NFS

Nuclear Fuel Services, Inc. ERWIN, TENNESSEE 37650

(615) 743-91

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LIC-01-01

July 27, 1984

Director, Office of
Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Material Licensing Branch
Division of Fuel Cycle
and Material Safety

Reference: (1) Docket 70-143;SNM-124
(2) Letter dated February 11, 1984; A. L. Soong to R. L. Ideker
(3) Letter dated May 24, 1984; R. L. Ideker to R. G. Page

Gentlemen:

In accordance with the schedule contained in Reference (3), NFS submits twenty-five (25) complete copies of our Environmental Report.

Should you have any questions, please contact me.

Very truly yours,

R. L. Ideker, Manager
Safety and Decommissioning

RLI/degd

cc: USNRC, Region II
Mr. J. P. O'Reilly
Suite 3100
101 Marietta Street, NW
Atlanta, Georgia 30303

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UNCLASSIFIED

Reviewed By 7/27/84 Date

Nuclear Fuel Services, Inc.

ENVIRONMENTAL REPORT

July, 1984

Erwin Plant

ERWIN, TENNESSEE

UNCLASSIFIED

7/27/84

Reviewed By Date

July 27, 1984

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INTRODUCTION

1.0 Nuclear Fuel Services, Inc. (NFS) operates nuclear fabrication and scrap recovery facilities on its property near Erwin, Tennessee. This report provides environmental information on these facilities and is being submitted to the Nuclear Regulatory Commission (NRC) in support of an application for renewal of NFS' Special Nuclear Material License. This report represents an update of the previously submitted report titled "Environmental Information Report on the Nuclear Fuel Services, Inc., Operation at Erwin, Tennessee, January 1976" including revisions thereto dated November 1, 1976, January 17, 1977 and May 31, 1977 and the resulting U.S. Nuclear Regulatory Commission published "Environmental Impact Appraisal" which was based on these documents.

Throughout this report, where reference is made to specific manufacturers, service companies, equipment models, sampling frequencies, etc., such reference is intended to reflect current and/or past practices. It is not intended to imply that NFS is committed to a particular company, equipment, or frequency except as provided by Section 190 of the proposed License Conditions or such specific License Conditions which have been or may be issued by the Nuclear Regulatory Commission.

Significant environmental factors summarized herein include land use, demography, geology, hydrology, meterology, ecology, effluent controls, environmental monitoring, radiological and non-radiological impacts of routine operations, and accident potential.

1.1 Description of the Proposed Action

The proposed action for which this environmental report is prepared is the routine renewal of Nuclear Fuel Services' license for continuing operation. Licensed activities include production of fuel containing highly or slightly enriched uranium; recovery of uranium from scrap materials; and maintenance and/or decommissioning of a plutonium facility. Source materials (natural and depleted uranium and thorium) are licensed and controlled by the State of Tennessee. The processes used at the site are numerous and changed from time to time in response to the changing needs of the government and the nuclear industry. The activities that will continue under the authorization resulting from renewal of the present license are of the same general type; i.e. chemical and physical processing of special nuclear and source materials, which have been in progress since 1958. During those 26 years, no adverse environmental effects have been observed. Liquid and airborne discharges of radioactive and other hazardous materials must meet Federal and State standards.

DESCRIPTION OF SITE ENVIRONMENT

2.0 This section provides basic information about the physical, biological and cultural environment surrounding the (NFS) plant at Erwin.

2.1 Site Location

The NFS plant at Erwin is located in Unicoi County in northeast Tennessee. As shown in Figure 2.1, the NFS Erwin site is approximately 0.5 mile southwest of the city limits of Erwin and is immediately west of the unincorporated community of Banner Hill.

The site consists of a 57.8-acre tract, surrounded for the greatest part by privately owned property. Carolina Avenue runs parallel to the site on the southeast, and the Clinchfield Railroad right-of-way parallels the site boundary on the northwest. The restricted area containing the plant facilities occupies approximately 21 acres within the site boundary.

Situated in a narrow valley almost entirely surrounded by rugged mountains, the site occupies a relatively level area some 50 to 100 ft above the Nolichucky River. To the north, east, and south, the mountains rise to elevations of 3500 to 5000 ft within a few miles of the site.

2.2 Demography

Population distributions within a 5-mile radius of the NFS Erwin plant are detailed in Figures 2.2 and 2.3. These figures were based on 1970 census data. However, 1980 census data shows no change in Erwin City population from 1970 to 1980 whose totals showed 4715 and 4729 persons respectively. Unicoi County showed a population increase of 7.3% from 1970 to 1980 (population totals: 1970 - 15254, 1980 - 16362).

Some 3,100 persons reside within a 1-mile radius of the plant, with the distribution reflecting the proximity of the Erwin and Banner Hill communities to the east. The nearest residences are located ESE of the plant, approximately 350 m from the center of the site.

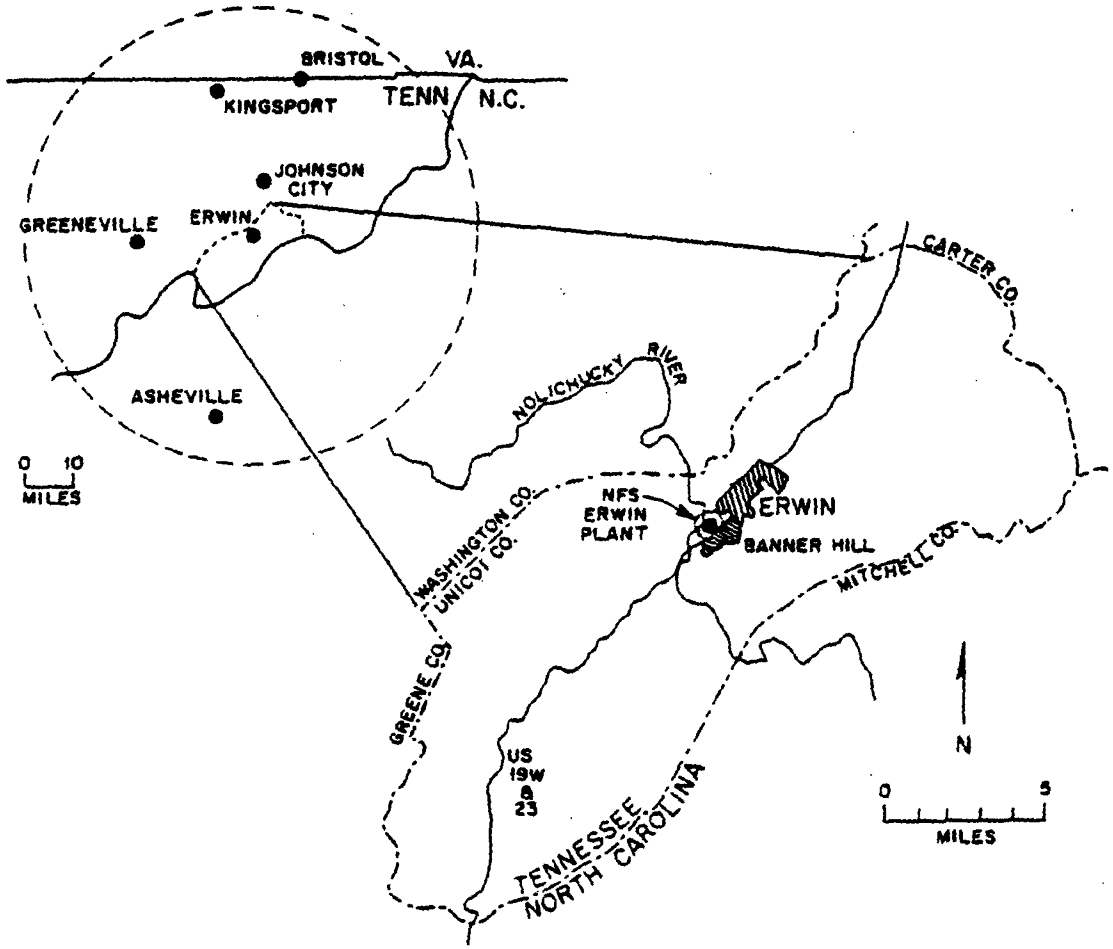


FIGURE 2.1 Location map of the Nuclear Fuel Services plant at Erwin, Tennessee.

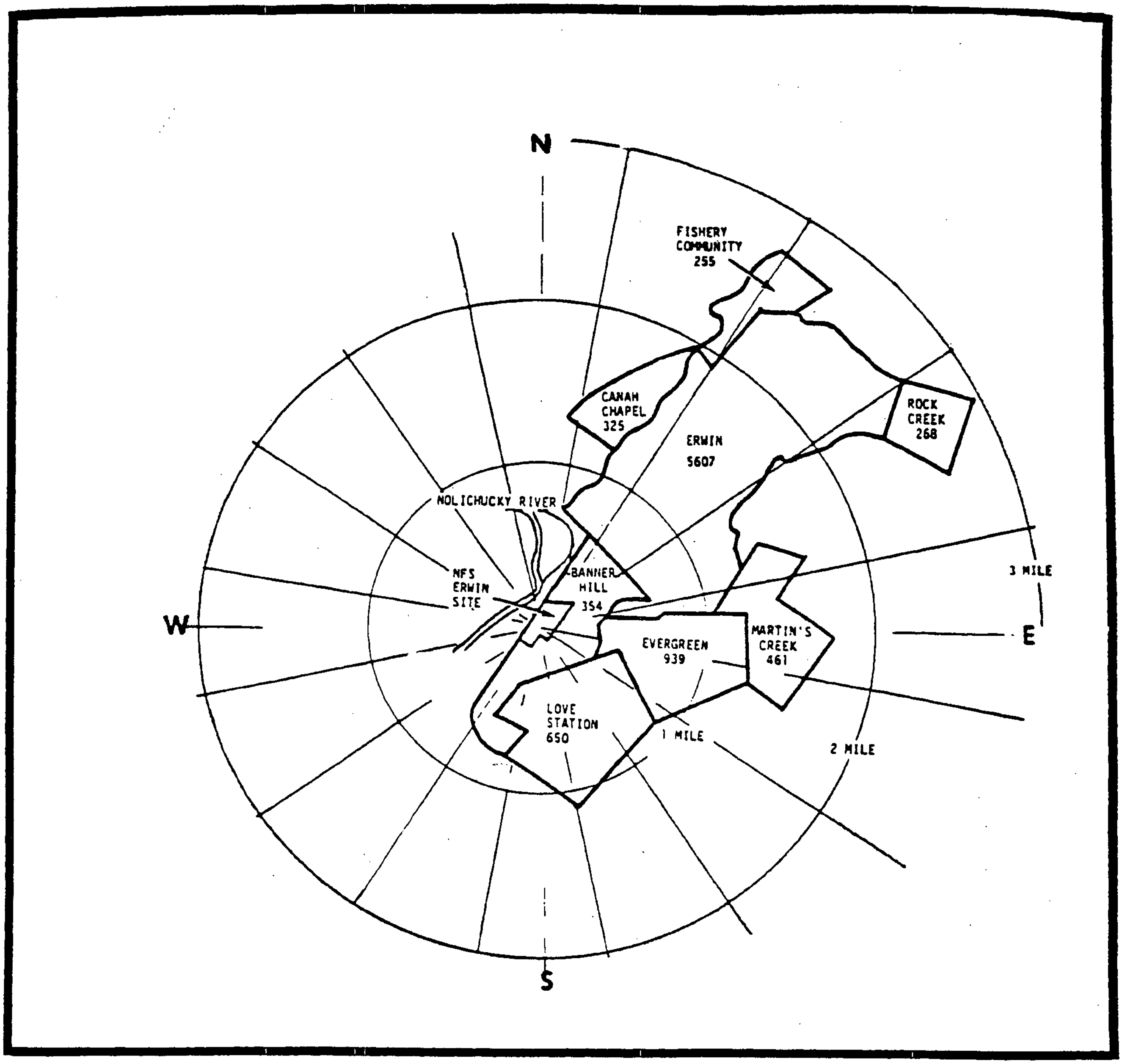


FIGURE 2.2

Population of Residential Areas
Surrounding the NFS-Erwin Site

SOURCE: Section 4.4.2, Demography, NFS EIR, January, 1976.

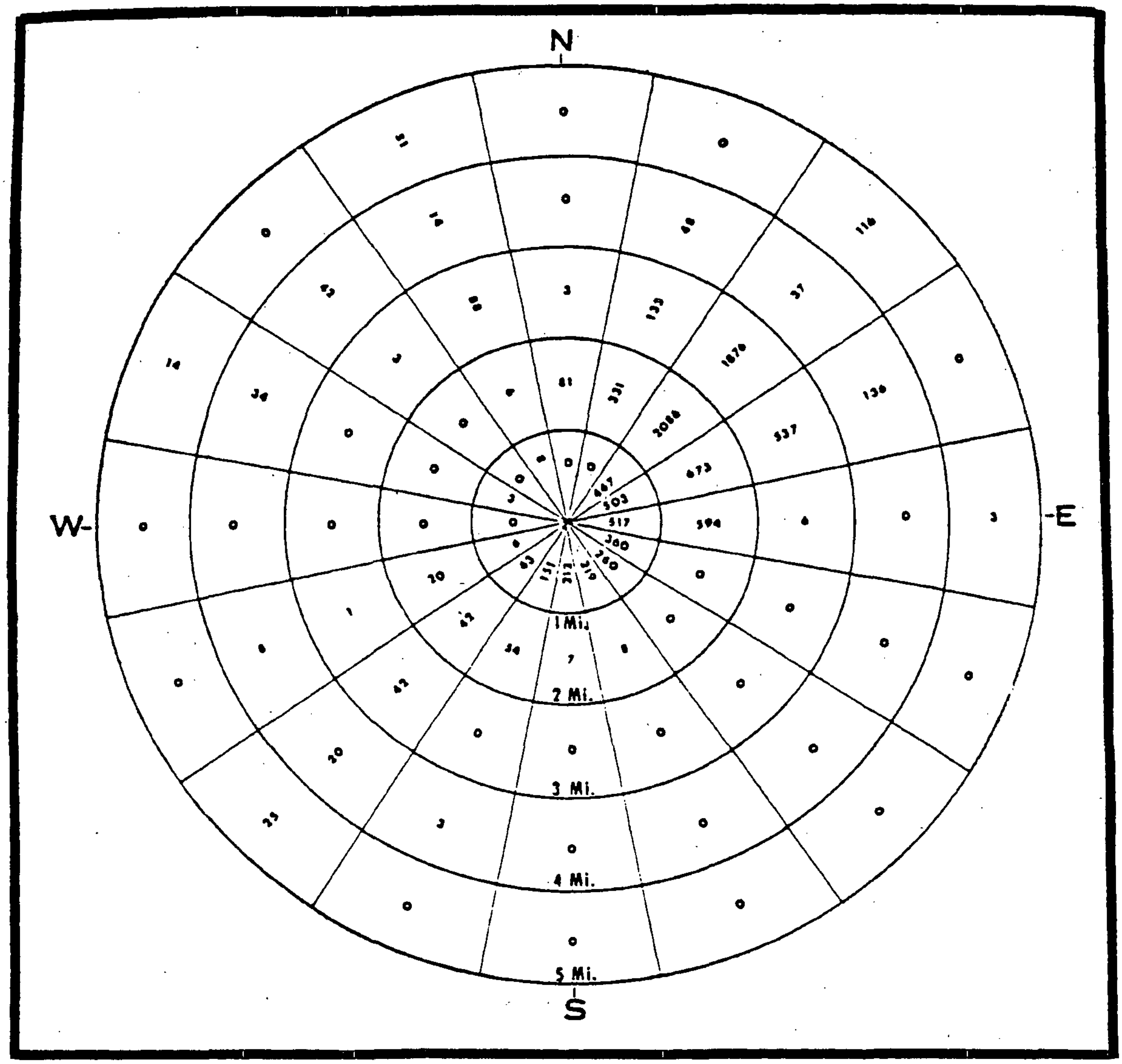


FIGURE 2.3

Estimated Population Within
5 Miles of the NFS-Erwin Site

SOURCE: Section 4.4.2, Demography, NFS EIR, January, 1976.

An estimated 800,000 persons live within a 50-mile radius of the plant. As shown in the inset map in Figure 2.1, the 50-mile radius includes parts of three States: Tennessee, Virginia, and North Carolina.

2.3 Land Use[1]

The NFS Erwin facilities are located in the mountainous region of east Tennessee in which three-fourths or more of the land is forested. The mountains have steep slopes and sharp crests, and are dissected by deep narrow valleys. The city of Erwin and the NFS plant lie in a valley traversing the region southwest to northeast.

Figure 2.4 illustrates the general land use within a 3-mile radius of the NFS plant. Generally, the areas to the east and northeast of the site are used for residential, commercial, and industrial purposes. In the narrowing river valley to the southwest of the plant, small farms and suburban residences prevail. There are also a few small farms northwest of the plant.

Forest land occurs in every direction from the site (see Section 2.8.1 for description of composition of forest land).

Nearly 74% of the land within a 3-mile radius of the NFS plant is mountainous forest land (Table 2.1). Residential, commercial, and industrial lands constitute 19% of the area, and only 7% is covered by farms and suburban homes.

Approximately 38% (44,600 acres) of Unicoi County has been classified as commercial forest, producing crops of industrial wood and generally capable of producing at least 20 ft^3 of annual growth per acre. About 16% of the commercial forest lands in Unicoi County are grazed by domestic livestock.

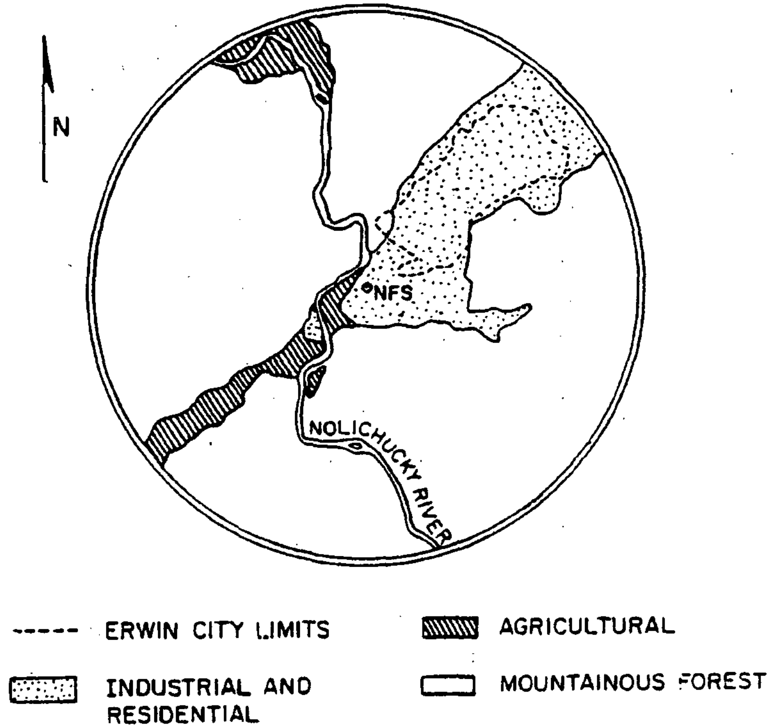


FIGURE 2.4 Land-use diagram within a 3-mile radius of the Nuclear Fuel Services plant.

SOURCE: NFS, Responses to Environmental Information Report: NRC Questions of April 15, 1977, Erwin, Tennessee, May 31, 1977.

Table 2.1 Land use within a 3-mile radius of the Nuclear Fuel Services Plant

Land Use	Percent of total area (18,100 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, Responses to Environmental Information Report: NRC Questions of April 15, 1977, Erwin, Tennessee, May 31, 1977.

The U.S. Soil Conservation Service estimates that there are approximately 325 acres of prime and unique farmland within a 3-mile radius of the plant. Tobacco, hay, and corn are the primary crops within the area, with a few acres of commercial strawberries approximately 1 mile south of the plant. The nearest crop (tobacco) is approximately 0.25 mile from the plant in an southerly direction. Beef and swine production in the area is low, and generally is limited to personal use by farm occupants. Presently, no dairy herds exist within Unicoi County.

The National Register of Historic Places lists one historic site in Unicoi County: the Clarksville Iron Furnace southwest of Erwin, founded in 1833, and located off State Highway 81 in the Cherokee National Forest. Production ended in 1844, when the millrace of the waterwheel collapsed, flooding the furnace and chilling the charge in the smelting process. The site is now owned by the U.S. Forest Service.

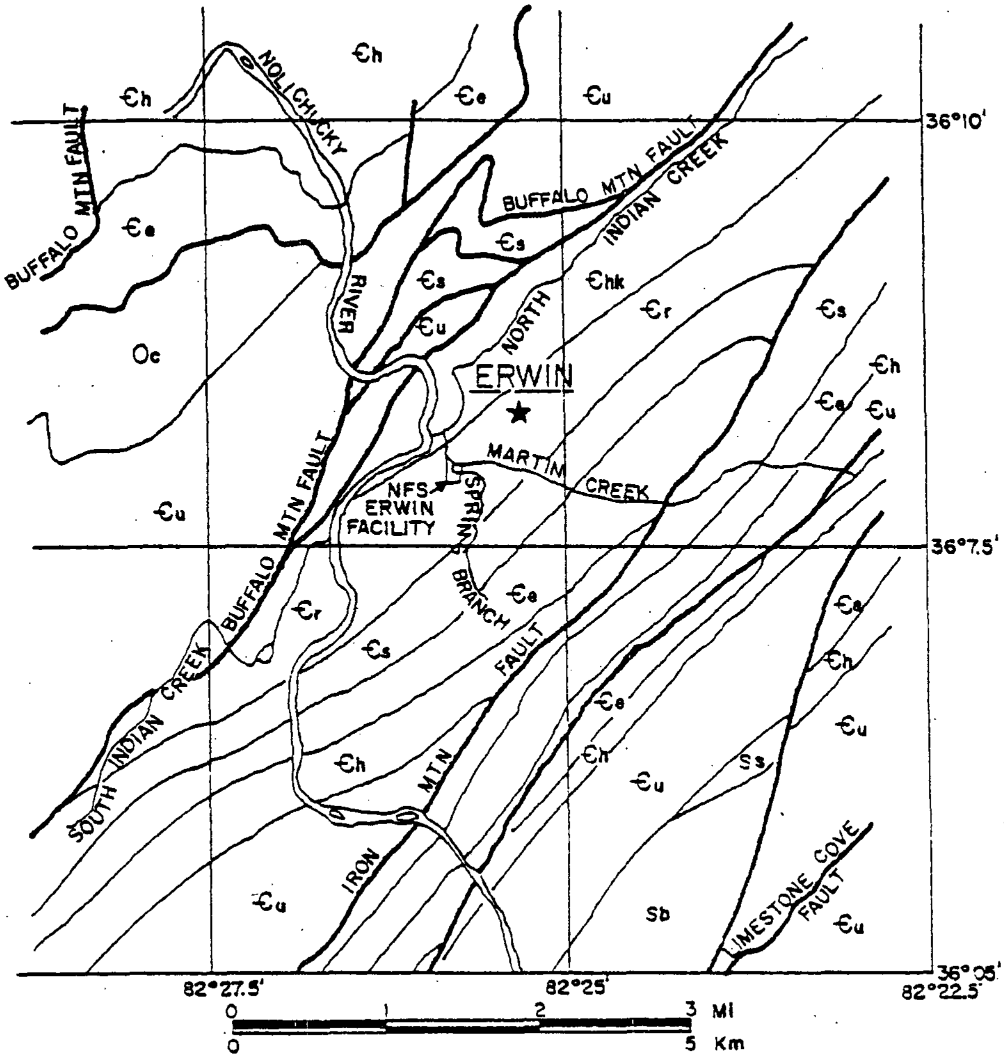
2.4 Geology[2]

This section presents information on the surface and subsurface environments in the vicinity of the Erwin site of the NFS plant.

2.4.1 Physiography

The NFS Erwin facility is located near the southeastern edge of the Valley and Ridge Province in eastern Tennessee. The boundary with the Blue Ridge Province lies 10 km (6 miles) to the southeast of the town of Erwin.

There are several major topographic features worthy of note. The town of Erwin and the NFS site lie on a flood plain formed by North Indian Creek and South Indian Creek (Figure 2.5) which flow parallel (northeast to southwest) to the strike of stratigraphic and strucutural units of the region. The Nolichucky River generally cuts across the grain of the structure except where it is joined by the two creeks. Because the Nolichucky River cuts across erosion-resistant strata southeast of the Buffalo Mountain fault, its flood plain is narrow and poorly developed. Strata imme-



PRECAMBRIAN	(pꞒ)	CAMBRIAN	(Ꞓ)
OCOEE GROUP	Oc	HONAKER DOLOMITE	Ꞓhk
SANDSUCK SHALE	Ss	ROME FORMATION	Ꞓr
SNOWBIRD FORMATION	Sb	SHADY DOLOMITE	Ꞓs
		ERWIN FORMATION	Ꞓe
		HAMPTON FORMATION	Ꞓh
		UNICOI FORMATION	Ꞓu

FIGURE 2.5 Geologic map of the Erwin region.

SOURCE: J. Rodgers, Compiler, Geologic Map of East Tennessee, Open File Sheet 199, Tennessee Division of Geology, Knoxville, Tennessee.

diately adjacent to the fault, however, are easily eroded, accounting for the broad flood plain there. The valley of Indian Creek is paralleled by a series of ridges in sharp relief. Most of the terrain is in steep slope, maximum relief in the region being approximately 1500 m (5000 ft).

2.4.2 Structure and Stratigraphy

The Erwin region is underlain by the Buffalo Mountain thrust sheet (Figure 2.5) which has been separated by two minor thrust faults into three imbricate thrust blocks. Cambrian and Precambrian (pꞒ) rocks in the Buffalo Mountain thrust sheet consist of the Unicoi (Ꞓu), Hampton (Ꞓh), and Erwin (Ꞓe) formations of the Chilhowee Group and of the Shady Dolomite (Ꞓs). Younger Cambrian-Ordovician rocks lie beneath the thrust sheet. The footwall strata include the Rome Formation (Ꞓr), Honaker Limestone (Ꞓhk), Nolichucky Shale (Ꞓn), Knox Dolomite (OꞒk), and Athens Shale (Oa). The Hampton Formation (Ꞓh) is believed to be the detachment zone between the thrust sheets and the younger strata lying beneath them. Locally, along subsidiary thrusts, the Rome Formation also serves as a detachment zone. The complete lower Paleozonic section of northeastern Tennessee is described in Table 2.2.

Strata in the vicinity of Erwin dip 30 degrees or more to the northwest. Locally, strata are near vertical or overturned, especially in the vicinity of faults.

During or following the thrusting, all the rocks in the area were folded into a northeast trending synclinorium. Slices of rock have been broken off and dragged along the surfaces of the thrusts. Rock cleavage (fractures) and low-rank metamorphism are present. Deformation probably occurred in late Paleozoic time during the Appalachian

TABLE 2.2 Generalized section of lower Paleozoic formations in Northeastern Tennessee.

Age	Formation (Map symbol)		Lithology	Thickness meters	Thickness feet
Lower Ordovician	Athens Shale Oa		Gray to black shale, calcareous below, sandy above	300–1500	1000–5000
Lower Ordovician / Upper Cambrian	Knox Dolomite OЄk		Gray to blue-gray limestone and dolomite, in part cherty; argillaceous seams in lower part	1200	4000
Upper Cambrian	Nolichucky Shale Єn		Green calcareous and dolomitic shale, and shaly dolomite	30	100
Upper Cambrian / Middle Cambrian	Honaker Dolomite Єhk		Gray to blue-gray dolomite and limestone, with many silty and shaly laminae	600	2000
Middle Cambrian	Rome Formation Єr		Red shale and siltstone, some green shale, and some dolomite; residual clay contains some manganese deposits	360–550	1200–1800
Lower Cambrian	Shady Dolomite Єs		Blue-gray dolomite, white dolomite, ribboned dolomite and limestone; residual clay contains many manganese deposits	270–360	900–1200
Lower Cambrian	Chilhowee Group	Erwin Formation Єe	White quartzite, greenish sandy shale and siltstone	360–460	1200–1500
Lower Cambrian	Chilhowee Group	Hampton Formation Єh	Dark-greenish argillaceous shale, sandy shale, and siltstone; some beds of arkosic quartzite	360–460	1200–1500
Lower Cambrian	Chilhowee Group	Unicoi Formation Єu	Arkosic quartzite, conglomerate, arkosic sandy shale and siltstone; some beds of amygdaloidal basalt	600–1500	2000–5000

*The Ocoee Group (Oc), conformably underlies the Chilhowee Group and it, as well as lowermost Chilhowee strata, are tentatively considered to be Precambrian age. The Sandsuck (Ss) and Snowbird (Sb) formations are members of the Ocoee Group, the Snowbird being the oldest and resting unconformably on Precambrian crystalline rocks. The correlation of Ocoee Group rocks in the Erwin area is uncertain with respect to similarly named units found further to the south.

SOURCE: Modified After R.J. Ordway, Geology of the Buffalo Mountain-Cherokee Mountain Area, Northeastern Tennessee, Tennessee Department of Conservation and Commerce, Division of Geology, Report of Investigation No. 9, Nashville, Tennessee, 1959.

orogeny. Although there is some seismic activity in the southern Appalachian region today (Section 2.4.4), none of it is related to the deformation produced during the Appalachian orogeny. No movement has taken place on these faults for a 100 million years.

Three stratigraphic units will be described in detail because of their relationship to the NFS site (Figure 2.5). These are the Rome Formation (Єr), which underlies the site, and the Shady Dolomite (Єs) and Honaker Dolomite (Єhk) which lie to either side of the Rome Formation. The dolomite units are also important because they are aquifers, providing Erwin's public water supply. Groundwater is discussed in detail in Section 2.5.

The NFS site is underlain by the Rome Formation which occupies a valley broken by low hills to the northeast of Erwin. The Rome Formation is chiefly composed of red to maroon or brown shale, silty and well consolidated. Some beds are fine-grained sandstones that underlie higher ground owing to their resistance to erosion. There are thin (about two feet thick) interbeds of dolomite in the shale units in places.

Soils weathered from the Rome Formation are thin (a few inches to a foot thick), charged with shale chips, and are acidic. Near the Nolichucky River, deposits of alluvial materials have accumulated above the bed rock. These deposits are bouldery, to cobbly, to sand and silt-sized unconsolidated materials. The detritus is largely composed of quartzitic fragments from the adjacent higher ridges and mountains.

The Rome Formation in the area of the plant site dips northwest at an angle of approximately 30 degrees, but locally the angles of inclination are steeper. The Rome outcrop is some 3700 ft wide in the horizontal plane.

Southeast of the Rome Formation, along the axis of Banner Hill and Hulen Hollow, the Shady Dolomite crops out below the Rome. The contact is poorly exposed but is conformable.

The Shady Dolomite is a blue-gray magnesian limestone that is generally weathered to a thick, yellowish, plastic clay. Weathering may be as deep as 100 ft or more.

The Honaker Dolomite is similar to the Shady in its lithology. Beds crop out along the southeast side of the Buffalo Mountain fault and are vertical to overturned in position throughout much of their area of outcrop.

Still farther southeast is the high, rugged topography of the Unaka Mountains. These mountains are held up by the tough, resistant Chilhowee Group rocks (Erwin Quartzite, Hampton Shale, and Unicoi Formation). These rocks are sandstones, siltstones, and conglomerates of great thickness, thoroughly indurated and very resistant to erosion.

Due to the faulting in Paleozoic time (over 300 million years ago), masses of the Chilhowee Series also crop out in Buffalo Mountain northeast of Erwin. The masses of ancient sandstones and conglomerates are in fault contact with younger strata that form the valley in which Erwin is located. The transit of the Nolichucky River and of Tennessee Highway 81 through them is via a deep gorge.

2.4.3 Engineering 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 flood plain and terraces of the Nolichucky River. Structures supported by alluvium are subject to differential settlement, depending upon the character of the distribution of the load, and the inhomogeneity of the sediments bearing the load.

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 flood plain where slopes are gentle.

