data

Pathway	Maximum exposed individual	Average exposed individual[b]
Vegetables, kg/year	281[c]	190
Milk, L/year	310	110
Meat, kg/year	110	95
Drinking water, L/year	730	370
Fish, kg/year	21	6.9
Inhalation, m^3/year	8000	8000

[a]From NRC Regulatory Guide 1.109.
[b]Used for calculating population doses.
[c]This value includes leafy vegetables.

A.1.4 Radiation dose to the population

The total dose received by the exposed population is estimated by the summation of individual dose estimates within the population. The area within the 80-km (50-mile) radius of the site is divided into 16 sectors (22.5° each) and into a number of annuli. The average dose for an individual in each division is estimated, that estimate multiplied by the number of persons in the division, and the resulting products are summed across the entire area. The unit used to express the population dose is man-rem. For this report, the population dose estimates are calculated for a population composed entirely of adults. The dose conversion factors and intake parameters used for calculating population doses are the same as those used for the individual doses.

A.2 METHODOLOGY AND ASSUMPTIONS FOR AQUEOUS RELEASES

The methodology used for calculating the 50-year dose commitments to man from the release of radionuclides to an aquatic environment is described in detail by Dunning et al. (1981). Sample problems and bioaccumulation factors for radionuclides in freshwater fish are also given by Dunning et al. (1981). AQUAMAN is a computer code (Shaeffer and Etnier 1979) that can also be used for calculating similar dose commitments from exposures to aquatic pathways.

Three exposure pathways are considered in dose determination: water ingestion, fish ingestion, and submersion in water (swimming). The internal dose conversion factors for converting exposure to dose are discussed in Sect. A.1.2, and the factors are shown in Table A.3. The external dose conversion factors are shown in Table A.1. Intake parameters are shown in Table A.4.

A.3 ATMOSPHERIC DISPERSION

The atmospheric dispersion model used in estimating the atmospheric transport to the terrestrial environment is discussed in detail in NRC Regulatory Guide 1.111, Rev. 1, (NRC 1977b). For particulate release, the meteorological χ/Q values are used in conjunction with dry deposition velocities and scavenging coefficients to estimate air concentrations and steady state ground concentrations. The atmospheric dispersion model estimates the concentration of radionuclides in air at ground surfaces as a function of distance and direction from the point of release. Averages of annual meteorological data from the site or from the nearest weather station, if suitable, are supplied as input for the model. Radioactive decay during the plume travel is taken into account in the AIRDOS-EPA code (Moore et al. 1979). Daughters produced during plume travel are calculated and added to the source term.

The area surrounding the plant site is divided into 16 sectors by compass direction (Sect. 3.3). The meteorological χ/Q values (shown in Table 3.2) are calculated for the midpoint of each sector. Concentrations in the air for each sector are used to calculate dose via inhalation and submersion in the air. The ground deposits result in external dose and, in addition, are assimilated into food and contribute dose upon ingestion via the food chain.

The meteorological data required for the calculations are joint frequency distributions of wind velocity and direction summarized by stability class. Meteorological data from the nearest weather station are used to calculate the concentrations of radionuclides at a reference point per unit of source strength. Depletion of the airborne plume as it is blown downwind is accounted for in the AIRDOS-EPA code by taking into account the deposition on surfaces by dry deposition, scavenging, and radioactive decay.

REFERENCES FOR APPENDIX A

Dunning, D. E., Jr., et al. 1981. *Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities*, Vol. III, ORNL/NUREG/TM-190/V3, Oak Ridge National Laboratory, October. (Also published as NUREG/CR-0150.)

Eve, I. G. 1966. "A Review of the Physiology of the Gastrointestinal Tract in Relation to Radiation Doses from Radioactive Materials," *Health Phys.* 12, 131-62.

ICRP (International Commission on Radiological Protection) Task Group on Lung Dynamics. 1966. "Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract" *Health Phys.* 12, 173-207.

Kocher, D. C. 1981. *Dose-Rate Conversion Factors for External Exposure to Photons and Electrons*, ORNL/NUREG-79, Oak Ridge National Laboratory, August.

Moore, R. E., et al. 1979. *AIRDOS-EPA. A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides,* ORNL-5532, Oak Ridge National Laboratory, June.

NRC (U.S. Nuclear Regulatory Commission). 1977a. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109, Office of Standards Development, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 1977b. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases From Light-Water-Cooled Reactors," Regulatory Guide 1.111, July.

Sangendorf, J. F. 1974. *A Program Evaluating Atmospheric Dispersion from a Nuclear Power Station,* NOAA Technical Memo ERL-ARL-42.

Shaeffer, D. L., and E. L. Etnier. 1979. *AQUAMAN—A Computer Code for Calculating Dose Commitments to Man from Aqueous Releases of Radionuclides,* ORNL/TM-6618, Oak Ridge National Laboratory, February.

Slade, D. H., ed. 1968. *Meteorology and Atomic Energy,* pp. 97-104, U.S. Atomic Energy Commission, July.

