III. CHARACTERIZATION OF THE EXISTING ENVIRONMENT

A. SITE LOCATION

The Savannah River Plant (SRP) occupies an approximately circular area of 300 square miles (192,000 acres) in South Carolina, 25 miles southeast of Augusta, Georgia (Figure III-1). The site borders the Savannah River for approximately 17 miles. The plantsite is closed to the public except for guided tours, controlled deer hunts, controlled through-traffic along South Carolina Highway 125 (SRP Road A) and along the Seaboard Coast Line Railroad, traffic on U.S. Highway 278 along the north edge of the site (Figure III-2), and authorized environmental studies.

The Savannah River Plant was constructed during the 1950s to produce the basic materials, primarily ^{239}Pu and tritium, used in the fabrication of nuclear weapons. The plant facilities (Figure III-2) consist of three operating nuclear production reactors (P, K, and C), two nuclear production reactors in standby condition (R and L), a small test reactor in standby condition (U), two separations areas (F and H) for processing irradiated materials, a heavy water extraction and recovery plant (D), a fuel and target fabrication facility (M), containing two test reactors, the Savannah River Laboratory (a process development laboratory to support production operations and containing three test reactors), and administrative facilities (A), and the many non-nuclear facilities necessary for plant operations.

The storage areas for high-level liquid waste are adjacent to the separations areas and consist of two tank farms linked to the separations areas and to each other by pipelines with secondary containment. In addition, a 195-acre burial ground area located between the F and H separations areas is used for controlled storage of solid radioactive wastes. The waste storage areas are at least six miles from the nearest Plant boundary.

Three major alternatives for long-term waste management at SRP are described in Section IV.B. Facilities needed for these management alternatives would be located as follows:

- New tanks for the alternative described in Section IV.B.1 would be built adjacent to the existing tank farms in F and H Areas (Figure III-2).

- The waste solidification facility and surface storage vault for the alternatives described in Section IV.B.2 would be built adjacent to and north of H Area (Figure III-2).

- Additional research and exploration would be necessary before a decision is made on the specific onsite location of the bedrock caverns for the alternatives described in Section IV.B.3.

B. SITE CHARACTERISTICS

1. Introduction

Characteristics of the SRP site that are pertinent to the long-term management of defense high-level radioactive waste include the geology, hydrology, meteorology, seismicity, biota, and background radiation. These characteristics are briefly reviewed below; a more detailed discussion may be found in DP-1323[1] and ERDA-1537.[2]

2. Geology

The plant is located in the Coastal Plain geologic province. This province is characterized by flat, mostly unconsolidated sediment of Cretaceous age or younger. About 20 miles northwest of the plantsite is the lower edge of the Piedmont Plateau (the other main geologic province in S.C.).

The soil layers of the plantsite affect the migration rates and directions of ground water and of any radioisotope present in the soils and ground water of the site. Geologic formations beneath the Savannah River Plant site are shown in Figure III-3, a cross section that bisects the plantsite. The formations are the Hawthorn, Barnwell, McBean, Congaree, Ellenton, Tuscaloosa, and bedrock (crystalline metamorphic rock and the Dunbarton Triassic Basin).[3] The sediments that constitute the formations above bedrock are either unconsolidated or semiconsolidated. The crystalline metamorphic rocks outcrop at the Fall Line and dip approximately 36 ft/mi to the southeast underneath the Coastal Plain sediments.

A large Triassic deposit in a basin of the crystalline rock underlies one-third of the plant area and is located in the southeastern section of the site. This deposit consists of sedimentary material formed into sandstones, siltstones, and mudstones.

The basement rock under the center of the plantsite is about 1000 ft below the surface. The geologic formations that immediately overlay the basement rock are called the Tuscaloosa and Ellenton formations; they are 500 to 600 ft thick below the plant. These formations consist of sand and clay and contain several prolific water-bearing beds, which supply over 1000 gal/min of water from each of several individual wells on the plantsite. Overlying the Tuscaloosa and

Ellenton formations are several formations of the Tertiary Period that range in age from about 10 million to about 50 million years. These formations have a combined thickness of about 350 ft in the central part of the plant. They consist predominantly of compact clayey sand and sandy clay with a few beds of sand and a few beds of hard clay. At depths ranging from about 100 to 180 ft, there is a zone in which the sandy deposits include calcareous cement, small lenses of limestone, and some shells. At scattered discontinuous localities, slowly moving ground water has dissolved this calcareous material and left these less consolidated than the sediments surrounding them. Some of these areas were filled with a concrete grout before major SRP facilities were constructed. At some places on the Savannah River Plant, the rocks of the Tertiary Period are overlain by more recent terrace deposits of alluvium. These deposits are usually thin in the upland areas, but are of significant thickness in the valleys of the Savannah River and some of its larger tributaries.