2.4.4 Seismicity[3]

The Appalachian region is one of moderate seismic risk (Zone 2 in Figure 2.6). Moderate damage is the maximum credible event for the region. Most earthquakes can be expected to cause minor damage or none at all.

There is a 90% probability that horizontal acceleration (a_h) will not exceed 7% (a_h 7%) of gravity over a 50-year period in the southern Appalachian region (Figure 2.7). This horizontal acceleration is comparable to that expected for western Ohio but is less than that of the Central Mississippi Valley seismic region ($a_h \leq 19\%$) and the South Carolina seismic region ($a_h \leq 11\%$). As a basis for comparisons, the more dangerous seismic regions of western United States have much higher expected horizontal accelerations ($40\% \leq a_h \leq 80\%$). A horizontal acceleration of 20% is considered to be on the threshold for causing extensive damage. Therefore, an earthquake is not expected to cause extensive damage anywhere within the southern Appalachian region within a 50-year period.

Table 2.3 lists recurrence intervals and maximum credible earthquakes for the southern Appalachian and adjacent seismic regions. The San Andreas fault zone is also listed for comparative purposes. Earthquakes originating from the New Madrid area (in 1811-1812) of the central Mississippi Valley seismic region and at Charleston (August 1886) in the South Carolina seismic region have been felt in east Tennessee, but no local damage was caused by them.

Although damaging earthquakes are not expected anywhere within the southern Appalachian region over a 50-year period, Table 2.3 suggests that the region is by no means aseismic. It is expected that a modi-

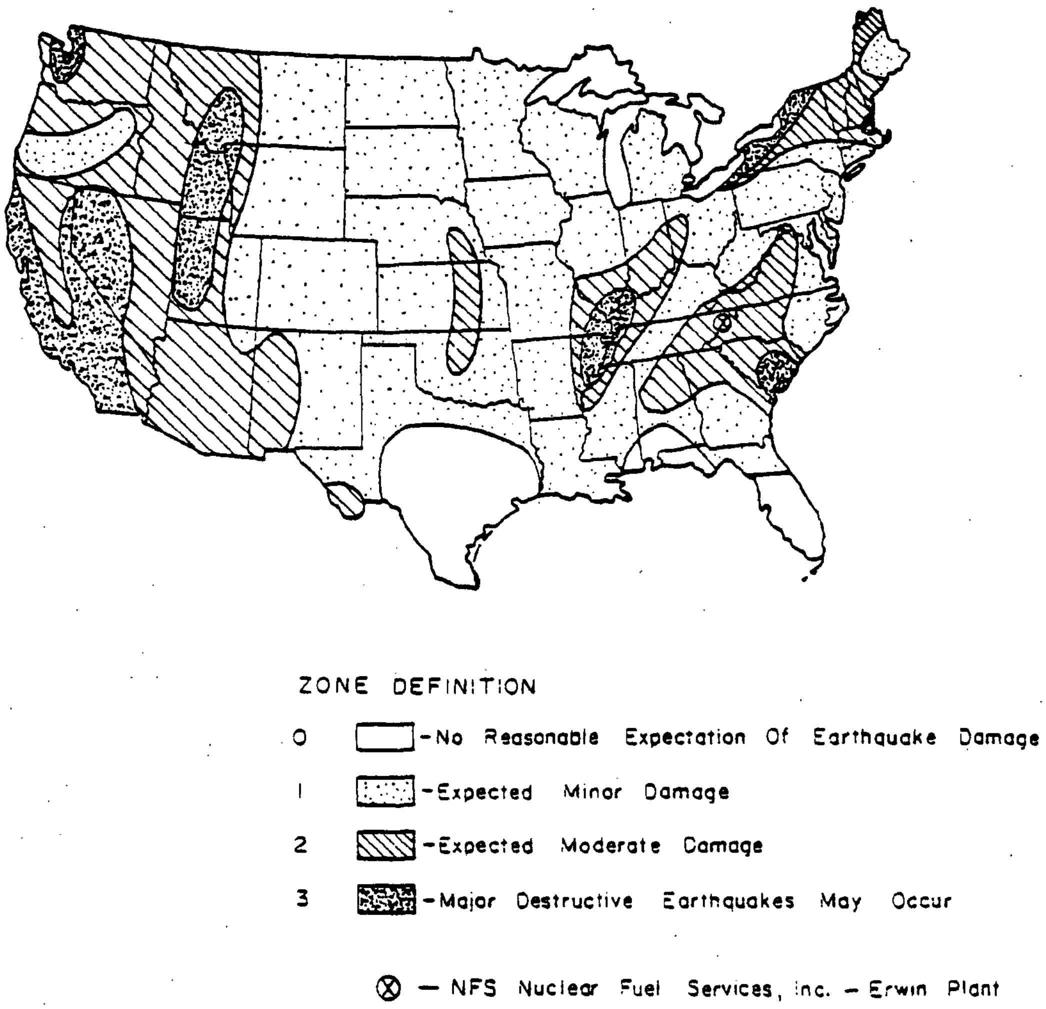


FIGURE 2.6 Seismic-risk map of the United States.

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

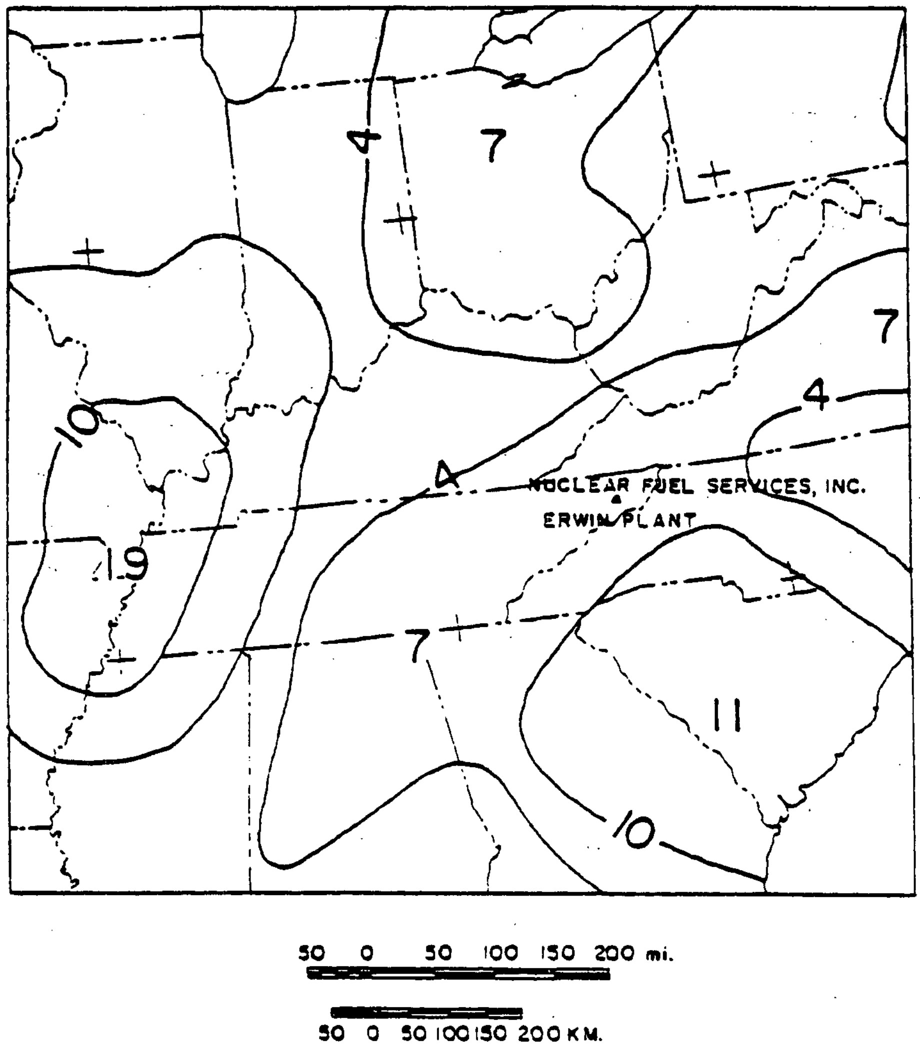


FIGURE 2.7 Preliminary maps of horizontal acceleration (expressed as percent of gravity) in rock with 90% probability of not being exceeded in 50 year.

SOURCE: S.T. Algermissen and D.M. Perkins, A Probabilities Estimate of Maximum Acceleration in Rock in the Contiguous United States, U.S.G.S. Open File 76-416, Denver, Colorado, 1976.

TABLE 2.3

MAXIMUM CREDIBLE EARTHQUAKES FOR SELECTED SEISMIC REGIONS IN THE UNITED STATES

Seismic Region	Number of Modified Mercalli V Earthquakes per 100-year Period	Maximum Credible Intensity	Maximum Credible Magnitude
Central Mississippi Valley	84.5	X	7.3
South Carolina	19.9	X	7.3
Western Ohio	22.0	VIII[a]	6.1
Southern Appalachian	54.4	VIII[a]	6.1
San Andreas	110.0	XII	8.5

[a]Horizontal acceleration equal to 20% gravity is roughly equivalent to a Modified Mercalli Scale intensity of VIII. This is considered to be the threshold of extensive damage.

SOURCE: S.T. Algermissen and D.M. Perkins, A Probabilities Estimate of Maximum Acceleration in Rock in the Contiguous United States, U.S.G.S. Open File 76-416, Denver, Colorado, 1976.

fied Mercalli Scale V earthquake will occur somewhere within the southern Appalachians about once every two years. Even though such earthquakes are felt by nearly everyone in the vicinity, damage is negligible.

Although recurrence intervals for Modified Mercalli Scale VIII earthquakes are not available due to the limited data base, the occurrence of such an earthquake somewhere within the southern Appalachian region is not beyond the realm of possibility.

Table 2.4 describes earthquake conditions as outlined in the Modified Mercalli Intensity Scale of 1931.

2.5 Hydrology

2.5.1 Surface Water

Figure 2.8 shows the three natural surface-water bodies at the NFS Erwin site: Banner Spring Branch, Martin Creek, and the Nolichucky River.

Banner Spring Branch is a small (1.5 to 3 ft wide) spring-fed stream lying entirely within NFS Erwin plant boundaries. (However, it is not totally owned by NFS. Banner Spring is owned by the town of Erwin. It is not now used as a potable water source, but could be so used in the future. The spring is fenced and protected.) The spring branch originates to the south and flows at a rate of 200 to 300 gal/min (0.45 to 0.67 cfs) into Martin Creek at the north corner of the NFS Erwin site about 1200 ft from its source. Table 2.5 provides an accounting of daily average, high, and low stream flows.

Martin Creek, fed by mountain springs, rain, and snow-water drainage from Martin Creek Hollow, runs nearly parallel to the northern property line of the site, crossing the property for just a few yards at the north corner of the site where the creek is joined by Banner Spring Branch (Figure 2.8). The lower course of Martin Creek runs parallel to the fill for highway 19-23 Bypass paralleling the Nolichucky River (Figure 2.8) and enters North Indian Creek to the north,

TABLE 2.4

MODIFIED MERCALLI (MM) INTENSITY 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; ojbects 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 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.

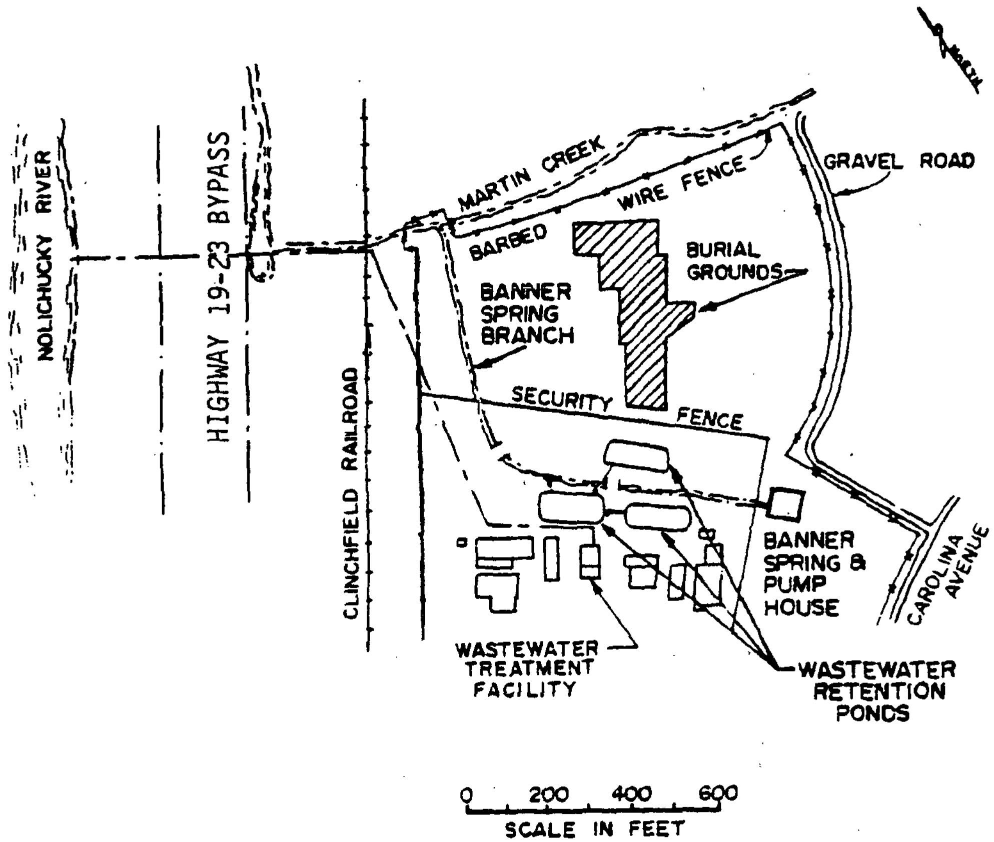


FIGURE 2.8 Banner Spring Branch, Martin Creek, and the Nolichucky River in relation to the NFS plant site.

TABLE 2.5

FLOW RATES FOR BANNER SPRING BRANCH, MARTIN CREEK, AND THE NOLICHUCKY RIVER

Daily Flow Level	Flow Rate (ft^3/sec)		
	Banner Spring Branch[a]	Martin Creek[a]	Nolichucky River[b]
Average	6.69×10^{-1}	6.68	1,347(1919 to 1976)[c]
High	7.70×10^{-1}	11.14	30,700(1940)[c]
Low	5.57×10^{-1}	2.23	88(1924)[c]

[a]The period of time over which the measurements were made is unknown.

[b]Measurements taken at Embreeville Station gage two miles downstream from the mouth of Martin Creek.

[c]Time period during which measurements were made on the Nolichucky River.

SOURCE: U.S. Department of the Interior, Water Resources Data for Tennessee Water Year 1975, USGS Water Data Report TN-75-1, Washington, D.C., 1975.

which in turn enters the Nolichucky River to the west (Figure 2.5). The width of Martin Creek varies from 8 to 15 ft, and depth varies from a few inches to pools of three or four feet. The flow rate varies seasonally from 1000 to 5000 gal/min 2.23 to 11.14 cfs (Table 2.5) .

As shown in Figure 2.9, the Nolichucky River is formed by the North Toe and Cane rivers in Yancey and Mitchell counties, North Carolina (110.7 river miles above the Nolichucky's confluence with the French Broad River), and flows westwardly from North Carolina and southwestwardly through Tennessee to join the French Broad River at mile 69.1 (French Broad river mile). The Nolichucky belongs to the upper Tennessee River basin, forming a part of the French Broad River watershed. The French Broad River in turn joins the Holston River to make up the Tennessee River at mile 652.1 (Tennessee river mile). The Nolichucky River basin in Tennessee includes practically all of Greene and Unicoi counties, and parts of Hawkins, Hamblen, Jefferson, Washington, and Cooke counties. The entire drainage area totals 1756 sq. miles, of which approximately 1126 sq. miles are in Tennessee. The remaining 630 sq. miles are in North Carolina. Approximately 101 miles of this river are in Tennessee.

The Nolichucky River averages from 100 to 200 feet wide in the area of the NFS Erwin site. It has an average flow rate of 1347 cfs, measured 3 miles northwest of the site at Embreeville (river mile 89.0), as calculated over a 57-year period between 1919 and 1976. The average low flow statistically expected to occur for a duration of ten days in any seven-year period (7 day 10) is 247 cfs, and for a duration of 20 days in any three-year period (3 day 20) is 197 cfs. These values were determined for the portion of the Nolichucky at river mile 95.9, at a point 2 miles southwest (upstream) of Erwin (Figure 2.10). The minimum and maximum flows of record are 85 cfs (September 8-9, 1925) and 120,000 cfs (May 21, 1901) respectively. Table 2.5 shows the daily average, high, and low flows measured by the U.S.

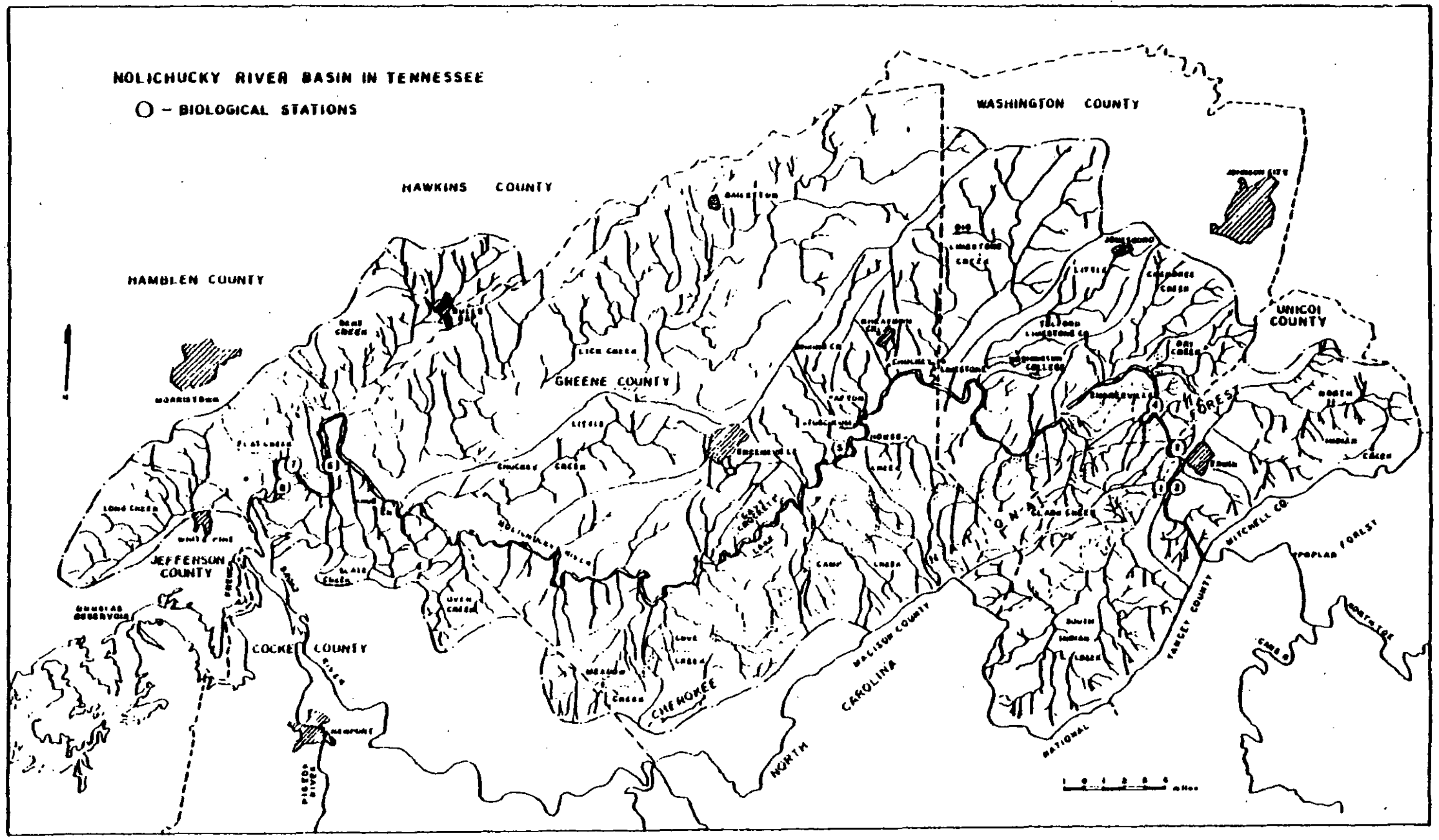


FIGURE 2.9 Nolichucky River Basin in Tennessee.

SOURCE: Tennessee State Highway Department.

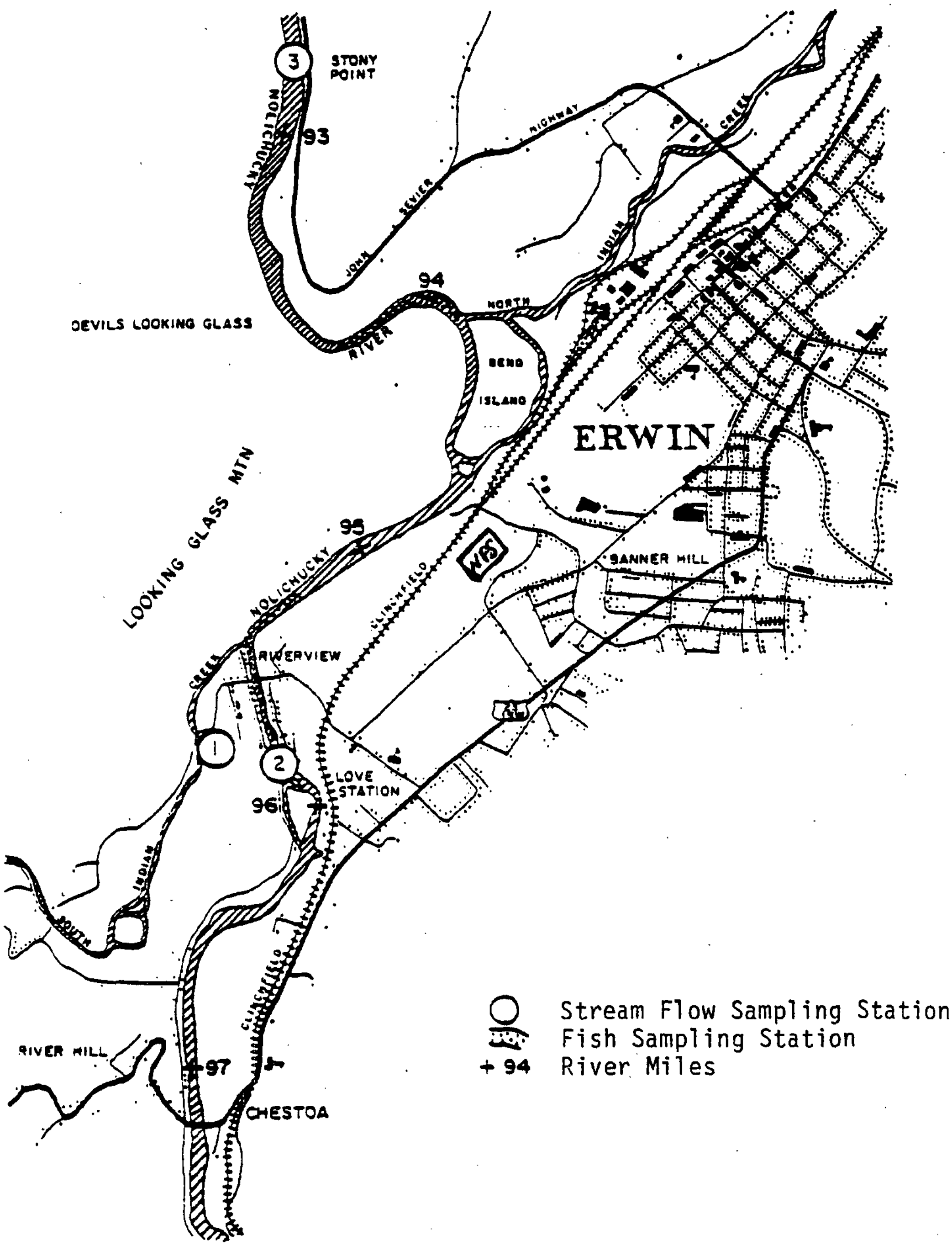


FIGURE 2.10 Erwin site showing stream flow sampling locations

SOURCE: U.S. Department of the Interior, Water Resources Data for Tennessee Water Year 1975, U.S. Geological Survey Water Data Report TN 75-1, Washington, D.C., 1975.

Geological Survey (USGS) at the Embreeville gage. Figure 2.11 shows the seasonal variation at the same gaging station between October 1954 and June 1959, during which time the Tennessee Stream Pollution Control Board conducted surveys of the Nolichucky River. Although the river was rechanneled in the Erwin area during the construction of highway 19-23 bypass (June-July 1976), the flows have remained the same. The only consideration affected by the rechanneling is a significant reduction in the probability of backwater flooding of the plant.

2.5.2 Groundwater

Groundwater is present as the main water table and as separate perched water tables. The water table lies at the same elevation as the Nolichucky River at the NFS Erwin site and is below the alluvial material in the Rome Formation (Section 2.4.2). The perched water tables are formed by rainfall which saturates the thin topsoil layer but which fails to penetrate the underlying impermeable Rome Formation. Dug wells tap the perched water tables, but not the main water table beneath the Rome Formation. The yield from the dug wells is often sufficient for domestic use, unlike the yield from those tapping the Rome Formation, which only yield 3 gal/min (6.68 x 10^{-3}cfs) or less. In general, perched water from higher elevations moves to the northwest through the alluvium into Banner Spring Branch, into Martin Creek, and into the Nolichucky River. However, groundwater motion in bedrock aquifers is unknown because there are few wells that tap bedrock aquifers. Groundwater flow in the Erwin area is probably complex due to the structural deformation in this area (Section 2.4.2).

2.5.3 Water Use

2.5.3.1 Surface Water

Banner Spring Branch

Banner Spring may be used as a potable water supply in the Erwin City Water System. There is no

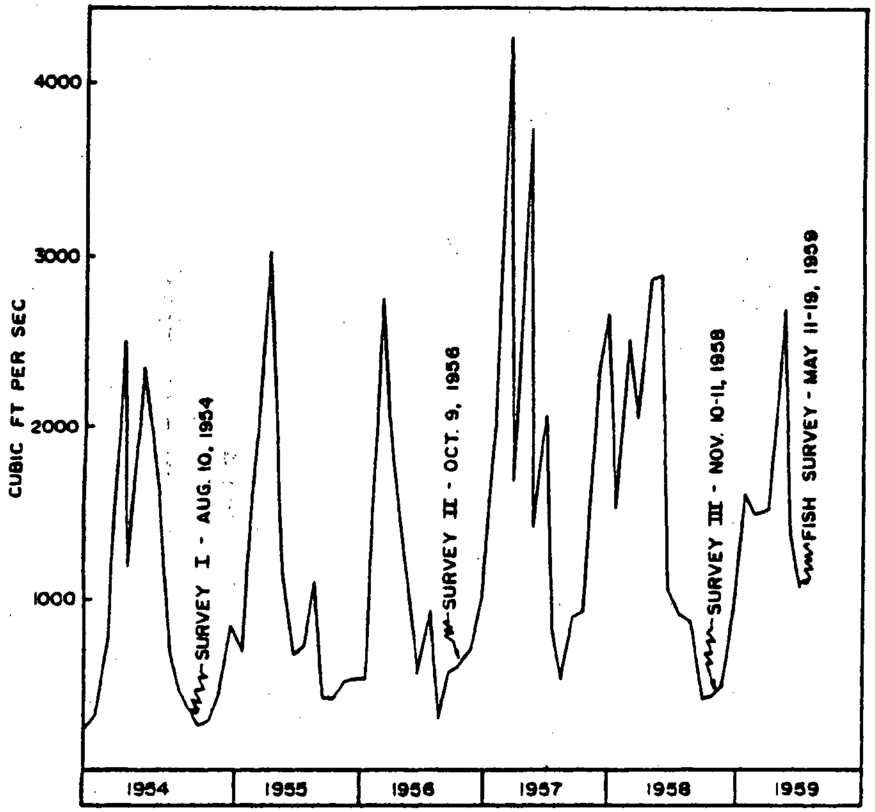


FIGURE 2.11 Seasonal variation in Nolichucky River flow rate, showing dates of surveys conducted by the Tennessee Stream Pollution Control Board.

SOURCE: H. Mullican, R.M. Sinclair, and B.G. Isom, Aquatic Biota of the Nolichucky River, Tennessee Pollution Control, Tennessee Department of Public Health, Nashville, Tennessee, 1973.

recreational use because the spring branch originates and terminates on restricted NFS Erwin property. The spring water is also used as a source of industrial water by the NFS Erwin facility for cooling (approx. 100,000 gal/day).

Martin Creek

Approximately 200 yards upstream of the NFS Erwin site along Martin Creek is a State-operated fish hatchery (Erwin Trout Rearing Station) located on Love Spring Branch. Love Spring, which feeds Love Spring Branch, serves as the hatchery water supply (approx. 1,411,000 gal/day) Martin Creek itself, however, is used only for recreational fishing. Fishing in the vicinity of the NFS Erwin site is infrequent because this short length of creek is not readily accessible to the public due to limited access roads. The creek is not classified as a trout stream by the State of Tennessee Fish and Wildlife Commission, nor is it used as a potable water source.

The Nolichucky River

The nearest municipal user of water (approx. 800,000 gal/day) from the Nolichucky River is the city of Jonesboro, 8 miles downstream (river mile 86.9). The only known crop irrigation occurs approximately 10 to 15 miles downstream from the NFS Erwin plant discharge to the Nolichucky River. Because the annual average rainfall in the area is generally adequate (approx. 54 in.), irrigation is not usually required. However, during the late part of the growing season, some farmers use overhead sprinkler irrigation to reduce frost damage to tomatoes and to extend the growing season. The same overhead irrigation technique is used in late spring to prevent frost damage to strawberry crops in that area. In addition, late summer irrigation is used to prevent cracking of the tomato crop caused by inflexibility of the tomato skin due to a lack of moisture.

The Nolichucky River is used recreationally in a limited way for swimming, rafting, boating and canoeing, picnicing, and for similar activities in the 94 miles from its origin to its mouth at Douglas Lake (a TVA reservoir shown in Figure 2.9). In the vicinity of the NFS Erwin plant (10 to 15 miles downstream), the primary recreational activities are canoeing and rafting. There are few developed recreational facilities in this area, such as picnic tables and parks. Some fishing occurs. largely for warm-water fish such as bass, walleye, and catfish.