APPENDIX B

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR THE NUCLEAR FUEL SERVICES, INC., ERWIN PLANT

84N-91-0088
GOV-05-01

RECEIVED
MAR 7 '91

TENNESSEE DEPARTMENT OF CONSERVATION
NASHVILLE, TENNESSEE 37243-0438

February 28, 1991

Mr. J. A. Long
Nuclear Fuel Services, Inc.
205 Banner Hill Road
Eewin, Tennessee 37650

RE: **NPDES Permit No. TN0002038**
Nuclear Fuel Services, Inc.
Erwin, Unicol County, Tennessee

Dear Mr. Long:

In accordance with the provisions of "the Tennessee Water Quality Act" (Tennessee Code Annotated, Sections 69-3-101 through 69-3-120) the enclosed NPDES Permit is hereby issued by the Division of Water Pollution Control. The continuance and/or reissuance of this NPDES permit is contingent upon your meeting the conditions and requirements as stated therein.

Please be advised that you have the right to appeal any of the provisions established in this NPDES Permit, in accordance with Tennessee Code annotated, Section 69-3-110, and the General Regulations of the Tennessee Water Quality Control Board. If you elect to appeal, you should file a Petition within thirty (30) days of the receipt of this permit.

If you have any questions concerning this correspondence, please contact Mr. Robert G. O'Dette at (615) 741-7883.

Sincerely,

Garland P. Wiggins III

Garland P. Wiggins
Deputy Director
Division Water Pollution Control

GPW/RGO

Enclosure

cc: U.S. Environmental Protection Agency - Region IV, Atlanta, GA
Division of Water Pollution Control, Johnson City Field Office

STATE OF TENNESSEE

NPDES PERMIT

Permit No. TN0002038

Authorization to discharge under the
National Pollution Discharge Elimination System

Issued By

Division of Water Pollution Control
150 Ninth Avenue North
Tennessee Department of Conservation
Nashville, Tennessee 37247-3420

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101, et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger: **Nuclear Fuel Services, Inc.**

is authorized to discharge: treated industrial process wastewater through Outfall 001, and non-contact cooling water through Outfall 002

from a facility located: near Erwin, Unicoi County, Tennessee

to receiving waters named: the Nolichucky River at mile 94.6 (Outfall 001), and Banner Spring Branch at mile 0.17 (Outfall 002)

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on: **FEBRUARY 28, 1991**

This permit shall expire on: **FEBRUARY 27, 1996**

Issuance date: **FEBRUARY 28, 1991**

Paul E. Davis
Paul E. Davis
Director
Division of Water Pollution Control

PH-0609

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Nuclear Fuel Services is authorized to discharge treated industrial process wastewater from Outfall 001 to the Nolichucky River at mile 94.6; and non-contact cooling water from Outfall 002 to Banner Spring Branch at mile 0.17. Discharges 001 and 002 shall be limited and monitored by the permittee as specified below:

Discharge 001

PARAMETER	EFFLUENT LIMITATIONS Monthly Avg. Conc. mg/l	Monthly Avg. Amount lb/day	Daily Max. Conc. mg/l	Daily Max. Amount lb/day	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Flow	NA	NA	NA	NA	1/batch	volumetric
COD (See Below)	148	NA	221	NA	1/batch	grab
TSS	NA	NA	40	8.7	1/batch	grab
Ammonia (N)	NA	NA	30	6.5	1/batch	grab
Nitrates (N)	NA	NA	NA	650	1/batch	grab
Fluoride, Total	NA	NA	30	NA	1/batch	grab
Arsenic	NA	NA	NA	NA	1/90	grab
Cadmium	NA	NA	0.01*	NA	1/week*	grab
Uranium	2.0	NA	4.0	NA	1/batch	grab
Chromium (T)	NA	NA	NA	NA	1/90	grab
Copper (T)	NA	NA	1.0*	NA	1/week*	grab
Lead (T)	NA	NA	0.1*	NA	1/week*	grab
Nickel (T)	NA	NA	NA	NA	1/90	grab
Zinc (T)	NA	NA	NA	NA	1/90	grab
Silver (T)	NA	NA	0.05*	NA	1/week*	grab
Settleable Solids	NA	NA	0.5 ml/l		1/batch	grab
pH	within range 6.0 to 9.0				1/batch	grab
Chlorine, Tot. Residual**	NA	NA	2.0**	NA	1/batch**	grab
Trichloroethylene	0.5***	NA	1.0***		1/batch***	grab
1,1,1-Trichloro ethane	0.6***	NA	1.0***	NA	1/batch***	grab

An 18 month compliance shcedule is provided for COD. If adequate correlation exists between BOD_5, COD, and TOC, then the appropriate level of COD or TOC can be used to determine compliance with this permit.

* Effective ninety (90) days from the effective date of this permit.

** Only applicable when chlorine is used in the treatment process.

*** These limits apply after steam stripping and before mixing with other waste streams.

Discharge 002

PARAMETER	EFFLUENT LIMITATIONS Monthly Avg. Conc. mg/l	Monthly Avg. Amount lb/day	Daily Max. Conc. mg/l	Daily Max. Amount lb/day	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Flow	NA	NA	NA	NA	Daily	Instantaneous
pH	within range 6.0 to 9.0				1/7	grab
Temperature	monitor only				1/7	grab
96 HR LC50*	Survival in 100% effluent				1/90*	composite*
NOEL*	Survival, reproduction, and growth in 100% effluent				1/90*	composite*

* See Part III for methodology.

The following conditions apply to Discharges 001 and 002.

The wastewater discharge must not cause an objectionable color contrast in the receiving stream.

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must result in no other materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner which prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq.

B. MONITORING PROCEDURES

1. Representative Sampling

Samples and measurements taken in compliance with the monitoring requirements specified above shall be representative of the volume and nature of the monitored discharge, and shall be taken at the following location(s):

After treatment, prior to mixing with uncontaminated storm runoff or the receiving stream.