3. Hydrology

Surface waters provide a mechanism for transporting unavoidable releases of radioactive elements, stable elements, and heat offsite. These materials, if discharged to a plant stream, will move toward the Savannah River because almost all of the plantsite is drained by tributaries of the river (Figure III-2). Only one small stream (not shown on Figure III-2) in the northeastern sector of the site drains to the Salkehatchie River to the east, and this small stream has no operating facilities on it. Also, none of the facilities discussed in this statement will drain to this stream. Each of the tributaries is fed by smaller streams; therefore, no location on the site is very far from a continuously flowing stream. Knowledge of the flow in the streams is used to predict the offsite consequences of various routine and accidental releases.

In addition to the flowing streams, surface water is held in over 50 artificial impoundments covering a total of over 3000 acres. The largest of these, Par Pond, has an area of approximately 2700 acres. Water is held intermittently in marshes and over 200 natural basins, called Carolina Bays. A large swamp bordering the Savannah River receives the flow from several of the plant streams.

The source of most of the surface water on the plantsite is either natural rainfall or water pumped from the Savannah River to cool the nuclear reactors. The cooling water is discharged to the streams to flow back to the river or to Par Pond. Additional small amounts are discharged from other plant processes to the streams.

Two large reservoirs on the Savannah River upstream of the Savannah River Plant provide power, flood control, and recreational areas. Clark Hill Reservoir, completed in 1952, is 35 miles (70 river miles) upstream. Hartwell Reservoir, completed in 1961, is 90 miles (150 river miles) upstream. Operation of these reservoirs stabilized the river flow in the vicinity of the plant to a yearly average flow of 10,400 ±2900 cfs during 1961 to 1970. The minimum daily flow during this period was 6000 cfs. River water requires a minimum of 3 days to reach the coast from SRP, and the average flow times of 5 to 6 days probably better represents the travel time.

The monthly average temperature of the river water measured since July 1955, upstream from all SRP process water discharges, ranged from 6.8 to 26.8°C. The daily river temperature has reached 25.5°C or higher only during the months of June through September.

The Savannah River is used for fishing, both commercial and sport, and pleasure boating downstream of the plant, and also as a drinking water supply at Port Wentworth, Ga., for an effective consumer population of about 20,000, and at Hardeeville, S.C. (Beaufort-Jasper Water Treatment Plant), for a consumer population of approximately 50,000.

The five main streams on the plantsite are Savannah River tributaries. These are Upper Three Runs, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs (Figure III-2). They arise on the Aiken Plateau and descend 100 to 200 ft before discharging to the river. On the plateau, the streams are clear except during periods of high water. Rainfall soaks into the ground, and seepage from the sandy soil furnishes the streams with a rather constant supply of water throughout the year. In addition, four of the streams have received reactor cooling water discharges. These discharges, many times the natural stream flows, cause the streams to overflow their original banks along much of their length. For additional details on these streams see Reference 2.

The results of detailed studies[3] on the site reveal how the geology and hydrology of the plantsite affects ground water movement. Differences in the piezometric head (water pressure) measurements show the direction that ground water flow will take. Figure III-4 shows the vertical distribution of hydrostatic head in ground water near H Area, measured with six piezometers near the H-Area waste tank farm and four other piezometers outside H Area. Downward percolation of water from the water table is indicated by decline to minimum head in the Congaree formation. In the two piezometers (1E, 1D, Figure III-4) above the tan clay, the decline is probably fairly uniform with depth. Across the tan clay (1D to 1C), the decline is relatively abrupt (about 12 ft of head decline in 18 ft of depth). The tan clay, maximum 12 ft thick, is sufficiently impermeable to divert some of the water laterally to creeks, the nearest being several thousand feet away.

Within the fairly permeable sands of the McBean formation, the head declines only 2 ft in ∿50 ft of geologic material (1C to 1B). The green clay shown in Figure III-4 is one of the more significant hydrologic units in the region; it is only 6 to 10 ft thick in H Area (although somewhat thicker elsewhere), and its importance is easily missed if only drilling information is available. The 80-ft decline in piezometric head (1B to 3B, 1A) across the green clay indicates that the clay is continuous over a large area and has low permeability. Thus, the green clay also diverts water laterally to creeks that have eroded down into the McBean. These points of discharge are farther from H Area than the discharges from the Barnwell formation.

