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National Environmental Research Park Program

SUMMARY—The National Environmental Research Park (NERP) program was established to designate selected DOE sites as outdoor laboratories for studies on the environmental impact of human activities. The Savannah River Site, designated as the first NERP in 1972, has been the location of numerous research projects directed by hundreds of resident and visiting scientists.

In 1989, approximately 10 research projects were conducted under the NERP program, including studies on SRS wetlands (especially Carolina bays), the upgrading of the SREL herbarium collection, and a potentially rare and endangered species of freshwater clam from SRS.

INTRODUCTION

When the Department of Energy (DOE) designated the Savannah River Site (SRS) as the first National Environmental Research Park (NERP) in 1972, scientific investigators from universities and other organizations were encouraged to use SRS as an outdoor laboratory to study the environmental impact of man's activities. Since 1972, hundreds of scientists have worked at SRS in cooperation with the Savannah River Laboratory (SRL), the Savannah River Ecology Laboratory (SREL), and the Savannah River Forest Station (SRFS).

The SRS National Environmental Research Park also attracts numerous scientists and students who visit the site to work with resident scientists, present seminars, use specialized research facilities, and conduct research. During 1989, about 500 visitors came to SREL for such purposes.

In 1989, SRS expanded the National Environmental Research Park program called "set asides," which designates selected areas onsite to be protected exclusively for research. After adding 19 additional areas, the set-aside program grew from the 892 acres originally designated in 1968 to almost 12,000 acres in 1989.

The goal of the set-aside program is to ensure that areas unaffected by site operations will be available for comparison with other areas affected by site operations or by land management activities. The new areas set aside for research in 1989 represent a variety of Carolina bays, hardwood forests, stream bottomland, and sandhills. Boundaries are currently being marked around the set-aside areas, which now comprise about 5% of the SRS. Figure 14-1 gives the set-aside locations.

ENVIRONMENTAL RESEARCH PROJECTS

Resident and visiting scientists have conducted a variety of small innovative research projects at SRS under the NERP program. Research has also been conducted at five NERP sites in addtion to SRS. In the future, DOE plans to synthesize and compare data that have been collected at the various DOE parks, which are located in Idaho, Washington, New Mexico, Tennessee, and Illinois.

Several cross-site activities began in 1989 with SREL participating in the first attempt to integrate environmental research data among the National Environmental Research Parks. A long-term database, compiled from plant succession studies on agricultural fields abandoned when SRS was established in 1951, was used in a cross-site workshop on plant succession. Plant succession patterns at SRS were compared with those at the DOE Hanford site located in Washington.

During 1989, approximately 10 research projects were conducted under the National Environmental

Research Park program. In one project, the SREL herbarium collection was upgraded; while in another project, clam identification experts studied a potentially rare and endangered species of freshwater clam from SRS.

Many of the 1989 studies focused on SRS wetlands, especially the shallow ponds called Carolina bays. Listed below are summaries of the wetlands studies:

- A collaborative study between SREL and Louisiana State University examined the relationship between water level fluctuations in Carolina bays and their vegetation.
- The resting stages of microscopic animals found in dry bays were compared to those of species that successfully recolonize the bay when water returns to the bay.
- Historical land uses were compared with current bay vegetation patterns using aerial photographs.
- A report was published that describes the physical, chemical,and biological characteristics of about 194 Carolina bays on SRS.

In addition, the Savannah River flood plain was the focus of the following two studies:

- analysis of wetland vegetation and disturbances of the flood plain with the Geographic Information System
- comparison of three river systems for fragmentation of the hardwood forest—including the Savannah River bottomland—by scientists from Memphis State University

Set Asides Before 1989

1 Field 3-142
2 University of GA
Old Laboratory Site
3 Sandhills
4 Loblolly Pine Stand
5 Oak-Hickory Forest
6 Beech Harwood Forest
7 Mixed Swamp Forest
8 Steel Creek Bay
9 Cypress Grove
10 Risher Pond

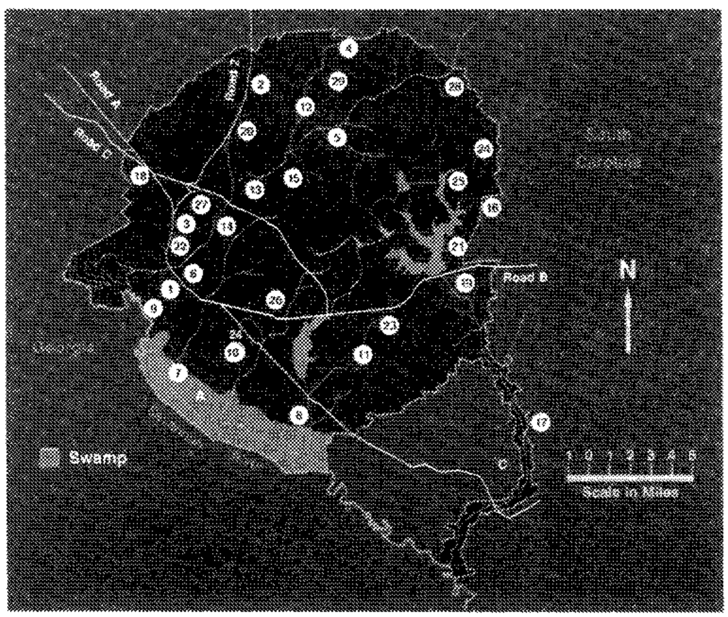


Figure 14-1. Set-aside areas on the SRS

New Set Asides In 1989

11 Meyers Branch
12 Oak-Hickory Forest
13 Organic Soils
14 Mature Hardwood
Forest
15 Whipple/OHER Study Site
16 Sarracenia Bay &
Craigs Pond
17 Boiling Springs
Natural Area
18 Ginger's Bay
19 Thunder Bay
20 Flamingo Bay
21 Little Cypress Bay
22 Dry Bay
23 Cypress Bay
24 Carolina Bay &
Woodward Bay
25 Sandhills Firesite
26 Road 6 Bay (172)
27 Field 3-409
28 Scrub Oak Natural Area
29 Upper Three Runs Creek
& Tinker Creek

1989 HIGHLIGHTS

- During 1989, about 500 visitors came to SREL to collaborate with resident scientists, to use specialized research facilities, and to conduct research.
- In 1989, the long-term database, compiled from plant succession studies on agricultural fields that were abandoned when SRS was established in 1951, was used in a cross-site workshop comparing plant succession patterns at SRS with those at DOE's Hanford site in Washington.
- SRS expanded the program that designates "set asides," which are selected areas onsite to be protected for research. Set asides have increased from 892 acres in 1968 to almost 12,000 acres in 1989.
- In 1989, a published report described the physical, chemical, and biological characteristics of about 194 Carolina bays on SRS.

15 Savannah River Ecology Laboratory Programs

SUMMARY—The Savannah River Ecology Laboratory conducts independent environmental studies of the SRS in three major research areas: biogeochemical ecology, stress and wildlife ecology, and wetlands ecology. The programs encompass a variety of studies from the impact assessment of the coal piles and ash basins on nearby surface waters to the biogeochemistry of dissolved organic matter and chemicals in SRS streams. SREL has investigated the environmental chemistry and toxicity of mercury in Upper Three Runs Creek and the radionuclide cycling of plutonium and cesium in Pond B.

SREL and SRL collaborated on several projects including the testing of a new technology, the biobarrier, as a plant root barrier in hazardous waste containment systems, and the development of a biodiversity plan to inventory species on SRS that fall under legislation currently proposed in congress.

A major thrust of the SREL research continues to be the population dynamics of fish communities in Four Mile Creek and Upper Three Runs Creek, and improvement of wetlands habitats for waterfowl, amphibians, and reptiles. In 1989, SREL submitted a Site-Use Plan that increased the total acreage of SRS set-asides (areas where scientists may conduct research) from 892 acres to 11,445 acres.

INTRODUCTION

The Savannah River Ecology Laboratory (SREL) is operated by the University of Georgia under contract with the Department of Energy (DOE). Since 1952, SREL has conducted independent environmental studies of SRS, its streams, ponds, and the Savannah River.

Because public access to SRS is limited, many long-term research programs are conducted without problems that may be encountered in nonrestricted areas. Some of the first studies performed on SRS included biological inventories, competition in animal and plant communities, and the use of radioactive tracers to chart food chains.

Over the years, the research programs have evolved and are now composed of three major divisions—biogeochemical ecology, wildlife and stress ecology, and wetlands ecology. Research activities in these divisions focus on both freshwater and terrestrial systems in natural and disturbed habitats. This chapter describes many of the research activities conducted on SRS during 1989.

BIOGEOCHEMICAL ECOLOGY

To understand biogeochemical principles in terrestrial and aquatic systems—the basic objective of biogeochemical ecology—major emphasis is placed on interactions among biological and chemical cycling processes and their effect on transport, bioavailability, fate, and effects of potential contaminants.

Many of the biogeochemical research programs described in this section include cycling of radionuclides, environmental chemistry and toxicology, and modeling the transport and fate of environmental contaminants.

Contaminants in Coal Piles and Ash Basins

Listed on the following pages are studies currently underway at SRS to investigate the release of organic and inorganic contaminants from coal piles and ash basins, and the potential for these contaminants to enter nearby surface waters and groundwater:

- SREL and Westinghouse Savannah River Company (WSRC) sampled shallow wells around the 400-D Area coal pile and coal-pile runoff basin and analyzed the samples for various constituents. A new technique called Hydropunch was cooperatively tested to obtain depth-discrete groundwater samples which were analyzed and compared with traditional well samples. Based on these data, a preliminary hydrogeologic model was developed showing two contaminant plumes, one from the coal pile and the other from the coal-pile runoff basin.

- SREL developed and initiated a study plan to determine the factors responsible for the death of vegetation in an area downgradient of a reject coal basin in the 400-D Area.

- SREL initiated studies to investigate the source of coal-derived polycyclic aromatic hydrocarbons (PAH) to a wetland in the 700 Area, where sediments have shown elevated concentrations of PAH. This study is discussed in the following section.

All of the studies and activities listed above will continue in 1990.

Coal-Derived Polycyclic Aromatic Hydrocarbons

Coal is a widely used energy source and its use is expected to increase over the next decade. SRS operates several coal combustion power facilities and maintains a three-month supply of coal onsite.

Very little is known about organic contaminants derived from coal-pile runoff. Therefore, current studies are investigating the transport of coal-derived polycyclic aromatic hydrocarbons (PAH) to an SRS wetlands system. The sediments of this wetland system contain elevated concentrations of PAH; however, the sources of the PAH have not been identified. Several possible sources include coal pile leachate, parking lot runoff, chemical waste basin overflow, and atmospheric deposition. The distribution of alkyl-substituted PAH, parent PAH, and terpenoid hydrocarbons in potential source materials and wetland sediments is under investigation. Future work will compare these hydrocarbons to assess the current and historical inputs of PAH from various sources to the wetland.

Chemical Speciation of Metals

Chemical speciation determines the mobility, bioavailability, and toxicity of metals in surface and subsurface environments. Specific information on species distribution and the kinetics of species transformation is required for providing information on the processes regulating the mobility of metals within soils and subsequent transport to surface waters and groundwater.

In 1989, researchers focused on the refinement of geochemical speciation models for predicting the fate of locally important metals and radionuclides in soils, surface waters, and groundwater on SRS. Researchers are also developing specific analytical techniques for measuring the speciation of metals and radionuclides.

SREL investigated the kinetics of species transformations and identified certain processes that limit the rate of transformations. These rate limiting processes may be important in regulating the mobility and transport of some metals and radionuclides in the environment.

Future studies will concentrate on identifying specific equilibrium and nonequilibrium processes that are potentially involved in facilitated transport of contaminant metals, radionuclides, and organics in SRS surface and subsurface environments. Examples of such equilibrium processes include complexation of metals and partitioning of contaminant organics to humic substances in soils, groundwater, and surface waters. Nonequilibrium processes include adsorption and precipitation/dissolution reactions.

Environmental Chemistry and Toxicity of Mercury

This program assesses the effects of discharges from the Effluent Treatment Facility (ETF) into Upper Three Runs Creek by examining the following areas:

- fish population-level responses to inorganic mercury

- mercury bioaccumulation in fish species

- mercury concentrations in the creek water

Laboratory studies have defined potential genetic markers for population responses to inorganic mercury. Mercury bioaccumulation in fish species native to Upper Three Runs Creek and total mercury concentrations in waters from Upper Three Runs Creek were determined for the period prior to ETF releases.

SREL will compare the results of the ETF pre-operational studies with the post-operational characteristics of Upper Three Runs Creek waters and fish populations to detect any significant change after associated mercury releases. During 1990, population studies will extend to chronic and sublethal exposure scenarios including multiple generation mesocosm studies. Post-discharge sampling will also take place during 1990.

Transformation of Organic Compounds in Streams

Dissolved organic matter (DOM) plays an important role in chemical and biological processes in all aquatic ecosystems. Recent studies show that DOM can facilitate the transformation of certain organic compounds by sensitized (indirect) photochemical reactions. Sensitized photochemical reactions are initiated when light is absorbed by organic compounds other than the substrate of interest. An excited compound is formed that may react directly with the substrate or may produce a reactive transient species (e.g., singlet O_2, organic peroxy radicals), which can subsequently react with the substrate.

SREL is currently investigating photochemical reactions sensitized by DOM in southeastern blackwater stream systems. The photosensitizing ability of DOM from different sources, including leachate from senescent leaves and flood plain sediments, is under evaluation.

In addition, DOM from selected sources is being fractionated chemically and by molecular size to determine if the relative reactivity differs between fractions. Several organic substrates known to react through specific mechanistic pathways at well defined rates are being used in this study. From these studies, the production rate of specific reactive transient species by DOM from different sources or by different fractions of DOM from a particular source will be determined.

This information will provide a better understanding of the relationship between the input and diagenesis of DOM and the spatial and temporal variation in the rates of sensitized photochemical reactions in streams.