2. Test Procedures

   a. Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304 (h) of the Clean Water Act, as amended, under which such procedures may be required.

   b. Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40, CFR, Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act.

3. Recording of Results

   For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

   a. The exact place, date, and time of sampling;

   b. The exact person(s) collecting samples;

   c. The dates and times the analyses were performed;

   d. The person(s) or laboratory who performed the analyses;

   e. The analytical techniques or methods used, and;

   f. The results of all required analyses.

4. Records Retention

   All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Division of Water Pollution Control.

C. DEFINITIONS

The **"daily maximum concentration"** is a limitation on the average concentration, in milligrams per liter, of the discharge during any calendar day.

When a proportional-to-flow composite sampling device is used, the daily concentration is the concentration of that 24-hour composite.

The **"daily maximum amount"** is a limitation on the total amount of any pollutant in the discharge by weight during any calendar day.

The **"monthly average concentration"**, a limitation on the discharge concentration in milligrams per liter, is the arithmetic mean of all individual concentrations determined in a one-month period. For parameters measured less than twice per month, only the daily maximum value shall be reported. The Division may, by letter, increase the monitoring frequency and/or establish a monthly and/or weekly average limit.

The **"monthly average amount"**, a discharge limitation, means the total discharge by weight during a calendar month divided by the number of days in the month that the facility was operating. Where less than daily sampling is required by a Permit, the monthly average discharge amount shall be determined by the summation of all the measured individual discharges by weight divided by the number of days during the calendar month when the measurements were made. For parameters measured less than twice per month, only the daily maximum value shall be reported. The Division may, by letter, increase the monitoring frequency and/or establish a monthly and/or weekly average limit.

A **"composite sample"**, for the purposes of this permit, is said to be a sample collected continuously over a period of 24 hours at a rate proportional to the flow.

For the purpose of this permit a **"quarter"** is defined as any one of the following three month periods: January 1 through March 31, April 1 through June 30, July 1 through September 30, October 1 through December 31.

For the purpose of this permit a **"calendar day"** is defined as any day during which normal production activity occurs.

D. REPORTING

1. Monitoring Results

Monitoring results shall be recorded monthly and submitted monthly using Discharge Monitoring Report Forms supplied by the Division of Water Pollution Control. Submittals shall be postmarked no later than 15 days after the completion of the reporting period. The top two copies of each report are to be submitted. A copy should be retained for the permittee's files. Discharge Monitoring Reports and any communication regarding compliance with the conditions of this permit must be sent to:

Division of Water Pollution Control
Attention: Compliance Review
150 Ninth Avenue North (4th Floor)
Department of Conservation
Nashville, Tennessee 37247-3420

The first Discharge Monitoring Report is due April 15, 1991

Discharge Monitoring Reports must be signed and certified by a responsible corporate officer, as defined at 40 CFR 122.22, or a general partner or proprietor, or a principal municipal executive officer or ranking elected official, or his duly authorized representative. Such authorization must be submitted in writing and must explain the duties and responsibilities of the authorized representative.

2. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form. Such increased frequency shall also be indicated.

3. Falsifying Reports

Knowingly making any false statement on any report required by this permit may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Water Pollution Control Act, as amended, and in Section 69-3-115 of the Tennessee Water Quality Control Act.

PART II

A. GENERAL PROVISIONS

1. Duty to Reapply

Permittee is not authorized to discharge after the expiration date of this permit. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information and forms as are required to the Director no later than 180 days prior to the expiration date.

2. Right of Entry

The permittee shall allow the Director, the Regional Administrator of the U.S. Environmental Protection Agency, or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or where records are required to be kept under the terms and conditions of this permit, and at reasonable times to copy these records;

b. To inspect at reasonable times any monitoring equipment or method or any collection, treatment, pollution management, or discharge facilities required under this permit; and

c. To sample at reasonable times any discharge of pollutants.

3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, as amended, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division of Water Pollution Control. As required by the Federal Act, effluent data shall not be considered confidential.

4. Proper Operation and Maintenance

a. The permittee shall at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory and process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. Backup continuous pH and flow monitoring equipment are not required.

b. Where a backup power source is provided for the treatment system or a pumping station, the power source must be tested once per month to prove reliability. The date of this test shall be reported on the MOR.

c. Dilution water shall not be added to comply with effluent requirements to achieve BCT, BPT, BAT and or other technology based effluent limitations such as those in State of Tennessee Rule 1200-4-5-.03.

5. Treatment Facility Failure

The permittee, in order to maintain compliance with this permit, shall control production, all discharges or both, upon reduction, loss, or failure of the treatment facility, until the facility is restored or an alternative method of treatment is provided. This requirement applies in such situations as the reduction, loss, or failure of the primary source of power.

6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

7. Severability

The provisions of this permit are severable. If any provision of this permit due to any circumstance, is held invalid, then the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

8. Other Information

If the permittee becomes aware that he failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, then he shall promptly submit such facts or information.

B. CHANGES AFFECTING THE PERMIT

1. Planned Changes

The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1).