Ground water in the Congaree zone below the green clay also discharges into Upper Three Runs. This formation has the lowest hydrostatic head. The Ellenton formation has a head ∿7 ft higher than the Congaree, thus indicating the Ellenton is not receiving water from the Congaree formation.

Head is uniform in the three Tuscaloosa piezometers (P3C, P3B, P3A), lower than that in the Ellenton formation (DRB7WW), but higher than those in the Congaree. Both the recharge and discharge regions of the Tuscaloosa are principally off the plantsite, and they control its water level within the plantsite.

Piezometric contours for the Tuscaloosa formation (Figure III-5) indicate that the Tuscaloosa water flows from the Aiken Plateau in a curved path to the Savannah River valley. This lateral flow through the very permeable formation supports the Tuscaloosa water level on the plantsite. Recharge by vertical percolation from above probably does not occur at SRP. The Tuscaloosa aquifer underneath a portion of southeastern Georgia also flows toward and outcrops in the Savannah River valley as shown in Figure III-5.

4. Local Climate and Meteorology

The climate in the SRP area is tempered with mild winters and long summers. Augusta temperatures average 48°F in the winter, 85°F in summer, and 65°F annually. The average relative humidity is 70%. The average annual rainfall at SRP is 47 in. A detailed discussion of the methods for estimating environmental effects of radionuclides released from SRP to the atmosphere is presented in Appendix F of Reference 2.

The probability and magnitude of severe storms have been analyzed to determine their effects on SRP facilities. Two types of major storms, hurricanes and tornadoes, occur in South Carolina. Both types of storms are discussed in detail in Reference 2, including their frequency of occurrence.

The Savannah River Laboratory maintains its own meteorological station with an online computer to provide input from local weather conditions on the offsite dose effects of any SRP radionuclide releases.[4]

5. Seismicity

The Savannah River Plant is located in an area where moderate ground shaking might occur from earthquakes, based on earthquake risk predictions by the U. S. Coast and Geodetic Survey.[1,5,6] The only significant shaking in the SRP area during the last 3 centuries was from the 1886 Charleston, S. C. earthquake, centered 90 miles to the southeast. The maximum acceleration of that earthquake in the SRP area has been estimated at 0.05 g.[2] From geologic information as well as from seismic history of the east coast region a major earthquake near SRP is improbable.[2]

The Belair fault has had local interest in recent years. Based on a study of the Belair fault by the U.S. Geological Survey,[7] the Nuclear Regulatory Commission states:[8]

> The Belair fault zone is located about 16 km west of Augusta, Georgia. It is actually a number of faults, each 1.1 to 4.7 kilometers in length, which when taken together comprise a zone at least 21 kilometers long trending approximately north-northeast.
>
> The conclusion of the latest report by the U.S. Geological survey indicates that the age of the oldest unfaulted stratigraphic unit is thought to be between 2,000 and approximately 23,000 years old. The age of the youngest faulted unit is approximately 65 million years old. To date, no intermediate age strata have been found which would provide a more definitive date of last movement on the fault. Thus, although the study does not absolutely demonstrate lack of movement in the last 35,000 years, it does provide a high level of confidence that the last movement is not as recent as previously believed. With the absence of any correlation of macroseismicity with this fault zone, we have concluded that this fault is not capable within the meaning of Appendix A to 10 CFR Part 100, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." We will continue to monitor research activities which could lead us to modify this finding.

The design basis earthquake for SRP incorporates an acceleration of 0.26 g, equivalent to an earthquake intensity of VII to VIII on the Modified Mercalli scale.[9]

Seismic monitors, which were installed in SRP reactor buildings between 1952 and 1955, are set to alarm at 0.002 g (intensity II) and have never indicated an earthquake shock of this intensity since their installation. In addition to the seismic monitors installed in the reactor buildings, a modern seismograph network,

consisting of three short period vertical seismometer stations and a central recording station, was installed in 1976. This system was designed to provide a continuous record of any local seismic activity. Data on individual events collected by this network are provided to seismologists with the U.S. Geological Survey, the University of South Carolina, and Georgia Institute of Technology.

6. Biota

The Savannah River Plant site provides a wide variety of protected habitats; hence, the species' diversity and populations are both large. In general, the plantsite is a natural preserve for biota typical of the Southeastern Coastal Plain. The major effect of SRP on wildlife has resulted from changed habitat conditions since the government acquired the site. The production and support facilities occupy less than 5% of the plantsite. Radioactive releases are limited to low levels in limited areas and are shown by monitoring programs to result in only minor contributions to the ^{137}Cs content of deer and fish taken on or adjacent to the plantsite. For detailed discussion of the biota, see References 1 and 2.