2.5.3.2 Groundwater

The groundwater supplies within a 5-mile radius of the NFS Erwin site are shown in Figure 2.12 and uses are indicated in the last column of Table 2.6. The Erwin municipal water supply is provided by five springs. In 1983, the average daily use was 1,676,000 gal/day.[4] The Temple Hill Utility District in Unicoi County also relies on the groundwater system for its water supply, which is estimated to average 83,000 gal/day. Other groundwater users in Unicoi County are the Flag Pond Elementary School, supplied by a spring (5000 gal/day); Limestone Cove Campground, supplied by a well (280 gal/day); Rock Creek Recreation Area, supplied by two wells (4700 gal/day): Temple Hill Elementary School, supplied by a well (4400 gal/day); Morrill Motors of Tennessee, supplied by a well (2000

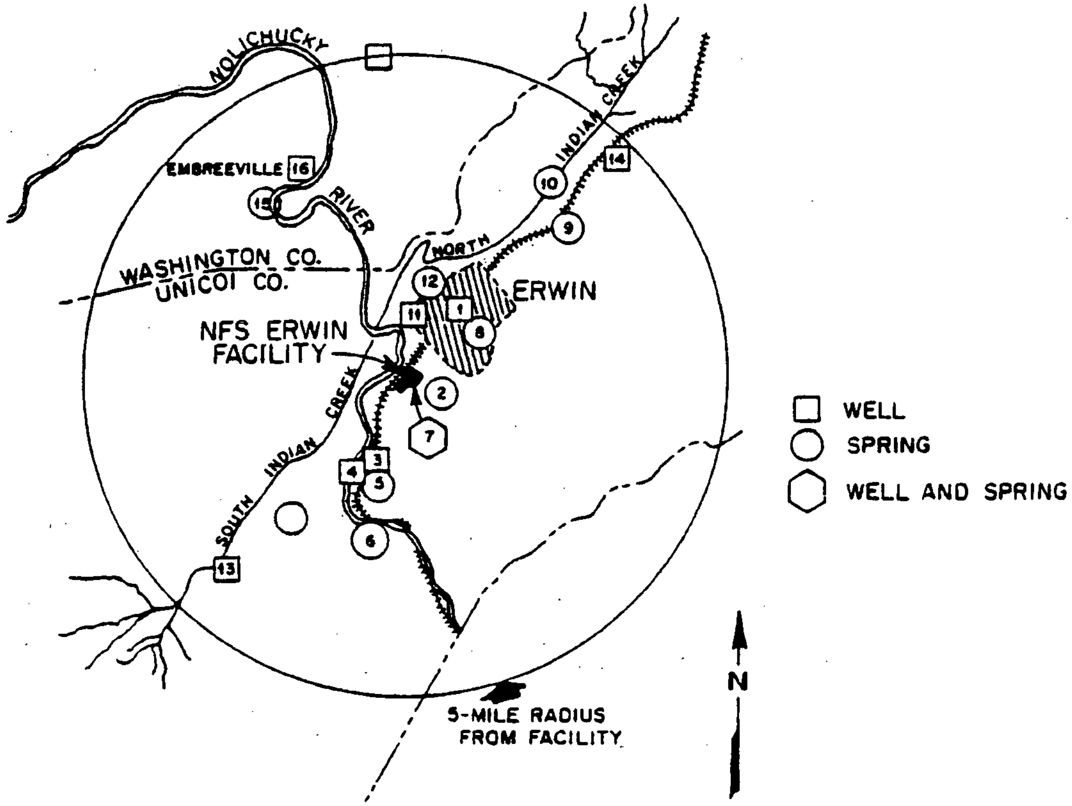


FIGURE 2.12 Springs and wells within a 5-mile radius of the NFS Erwin Plant. Numbered locations indicate sampling sites. (See Tables 2.6 and 2.10 for physical characteristics and sampling data.) Unnumbered wells and springs were not sampled.

SOURCE: Tennessee Department of Public Health, Water Quality Management Plan for the French Broad River Basin, Division of Water Quality Control Nashville, Tennessee, 1976.

TABLE 2.6 Surveyed wells and springs within a 5-mile radius of the Nuclear Fuel Services, Inc. Erwin Facility.

Well or spring number[a] (w = well; s = spring)	Owner or name of spring or well	Topographic situation[b]	Altitude above sea level (ft)	Well depth (ft)	Probable water-bearing beds: Character of material	Probable water-bearing beds: Geologic horizon[c]	Yield (gallons per minute)	Use of water supply
1-w	Crystal Ice, Coal and Laundry Co.	V	1680	135	Dolomite	Ꞓhk	75	Industrial
2-s	Love Spring	V	1700		Dolomite	Ꞓs	500	
3-w	Grady Ledford	V	1760	122	Sandstone	Ꞓe	Not measured	Domestic
4-w	Sam Tipton	S	1720	80	Sandstone	Ꞓe	Not measured	Domestic
5-s	E. L. Lewis	S	1920		Sandstone	Ꞓe	5	Domestic
6-s	Unaka Springs	S	1720		Sandstone	Ꞓu	Not measured	Domestic
7-s	Banner Hill Spring	V	1640		Shale	Ꞓr	300	
8-s	Erwin Water Department	S	1730		Dolomite	Ꞓs	640	Public supply
9-s	U.S. Dept. of the Interior Fish Hatchery	V	1760		Dolomite	Ꞓhk	916	Industrial
10-s	Erwin Water Department	S	1760		Dolomite	Ꞓhk	450	Public supply
11-w	Fess Radford	V	1340	30	Residual dolomite	Ꞓhk	Not measured	Domestic
12-s	Birchfield Spring	V	1650		Dolomite	Ꞓs	2000	
13-w	Kelley Rice	V	1780	24	Residual dolomite	Ꞓs	Not measured	Domestic
14-w	Charles Erwin	S	1900	323	Dolomite	Ꞓhk	Not measured	Domestic[d]
15-s	Yates Spring	V	1620		Sandstone	Ꞓu	10	Domestic
16-w	W. B. Walker	V	1590	Not measured	Shale	Ꞓh	3	Domestic

[a]Numbers of wells and springs correspond to locations shown in Figure 2.12.

[b]V = Valley; S = Slope.

[c]Ꞓhk = Honaker Dolomite; Ꞓs = Shady Dolomite; Ꞓe = Erwin Formation; Ꞓu = Unicoi Formation; Ꞓr = Rome Formation; Ꞓh = Hampton Formation.

[d]Well supplies two houses.

gal/day); the Erwin Trout Rearing Station (Sect. 2.5.3.1), supplied by springs (1,411,000 gal/day), and a U.S. Department of the Interior trout hatchery, supplied by two springs (1,440,000 gal/day).

2.6 Meterology and Climatology[5]

2.6.1 Climatology

The climate of the Erwin area is influenced by cold and dry polar continental air masses in the winter and humid gulf maritime air masses in the summer. The mean temperature is about 56 degrees F with normal average temperatures ranging from 75 degrees F in July to 35.5 degrees F in January. Rainfall amounts at Erwin can be expected to average at 54 inches in any given year. Snowfall in the Erwin area generally occurs between December and March. The mean yearly snowfall total is 15 inches. Winds at Erwin are predominately from the southwest with a mean speed of 5 mph. There are normally 180 days between killing frosts.

2.6.2 Winds, Tornadoes, and Storms

The maximum sustained wind at the nearest airport (Tri-City airport, near Kingsport, Tennessee) was 50 mph (22.4 m/sec) in 1951. One tornado was recorded in Unicoi County by the U.S. Weather Service since 1950, however, their records did not specify the exact year or extent of damage.

The Tennessee Valley Authority, Division of Water Control Planning has estimated the frequencies at which the Nolichucky River will achieve pertinent elevations at the Erwin Plant. From these estimates it can be expected that a power failure could occur due to flooding once every 600 years, and water damage to the plant could occur once every 1000 years.

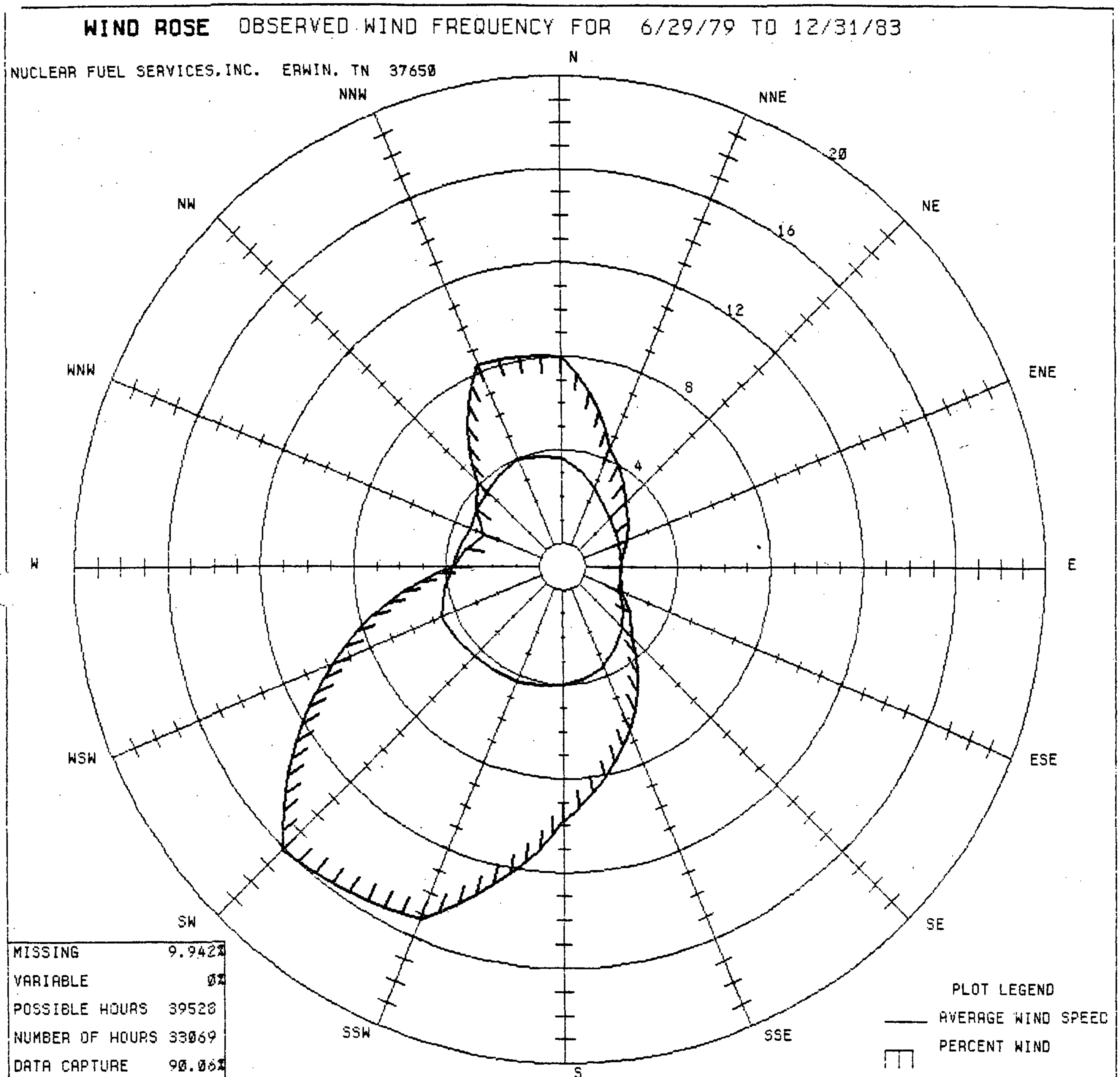
2.6.3 Atmospheric Dispersion

The meterological data for wind speed and direction is obtained onsite from a Bendix Corporation Aerovane Transmitter and Recorded on a Bendix Stripchart Recorder. In order to summarize the wind conditions at the plant, each strip chart is sent offsite for digitizing into wind roses and frequency distribution charts.

The digitizing is accomplished by electronically changing the analog recordings to many x and y locations and is inserted on magnetic tape by manually tracing the curves with an electronic cursor. The digitized data is then adjusted for strip chart skew, transformed to simple chart units and averaged to produce hourly averages. The results are then checked and verified for accuracy and completeness, adjusted for instrument calibration corrections (zero and span drift), transformed to engineering units and delivered to NFS on a printed report for review.

The wind rose shown in Figure 2.13 has been compiled by this method. It represents an average of all collected data for the period June 1979 through December 1983. An average azimuth direction is computed as a vector average of unit vectors. That is, normal averages are computed for the north-south and east-west components, then the average direction is computed from the components.

Based on data collected over approximately two years (11/81-12/83), and using the fluctuation of wind direction method[6], the Pasquill stability distribution was computer generated. The Pasquill Class frequencies are shown in Table 2.7.



CALM	.100-.900	1-3.90	4-7.90	8-12.9	13-18.9	19-24.9	25-31.9	32- 99
7.6%	21.5%	41.0%	27.2%	8.93%	1.30%	.064%	.003%	.003%

FIGURE 2.13

Table 2.7

Pasquill Stability Distribution (%)

	A	B	C	D	E	F	G
11/81 - 12/81	32.69	25.81	27.51	13.24	0.74	0.00	0.00
1982	25.09	24.47	30.45	19.04	0.92	0.013	0.00
1983	36.81	24.16	24.10	21.90	1.92	0.086	0.037

2.7 Background Characteristics

2.7.1 Radiological Characteristics

The background radiological characteristics presented in this section were developed from selected data from published reports and from the plant environmental monitoring program.

2.7.1.1 Total-Body Dose Rates

Based on data from Natural Radiation Exposure in the United States the total-body dose rate from natural background radiation in the vicinity of Erwin, Tennessee, is expected, in general, to be on the same order as that of the State: 100 millirems/year (43 millirems/year from cosmic rays, 39 millirems/year from terrestrial radiation, and 18 millirems/year from internal emitters).

2.7.1.2 Soil, Vegetation, and Water

Upstream sampling of water and sediment in the Nolichucky River and of soil and vegetation at a distant location from the plant is routinely performed to establish background levels. The measured background radioactivity is summarized in Section 5.3.

2.7.2 Nonradiological Characteristics

2.7.2.1 Atmospheric effluents

Ambient concentrations of atmospheric nonradiological pollutants near the NFS site are not known. Low-level fluorides and ammonia are the primary atmospheric chemicals which could be discharged as a result of plant operations.

Knowledge of background concentration of ammonia in the plant vicinity is not necessary because approximately 99.9% of the atmosphere's ammonia concentration is produced by natural biological processes. Fluorides from the NFS facility have been characterized by direct stack measurements. Offsite concentrations have been calculated from these data and show a range of from 0.9 to 0.15 micrograms per cubic meter as compared to the State of Tennessee's Ambient Air Quality Standard for fluoride of 1.18 micrograms per cubic meter. Generally, in rural areas free of industrial contamination, the concentration of fluoride in air is below detectable levels. The maximum concentration detected by the National Air Pollution Control Administration in a nonurban area was 0.16 ug/m^3, whereas samples from urban areas were as high as 1.89 ug/m^3.

Soil and vegetation results for samples collected in 1975, 1981, and 1984 are shown in Table 2.8. The wide differences in fluoride levels between the three sets of samples is believed to be due to an analytical (or reporting) error from the laboratory. The same laboratory (an independent laboratory located in Knoxville, TN) performed all analyses. Data collected in 1984 appears to be more in line with expected levels of fluoride in soil and vegetation .

2.7.2.2 <u>Surface Water</u>

<u>Banner Spring Branch</u>

Chemical characteristics of Banner Spring Branch have been determined at a sampling location downstream from plant inputs only. These data are included in Section 5.3, Table 5.20.

TABLE 2.8

FLUORIDES IN SOIL AND VEGETATION

Sample Location	1975 Soil	1975 Vegetation	1981 Soil	1981 Vegetation	1984 Soil	1984 Vegetation
	Fluoride Concentration (μg/g-dry wgt.)					
1. West Boundary (RR Spur)	0.13	0.02	1.4	---	284	15
2. West Boundary (Bldg. 131)	28.6	0.01	---	---	214	33
3. West Boundary (300B)	0.06	0.01	---	---	266	133
4. East Boundary	0.06	<0.01	2.5	5.4	653	10
5. North of Plant (1000')	0.05	0.02	0.6	---	118	8.9
6. Control (Asheville Hwy.-5 mi.S)	0.09	<0.01	2.0	---	514	51

Martin Creek

In May of 1977, a site survey was conducted by biologists from East Tennessee State University to supply information on Martin Creek in the vicinity of the NFS plant.

According to this survey, Martin Creek was characterized as typical of creeks found in east Tennessee. The pH was 5.8, which is within the range for water used by the fish hatchery upstream (Section 2.5.3.1). The water had a fishy odor, as was somewhat expected because most of it had passed through the fish-rearing troughs which contain a dense trout population. Water temperature was 60° F (15.5° C). No other chemical or physical determinations were made. It was noted that there was some pollution from the septic tanks of upstream houses, but that this had no noticeable influence on the character of the water.

Downstream chemical characteristics have been determined and are summarized in Section 5.3, Table 5.20.

Nolichucky River

Turbidity has been a problem in the Nolichucky River for years. Inputs of silt from mica and feldspar mining near Spruce Pine, North Carolina and the effect of heavy rainfall and runoff contribute to the river's turbidity. Downstream chemical monitoring is summarized in Section 5.3, Table 5.20. In May of 1983, the State of Tennessee Health Department conducted a 96-hour flow-through acute toxicity study of NFS' Waste Water.During that study, both chemical and biological sampling of the Nolichucky River were conducted which involved collection and analysis of river water samples.

Results of chemical analysis are summarized in Table 2.9. The general conclusions drawn in that report from the biological sampling are stated in Section 2.8.2.3.

2.7.2.3 Groundwater

The general water quality of groundwater supplies within a 5-mile radius of the NFS Erwin site are shown in Table 2.10. The locations of the wells and springs listed in this table are shown in Figure 2.12.

2.8 Ecology

2.8.1 Terrestial Biota

2.8.1.1 Flora

The potential natural vegetation of the area is classified as Appalachian oak forest.[8] Such vegetation forms a tall, broadleaf, deciduous forest dominated by white oak (Querous alba) and norther red oak (Q. rubra). Other species would include red maple (Acer rubrum), sugar maple (A. saccharum), sweet birch (Betula lenta), three hickory species (Carya cordiformis, C. glabra, C. tomentosa), American chestnut (Castanea dentata), beech (Fagus grandifolia), tulip poplar (Liriodendron tulipifera), white pine (Pinus strobus), hemlock (Tsuga canadensis), and several oak species (Querous coccinea, Q. ilicifolia, Q. muhlenbergii, Q. prinus, Q. velutina). Presently, the U.S. Forest Service describes two major forest types in Unicoi County. The northwest half of the county consists of an oak-pine forest in which 50% or more of the stand is hardwood, usually upland oak, and in which southern pines make up 25 to 49%. Common associates include gum (Liquidambar

July 27, 1984

TABLE 2.9

SUMMARY OF CHEMICAL AND PHYSICAL CHARACTERISTICS NOLICHUCKY RIVER WATER COLLECTED BY THE STATE OF TENNESSEE IN THE AREA OF NFS' DISCHARGE

Characteristics	Sample Collection Dates 5/2/83	5/4/83
Temperature (°C)	17.0	14.5
Dissolved Oxygen (mg/l)	9.0	9.0
B.O.D.$_5$ (mg/l)	<1.0	<1.0
C.O.D. (mg/l)	<5.0	99.0
Suspended Residue (mg/l)	2	19
Settleable Residue (ml/l)	0.1	0.1
Total Residue (mg/l)	60	57
Sulfates (SO_4) (mg/l)	<4	4
Total Phosphate P (mg/l)	0.04	0.04
Total Organic Carbon (mg/l)	<1	<1
Ammonia (as N) (mg/l)	0.08	0.06
NO_3 & NO_2 (as N) (mg/l)	0.34	0.45
Sodium (Na) (mg/l)	2.0	1.4
Chloride (Cl) (mg/l)	1	1
Fluoride (F) (mg/l)	0.1	0.1
Potassium (K) (mg/l)	1.5	1.0
Magnesium (Mg) (mg/l)	1.0	1.0
Iron (Fe) (μg/l)	700	1000
Manganese (Mn) (mg/l)	7	18
Nickel (Ni) (μg/l)	10	10
Mercury (Hg) (μg/l)	<0.2	<0.2
Lead (Pb) (μg/l)	<10	<10
Copper (Cu) (μg/l)	3	6
Arsenic (As) (μg/l)	<1	<1
Cadmium (Cd) (μg/l)	<1	<1
Zinc (Zn) (μg/l)	6	9
Barium (Ba) (μg/l)	<10	<10
Total Chromium (Cr) (μg/l)	<1	<1
Cobalt (Co) (μg/l)	<10	<10
Silver (Ag) (μg/l)	<1	<1
Boron (B) (μg/l)	<200	<200
Molybdenum (μg/l)	<10	<10

TABLE 2.10 Analysis of water samples from wells and springs within a 5-mile radius of the Nuclear Fuel Services, Erwin plant.

Well or spring number[b]	Owner or name of spring or well[c]	Geologic horizon[d]	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)
1 w	Crystal Ice, Coal and Laundry Co.	Ɛhk	12/23/47	11.0	16	4.3	4.0	0	62	3	6.6	2.8	90	66	119
2 s	Love Spring	Ɛs	12/23/47	18.0	17	7.6	4.0	0	86	4	6.0	0.6	103	73	148
3 w	Grady Ledford	Ɛe	3/9/48	10.0	22	11.0	6.6	0	130	3	3.0	0.8	124	100	206
4 s	Sam Tipton	Ɛs	3/9/48	8.0	16	6.7	7.3	0	68	3	7.0	10.0	108	61	153
5 s	E. L. Lewis	Ɛu	3/9/48	8.8			4.6	0	8	2	6.0	0.2		6	26
6 s	Unaka Springs	Ɛu	3/8/48	28.0	16	7.1	6.2	0	70	18	3.0	0.2	145	69	168
7 s	Banner Hill Spring	Ɛs	3/8/48	14.0	16	8.6	0.6	0	78	6	3.0	4.0	109	76	156
8 s	Erwin Water Department	Ɛs	3/8/48	9.2	16	8.4	3.0	0	86	2	3.0	2.2	93	72	160
9 s	U.S. Dept. of the Interior fish hatchery	Ɛhk	3/10/48	14.0	18	9.6	2.2	0	80	4	3.0	1.8	108	84	166
10 s	Erwin Water Department	Ɛhk	3/8/48	16.0	16	8.8	2.9	0	86	4	4.0	2.8	108	78	164
11 w	Fess Radford	Ɛhk	3/8/48	18.0			5.8	0	14	7	4.0	4.0		16	66
12 s	Birchfield Spring	Ɛs	3/8/48	18.0	19	9.0	0.6	0	78	3	2.0	3.2	110	84	169

[a]Concentrations are in parts per million (mg/liter).

[b]Well and spring numbers correspond to locations shown on map in Figure 2.12.

[c]All sampling locations are in Unicoi County.

[d]Geologic horizon: Ɛhk - Honaker Dolomite; Ɛs - Shady Dolomite; Ɛe - Erwin Formation; Ɛu - Unicoi Formation; Ɛr - Rome Formation; Ɛh - Hampton Formation.

SOURCE: Nuclear Fuel Services, Inc., Environmental Information Report on the Nuclear Fuel Services, Inc. Operations at Erwin, Tennessee, January, 1978.

styraciflua) and hickory (Carya sp.). The southeastern half of the county is oak-hickory forest in which 50% or more of the stand is upland oak and hickory, singly or in combination, and in which southern pines or red cedar make up less than 25%. Common associates are gum, tulip poplar, elm (Ulmus sp.), and maple (Acer sp.).

Very little natural vegetation occurs on the NFS property, primarily due to the compact nature of the plant. The area within the security fence contains primarily urban ornamental vegetation. However, a wetland habitat of cattail and willow occurs on the northeast end of the property along Banner Spring Branch, a drainage area for a natural spring located just outside the east corner of the security fence. The land outside the security fence includes facility parking space, burial grounds, and undisturbed forest. There are no critical habitats on the site known to be unique or important to endangered or threatened fauna.

2.8.1.2 Fauna

Very little site-specific information exits. Fauna surveys in the immediate vicinity of the plant have never been conducted. In May 1977, biologists from ETSU performed a field survey on the plant site and concluded that "the NFS site contains nothing of unique biotic value". It is doubtful that the site is of critical importance to any endangered or economically important species. Birds and mammals whose territories might include the NFS site could include the cardinal (Richmondena cardinalis), titmice and chickadees (Parus sp.), woodpeckers (Picidae), English sparrow (Passer domesticus), mourning dove

(Zenaidura macroura carolinensis), red-winged blackbird (Agelaius phoeniceus), house mouse (Mus musculus), white-footed mouse (Peromyscus leucopus), gray squirrel (Sciurus carolinensis), opossum (Didelphis marsupialis virginiana), and white-tailed deer (Odocoileus virginianus), Other animals associated with the riparian habitat in the vicinity (Banner Spring Branch, Martin Creek, Nolichucky River) might include some species of ducks (Anseriformes), yellow throat (Geothlypis trichas), shrews (Sorex and Blarina), muskrat (Ondatra zibethicus), raccoon (Procyon lotor), and a number of species of water snakes, salamanders, and frogs.

The potential for habitats for game species in Unicoi County is high. The Tennessee Game and Fish Commission estimates that 91% of the land within the county is potential deer habitat; 88% is potential forest game habitat (for squirrel, raccoon, grouse); and 9% of the land is potential farm game habitat (for quail, rabbit, and dove).

2.8.1.3 Threatened and endangered species

There are 27 endangered species whose ranges include Tennessee. Habitat requirements for all but one of these species indicate that the species could potentially be in the vicinity of the site, but none have been reported. A cursory field survey of the site by biologists from ETSU revealed no endangered species or critical habitats for endangered species. Also, it is quite unlikely that any of these species would occur within the security-fenced area due to the plant-related distrubances. A somewhat greater potential for occurrence of the endangered species exists on the undistrubed forest land outside the security fence.

Threatened and endangered animal species whose ranges include Tennessee are listed in Table 2.11. The southern bald eagle, whose nesting habitat includes western Tennessee, may be expected to be seen occasionally in the Erwin area. The arctic peregrine falcon occurs only as a migrant in Tennessee. Because the number of specialized nesting sites is limited, the red-cockaded woodpecker is not likely to found in the area. Bachman's warbler is so infrequently seen, that little is known about its present breeding or wintering distribution. It is possible, but not very likely, for this species to be found in the river-bottom forested habitat near the site. The Indiana bat has a fairly restricted geographic range because it is associated with major cavernous limestone areas. In the winter, the bats show a high degree of aggregation; over 90% of the estimated bat population is found in only four caves. Therefore, it is unlikely for this endangered species to appear in the Erwin area. The Virginia big-eared bat, which is very intolerant of human distrubance, is not expected to be found on site. The eastern cougar, formerly regarded as extinct, has been sighted by reliable observers hundreds of times in recent years from eastern Canada to the Carolinas. Very recently, the eastern cougar was sighted on the Department of Energy (DOE) reservation at Oak Ridge, Tennessee, which is located approximately 120 miles southeast of Erwin. Due to the

Table 2.11 Threatened And Endangered Animal Species Whose Ranges Include Tennessee

Common Name	Scientific Name	Status
Birds		
Southern bald eagle	*Haliaeetus leucocephalus leucocephalus*	Endangered
Arctic peregrine falcon	*Falco peregrinus tundrius*	Endangered
Red-cockaded woodpecker	*Dendrocopos borealis*	Endangered
Bachman's warbler	*Vermivora bachmanii*	Endangered
Mammals		
Indiana bat	*Myotis sodalis*	Endangered
Virginia big-eared bat	*Plecotus townsendii virginianus*	Threatened
Eastern cougar	*Felis concolor cougar*	Endangered

U.S. Department of the Interior, Fish and Wildlife Service, *Threatened Wildlife of the United States Resource Publication 114*, U.S. Government Printing Office, Washington, D.C. 1973

U.S. Department of the Interior, "Endangered and Threatend Wildlife and Plants," Fed. Regist. 41 (208): 47180-47198, 1976.

abundance of habitat for prey species in Unicoi County (Section 2.8.1.2), it is possible for the eastern cougar to be found in this heavily forested, mountainous region of the State.

2.8.2 Aquatic ecology

2.8.2.1 Banner Spring Branch

At the time of a site survey conducted in May 1977, the major faunal forms within the spring were the immature of the following insect orders: Diptera (flies), Ephemeroptera (mayflies) and Trichoptera (caddis flies). Aquatic or semiaquatic adults observed flying over the stream or on the vegetation immediately adjacent to the water were members of the following orders: Ephemeropter, Mecoptera (scorpion flies), Odonata (ruby-winged damsel flies) and Plecoptera (stone-flies). Only a very sparse growth of diatoms was seen; collections for microscopic study were not taken. Vertebrates, mollusks, and crustaceans were absent.

Abundance and diversity of aquatic biota were low. This was attributed to the small size of the stream (1.5 to 3 ft wide and 1200 ft long), the lack of microhabitat diversity (all sandy bottom with only a few small stones), and the lack of organic material. The lack of organic material is attributed to the distance of the stream from woody vegetation and to the fast flow of the water.

2.8.2.2 Martin Creek

The survey also included Martin Creek, in which the vertebrates observed consisted of amphibians, fish, and one pair of mallard ducks with chicks. One of the fish was a rainbow trout, believed to have been an escapee from the fish hatchery located 200 yards upstream from where it was captured. The invertebrates were represented by five orders of insects, numerous crayfish, and one mollusk (a periwinkle snail). Aquatic plants consisted of green algae, blue-green algae, and diatoms. Martin Creek was judged typical of creeks in east Tennessee, possessing the usual and anticipated kinds of flora and fauna. The stream bed is composed of sand, pebbles, and rocks mixed with some organic material, such as leaves and branches from dead trees.

2.8.2.3 Nolichucky River

In their 305(b) Report titled "Status of Water Quality in Tennessee", the Tennessee Department of Health and Environment published the following summary of the Nolichucky River:

The Nolichucky River ambient monitoring station is located at the North Carolina-Tennessee state line (R.M. 98.5). This river at one time was impacted severely by mineral mining. Major efforts towards point and non-point source abatement of mining wastes in North Carolina and mine reclamation demonstration projects in this River's watershed have improved water quality since the 1960's. Field biologists report that visually the river looks much cleaner and small-mouth bass have returned. The WQI for this river is 1.25, the fourth best in the State. The plot of the WQI values and biological data both show improvement over the six-year period of record. The trend for the period 1981 to 1982 was slightly negative, but would be insufficient to project any true trend.

A survey of the Nolichucky River in the vicinity of Nuclear Fuel Services, Inc. was conducted on May 5, 1983 to evaluate the impact of plant effluents on the aquatic macrobenthic community by the State of Tennessee Health Department.

Normal stream flow in the vicinity of the survey is 1000-2000 cfs. Therefore, the area of the river likely to be impacted by the discharge is confined to the small area immediately downstream of the discharge point due to the large dilution factor.

Station number one was located immediately downstream of the NFS discharge to the Nolichucky River at mile 94.8. An area of approximately twenty-five feet wide by thirty-five feet long was sampled on the right bank. This area had a sandy substrate with bedrock and large rock and boulders present. No aquatic moss was noted. The current was moderately swift. Depths ranged from 6 inches to three feet.

Station number two was located immediately upstream of NFS's discharge. An area approximately the same size as station one was sampled. The substrate at station was consisted of more loose boulders and rock and less sand than at station one. Aquatic mosses were present. The current was noticeably swifter at this station than at number one. Depths ranged from one to three feet.

The macrobenthos in the vicinity were sampled using the selected pickings method. All collected macrobenthic organisms were preserved in 70% ethanol and transported to the laboratory for taxonomic identification to the lowest possible taxa and enumeration.

The results of the macrobenthic sampling of the stations in the Nolichucky River mile 94.8 upstream and downstream of the Nuclear Fuel Service (NFS) discharge are presented in the Table 2.14 and 2.15. After identification of the organisms were complete, a relative ranking system was utilized in reporting each taxon. According to this system a taxon was considered rare (R) if less than three individuals were collected, occasional(O) if between 3 and 10 individuals were found, common (C) if between 10 and 20 individuals were collected, and abundant (A) if greater than 20 individuals were found.

Nineteen taxa were collected at the downstream station compared to twenty-four taxa at the upstream station. Also, the number of individuals collected at the upstream station was much greater than at the downstream station. Upstream of the discharge at station 2 five taxa were commonly found while downstream at station 1 only one taxa was commonly encountered.