Microbial Activity in L Lake

This research will characterize the microbial community in the L-Lake ecosystem with regard to the heterotrophic use and biodegredation of the two primary sources of organic matter in the lake:

- algal biomass, including the dramatic blooms of cyanobacteria (blue-green algae) which occur under conditions of elevated water temperatures
- vascular plant biomass, including contributions from the emergent plant communities planted along the periphery of L Lake in 1987 to accelerate the natural development of littoral and wetlands vegetation

Microbial growth is directly related to the degradation of organic matter in the lake. As bacteria degrades the plants, the bacterial population increases. This increase in bacterial production is measured as

L Lake is a cooling reservoir for L Reactor

the level of bacterial carbon per weight of the plant detritus per day, and is based upon the nitrogen content, lignin content, and carbon/nitrogen ratio of the degraded plant material.

Bacterial production of vascular plant detritus was measured for three emergent plant species (*Juncus effusus*, *Panicum hemitomon*, and *Typha latifolia*) degrading in the littoral zone of L Lake. Bacterial production ranged from 0.01 to 0.81 μg of bacterial carbon/mg detritus/day. However, the production varied among the plant species according to the predicted biodegradability of the plant material (based on initial nitrogen content, initial lignin content, and carbon/nitrogen ratio). Bacterial production throughout the 22 weeks of decomposition was positively related to the temperature of the water in L Lake, as well as to chemical characteristics of the degrading plant material.

SREL compared the rates of bacterial degradation of algal detritus (derived from cyanobacteria and from a mixed diatom community) to degradation rates in a naturally acidic freshwater swamp (the Okefenokee Swamp, GA) and a marine marsh (Sapelo Island, GA). Decomposition rates were generally higher for all substrates in L Lake compared to rates in the freshwater swamp, and equivalent to or lower than rates in the salt marsh. The pH of the environment was an important factor in determining the rates of decomposition. Degradation of algal carbon was less affected by pH than degradation of the refractory lignocellulose complex derived from vascular plants.

Humic substances, which make up an average of 48% of the dissolved organic matter in the L-Lake water column, are often considered too refractory to be important in the support of aquatic food webs. However, ongoing studies suggest that these substances in L Lake may be as important as the non-humic dissolved compounds for supporting bacterial growth.

Results of these studies contribute to understanding microbial activity in L Lake and allow a comparison of bacterial decomposition and growth rates between the lake and other temperate, shallow-water ecosystems. Future studies will focus on the dynamics of humic substances in L Lake, the relative contributions of cyanobacterial blooms and vascular plants to dissolved organic matter and humic substances, and the stability and persistence of bacterial genetic material (including engineered bacterial DNA) in the L-Lake ecosystem.

Biobarrier Testing for Waste Management Applications

Vegetation is a viable long-term means of soil stabilization over buried hazardous waste, only if plant roots are not permitted to recycle constituents of the waste. SREL and SRL collaborated to determine if a new technology, the biobarrier, could be used as a plant root barrier in hazardous waste containment systems at SRS. Initial tests show promise for biobarrier use at SRS.

The biobarrier product consists of a fabric material containing encapsulated Trifluralin, a herbicide that inhibits root growth. The biobarrier, designed to remain effective for 100 years or more, is placed in the soil between the plant root zone and the waste containment zone.

The herbicide is released slowly, but at levels high enough to prevent root growth near the biobarrier. Initial tests at the SREL rhizotron facility indicate that the biobarrier is effective at preventing penetration by roots of soybean, Bermuda grass, Bahia grass, and bamboo. Glass-walled trenches located on SRS show similar results for pine and oak trees.

Based on these results, SREL and SRL have planned an expanded, rigorous testing program for 1990. These tests will address the longevity of biobarrier effectiveness and will identify plant species that are compatible with biobarrier use in waste management applications. Results of these studies will comprise a test of the current biobarrier product and may be used, if necessary, to re-engineer the product to suit specific needs of SRS.

Radionuclide Cycling in Pond B

Plutonium Cycling

SREL is currently conducting research on the radionuclide cycling of ^{238}Pu and $^{239,240}Pu$ in aquatic and terrestrial habitats with emphasis on annual remobilization cycles from Pond B sediments. The role of remobilization in the availability of plutonium to the biota and the potential transport of plutonium to downstream environments are also under study.

Previous work demonstrated an annual plutonium remobilization cycle with a spring maximum and a fall minimum. The spring maximum occurs concurrently with the maximum pond discharge and the onset of biological activity. During 1989, SREL completed analyses of sediments, macrophytes, and sediment trap samples to determine the plutonium redeposition from the water column to the sediments and the plutonium accumulation on macrophyte surfaces. Both processes must be quantified to determine the fluxes and activity budgets of plutonium in the water column.

In addition, research, conducted in cooperation with Colorado State University and Argonne National Laboratory, focused on naturally occurring thorium isotopes and the possible redistribution of plutonium and cesium in Pond B sediments.

Research on terrestrial habitats focused on two processes: particulate transport processes of interception and retention of atmospheric deposition; and the resuspension of soil particles in natural and agricultural ecosystems. New and reanalyzed data provided insights on resuspension and on the accuracy of models designed to assess interception and retention. In 1989, SREL used existing plutonium data to determine the following:

- the role that resuspension of soil particles to plant surfaces plays in transporting insoluble contaminants (e.g., heavy metals and hydrophobic organics) in agricultural systems
- how the atmospheric dispersion model used by NRC Regulatory Guide 1.109 can consistently underpredict the interception and retention of particulate deposition

Much of the terrestrial work is designed to interface with the Biosphere Model Validation Study (BIOMOVS), an international effort to evaluate the accuracy of radionuclide transfer models.

Cesium-137

Among the SRS locations contaminated with long-lived radionuclides such as ^{137}Cs, the Pond B reservoir is unique because of its size (87 hectare) and attractiveness as a water fowl habitat. The water fowl may serve as carriers of contaminants to hunters who may harvest them in neighboring counties or along migratory pathways.

Studies of the uptake and concentration of ^{137}Cs by Pond B water fowl revealed that under natural conditions, these processes occur differently than previously predicted by laboratory studies. Specifically, delays in the early uptake of this radionuclide by newly arrived birds resulted in accumulation of lower-than-predicted body burdens after short stays on the reservoir.

Studies during 1990 will attempt to explain further the failure of Pond B water fowl to show trophic-level concentrations of ^{137}Cs in the more carnivorous species of the food chain. The implications of the high concentration ratios of this contaminant in the edible muscle tissue of Pond B biota will also be examined. These types of studies will impact the long-term management strategies of waste sites and contaminated habitats on SRS.

STRESS AND WILDLIFE ECOLOGY

The study of natural populations and communities of plants and animals emphasizing the impact of human-caused stresses on these communities is the major focus of stress and wildlife ecology.

Some of the programs conducted at SRS include research on the effects of reactor effluents on aquatic organisms, the effectiveness of alternative habitats to populations whose primary habitat has been destroyed, and studies of endangered species.

SREL conducts various stress and wildlife ecology studies, many in collaboration with WSRC. The following sections summarize the studies receiving emphasis during 1989.

Biodiversity Research

The biodiversity program concentrates on research that is directly applicable to prudent land management of SRS. During 1989, SREL, SRL, and the U. S. Forest Service developed a research plan to conduct biodiversity studies on SRS. The program focuses on biodiversity research that is directly applicable to prudent land management on SRS. Some questions that will be addressed in this research include the following:

- What is the role and significance of wildlife corridors on SRS?
- How can the indicator species for which extensive databases are available be best used in assessing changes in biodiversity on the site?
- What are the long-range spatial and temporal extensions of Savannah River Site activities on biodiversity?

- What are the impacts of habitat modification through forestry and construction activities on biodiversity?
- What is the range of variability in biodiversity resulting from natural environmental variability?

Population Genetic Studies of SRS Vertebrates

SREL performed studies on genetic characteristics of several vertebrate species on SRS using electrophoretic techniques. The purposes of these studies are listed below:

- to document the spatial-demographic genetic structure of vertebrate populations on SRS
- to determine the extent that these populations are temporally stable in terms of their genetic characteristics
- to test for genetic correlations with the functional characteristics of these populations
- to document possible effects of onsite operations on the species' genetic characteristics

Most of the work involved white-tailed deer, eastern mosquitofish, blue-back herring, cotton rats, eastern moles, cotton mice, and largemouth bass. In general, most of the species studied show significantly different gene frequencies in different areas of SRS and across time at the same area.

The studies also demonstrated correlations between the measured genetic characteristics and functional characteristics of the populations (e.g., average number of offspring or body size).

Finally, these studies documented changes in gene frequencies of fish populations in response to heated reactor effluents. The genes that were observed control the metabolic enzymes involved in the breakdown of sugar molecules to generate energy for the fish's activity. Largemouth bass and mosquito fish living in heated effluents tend to have different enzymes for these functions.

Fish Community Development in Four Mile Creek

Following many years of thermal discharges from C Reactor into Four Mile Creek, SREL began two separate studies in 1987 to investigate the development of fish communities in Four Mile Creek under ambient thermal conditions. One study focuses on describing the composition of fish communities; the second study focuses on describing the feeding habits, growth, reproduction, and lipid storage of the dusky shiner.

In the Four Mile Creek community development study, eight sites are sampled twice each year. Four sites are above a small dam that would block upstream colonization; four sites are sampled below the dam. Sites are also paired so that slow and fast waters are sampled in each area. Samples were collected in fall 1987, spring 1988, fall 1988, and spring 1989.

Since the study began, SREL has collected 32 fish species and 8,105 individual fish. The average fish density in Four Mile Creek was 0.43 fish/m^2, while the average density in unimpacted SRS streams was 1.80 fish/m^2. In Four Mile Creek, nine species comprised over 95% of the fish collected; in unimpacted streams, 15 species comprised 95% of the fish. The dominant species was the eastern mosquitofish, which is typical of disturbed or early successional habitats.

In the dusky shiner study, samples are taken from two sites throughout the year to study feeding, growth, reproduction, and lipid storage. SREL collects samples concurrently with those collected in a similar study in Upper Three Runs Creek. Paired sampling allows the species in Four Mile Creek to be contrasted with populations in an older community such as Upper Three Runs Creek.

Preliminary data on growth and reproduction of the dusky shiner indicate a faster growth rate and greater energy availability for reproduction in Four Mile Creek than in Upper Three Runs Creek. This is likely due to higher productivity in this system, combined with a broader resource spectrum resulting from fewer competing species.

Early results indicate that Four Mile Creek is recovering, but it is still immature and does not resemble an undisturbed stream of the region. Sampling of the Four Mile Creek system will continue in 1990.

Studies of Fishes in Upper Three Runs Creek

SREL initiated studies in late 1987 to study fish species and communities in Upper Three Runs Creek, with special reference to the new Effluent Treatment

Facility (ETF) outfall and other pollutants in the system. Annual studies examined the community structure, feeding, growth, reproduction, and lipid storage mechanisms of dusky shiners. Quarterly sampling of dusky shiners and pirate perch are performed for population genetic and asymmetry analyses. All of these factors could be indicators of pollutant effects.

Results from community studies done prior to ETF releases indicate a diverse system and there is no indication of pollution effects. However, a sample has not been taken after ETF releases. SREL continues to collect data on the seasonal pattern of the allocation of energy to growth and reproduction. These studies are conducted by analyzing stored lipids in somatic and reproductive tissues. Results will be available in late 1990.

SREL collected extensive genetics and asymmetry samples, which are currently being analyzed. When complete, these studies will provide information on pollutant impacts over a broad range of biological indicators. These studies will also help determine whether current operations are having significant impacts on fish in this system.

Plans for 1990 include continued sampling on a reduced schedule and completing analyses of the many samples collected in 1987 and 1988.

Biodiversity on the SRS

The Savannah River Site is an area rich in biological diversity. SRS supports such a diversity due to the well-protected nature of the site, and because a many natural and managed habitats exist on the 300-square-mile area.

Listed below are several examples of SRS's biodiversity:

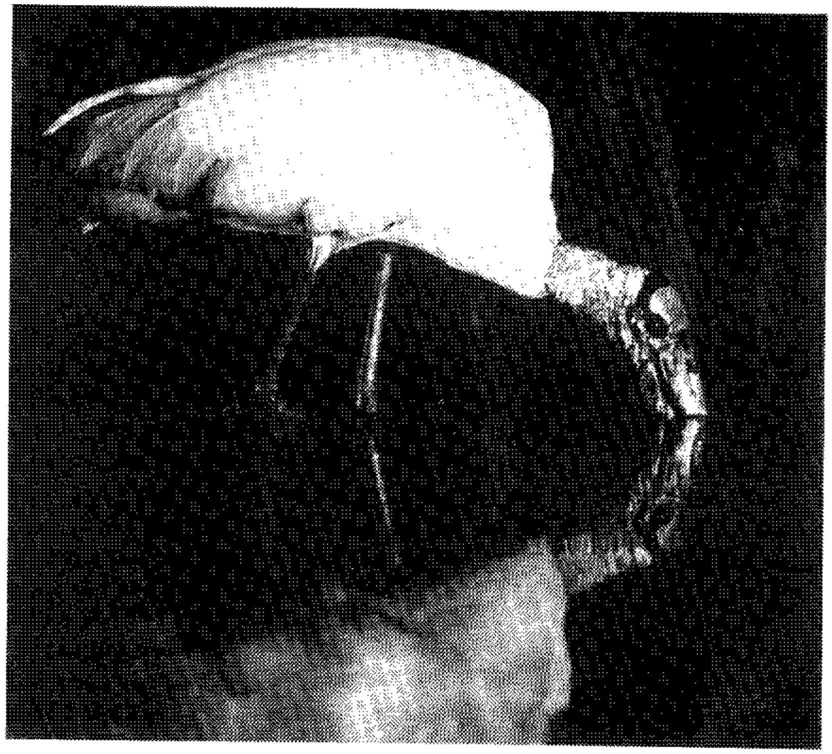
- Scientists and researchers have identified over 1,300 species of vascular plants on SRS. Major plant communities on SRS include old agricultural fields, sandhills, upland hardwoods, pine forests, bottomland hardwoods, swamp forests, Carolina bays, and freshwater streams, ponds, and marshes.
- Scientific literature has reported that more species of aquatic insects and other invertebrates are found in Upper Three Runs Creek than in any other stream of its size in the world.
- Scientists have identified more than 100 species of reptiles and amphibians on SRS, more species than observed in most states in the United States.
- Approximately 200 species of birds—including about 100 breeding species—occur on SRS. The endangered bald eagle, wood stork, and red-cockaded woodpecker number among the feathered species. In addition, SRS scientists and researchers conduct significant research and recovery programs on the endangered wood stork and red-cockaded woodpecker.
- SRS supports approximately 50 species of mammals.
- Both resident and visiting scientists have discovered several species on SRS new to science. Much of the biodiversity research—including habitat descriptions, species lists and taxonomic keys of species rarely studied—is possible because SRS is one of DOE's six National Environmental Research Parks.