2. Permit Modification, Revocation, or Termination

   a. This permit may be modified, revoked and reissued, or terminated for cause as described in 40 CFR 122.62 and 122.64, Federal Register, Volume 49, No. 188 (Wednesday, September 26, 1984), as amended.

   b. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

   c. If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established for any toxic pollutant under Section 307(a) of the Federal Water Pollution Control Act, as amended, the Director shall modify or revoke and reissue the permit to conform to the prohibition or to the effluent standard, providing that the effluent standard is more stringent than the limitation in the permit on the toxic pollutant. The permittee shall comply with these effluent standards or prohibitions within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified or revoked and reissued to incorporate the requirement.

3. Change of Ownership

   This permit may be transferred to another person by the permittee if:

   a. The permittee notifies the Director of the proposed transfer at least 30 days in advance of the proposed transfer date;

   b. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and liability between them; and

   c. The Director, within 30 days, does not notify the current permittee and the new permittee of his intent to modify, revoke or reissue, or terminate the permit and to require that a new application be filed rather than agreeing to the transfer of the permit.

4. Change of Mailing Address

   The permittee shall promptly provide to the Director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

C. NONCOMPLIANCE

1. Effect of Noncompliance

   All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable State and Federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

2. Reporting of Noncompliance

a. 24-Hour Reporting

In the case of any noncompliance which could cause a threat to public drinking supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the appropriate Division field office within 24 hours from the time the permittee becomes aware of the circumstances. (The field office should be contacted for names and phone numbers of emergency response personnel.)

A written submission must be provided within five days of the time the permittee becomes aware of the circumstances unless this requirement is waived by the Director on a case-by-case basis. The permittee shall provide the Director with the following information:

i. A description of the discharge and cause of noncompliance;

ii. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and

iii. The steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph 2.a. above, the permittee shall report the noncompliance on the Discharge Monitoring Report. The report shall contain all information concerning the steps taken, or planned, to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

3. Bypassing

a. "Bypass" means the diversion of wastes from any portion of a treatment facility other than through parallel treatment processes. "Bypass" also means overflows anywhere in the collection system. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypass is prohibited unless the following (3) conditions are met:

i. Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

ii. There are not feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment down-time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment down-time or preventative maintenance;

iii. The permittee submits notice of an unanticipated bypass to the appropriate field office of the Division of Water Pollution Control within 24 hours of becoming aware of the bypass (if this information is provided orally, a written submission must be provided within five days). When the need for the bypass is foreseeable, prior notification shall be submitted to the Director, if possible, at least ten (10) days before the date of the bypass.

c. The permittee shall operate the collection system so as to avoid bypassing. No new or additional flows shall be allowed that will contribute to bypass discharges or would otherwise overload any portion of the system.

4. Upset

a. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. An upset shall constitute an affirmative defense to an action brought for noncompliance with such technology - based permit effluent limitations if the permittee demonstrates, through properly signed, contemporaneous operating logs, or other relevant evidence that:

i. An upset occurred and that the permittee can identify the cause(s) of the upset;

ii. The permitted facility was at the time being operated in a prudent and workman-like manner and in compliance with proper operation and maintenance procedures;

iii. The permittee submitted information required under "Reporting of Noncompliance" within 24 hours of becoming aware of the upset (if this information is provided orally, a written submission must be provided within five days); and

iv. The permittee complied with any remedial measures required under "Adverse Impact."

5. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. LIABILITIES

1. Civil and Criminal Liability

Except as provided in permit conditions or **"Bypassing"**, **"Upset"**, and **"Treatment Facility Failures"**, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

2. Liability Under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or the Federal Water Pollution Control Act, as amended.

PART III
OTHER REQUIREMENTS

A. TOXIC POLLUTANTS

The permittee shall notify the Division of Water Pollution Control as soon as it knows or has reason to believe:

a. That any activity has occurred or will occur which would result in the discharge on a routine or frequent basis, of any toxic substance(s) (listed at 40 CFR 122, Appendix D, Table II and III) which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

(1) One hundred micrograms per liter (100 ug/l);
(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4- dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/l) for antimony;
(3) Five (5) times the maximum concentration value reported for that pollutant(s) in the permit application in accordance with 122.21(g)(7); or
(4) The level established by the Director in accordance with 122.44(f).

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

(1) Five hundred micrograms per liter (500 ug/l);
(2) One milligram per liter (1 mg/l) for antimony;
(3) Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with 122.21(g)(7); or
(4) The level established by the Director in accordance with 122.44(f).

Additional Analyses

The permittee is required to submit complete analyses for Discharge 002 for all parameters listed under Section V, Parts A and B, and the metals listed under Part C of the NPDES Permit Application Form 2C within ninety days of the effective date of this permit.

B. BIOMONITORING REQUIREMENTS, CHRONIC

The permittee shall conduct a 7-Day *Ceriodaphnia* Survival and Reproduction Test and a 7-Day Fathead Minnow (*Pimephales promelas*) Larval Survival and Growth Test on samples of final effluent from Outfall 002. Toxicity will be demonstrated if more than 50% lethality of the test organisms occurs in 96 hours in 100% effluent or the no observable effect level (NOEL) is less than 100%. All tests will be conducted on 24-hour composite samples of final effluent. All test solutions shall be renewed daily. If, in any control, more than 10% of the test organisms die in 96 hours or more than 20% of the test organisms dies in 7 days, that test (control and effluent) shall be repeated. Such testing will determine whether the effluent affects the survival, reproduction, and/or growth of the test organisms.