This information seems to indicate that the NFS discharge has had a detrimental impact upon the benthic community in the Nolichucky River immediately downstream of its location. However, closer examination of the data shows some inconsistencies. Most notably there are five taxa that were collected downstream of the discharge that were not collected upstream. Also, there were ten taxa collected upstream and not collected downstream. The variability in taxa at the two stations are not clear cut differences between pollution tolerant and pollution intolerant

TABLE 2.14

TAXA SUMMARY
IMMEDIATELY DOWNSTREAM OF
NUCLEAR FUEL SERVICES EFFLUENT

Classification	No.
Oligochaeta	0
Plecoptera	
Perlidae	
Acroneuria Georgiana	R(1)
Ephemeroptera	
Heptageniidae	
Stenacron sp.	0
Stenonema mediopunctatum	0
S. Ithica	0
Ephemerellidae	
Ephemerella (Ephemerella) sp.	0
Ephemerella (Drunnella sp.	0
Ephemerella (Eurylophela) sp.	R(2)
Ephemeridae	
Ephemera sp.	R(1)
Odonata	
Zygoptera	
Coenagrionidae	
Argia so.	0
Megaloptera	
Corydalidae	
Corydalus Cornutus	0

Classification	No.
Trichoptera	
Hydropsychidae	
Symphitopsyche morosa	0
Cheumatopsych sp.	0
Polycentropodidae	
Polycentropus sp.	R(2)
Diptera	
Tipulidae	
Antocha sp.	C
Empididae	
Hemerodromia sp.	0
Chironomidae	
Tanypodinae	
Thienimenemyia grp.	R(1)
Orthocladinae	
Cricotopus tremulans	0
Mollusca	
Ancylidae	
Ferissia sp.	R(1)

TABLE 2.15

TAXA SUMMARY
IMMEDIATELY UPSTREAM NUCLEAR FUEL SERVICES EFFLUENT

Classification	No.	Classification	No.
Oligochaeta	0	Megaloptera	
		Corydalidae	
Decapoda		Corydalus	
Cambaridae		cornutus	C
Oroconectes		Trichoptera	
spinosis	R(1)	Hydropsychidae	
Plecoptera		Symphitopsyche	
Perlidae		morosa	C
Pelesta		S. bronta	
placida	R(1)	(Appalachian form	R(2)
		S. sp. (depravata grp.)	C
Ephemeroptera		Cheumatopsyche sp.	C
Heptageniidae		Psychomyiidae	
Stenacron sp.	R(1)	Psycomyia	
Stenonema		flavata	R(2)
terminatum	C	Brachycentridae	
Stenonema sp.		Micrasema sp.	R(2)
(early instar)	0		
Cinygmula sp.	R(1)	Coleoptera	
Baetidae		Elmidae	
No generic I.D.	R(1)	Promoresia	
Ephemerellidae		elegans	0
Ephemerella		Diptera	
(Ephemerella)sp.	C	Tipulidae	
Ephemerella		Antocha sp.	0
(Drunella) sp.	0	Rhagionidae	
Odonata		Atherix sp.	R(1)
Zygoptera			
Coenargrionidae		Mollusca	
Argia sp.	0	Ancylidae	
Anisoptera		Ferissia sp.	R(1)
Gomphidae			
Genus A	R(1)		
rogersi			

groups, but rather throughout the pollution intolerant groups; i.e. caddisflies (Trichoptera) and mayflies (Ephemeroptera). Therefore, although the NFS discharge may have a deleterious effect on the macrobenthic community it is difficult to separate these effects from the naturally occuring effects caused by differences in current flow, substrate available for colonization, and instream vegetation.

2.8.2.5 Rare, threatened, and endangered species

The Endangered Species Technical Bulletin lists about 20 freshwater snails which the Department of the Interior has proposed for endangered or threatened status. Twelve of these are found in Tennessee. One of these proposed for the threatened list is Anthony's river snail (Athearnia anthonyl) which has recently been discovered living in the Nolichucky River. However, Anthony's river snail is not known to exist in the section of the Nolichucky between the North Carolina border and Davy Crockett Lake, about 15 miles west of Erwin, although this may be a reflection of the lack of study devoted to snails in this part of the river.

Another species of snail inhabiting the Nolichucky River, the spiny river snail (Io fluvialis), has been proposed by TVA for endangered species classification on the Federal list. According to TVA biologists, a fish species called the sharphead darter (Etheostoma acuticeps) should be added to the list because of its rare status. Neither of these species is known to inhabit the portion of the

Nolichucky River between the NFS Erwin site and Davy Crockett Lake. Biologists from ETSU found no rare, threatened, or endangered species during their recent survey of Banner Spring Branch and Martin Creek.

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(2) R. J. Ordway, Geology of the Buffalo Mountain-Cherokee Mountain Area, Northeastern Tennessee, Report of Investigation 9, Tennessee State Department of Conservation and Commerce, Division of Geology, Nashville, TN, 1959.

(3) S. T. Algermissen, United States Earthquakes 1968, U.S. Department of Commerce, U.S. Government Printing Office, Washington, DC, 1968.

(4) Personal Communication, Erwin Utilities, Based on water usage in Erwin from 1970 to 1983.

(5) State of Tennessee, Department of Economic and Community Development, Tennessee Community Data for Erwin, July, 1983.

(6) Meteorology and Atomic Energy, 1968, USAEC

(7) Biologic Effects of Atmospheric Pollutants-Fluorides, National Academy of Sciences, 1971; Page 6.

(8) A. W. Kucher, Potential National Vegetation of the Conterminous United States, Special Publication 36, American Geographical Society, NY, 1964.

(9) Biological Survey of the Nolichucky River Mile 94.8 in the Vicinity of Nuclear Fuel Services, Inc., Discharge 1983, Tennessee Department of Health and Environment.

THE FACILITY

3.1 General Description

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. The burial grounds for low-radioactivity solid wastes, used until 1981, and non-contaminated solid wastes, used until 1984, are outside the security fence but inside a barbed-wire fence.

The average employment on 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.

Process work includes production of nonirradiated nuclear fuel components and other products from uranium. Some work done in the past with thorium and plutonium is briefly described here, but principal attention in the following sections is given to currently active processes.

3.2 Summary of Processes

Processing buildings and most other buildings have been designated with numbers and names which are shown in Figure 3.1. The processes are associated with the names of the buildings in which they are performed. Effluent monitoring data for each building is summarized in Section 5.3.

3.2.1 Warehouse facilities

The warehouse facilities and shops include buildings 110B, 120, 300, 310, east half of 304, South and East sides of 306, 135, 133, 132, 110E, the main central portion of 230, and the low bay area of 220 (South Portion). No stable or radioactive chemicals are stored in these buildings such that release to the environs is probable. Double containment is provided for storage of radioactive materials as a general principal. The only waste from these buildings is sanitary sewage and some solid waste. The sewage is sampled through a port in the main sewer pipe prior to release to the city sewer. Solid wastes are packaged for offsite burial or are incinerated on site as described in Section 3.2.12.

(b)(4)

3.2.2 Plutonium fuel fabrication, Building 234

Reactor fuel elements containing uranium and plutonium have been fabricated on site. The plutonium fuel element fabrication operations have not been performed for some time. These operations are shut down, and decommissioning plans are now being developed.

3.2.3 High-enriched uranium scrap recovery, Building 233

Highly enriched uranium fuel that does not meet specifications and various scrap materials generated in the fabrication of highly enriched uranium fuel are processed in Building 233 to reclaim the uranium. The final product may be recycled to fabrication facilities on site or shipped off site.

The recovery process for highly enriched uranium from scrap materials makes use of hydrofluoric acid and/or sulfuric acid, nitric acid and small amounts of tributyl phosphate and Amsco-125, an organic solvent. The process is diagrammed in Figure 3.2.

Liquid effluents generated in the recovery process are sampled for uranium prior to transfer to the wastewater treatment system. Gaseous effluents from the process are treated by dual high-efficiency particulate air (HEPA) filtration and/or by scrubbing and are discharged to the main stack. (See Section 3.3.1).

3.2.4 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, which is sampled routinely for worker protection, and dryer exhaust vents which are sampled continuously for radioactivity. The only liquid effluents are laundry waste and sanitary sewage. Sanitary sewage is discharged into the main sewer pipe where it is sampled. Laundry waste is collected and sampled then discharged to the waste treatment system or to the municipal sewage system.

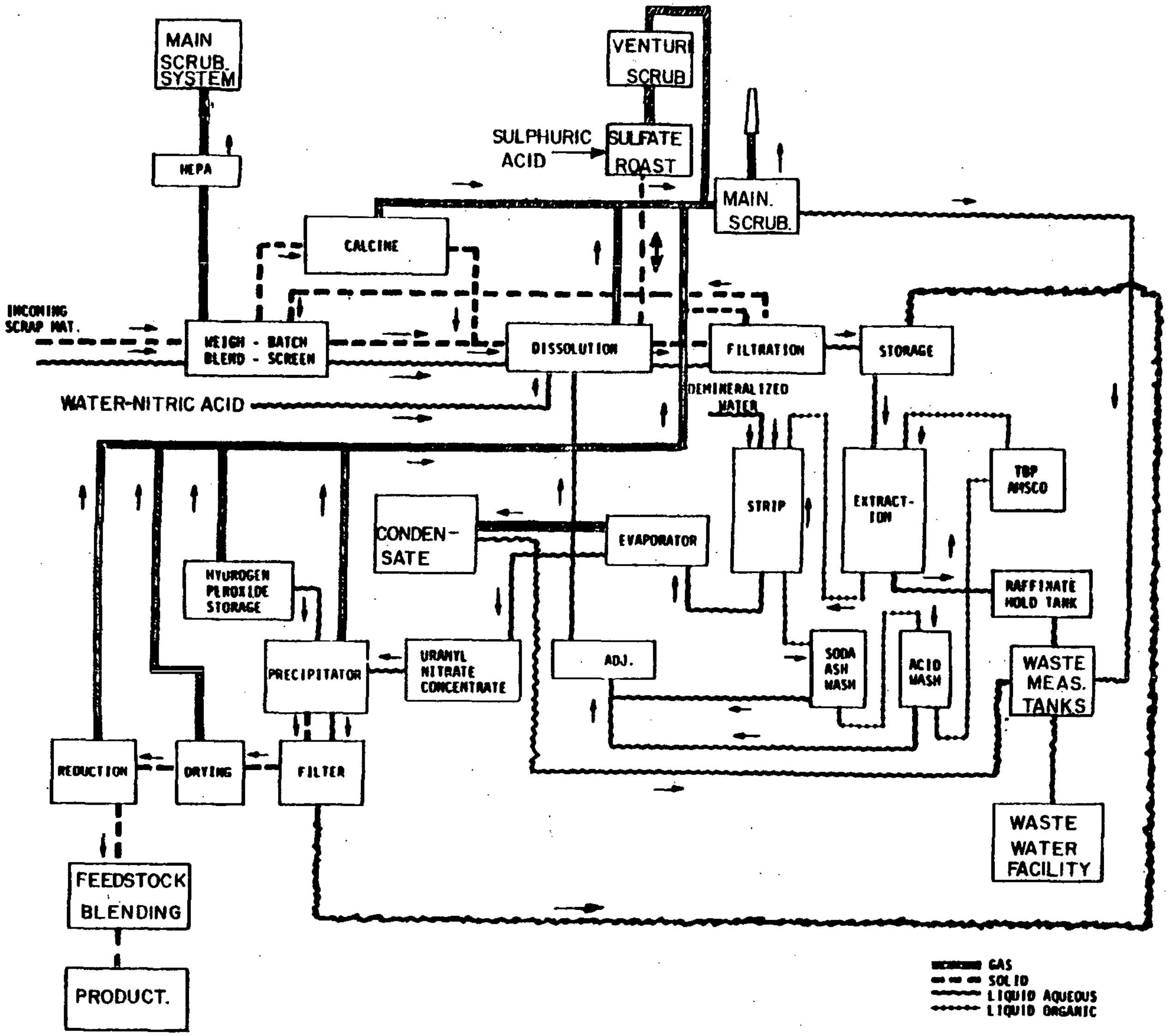

FIGURE 3.2 High Enriched Uranium Scrap Recovery Bldg. 233.

3.2.5 Ceramics Building 110

The ceramics building contained a processing facility which has been decommissioned. This processing facility formerly fabricated enriched uranium, Uranium-233 thorium, or thorium blend fuel rods.

Currently the building (the A portion) contains a solid waste reduction process (for high enriched uranium bearing materials) and several laboratories most of which are no longer in operation. The PVD lab, U-233/PU Spectrographic Lab and LWB lab are no longer in operation. The D portion of the building currently houses a functioning Non-Destructive Assay (NDA) lab. There are no liquid effluents from this building other than sanitary sewage which is discharged to the main sanitary sewer. Gaseous effluents include that generated by the waste reduction (compaction) process, the NDA lab hood and building air which is discharged through single or double HEPA filters. All these release points are continuously sampled for radioactivity.

3.2.6 Chemical building, Building 111

Three process lines have operated in the chemical building. The one for low enriched uranium (LEU) scrap is illustrated in Figure 3.3. Scrap material containing enriched uranium is processed to recover the uranium. Thorium dioxide powder and thorium metal pellets were also produced in the facility. Certain equipment is common to these processes, including the two scrubbers on stacks 278 and 287. The scrubber to stack 278 is a wet-venturi type, while the scrubber on stack 287 is a packed-bed type. Process waste water is collected and pumped to the Waste Water Treatment Facility for processing.

3.2.7 Administration and laboratory

Buildings 220, 305, 320, & 105 primarily house offices and computer facilities that generate no effluents other than sanitary sewage and wastepaper which is disposed of on site. Some laboratory facilities are also located in Building 105.

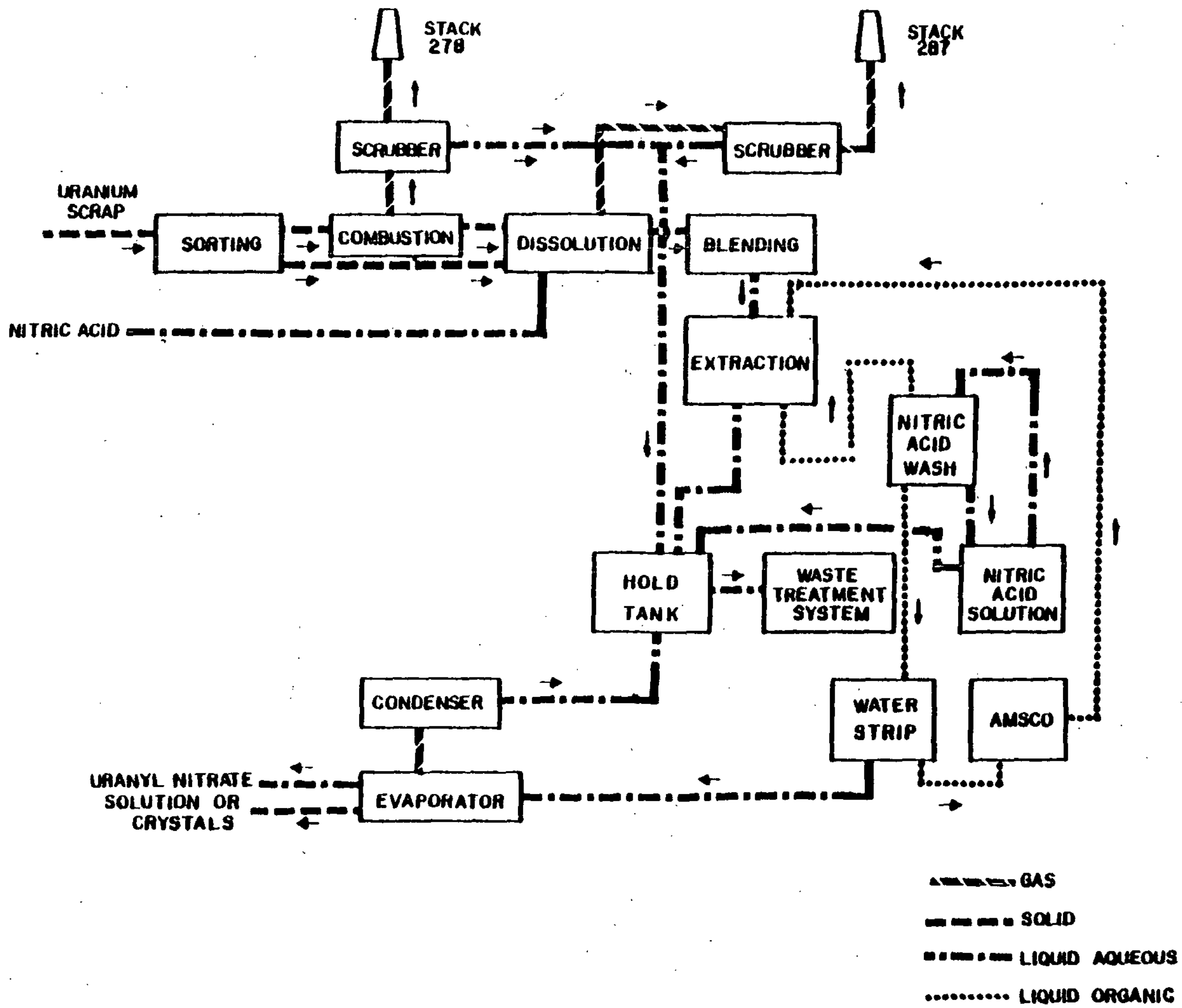

FIGURE 3.3 Low-enriched-uranium scrap recovery, Building 111.

Liquid wastes from the laboratories are processed in the waste treatment system or discharged directly to the sanitary sewage. Generally, high enriched uranium-bearing liquid wastes are discharged through the Wastewater Treatment Facility. Low-enriched uranium-bearing wastewater is discharged to the municipal sewer system (after hold-up and analysis). Gaseous effluents from the analytical laboratories housed in Bldg. 105 are discharged via the main plant ventilation system.

3.2.8 Metals, Building 130

Except for UF6 cylinder cleaning, the metals building has not operated since 1973. In the past, it was used to produce uranium metal, uranium tetrafluoride, or thorium metal.

The UF6 cylinder wash process is illustrated in Figure 3.4. Cylinders which have been used to transport LEU hexafluoride are washed free of uranium and are air dried. The UF6 is hydrolized with water. Gaseous effluents from this process are treated by a packed-bed scrubber prior to discharge. Water is removed from the cylinder by a vacuum transfer system in which a steam ejector is used to create the vacuum. The water which is removed from the cylinders is sampled and is transferred to the scrap recovery facility in Building 111. Condensate from the steam ejector is transferred to the waste treatment system. The cylinders are emptied and refilled several times until the wash solution contains 5.0 g/liter or less of uranium. The cylinders are then air dried and shipped off site. The only liquid effluent from the metals building is the air scrubber solution resulting from the cylinder wash process, which is recycled for uranium recovery and then treated in the Wastewater Treatment Facility.

3.2.9 Pilot plant, Building 131

The pilot plant has been used for process development but not for actual production work. Hoods, dryboxes, and muffle furnaces have been used with both high- and low-enriched uranium. No plutonium has been used in this facility. Exhaust air is filtered through HEPA filters before discharge. Liquid effluents are sent to the waste treatment system.

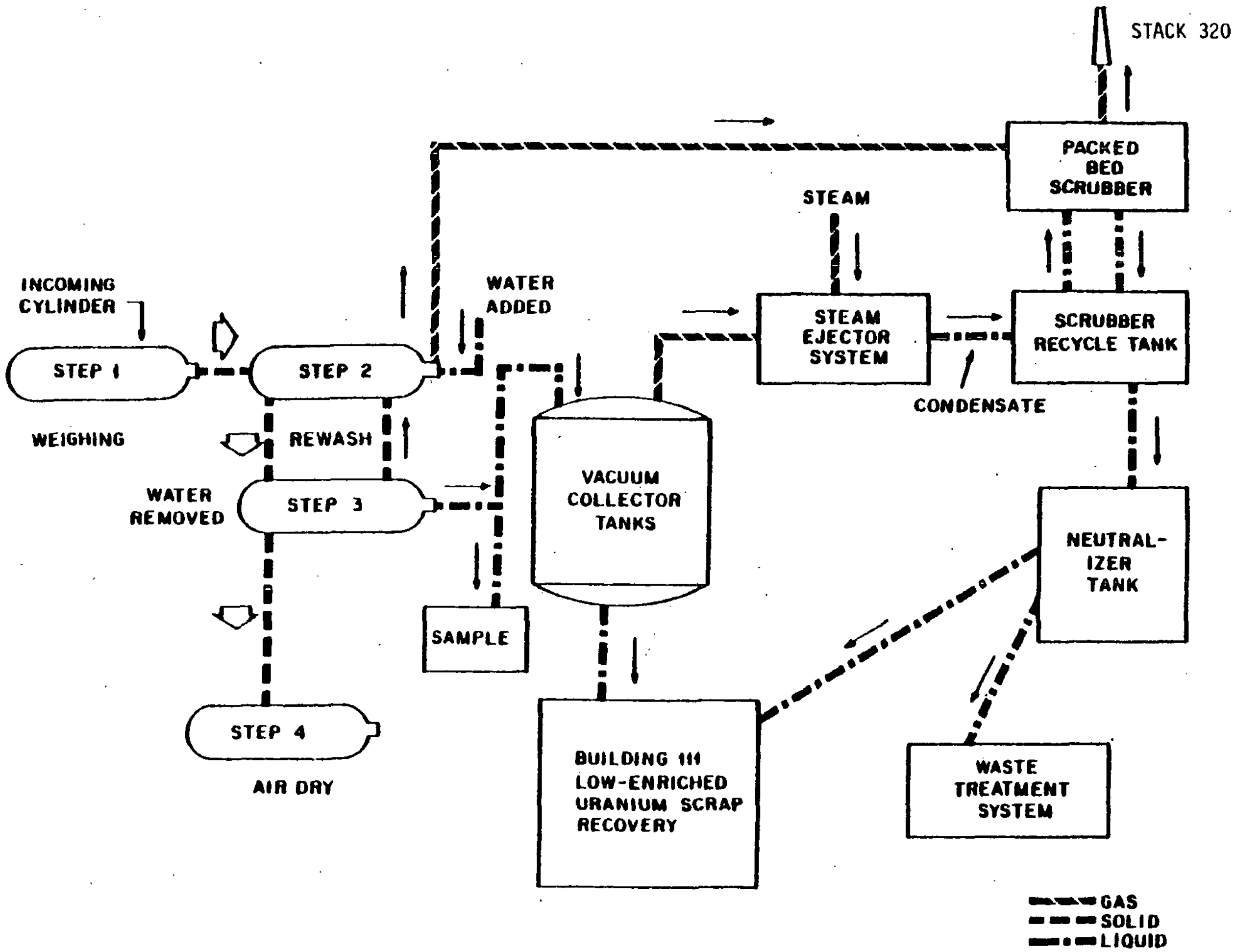

FIGURE 3.4 Uranium hexafluoride cylinder wash, Building 130.

(b)(4)

3.2.12 Auxiliary Facilities

In addition to effluents generated by the processing facilities, certain support equipment also generates gaseous and liquid effluents. Gaseous effluents are generated from incinerators for clean and contaminated solid wastes, building heaters, boilers, and emergency generators. Liquid effluents are generated from restrooms and showers, and stormwater runoff. The generation, treatment, and disposal of the effluents from these sources are described in the following sections and in Section 3.3.

Incinerator (Office and Lunchroom Wastes)

Solid nonradioactive 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.

Gaseous effluents from the incinerator are expected to contain small quantities of particulates, oxides of sulfur and nitrogen, and carbon monoxide. The gaseous effluent is discharged from a 15-ft. stack.

Incinerator (Contaminated Wastes)

Process or laboratory wastes are incinerated in a Combustall Waste Incinerator, which has been modified to greatly reduce particulate emissions which might contain small quantities of uranium. Batch loading and ash cleanout after each incineration preclude any possibility of criticality. Complete combustion is assured by the use of a gas-fired afterburner. Soluble products of combustion are removed by the venturi scrubber along with particulates before the effluent is discharged through the main plant process ventilation system.

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

(b)(4)

Decon Facility

The Decon Facility which is housed in the west end of Building 304 serves to clean, reduce, and segregate contaminated wastes generated by plant operations. The cleaning is accomplished by freon washing, vibratory finishing, and electropolishing. Waste is reduced by compaction. Liquid wastes produced include NaOH solution and phosphoric acid. The NaOH solution is either solidified and sent to off site burial, or reprocessed. The phosophoric acid solution is solidified and sent to off site burial.

Building and Process Heat

Process steam is provided by three boilers that are fired using either natural gas or No. 2 diesel oil. Measurements of emission have not been made, but total emissions can be computed from fuel consumption and average emission factors for similar equipment which have been published by the Environmental Protection Agency. The estimate is, however, complicated by the fact that both No. 2 diesel oil and natural gas are used in the boiler. In addition, some building heat is provided by small oil or gas-fired units in the processing buildings.

It is assumed that the diesel building heaters have the same emission factors as those of a small boiler; the emissions in Table 3.1 are predicted from estimated usages of oil or gas.

Table 3.1. Emissions From Heating Plant

Contaminant	Emission rate (lb/year)[a]	Emission rate (kg/year)[a]	Concentration ($\mu g/m^3$)[b]
	With oil		
Particulates	3,015	1368	6,707
Sulfur dioxide	5,708	2589	12,698
Sulfur trioxide	80	36	178
Carbon monoxide	40.2	18.2	89
Hydrocarbons	603	274	1,341
Oxides of nitrogen	16,080	7294	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 SO2)	10	5	0.2
Hydrocarbons (as CH)	100	45	1.8
Oxides of nitrogen (as NO2)	300	140	5.4
Aldehydes (as HCHO)	8	140	0.1
Organics	18	8	0.3

a Based on 210,000 gal (790,000 liters) oil or 25,200 MCF (700,000 m^3) gas.

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

Source: Air Pollution Emmission Factors PG209559, USEPA February, 1972.

3.3 Waste Confinement and Effluent Control

Release data for each facility are based on analysis of gaseous and liquid effluents. This section summarizes the nature of the effluents, and methods and principles for their control. Locations of releases of gaseous and liquid effluents are those shown in Figures 3.5 and 3.6, plus a direct line from the waste treatment facility (Building 330) to the Nolichucky River.

(b)(4)

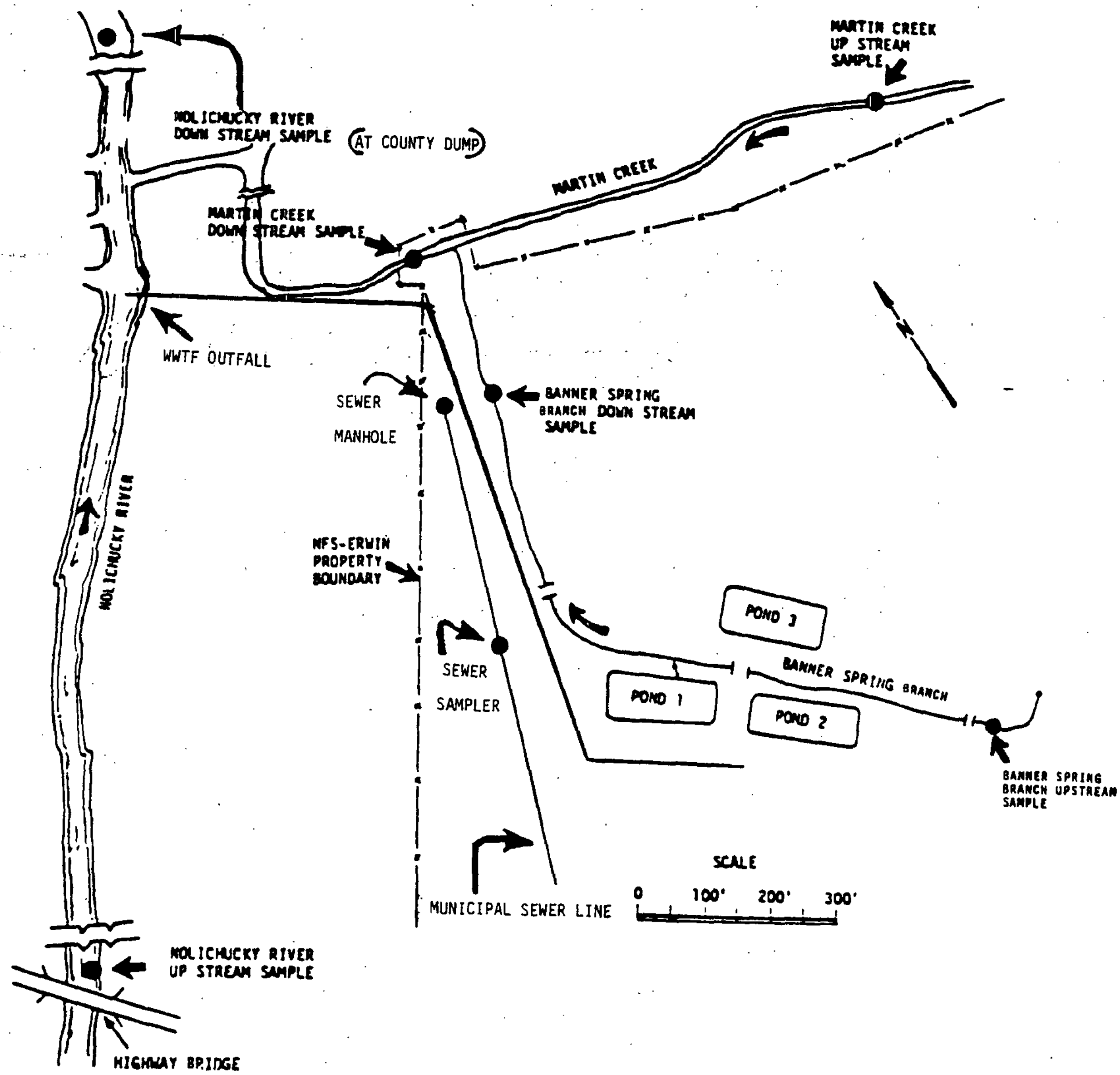

Figure 3.6

LIQUID EFFLUENT RELEASE LOCATIONS

3.3.1 Gaseous Effluents

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

30% efficient ASHRAE prefilters followed by 80% ASHRAE filters are utilized on the HVAC recirculating room air handlers in both the 200 complex (Bldg. 220/230/233) and 300 complex (Bldgs. 302/303/304/306).

The main plant process ventilation system receives inputs from essentially all high enriched uranium operations where treated air is discharged through a common stack. This system includes gas streams from the 200 complex, 300 complex and Building 105 labs. The air cleaning systems in the 200 and 300 complexes are essentially the same and each consists of Orifice Scrubbers, Chevron Demisters, mesh demisters, air heaters and HEPA filters (Figure 3.7 and Figure 3.8).

Packed-bed scrubbers are used in several buildings (e.g. Bldg. 105) where water, potassium hydroxide, aluminum nitrate, or ammonium hydroxide is used as the scrubbing solution.

Also high-efficiency particulate air filters are in use throughout the facility. They are rated at 99.97% efficient for removal of 0.3 um dia dioctyl phthalate (DOP) particles. In some cases, two or three HEPA filters are connected in series. This arrangement provides increased removal efficiency and is environmentally beneficial as a contingency against releases which may occur during filter change or from accidental damage to one filter. The HEPA filters are tested by the manufacturer and certified as to their efficiency.

Table 3.2 summarizes some physical characteristics of all process stacks and release points.

3.3.2 Liquid Waste Retention

There are three underground waste retention tanks; two have a 6000-gal (23,000-liter) capacity, and one has a 140-gal (430-liter) capacity. In addition, numerous above ground waste tanks are used. All above ground tanks are diked to contain leaks or spills.