Status of the Red-Cockaded Woodpecker

SREL is surveying the genetic variability in the red-cockaded woodpecker to provide management guidelines for the expansion and recovery of the SRS population. Because genetic variability is critical for the short-term health of the SRS population, rangewide surveys of the species were undertaken. All field research was completed in 1989 and data are available from 26 populations of red-cockaded woodpeckers in seven states.

Results indicate that the SRS woodpecker population is genetically healthy at the present time, but that it may be losing genetic variability due to the small population size. This loss can be corrected by rapidly expanding the population. Rangewide genetic surveys indicate that red-cockaded woodpeckers from other South Carolina populations are suitable for augmentation onto SRS.

Ecology of Wood Storks



Wood storks forage often at Kathwood artifical pond

In 1989, the Kathwood artifical foraging ponds for wood storks were made available to storks for the fourth year. In addition, research on the breeding biology and foraging ecology of wood storks at the Birdsville colony, located in Jenkinsville, GA, continued to provide important information for managing the Kathwood ponds.

The average density of potential prey at the Birdsville colony was 10.3 items/m^2 in 1989, up from 6.4 during the dry summer of 1988. Although sufficient prey was available, breeding success was 0.63 fledglings per nest attempt (compared with 2.86 in 1986, the highest breeding success). The low success was largely due to parents abandoning nests during periods of inclement weather in the early spring. Many of these parents attempted to nest again, and the reproductive success per pair was somewhat higher than the 0.63 fledglings per nesting attempt.

SREL made the Kathwood ponds available to the wood storks in April, but no storks visited the ponds. The ponds were made available again in early July, as was done in 1986 and 1987. The numbers of storks gradually increased, and on July 28, SREL counted 223 storks at the ponds. This was the highest number since SREL first made the ponds available in 1986. The storks depleted the fish in the ponds by mid-August, and SREL began filling the ponds in late August.

In 1990, the Kathwood ponds will again be made available to the wood storks. The studies at the Birdsville colony have determined many details of breeding and foraging biology of storks during the last few years. The Birdsville colony studies will be reduced to a few critical surveys, which will provide the important information for managing the Kathwood ponds in 1990.

Ecology of Breeding Wood Ducks on the SRS

Long-term research on the nesting biology of wood ducks on SRS has provided a better understanding of factors that relate to the productivity of this species. During 1989, nesting boxes in which wood ducks lay and incubate eggs were checked weekly from January–June. In 1989, the breeding wood ducks used 85 of 138 nest boxes (62%) to lay a total of 1,468 eggs. These nests contributed 690 day-old ducklings to the population.

Annual population recruitment rates based on seven years of study indicate that about 18 female day-old ducklings will survive to breed on SRS in 1990. It is estimated that the surviving female wood ducks will disperse an average of 1.6 km from their natal areas to establish nests of their own. Male wood ducks typically dispersed to greater distances, with some males hatched on SRS being recovered by hunters as far away as Ontario, Canada.

Listed below are additional data on the ecology of breeding wood ducks:

- Nesting females require more time to successfully incubate larger clutches.
- About 7% of the nesting population success fully hatches two broods of ducklings in a single year.

- Females that are heavy at the beginning of incubation tend to lose more weight during incubation.

- Body condition of females at the beginning of incubation does not influence hatching success of the nest or the length of the incubation period.

- In some cases, females in better physical condition after incubation are more likely to survive to the next breeding season than females in poorer condition.

Water Fowl Use of L Lake and Par Pond

L Lake, a man-made cooling lake on SRS, provides a unique opportunity to observe the wintering water fowl's response to a new freshwater ecosystem. Initially, the value of the reservoir to water fowl was limited because it lacked basic components of a balanced biotic community that provide the necessary resources used by these species. Although numerous species of water fowl were observed on the reservoir during the early years of lake growth, the number of individuals was very unstable. This suggests that the reservoir served primarily as a brief resting area for bird flocks heading toward more southerly wintering grounds.

The aquatic plant communities and associated invertebrate communities that serve as a food source for water fowl are now established in L Lake. As a result, the numbers of water fowl seen on L Lake during aerial water fowl surveys have steadily increased and stabilized through the winter period.

During the winter of 1988–1989, SREL researchers conducted nine water fowl surveys over L Lake and observed nine different species using the reservoir. The most abundant species were lesser scaup, ring-necked ducks, and American coots.

These three species were also the most numerous found on Par Pond, a well-established SRS freshwater ecosystem that is important for locally wintering waterfowl. Important additional findings from wintering water fowl research include the following:

- A ring-necked duck trapping program on Par Pond since November 1985 resulted in the trapping and banding of over 150 individuals using that reservoir during the winter.

- Samples of trapped ring-necked ducks indicate that the population using Par Pond is largely adult (68%) and male (78%).

- Each winter, adult males were in the best physical condition, and immature females were in the worst physical condition.

- Ring-necked ducks trapped and banded on SRS during winter months have been recovered as far south as Florida and as far north as Ontario, Canada.

- Sport hunters have also collected SRS banded ring-necked ducks in Georgia, South Carolina, North Carolina, Virginia, Ohio, and Michigan.

SREL will continue to monitor the levels of L Lake usage as a wintering habitat for the following reasons:

- the potential for SRS operations to affect these species

- the species' high degree of mobility

- the species' popularity for sport hunting

Water Fowl Use of Four Mile Creek Delta

Before C-Reactor effluent flow was terminated, the Four Mile Creek delta, an area of the Savannah River swamp, was used extensively by mallards wintering on the SRS. Decreased reactor operating levels reduced the area of thermal influence, and consequently, outlying portions of the delta began to recover.

Establishment of herbaceous floral communities characterizes the first stages of post-thermal recovery. These communities are an important source of protective cover and food for water fowl. These communities, coupled with the absence of a bottomland forest canopy in the delta and shallow flooding from continued levels of reactor operation, create a habitat suitable for use by wintering dabbling ducks. Aerial counts of mallards from 1981 to 1985 demonstrated that water fowl extensively used the Four Mile Creek delta during this period.

The reduced water flow into Four Mile Creek resulting from reactor shutdown has lowered water levels in the delta. As a result, the water fowl use of the Four

Mile Creek delta diminished. For example, during the winter of 1988–1989, the combined sightings from nine aerial surveys of the Four Mile Creek delta vicinity yielded only 20 mallards. No waterfowl were seen in this delta during aerial surveys the previous winter.

Dwindling numbers of mallards observed throughout the swamp are attributed, in part, to local drought conditions since 1985. However, inoperative SRS reactors also contributed significantly to lower water levels throughout much of the swamp. Water fowl may possibly resume use of the Four Mile Creek delta if it can be reflooded shallowly in the future.

Amphibian and Reptile Ecology

General population ecology studies throughout SRS focus on reptiles and amphibians because of the high species diversity in this region of the country. Researchers have found more species of reptiles and amphibians on SRS than are found in most states of the U.S.

Since extensive information exists on the population ecology, natural abundance, and habitats of reptiles and amphibians of SRS, these groups serve as two of the most suitable animal groups for biodiversity studies. SREL developed the *Guide to the Reptiles and Amphibians of the Savannah River Site,* which reviews published and some unpublished data on the 100 species of reptiles and amphibians found on SRS. The book, being published by University of Georgia Press, discusses the known ecology of each species occurring on SRS and identifies research areas that deserve further investigation.

Population Dynamics of Turtles

During 1989, SREL organized databases from long-term research programs on SRS turtle populations. This effort resulted in the book, *Life History and Ecology of the Slider Turtle*, which will be published by the Smithsonian Institute Press in 1990. Although the abundant slider turtle is the focal species, the book also provides information on other freshwater turtles occurring on SRS.

These studies are being continued to capitalize on this base of information. The turtles' ecological responses to prolonged regional drought was a notable feature of the past year's research. The aquatic species of turtles (i.e., slider) appears to suffer greatly from the disappearance of many aquatic sites. However, researchers can now observe the response of semi-terrestrial species such as the common mud turtle to the continuing drought condition. These species rely on aquatic habitats for only a portion of the year.

When the survivorship and mortality patterns of the small-bodied mud turtles are compared to the nor-

SREL Publications Highlight SRS Species and Research

Guide to the Reptiles and Amphibians of the Savannah River Site. Ecologists recognize SRS as an area where extensive field studies have been conducted on reptiles and amphibians. SREL staff members, J. Whitfield Gibbons and Raymond D. Semlitsch, recently compiled much of that valuable information into the publication, *Guide to the Reptiles and Amphibians of the Savannah River Site*, University of Georgia Press, 1990. The guide presents 35 years of ecological information on each of the more than 100 species of the animals identified at the site. In the guide, the reader finds identification keys and descriptions of each species as well as details on their habitats and activity patterns.

Life History and Ecology of the Slider Turtle. Scientists associated with SREL have conducted the longest continual field research studies on freshwater turtles ever documented. The *Life History and Ecology of the Slider Turtle*, J. Whitfield Gibbons, Smithsonian Institute Press, 1990, details the continuous research on more than 20,000 turtles captured, marked, and released since a study began in 1967. Research documented in the book reveals unprecedented findings regarding long-term growth rates, movement patterns, and survivorship potential of the slider turtle. Several of the chapters in the book were contributed by investigators who conducted indepth research on SRS slider turtles.

mally more abundant and larger slider turtle that inhabit the same aquatic areas, it is clear that mud turtles are much less affected by drought conditions.

Previous research based on mark-recapture studies on SRS revealed that slider turtles occasionally reached ages of more than 25 years. It has now been determined that mud turtles reach ages of 35 years or more, which makes mud turtles one of the longest-lived species of animals under field conditions.

Table 15-1
Comparison of Seepage Basin and Pond B Turtles

Location	Average ^{137}Cs (Bq/g of body mass)	Average ^{90}Sr (Bq/g of body mass)
Seepage basins	3.02	94.03
Pond B	1.00	2.24

Turtles in Contaminated Aquatic Habitats

The yellow-bellied pond slider is a long-lived species with broad ecological tolerances. These turtles inhabit a variety of contaminated aquatic habitats on SRS that are marginal, if not uninhabitable, for many other aquatic vertebrates. Thus, the slider may be an important carrier of radiological and nonradiological pollutants. To assess the slider's ability to disperse contaminants through emigration, as well as the effects of these agents on the turtles themselves, SREL focused on two aspects of turtle research.

First, an extended survey of natural and man-made aquatic sites on SRS and its perimeter was conducted. In 1989, most trapping of turtles centered on offsite locations adjacent to Lower Three Runs Creek. Of the 82 turtles captured, none demonstrated significant levels of contamination. Extensive trapping was also conducted onsite in areas previously identified as contamination sources, including basins fenced to prohibit turtle movement. Eighteen sliders were removed from these sites, all of which demonstrated levels of contamination.

In addition to research on contaminated turtle dispersal, SREL has conducted genetic surveys on pond slider turtles inhabiting areas contaminated with radioactivity. Flow cytometric research of the slider populations showed evidence for genetic alteration, presumably resulting from exposure to environmental mutagens. Three experimental populations of turtles were examined, including turtles from the H-Area seepage basins, 700-Area seepage basins, and Pond B. In each case, DNA content variation was higher in samples from the contaminated sites than in samples from the control sites not on SRS. Moreover, concentrations of ^{137}Cs and ^{90}Sr were higher in the seepage basin turtles than in the Pond B turtles as shown above in Table 15-1.

The results from the Pond B study suggest a sensitive genetic response to low-level radiation. SREL is conducting further research to complement and extend these preliminary findings.

Ecological Effects of DWPF Construction

An SREL research program on the Defense Waste Processing Facility (DWPF) examines the ecological effects of the facility's construction and the effectiveness of mitigation measures. This program emphasizes the effects of runoff to streams peripheral to the construction site and the impacts of construction on wetland Carolina bay vertebrates.

During 1989, SREL collected monthly water samples from nine stream locations near the construction site. Samples were analyzed for total suspended solids, turbidity, specific conductivity, and percent ash weights. Analytical results of measurements taken on six sample dates following rainfall indicated increased levels of suspended solids in Upper Three Runs Creek. The analytical results indicate that stream water quality is directly affected by DWPF construction. Therefore, continued erosion control measures will be necessary to minimize the impact of the DWPF site on peripheral stream water quality. Monitoring will continue in 1990.

Additional studies have examined the effectiveness of artificial refuge ponds built near the DWPF site as an experimental attempt to mitigate the loss of a Carolina bay during DWPF construction. These artificial ponds were compared to Rainbow Bay, one of over 200 Carolina bays located on SRS used as an undisturbed control site. Over the 11 years of study at Rainbow Bay, researchers have observed extreme natural variation in the amount of time the site holds water (i.e., the hydroperiod). The hydroperiod of a bay greatly influences the reproductive success of most species because most amphibians depend on water to complete their life cycle. Studies during 1989 also focused on predation by dragonfly larvae on salamander larvae in the laboratory, artificial ponds, and field enclosures. Because dragonfly larvae are effective predators, the hydroperiod exerts both direct and indirect effects on amphibian reproductive success. SREL determined that the artificial ponds do not mimic the hydrologic cycle of the former bay. Therefore, the artificial ponds' effectiveness as alternative breeding sites for amphibians may be compromised.

Research on the interaction between processes regulating wetland vertebrate populations in the wetland itself, and processes acting in the habitats surrounding the wetland, began in 1989. The continuation of these studies in 1990 will provide information on the nature and extent of buffer zones needed around wetlands at DWPF and elsewhere on SRS.

WETLANDS ECOLOGY

Wetlands ecology is the study of biological community development and factors that affect its development in both natural and disturbed wetlands. Some of the current wetlands studied at SRS include Carolina bays, swamp and bottomland forests, cooling reservoirs, and creeks. This section describes many of the research programs conducted by SREL to study the diverse wetlands onsite.