The toxicity tests specified above shall be conducted once within ninety days from the effective date of this permit. The first test shall be conducted no later than ninety (90) days from the effective date of this permit. Results shall be reported according to EPA/600/4-89/001, Section 9, Report Preparation, and shall be submitted to the Division with the monthly discharge monitoring report. If any one test shows lethality to more than 50% of the test organisms in 100% effluent in 96 hours and/or the NOEL is less than 100%, then the next paragraph applies.

If toxicity (greater than 50% lethality of test organisms in 100% effluent in 96 hours or a NOEL of less than 100%) is found in any of the tests specified above, this will constitute a violation of this permit. The permittee will then be subject to the enforcement provisions of the Clean Water Act.

The determination of effluent lethality values will be made in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA/600/4-85/013.

All test organisms, procedures and quality assurance criteria used shall be in accordance with Short-term Methods For Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Section 12: Ceriodaphnia Survival and Reproduction Test Method 1002.0 and Section 10: Fathead Minnow (Pimephales promelas) Larval Survival and Growth Test Method 1000.0, EPA/600/4-89/001. The permittee's selection of an appropriate control water for the toxicity tests shall be submitted to the Division for review and approval prior to use. The permittee shall submit the name of the laboratory performing the toxicity test(s) to the Division.

C. SCHEDULE OF COMPLIANCE

The permittee shall have eighteen (18) months from the effective date of this permit to comply with the COD limitations. The permittee may utilize COD or TOC analyses to determine compliance with the BOD_5 limits. If the TOC parameter is chosen, the permittee shall document, based on data acceptable to the Division of Water Pollution Control, the relationship between BOD_5, COD, and TOC.

D. REOPENER CLAUSE FOR PERMITS ISSUED TO SOURCES IN PRIMARY INDUSTRIES

If an applicable standard or limitation is promulgated under Sections 301(b)(2)(C) and (D), 304(B)(2), and 307(a)(2) and that effluent standard or limitation is more stringent than any effluent limitation in the permit or controls a pollutant not limited in the permit, the permit shall be promptly modified or revoked and reissued to conform to that effluent standard or limitation.

E. PLACEMENT OF SIGNS

The permittee shall place and maintain a sign(s) at each outfall and any bypass/overflow point in the collection system. The sign(s) should be clearly visible to the public from the bank and the receiving stream. The <u>minimum</u> sign size should be two feet by two feet (2' x 2') with two inch (2") letters. The sign should be made of durable material and have a white background with black letters.

The sign(s) are to provide notice that the discharge is regulated by the Tennessee Department of Health and Environment, Division of Water Pollution Control. The following is given as an example of the minimal amount of information that must be included on the sign:

NPDES permitted industrial outfall:

TREATED INDUSTRIAL WASTEWATER
(PERMITTEE'S NAME)
(PERMITTEE'S PHONE NUMBER)
NATIONAL POLLUTANT DISCHARGE ELIMINATION
SYSTEM PERMIT #________
TENNESSEE DEPARTMENT OF CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

NPDES permitted cooling water discharge:

COOLING WATER DISCHARGE
(PERMITTEE'S NAME)
(PERMITTEE'S PHONE NUMBER)
NATIONAL POLLUTANT DISCHARGE ELIMINATION
SYSTEM PERMIT #________
TENNESSEE DEPARTMENT OF CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

Addendum No. 1
Rationale Sheet
NPDES Permit No. TN0002038
August 1990

On the basis of review comments received from the applicant, the Division's Johnson City Field Office (JCFO), and a meeting with the applicant on August 2, 1990, the following changes are being made to the draft NPDES permit:

1. COD will be used as a surrogate for BOD_5. The JCFO established a correlation between BOD_5 and COD that equated a COD of 148 mg/l and 221 mg/l to a BOD_5 of 30 mg/l and 45 mg/l, monthly average and daily maximum, respectively. Therefore, the new permit limits will be for COD rather than BOD_5 as follows:

   148 mg/l - monthly average

   221 mg/l - daily maximum

   An 18 month compliance schedule for COD will be provided, because this provision represents a more restrictive effluent limitation than the applicant is presently able to meet. During the 18 month period, the applicant may submit additional TOC analyses to the Division of Water Pollution Control. If adequate correlation exists between BOD_5, COD, and TOC, then the appropriate level of either COD or TOC can be used to determine compliance with the permit.

2. A poundage limit for TSS (daily maximum) has been added to accommodate the applicant's request for consideration of the 0.026 MGD flow. The 40 mg/l (daily maximum) concentration level will satisfy the requirements of State Rule 1200-4-5-.03(2).

3. After further evaluation of the Nitrate limit, it was decided to retain a maximum pounds per day limitation (per the previous permit), rather than a concentration limitation. Therefore, the new permit limit will be 650 lbs/day (daily maximum). This represents 3,000 mg/l at 0.026 MGD. Also note that nitrates will be in terms of nitrogen ("as N").

4. The Soluble Fluoride limitation will be deleted from the new permit, because there is no approved method for soluble fluoride listed in 40 CFR part 136. Furthermore, the concensus is that the total fluoride limit is adequate, based upon the nature of the discharge.

5. The oil and grease limitation is being deleted from the new permit. Oil and grease is not associated with this process; and the analytical extraction procedures using Freon 113, result in the generation of a hazardous or mixed waste.