July 27, 1984

(b)(4)

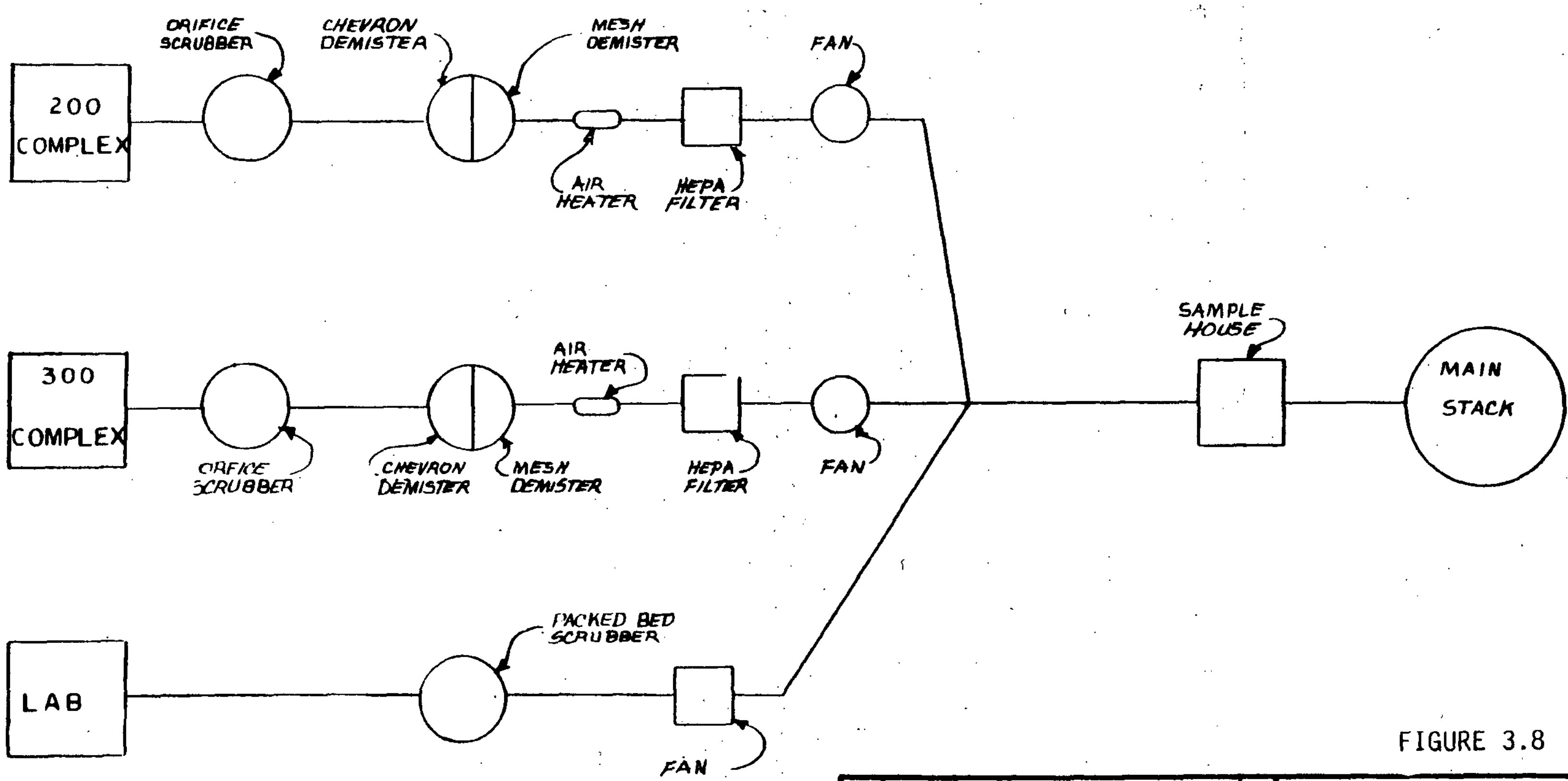

FIGURE 3.8

BY	DATE	REVISIONS	LET.

NUCLEAR FUEL SERVICES, INC.
ERWIN, TENNESSEE

NAME: MAIN PLANT PROCESS VENTILATION SYSTEM FLOW DIAGRAM

MADE BY B M' | SCALE NONE | DATE 6-6-84
TRACED BY
CHECKED BY
APPROVED BY
DRAWING NO. RMB-892-B

July 27, 1984

TABLE 3.2
PHYSICAL CHARACTERISTICS OF NUCLEAR FUEL SERVICES
PROCESS STACKS AND WALL FANS

Stack No.	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	0.61	9.0	8.26	H.E.U.	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	L.E.U.	Scrubber
287	111	0.41	12.0	10.8	L.E.U.	Scrubber
320	130	0.23	9.0	4.65	L.E.U.	Scrubber
354	110	0.30	6.0	4.28	H.E.U.	None
185	131	0.20	6.0	5.35	H.E.U	None
416	300/ 200/105	1.52	33	11.57	H.E.U. HEPA	Scrubber
333	110	0.25	5.0	8.35	H.E.U.	None
332	120	0.20	6.0	13.18	H.E.U.	HEPA
421	100	0.30	Horizon- tal Vent.	15.3	H.E.U.	None
W Wall Fan #1	111		4.5	2.03	L.E.U.	None
W Wall Fan#2	111		4.5	2.03	L.E.U.	None
N Wall Fan	111		4.5	1.08	L.E.U.	None
S Wall Fan	111		3.0	0.04	L.E.U.	None

The 140-gal emergency collection tank is made of stainless steel and is filled with borosilicate raschig rings. This tank is buried within Building 233 on 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 were used as the result of an accident, it would be emptied and the contents would be reprocessed as soon as practicable.

The two other underground collection tanks are located adjacent to Buildings 105 and 303. These 6000-gallon (23,000-liter) fiberglass tanks are used to collect uranium-bearing process wastes for sampling before release or reprocessing. They are used to route the process wastes to the waste treatment facility.

3.3.3 Liquid Effluents

The bulk of aqueous process wastes, are disposed to the waste treatment system. This volume averages less than 50,000 gal (190,000 liters) per day.

Prior to 1977, waste treatment consisted of pH adjustment and settling in unlined ponds. Discharge was to Banner Spring Branch, which flows into Martin Creek and then to the Nolichucky River. When this treatment method was used, the effluent met existing water quality criteria with respect to radiological contaminants. It did not, however, meet water quality criteria as they were developed with respect to ammonia, nitrates, fluorides, and biological oxygen demand (BOD). For this reason, a wastewater treatment facility (Building 330) was put into service, and the use of the ponds was discontinued.

NFS maintains the ponds by keeping sediment wet and replacing water lost through evaporation or seepage in order to prevent the spread of radioactivity by blowing dust. Monitoring for radioactivity (and occasional chemical parameters) continues downstream in Banner Spring Branch and Martin Creek. This monitoring along with the monitoring of 14 groundwater wells installed during 1984 in the vicinity of the ponds should detect any seepage.

The general process of the wastewater treatment facility involves adjustment of the pH of wastewater on a batch basis with caustic soda (sodium hydroxide) precipitation and removal of fluoride ions through the addition of lime slurry $Ca(OH)2$. Normally, dissolved ammonia is subsequently removed by air stripping when the ambient air temperature is above 40 degrees F and by addition of elemental chlorine for breakpoint chlorination when the ambient temperature is below 40 °F and when air removal of ammonia is inefficient. After the removal of ammonia, the pH is adjusted to discharge values (6 to 9), and the water is discharged to the Nolichucky River. The process flow diagram for this facility is shown in Figure 3.9.

During the operation of the wastewater treatment facility, each batch is analyzed for gross alpha and gross beta radioactivity prior to discharge. A monthly composite sample is analyzed for isotopes of uranium. The chemical parameters prescribed in the State of Tennessee NPDES permits are also analyzed at least on the frequency specified in the permits. Samples of the treated wastewater are collected from the final neutralization tank prior to discharge.

Sanitary wastes are generated from showers and restrooms throughout the facility. These wastes are collected in one main pipe for discharge to the Erwin municipal sewage treatment facility. Daily samples are analyzed for alpha contamination.

A new Plant Drainage System was recently constructed at the NFS - Erwin Plant site. General flow patterns are indicated on Figure 3.10.

The predominant flow is to the north and routinely all run-off enters Banner Spring Branch. Subsequently the flow enters Martin Creek, Indian Creek, and then the Nolichucky River.

Sluice Gates are located as noted on Figure 3.10. These enable the plant to terminate flow from an area should a spill of hazardous material occur. This would enable clean-up of that area without loss of containment to the environment.

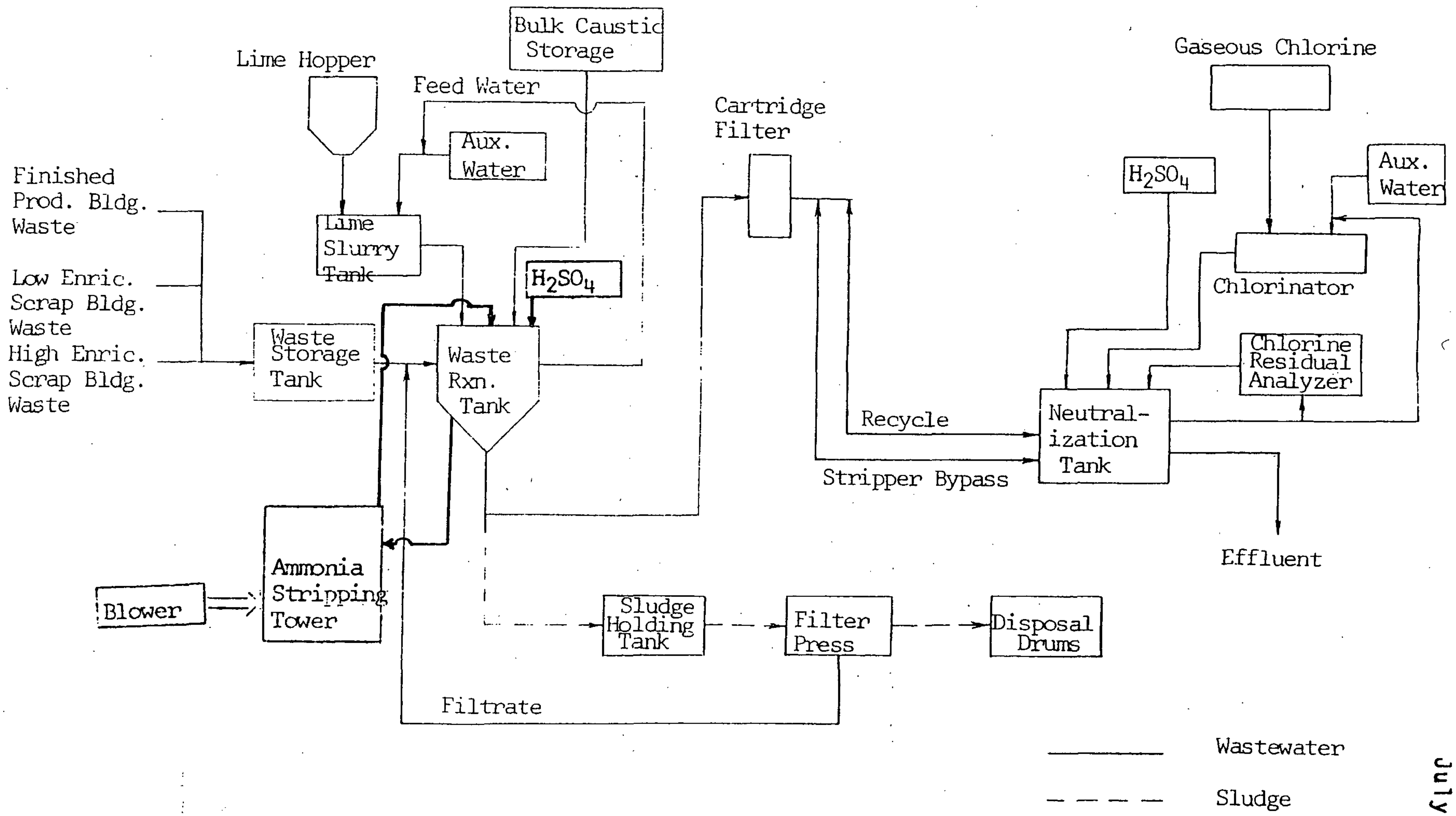

FIGURE 3.9
WASTEWATER TREATMENT FACILITY
BUILDING 330
FLOW DIAGRAM

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(b)(4)

Drainage from inside the restricted (fenced) area enters Banner Spring Branch at three points. Drainage from east of the protected area (i.e. the parking lot and the hill north of the parking lot) enters the creek at one point.

Because there is a possibility for contamination outside the buildings during transport of contaminated material between buildings, through dispersion by people, and through fallout from gaseous effluents, runoff is sampled. Samples are collected at the northwest corner of the plant perimeter and in Banner Spring Branch at a point downstream from all plant inputs.

3.3.4 Solid Waste Retention: Burial Grounds

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

Prior to the 1981 revision of Title 10 CFR Part 20 which requires specific licensing for disposal of low-level radioactive wastes in soil, NFS did bury low-level radioactive wastes at the site. Burial during that time period (prior to 1981) was carried out as authorized by the then existing 10 CFR 20 regulations. Non-radioactive solid waste burial continued until 1984. These solid wastes consisted of non-contaminated incinerator ash, packaging materials, construction debris, and the like. NFS is presently processing an application for a State of Tennessee solid waste disposal permit (non-radioactive) to allow continued disposal of this type of solid waste on-site.

The location of the burial ground is shown in Figure 2.8. Burial operations used two types of pits. Small pits contain packaged, uranium or thorium-contaminated wastes; larger pits contain unpackaged, clean or very low-level uranium or thorium-contaminated wastes. Wastes in the small pits are packaged in plastic-lined buckets or plastic bottles. The quantity of uranium in the pits (used before the regulation changed May, 1970) was limited to 50 mCi of uranium-234/235 per pit. The estimated quantities of uranium in each pit are shown in Table 3.3. Pits used after May 1970 contain 10 μCi or less of uranium-235 per pit. No onsite burial of contaminated wastes has occurred since January 1981.

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TABLE 3.3

NFS BURIAL PIT CONTENTS

Pit No.	Closure Date	Quantity	Nuclides	Mass	Description
66-1	Dec. 1966	65.4 mCi	U-93% enriched Dep U Thorium	96 g 86.2 Kg 126.0 Kg	Mostly non-combustable trash
67-1	Nov. 1967	68.4 mCi	U-93% enriched Dep U Thorium	357 g 33 g 131 Kg	Combustables
68-1	No date	35.4 mCi	Dep U Thorium	117.6 Kg 63.1 Kg	
69-1		(0)			
69-2		(0)			
69-3	July	30.0 mCi	Thorium Enriched U	271.2 Kg 0.5 g	Trash
69-4	June	98.0 mCi	Thorium U-235	400 Kg 0.5 g	10,000 cu ft of trash & 12 drums
69-5	July	0.04 mCi	U-235	1 g	Contaminated trailer
69-6	Oct.	2.5 mCi	Dep U U-235 U-233 Pu-239 Thorium	2.3 g 53.4 g < 1 g 1 ug 600 g	
69-12	Dec. 1969	0.2 mCi	U-238 U-235 Thorium	129 g 3 g 160 g	
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	628 g	
70-4	March 1970	50 mCi	U-70% Enriched	2201 g	Bottles & 5 gal cans
70-5	March 1970	49.1 mCi	U-88% Enriched U-20% Enriched U-20% Enriched U-20% Enriched U-52% Enriched	629 g 3195 g 600 g 600 g 42 g	
70-6	April 1970	48.6 mCi	U-70% Enriched U-52% Enriched U-2.5% Enriched	333 g 2249 g 2640 g	
70-7	April 1970	53.31 mCi	U-93% Enriched U-76.38% Enriched U-52% Enriched U-20% Enriched U-16% Enriched	108.6 g 704 g 1551 g 50 g 56 g	
70-8	April 1970	49.28 mCi	U-238 U-235	15557 g 1239 g	
70-9	April 1970	2.6 μCi	Dep U	11 g	
70-10	May 1970	76.3 mCi	U-97% Enriched 93% Press cake	1.244 g 867 g	
70-11	May 1970	87 mCi	93%-U Enriched	1046.8 g	
71,72-1	Aug. 1973	0.228 mCi 2.76 mCi	97%-U Enriched Dep U	0.003 g 11.35 Kg	
73,74-1	May 1977	1.747 uCi	U-235 U-235-5% U-235-93%	22.831 mgm 4 mgm 106 mgm	
75-2	May 1975	6.5 uCi	Enriched U	4.87 g	
75-3	May 1975	9.2 uCi	Enriched U	6.88 g	
75-4	May 1975	3 uCi	Enriched U	2.29 g	
76,75, 74,73-1	1977	6.2 uCi	U-93% Enriched U-5% Enriched U-93% Enriched	22.831 mgm 4 mgm 101 mgm	

Waste in the large pits consists mainly of shipping containers which are free of contamination, ash from the clean incinerator, very low-level uranium/thorium contaminated laboratory waste, and other miscellaneous items. Covered burial sites are marked on all four corners with 6-in.-square, reinforced concrete posts with metal end plates stamped for identification.

ENVIRONMENTAL IMPACTS OF NFS OPERATIONS

4.0 Section 4.1 covers the radiation dose commitment to members of the general population that results from NFS-Erwin plant operations. Section 4.2 covers non-radiological impacts of plant operation.

4.1 Radiation Impact

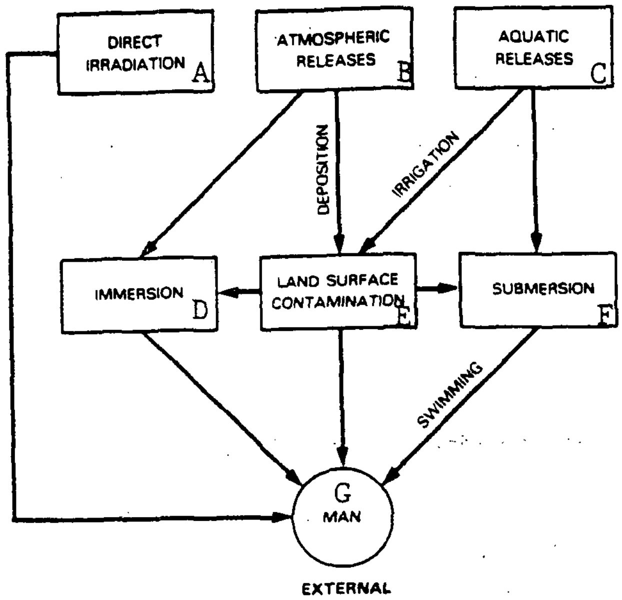
Exposure pathways to man are summarized in Figure 4.1 for radioactive releases from nuclear facilities. Summarized therein are both internal and external exposure modes. Since NFS-Erwin operations process radioactive materials that are largely alpha emitters, all external direct exposure pathways are considered insignificant, including:

- Direct radiation from the facility and fuel shipments,
- External dose rates from atomspheric releases, and
- External dose rates from liquid (aquatic) releases.

Consequently, the internal exposure mode need only be considered. From Figure 4.1, fourteen direct and indirect exposure pathways are presented. The exposure to man can generally be summarized into two major entry modes: 1) inhalation (pathway through D) and; 2) ingestion (pathways through E, F, G, and H.)

Ingestion pathways which include boxes E, F, and H are considered insignificant compared to pathways through box G. According to "Environmental Analysis of the Uranium Fuel Cycle", natural uranium concentrations of 1×10^{-10} μCi/ml in water and 10^{-13} μCi/gram in soil result in doses from ingestion of animals, fish and shellfish of less than 10^{-5} millirem per year. By applying this relationship to concentrations discussed in Section 5, doses of 10^{-3} millirem result from these pathways due to NFS operations.

Because radionuclides of uranium are not selectively concentrated by plants where minimal irrigation is practiced, the ingestion pathway B-C-E-I is also considered insignificant.



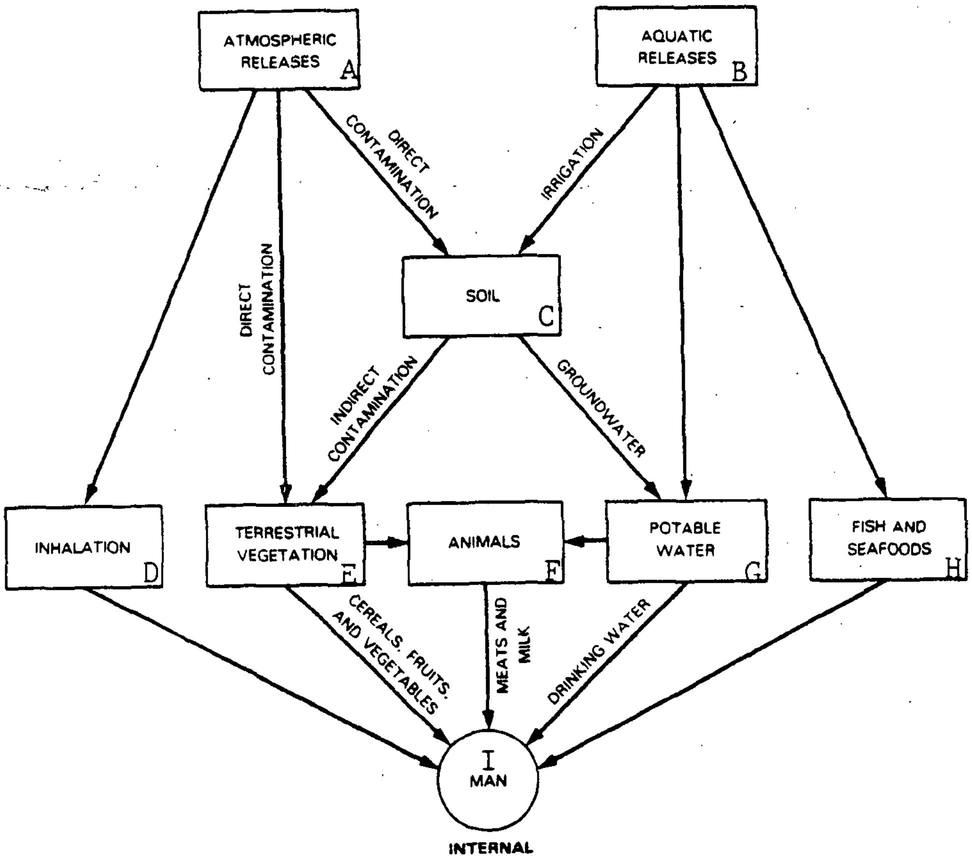


FIGURE 4.1 Pathways for exposure to man from releases of radioactive effluents.

The term "dose" or "exposure" as referred to in subsequent portions of this section is actually a 50-year dose equivalent commitment for all internal exposures, that is, the total dose that will accrue from one year of intake of radionuclides during the remaining lifetime (50 years) of the individual. The dose reflects the annual release of radionuclides from the combined effluents unless otherwise stated.

Dose conversion factors were taken from NUREG/CR-150, Volume 3, "Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities."

"Effective Dose Equivalent Commitment" dose conversion factors were utilized only. The effective dose equivalent commitment is equal to that dose equivalent commitment, delivered at a uniform whole-body rate, that corresponds to the same expected number (but possibly dissimilar distribution) of fatal stochastic health effects as the particular combination of committed organ dose equivalents under consideration.

The use of effective dose equivalent commitment serves in the place of a more extensive compilation of committed dose equivalent per unit intake for a number of individual organs.

4.1.1 Exposure From Drinking Water

The Nolichucky River serves as the water supply for Jonesboro, Tennessee, which is about 10 miles downstream from the NFS-Erwin facility. Assuming no radionuclide removal by the Jonesboro water treatment plant or dilution by incoming streams, a maximum intake rate of 730 liters/year, and an average intake rate of 370 liters/year, the following doses have been calculated:

- Maximum exposed individual — 6.9 mRem
- Average exposed individual — 3.5 mRem

4.1.2 Exposure From Airborne Effluents

Atmospheric discharge from NFS-Erwin Plant operations have changed considerably over the reporting period of 1979 through 1983 discussed in Section 5.0. Total effluent losses show the following (See Table 5.7):

Nuclide	Average µCi Released During Reporting Period	Total µCi Released During 1983
Pu	3.93	1.04
U-233	18.04	0.0
H.E.U.	43,750.19	4,286
L.E.U.	2,119.92	595

These reductions were brought about by changes discussed elsewhere in this report. It is clear, from these data, that current dose commitment estimates should be based on 1983 data rather than averages of the entire reporting period.

The dose estimates that follow neglect Plutonium and Americium contributions. This is because they represent only 0.0015% of the total dose to the general public resulting from NFS operations. That is, 99.9985% of the total dose is a direct result of High and Low Enriched Uranium Operations.

Additional assumptions utilized in arriving at the doses that follow included: (1) an Activity Median Aerodynamic Diameter (AMAD) of 1 micro-meter; (2) lung solubility of 65% Class Y and 35% Class D; (3) A constant discharge rate of plant effluents; (4) Pasquill stability Class D; (5) Average wind speed and frequency from Figure 2.13; (6) Breathing rate of 8000 cubic meters per year for an adult; and (7) 80% occupancy (outdoors). (AMAD and Lung Solubility assumptions are based on average measured values.)

The inhalation dose resulting from annual NFS-Erwin Plant operations is summarized in Table 4.1. From this table, it can be seen that the maximally exposed individual would be living 250 meters north of the plant site. This area is immediately adjacent to

TABLE 4.1

SUMMARY OF EFFECTIVE DOSE EQUIVALENT COMMITMENTS (mRem) BY SECTOR & DISTANCE RESULTING FROM NFS OPERATIONS

Distance (Kilometers)

Sector	.25	.50	1.0	1.5	2.41[a]	4.02[b]	5.63[c]	7.24[d]
S	0.71	0.37	0.44	0.28	0.17	0.09	0.06	0.04
SSW	0.48	0.20	0.26	0.17	0.11	0.06	0.04	0.03
SW	0.25	0.08	0.10	0.07	0.05	0.03	0.02	0.01
WSW	0.30	0.09	0.07	0.01	0.05	0.03	0.02	0.01
W	0.22	0.07	0.06	0.04	0.04	0.02	0.02	0.01
WNW	0.17	0.06	0.07	0.05	0.03	0.02	0.01	0.01
NW	0.16	0.08	0.09	0.06	0.04	0.02	0.08	0.01
NNW	0.18	0.20	0.14	0.08	0.04	0.02	0.01	0.01
N	0.82	0.32	0.24	0.13	0.07	0.04	0.02	0.02
NNE	0.38	0.33	0.30	0.17	0.10	0.05	0.03	0.02
NE	0.50	0.34	0.36	0.21	0.12	0.07	0.04	0.03
ENE	0.66	0.35	0.43	0.27	0.16	0.09	0.05	0.04
E	0.44	0.32	0.32	0.17	0.11	0.06	0.04	0.03
ESE	0.35	0.17	0.21	0.13	0.08	0.04	0.03	0.02
SE	0.41	0.18	0.23	0.15	0.09	0.05	0.03	0.02
SSE	0.56	0.29	0.35	0.22	0.13	0.07	0.05	0.03

[a] 1.5 miles
[b] 2.5 miles
[c] 3.5 miles
[d] 4.5 miles

NFS and includes the Clinchfield Railroad property. No residences currently exist on that property. The maximally exposed, nearest actual resident is in the South Sector. The dose to this individual is 0.71 millirem. The dose resulting from drinking water (Section 4.1.1) and the dose resulting from atmospheric releases are received by different populations and are therefore not additive.

The maximally exposed individual thus received only a small fraction of the applicable NRC regulations of 500 millirem/year to the total body. Similarly, the doses are well below the EPA standards for the commercial uranium fuel cycle (49CFR190), although the EPA standards are not legally applicable to the NFS facility. The dose is only 2.8% of the EPA standard of 25 millirem per year.

Additionally, the dose of 0.71 millirem is only 0.7% of the natural background for the area, and thus the contribution to the existing background levels would be negligible.

4.1.3 Dose to the Population

The population distribution within a five mile (8 kilometers) radius is shown in Figure 2.3. These data when coupled with Table 4.1 data result in a population dose of 0.93 man-rem. This is only 0.094% of the population dose of 987 man-rem resulting from natural background radiation.

4.2 Chemical Impact

In "Environmental Survey of the Uranium Fuel Cycle," the Atomic Energy Commission (now NRC) reported on general findings covering environmental impact from fuel fabrication plants:

> "The most significant effluents from the standpoint of potential environmental impact are chemical in nature...The only significant airborne chemical effluent from the process operations of the fabrication plant is fluorine and fluorides... The most significant chemical species in liquid effluents are nitrogen compounds..."

The concentrations of these compounds in the environment are discussed in Sections 2.7.2 and 5.3.10. It is the purpose of this section to compare these concentrations to background levels and applicable standards and indicate any environmental effects that might result as a consequence of facility effluents.

4.2.1 Liquid Effluents

Table 2.9 presents a summary of the water quality information for the Nolichucky River available from the Department of Public Health. Two chemicals are of interest in liquid effluents--nitrates and fluorides.

Nitrates

Nitrates occur in natural waterways from a variety of natural and man-made sources. Biodegradation of organic matter and sewage are among the primary sources. Runoff from fertilized land and effluent from fertilizer production plants may contain relatively large quantities of nitrates.

Nitrates in surface waters are normally incorporated into photosynthetic algae. Such algae ordinarily serve as food for herbivorous fish. A temporary ecological upset may result when a combination of factors promote algal plankton bloom. The low nitrate levels measured in the Nolichucky River would probably not be sufficient to support such blooms. It is, however, possible that an unknown combination of events might result in such a bloom.

From Table 2.9, the average total nitrogen, which includes organically combined nitrogen, ammonia and nitrate in the river is 0.465 mg/l. Facility effluents may increase this by as much as 0.082 mg/l. The majority of this increase is from nitrates. The U.S. Public Health Service limit for nitrate is 45 mg/l as nitrate or 10 mg/l as nitrogen. Nitrate above 50 mg/l nitrate as nitrogen has been reported to cause infant methemoglobinemia.

At the nitrate levels expected in the Nolichucky River, the only environmental effect anticipated is a very slight promotion of growth of photosynthetic algae.

Fluorides

From Table 2.9, the fluoride concentration in the Nolichucky River is 0.1 mg/l. The increase from plant operation is 4.0 E-3 mg/l.

Many dental authorities recommend fluoride concentration between 0.8 and 1.5 mg/l to prevent tooth decay. Significantly higher concentrations may interfere with the deposition of tooth enamel causing a mottled appearance.

The U.S. Public Health Service (USPHS) has set upper and lower limits of fluoride concentrations in drinking water based on the average annual temperature. The total recommended consumption of fluoride is approximately the same, but since people drink more water in warmer climates a lower fluoride concentration is advised. For the Erwin area, where the average annual temperature is between 63.9 and 70.6°F, the USPHS lower, optimum and upper limits for drinking water are 0.7, 0.9, and 1.2 mg/l, respectively.

No measurable impact is expected from fluorides in either current or future facility effluents.

4.2.2 Gaseous Effluents

Boiler and heater combustion products are released to the atmosphere in relatively small amounts. Ammonia is released in relatively large amounts, but in concentrations below the threshold for odor and irritation. Ammonia is dispersed in the atmosphere where it is dissolved and returned to the soil in rain water. Ammonia serves as fertilizer and is rapidly taken up by plants and incorporated into their cellular structure.

Only hydrogen fluoride is of interest among chemicals in gaseous effluents. Other effluent gases are either chemically inert (e.g., nitrogen and argon) or occur in very small quantities (e.g., hydrogen chloride).

Hydrogen Fluoride

The state of Tennessee has established the air quality standards outlined in Table 4.2.

Based upon these and the calculated concentrations discussed in Section 2.7.2.1, no significant environmental impact due to fluorides in gaseous effluents can be predicted.

TABLE 4.2
TENNESSEE AMBIENT AIR QUALITY STANDARDS FOR GASEOUS FLUORIDES EXPRESSED AS HF

Primary Standards			Secondary Standards		
Concentration			Concentration		
μg/m³	ppb by vol	Averaging Interval	μg/m³	ppb by vol	Averaging Interval
1.2	1.5	30 days	1.2	1.5	30 days
1.6	2.0	7 days	1.6	2.0	7 days
2.9	3.5	24 hours	2.9	3.5	24 hours
3.7	4.5	12 hours	3.7	4.5	12 hours

Note:

1. All values are maximums not to be exceeded more than once per year.
2. Concentrations in micrograms per cubic meter (μg/m³) are approximate only.
3. All concentrations relate to air at standard conditions at 25°C temperature and 760 millimeters of mercury pressure.

"Primary ambient air quality standards define levels of air quality believed adequate, with an appropriate margin of safety, to protect the public health.

Secondary ambient air quality standards define levels of air quality believed adequate, with an appropriate margin of safety, to protect the public welfare from any known anticipated adverse effects of the pollutant."

ENVIRONMENTAL MONITORING PROGRAM

5.0 A summary of the environmental monitoring program is presented in Table 5.1. A summary of data for each sample medium and location mentioned is presented in Section 5.3.