Resource Allocation Models

The manner in which an animal allocates its limited energetic resources to vital activities, (e.g., growth or reproduction) greatly influences its ability to survive. Although animals may not achieve optimal life histories due to morphology or developmental processes, models can predict the direction and intensity of selective pressures on expected life history traits.

SREL uses models to predict optimal life history strategies under various conditions for the cladoceran *Daphnia*, which can continue to grow after reaching reproductive maturity. Many other animals, including various crustaceans, fish, turtles, and other reptiles, also have a similar growth pattern as adults. For a cladoceran, the energy available for growth or reproduction increases with body size. The model treats the life history as an n-dimensional optimization problem where the number of dimensions (n) are set by the number of times that the animal can reproduce (typically 10). Under stable environmental conditions, the models predict that prolonged adult growth will occur only if mortality decreases with increased body size, although limited adult growth can occur with other mortality patterns.

SREL is now testing the effect that the mean and variance of the length of the growing season has on optimal growth patterns. For the next project in this series, SREL will add spatial complexity to the environment and test the effect of migration among populations in various spatial configurations on their success. These models will help provide a theoretical basis for predicting how changes in an environment will influence the composition of its inhabitants.

SREL Set-Aside Program

The set-aside program is designed to protect and preserve unique and representative areas on SRS where scientists may conduct research. During 1989, over 11,000 acres were added to the original 892 acres that were set aside in 1968. The nineteen new set-aside areas include ten Carolina bays, a major section of Upper Three Runs Creek and its tributaries, and the entire Meyers Creek drainage. Set-aside areas now comprise about 5% of SRS.

The boundaries of eight set-asides along with several sections of Upper Three Runs Creek were completely marked. Marking boundaries will provide permanent locations for ecological research.

SREL also submitted a five-year research proposal to DOE which integrated elements of the SREL Biodiversity Program discussed earlier in this chapter.

Plans for 1990 include completing marking the boundaries for set-asides areas and documenting unique features of these areas.

Management Zones of Upper Three Runs Creek

Upper Three Runs Creek is the most species-diverse stream of its size in the world ever studied. When management zones on the creek were developed, SREL identified various research strategies. During 1989, SREL completed a proposal to DOE describing plans to catalog all existing data bases collected in Upper Three Runs Creek by management zone.

Additionally, SREL will begin studies to determine if SRS discharges into Upper Three Runs Creek will affect ecosystem processes. SREL will use modern molecular techniques (DNA fingerprinting) to relate aquatic macroinvertebrate adults to immature forms found along the Upper Three Runs Creek drainage. These baseline data will aid in determining impacts of site operations on the distribution of aquatic macroinvertebrates and their potential for recovery.

Wetland Succession in Steel Creek and Four Mile Creek

SREL continually studies revegetation in flood plain areas of the Savannah River where the original bald cypress-water tupelo forest was destroyed by thermal discharges from SRS nuclear production reactors. Thermal discharges from L Reactor to Steel Creek ceased in 1968, but discharges to Steel Creek resumed in 1985 after construction of L Lake. Although flow rates and water levels increased after discharges resumed, water temperatures in Steel Creek remained near ambient because of L Lake.

After thermal discharges to Steel Creek stopped, herbs rapidly invaded throughout the disturbed areas. SREL examined the recovery of plant community structure and spatial distribution in Steel Creek through long-term wetlands succession studies. Vegetation was sampled in 1972, 1974, 1981, and 1985. The results reveal that after 20 years, much of the Steel Creek delta area on the river flood plain remains dominated by herbaceous marsh communities. Shrubs (especially willow and buttonbush) have gradually occupied more of the flood plain and delta areas. Regeneration of bald cypress and water tupelo, the original forest species, is rare because the seedlings of these species are unable to compete with the dense herbs and shrubs.

Species composition in the affected area correlated with water depth, substrate type, and severity of disturbance. Increased water levels following L-Reactor restart resulted in death of the willow and buttonbush and an increase in herbaceous marsh species in Steel Creek.

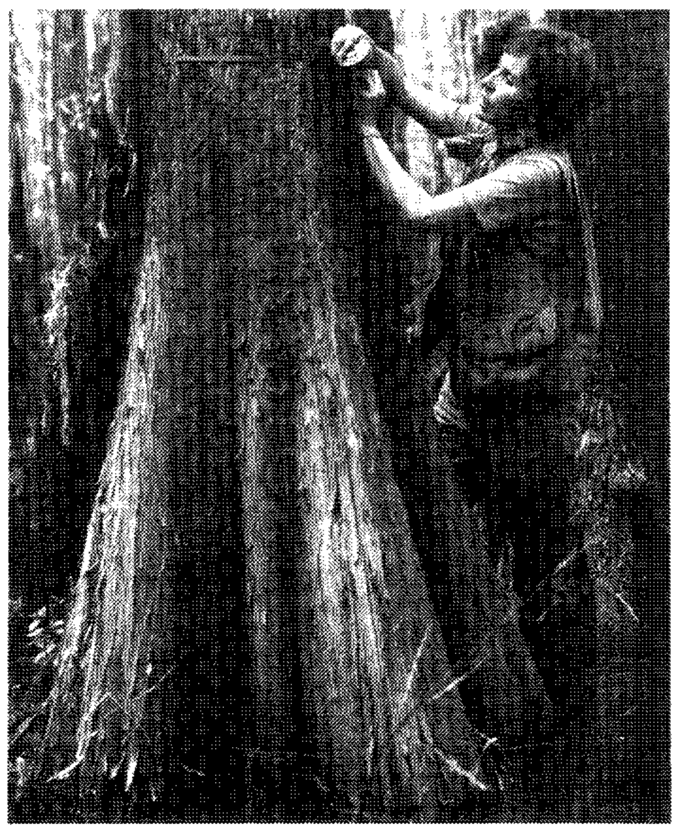
Thermal discharges to Four Mile Creek stopped in 1985. Drier conditions in the Four Mile Creek area allow species that are characteristic of abandoned fields and well drained sites to be established. In 1987 and 1988, natural fires also burned portions of the Four Mile Creek delta.

A comparison of the Steel Creek and Four Mile Creek natural succession process demonstrated that the hydrologic regime is important in determining species abundance, successional patterns, and ultimate community composition. Field manipulations to control early establishment patterns in the Four Mile Creek delta area are underway to evaluate natural mechanisms of succession and potential methods to enhance establishment by woody wetland species.

Seedling Recruitment and Tree Dynamics in SRS Forested Wetlands

SREL is studying the recruitment of wetland forest species and the potential effects of an altered hydrologic regime in the SRS Savannah River flood plain. Discharge of nuclear reactor cooling waters into tributary streams of the river and construction of reservoirs upstream altered the hydrology of the river flood plain. Long-term studies were established to evaluate effects that this altered hydrology has on establishment of forest species, in the context of climatic trends and natural variations in water level and timing of floods.

Research focused on the bald cypress and water tupelo, the dominant forest canopy species in much of



Bald cypress is a dominant forest canopy species in the Savannah River swamp

the Savannah River swamp. Annual seed production is relatively high for both species, although it is highly variable in bald cypress. Seed viability is low in both species. In bald cypress, the low viability results from several biological factors, including a lepidopteran seed parasite. In the water tupelo, the low seed viability is due, in part, to early abortion of immature fruits during heavy windstorms.

Critical elements for the successful recruitment of these species' seedlings include environmental conditions that control water levels and the availability of emergent microsites (safe sites) for germination and early seedling establishment and growth. Because major portions of the Savannah River flood plain remained flooded for most of the growing season, seedling success in the SRS cypress-tupelo forests was poor.

The 1988 drought, coupled with a period of no reactor discharges, resulted in a drawdown of water in the river flood plain and allowed extensive establishment of bald cypress and water tupelo for the first time since SRS initiated operations. Such occasional periods of successful recruitment are essential for the long-term maintenance of flood plain forest community structure.

Leaf-Litter Processing Rates of Flood Plain Riparian Vegetation in Upper Three Runs Creek

To better understand terrestrial-aquatic linkages in flood plain forests, SREL examined the importance of qualitative differences in leaf type by studying variability in leaf-litter processing rates. Researchers based comparisons on leaf packs made during the spring and summer from green leaves of laurel oak, red maple, and mixed leaf litter from the flood plain floor.

Decomposition rates differed significantly according to season and leaf type. Leaf litter from the flood plain was processed the slowest, and did not differ between seasons. After 10 weeks, 44% of the original leaf weight remained. Green leaves were processed much faster, but species specific patterns of weight loss changed seasonally. During spring, there was no detectable difference in leaf decomposition rates for either the oak or maple. In summer, however, red maple leaves were processed more rapidly than oak leaves.

Patterns of leaf weight loss did not correlate with the biomass of leaf shredding aquatic insects. This suggests that either other groups of aquatic invertebrates are functionally more important in stream energetics than previously suggested, or the importance of the microbial component in detrital pathways has been underestimated. Therefore, input of green leaves may potentially represent an important source of nutrients to stream systems. While not of comparable quality, the quantity of litter accumulating on the flood plain also represents an important source of material mobilized during periods of flooding.

Future work will continue to emphasize elemental dynamics and shoreline (riparian) vegetation to better understand stream structure and function, and how disturbance events, both natural and man-made, will affect an ecosystem. These goals will also offer qualitative and quantitative solutions to mitigate potential habitat degradation.

Creation and Function of Shoreline at L Lake

For the third consecutive year, SREL examined the shoreline vegetation communities at L Lake. Transects established in planted and unplanted areas were used to evaluate the success of the wetlands creation and to determine plant succession and community structure.

Established submersed and floating-leaved vegetation is rapidly colonizing unplanted areas, while emergent shoreline vegetation coverage continues to increase. Cattail is the most successful emergent plant to colonize unplanted areas.

SREL will use the vegetation database to determine the relative colonizing and competitive strategies of plants. The data will be used to evaluate the effectiveness of establishing shoreline vegetation as part of the balanced biological community.

Recovery Dynamics in Stream Ecosystems

In the fall of 1987, SREL began quantitative sampling of macroinvertebrates (e.g., aquatic insects) in all major SRS stream habitats on a quarterly basis. Three sites located approximately 2, 10, and 15 km downstream from reactor outfalls were sampled. SREL has identified 89 macroinvertebrate taxa (mostly species designations) since the sampling began.

Contrary to preliminary expectations, macroinvertebrates were the most diverse in the upper site, followed by the lowest site and then the intermediate site. The collector-gatherer (62.5%) and collector-filterer (20.8%) functional feeding groups represented the majority of the total numbers of macroinvertebrates, while the predators, shredders, and scrapers represented only 8.3, 7.8, and 0.6%, respectively. Stoneflies, which are common on SRS, were absent in Four Mile Creek except for a few rare predatory individuals.

While some groups of aquatic insects are represented by disproportionately large populations, others common to SRS drainages are either rare or absent. Although many taxa have rapidly colonized Four Mile Creek, early successional species (e.g., oligochaetes, midge and black fly larvae) still dominate the creek.

Studies indicate that Four Mile Creek may never return to predisturbance conditions. However, further recovery will likely continue as the shoreline vegetation returns, and as the less vagile species (e.g., stoneflies) begin to colonize.

Macroinvertebrate sampling concluded in November 1989. However, species identification and characterization of available habitat will continue throughout 1990. This information, combined with fish and shoreline vegetation data, will provide a comprehensive report on the recovery dynamics of disturbed stream ecosystems of SRS.

Influence of Trophic Relationships on Community Structure and Ecosystem Processes

SREL conducted preliminary experiments to determine the natural densities of predacious stoneflies on snag habitats. Because of relatively high densities, stoneflies may influence the community structure of snag habitats. They may also influence the rates of organic matter processing by consuming the macroinvertebrates responsible for decomposition.

To understand the effects that an organism has on other organisms or processes, factors that determine an organism's distribution and abundance must be understood. Preliminary results indicate that the amount of time the stonefly remains on a snag is not determined by its hunger level but may be influenced by intraspecific competition (i.e., competition between individuals of the same species).

Stoneflies are directly affected by many forms of disturbance, including chemical and thermal pollution. Since predacious stoneflies are often affected before other species, they can be an indicator of general stream health. If the predacious stoneflies are eliminated from a stream by site operations, then the overall community structure of the stream invertebrates will likely change. The change will subsequently affect organic matter processing.

During 1990, SREL will continue preliminary observations to prepare for a large scale manipulative experiment that will vary stonefly and fish density and monitor organic matter processing.

Zooplankton in L Lake

The zooplankton community in L Lake has undergone major changes in composition since the reservoir filled four years ago. Research indicates that the most striking shift is the reduced numbers of larger zooplankton, including cladocerans and calanoid copepods, from the summers of 1988 and 1989, compared to the summers of 1986 and 1987.

Analyses of diets and experimental measurements of feeding rates indicate that population densities of invertebrate predators (e.g., phantom midge larva and the cyclopoid copepod) are too low to strongly affect populations of their prey. In 1989, work began with experimental exclosures to test the effect planktivorous fish have on the zooplankton. The exclosures are large plastic bags supported by PVC pipe from which fish can be excluded or included in controlled numbers. This research will continue in 1990.

SREL will also study the interaction between planktonic and littoral communities by focusing on the near shore community. Experimental manipulations to test the importance of littoral cover to the fish community will provide data on processes influencing dynamics and successional development of the plankton community. This information will be valuable for interpreting the community's progress toward a state of biological balance.

Zooplankton in Carolina Bays

More than 200 Carolina bays are located on SRS. Although they typically hold water for only part of the year, Carolina bays support diverse aquatic communities. To make decisions on mitigating adverse environmental impacts, SREL conducts studies to obtain basic information on the animal and plant communities of these wetland habitats. SREL is currently studying two Carolina bays, Flamingo Bay and Rainbow Bay.

Current studies in Flamingo Bay focus on zooplankton responses to algal and microbial food resources. This work includes field population studies and experiments to measure growth rates of cladocerans and feeding rates on bacteria-sized particles.

The bays are neither nutrient-rich or extremely productive of the algae and bacteria that support the zooplankton. Although these food resources are abundant early in the season, they are quickly depleted by the rapidly increasing zooplankton populations.

Rainbow Bay did not fill normally in 1988 or 1989 because of a drought in the area. During 1989, SREL and James Madison University studied the effect of the extended dry period on resting stages in the bay's sediments. Studies centered on emergence experiments on samples of sediment incubated with water in the laboratory, and on sampling field populations during brief intervals when the bay began holding water.