6. The new permit will consider all "heavy metals" on an individual parameter basis. A further review and evaluation of DMRs, 2C application, and the nature of the discharge, have resulted in the following conclusions relative to heavy metal effluent limitations:

   a. Cadmium, Copper, Silver, and Lead limitations will be retained with sampling frequency of once per week. Since these are new requirements that the applicant is not set-up to handle at present, the limitations will not become effective until ninety (90) days after the effective date of the permit.

   b. Arsenic, Chromium, Nickel, and Zinc could potentially be discharged based upon the 2C. However, at this time the levels are insignificant. Therefore, monitoring only, at a frequency of once per quarter will be the requirements for these parameters.

   c. Iron will be deleted from the new permit. This is because of non-detection in the applicant's discharge, and no environmental significance.

7. The JCFO agrees that a control point temperature is all that is necessary to achieve the desired results relative to Discharge 002 to Banner Spring Branch. Therefore, the permittee will be required to monitor for temperature and validate their calculations to the satisfaction of the JCFO.

RATIONALE SHEET
NPDES PERMIT NO. TN0002038
February 1990

I. FACILITY IDENTIFICATION

Name: Nuclear Fuel Services, Inc.
Location: Erwin, Unicoi County, Tennessee
Nature of Business: Manufacture and recovery of nuclear reactor fuel (non-irradiated)
SIC Code: 2819
Industrial Classification: Primary
Discharge Rating: Major
Facility Contact: Donald Paine, Ph. D.
Tel.No. (615) 743-9141

II. PERMIT STATUS

Previous Permit Issued: September 30, 1988 (MOD)
Previous Permit Expired: January 31, 1989
Application Received: August 11, 1988

III. FACILITY DISCHARGES

Discharge 001

Consists of approximately 10,400 gallons per day of treated process wastewater

Discharge 002

Consists of approximately 82,000 gallons per day on untreated, non-contact cooling water for the calciner furnace.

IV. RECEIVING STREAMS

Discharge 001

Nolichucky River at mile 94.6
Stream Low Flow (3Q20) = 197 cfs = 127 MGD
Stream Classified Uses :

Fish and Aquatic Life
Recreation
Irrigation
Livestock Watering and Wildlife
Industrial Water Supply
Domestic Water Supply

Discharge 002

	EFFLUENT LIMITATIONS				MONITORING REQUIREMENTS	
PARAMETER	Monthly Avg. Conc. mg/l	Monthly Avg. Amount lb/day	Daily Max. Conc. mg/l	Daily Max. Amount lb/day	Measurement Frequency	Sample Type
Flow					Daily	contin
pH	6.0 - 9.0 standard units				1/7	grab
Temperature	see below				1/7	grab

It is recognized that the temperature of the cooling water discharge will be greater than the temperature of the water prior to its use for cooling or other purposes. This discharge must not cause the temperature change in Banner Spring Branch to exceed 3C° relative to an upstream control point. Also, this discharge must not cause the temperature of Banner Spring Branch to exceed 30.5°C (except as a result of natural causes), and this discharge must not cause the maximum rate of temperature change in Banner Spring Branch to exceed 2C° per hour (except as a result of natural causes).

The following conditions apply to Discharges 001 - 002

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must result in no other materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner which prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, T.C.A. 53-4301 et seq. and the Tennessee Hazardous Waste Management Act, T.C.A. 53-6301 et seq.

Permittee shall comply with the statutes and rules administered by the Tennessee Department of Public Health, Division of Radiological Health, with regard to all effluent discharges containing radiological materials. The <u>State Regulations for Protection Against Radiation</u>, shall be followed. Rule 1200-2-5-.08 specifically limits quantities of permissible discharge by element, and that rule and Schedule RHS 8-1, Table II, column 2 is hereby incorporated by reference into this permit and made part and parcel of the same to be complied with by permittee.

VI. PRESENT PERMIT LIMITS AND MONITORING REQUIREMENTS

Discharge 001

PARAMETER	EFFLUENT LIMITATIONS Monthly Avg. Conc. mg/l	Monthly Avg. Amount lb/day	Daily Max. Conc. mg/l	Daily Max. Amount lb/day	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Flow (*See Note 1*)					1/batch	volume
BOD & COD	NA	NA	NA	NA	(*See Note 2*)	
TSS	NA	NA	NA	9.0	1/batch	grab
Ammonia, as N	NA	NA	30	6.5	1/batch	grab
Nitrates, as N	NA	NA	NA	656	1/batch	grab
Fluoride	NA	NA	30	6.5	1/batch	grab
Uranium	NA	NA	4.0	0.9	1/batch	grab
Heavy Metals	NA	NA	NA	NA	(*See Note 3*)	grab
Settleable Solids	NA	NA	0.5 ml/L		1/batch	grab
pH	within range 6.0 - 9.0 standard				1/batch	grab
Trichloro- ethylene	0.5 (See Note 4)	---	1.0	---	1/batch	grab
*1,1,1-Tri- chloroethane	0.6 (*See Note 4*)	---	1.0	---	1/batch	grab

Note 1 - This discharge shall be released uniformly over as long a time period as operational constraints allow.

Note 2 - Permittee shall continue to demonstrate 85% in house removal of BOD and COD. This shall be reported by addendum to the DMR submitted June 30th and December 31st of each year.

Note 3 - Permittee shall monitor quarterly heavy metals arsenic, cadmium, chromium, copper, lead, nickel, zinc, and silver and report results quarterly by addendum to the quarterly DMR's.

The total chlorine residual shall not exceed 2.0 mg/l when chlorine is used for treatment.

Note 4 - These limits apply after steam stripping and before mixing with other waste streams.