7. Background Radiation

Natural background radiation includes both cosmic and terrestrial sources. These sources vary with location but are assumed constant with time within the recorded span of human history.[10] The calculated annual background radiation dose received by the average person living in the vicinity of the Savannah River Plant is approximately 120 mrem from natural sources; 35 mrem from cosmic radiation, 55 mrem from external terrestrial radiation and 27 mrem from internal radiation. For more details on natural background radiation in the vicinity of Savannah River Plant see Reference 2.

8. Environmental Park

The plant was designated as a National Environmental Research Park in June 1972. The various portions of the plantsite offer unusual opportunities for observing interactions between large industrial complexes and the environment. There are extensive areas of land protected from heavy traffic patterns, casual visitors, real estate development, and other disruptive influences. Because the land area is owned by the U.S. Government, long-term ecological research can be based at the Park with confidence in the continuation of the existing habitats. Several of the unusual opportunities offered are for observing and comparing the ecosystem changes brought about by heated water, flooding, atmospheric and aqueous emissions from fossil fuel power plants, uptake and

retention of low levels of radioactive materials, forest management activities, and other stresses on the environment. Researchers from universities and government agencies are currently taking advantage of these opportunities for study.

9. Environmental Studies by Outside Contractors, Universities, and Researchers

Before the start of plant construction in 1951, the Limnology Department of the Academy of Natural Sciences of Philadelphia began a baseline study of the Savannah River in the vicinity of the Savannah River Plant. This study considered all the major groups of aquatic organisms (protozoa, lower invertebrates, insects, fish, and algae) together with the general chemical and physical characteristics of the river. The purpose of this study was to provide a comprehensive picture so that future changes that might occur in the Savannah River could be measured. Such changes might be due to the activities of the Savannah River Plant or to changes in upstream river conditions.

Since the baseline study, the Limnology Department has carried on a continuous program of detailed surveys of the river's biological, chemical, and physical condition.

The Savannah River Ecology Laboratory (SREL) of the University of Georgia was established in 1961 to study the ecology of the SRP site. It has conducted diversified studies of site characteristics to identify and follow natural changes since acquisition of the property in 1950 as well as to investigate the effects of SRP operations. Research is currently centered in three major programs: thermal ecology, mineral cycling, and radioecology of transuranic elements. Each of these programs is strengthened by the ongoing accumulation of knowledge of the basic ecology of the site. For further details of these studies see Reference 2.

10. Historic and National Landmarks

There are no known historic or national landmarks on the Savannah River plantsite. The site was set aside by the U.S. Government in 1950 as a controlled area for production of nuclear materials needed for national defense. It is not expected that the location for any of the facilities to be built on the Savannah River plantsite would have any historical or archeological interest; however, before any disturbance of a site is made, a site use permit will be processed through the Institute of Archeology and Anthropology, University of South Carolina.

C. SURROUNDING REGION

1. Demography

The location of the Savannah River Plant relative to population centers and geographic features within a 150-mile radius is shown in Figure III-1. The distribution of population within 150 km (about 95 miles) from the center of the plant is shown in Figure III-6. The projected population, within 80 km of the center of the plant, for the year 2000 is shown in Figure III-7.[11] According to the 1970 census, major population centers within about 25 miles of the center of the plant are:

City	*Distance, miles*	*Direction from Plant*	*1970 Population*
Augusta, GA	25	Northwest	59,864
N. Augusta, SC	25	Northwest	12,883
Aiken, SC	20	North	13,436
Williston, SC	15	Northeast	2,594
Barnwell, SC	15	East	4,439
Allendale, SC	26	Southeast	3,620
Waynesboro, GA	28	Southwest	5,530

2. Regional Land Use

In the counties surrounding the Savannah River Plant, approximately 65% of the land is forest[12] and approximately 30% is used for farming. The primary farm products are soybeans, corn and cotton.[13]

3. Nearby Nuclear Facilities

Three nuclear facilities are either planned, under construction, or in use adjacent to SRP (Figure III-2). Georgia Power Company plans to construct two power reactors at the Alvin W. Vogtle Nuclear Plant on the Savannah River at the southwest boundary. The Barnwell Nuclear Fuel Plant of Allied-General Nuclear Services is on the eastern boundary for chemical separations of commercial reactor fuels. A commercial facility for burying noxious chemicals and low-level radioactive wastes, Chem-Nuclear Services, is located adjacent to the Allied-General facility.

D. REFERENCES FOR SECTION III

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