Results from both studies indicated that viable resting stages of zooplankton were greatly reduced by the drought. In the 1990 field season, experiments to measure predation rates on zooplankton at Flamingo Bay will begin.

Limiting Factors of Swamp and Bottomland Hardwood Forest Succession

Since forest succession is affected by soil moisture and light intensity, SREL will determine the differences in growth patterns of bottomland hardwood forest species along hydrologic and light gradients. This study is being conducted to obtain a better understanding of the regeneration of bottomland hardwood forests.

To determine the dimensional growth and biomass responses of bottomland hardwood species grown in simulated flood plain environments, SREL conducted an experiment by varying first, soil moisture, which reflects elevation gradient relevant to stream level, and second, light intensity, which reflects differences in canopy cover.

These studies revealed several general characteristics of bottomland hardwood species, specifically that maximum biomass and height vary greatly among species. The American elm had the largest biomass and height. Other general characteristics of the species studied are listed below:

- Biomass was differentially allocated to various compartments. For example, the percent leaf production of red maple, southern red oak, and Darlington oak exceeded 40% at all light levels; leaf production in American elm, river birch, and American sycamore was variable and tended to produce proportionately more leaf tissue at lower light levels.
- The two oak species, southern red oak and Darlington oak, also had greater root production than the other four species.

There were a large number of species responses relative to the light and hydrologic treatments. These responses were also species-specific. All species except river birch reached a maximum height at 53% light intensity. Seedlings grown at field capacity were generally taller than those in saturated soil.

As light intensity decreased, percent leaf production of American sycamore and river birch increased, while percent root production decreased. Soil moisture treatment did not alter leaf production in any species.

For red maple, river birch, and Darlington oak, the greatest total biomass was in full sunlight. For southern red oak, sycamore, and elm, total biomass in 53% light was similar to that in full sunlight. Below 53% light, biomass production was reduced as light intensity decreased for all species.

Two conclusions were drawn from these results. First, the growth of the six species studied was reduced in saturated soil. These species appear more suited to positions higher on the flood plain where soil moisture content is lower. Any activity that raises the water level of the streams would not favor any of these species. Second, activity that opens the canopy and allows more light penetration favors American elm, American sycamore and river birch. However, heavy shade most affected these species. Therefore, they are least likely to persist in the understory of an undisturbed full canopied forest.

Role of Anthropogenic Disturbance in Altering Swamp and Bottomland Forest Species

Energy generation produces many potentially hazardous byproducts. Fly ash is one byproduct of coal which may contain toxic levels of boron. Fly ash produced from site operations is washed to ash settling basins. The consequences of an accidental release of fly ash from these basins into adjacent aquatic ecosystems are unknown. During 1989, SREL conducted greenhouse experiments to determine the effect of fly ash on the growth of water tupelo and bald cypress, the dominant swamp species.

Fly-ash concentrations, less than 2.5% (by weight), increased the growth of water tupelo and bald cypress. Above this concentration, water tupelo growth decreased, but bald cypress growth did not decrease. At concentrations greater than 2.5%, water tupelo seedlings had reduced height and diameter growth, pale yellow-green to white coloration of new leaves and death of the apical meristem. Damage was proportional to fly-ash concentration. Although height of bald cypress seedlings was reduced in the 5 and 10% concentration, the greatest biomass was at the highest fly-ash concentration.

Both species contained similar boron concentrations in their leaves. While leaf concentrations in control plants were less than 25 mg/kg, the addition of fly ash dramatically increased the boron concentrations in the leaves (14, 28, and 35 times the control for the 2.5, 5, and 10% treatments, respectively). Although leaf boron concentrations were similar between species, growth was differentially affected. These results indicate that fly-ash releases to swamp forest ecosystems could cause changes in the species composition due to the greater sensitivity of water tupelo. Current studies are focusing on the effects of boron, in isolation from the other potentially hazardous compounds found in fly ash.

1989 HIGHLIGHTS

- SREL and Westinghouse Savannah River Company developed a preliminary hydrogeologic model of shallow wells around 400-D Area that shows two contaminant plumes, one from the coal pile and the other from the coal-pile runoff basin.
- The dominant species in Four Mile Creek was the eastern mosquitofish, a typical dominant species of disturbed or early successional habitats.
- In 1989, breeding wood ducks used 85 of 138 nest boxes to lay 1,468 eggs. These nests contributed 690 day-old ducklings to the population.
- Measurements taken from nine stream locations near the Defense Waste Processing Facility construction site indicated increased levels of suspended solids in Upper Three Runs Creek.
- L Lake has undergone major changes in zooplankton composition since the reservoir filled four years ago; the most striking shift in 1988–1989 was the reduced numbers of larger zooplankton.
- In greenhouse experiments conducted to determine the effect of fly ash on the growth of water tupelo and bald cypress, SREL found that the species composition could change because of the greater sensitivity of water tupelo.

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U.S. Forest Service Savannah River Forest Station Programs

SUMMARY—The Savannah River Forest Station (SRFS) directs the forest management program at the Savannah River Site to protect endangered species, to provide quality habitats for native wildlife, to protect soil and watershed quality, and to provide a healthy forest for environmental research. The chapter focuses on timber production and reforestation methods, as well as on research activities to improve the overall forest environment.

During 1989, 52 forest-related studies, including eight new Southeastern Forest Experiment Station (SEFES) research studies, were underway at SRS. The SRS populations of endangered southern bald eagles and red-cockaded woodpeckers continued to be the subjects of intensive research on their habitat. The SRFS expanded their soil management program by providing consultation to Westinghouse Savannah River Company (WSRC) and Bechtel Savannah River Corporation (BSRC) in soil stabilization and wetlands protection. In June, DOE requested that SRFS prepare a plan for restoring Lost Lake to natural wetlands condition.

INTRODUCTION

When the Atomic Energy Commission (AEC) allocated 300 square miles of land for the Savannah River Site (SRS), effective use of the public land under its control was necessary. To develop and maintain the land, a forest management program to produce forest products was initiated in 1952 through an inter-agency agreement with the U. S. Department of Agriculture Forest Service (USFS) and the AEC (now the Department of Energy).

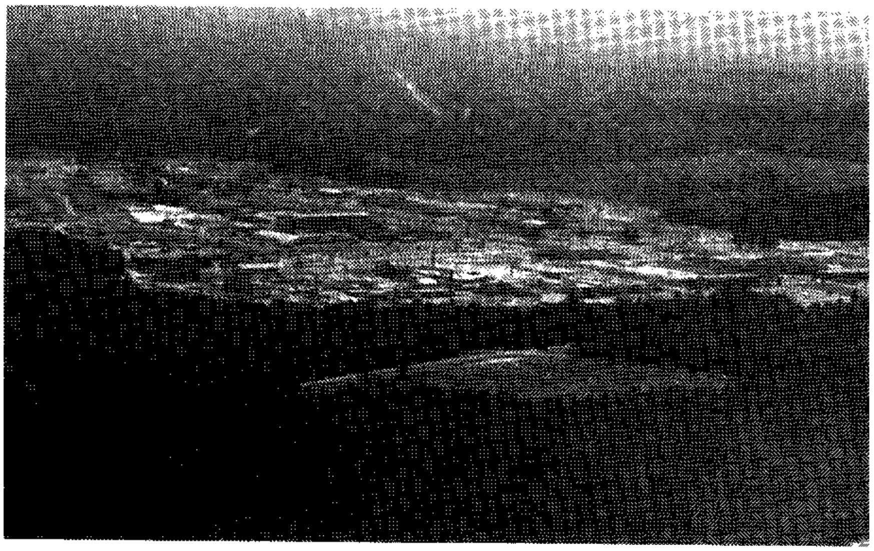
This program, conducted by the Savannah River Forest Station (SRFS), produces timber and contributes to environmental protection and research. The many sitewide SRFS programs play significant roles in protecting endangered species, providing quality habitats for native wildlife, protecting soil and watershed quality, and providing a healthy forest for environmental research.

FOREST MANAGEMENT PLANNING AND OPERATIONS

To enhance forest management planning, SRFS prepares timber compartment prescriptions for one-tenth of the forest area each year. A prescription is a 10-year plan that defines specific activities for the timber compartment. These prescriptions include a comprehensive collection of data required for vegetative manipulation (e.g., cutting and treatment) and for road construction and maintenance. The data are also required to coordinate other onsite programs using the DOE Site-Use Approval System, a DOE permitting process. More than 800 activities using SRS land for operations and research programs are included in the DOE Site-Use Approval System.

The data for the prescriptions include timber stand types and condition, as well as inventories of areas that are valuable for wildlife. Based on the prescriptions, trees are marked, cut, and sold. During 1989, the federal government received nearly $2.4 million for 20.7 million board feet of cut timber. Before reforestation, the cut-over land was prepared for pine planting by burning, shearing and raking, drum chopping, and herbicide application. Pine seedlings were planted on nearly 2,747 acres during 1989.

SRFS planted longleaf pine on 825 acres. Although difficult to grow, longleaf pine is the native pine of SRS sandhill habitats and is preferred by the endangered red-cockaded woodpecker. Superior tree seedlings are needed for successful survival of planted



Site reforestation is a major SRFS activity

longleaf pines. DOE has subcontracted the South Carolina Forestry Commission Nursery to use the most advanced technology identified by USFS to grow seedlings for future planting at SRS.

On 1,174 site acres, SRFS reduced the competition of undesirable vegetation by applying selective herbicides. Aerial fertilization was applied to 1,763 acres of young pine plantations.

Secondary roads, used during timber harvest, are upgraded annually to handle large trucks that haul tree-length sawtimber and pulpwood. During 1989, SRFS upgraded 189 miles of secondary roads, reconstructed 5.8 miles, and constructed 4.4 miles. In addition, road banks were seeded with plants that provide erosion control and food for wildlife.

Under a continuing program to reclaim eroding land, 27.5 acres of bare land were reshaped, subsoiled, and planted with legumes, grasses, hardwoods, and other wildlife food plants. An additional 57.4 acres were fertilized. These programs are very efficient in controlling erosion.

Endangered species and their habitats receive special consideration in the management of SRS forest lands. Southern bald eagles are among the endangered species finding refuge at SRS. For the past three years, an adult pair of eagles have nested at SRS. However, in the spring of 1989, a violent windstorm occurred after the eagle nesting season, resulting in the loss of the eagle nest and chicks. The adult pair made no attempt to rebuild their nest during the breeding season.

To facilitate future nesting and breeding at the site by the eagle pair, the SRFS, the South Carolina Wildlife and Marine Resources Department, and nongame biologists constructed an artificial nesting platform on the same nest tree. The site will be closely monitored to determine whether the adult eagles return in the winter of 1990.

The SRFS Eagle Management Plan, which was prepared in 1987, called for the improvement of perching and nesting sites, and the identification of "key" sites that would provide favorable breeding locations. During 1989, selected trees within six eagle management key areas were shaped and modified.

The SRS population of endangered red-cockaded woodpeckers continues to be the subject of intensive research. The Savannah River Ecology Laboratory (SREL) gathered genetic variability information from the birds to determine in-breeding comparisons for translocation within the SRS population.

In 1989, the Southeastern Forest Experiment Station (SEFES) began new research constructing artificial cavities to attract the red-cockaded woodpecker to SRS. Cavities are cut into living trees that are not old enough to be infected with natural "red-heart" wood rot. Although the red-cockaded woodpeckers cannot excavate the trees themselves, the birds accept and maintain the artificial cavities once they are constructed.

The artificial cavity research at SRS has been used extensively to replace old-growth cavity trees that were lost during Hurricane Hugo on the Francis Marion National Forest near Charleston, SC.

The habitat for red-cockaded woodpeckers was improved on more than 99 acres of older pine forest by applying herbicide to weed out the competing scrub oak. Prescribed burning of 579 acres had a similar effect. On 101 acres, noncommercial thinning opened up the longleaf pine forest to the park-like condition preferred by the red-cockaded woodpecker for foraging and nesting. In 1989, the population of red-cockaded woodpeckers on SRS grew from 14 birds to 18 birds.

Certain wildlife species must be controlled to protect forests, roads, and research sites. During 1989, trapping contractors removed 177 feral hogs from locations where the animals were causing damage.

Prescribed burning of 2,799 acres stimulated vegetation growth on the forest floor for wildlife food. Cool burns, conducted each winter under carefully selected weather conditions, reduce fuel (e.g., leaves, pinestraw, and shrubs) on the forest floor and serve to protect the forest against wildfires. Smoke management restrictions and dry periods during the winter limited the number of days available for burning. Acreage goals for prescribed burning will not be met until an aerial fire ignition program is implemented at SRS, which is under consideration for 1990.

On April 1, 1989, total wildland fire suppression was assigned to USFS. Fire incidence was low because of low fire danger during the spring and summer of 1989; a total of four fires consumed only 6.5 acres.

The USFS recently prepared and submitted a Natural Resources Management Plan for SRS to DOE. The plan coordinates SRFS activities with other site contractors involved in natural resources research and management. The plan also describes an expanded role for the SRFS in management of SRS resources.

The SRFS, working jointly with the resident soil scientist for the Soil Conservation Service, expanded their soil management program by providing consultation to WSRC and BSRC in soil stabilization and wetland protection. Five construction waste area sites were stabilized. Most areas required a plan for contouring the soil and providing water control structures to provide proper drainage and reduce offsite sedimentation. SRFS personnel also stabilized three construction sites to grass to keep steeper slopes from eroding.

SEFES Constructs Artificial Homes for Red-Cockaded Woodpeckers

SEFES initiated an innovative project in September 1988 that focuses on creating artificial cavities for the endangered red-cockaded woodpeckers. Cavity excavation was developed to promote colony expansion and population growth of the red-cockaded woodpecker population at SRS.

Because red-cockaded woodpeckers take several months to several years to excavate a tree cavity for themselves, SEFES researchers decided to speed the process by creating artificial cavities. The artificial cavities are constructed by cutting a 4 x 8 x 6 in. box from a large pine tree ranging from 12 to 24 ft in height. A prefabricated cavity box, painted to match the natural habitat of a red-cockaded woodpecker cavity, is then inserted into the tree.