5.1 Radiological Monitoring Program

5.1.1 Ambient Air Monitoring

Environmental air sampling is conducted continuously at seven (7) boundary site locations and nine (9) offsite locations. (Figure 5.1). The filters are exchanged weekly and are counted for gross alpha and beta radioactivity. In addition, composites from these locations are analyzed offsite for isotopic uranium on a semi-annual basis and for isotopic plutonium and thorium on an annual basis.

Air sample filters are exchanged weekly from a high volume sampler located at the NFS - Erwin site parking lot entrance. Filters are composited on a quarterly basis and sent to an offsite laboratory for uranium lung solubility analysis.

Ambient particle size distribution is conducted at least semi-annually at the NFS-Erwin site parking lot entrance. The sample is collected utilizing a multiple stage cascade impactor for a one-week sampling period. After collection, the sample is analyzed for gross alpha radioactivity for determination of Activity Median Aerodynamic Diameter.

5.1.2 Gaseous Effluent Monitoring

Samples of gaseous effluents, discharged from process facilities to the environs, are routinely taken at points as shown in Figure 5.2. Additional samples are taken as needed to supplement routine data or to verify/investigate the impact of process changes and unsubstantiated trends.

ENVIRONMENTAL LIQUID EFFLUENT MONITORING PROGRAM

TABLE 5.1

SAMPLE # &/OR DESCRIP.	COLLECTION FREQUENCY	SAMPLE VOLUME & TYPE	ALIQUANT VOL. PLATED/CT. TIME	H & S ANALYSIS (ES)	SPECIAL ANALYSIS (ES) IN HOUSE &/OR OUTSIDE LABS	VOLUME COMPOSITED	COMPOSITE ANALYSIS (ES) & FREQUENCY	VOLUME OF COMPOSITE SENT FOR ANALYSIS
#1 Martin Creek Upstream	Daily Mon-Fri	500 ml GRAB	100ml/30 min	gross α pH	None	None	None	Zero
2 Martin Creek Downstream	Daily Mon Tues-Fri	1000 ml GRAB 500 ml GRAB	100 ml/30 min 100 ml/30 min	gross α & β gross α & β pH	Send a 500 ml sample to the Bldg. 105 Labs for Ammonia (as N), Fluoride pH & Hg analysis. Nitrate (as N) None	100 ml/day	Gross α & β, isotopic uranium, isotopic thorium, isotopic plutonium on a <u>monthly</u> frequency.	1 liter to off-site lab.
3 Banner Spring Branch	(Same as #2 except use proportional sample from the water wheel.)							
4 Lower Pond #1	Daily Mon-Fri	500 ml GRAB	5 ml/30 min	gross α & β pH	None	Zero	None	Zero
5 Upper Pond #3	Daily Mon-Fri	500 ml GRAB	5 ml/30 min	gross α pH	None	Zero	None	Zero
Surface Drainage Ditch West	Daily Mon-Fri	500 ml GRAB	5 ml/30 min	gross α pH	None	50 ml/day	Gross α & β, isotopic U, isotopic Th, α isotopic Pu on a <u>quarterly</u> basis.	1 liter to off-site lab.
Sewer at Banner Creek	Daily Mon-Fri	500 ml from proportional sampler or a daily (Sat-Sun also) GRAB if sampler is not working.	5 ml/30 min	gross α pH	None	200 ml each per 100,000 liter flow per day or 200 ml/day if sampler is not working	Gross α & β, isotopic U, isotopic Th, and isotopic Pu on a <u>monthly</u> basis. Isotopic U on an <u>Inventory Period</u> basis.	1 liter to off-site lab. 500 ml each to off-site lab.
R Sewer Replicate	(Same as #8)							
Well at Burial Ground	Weekly Monday	2000 ml GRAB	100 ml/30 min	gross α & β pH	Send a 500 ml sample to the Bldg. 105 labs for Ammonia (as N), Fluoride pH and Hg Analysis. Nitrate (as N)	400 or 500 ml per weekly sample.	Gross α & β, isotopic uranium, isotopic Thorium, isotopic plutonium on a monthly basis.	500 ml to off-site lab. 1 liter retained for state.
0 Well between 6,000 Gallon Tanks	Weekly Monday	500 ml GRAB (302/3 Operator)	100 ml/30 min	gross α & β pH	None	200 or 250 ml per weekly sample.	Total F, Ammonia (as N), Nitrates (as N), pH, isotopic uranium on a <u>quarterly</u> basis.	500 ml to Bldg. 105 Lab. 500 ml to off-site lab.

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ENVIRONMENTAL LIQUID EFFLUENT MONITORING PROGRAM
TABLE 5.1 (CONT.)

SAMPLE # &/OR DESCRIP.	COLLECTION FREQUENCY	SAMPLE VOLUME AND TYPE	ALIQUANT VOLUME PLATED/CT. TIME	H & S ANALYSIS (ES)	SPECIAL ANALYSIS (ES) IN-HOUSE &/OR OUTSIDE LABS	VOLUME COMPOSITED	COMPOSITE ANALYSIS (ES) AND FREQUENCY	VOLUME OF COMPOSITE SENT FOR ANALYSIS
#11 Coolant Water Discharge (233)	Weekly Tuesday	500 ml GRAB	100 ml/30 min	gross α & β pH	None	Zero	None	Zero
#12 Pond #2	Daily Mon.-Fri.	500 ml GRAB	5 ml/30 min.	gross α pH	None	Zero	None	Zero
#13 Laundry Rinse Tank	When full	100 ml each per every lanudry load (Laundry Operator)	1 ml/30 min.	gross α	None	200 or 250 ml/week	Isotopic U on an <u>Inventory</u> <u>Period</u> basis.	500 ml to off-site lab.
#14 Laundry Rinse Tank - Replicate	"		"	"	"	200 or 250 ml/month	"	"
#15 Laundry Wash Sump	"		Composite weekly and count 1 ml/30 min.	"	"	"	"	"
#16 Laundry Wash Sump - Replicate	"		"	"	"	"	"	"
#17 Coolant Water Discharge (130)	Quarterly	500 ml GRAB	100 ml/30min	gross α & β pH	None	Zero	None	Zero
Waste Water Treatment Facility Discharge Batches	Every Batch	1000ml GRAB (WWTF Operator)	5 ml/30 min	gross α & β	None	0.005 ml for every liter discharged	Gross α & β, isotopic U, Tc-99, Th-234, Pu-234, on a <u>monthly</u> basis.	1 liter to off-site lab, 1 liter for state, and 1 liter retained.
	1 Batch/ Month	3 x 1 L/Batch (WWTF Operator) a) 1 L Treated 2 ml HNO_3 b) 1 L Treated 2 ml H_2SO_4 c) 1 L Untreated (a, b, & c are stored at 4°C & shipped off-site packed in ice)	Zero	None	a) Analysis off-site for As, Cd, Cr, Cu, Pb, Ni, Zn, & Ag b) Analysis off-site for COD & Ammonia c) Analysis off-site for BOD, Nitrate, Fluoride.			

ENVIRONMENTAL LIQUID EFFLUENT MONITORING PROGRAM

TABLE 5.1 (CONT.)

SAMPLE # &/OR DESCRIP.	COLLECTION FREQUENCY	SAMPLE VOLUME & TYPE	ALIQUANT VOLUME PLATED/CT. TIME	H & S ANALYSES (ES)	SPECIAL ANALYSIS (ES) IN-HOUSE &/OR OUTSIDE LABS	VOLUME COMPOSITED	COMPOSITE ANALYSIS(ES) & FREQUENCY	VOLUME OF COMPOSITE SENT FOR ANALYSIS
Nolichucky River Upstream	Monthly	5 liter GRAB	100 ml/30min	Gross α & β	Sample split in half and blended for state analysis.	Zero	None	Zero
Nolichucky River Downstream	Monthly	5 liter GRAB	100 ml/30 min	Gross α & β	Sample split in half and blended for state analysis. 500 ml sent to Bldg. 105 Lab for Ammonia Fluorides pH and Hg analysis. Nitrate.	1 liter monthly	Gross α & β, isotopic U, isotopic Th, and and isotopic Pu.	1 liter to off-site lab.
Martin Creek Upstream (Carolina Avenue)	Monthly	500 ml GRAB	100 ml/30 min	Gross α & β	None	Zero	None	Zero
Banner Spring Branch Upstream	Monthly	500 ml GRAB	100 ml/30 min	Gross α & β	None	Zero	None	Zero
Municipal Sewer (Outside Perimeter)	Monthly	5 liter GRAB	100 ml/30 min	Gross α & β	Sample split in half and blended for state analysis.	Zero	None	Zero
Waste Water Treatment Facility (At outfall at Nolichucky River)	Monthly (When Discharging)	5 liter GRAB	100 ml/30 min	Gross α & β	Sample split in half and blended for state analysis	Zero	None	Zero
Groundwater Monitoring Wells #1 - 14	Monthly	2 liter GRAB	250ml/30 min	Gross α & β	Isotopic U, Th, Pu NO_3 (as N) F Hg NH_4 (as N)			

ENVIRONMENTAL SOIL AND SEDIMENT MONITORING PROGRAM

TABLE 5.1 (CONT.)

SAMPLE LOCATION OR DESC	COLLECTION FREQUENCY	SAMPLE WEIGHT & TYPE	WT. ALIQUANTED AND VOLUME PLATED/ COUNT TIME	H & S ANALYSIS(ES)	SPECIAL ANALYSIS(ES) IN HOUSE &/OR OUTSIDE LABS	VOLUME COMPOSITED	COMPOSITE ANALYSIS(ES) & FREQUENCY	VOLUME OF COMPOSITE SENT FOR ANALYSIS
SOIL								
Soil at Asheville Highway Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Soil at Carolina Avenue Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Soil at Little Mtn Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
SEDIMENT								
Nolichucky River Silt at Upstream Sampling Point	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Nolichucky River Silt at Downstream Sampling Point	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Martin Creek at Upstream Sampling Point (Carolina Avenue)	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Martin Creek at Downstream Sampling Point (RR Trestle)	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Banner Spring at Upstream Sampling Point	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Banner Spring at Downstream Sampling Point	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Lower Pond #1	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Upper Pond #3	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero

ENVIRONMENTAL VEGETATION MONITORING PROGRAM

TABLE 5.1 (CONT.)

SAMPLE LOCATION	COLLECTION FREQUENCY	SAMPLE WEIGHT & TYPE	WT. ALIQUANTED & VOLUME PLATED/ COUNT TIME	H & S ANALYSIS(ES)	SPECIAL ANALYSIS(ES) IN HOUSE &/OR OUTSIDE LAB	VOLUME COMPOSITED	COMPOSITE ANALYSIS(ES) & FREQUENCY	VOLUME OF COMPOSITE SENT FOR ANALYSIS
Vegetation at Asheville Highway Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Vegetation at Carolina Avenue Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero
Vegetation at Little Mountain Sampling Station	Monthly	500 gram GRAB	10 grams 2 mls/30 min	Gross α & β	Special Request Only	Zero	None	Zero

ENVIRONMENTAL AIR MONITORING PROGRAM
TABLE 5.1 (CONT.)

SAMPLE LOCATION	COLLECTION FREQUENCY	SAMPLE TYPE	COUNT TIME	H & S ANALYSIS(ES)	SPECIAL ANALYSIS(ES) IN-HOUSE &/OR OUTSIDE LAB	FILTER MEDIA COMPOSITED	COMPOSITED ANALYSIS(ES)	FREQUENCY
Perimeter Air Samp-ng Station #170	Weekly	Glass Fiber Type AE Filter	180 min	Gross α & β	Special Request Only	½ Filter/Week ½ Filter/Week	Isotopic Uranium Isotopic Thorium & Plutonium	Semi-annually To Off-site Lab Annually to Off-site Lab
Perimter Air Sampling ation #171	"	"	"	"	"	"	"	"
Perimeter Air Sampling ation #172	"	"	"	"	"	"	"	"
Perimeter Air Samp-ig Station #173	"	"	"	"	"	"	"	"
'erimeter Air Samp-ig Station #174	"	"	"	"	"	"	"	"
Perimeter Air Samp-ig Station #217	"	"	"	"	"	"	"	"
'erimeter Air Samp-ig Station #218	"	"	"	"	"	"	"	"
tle Mountain Air ipling Station #322	"	"	"	"	"	½ Filter/Week ½ Filter/Week	Isotopic Uranium Isotopic Thorium & Plutonium	Quarterly to Off-site Lab Annually to Off-site Lab
olina Avenue Air pling Station #323	"	"	"	"	"	"	"	"
king Lot Entrance Sampling Station 2	"	"	"	"	"	"	"	"
olina Avenue/Stalling e Air Sampling Sta-n #381	"	"	"	"	"	"	"	"
lling Lane SE Air pling Station #382	"	"	"	"	"	"	"	"
hland Ave/1st Street Sampling Station 3	"	"	"	"	"	"	"	"

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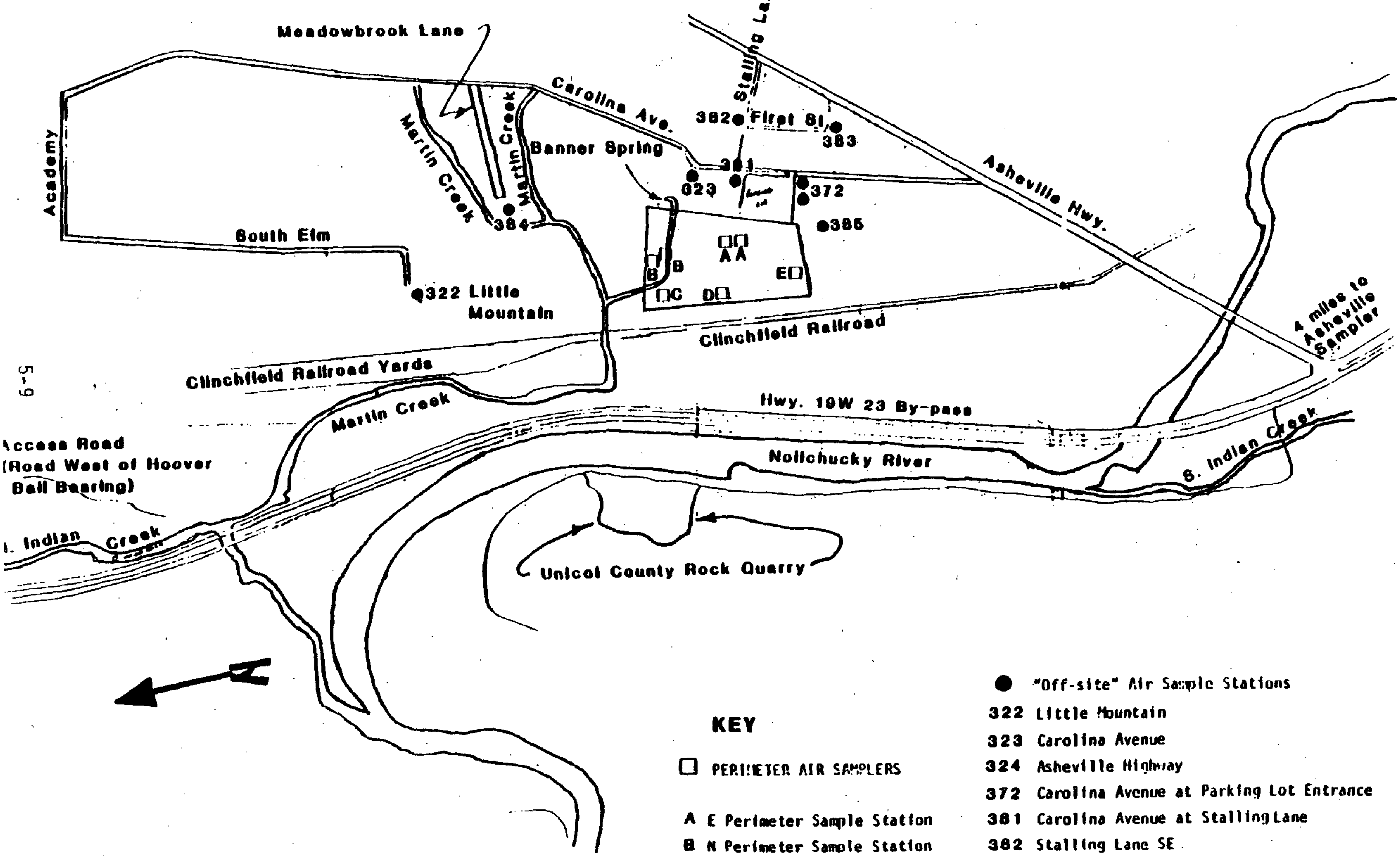
ENVIRONMENTAL AIR MONITORING PROGRAM
TABLE 5.1 (CONT.)

SAMPLING LOCATION	COLLECTION FREQUENCY	SAMPLE TYPE	COUNT TIME	H & S ANALYSIS(ES)	SPECIAL ANALYSIS(ES) IN-HOUSE &/OR OUTSIDE LAB	FILTER MEDIA COMPOSITED	COMPOSITED ANALYSIS(ES)	FREQUENCY
Meadowbrook Lane NE Air Sampling Station #384	Weekly	Glass Fiber Type AE Filter	180 min	Gross α & β	Special Request Only	½ Filter/Week ½ Filter/Week	Isotopic Uranium Isotopic Thorium & Plutonium	Quarterly to Off-site Lab Annually to Off-site Lab
ecurity Fence SE Air ampling Station #385	"	"	"	"	"	"	"	"
ittle Mountain Redundant ampling Station #415	"	"	"	"	"	"	"	"

FIGURE 5.1

PERIMETER AND OFFSITE AIR SAMPLERS



KEY

□ PERIMETER AIR SAMPLERS

A E Perimeter Sample Station
B N Perimeter Sample Station
C NW Corner Security Fence
D W Perimeter Sample Station
E S Perimeter Sample Station

● "Off-site" Air Sample Stations

322 Little Mountain
323 Carolina Avenue
324 Asheville Highway
372 Carolina Avenue at Parking Lot Entrance
381 Carolina Avenue at Stalling Lane
382 Stalling Lane SE
383 Highland Avenue at First Street
384 Meadowbrook Lane NE
385 Security Fence SE

(b)(4)

TABLE 5.10A

ANNUAL AVERAGE SURFACE WATER BETA RADIOACTIVITY
(uCi/ml X E-06)

LOCATION	1984	1985	1986	1987	1988	1989
Banner Spring Branch (Upstream)	0	0	0.0075	0.0087	0.0102	0.0071
Banner Spring Branch (Downstream)	0	0.02	0.0135	0.0108	0.0113	0.0106
Martin Creek at Carolina Avenue (Upstream)	0	0	0.0042	0.0136	0.0092	0.0076
Martin Creek at Banner Spring Mouth (Upstream)	---	---	---	0.0073	0.0097	0.0055
Martin Creek (Downstream)	0	0.01	0.0137	0.0092	0.0114	0.0085
Nolichucky River (Upstream)	0	0	-0.0005	0.0134	0.0095	0.0067
Nolichucky River (Downstream)	0	0	0.0022	0.0145	0.0102	0.0077

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Each release point that may contain radionuclides is provided with a particulate filter and sample pump that operates continuously during facility use. The filters are exchanged and analyzed daily Monday through Friday. Certain release points having potential for more significant releases are analyzed 7 days a week.

In addition to the filter sampling systems used on all process exhausts, some gaseous effluent streams are equipped with absorbing impingers after the particulate sampler.

Samples are collected at a rate of 40 liters per minute (10 liters per minute with impingers). Stack samples are collected isokinetically.

The main high enriched uranium stack is also equipped with an alarming constant air monitoring system.

The concentration of radionuclides released via the wall vents in Bldg. 111 is calculated based on the average room air concentration within the facility as measured by the stationary room air samplers, taking into consideration the discharge rate of the fans.

The laundry dryer vent is equipped with a continuous sampler, with the filter being collected daily, Monday through Friday and is analyzed for gross alpha radioactivity.

5.1.3 Surface Water Monitoring

Samples collected in the following surface waters constitute the surface water monitoring program: Banner Spring Branch both upstream and downstream of the plant, Martin Creek both upstream and downstream, Nolichucky River both upstream and downstream, and the previously utilized waste retention ponds numbers 1, 2, and 3 (See Figure 5.3).

Water samples are collected daily, Monday thru Friday from Martin Creek upstream and downstream, and Banner Spring Branch downstream. Samples are analyzed for gross

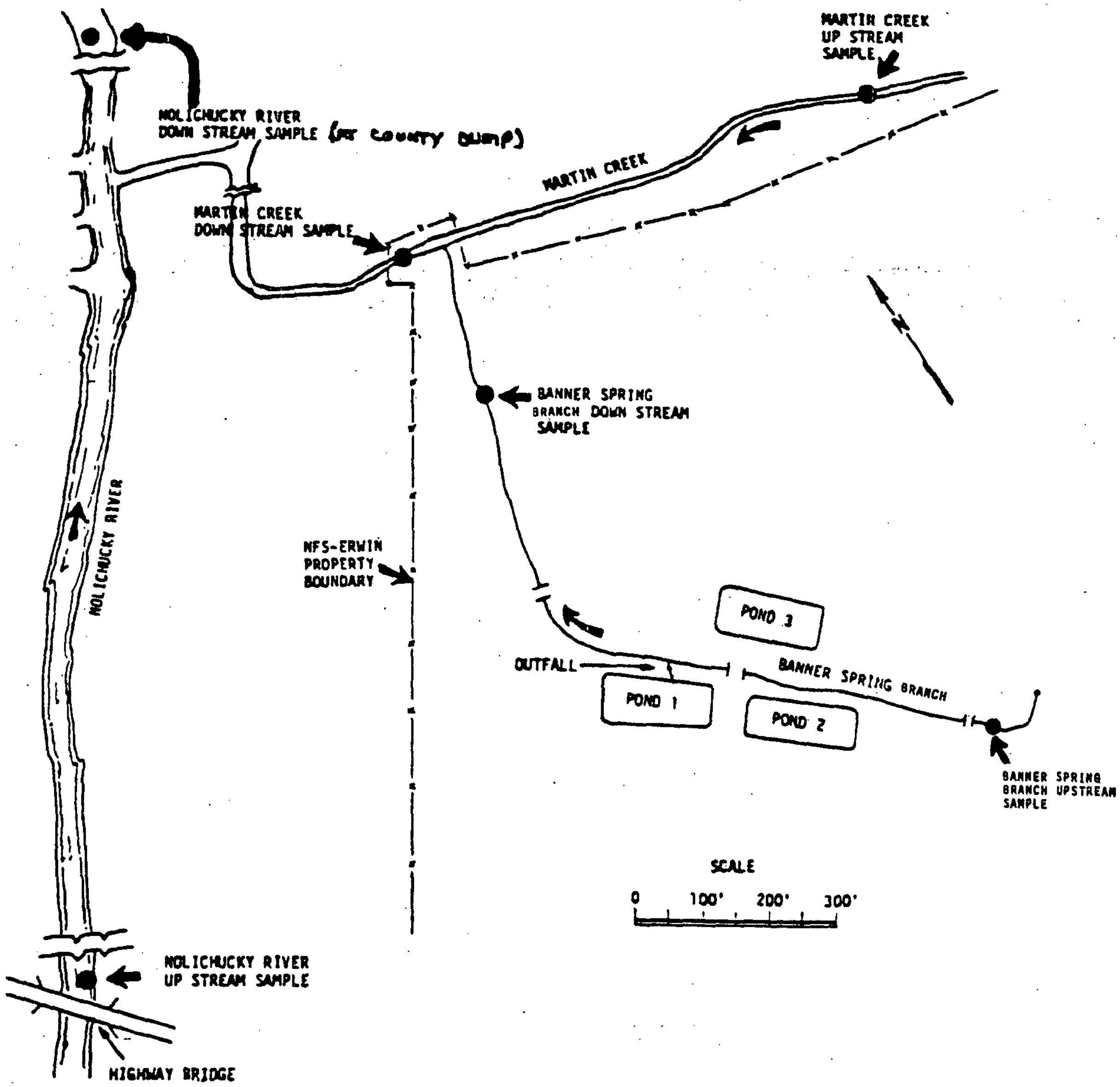


FIGURE 5.3
LIQUID SAMPLING LOCATIONS

alpha radioactivity. Water samples are also collected on a monthly basis from Martin Creek upstream (at Carolina Ave.), and downstream, and Banner Spring Branch upstream. These samples are analyzed for gross alpha and beta radioactivity.

An aliquot from each daily sample, Martin Creek and Banner Spring downstream, is composited and sent to an offsite laboratory monthly, for analysis of isotopic uranium, thorium, and plutonium, as well as gross alpha and beta radioactivity.

Water samples are collected monthly from Nolichucky River upstream and downstream. Upstream samples are analyzed for gross and beta radioactivity. Downstream samples are analyzed for gross alpha and beta radioactivity and an aliquot is composited monthly and sent to an offsite laboratory for analysis of gross alpha and beta radioactivity, isotopic uranium, thorium, and plutonium. Also, both upstream and downstream samples are blended and split in half for comparative analysis with the State Health Department.

Water samples from the previously utilized waste retention ponds are collected daily, Monday thru Friday. Samples are analyzed for gross alpha and beta radioactivity.

5.1.4 Groundwater Monitoring

Prior to the installation of fourteen (14) additional groundwater wells, this program consisted of well sampling in the vicinity of the 6,000 gallon underground tanks north of Building 303 and the sampling of groundwater from a well located north of the burial ground at the extreme north end of the plant property. Water samples from the well at the burial ground are collected on a weekly basis and analyzed for gross alpha and beta radioactivity. An aliquot is sent monthly to an offsite laboratory to be analyzed for gross alpha and beta radioactivity, isotopic uranium, thorium and plutonium. One liter of the well water sample is retained and given to the State Health Dept. on a monthly basis for comparative analysis.

Water samples are collected on a weekly basis from the well between the 6,000 gallon tanks and is analyzed for gross alpha and beta radioactivity. An aliquot is composited quarterly and sent to an offsite laboratory to be analyzed for isotopic uranium.

In February 1984, fourteen (14) additional groundwater wells were installed for the purpose of determining the impact of the plant operations on the perched water table. See Figure 5.4 for approximate well locations. Water samples are collected on a monthly basis and are analyzed for gross alpha and beta radioactivity. If the gross alpha concentration exceeds the action limit of 15 pCi/l, offsite isotopic analysis is conducted for uranium, plutonium, and thorium. If the beta concentration exceeds the action limit of 50 pCi/l, offsite technetium 99 analysis is performed. Monthly samples are composited on a quarterly basis and sent to an offsite laboratory to be analyzed for isotopic uranium and isotopic plutonium.

5.1.5 Municipal Sewer Monitoring

Sewer samples taken from a location inside the plant perimeter, are collected daily and analyzed for gross alpha and pH. An aliquot of daily samples is composited and sent monthly to an offsite lab to be anlayzed for gross alpha and beta radioactivity, isotopic uranium, thorium, and plutonium. Sewer samples taken from a location outside the plant perimeter (Figure 3.6), are collected on a monthly basis and analyzed for gross alpha and beta radioactivity. This sample is split in half and blended for comparative analysis with the State Health Department.

(b)(4)

TABLE 5.15A

PROCESS WATER EFFLUENT AVERAGE RADIOACTIVITY LEVELS
WASTE WATER TREATMENT FACILITY
(All Values in Units of uCi/ml E-7)

YEAR	GROSS ALPHA	GROSS BETA	U-234	U-235	U-238	234 Th-Pa	99 Tc
1984	48.96	104.56	68.06	2.52	1.86	10.34	87.21
1985	24.54	80.44	39.47	3.50	1.85	4.72	48.18
1986	22.36	64.54	43.19	3.97	1.56	0.59	133.98
1987	18.24	88.11	24.12	1.50	0.84	2.92	185.23
1988	13.80	30.13	26.68	0.79	0.74	1.78	68.61

5.1.6 Process Water Monitoring

Process water monitoring includes samples collected from the Waste Water Treatment Facility (prior to discharge) and the Building 233 cooling water loop.

Samples are collected from every W.W.T.F. discharge batch and are analyzed for gross alpha and beta radioactivity and grams uranium per liter. An aliquot is composited monthly and sent to an offsite laboratory to be analyzed for gross alpha and beta radioactivity, isotopic uranium, technetium-99, thorium-234, and protactinium-234. An aliquot is composited monthly and retained for the comparative analysis with the State Health Department. Discharges from the W.W.T.F. are all directed to the Nolichucky River.

The coolant water discharge sample is collected on a weekly basis and analyzed for gross alpha and beta radioactivity.

5.1.7 Stormwater and Surface Drainage Monitoring

Prior to the construction of the new plant stormwater drainage system, this program consisted of sampling the standing water in the Drainage Ditch at the Railroad Siding and the Surface Storm Drainage Ditch. With the completion of the new plant stormwater drainage system in December, 1983, the previously monitored ditches no longer exist. The current program consists of samples collected from standing water in the concrete ditch on the west side of the plant at the main sluice valve and the continuous sampler located just outside the security fence in Banner Spring Branch. Banner Spring Branch receives storm water runoff via four separate branches (see Section 3.3.3). Water samples are collected daily, Monday thru Friday from the Surface Drainage Ditch West. Samples are analyzed for gross alpha radioactivity. An aliquot is composited quarterly and sent to an offsite laboratory for analysis of isotopic uranium, thorium, and plutonium, as well as gross alpha and beta radioactivity. Water samples are collected daily, Monday thru Friday from the continuous sampler located in Banner Spring Branch. Samples are analyzed for gross alpha and beta radioactivity. An aliquot is composited monthly and sent to an offsite laboratory to be analyzed for gross alpha and beta radioactivity, isotopic uranium, thorium and plutonium.

5.1.8 Sediment Monitoring

Sediment samples are taken once per month from the previously utilized waste retention ponds numbers 1 & 3; both upstream and downstream in: 1) Banner Spring Branch; 2) Martin Creek; & 3) Nolichucky River. Sediment from the top one-quarter inch of a square foot of stream bed is analyzed for gross alpha and beta radioactivity.

5.1.9 Soil & Vegetation Monitoring

Soil and Vegetation samples are collected monthly at the Asheville Highway, Little Mountain, and Carolina Avenue locations. Because the prevailing wind is out of the south, most of the sample locations were chosen north of the release point. The Asheville Highway sampling site, which is located 5 miles south of the plant is considered to represent the background for the area. Samples are analyzed for gross alpha and beta radioactivity.

5.1.10 TLD Monitoring

Twelve (12) permanent TLD stations are maintained on and around the site (Figure 5.5). TLD's are exchanged on a quarterly basis.