VII. NEW PERMIT LIMITS

The new permit limits are determined by comparing any applicable state effluent guidelines with the previous permit limits. The more restrictive limit of this comparison is checked against the appropriate water quality criteria, if applicable. The most restrictive limit is use as the new permit limit.

The following formulas are used to evaluate water quality protection:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where,

C_m = resulting in-stream concentration after mixing
C_w = concentration of pollutant in wastewater
C_s = stream background concentration
Q_w = wastewater flow
Q_s = stream low flow (3Q20)

to protect water quality,

$$Cw \leq \frac{Cm\ (Qs+Qw) - QsCs}{Qw}$$

Discharge 001

BOD_5

The previous permit required 85% removal per batch. Based upon current state regulations, it is believed that the appropriate limits should be 30 mg/l (monthly average) and 45 mg/l (daily maximum). These will be the new permit limits for BOD_5.

COD

The previous permit required an 85% reduction of COD. At the present time there is no basis for limiting COD. Therefore, this parameter will be deleted from the new permit.

TSS

The previous permit limit is 9.0 lbs/day as a daily maximum and was calculated using a flow of 0.026 MGD which is no longer valid. Therefore, the state maximum limit of 40 mg/l will be the new permit limit as concentration value.

Ammonia

The previous permit limits will be retained as they do not violate state regulations.

Nitrates

There are no state regulations for nitrates. The previous permit limits were based upon a daily maximum concentration of 3000 mg/l, but used a flow of 0.026 MGD which is no longer valid. Therefore, the new permit limits will be 3000 mg/l as a daily maximum.

Fluoride

The state limit for soluble fluoride is 20 mg/l as a daily maximum value. The new permit limits will be 20 mg/l for soluble fluoride. The values for total fluoride of 30 mg/l (daily maximum) will be retained; however, the 6.5 lbs/day daily maximum value will be deleted because it is based upon the invalid flow of 0.026 MGD.

Uranium

The previous permit limitations were based upon a treatment technology for uranium extraction of 2 mg/l (average) and 4 mg/l (maximum). These values came from a Development Document relative to FR Vol. 43 29776, July 11, 1978 (BPT limits for uranium in Subpart E of the Ore Mining and Dressing Category). Therefore, the new permit limits will be 2.0 mg/l (monthly average) and 4.0 mg/l (daily maximum). There will be no poundage limitations established.

Other Heavy Metals

The previous permit established monitoring and reporting requirements, but no limitations for arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc. The new permit will establish values for these parameters based upon state regulations.

Arsenic

The new permit limits will be 1.0 mg/l (daily maximum).

Cadmium, total

The new permit limit will be 0.01 mg/l (daily maximum).

Chromium, total

The new permit limit will be 3.0 mg/l (daily maximum).

Copper, total

The new permit limit will be 1.0 mg/l (daily maximum).

Iron, total

The new permit limit for Iron is 10.0 mg/l (daily maximum).

Lead, total

The new permit limit for lead is 0.1 mg/l (daily maximum).

Nickel, total

The new permit limit for Nickel is 3.0 mg/l (daily maximum).

Silver, total

The new permit limit for Silver is 0.05 mg/l (daily maximum).

Zinc, total

The new permit limit for Zinc is 2.0 mg/l (daily maximum)

Settleable Solids

The previous permit limits will be retained as they are consistent with state regulations.

pH

The previous permit limits will be retained.

Chlorine, total residual

The new permit limit will be 2.0 mg/l (daily maximum) per state regulations.

Oil and Grease

The new permit limits will be 30 mg/l (daily maximum) per state regulations.

Trichloroethylene

The previous permit limits of 0.5 mg/l (monthly average) and 1.0 mg/l (daily maximum) will be retained.

1,1,1 -Trichloroethane

The pervious permit limits of 0.6 mg/l (monthly average) and 1.0 mg/l (daily maximum) will be retained. These appear to be acceptable limits, because OCPSF BAT guidelines are 22 ug/l (monthly average) and 59 ug/l (daily maximum).

Discharge 002

pH

The previous permit limits of 6.0 to 9.0 will be retained because they protect water quality.

Temperature

The previous permit requirements relative to temperature will be retained.

VIII. BIOMONITORING

Discharge 001

$$\text{Dilution Factor} = \frac{Qs}{Qw} = \frac{127}{0.01} > 12{,}000 \text{ to } 1$$

Therefore, no biomonitoring required for Discharge 001, since dilution factor is greater that 500 to 1 (per State/EPA agreement).

Discharge 002

Since Banner Spring Branch is considered a zero flow stream Acute and chronic toxicity will be required using 100% effluent. One test will be required within 90 days of the effective date of the permit. If there is no toxicity indicated additionally tests will not be required. However, if toxicity is shown the state will modify the permit making toxicity testing a requirement for the duration of the permit of a frequency to be determined at the time of the modification.