SEFES has created 32 cavities since the project began. The project appears successful, with woodpeckers currently using two of the cavities. SEFES also shared the method—and artificial inserts—with the hurricane-strickened area of Francis Marion National Forest in South Carolina. Scientists at the national forest are using the same cavity excavation methods to revitalize their red-cockaded woodpecker population. Red-cockaded woodpeckers currently use 25% of the 130 artificial cavities created in the effort.

In June 1989, DOE requested that SRFS prepare a plan for restoring Lost Lake to natural wetland conditions. Lost Lake, a Carolina bay located in M Area, is severely altered by the contamination and subsequent clean-up of the adjacent M-Area settling basin. A team of SRFS specialists, including soil scientists, hydrogeologists, plant ecologists, and a landscape architect, began developing a plan that will rehabilitate Lost Lake. This plan will include stabilizing approximately 40 acres adjacent to the lake and basin, and enhancing wildlife habitat and visual quality. SRFS will present this plan to WSRC for approval in early 1990.

FOREST MANAGEMENT RESEARCH

SEFES scientists are conducting numerous studies that are anticipated to improve the overall forest management activities conducted at SRS. During 1989, a total of 52 forest-related studies, including eight new SEFES research studies, were active at SRS. Two new biological diversity studies, designed for optimizing forest management planning and determining the effects of forest management practices, are now underway at SRS.

In several studies, techniques to produce seedlings for more successful reforestation are being tested. Scientists prepare seedlings for their environment in which they will mature. To enhance field performance, the seedlings in nursery beds are inoculated with superior, selected fungi that facilitate the absorption of water and nutrients. If the feeder roots develop a symbiotic relationship with mycorrhizal fungi, the trees grow better.

In another study, lateral rooting of seedlings is promoted to improve field performance. Scientists use genetic selection to obtain families that have a higher percentage of lateral roots. Pruning the roots in the nursery bed also improves root structure.

In two large pine-field studies, certain common nursery practices (e.g., controlling seedbed densities and top pruning) are being studied to determine their effect on lateral root development and mycorrhizal development. These nursery practices are also being studied to determine their influence on survival and early growth.

A third study will measure the effect that removing pine straw from the forest floor has on the growth and nutrition of trees. If changes are observed, scientists will determine if fertilization can compensate for the nutrients removed.

Fungus Used to Enhance Tree Superiority

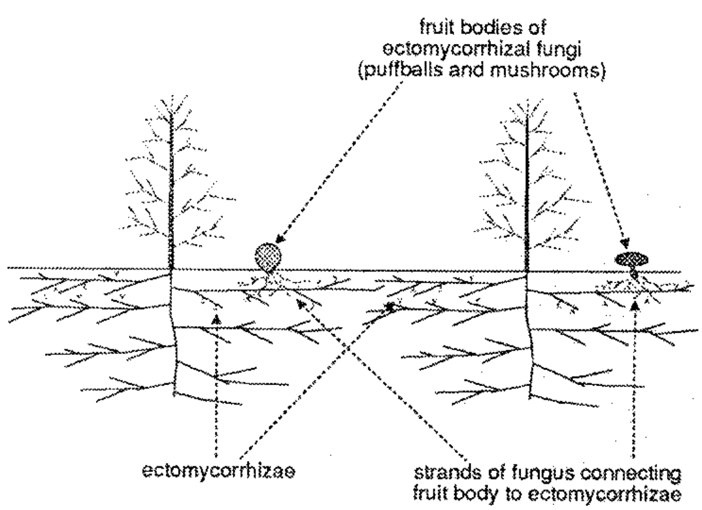
Four years ago, the fungus *Pisolithus tinctorius* became an important ingredient in SRS's reforestation program. The Savannah River Forest Station (SRFS) started using the mycorrhizal fungus to grow better trees by tapping into the fungus' ability to absorb water and nutrients.

The actual process begins at a local nursery in the spring of each year where the fungus is put in the soil just prior to sowing the beds with tree seeds. As the tree seeds germinate and begin to grow, their roots become inoculated with the fungus and a symbiotic relationship develops between the tree seedlings and the fungus. The figure below depicts the symbiotic relationship between the tree roots and the fungus.

This special "symbiotic" relationship improves the performance of the trees by using the fungus' ability to absorb additional water. The growth structures of the fungus can reach farther into the soil than the roots of the tree. As a result, research shows that a tree inoculated with the fungus withstands longer periods of drought than an untreated tree.

SRFS picks up the fungus-enhanced seedlings in early December for outplanting, with the planting season ending in late February. During a typical year, 1 million longleaf and 1.2 million loblolly inoculated pines are planted on approximately 2,700 acres at SRS.

A FOREST TREE SYMBIOTIC RELATIONSHIP



1989 HIGHLIGHTS

- During 1989, the federal government received nearly $2.4 million for 20.7 million board feet of cut timber from SRS.
- Pine seedlings were planted on nearly 2,747 acres. Longleaf pine, the native pine of SRS sandhill habitats and that preferred by the endangered red-cockaded woodpecker, were planted on 825 of these acres.
- SRFS upgraded 189 miles of secondary roads, reconstructed 5.8 miles, and constructed 4.4 miles during 1989.
- An artificial nesting platform was constructed for the adult pair of eagles that have nested at SRS for the past three years after a violent spring windstorm destroyed their nest and chicks.
- In 1989, the population of red-cockaded woodpeckers on SRS grew from 14 to 18 birds.
- Total wildland fire suppression was assigned to USFS in April 1989. A total of four fires consumed only 6.5 acres because the fire danger was low during spring and summer.
- Five construction waste area sites and three construction sites were stabilized to prevent off-site sedimentation and erosion.

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Glossary

a posteriori. Decisions and observations based on facts, experiment, or "after the fact" observations.

a priori. Decisions made before or without examination ("before the fact"); based on hypothesis or theory rather than on experiment or experience.

absorbed dose. The amount of energy deposited by radiation in a given amount of mass. The unit of absorbed dose is the rad.

absorption. The process by which the number and energy of particles or photons entering a body of matter is reduced by interaction with the matter.

accuracy. The closeness of the result of a measurement to the true value of the quantity measured.

activity. (see radioactivity).

aliquot. The quantity of sample being used for analysis.

Alpha test release. The first test release (usually of software).

ALARA. The acronym meaning "As Low As Reasonably Achievable" that describes an approach to radiation exposure control or management whereby the exposures and resulting doses are maintained as far below the limits specified for the appropriate circumstances as social, economic, technical, and practical considerations permit.

algaculture. The growth of microorganisms in a nutrient medium.

alpha particle. A positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (2 protons and 2 neutrons).

ambient air. The surrounding atmosphere as it exists around people, plants, and structures. It is not considered to include the air immediately adjacent to emission sources.

analyte. A constituent or parameter that is being analyzed.

anion. A negatively charged ion.

anneal, annealing. Maintenance of glass or metal at a specified temperature for a specific length of time, then gradually cooling. This treatment removes internal strains and eliminates distortions and imperfections. A more uniform material results.

anticoincidence shielding. Method of discerning between background radiation and radiation in the sample.

aquifer. A saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.

ash. Inorganic residue remaining after ignition of combustible substances.

assimilate. To take up or absorb into the body.

atom. Smallest particle of an element capable of entering into a chemical reaction.

atomic absorption spectrometry (AA). Chemical analysis performed by vaporizing a sample and measuring the absorbance of light by the vapor.

Atomic Energy Commission (AEC). A federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian application. It was abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration (now part of the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission).

attenuation. The process by which a beam of radiation is reduced in intensity when passing through some material. It is a combination of absorption and scattering processes.

beta particle. A negatively-charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

biobarrier. A general term for a variety of materials or approaches that prevent organisms from moving into a defined area. A barrier in the soil that prevents root growth is one example of biobarrier technology.

biogeochemical ecology. The study of interactions among biological and chemical cycling processes and their effect on transport, bioavailability, fate, and effects of potential contaminants.

bioluminescence. Production of light due to biological organisms which interferes with tritium measurements.

biomass. The weight of any specific or general kind of organic matter, usually expressed per area or volume.

bioreactor. A container filled with microbial organisms which degrade substances (such as oil) as the substance passes through the container.

biota. The animal and plant life of a particular region considered as a total ecological entity.

bivane. Meteorological instrument which simultaneously measures vertical and horizontal wind direction.

blank. A control sample that is identical, in principle, to the sample of interest, except that the substance being analyzed is absent. In such cases, the measured value or signal for the substance being analyzed is believed to be due to artifacts and should be subtracted from the measured value to give a net result reflecting the amount of the substance in the sample.

blind sample. A control sample of known concentration in which the expected values of the constituent are unknown to the analyst.

Brailsford pump. A surface water sampling device which is stationed on a stand above a stream. The device, which continuously samples stream water, consists of an all-plastic valveless piston driven by a Brailsford small electric motor. The variable pump speed is set normally at 0.75 gallons/day.

"C" Com room. Area where various SRS electrical instruments are installed and radios are repaired.

calibration. Determination of variance from a standard or accuracy of a measuring instrument to ascertain necessary correction factors.

carcinogen. A cancer-causing substance.

Carolina bay. A type of shallow depression commonly found on the coastal plains of the Carolinas. Carolina bays are typically circular or oval. Some are wet or marshy, while others are dry.

carrier. A quantity of non-radioactive or non-labeled material having the same chemical composition as its corresponding radioactive or labeled counterpart. When mixed with the corresponding radioactive labeled material, (to form a chemically inseparable mixture), the carrier permits chemical (and some physical) manipulation of the mixture with less label or radioactivity loss than would be true for the undiluted label or radioactivity.

cation. Positively charged ion.

cavity/wake zones. Areas where air is recirculated or altered due to the proximity of obstacles such as buildings or trees.

Central Savannah River Area (CSRA). A 12-county area in Georgia and South Carolina surrounding Augusta, GA. SRS is included in the CSRA.

chain-of-custody. A form that documents sample collection, transport, analysis, disposal.

chemical speciation. The occurrence of chemical elements indifferent forms or species (eg., elemental, ionic, complexed) depending upon environmental conditions.

chlorocarbon. A compound of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, tetrachloroethylene, etc.

committed dose equivalent. The predicted total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert).

collective dose equivalent/collective effective dose equivalent. The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 50-mile (80-km) radius, and expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or DOE program activities.

committed effective dose equivalent. The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

community evenness. A measure of the degree to which the total number of individuals in a collection are evenly apportioned among the various species represented.

committed dose equivalent. The time-integral of the dose equivalent rate in a specific tissue following intake of a radionuclide into the body. For radionuclides with approximate effective half lives ranging up to about three months, the committed dose equivalent is approximatley equal to the annual dose equivalent for the year of intake.

concentration. The amount of a substance contained in a unit volume or mass of a sample.

confluence. The point at which two or more streams meet; the point where a tributary joins the main stream.

contamination. The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

control chart. A statistical tool used to demonstrate whether or not a specific process is within acceptable standards or limits of performance.

control limits. A statistical tool used to define the bounds of virtually all values produced by a system in statistical control.

cosmic radiation. Ionizing radiation with very high energies, originating outside the earth's atmosphere. Cosmic radiation is one source contributing to natural background radiation.

count. The signal that announces an ionization event within a counter; a measure of the external radiation of an object or device.

counter. A general designation applied to radiation detection instruments or survey meters that detect and measure radiation.

counting geometry. A well defined sample size and shape for which a counting system has been calibrated.

curie (Ci). A unit of radioactivity. One curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are in common usage:

> **kilocurie (kCi)** –10^{3}Ci, one thousand curies; 3.7×10^{13} disintegrations per second.
> **millicurie (mCi)** –10^{-3} Ci, one-thousandth of a curie; 3.7×10^{7} disintegrations per second.
> **microcurie (μCi)** –10^{-6} Ci, one-millionth of a curie; 3.7×10^{4} disintegrations per second.
> **nanocurie (nCi)** –10^{-9} Ci, one-billionth of a curie; 37 disintegrations per second.
> **picocurie (pCi)** –10^{-12} Ci, one-trillionth of a curie; 0.037 disintegrations per second.
> **femtocurie (fCi)** –10^{-15} Ci, one-quadrillionth of a curie; 0.000037 disintegrations per second.
> **attocurie (aCi)** –10^{-18} Ci, one-quintillionth of a curie; 0.000000037 disintegrations per second.

daughter. A nuclide formed by the radioactive decay of another nuclide, which is called the parent.

decay, radioactive. The spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same radionuclide.

derived concentration guide (DCG). The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air or inhalation), would result in either an effective dose equivalent of 0.1 rem (1mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and lens of the eye. The standards for radionuclides in air and water are given in DOE Order 5480.1A.

detector. Material or device (instrument) that is sensitive to radiation and can produce a signal suitable for measurement or analysis.

diagenesis. The chemical and physical changes that occur in sediments during and after their deposition, but before consolidation.

diatoms. Unicellular or colonial algae of the class Bacillariophyceae, having siliceous cell walls with two overlapping, symmetrical parts. Diatoms represent the predominant periphyton (attached algae) in most water bodies and have been shown to be reliable indicators of water quality.

diatometer. Diatom collection equipment consisting of a series of microscope slides in a holder that is used to determine the amount of algae in a water system.

disintegration, nuclear. A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

dose. The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium.

dose equivalent. The product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem=0.01 sievert).The dose equivalent to an organ, tissue, or whole body in a year will be that received from the direct exposure plus the 50-year committed dose equivalent received from radionuclides taken into the body during the year.

dosimeter. A portable detection device for measuring the total accumulated exposure to ionizing radiation.

dosimetry. The theory and application of principles and techniques involved in the measurement and recording of radiation doses. Its practical aspect is concerned with using various types of radiation instruments to make measurements.

drum chopping. A mechanical means to prepare a clear-cut site for planting a new strand of trees. A large, heavy cyclinder (drum) with blades perpendicular to the drum is pulled behind a large crawler tractor. The blade chops limbs and small non-merchantable stems into pieces.

dusky shiner. The common name for *Notropis cummingsae*, an abudant schooling minnow in SRS streams.

effective dose equivalent. An estimate of the total risk of potential health effects from radiation exposure. It is the sum of the committed effective dose equivalents from internal deposition and the effective dose equivalent from external penetrating radiation received during a calendar year. The committed effective dose equivalent is the sum of the individual organ committed dose equivalents (50 year) multiplied by weighting factors that represent the proportion of the total random risk that each organ would receive from uniform irradiation of the whole body.

effluent. A liquid or gaseous waste discharge to the environment.

effluent monitoring. The collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying the release of contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.

electrophoretic techniques. Laboratory techniques, based on the differential migration of particles in an electrical field, that are used to determine genetic characteristics of an organism.

eluate. The liquid resulting from removing the trapped material from an ion-exchange resin.

elute. To remove absorbed ions from an ion exchange resin.

environmental surveillance. The collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media to determine environmental quality of some industry or community. It is commonly performed at sites containing nuclear facilities.

epidemiological studies. Studies that focus on the occurrence of diseases in human populations. Disease occurrence is measured and related to different characteristics of individuals or their environments.

erosion. The process in which exposed geologic materials are worn away by the action of wind or water.

eutrophication. Accelerated growth of organisms in a body of water due to excess nutrients.

exposure (radiation). The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is that exposure to ionizing radiation which takes place during a person's working hours. Population exposure is the exposure to the total number of persons who inhabit an area.

external radiation. Exposure to ionizing radiation when the radiation source is located outside the body.

fauna. The population of animals at a given area, environment, formation, or time span.

flora. The population of plants at a given area, environment, formation, or time span.

friable asbestos. Asbestos that is brittle or readily crumbled.

gamma ray. High-energy, short-wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma radiation frequently accompanies the emission of alpha or beta particles. Gamma rays are identical to x-rays except for the source of the emission.

gamma spectrometry. A system consisting of a detector, associated electronics, and a multichannel analyzer that is used to analyze samples for gamma-emitting radionuclides.

gas-flow proportional counter. A device or instrument in which an appropriate atmosphere is maintained in the counter tube by allowing a suitable gas to flow slowly through the sensitive volume thereby allowing ionization to occur.