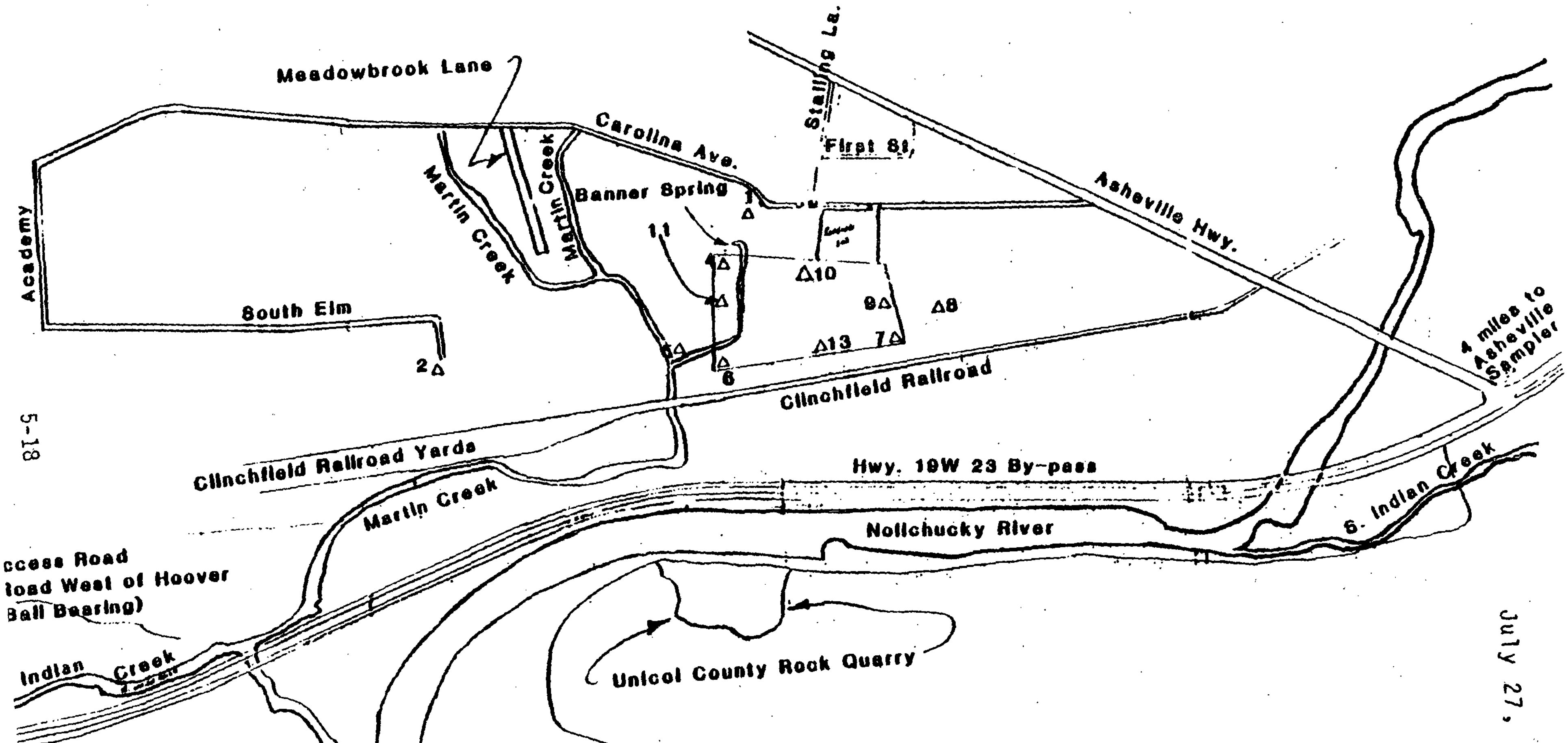
5.2 Non-Radiological Monitoring Program

5.2.1 Air Monitoring

No routine-on or offsite nonradiological monitoring is currently conducted. However, for an extended period prior to the installation of the upgraded high enriched uranium process ventilation system, extensive air

FIGURE 5.5

TLD LOCATIONS



KEY

- Δ TLD Locations
- 1 Carolina Avenue Station 323
- 2 Little Mountain Station 322
- 3 Asheville Highway Station 324
- 4 NE Corner Security Fence
- 5 Fence N of Plant near Martin Creek
- 6 NW Corner Security Fence
- 8 Telephone Pole S of Plant
- 9 S Perimeter Sample Station
- 10 E Perimater Sample Station
- 11 N Perimeter Sample Station
- 13 W Perimeter Sample Station

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effluent monitoring for fluorides was conducted. After demonstration that ambient fluoride levels were not exceeded, the monitoring was discontinued(Section 2.7.2.1).

5.2.2 Surface Water Monitoring

Downstream samples from Martin Creek, Banner Spring Branch and the Nolichucky River are analyzed for pH, ammonia, nitrate, fluoride, and mercury. Pond samples are analyzed for pH.

5.2.3 Groundwater Monitoring

Samples collected from the 16 groundwater wells are analyzed on a weekly or monthly basis for ammonia, nitrate, fluoride, pH and mercury.

5.2.4 Municipal Sewer Monitoring

Daily sewer samples are analyzed for pH.

5.2.5 Process Water Monitoring

A new NPDES permit was issued by the State Health Department for the operation of NFS' Waste Water Treatment Facility in February of 1984 (Discharge 001). It contained the discharge limitations summarized in Table 5.2. NFS' previous NDPES permit included different limitations also summarized in Table 5.2. Monitoring for these parameters was conducted on a per batch basis. In addition, monthly samples were/are analyzed offsite for Nitrate, Ammonia, COD, BOD, Boron, Cadmium, Total Suspended Solids, Fluoride, Mercury, Arsenic, Chromium, Copper, Lead, Nickle, Zinc and Silver.

The non-contact coolant water loop (discharge 002) is monitored on a weekly basis with analyses for pH, flow, and temperature. See Table 5.3 for NFS' NPDES permit limitation history on this source.

TABLE 5.2

PERMIT LIMITS FOR DISCHARGE 001

	1979 Average	1979 Maximum	1980-83 Average	1980-83 Maximum	1984 Average	1984 Maximum
Discharge Volume - M^3/day	NA	NA	NA	NA	NA	NA
Total Suspended Solids - kg/day (mg/l)	3.90 (40)(3)	17	5	8	NA	4.05
Ammonia as N - kg/day (mg/l)	1.95 (20)(1)	8	NA	3.0 (30)	NA	2.90 (30)
Nitrates as N - kg/day	NA	297.5	NA	298	NA	296
Fluoride - kg/day (mg/l)	1.95 (20)(1)	8	NA	3.0 (30)	NA	2.9 (30)
Boron - kg/day	NA	42	42	42	NA	NA
Mercury	5 μg/l	5 μg/l	0.005 mg/l	0.005 mg/l	NA	NA
Settleable Solids - (ml/l)	(1)	(1)	(1)	(1)	NA	(0.5)
Chlorine Residual - (mg/l)	NA	NA	NA	(2.0)	NA	(2.0)
pH - Standard Units 6.0 minimum	NA	9.0	NA	9.0	NA	9.0
Cadmium	NA	10 μg/l	0.01 mg/l	0.01 mg/l	NA	NA (5)
BODs - kg/day (mg/l)	2.95 (30)(2)	12	NA	NA	NA	NA (4)
COD	NA	NA	NA	NA	NA	NA (4)
Uranium - kg/day (mg/l)	NA	NA	NA	NA	NA	0.41 (4.0)
(5) Heavy Metals	NA	NA	NA	NA	NA	NA (5)

(1) - Monthly average on Concentration. Daily maximum limit is 30 mg/l.
(2) - Monthly average on Concentration. Daily maximum limit is 40 mg/l.
(3) - Monthly average on Concentration. Daily maximum limit is 50 mg/l.
(4) - No limits were imposed in the 1984 permit. An addendum to the DMR will be submitted semi-annually demonstrating 85% in-house removal of BOD and COD
(5) - No limits were imposed in the 1984 permit. Heavy metals arsenic, cadmium, dhromium, copper, lead, nickel, zinc, and silver will be monitored quarterly and reported quarterly by addendum to the DMR.

TABLE 5.3

PERMIT LIMITS FOR DISCHARGE 002

	1979		1980-83		1983-84	
	Average	Maximum	Average	Maximum	Average	Maximum
Discharge Volume - M^3/day	NA	NA	NA	NA	NA	NA
Discharge Temperature - ^oF	NA	95	95	100	NA	150
pH - Standard Units (minimum = 6.0)	NA	NA	NA	9.0	NA	9.0

5.2.6 Stormwater and Surface Drainage Monitoring

Daily surface drainage ditch and downstream Banner Spring Branch samples are analyzed for pH. Once per week Banner Spring Branch samples are analyzed for ammonia, fluoride, nitrate and mercury.

5.2.7 Soil, Sediment and Vegetation Monitoring

No routine nonradiological monitoring of soil, sediment or vegetation is currently conducted.

5.2.8 Meterological Monitoring

Wind direction and velocity are measured by sensors located atop a 120 foot tower northeast of Building 340. The wind speed and direction data are used to assess the dispersion of routine releases and in the event of an emergency (criticality or a uranium release). Strip charts are sent to an offsite laboratory every two weeks. The average wind velocity and direction are summarized. A wind rose which plots the observed wind direction, frequency, and speed is also included. This information is then composited on a quarterly basis for review. (See Section 2.6.3).

In addition to wind data, a precipitation gauge measures daily precipitation.

5.3 Summary of Effluent and Environmental Monitoring Data and Interpretation

Several significant changes in plant operation and available control equipment have been made in the five year data reporting period. These changes are noted in the applicable discussion that follows. Sections 5.3.1 through 5.3.9 summarize radiological monitoring data and Section 5.3.10 summarizes non-radiological monitoring.

5.3.1 Ambient Air Monitoring

Background station, perimeter and offsite air sampling data for the period January 1979 through December 1983 is summarized in Table 5.4. Generally, decreases have been noted at all locations. The decreases were

TABLE 5.4

SUMMARY OF ENVIRONMENTAL AIR SAMPLING
AVERAGE GROSS ALPHA RADIOACTIVITY (uCi/ml x 10^{-14})

LOCATION	1979	1980	1981	1982	1983
Background Station					
Asheville Highway (8 km SW)	1.05	1.4	0.8	0.35	0.49
Perimeter					
Northeast	4.2	5.25	2.3	1.4	1.07
East	15.8	5.4	4.0	1.5	1.42
South	3.0	3.0	1.4	0.7	0.87
West	4.0	5.25	3.25	2.4	2.32
Northwest	4.0	6.0	4.0	2.15	1.76
Offsite					
Little Mtn. (800 m NE)	2.6	2.1	1.8	0.45	0.48
Carolina Ave. (300 m ESE)	2.6	2.35	1.15	0.40	0.58
(1) Emergency Hse. (280 S) (Station B)	--	--	0.7	0.70	0.75
(1) Carolina Ave./Stalling Ln. (215 m SE)	--	--	0.7	0.50	0.78
(1) Stalling Lane (315 m SE)	--	--	0.4	0.45	0.78
(1) Highland/1st st. (405 m S)	--	--	0.6	0.45	0.58
(1) Meadowbrook Lane (540 m ENE)	--	--	0.4	0.85	0.51
(1) Security Fence (210 m SSW)	--	--	0.7	0.7	0.62

(1) - Six (6) new samplers began operation during the second half of 1981.

TABLE 5.4A

SUMMARY OF ENVIRONMENTAL AIR SAMPLING
AVERAGE GROSS ALPHA RADIOACTIVITY (uCi/ml E-14)

LOCATION/SAMPLE TYPE	1989
PERIMETER - NE* (2 SAMPLE AVG) #173,217	0.26
PERIMETER - E (2 SAMPLE AVG) #174,218	0.42
PERIMETER - S #172	0.46
PERIMETER - W #171	0.36
PERIMETER - NW #170	0.24
PERIMETER - ENE #555	0.42
OFF-SITE - LITTLE MTN. (APPROX. 800 M NE)#322	0.24
OFF-SITE - CAROLINA AVE (APPROX. 300M ESE)#323	0.23
OFFSITE - ASHEVILLE HWY. (APPROX. 8 km SW) #324	0.2
OFFSITE - EMERG. HOUSE (280 m S) #372	0.27
OFFSITE - CAROLINA AVE. STALLING LANE (215 m SE)#381	0.27
OFFSITE - STALLING LANE (315 M SE) #382	0.25
OFFSITE - HIGHLAND AVE. FIRST STREET (405 m S) #383	0.26
OFFSITE - MEADOWBROOK LANE (540 m ENE) #384	0.2
OFFSITE - SECURITY FENCE (210 m SSW) #385	0.29
OFFSITE - SEWER MOUND (APPROX. 300 m N) #553	0.33

* DOWNWIND OF PREVAILING WIND

MOST RESTRICTIVE UNRESTRICTED AREA MPC FOR URANIUM (INSOLUBLE): 400 E-14
MOST RESTRICTIVE UNRESTRICTED AREA MPC FOR PLUTONIUM (SOLUBLE): 6 E-14 uCi/ml

TABLE 5.4B

LUNG SOLUBILITY AND PARTICLE SIZE SUMMARY
FROM SAMPLES COLLECTED
AT THE PARKING LOT ENTRANCE

PERIOD	AMAD (MICRO METERS)	%CLASS D	%CLASS W	%CLASS Y
1st Qtr 1988	1.5	47	0	53
2nd Qtr 1988	1.2	53	0	47
3rd Qtr 1988	1.3	62	0	38
4th Qtr 1988	1.1	43	0	58
1st Qtr 1989	1	26	0	74
2nd Qtr 1989	0.7	29	0	71
3rd Qtr 1989	0.7	38	0	62
4th Qtr 1989	1.5	*	*	*

*DATA NOT YET RECEIVED FROM CONTRACTOR LABORATORY.

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caused by increased control over plant discharges. Also, a contributor to these decreases was the construction and operation of a new laboratory. The purpose of this laboratory was to provide a separate area to process low activity environmental samples away from potentially high activity in-plant samples. The operation of this Environmental Lab has resulted in increased sensitivity and precision over the previous arrangement.

5.3.2 Stacks and Room Ventilators

Tables 5.5 and 5.6, summarize stack and room ventilator effluent concentrations for the period January 1979 through December 1983. Table 5.7 and 5.8 summarizes total activity discharged over the same period.

A total of 19 room ventilators operated in both the main production facility (Bldgs. 302/303) and the high enriched scrap recovery facility until the installation of the main plant process air cleaning system in 1983 (See Section 3.3.1). These data show highly variable annual average discharge concentrations. This variability was caused by several factors: 1) The specific activity (U-234 Percentage) of the uranium feed material fluctuated by a factor of two during the period 2) Room ventilator discharges were not continuously monitored. Rather grab samples coupled with rated ventilator discharge flows were used to calculate the reported concentrations. High enriched uranium room ventilators no longer exist at the NFS facility.

The wall vent concentrations in Building 111 have shown a slight decrease which is a function of a decrease in total material processed per year.

Twenty six separate stacks have vented radioactive material over the period 1979-1983. Eleven of these do not currently operate. A review of these data show: 1) A slight decrease in LEU discharges for the reason stated above; 2) Plutonium discharges which decrease with time since production in the facility ceased in 1972

TABLE 5.5

ROOM AIR VENTILATOR EFFLUENT CONCENTRATIONS
GROSS ALPHA

(μCi/ml x 10-12)

VENT NO.	BLDG. NO.	1979	1980	1981	1982	1983
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**
6	303	0.20	0.74	1.44	4.55	2.28**
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**
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**
WALL VENTS	111	5.10	5.65	4.47	4.67	2.26

* These vents were decommissioned prior to January 1983.

** These vents were decommissioned during 1983. No room air ventilators exist in HEU areas.

TABLE 5.6

SUMMARY OF STACK EFFLUENT CONCENTRATIONS
ALL UNITS IN $\mu Ci/ml \times 10^{-12}$

PROCESS MATERIAL	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.
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
	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
	29	234A	Wet Cell Scrubber	2.7	0.2	1.5	0.1	6.4	0.2	0.5	0.1	0.4	0.1
	224	234C	Dissolution Glove Boxes	4.1	0.6	2.9	0.2	0.9	0.1	1.2	0.1	0.6	0.04
	36	234C	Purification Cell	10.0		32.9	1.3	43.5	1.5	*			
	51	234C	Purification Dry Boxes	5.7		87.4	1.7	*					
H.E. Uranium	185	131	Pilot Plant Dry Boxes	38.8		26.6	0.7	524.0	1.1	5.0	0.4	2.3	0.2
	207/358	302	Prod. Gloves Boxes & Hoods	15513.4		4074.7	189.2	23,000.0	212.3	335.0	23.9	*	
	219	233	"Wet" Line Hoods	615.6		10,172.0	27.2	11,086.0	177.6	869.0	42.2	*	
	253	233	Calciner Dry Box Line	63.9		200.9	9.6	19.8	1.2	25.0	1.2	*	
	299	105	Spec Lab Prep. Dry Box	26.4		*							
	300	105	Phys. Test Dry Boxes	18.5		*							
	317	302	Incinerator Room	4091.2		124.4	5.4	458.2	32.0	612.0	30.6	*	
	332	120	Maintenance Welding Hood	87.9		216.7	1.6	11.9	0.4	2.3	0.4	6.4	0.2
	333	110D	Spec Lab Arc Stand	56.5		37.9	0.8	6.5	0.4	5.0	3.3	4.1	0.7
	334	105	Laboratory Hoods & Glove Boxes ***			110.8	12.9	43.0	2.9	19.0	2.6	*	
	337	105	Physical Testing Stand	21.0	1.2	*							
	338	105	Physical Testing Lab	23.3	0.8	*							
	416		Main Process Ventilation ***									51.5	4.0
	376	301	BEST Facility ***									94.7	5.5
	421	100	Laundry Stack	2.3	1.2	7.6	2.6	3.7	2.0	2.3	1.8	1.8	0.8
L.E. Uranium	103	110		0.5	0.1	12.7	0.8	6.6	0.2	1.0	0.1	0.6	0.1
	104	110		0.8	0.1	8.1	0.8	119.9	0.6	1.4	0.1	0.6	0.1
	278	111		508.9	50.1	344.8	31.9	428.0	24.9	207.0	7.3	91.7	10.7
	287	111		37.1	8.0	710.6	97.7	1436.8	72.8	128.4	12.7	24.5	2.9
	320	130		11.3	0.9	**		117.7	1.5	1759.0	26.1	678.7	11.3
	354	110	Trash Compactor ***					34.0	0.5	22.0	0.4	3.9	0.1

* - Decommissioned
** - Not in Operation
*** - Installed during the year data appears.

TABLE 5.6.1A

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

PROCESS MATERIAL		STACK NO.	BLDG. NO.	DESCRIPTION	1984 MAX	1984 AVG	1985 MAX	1985 AVG	1986 MAX	1986 AVG
PLUTONIUM		27	234A	PROD. GLOVE BOX LINE	1.80	0.06	2.25	0.06	0.65	0.05
		28	234A	ROOM AIR CELL	0.78	0.04	2.69	0.05	4.77	0.12
		29	234A	WET CELL SCURBBER	0.69	0.06	0.66	0.04	0.41	0.06
		224	234A	DISSOLUTION GLOVE BOXES	0.51	0.02	0.46	0.02	1.59	0.07
	(1)	554	110	ROOM AIR FROM CWB LAB .	---	---	---	---	---	---
	(7)	583	234	PU LAB EXHAUST	---	---	---	---	---	---
		103	110	DRY BOXES	1.56	0.06	0.78	0.04	0.68	0.04
		104	110	DRY BOXES	0.41	0.03	0.62	0.04	0.32	0.04
H. E. URANIUM	(2)	185	131	PROD. DRY BOXES	3.74	0.12	1.06	0.10	---	---
		332	120	MAINTENANCE WELDING HOOD	0.76	0.06	7.18	0.11	1.91	0.14
		333	110	SPEC LAB ARC STAND	0.82	0.10	2.70	0.07	0.71	0.07
		416		MAIN PROCESS VENTILATION	450.8	7.66	107.07	3.02	54.08	5.55
	(3)	376	301	VENTILATION	---	---	23.53	1.17	9.82	1.22
	(4)	573 302	303	FINISHING OFFGASES	---	---	---	---	---	---
		421	100	LAUNDRY EXHAUSTS	.038	0.18	0.61	0.17	0.53	0.22
	(5)	547	100	LAUNDRY EXHAUSTS	---	---	---	---	---	---
	(6)	278	111	CALCINER FURNACE	48.93	3.61	70.74	2.43	58.81	9.44
	(6)	287	111	MAIN VENT SCRUBBER	130.23	9.08	136.46	8.17	79.78	3.62
		320	130	CYLINDER WASH OPERATION	145.84	5.01	113.25	5.95	22.77	3.19
		354	110	TRASH COMPACTOR	6.10	1.80	1.80	0.10	3.01	0.12

(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
(6) BUILDING 111 WAS SHUT DOWN DURING 1987 AND 1988
(7) EXHAUST NO. 583 WAS STARTED SECOND HALF OF 1989

TABLE 5.6.2A

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

PROCESS MATERIAL		STACK NO.	BLDG. NO.	DESCRIPTION	1987 MAX	1987 AVG	1988 MAX	1988 AVG	1989 MAX	1989 AVG
PLUTONIUM		27	234A	PROD. GLOVE BOX LINE	2.14	0.06	0.17	0.02	0.24	0.04
		28	234A	ROOM AIR CELL	0.28	0.05	1.04	0.06	0.18	0.03
		29	234A	WET CELL SCURBBER	3.00	0.13	0.21	0.03	0.39	0.03
		224	234A	DISSOLUTION GLOVE BOXES	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	---	---	---	---	0.10	0.04
		103	110	DRY BOXES	0.70	0.15	0.24	0.04	0.72	0.05
		104	110	DRY BOXES	0.19	0.05	0.40	0.04	1.46	0.12
H. E. URANIUM	(2)	185	131	PROD. DRY BOXES	---	---	5.13	0.06	5.13	0.35
		332	120	MAINTENANCE WELDING HOOD	0.82	0.09	0.17	0.05	0.07	0.07
		333	110	SPEC LAB ARC STAND	0.22	0.02	0.10	0.02	0.07	0.05
		416		MAIN PROCESS VENTILATION	153.70	3.22	36.88	1.94	230.0	2.80
	(3)	376	301	VENTILATION	14.83	0.56	5.10	0.34	3.74	0.24
	(4)	573 302	303	FINISHING OFFGASES	---	---	95.87	3.86	3260.00	82.33
		421	100	LAUNDRY EXHAUSTS	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
	(6)	278	111	CALCINER FURNACE	---	---	---	---	---	---
	(6)	287	111	MAIN VENT SCRUBBER	---	---	---	---	---	---
		320	130	CYLINDER WASH OPERATION	31.67	3.70	171.19	4.30	0.30	0.09
		354	110	TRASH COMPACTOR	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
(6) BUILDING 111 WAS SHUT DOWN DURING 1987 AND 1988
(7) EXHAUST NO. 583 WAS STARTED SECOND HALF OF 1989

TABLE 5.7
STACK EFFLUENT RADIOACTIVITY RELEASED
ALL UNITS IN μCi

MATERIAL PROCESSED	STACK NO.	BLDG. NO.	DESCRIPTION	1979	1980	1981	1982	1983
Plutonium	27	234A	Prod. Glove Box Line	1.20	2.30	1.51	0.25	0.39
	28	234A	Room Cell Air	2.40	3.70	2.25	0.73	0.47
	29	234A	Wet Cell Scrubber	0.43	0.68	1.43	0.50	0.16
	224	234C	Dissolution Glove Boxes	0.38	0.37	0.42	0.07	0.02
TOTAL				4.41	7.05	5.61	1.55	1.04
Uranium 233	36	234B	Purification Cell	9.21	10.09	23.01	*	
	51	234B	Purification Dry Box	2.53	9.87	*		
TOTAL				11.74	19.96	23.01		
H.E. Uranium	185	131	Pilot Plant Dry Boxes	8.17	4.50	7.70	2.60	0.75
	207/358	302	Production Glove Boxes & Hoods	83,000.00	34,000.00	30,000.00	5,300.00	*
	219/371	233	"Wet" Line Hoods	3,900.00	27,000.00	21,000.00	4,600.00	*
	253	233	Calciner Dry Box Line	35.78	66.47	10.85	9.41	*
	299	105	Spec Lab Prep. Dry Box	8.83	*			
	300	105	Phys. Test Dry Boxes	5.01	*			
	317	302	Incinerator Room	1,800.00	210.00	9.85	680.00	*
	332	120	Maintenance Welding Hood	27.00	27.00	4.80	3.81	2.83
	333	110	Spec Lab Arc Stand	0.17	0.09	0.48	0.25	0.13
	334	105	Laboratory Hoods & Glove Boxes ***		1,900.00	400.00	410.00	*
	337	105	Physical Testing Stand	7.53	*			
	338	105	Physical Testing Lab	3.74	*			
	416		Main Process Ventilation ***					4,100.00
	376	301	BEST Facility ***					180.00
	421	100	Laundry Stack	4.72	9.36	4.42	2.06	2.66
TOTAL				88,800.95	63,217.42	51,438.10	11,008.13	4,286.37
.. E. Uranium	103	110	Dry Boxes	2.10	23.00	5.80	0.67	0.37
	104	110	Dry Boxes	2.20	27.00	24.00	1.20	0.43
	278	111	Calciner Furnace	540.00	300.00	220.00	53.00	31.00
	287	111	Main Ventilation Scrubber	420.00	2,900.00	4,600.00	710.00	470.00
	320	130	UF_6 Cylinder Wash	1.41	**	8.80	160.00	92.00
	354	110	Trash Compactor ***			3.30	2.40	0.83
TOTAL				965.71	3,250.00	4,861.90	927.27	594.63

* - Decommissioned; ** - Not Operating; *** - Installed during the year data appears.

July 27, 1984

July 27, 1984

TABLE 5.8

ROOM AIR VENTILATOR RADIOACTIVITY RELEASED
(μCi)

BLDG. NO.	VENT NO.	1979	1980	1981	1982	1983
302	1	4.63	27.52	33.45	58.02	-
302	2	3.45	129.34	235.04	17.38	-
302	3	0.99	9.98	12.69	5.50	-
302	4	4.41	7.97	17.36	21.52	-
303	5	4.87	76.15	22.75	20.78	14.60
303	6	0.70	3.59	5.12	7.54	4.06
303	7	1.74	59.96	51.92	5.73	-
303	8	2.98	21.82	11.30	5.83	-
303	9	1.37	62.95	44.39	4.71	-
303	10	1.85	93.60	50.63	2.53	-
233	11	7.80	19.04	2.04	4.05	0.21
233	12	3.01	14.59	6.28	6.77	-
233	13	6.35	19.56	48.40	3.43	-
302	14	2.07	122.62	94.80	10.44	-
302	15	0.03	0.39	0.19	0.21	-
302 - Incinerator	16	4.41	43.67	156.72	113.49	-
302	16	0.79	5.03	14.05	3.23	-
302	17	0.26	7.15	11.03	1.77	-
303	19			3.53	41.42	1.00
WALL VENTS	20	87.60	97.05	76.78	80.22	38.82

* Process Room air vent decommissioning began in 1983. At present, there are no active room vents.

3) A consistent decrease in HEU discharges. The HEU decreases resulted from increase control of production activities and daily surveillance of stack concentrations with corrective action taken when internal limits were exceeded.

5.3.3 Surface Water Monitoring

Tables 5.9, 5.10, and 5.11 summarize monitoring data for the period 1979 through 1983 for the surface water monitoring program. Generally, decreases with time are seen from a review of these data. Two factors contributed to these decreases: 1) NFS discontinuance of the use of the waste water retention ponds and; 2) the construction and subsequent operation of the Environmental Lab mentioned above.

The fluctuation seen in the pond water data resulted from a decrease in total pond water volume during periods of high evaporation. This condition was often aggravated by the resuspention of sediment when the ponds were refilled with Banner Spring Branch water.

5.3.4 Groundwater Monitoring

Table 5.12 summarizes groundwater monitoring data for samples collected at the "well at the burial site". Table 5.13 summarizes groundwater monitoring data for samples collected from the "well between the 6000 gallon process waste water holding tanks". Slight decreases or no change is seen from a review of these data.

Complete data are not yet available for samples collected from the fourteen additional wells described in Section 5.1.4.

5.3.5 Municipal Sewer Monitoring

Radioactivity monitoring data for samples collected from the municipal sewer line are summarized for the period 1979 through 1983 in Table 5.14. The decreases seen are the result of NFS' efforts to divert some potentially contaminated water to the Waste Water Treatment Facility rather than the sewer. Currently, only employee showers and ordi-

TABLE 5.9

ANNUAL SURFACE WATER ALPHA RADIOACTIVITY
($\mu Ci/ml \times 10^{-6}$)

LOCATION	1979	1980	1981	1982	1983
Banner Spring Branch (Upstream)	0.014	0.013	0.003	0.004	0.005
Banner Spring Branch (Downstream)	0.284	0.389	0.031	0.024	0.015
Martin Creek (Upstream)	0.032	0.012	0.006	0.002	0.005
Martin Creek (Downstream)	0.204	0.062	0.020	0.009	0.006
Nolichucky River (Upstream)	0.072	0.009	0.003	0.004	0.002
Nolichucky River (Downstream)	0.030	0.019	0.003	0.004	0.006
Pond #1	4.27	10.43	19.95	11.11	4.29
Pond #3	3.10	2.51	4.40	8.40	37.33

TABLE 5.10

ANNUAL SURFACE WATER BETA RADIOACTIVITY
($\mu Ci/ml \times 10^{-6}$)

LOCATION	1979	1980	1981	1982	1983
Banner Spring Branch (Upstream)	0.06	0.04	0.02	0.003	0.003
Banner Spring Branch (Downstream)	1.67	1.11	0.33	0.008	0.007
Martin Creek (Upstream)	0.08	0.03	0.007	0.003	0.003
Martin Creek (Downstream)	0.92	0.06	0.006	0.007	0.004
Nolichucky River (Upstream)	0.06	0.01	0.006	0.003	0.001
Nolichucky River (Downstream)	0.10	0.04	0.007	0.003	0.002
Pond #1	39.28	48.68	31.72	2.84	1.14

TABLE 5.10A

ANNUAL AVERAGE SURFACE WATER BETA RADIOACTIVITY
(uCi/ml X E-06)

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 AT CAROLINA AVE (UPSTREAM)	0	0	4.2	13.6	9.2	7.6
MARTIN CREEK AT BANNER SPRING MOUTH (UPSTREAM)	---	---	---	7.35	9.7	5.5
MARTIN CREEK (DOWNSTREAM)	0	0.01	13.7	9.15	11.4	8.5
[illegible]ICHUCKY RIVER (UPSTREAM)	0	0	-.5	13.4	9.5	6.7
NOLICHUCKY RIVER (DOWNSTREAM)	0	0	2.2	14.5	10.2	7.7

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TABLE 5.11

SUMMARY OF ISOTOPIC RADIOACTIVITY
IN
SURFACE WATER SAMPLES
(µCi/ml x 10^{-7})

Banner Spring Branch	U-234	U-235	U-238	Total Pu	Total Th
1979	1.01	0.05	0.08	<0.05	<0.11
1980	0.11	<0.02	<0.02	<0.006	<0.13
1981	0.30	0.02	0.01	<0.002	<0.03
1982	0.60	0.01	0.02	0.00	0.01
1983	0.69	0.02	0.05	0.00	0.09
Martin Creek					
1979	0.32	<0.02	0.06	<0.02	<0.08
1980	0.05	0.01	0.01	<0.005	<0.04
1981	0.19	0.02	0.02	<0.001	<0.01
1982	0.16	0.00	0.01	0.00	0.02
1983	0.61	0.02	0.03	0.00	0.10
Nolichucky River					
1979	<0.030	<0.004	<0.02	<0.007	<0.03
1980	<0.030	<0.008	<0.02	<0.005	<0.02
1981	0.01	0.00	0.00	<0.001	0.002
1982	0.03	0.00	0.01	0.00	0.01
1983	0.04*	0.01	0.00	0.01	0.08

NOTE: "0.00" indicates <5 E-10 µCi/ml

*Average does not include apparently contaminated September sample.