IX. MONITORING FREQUENCIES AND SAMPLE TYPES

Discharge 001

Flow	1/batch	volumetric
BOD	1/batch	grab
TSS	1/batch	grab
Ammonia	1/batch	grab
Nitrates	1/batch	grab
Fluoride Soluble	1/batch	grab
Fluoride Total	1/batch	grab
Uranium	1/batch	grab
Arsenic	1/batch	grab
Cadmium, Total	1/batch	grab
Chromium, Total	1/batch	grab
Copper, Total	1/batch	grab
Iron, Total	1/batch	grab
Lead, Total	1/batch	grab
Nickel, Total	1/batch	grab
Silver, Total	1/batch	grab
Zinc, Total	1/batch	grab
Settleable Solids	1/batch	grab
pH	1/batch	grab
Chlorine, Total Residual	1/batch	grab
Oil and Grease	1/batch	grab
Trichloro ethylene	1/batch	grab
1,1,1-Tri-chloroethane	1/batch	grab

Discharge 002

Flow	daily	Instantaneous
pH	1/7	grab
Temperature	1/7	grab
Toxicity Test	1/90	composite

X. PERMIT DURATION

The proposed limitations meet the requirements of sections 301(b)(2)(A),(C),(D),(E), and (F) of the Clean Water Act, as amended. Therefore, the permit will be reissued for a five (5) year term.

Discharge 002

Banner Spring Branch at mile 0.17
Stream Low Flow (3Q20) estimated = zero
Stream Classified Uses :

Fish and Aquatic Life
Recreation
Irrigation
Livestock Watering and Wildlife

V. APPLICABLE EFFLUENT LIMITATIONS GUIDELINES

There are no EPA Effluent Guidelines applicable to this facility. When the rational sheet was developed for this permit (December 10, 1982 and Revised January 26, 1984), EPA-HQ in Washington, D.C. had stated that the agency would not consider the nuclear reactor fuel manufacturing and recovery sub-category in the development of BCT, BPT, and BAT guidelines. This point is further documented by the Federal Register dated Wednesday, August 22, 1984 p. 33420 - Item 9 of Appendix D.

State regulations applicable to these discharges are Rule 1200-4-5-.03(2).

REQUIREMENTS FOR MAKING A PERMIT APPEAL

Permit Appeal (Tennessee Department of Health and Environment, Chapter 1200-4-1.05(6), and T.C.A. Section 69-3-110)

1. Petitions must be made within 30 days following date of issuance of the final permit.

2. Petitions shall contain the following:

   (a) The name, mailing address, and telephone number of the person mailing the request and the names and addresses of all persons he or she represents;

   (b) A clear and concise statement of each legal or factual matter alleged to be at issue; and

   (c) Specific reference to each permit condition which the petitioner contests. The petitioner may suggest alternate permit terms which would meet the requirements of the Water Quality Control Act; if the petitioner challenges permit conditions which are justified in the fact sheet (or Rationale), the petitioner should indicate how the basis for the permit condition is in error or indicate why an alternate condition is necessary.

3. Petitions should be addressed to the Water Quality Control Board and filed in duplicate at the following address: Paul E. Davis, Director; Division of Water Pollution Control; T.E.R.R.A. Building - 4th Floor; 150 Ninth Avenue, North; Department of Health and Environment; Nashville, Tennessee 37247-3420.

4. The appeal of a permit or a permit condition has the effect of staying the contested provisions. Therefore, if a permit is being reissued, the permittee will be considered to be authorized under the terms of the old permit and/or any unappealed terms of the reissued permit. If it is a new permit, the applicant will be considered to be without a permit for the activity until final agency action.

E8060092-D4WPC1

Appendix C

CORRESPONDENCE CONCERNING RARE AND ENDANGERED SPECIES AT THE NUCLEAR FUEL SERVICES, INC., ERWIN PLANT

TENNESSEE DEPARTMENT OF CONSERVATION
701 BROADWAY
NASHVILLE, TENNESSEE 37203

January 31, 1985

Roger L. Kroodsma
Environmental Sciences Division
OAK RIDGE NATIONAL LABORATORY
Post Office Box X
Oak Ridge, Tennessee 37831

Subject: Nuclear Fuel Services, Inc. Erwin Plant, Erwin Tennessee

Dear Mr. Kroodsma:

In response to your request for information on rare species at the site referenced above, please be advised that the Ecological Services Division (ESD) data base lists recorded occurrences of the following species in the immediate vicinity of and within 5 miles downstream of the Erwin Plant.

SPECIES	STATUS Fed	STATUS TWRA	STATUS ESD
Carpiodes velifer (highfin carpsucker)		D	S
Neotoma floridana (Eastern woodrat)		D	S
Falco peregrinus (peregrine falcon)	E	E	E

	Fed	ESD
Buckleya distichophylla (piratebush)	2	T
Diervilla sessifolia var. rivularis (bush-honeysuckle)		T
Heracleum maximum (cow-parsnip)		S
Trillium rugellii (nodding trillium)		S
Tsuga caroliniana (Carolina hemlock)		S

I hope this information will prove useful. If you need additional information, please feel free to contact us at 615-742-6552.

Sincerely,

Roberta E. Hylton
Environmental Review Coordinator
Ecological Services Division

REH:vk

TENNESSEE WILDLIFE RESOURCES AGENCY

ELLINGTON AGRICULTURAL CENTER
P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

January 28, 1985

Dr. Roger L. Kroodsma
Environmental Sciences Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, TN 37831

Dear Dr. Kroodsma:

Reference is made to your letter of January 16, 1985, as related to the proposed relicensing of the Nuclear Fuel Services of Erwin, Tennessee. This is to advise that we are not aware of any rare or endangered wildlife species in that immediate vicinity where any adverse impact might be anticipated.

Thank you for this opportunity for comment.

Sincerely,
TENNESSEE WILDLIFE RESOURCES AGENCY

Robert M. Hatcher

Robert M. Hatcher,
Endangered Species Coordinator