Gaussian puff/plume model. Computer simulation of the dispersion of a particulate released in the atmosphere using a Gaussian (normal) statistical distribution to determine concentrations in air.

Geiger-Mueller (GM) counter. A highly sensitive, gas-filled radiation detector which operates at voltages sufficiently high to produce ionization. The counter is used primarily in the detection of gamma radiation and beta emission. It is named for Hans Geiger and W. Mueller who invented it in 1928.

genetic selection. A descent with modification due to differing survival rates among young who vary in fitness according to genetic background.

Geographic Information System. Computer-based system for storing, manipulating, and analyzing geographical information.

geotextile. A long-lasting fabric intended for burial; used for scientific or research purposes.

grab sample. A sample collected instantaneously using a glass or plastic bottle placed below the water surface to collect surface water samples. Grab samples are also called dip samples.

half-life, biological. The time required for a biological system, such as that of a human, to eliminate by natural processes half the amount of a substance (such as a radioactive material) that has entered it.

half-life, radiological. The time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

head reversal. The hydrologic phenomenon in which a deeper formation has a higher water pressure than a more shallow formation in the same location. This condition results in a tendency for groundwater to flow upward from the deeper media to the more shallow formation.

HEPA. The acronym for High Efficiency Particulate Air filter.

heterotrophic. Organisms that obtain energy from the breakdown of existing organic matter; the opposite of autrophic organisms, (e.g., plants that synthesize organic matter from inorganic elements).

Hilsenhoff's biotic index. An index which ranks species with respect to their ability to tolerate pollution with the highest values indicating greater pollution tolerance.

humic substances. A variety of complex organic molecules found in soils and water following the breakdown of leaves and other types of organic matter.

hydrology. The science dealing with the properties, distribution, and circulation of natural water systems.

hydrogeology. Hydrolic aspects of site geology.

hydropunch. A sampling device for collecting chemically representative groundwater samples without the installation, development, and sampling of a groundwater monitoring well.

in situ. In its original place; field measurements taken without removing the sample from its origin.

internal dose factor. A factor used to convert intakes of radionuclides to dose equivalents.

internal radiation. Internal radiation occurs when natural radionuclides enter the body by ingestion of foods, milk, and water, and by inhalation. Radon is the major contributor to the annual dose equivalent for internal radionuclides.

ion. An atom or compound that carries an electrical charge.

ion exchange. Process in which a solution, containing soluble ions is passed over a solid ion exchange column which removes the soluble ions by exchanging them with labile ions from the surface of the column. The process is reversible so that the trapped ions are removed (eluted) from the column and the column is regenerated.

irradiation. Exposure to radiation.

isopach map. A map showing the thickness of geologic units.

isotopes. Forms of an element having the same number of protons in their nuclei but differing in the number of neutrons.

> long-lived isotope - A radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).
>
> short-lived isotope - A radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

Keithly data acquisition system. Special computer interface that permits various sensors on the SRL TRAC mobile laboratory to communicate with onboard computers.

K_d (equilibrium distribution coefficient). The distribution coefficient that is the ratio of the contaminant concentration in sediments to the concentration of the contaminant in the water at equilibrium conditions. This method is used in modeling to determine the extent that a contaminant is adsorbed to sediments or desorbed to the surrounding water.

littoral zone. The shallow water along the shore line of a body of water.

liquid scintillation cocktail. A solution combined with a radioactive sample which converts the energy of the particle emitted during radioactive decay into light, which is detected by a liquid scintillation counter.

liquid scintillation counter. The combination of phosphor, photomultiplier tube, and associated circuits for counting light emissions produced in the phosphors.

lysimeters. A container that holds soil. A leachate collection system is located in the bottom of the container.

lower limit of detection (LLD). The smallest concentration/amount of analyte that can be reliably detected in a sample at a 95% confidence level.

joule. The unit for work and energy, equal to one newton along a distance of one meter.

macroinvertebrates. A size-based classification used for a variety of insects and other small invertebrates; as defined by EPA, those organisms that are retained by a No. 30 (590 micron) US Standard Sieve.

macrophyte. A plant that can be observed with the naked eye.

Marinelli beaker. A 1-L beaker molded to fit around a germanium or sodium iodide detector to optimize geometry.

maximally exposed individual. A hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

mesocosm. An intermediate-sized research facility where processes can be studied under controlled experimental conditions.

microbes. Microscopic organisms.

migration. The natural travel of a material through the air, soil, or groundwater.

milliroentgen (mR). A measure of x-ray or gamma radiation. The unit is one-thousandth of a roentgen.

minimum detectable concentration (MDC). The smallest amount or concentration of a radioelement that can be distinguished in a sample by a given measurement system in a preselected counting time at a given confidence level.

monitoring. Process whereby the quantity and quality of factors that can affect the environment and/or human health are measured periodically in order to regulate and control potential impacts.

mrem. The dose equivalent which is one-thousandth of a rem.

mycorrhizal fungi. A specialized group of root inhabiting fungi that naturally occur in all soils throughout the world. These specialized fungi form a symbiotic relationshipin and on the fine root systems of green plants.

natural radiation. Radiation arising from cosmic and other naturally occurring radionuclide (such as radon) sources that are present in the environment.

nonroutine radioactive release. Unplanned or non-scheduled release of radioactivity to the environment.

nonstochastic effects. Biological effects in which the severity in affected individuals varies with the magnitude of the dose above a threshold.

nuclide. An atomic nucleus specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

outfall. The end of a drain or pipe that carries wastewater or other effluents into a ditch, pond, or river.

paddlewheel sampler. A sampling device, constructed of a Lexan® wheel, suspended on two pontoons and anchored in streams and rivers.

Pasquill stability classes. This concept originated from diffusion experiments performed for Project Prairie Grass. Pasquill distinguished six stablity classes from A (highly unstable stratification) to F (highly stable stratification). The criteria for Pasquill's original classification considered the relationship of wind speed, isolation (amount of incoming solar radiation), and cloudines. These classes are used in standard meteorology.

part per million (ppm). A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

part per billion (ppb). A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or ng/mL.

person-rem. Collective dose to a population group. For example, a dose of one rem to 10 individuals results in a collective dose of 10 person-rem.

pH. A measure of the hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 6, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.

planchet. A small, round, lipped, metal dish that is used to mount samples for radiological analyses.

polycyclic aromatic hydrocarbons. Organic compounds consisting of two or more benzene rings; most are environmental pollutants resulting from combustion.

population dose commitment. (see collective dose equivalent)

precision. The closeness of approach of a value of similar or replicate results to a common value in a series of measurements.

process water. Water which is an integral part of the system process as opposed to cooling water, for example, which is segregated from the process.

process sewer. Pipe or drain, generally located underground, used to carry off process water and/ or waste matter.

pulse height analysis. A spectroscopy technique in which the voltage (height) of an electronic pulse from a detector is related to the energy of the detected radiation.

quality assurance (QA). Any action in environmental monitoring to assure the reliability of monitoring and measurement data. Aspects of quality assurance include procedures, interlaboratory comparison studies, evaluations, and documentation

quality control (QC). The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.

quality factor. The factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage to exposed persons. It is used because some types of radiation, such as alpha particles, are more biologically damaging than others.

quench. (a) The reduction of the signal from a liquid scintillation cocktail due to chemical or color interferences; (b) a process by which a gas (usually a halogen) is added to a detector to inhibit avalanche ionizations.

rad. The unit of absorbed dose.

radiation detection instruments. Devices that detect and record the characteristics of ionizing radiation.

Radioactive Waste Burial Ground (RWBG). A place for burying unwanted radioactive material to prevent escape of radioactivity. The surrounding water acts as a shield. Such material is placed in watertight, noncorrodible containers so that it cannot leach out and invade underground water.

radioactivity. The spontaneous emission of radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

radioisotopes. Radioactive isotopes.

radionuclide. An unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

reagent. Any substance used in a chemical reaction to detect or measure another substance or to convert one substance into another by means of the reaction which it causes.

reagent blank. A control sample which is used to determine the background of each reagent or solvent used in a given method of analysis. They are composed of all constituents that will contact the sample except the sample itself.

reclamation. The recovery of wasteland, desert, etc. by ditching, filling, draining, or planting.

red-heart wood rot. A serious disease caused by a virus that only occurs in mature or over-mature pine trees. The disease does not kill trees; it only attacks the internal physiologically inactive heartwood. The virus occurs primarily through dead branch stubs and deep stem wounds.

reference material. A material or substance with one or more properties that is sufficiently well established and is used for the calibration of an apparatus, the assessment of a measurement method, or for assignment of values to materials.

reforestation. The process of planting new trees on land once forested.

refractory. Not easily decomposed or broken down.

regression analysis. A collection of statistical techniques that serve as a basis for drawing inferences about relationships among quantities in a scientific system.

release. Any unintentional discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem. The unit of dose equivalent (rad x quality factor). Dose equivalent is frequently reported in units of millirem (mrem) which is one-thousandth of a rem.

resin. An organic polymer used as an ion-exchange material.

rhizotron. A facility designed to hold soil for plant and root growth. Such facilities are used often in research and study projects.

riparian. On or along the bank of a river or stream.

roentgen. A unit of exposure. One roentgen equals 2.58×10^{-4} coulombs per kilogram of air.

routine radioactive release. A planned or scheduled release of radioactivity to the environment.

screen zone. In well construction, the section of a formation that contains the screen, or perforated pipe that allows water to enter the well.

seepage basin. An excavation that receives wastewater. Insoluble materials settle out on the floor of the basin and soluble materials seep with the water through the soil column where they are removed partially by ion exchange with the soil. Construction may include dikes to prevent overflow or surface runoff.

self-absorption. Absorption of radiation by the sample itself, preventing detection by the counter.

senescent. Aged or old.

sensitivity. The capability of methodology or instrumentation to discriminate between samples having differing concentrations or containing varying amounts of analyte.

settling basin. A temporary holding basin (excavation) that receives wastewater which is subsequently discharged.

Shannon-Wiener diversity. An information theoretic index that is influenced by both the total number of species in a sample, as well as by the evenness with which individuals are distributed among species.

side-long terrestrial monitors. Detectors mounted on the sides of the SRL TRAC mobile laboratory that interface into onboard computers that are sensitive to gamma radioactivity in the environment (both natural and manmade).

sievert (Sv). The SI (International System of Units) of dose equivalent, 1 Sv=100 rem.

Site-Use Approval System. A system managed by DOE-SR to control the various uses of SRS. An organization or department must request approval from DOE to use any land on SRS. Examples of the system include requests by the Savannah River Forest Station to conduct timber sales, prescribed burning, research, and building construction.

slurry. A suspension of solid particles (sludge) in water.

source. A point or object from which radiation emanates.

source check. A preparation with a known amount of radioactivity used to check the performance of the radiation detector instrument.

source term. Quantity of radioactivity released in a set period of time that is traceable to the starting point of an effluent stream or migration pathway

spike. The addition of a known amount of reference material containing the analyte of interest to a blank sample.

SRS stream. Any natural stream on the SRS site. Surface drainage of the site is via these streams to the Savannah River.

stable. Not radioactive or not easily decomposed or otherwise modified chemically.

stack. A vertical pipe or flue designed to exhaust airborne gases and suspended particulate matter.

standard deviation. An indication of the dispersion of a set of results around their average.

standard reference material (SRM). A reference material distributed and certified by the National Institute of Standards and Technology.

stochastic effects. Biological effects, whose probability, rather than the severity, is a function of the magnitude of the radiation dose without threshhold (i.e., stochastic effects are random in nature).

substrate. The substance, base, surface, or medium in which an organism lives and grows.