TABLE 5.11A

SUMMARY OF ISOTOPIC RADIOACTIVITY
IN
SURFACE WATER SAMPLES (DOWNSTREAM)
(uCi/ml X E-07)

BANNER SPRING BRANCH	U-234	U-235	U-238	TOTAL PU	TOTAL TH
1984	0.58	0.05	0.06	0.01	0.01
1985	0.352	0.042	0.035	0.068	0.007
1986	0.353	0.015	0.036	0.403	0.052
1987	0.283	0.016	0.064	0.006	0.009
1988	0.232	0.021	0.029	0.003	0.024
1989	0.433	0.040	0.056	0.002	0.067
MARTIN CREEK					
1984	0.13	0.01	0.02	0	0
1985	0.261	0.019	0.026	0.005	0.01
1986	0.493	0.02	0.028	0.009	0.011
1987	0.283	0.016	0.064	0.006	0.009
1988	0.141	0.009	0.014	0.002	0.015
1989	0.158	0.014	0.014	0.002	0.043
NOLICHUCKY RIVER					
1984	0.013	0.001	0.001	0.012	0.005
1985	0.016	0.001	0.001	0.018	0.006
1986	0	0	0	0	0.012
1987	0.008	0.002	0.005	0.004	0.015
1988	0.013	0.003	0.005	0.001	0.04
1989	0.016	0.003	0.003	0.001	0.023

NOTE: "0" INDICATES <5E-10 uCi/ml

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TABLE 5.12

GROUND WATER RADIOACTIVITY
(WELL AT BURIAL SITE)
(μCi/ml x 10^{-7})

	Alpha	Beta	U-234	U-235	U-238	Total Pu	Total Th
1979	0.44	0.29	0.49	<.02	0.09	<0.03	<0.30
1980	0.12	0.06	<.04	<.007	<.02	<.005	<.04
1981	0.09	<0.09	<.038	0.00	0.00	<.001	<.002
1982	0.06	0.18	0.10	0.00	0.02	0.00	0.01
1983	0.06	0.12	0.06	0.00	0.01	0.01	0.13

NOTE: "0.00" indicates <5 E-10 μCi/ml

TABLE 5.13

GROUND WATER RADIOACTIVITY
(IN VICINITY OF 6000 GALLON UNDERGROUND HOLDING TANKS)
(μCi/ml x 10^{-7})

	Alpha	Beta	U-234	U-235	U-238
1979*	---	---	2.89	0.10	0.06
1980	8.99	24.72	0.40	0.06	0.07
1981	1.46	2.40	5.15	0.12	0.09
1982	2.60	0.40	3.61	0.07	0.02
1983	5.05	0.70	4.79	0.11	0.15

* Data reported are from second half of the year.
1st half sample was contaminated after collection.

TABLE 5.14

ANNUAL RADIOACTIVITY LEVEL
DISCHARGED TO MUNICIPAL SEWER
(Units of μCi/ml x 10^{-7})

	Gross Alpha	Gross Beta	U-234	U-235	U-238	Total Pu	Total Th
1979	109.60	9.07	94.80	3.25	1.62	<0.08	<0.25
1980	14.72	0.87	1.41	0.21	<0.10	<0.006	<0.23
1981	21.85	2.30	8.72	0.31	0.32	0.03	<0.01
1982	15.36	3.16	12.73	0.28	0.26	0.02	0.20
1983	6.91	1.02	11.07	0.33	0.19	0.01	0.17

nary sanitary sewage, hexanol washwater and laboratory X-ray machine cooling water are discharged directly to the sewer. All other inputs are collected and sampled prior to discharge to the sewer.

5.3.6 Process Water Monitoring

Radioactivity concentration for 1979 through 1983 are summarized in Table 5.15 for the Waste Water Treatment Facility and Table 5.16 for the non-contact cooling water loop servicing Building 233. No discernable trend can be seen from a review of the WWTF data. The Cooling Water data appear to show an increase with time. However, this is believed to have been caused by contamination introduced during sample analysis. Prior to 1984, these samples were analyzed in a laboratory which handles normally high activity samples. During 1984, this work was transferred to the Environmental Radioactivity lab (see Section 5.3.1). Results with greater accuracy are now being observed.

5.3.7 Stormwater & Surface Drainage Monitoring

Table 5.17 summarizes Stormwater and Surface Drainage monitoring in the "Railroad Ditch" and "Storm Drain" for 1979 through 1983. Both of these ditches no longer exist as they have been replaced by the new plant stormwater drainage system. A decreasing trend is seen in the Railroad ditch data while the opposite is true for the Storm drain. It should be noted that these samples were collected from standing water upstream of closed control valves. Thus, the concentrations reported do not reflect actual discharge quantities.

The Banner Spring Branch downstream sampler data indicate the average concentration of radioactive material leaving the plant site. A decreasing trend with time is seen in those data (see Tables 5.9, 5.10 and 5.11).

TABLE 5.15

PROCESS WATER EFFLUENT AVERAGE RADIOACTIVITY LEVELS
WASTE WATER TREATMENT FACILITY
(All Values in Units of µCi/ml x 10^{-7})

	Gross Alpha	Gross Beta	U-234	U-235	U-238	234 Th-Pa	99 Tc
1979	185.3	60.5	184.6	5.9	3.4	15.3	104.2
1980	11.4	1.3	2.1	0.7	0.6	2.3	10.0
1981	38.1	17.9	36.5	1.1	0.7	1.1	20.8
1982	69.9	18.8	67.24	1.32	0.38	1.1	2.76
1983	54.05	25.18	76.97	2.80	1.36	2.86	18.33

TABLE 5.16

SUMMARY OF COOLING DISCHARGE RADIOACTIVITY
BUILDING 233
($\mu Ci/ml \times 10^{-8}$)

	Measured Value	
	Alpha	Beta
1979	2.95	11.5
1980	2.55	7.25
1981	4.55	3.30
1982	14.1	1.87
1983	20.5	3.05

TABLE 5.16A

SUMMARY OF COOLING WATER DISCHARGE RADIOACTIVITY
BUILDING 233
(uCi/ml X E-08)

MEASURED VALUE

YEAR	ALPHA	BETA
1984	4.75	0.53
1985	5.75	1.75
1986	0.84	0.67
1987	0.07	0.27
1988	3.03	5.62
1989	3.59	5.82

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TABLE 5.17

STORM WATER RUNOFF
(μCi/ml x 10^{-7})

Railroad Ditch	Gross Alpha	Gross Beta	U-234	U-235	U-238	Total Pu	Total Th
1979	97.63	12.12	68.72	1.71	3.51	<0.02	0.31
1980	25.24	8.77	10.95	1.40	2.06	<0.005	<0.16
1981	45.85	4.99	40.98	0.97	0.47	0.008	0.024
1982	48.75	14.01	52.03	1.74	5.01	0.01	0.13
1983	2.18	0.33	4.70	0.29	0.28	0.00	0.26
Storm Drain							
1979	12.04	1.84	7.34	0.39	2.49	<0.02	0.35
1980	10.16	2.82	0.88	0.11	0.48	<0.005	<0.093
1981	7.82	2.43	4.94	0.20	1.47	0.003	0.03
1982	41.89	20.61	13.40	0.51	3.53	0.04	2.17
1983	42.45	16.82	22.26	1.27	7.36	0.02	2.56

5.3.8 Soil, Sediment and Vegetation Monitoring

Soil, sediment and vegetation monitoring data is summarized in Table 5.18. A complete revision of NFS' method of analyzing these samples, implemented in early 1982, improved chemical yields and decreased self absorption problems experienced during the analyses of earlier samples. This change has resulted in more credible data, but also makes trend analyses more difficult.

Pond sediment radioactivity appears to be increasing. However, since no process waste water has been discharged to the ponds during the data summary period, it is assumed this increase is due to gradual concentration of the sediment through settling.

Surface water sediment data shows, for the most part, decreasing levels. The slight increases seen in 1983 in the Banner Spring Branch and Martin Creek downstream data was a direct result of the dredging of Banner Spring Branch. This dredging was part of the new plant stormwater drainage system modifications. It resulted in the resuspention of previously contaminated sediment which has existed since the ponds were utilized as the process waste water treatment system. With that system, Banner Spring Branch received the treated pond water. Soil and Vegetation data all show a decreasing trend over the reporting period.

5.3.9 TLD Monitoring

Table 5.19 summarizes direct exposure results for the period 1979 through 1983 at the 12 fixed monitoring locations. No discernable trends are noted from a review of these data.

5.3.10 Non-Radiological Monitoring

Table 5.20 summarizes non-radiological monitoring data for surface and groundwater samples and Table 5.21 summarizes pH monitoring for other water samples. No significant trends can be identified from a review of these data.

TABLE 5.18

SUMMARY OF STREAM SEDIMENT, SOIL & VEGETATION RADIOACTIVITY

Location/Sample Type	Alpha (μCi/g x 10-⁶) 1979	1980	1981	1982	1983	Beta (μCi/g x 10-⁶) 1979	1980	1981	1982	1983
Pond #3 (Upper Pond) Sediment	3618.7	1518.0	4636.1	3248.28	6067.28	14286.0	6282.8	1983.4	832.77	1385.58
Pone #1 (Lower Pond) Sediment	754.6	776.8	326.9	288.0	1213.0	2539.5	393.9	143.8	70.49	287.0
Banner Spring Branch Upstream/Sediment	6.1	5.5	7.8	1.87	8.02	30.9	7.7	6.8	1.88	3.00
Banner Spring Branch Downstream/Sediment	61.0	19.8	52.3	18.88	48.20	195.0	15.4	23.8	6.41	3.85
Martin Creek Upstream/Sediment (Carolina Avenue)	10.2	4.4	8.2	1.91	2.30	26.9	12.0	6.8	2.70	2.00
Martin Creek Downstream/Sediment	8.0	7.1	13.2	9.49	35.14	20.0	18.5	8.2	5.02	6.96
Nolichucky River Upstream/ Sediment	6.3	5.5	9.3	1.83	2.44	16.8	6.4	8.9	2.73	3.26
Nolichucky River Downstream/ Sediment	13.5	4.7	4.0	1.42	2.26	23.5	6.9	6.6	3.20	2.57
Asheville Highway (Approx. 8 km S)/ Soil	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)/Soil	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)/Soil	12.3	8.2	5.6	2.47	1.94	15.1	7.3	21.4	1.55	1.93
Asheville Highway (Approx. 8 km S)/ Vegetation	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)/ Vegetation	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)/ Vegetation	9.7	4.6	10.0	1.98	0.72	12.4	17.7	12.4	4.17	2.65

TABLE 5.18A

SUMMARY OF 1989 STREAM SILT, SOIL & VEGETATION RADIOACTIVITY

LOCATION/SAMPLE TYPE	ALPHA (pCi/G)	BETA (pCi/G)
BANNER SPRING BRANCH (UPSTREAM/SILT)	0.23	0.25
BANNER SPRING BRANCH (DOWNSTREAM/SILT)	15.16	6.3
MARTIN CREEK (UPSTREAM/SILT CAROLINA AVE)	0.5	0.36
MARTIN CREEK (DOWNSTREAM/SILT)	3.4	1.71
NOLICHUCKY RIVER (UPSTREAM/SILT)	0.16	0.23
NOLICHUCKY RIVER (DOWNSTREAM/SILT)	0.15	0.21
LITTLE MTN. (APPROX. 0.6 m N) SOIL	0.53	0.41
CAROLINA AVE. (APPROX. 150 m E) SOIL	0.8	0.23
ASHEVILLE HWY. (APPROX. 8 Km S) SOIL	0.28	0.3
NFS MOUND (APPROX. 300m N)	4.2	2.16
LITTLE MTN. (APPROX. 0.6 m N) VEGETATION	0.15	0.13
CAROLINA AVE. (APPROX. 150 m E) VEGETATION	0.08	0.15
ASHEVILLE HWY. (APPROX. 8 Km S) VEGETATION	0.1	0.13
NFS MOUND (APPROX. 300m N) VEGETATION	0.9	0.15

NOTE: NO SOIL DATA AVAILABLE FOR DECEMBER 1989 DUE TO SNOW.

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TABLE 5.19

July 27, 1984

TLD SUMMARY
ANNUAL DOSE
(millirem)

Location	1979	1980	1981	1982	1983
Carolina Avenue Sample Station 323	(1) 95	95	(1) 25	115	(1) 65
Little Mountain Sample Station 322	145	85	35	95	105
Asheville Highway Sample Station 324	165	(1) 95	35	125	95
NE Corner Security Fence	145	95	35	125	95
Fence N of Plant near Martin Creek	(1) 125	(1) 45	35	(2) 15	(2) 45
NW Corner Security Fence	165	(2) 55	35	(1) 140	95
SW Corner Security Fence	255	195	150	(1) 115	195
Telephone Pole S of Plant	145	95	35	125	135
S Perimeter Sample Station	500	440	370	435	(2) 185
E Perimeter Sample Station	155	105	35	115	105
N Perimeter Sample Station	175	105	35	135	105
W Perimeter Sample Station	250	250	135	205	(1) 145

(1) - Based on three calender quarters of data.

(2) - Based on two calender quarters of data.

TABLE 5.19A

TLD SUMMARY
ANNUAL DOSE
(MILLIREM)

LOCATION	1984	1985	1986	1987	1988	1989
CAROLINA AVENUE	125	35	65	35	65	45 +
LITTLE MOUNTAIN	115	35	65	35	65	25 +
ASHEVILLE HIGHWAY	125	35	65	35	65	25 +
NE CORNER SECURITY FENCE	155	35	65	35	75	25 +
FENCE N OF PLANT NEAR \RTIN CREEK	155	35	65	30 +	65	65
NW CORNER SECURITY FENCE	185	35	65	35	65	65
SW CORNER SECURITY FENCE	195	35	65	35	45 +	45 +
TELEPHONE POLE S OF PLANT	155	35	55	35	65	25 +
S PERIMETER SAMPLE STATION	295	35	85	55	55 +	75
E PERIMETER SAMPLE STATION	115	35	75	35	65 +	65
N PERIMETER SAMPLE STATION	125	35	85	35	165 +	75
FENCE HIGH VOLTAGE TRANSFORMER	135	35	75	85	125	495 +
W PERIMETER STATION	155	35	95	35	75	65

+ : BASED ON LESS THAN 4 QUARTERS OF DATA

July 27, 1984

TABLE 5.20

SUMMARY OF NON-RADIOLOGICAL
MONITORING OF SURFACE WATER AND GROUNDWATER
(mg/l except pH)

Banner Spring Branch	pH	Ammonia	Nitrate	Fluoride	Mercury
1979	7.7	1.2	9.8	1.4	<1.0
1980	7.6	1.1	3.7	1.2	< .001
1981	7.7	<1.8	5.7	4.8	< .001
1982	7.4	<1.7	<1.5	<1.9	< .001
1983	7.7	<3.0	<4.2	<3.4	< .001
Martin Creek					
1979	7.6	1.2	1.1	1.3	<1.0
1980	7.6	1.2	1.6	1.0	< .001
1981	8.1	<1.7	4.3	<1.7	< .001
1982	7.3	<1.7	<1.0	<2.0	< .001
1983	8.0	<3.0	<3.0	<3.0	< .001
Nolichucky River					
1979	7.4	<1.0	<1.0	<1.0	< .001
1980	7.6	<1.0	0.7	<2.0	< .001
1981	8.0	<1.0	0.5	<1.0	< .001
1982	7.1	<1.0	<0.5	<1.0	< .001
1983	7.3	<2.3	<1.2	<2.5	< .001
Well Between 6000 Gal. Tanks					
1979	7.4	18.9	19.0	13.3	--
1980	7.0	14.3	20.10	11.3	--
1981	7.5	<2.0	38.7	<0.8	--
1982	6.5	<5.9	<44.4	7.5	--
1983	7.6	<3.3	21.0	<7.3	--
Well at Burial Grounds					
1979	6.8	4.0	17.1	1.0	<1.0
1980	6.6	3.7	10.3	1.0	< .001
1981	6.5	3.5	6.9	<1.7	< .001
1982	6.8	<6.5	2.7	<1.7	< .001
1983	7.1	<4.1	<6.1	<2.9	< .001

TABLE 5.21

SUMMARY OF pH MONITORING FOR OTHER THAN SURFACE AND GROUNDWATER SAMPLES

Municipal Sewer	pH	Pond #2	pH
1979	7.8	1979	7.2
1980	7.8	1980	7.8
1981	7.3	1981	7.5
1982	7.2	1982	8.1
1983	6.9	1983	7.6
Railroad Ditch	**pH**	**Pond #1**	**pH**
1979	6.8	1979	7.3
1980	6.9	1980	8.6
1981	6.3	1981	9.2
1982	6.9	1982	10.3
1983	6.7	1983	9.0
Storm Drain	**pH**	**Pond #3**	**pH**
1979	7.6	1979	6.5
1980	7.7	1980	7.0
1981	6.6	1981	6.7
1982	7.6	1982	6.6
1983	8.1	1983	6.5

Table 5.22 summarizes process waste water monitoring data for the period 1979 through 1983. Some problems were experienced in achieving the 1979 NPDES permit limits (see Table 5.2). However, during the effective period of the 1980 issued permit full compliance was achieved. Nothing of significance can be seen from a review of the cooling water data.

TABLE 5.22

SUMMARY OF NON-RADIOLOGICAL
MONITORING OF PROCESS WASTE WATER

	1979 Avg.	1979 Max.	1980 Avg.	1980 Max.	1981 Avg.	1981 Max.	1982 Avg.	1982 Max.	1983 Avg.	1983 Max.
Waste Water Treatment Facility Discharged at Mile 94.6 - Nolichucky River										
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	40 (1)	114	<1	4	<1	5	<1	5	<1	3
Ammonia (as N) - kg/day (mg/l)	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 (mg/l)	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)
Setteable Solids - (ml/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	9.0	NA	8.8	NA	8.8
Cooling Water Discharged to Banner Spring Branch										
Discharge Volume - M^3/day	239.6	1,096.0	230.20	486.4	93.47	400.07	192.53	887.2	214.43	1096.14
Discharge Temperature - ^oF	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

IMPACT OF ACCIDENTS

6.0 NFS has identified a number of accident situations and has indicated qualitatively or quantitatively the potential environmental impact of typical ones. With the exception of a criticality accident, accidents within the NFS facilities are of comparable probability, nature, and magnitude with nonnuclear process operations using small quantities of chemicals. Because nonirradiated fuel is processed, it is unlikely that any significant impact outside the confines of the plant would result from an accident.

6.1 Accidents Involving Nonradioactive Material

Plant accidents involving nonradioactive material have been divided into categories as follows:

Category 1	Expected to occur on site during plant life	Caused by pipe leaks, operator errors, exhaust-scrubber failure, minor spills and utility outages
Category 2	Not expected to occur during plant life, but possible	Caused by breach of bulk-chemical storage container, severe earthquake, fire, flood explosion
Category 3	Unexpected catastrophic natural events or combination of highly improbable (Category 2) events	Major earthquake, volcanic eruption, simultaneous failure of several independent systems

6.1.1 Category 1 Events

An accident in this category would be typified by a minor leak in a process or chemical pipeline resulting in the release of a few gallons of the material from the pipeline. A leak of this type inside the manufacturing buildings would be detected quickly because it would be visible to workers. Corrective action (such as isolation of the leaking pipeline section) would be taken immediately. The spilled liquid(s) along with any necessary water used in cleanup would be recycled into the process or transferred to the waste treatment system. Therefore, no environmental release would occur.

Similarly, a leak of the above type in an exposed pipeline outside of the facility would be observed within an hour, and corrective actions would be taken quickly due to the location of such lines with respect to normal access points into the building and the frequent movement of NFS employees and security patrol through such points. Consequently, the amount of material lost would easily be held by the upper few inches of soil and subsequently be removed.

Scrubber or filter failure could result in discharge of particulate matter. Such a failure is improbable due to an active maintenance program. Detection would most likely occur immediately becuase effluents are monitored continuously. No significant release has occurred from this cause during the history of the plant.

6.1.1.1 Utility Outages

Electrical failures have occurred and can be anticipated, especially during storms. Criticality alarms as well as ventilation and air samplers in areas containing hazardous materials are connected to diesel-powered generators. The absence of electrical power is not expected to exceed 10 minutes in these facilities. Processes that are not supplied with auxiliary power will be shut down immediately following an electrical failure. No significant environmental releases have been experienced as a result of electrical power outages.

Natural gas is supplied to the plant on an interruptable basis to cover peak loads. Liquid propane, bottled gas, and No. 2 diesel oil are stored at the site for substitution following notification of natural gas service interruption. No loss of operating time or environmental control has been attributed to the loss of natural gas service at the NFS Erwin site.

Water is supplied to the plant from two sources: Banner Spring Branch and the Erwin city water system. Banner Spring Branch supplies non-contact cooling water that is pumped from the spring and is returned to the creek. Routine maintenance of the pumping system reduces the probability of a cooling-water loss. However, failure of this system is considered possible. Consequently, temperature sensors have been installed in water-cooled processes. The sensors would trigger immediate action, including process shutdown if necessary, should cooling be lost. As a result, measurable release of chemicals and/or radionucldies is not anticipated.

Fire protection water is obtained from an elevated 750,000-gallon tank (owned by Erwin Utilities) and is supplied to the plant through an underground eight inch diameter pipe. Fire protection water is also available through the plant fire water loop by a second connection to the City of Erwin water lines. Except for cooling water, all other plant water is supplied from the Erwin water system. Failure of this supply without advance notice is improbable. However, this failure mode is considered here in order to allow evaluation of utility failures as a whole.

Certain operator errors could cause minor environmental releases. Situations where a single error could result in a significant environmental release or hazard to plant personnel have been addressed with engineered safeguards and/or strick administrative controls to prevent releases. Where physical safeguards to negate the consequences of operator error have been impractical to use, extensive training and administrative safeguards are employed.

6.1.2 Category 2 Events

Major leaks inside the buildings could not result in releases that would be of concern to the external environment for the reasons described under Category 1 events. Ruptures of indoor tanks might result in employee injury, and/or temporary shutdown of process operations, but are not expected to result in environmental degradation. External leaks of acids, bases, organics, etc. would be largely neutralized by the soil, or by addition of appropriate neutralizer. Liquid ammonia is transported, stored, and used, for example, in agriculture without serious risk.

The facility is located in seismic zone 2 on the seismic risk map of the United States (Figure 2.4), indicating the maximum probable earthquake would correspond to intensity VII on the Modified Mercalli Scale. No earthquakes in excess of a magnitude of 4.5 to 5 on the Richter scale have been reported in the area. Some minor onsite damage to buildings or interruption of processes may result from the maximum probable earthquake, but environmental releases would be expected to be limited to process-piping leaks described in Section 6.1.1 as Category 1 events.

A study of floods on the Nolichucky River in the vicinity of Erwin was published in March 1967 by the Tennessee Valley Authority. The greatest recorded flood (100-year period), regional flood, and maximum probable flood (1000-year period) are discussed in that report for the NFS Erwin property. The site buildings are above the level of the greatest recorded flood and of the regional flood (1644 feet above sea level). Since that report was published, a new by-pass highway (4-lane interstate type) has been constructed at an elevation of 1644 feet at the

Erwin Plant site, thereby effectively protecting the Erwin site from all but the maximum probable flood level.

Were a washout of the ponds to occur during a flood at the magnitude of the 1901 flood (greatest recorded level), and were the entire solid and liquid contents of the pond to be released in a period of 30 min, the resulting radionuclide concentration in the flood water would be 0.004% of the MPC for uncontrolled areas. Such a release would not add perceptibly to the impact and consequences of the flood.

Hydrogen gas is used in various small reduction furnaces in the NFS Erwin facility. Because hydrogen is extremely flammable and presents an explosion hazard, administrative controls require that the furnaces be purged with inert gas prior to any exposure to air.

An inadequate purge might result in an explosion in the furnace. The most violent postulated explosion could result if the largest muffle furnace were filled with one-third oxygen and two-thirds hydrogen. The largest furnace has a capacity of 20 ft^3 and operates at 1000°C. The explosion could cause releases of 300 k/cal (1200 BTU) of energy and would create an instantaneous pressure of 50 $lb/in.^2$ within the muffle furnace. If the furnace did not contain this explosion, the resulting instantaneous room-pressure rise would be 3 inches of water that could cause a room temperature increase of 4.5°F.

Minor structural damage and no measurable environmental release would be expected from such an explosion.

6.1.3 Category 3 Events

Events of this nature fall into two general categories. The first includes natural disasters such as mountain-raising earthquakes, unanticipated melting of the polar ice caps and volcanic eruption under the facility. All these events are of such environmental significance that the impact caused by destruction of NFS facilities would be quite inconsequential by comparison. The second category includes unanticipated combinations of improbable events such as an explosion in a muffle furnace, failure of the fire-protection system and simultaneous failure of the scrubber. In such calamities, environmental degradation is limited only by the quantity of stable and radioactive chemicals present in the facility (Table 6.1).

Although the probability and effect of this type of occurrence 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 is 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 has postulated a fire in a plutonium-contaminated glove box in Building 234, which is not in use. Less than 350 g of residual plutonium is thought to 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.

6.2 Accidents Involving Radioactive Material

6.2.1 Spills of process material

Spills within buildings would be transferred to waste, while external spills would be absorbed by the soil or collected in the plant drainage system. No significant release of solid material appears credible. In general, no offsite consequences are foreseen from in-plant spills.

(b)(4)

6.2.2 Criticality

In calculating the consequences of an accidental criticality, it has been hypothesized that a uranium solution is accidentally transferred into a vessel of unsafe geometry and the resultant excursion yields 1.4×10^{18} fissions. It is assumed that 50% of the iodine released escapes from the building, and the exposure occurs at 15 minutes after the burst. The source terms at the point of release are presented in Table 6.2.

There has been no change in that which follows from that included in the "1978 Environmental Impact Appraisal", however, those calculations were based on an outdoor storage tank which has since been enclosed. Therefore, the doses resulting for a prompt Gamma and neutron burst could be reduced by a factor of 2.5 and 2.3 respectively. The reported dose from airborne releases could also be reduced by a factor of 3.0. Such changes have not been made in that which follows. These factors are as provided in Nuclear Regulatory Guide 3.34 to account for building shielding.

For calculational purposes, the conservative meterological conditions of 1 m/sec and Pasquill Type F stability were used to estimate the atmospheric concentrations of radionuclides for a ground level release. A dry deposition of 0.01 m/sec for particulates was assumed. Due to the proximity of the nearest residents, the large number of onsite buildings and the highly variable terrain, a building wake factor of 0.33 was used in the calculations.

6.2.2.1 Maximum dose to the nearest residence

The maximum doses from all sources to the nearest resident, who lives at a distance of 245 m south of the plant center, are shown in Table 6.3. The estimated maximum total-body dose is 7.9 rems. The gamma and neutron doses resulting from the prompt burst are based on data from Caldwell[1]. The doses

TABLE 6.2

Source Terms for a Postulated Criticality
Accident of 1.4 x 10^{18} Fissions at the NFS Erwin Plant

Radionuclide	Amount Released (Ci)
Kr-83	3.64
Kr-85m	15.96
Kr-85	1.54 x 10^{-4}
Kr-87	1.68 x 10^{2}
Kr-88	64.96
Kr-89	4.06 x 10^{3}
Xe-131m	3.78 x 10^{-3}
Xe-133m	5.46 x 10^{2}
Xe-133	12.88
Xe-135m	11.06
Xe-135	15.96
Xe-137	3.78 x 10^{3}
Xe-138	1.20 x 10^{3}
I-129	4.2 x 10^{-11}
I-131	1.82 x 10^{-1}
I-132	6.44 x 10^{-1}
I-133	3.50
I-134	47.60
I-134	12.04

TABLE 6.3

Summary of Maximum Offsite Consequences[a] from a Nuclear Criticality Incident at the NFS Erwin Site with a Prompt Burst of 1.4×10^{18} Fissions

Organ[b]	Dose from Prompt Burst (rems)		Dose from Airborne Release (rems)[d]	Total (rems)
	Gamma[c]	Neutron[c]		
Total body	0.21	0.46	7.2	7.9
Thyroid	0.21	0.46	27.9	28.6

[a]Dose to nearest resident 245 m from location of incident.
[b]Dose to organs not shown is less than that of the total body.
[c]Based on Nuclear Regulatory Guide 3.34.
[d]Fifty-year dose commitment.

from the airborne radionuclides were calculated using the AIRDOS-II computer code[2]. Most of the total-body dose (75%) is due to Kr-89 via the submersion-in-air parthway. The highest organ dose (28.6 rems) is to the thyroid (Table 6.3) as a result of the iodine-131 (36%) and iodine-133 (27%) inhaled. As shown in Table 6.3, the maximum doses received by the nearest resident would not result in any fatalities or serious injury.

6.2.2.2 Population Dose

The population dose is based on the airborne release of radionuclides within the most populous sector up to 80 km (50 miles) of the effluent. Dose calculations were made using the AIRDOS-II computer code and are shown in Table 6.4. The population total-body dose is 0.85 man-rem, and the highest population organ dose is 1.6 man-rems to the thyroid. These doses may be compared to the dose from natural background radiation (based on State of Tennessee dose rates) of 1.76×10^4 man-rems to the 126,000 persons living in the designated sector.

Because there is a possibility of a serious accident at the facility due to the presence of hazardous materials, NFS has established a plan to cope effectively with emergencies that might arise. The purose of the plan is to protect the health of the employees and the public and to deal effectively with the emergency in a timely manner. Detailed procedures can be found in NFS' Radiological Contingency Plan.

TABLE 6.4

DOSES[a] TO THE POPULATION[b] FROM THE AIRBORNE RADIONUCLIDES RELEASED DURING A CRITICALITY ACCIDENT (1.4×10^{18} fissions)

Organ	Dose (man-rems)	Principal Contributing Radionuclides (%)
Total Body	0.85	Kr-88 (65%); Xe-135m (14%); Kr-87 (8%); Xe-135 (8%)
GI Tract	0.66	Kr-88 (68%); Xe-135m (13%); Kr-87 (8%); Xe-135 (6%)
Bone	0.98	Kr-88 (60%); Xe-135m (15%); Kr-87 (8%); Xe-135 (10%)
Thyroid	1.60	I-131 (26%); I-133 (18%); Kr-88 (32%); Xe-135m (8%)
Lung	0.81	Kr-88 (65%); Xe-135m (14%); Kr-87 (8%); Xe-135 (7%)
Kidneys	0.68	Kr-88 (64%); Xe-135m (16%); Kr-87 (8%); Xe-135 (7%)

[a] Fifty-year dose commitment based on one year of intake or exposure.

[b] Based on population in the single sector out to 80 km (50 miles) from the site which gives the highest population dose (126,000 persons).

6.3 Transportation Accidents [3]

The facility processed over 11,000 kg of uranium in 1983. This required more than 100 shipments to and from the facility. Although the safety of uranium shipments is the responsibility of the shipper, for purposes of this report, incoming and outgoing shipments are both considered.

All radioactive shipments are regulated by the Department of Transportation (DOT) and the NRC, and must also conform to State and other Federal requirements.

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 .

The radioactive materials shipped to and from the plant are packaged in containers that are approved by NRC and DOT and are in full accordance with State and Federal regulations governing the safe shipment of hazardous materials (Type B requirements).

The shipping containers required for significant quantities of radioactive materials are of such integrity that they survive with no release of contents in all but the most severe and unusual of transportation accidents.

Shipments of enriched uranium from the facility are packaged so that accidental criticality under all but nearly incredible conditions is impossible. The facility receives high-enriched uranium in cylinders which meet the Type B requirements. A criticality incident from such a cylinder is considered remotely credible, although such an event has never occurred.

If a cylinder containing highly enriched uranium were to rupture so that the cylinder filled with water without losing its contents, a criticality could result. A small hole in a submersed cylinder would be plugged by the products of reaction between uranium hexafluoride and water, and the cylinder would not fill, preventing criticality. Larger holes would allow contents to leak out and, consequently, would prevent criticality.

In addition to the stringent performance standards for the shipping containers, administrative controls are imposed over the exclusive-use truck-transport vehicles for high-enriched uranium (10 CFR Part 73). The number, type, and contents of the packages loaded on each truck are controlled to ensure that all vehicles will remain nuclearly safe both under normal transport conditions and during accident situations.

There is a slight probability that in time some radioactive material being shipped to or from the plant will be involved in a traffic accident. The probability that the accident will be severe enough to release any of the material from the packaging containers is significantly more remote than the probability of an accident. Finally, the probability that such an accident would result in measurable radiation exposure to the general public or environmental contamination is extremely slight, almost nonexistent.

REFERENCES FOR SECTION 6

1. Roger D. Caldwell, "The Effects of a Criticality Accident," Enviromental Data for License Renewal Application, Babcock and Wilcox, Nuclear National Materials Division, SNM-145, Docket No. 70-135, Sept. 24, 1975.

2. R. E. Moore, The AIRDOS-II Computer Code for Estimating Radiaiton Dose to Man from Airborne Radionuclides in Areas Surrounding Nuclear Facilities, ORNL-5245, ESD Publication 974, Oak Ridge, Tenn., April 1977.

3. Environmental Survey of the Uranium Fuel Cycle, WASH-1248 Washington, D.C., (April 1974).