Superfund reportable spill. A spill to the environment that exceeds reportable quantities as defined by CERCLA (Comprehensive Environmental Response Compensation and Liability Act).

surface water. All water on the surface of the earth, as distinguished from groundwater.

symbiotic relationship. When two or more dissimilar organisms live together in an intimate association that is mutually beneficial (food exchange) to all partners in the relationship.

tank farm. An installation of interconnected underground tanks for storage of high-level radioactive liquid wastes.

taxa richness. The abundance of any rank such as a particular species, family, or class.

terrestrial radiation. Ionizing radiation emitted from radioactive materials, primarily ^{40}K, thorium, and uranium, in the earth's soils. Terrestrial contributes to natural background radiation.

thermoluminescent dosimeters (TLDs). A device used to measure external gamma radiation.

thermal loading. Adding warm water to a body of water used in reactor operations.

timber compartment. SRS land that is divided into 2,000-acre sections for inventory purposes (i.e., wildlife, research opportunities, timber management, and soil stabilization and secondary road maintenance needs).

timber compartment prescriptions. A plan that is used to manage resources within a timber compartment.

total suspended particulates. Refers to the concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

transect. A line across an area being studied. The line is composed of points where specific measurements or samples are taken.

transmissivities. Capacity of an aquifer to transmit water.

trifluralin. An organic chemical [$C_{13}H_{16}F_3N_3O_4$] used commercially as an herbicide on a variety of crops. This chemical is currently being tested at SRS in biobarier research.

tritium (H-3). The hydrogen isotope with one proton and two neutrons in the nucleus. It emits a low-energy beta particle (0.0186 MeV max) and has a half-life of 12.5 years.

turbidity. A measure of the concentration of sediment or suspended particles in solution.

uncontrolled area. Any area to which access is not controlled for the purpose of protecting individuals from exposure to radiation and radioactive materials. The area beyond the boundary of the Savannah River Site is an uncontrolled area.

vadose zone. Soil zone located above the water table.

vagile. Able to move about and disperse; mobile.

variation. The divergence in the structural or functional characteristics of an organism from those that are considered typical of the group to which it belongs.

watershed. The region draining into a river, river system, or body of water.

weighting factor. A value used to calculate dose equivalents. It is tissue-specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors used in this report are recommended by the ICRP (Publication 26).

wetlands. A low-land area, such as a marsh or swamp, that is inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted for life in saturated soils.

worldwide fallout. Radioactive debris from atmospheric weapons tests that has been deposited on the earth's surface after being airborne and cycling around the earth.

zooplankton. microscopic animals that live in aquatic environments (e.g., copepods).

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TRADITIONAL AND NEW RADIOLOGICAL UNITS

(Conventional units are in parentheses)

Quantity	Name	Symbol	Expression in Terms of Other Units
activity	becquerel	Bq	1 dps
	(curie)	Ci	3.7×10^{10} Bq
absorbed dose	gray	Gy	J/kg
	(rad)	rad	10^{-2} Gy
dose equivalent	sievert	Sv	J/kg
	(rem)	rem	10^{-2} Sv
exposure	coulomb per kilogram		C/kg
	(roentgen)	R	2.58×10^{-4} C/kg

Note: In several data tables, the letter "E" is used to express the results in terms of scientific notation. For example, 1.2E+04 pCi/L = 1.2×10^4 pCi/L

WSRC-IM-90-60
Volume II
Figures and
Data Tables

Savannah River Site Environmental Report for 1989

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

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Savannah River Site Environmental Report for 1989 (U)

By

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Derivative Classifier:

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Introduction

This volume of *Savannah River Site Environmental Report for 1989* (WSRC-IM-90-60) contains the figures and tables referenced in Volume I. The figures contain graphic illustrations of sample locations and/or data. The tables present summaries of the following types of data:

- federal and state standards and guides applicable to SRS operations
- concentrations of radioactivity in environmental media
- the quantity of radioactivity released to the environment from SRS operations
- offsite radiation committed dose from SRS operations
- measurements of physical properties, chemicals, and metals concentrations in environmental media
- interlaboratory comparison of analytical results

The figures and tables in this report contain information about the routine environmental monitoring program at SRS unless otherwise indicated. No attempt has been made to include all data from environmental research programs.

Variations in the report's content from year to year reflect changes in the routine environmental monitoring program or the inability to obtain certain samples from a specific location.

Additionally, the following items will aid the reader in interpreting the data in this report:

- The uncertainty term is reported with up to—but no more than—two significant figures. The result is reported with up to three significant figures, with the last significant figure determined by the quantification of the uncertainty term. EMS attempted to report the appropriate confidence in the result with the correct number of significant figures. This item applies specifically to Tables 4-1, 5-1, 5-2, 5-3, 7-1, 9-1, 9-5, and 9-8.
- The reported uncertainty may be smaller than the actual uncertainty because only the counting error is quoted with individual results—not other components of random and systematic error present in the measurement process. For this reason, some results may imply a greater confidence than the determination would suggest.
- Uncertainties quoted with means represent the deviation of measurements about the mean value. This number is calculated from the results themselves, not from the uncertainties of the individual results.
- Less-than-detectable values are represented as "0± LLD". The true result is reported in the same decimal place as the uncertainty, eg., "0.00±1.25". This item applies specifically to Tables 4-1, 5-1, 5-2, 5-3, 7-1, 9-1, 9-5, and 9-8.

Chapter 1

Sample Collection, Analytical Procedures, and Data Interpretation

TABLE 1-1
SAMPLE MEDIA DATA

Sample Matrix or Media	Sample Size	Representative Aliquot
Gross Alpha:		
Water	1 L	1 L
Vegetation	1-2 kg	1 g
Rain (collection pan)	0.37 m^2	0.093 m^2 (1/4 total sample)
Air	whole filter	800 m^3
Nonvolatile Beta:		
Water	1 L	1 L
Vegetation	1-2 kg	2 g
Air	whole filter	800 m^3
Strontium-89,90:		
River water	7 L	7 L
Rain	0.37 m^2	0.031 m^2 (1/12 total sample)
Streams	1 L	1 L
Air composites		
site perimeter	20,000 m^3	8,000 m^3
25-mile radius	18,000 m^3	7,200 m^3
100-mile radius	6,000 m^3	2,400 m^3
Strontium-90:		
River water	7 L	7 L
Streams	6 L	3 L (duplicates)
Milk	0.5 L	0.5 L
Food	20 g	20 g
Rain	0.37 m^2	0.031 m^2 (1/12 total sample)

TABLE 1-2
GAS-FLOW PROPORTIONAL COUNTING DATA

Lower Limits of Detection (LLD) for Gas-Flow Proportional Counters

Analysis	Counting Interval (minutes)	LLD (pCi)	Yield ± 1 sigma
Gross Alpha	20	0.60	96.7%
Nonvolatile Beta	20	1.51	96.7%
Strontium-89,90	20	2.44	80% ± 15%
Strontium-90	20	1.94	80% ± 15%

TABLE 1-3
LIQUID SCINTILLATION COUNTING DATA

Lower Limits of Detection (LLD)
Liquid Scintillation Analyses for Weak Beta Emitters

Nuclide	Counting Interval (minutes)	Routine Aliquot	Average % Recovery	LLD (pCi/mL)
Tritium ("short count")[a]	20	5 mL	100%	1.09
Tritium ("long count")[b]	150	5 mL	100%	0.40
Tritium ("long count")[b]	300	5 mL	100%	0.28
Phosphorus-32	20	25 mL	81%	0.17
Sulfur-35	20	200 mL	87%	0.02
Promethium-147	20	100 mL	70% (approx.)	0.05

[a] Routine environmental samples (e.g. stream samples) are analyzed for tritium using a 20-minute short count

[b] Environmental samples such as air silica gel and rainwater are counted once for 150 minutes; all drinking water, river water, milk, and foodstuffs are counted twice, for a total of 300 minutes

TABLE 1-4
ALPHA SPECTROMETER COUNTING DATA

Alpha Spectrometer Semiconductor Detectors

Analyses for plutonium in environmental samples are performed in batches on multiple silicon surface barrier detector systems. The counting process is identical for each sample, but due to differences in the methods for preparing the samples for counting, and variations in actual collected sample aliquots, lower limit of detection (LLD) values are not directly comparable between sample types. The table below presents some typical (averages of actual) LLD values for several sample types.

Sample Type	Nuclide	Counting Interval (minutes)	Routine Aliquot	Lower Limit of Detection
Air Filters:				
Single Area Stations (F and H Areas, Burial Ground North and South)				
	Pu-238	5000	--varies	25 aCi/m^3
	Pu-239	5000	--varies	30 aCi/m^3
Site Perimeter composite				
	Pu-238	5000	--varies	1 aCi/m^3
	Pu-239	5000	--varies	1 aCi/m^3
25-Mile-Radius composite				
	Pu-238	5000	--varies	2 aCi/m^3
	Pu-239	5000	--varies	3 aCi/m^3
100-Mile-Radius composite				
	Pu-238	5000	--varies	4 aCi/m^3
	Pu-239	5000	--varies	5 aCi/m^3
Rain Ion Columns:				
	Pu-238	5000	0.031 m^2	0.3 pCi/m^2
	Pu-239	5000	0.031 m^2	0.3 pCi/m^2
River Water:				
	Pu-238	5000	6 L	0.67 fCi/L
	Pu-239	5000	6 L	0.67 fCi/L
Soil and Sediment:				
	Pu-238	5000	10 g	6 fCi/g
	Pu-239	5000	10 g	6 fCi/g
Foodstuff:				
	Pu-238	5000	100 g	0.6 fCi/g
	Pu-239	5000	100 g	0.6 fCi/g

NOTE: Several sample types are routinely prepared with replicates, but no statistical consideration is given to the accompanying improvement in the LLD.

TABLE 1-5
LOWER LIMITS OF DETECTION FOR HPGE GAMMA ANALYSIS OF VEGETATION, SOIL, WILDLIFE, AND FOODS
(fCi/g)

Nuclide	Vegetation	Soil	Seafood/ Wildlife	Foods
Ce-141	680	152	33	22
Ce-144	2,100	362	113	59
Co-58	322	61	21	11
Co-60	314	53	24	11
Cr-51	3,620	856	205	144
Cs-134	340	57	21	10
Cs-137	350	58	23	11
I-131	1,020	567	61	100
Mn-54	308	53	23	11
Nb-95	441	97	28	17
Ru-103	381	81	24	15
Ru-106	2,970	508	199	96
Sb-125	883	149	54	27
Zn-65	723	125	47	22
Zr-95	660	128	41	22

NOTE: The calculations were performed using a typical counting interval of 83 minutes for vegetation and soil, and 8.3 hours for seafood/wildlife and foods. The sample weights used were 100 g vegetation, 600 g soil, 250 g seafood/wildlife, and 1,000 g foods. Typical decay times used were two weeks for vegetation and seafood/wildlife, and four weeks for soil and foods. The chemical recovery is assumed to be 100%. The LLD values are based upon a background measurement and calculated at the 95% confidence level using Canberra Industries APOGEE gamma analysis software.

TABLE 1-6
LOWER LIMITS OF DETECTION FOR HPGE GAMMA ANALYSIS OF RIVER, STREAM, AND RAIN ION COLUMNS

Nuclide	River (pCi/L)	Stream (pCi/L)	Rain (pCi/m^2)
Ce-141	3	11	246
Ce-144	11	35	585
Co-58	2	5	99
Co-60	2	5	85
Cr-51	18	60	1,380
Cs-134	2	6	93
Cs-137	2	6	94
I-131	5	17	914
Mn-54	2	5	85
Nb-95	2	7	156
Ru-103	2	6	131
Ru-106	15	49	819
Sb-125	4	15	240
Zn-65	4	12	202
Zr-95	3	11	207

NOTE: The calculations were performed using a typical counting interval of 83 minutes. The typical sample decay times used were two weeks for river and stream waters, and four weeks for rain water. The sample volume (passed through the column) was 20 L for river water and 6 L for stream water. The rain deposition area was 4 ft^2. The chemical recovery is assumed to be 100%. The LLD values are based upon a background measurement and calculated at the 95% confidence level using Canberra Industries APOGEE gamma analysis software.

TABLE 1-7
LOWER LIMITS OF DETECTION FOR HPGE GAMMA ANALYSIS OF AIR FILTERS

Nuclide	fCi/m^3
Ce-141	149
Ce-144	310
Co-58	55
Co-60	44
Cr-51	858
Cs-134	49
Cs-137	49
I-131	58
Mn-54	45
Nb-95	94
Ru-103	77
Ru-106	433
Sb-125	126
Zn-65	108
Zr-95	116

NOTE: The calculations were performed using a typical flow volume of 713.7 m^3. I-131 was collected on a charcoal cartridge. The typical counting interval used for particulate filters was 83 minutes and for charcoal cartridges, 2.8 hours. The typical decay time used for filters was five weeks, and for cartridges, two weeks. The chemical recovery is assumed to be 100%. The LLD values are based on a background measurement and calculated at the 95% confidence level using Canberra Industries APOGEE gamma analysis software.

TABLE 1-8
LOWER LIMITS OF DETECTION FOR HPGE GAMMA ANALYSIS OF WATER SAMPLES
(pCi/L)

Nuclide	Water (Liter)	Water (500 mL)	Milk (Liter)
Ce-141	68	136	11
Ce-144	210	420	36
Co-58	32	64	5
Co-60	31	63	5
Cr-51	362	724	59
Cs-134	34	68	5
Cs-137	35	70	5
I-131	102	204	16
Mn-54	31	62	5
Nb-95	44	88	6
Ru-103	38	76	6
Ru-106	300	594	46
Sb-125	88	177	13
Zn-65	72	145	11
Zr-95	66	132	10

NOTE: The calculations were performed using a typical counting interval of 83 minutes for water, or 16.7 hours for milk, and a sample decay time of two weeks. The chemical recovery is assumed to be 100%. The LLD values are based upon a background measurement and calculated at the 95% confidence level using Canberra Industries APOGEE gamma analysis software.

Chapter 2

Quality Assurance/Quality Control of Environmental Monitoring Programs

TABLE 2-1
BLIND SAMPLE RESULTS FOR FIELD MEASUREMENTS

pH (Units)

Sample Identification	Result	Actual Value	% Difference
BpH-01-1	5.58	5.90	0.32
BpH-02-3	7.10	7.20	0.10
BpH-04-4	9.00	9.00	0.00
BpH-04-5	5.96	6.00	0.00
BpH-04-6	6.03	6.00	0.03
BpH-04-7	6.00	6.00	0.00
BpH-05-4	7.20	7.20	0.00
BpH-05-5	6.04	6.00	0.04
BpH-05-6	5.99	6.00	0.01
BpH-05-8	8.03	8.00	0.03
BpH-05-9	6.00	6.00	0.00
BpH-06-1	7.12	7.32	0.20
BpH-06-2	9.07	8.94	0.13
BpH-06-8	6.01	6.00	0.01
BpH-06-9	8.06	8.00	0.06
BpH-06-10	8.92	8.98	0.06
BpH-07-1	5.26	5.00	0.26
BpH-07-5	6.01	6.00	0.01
BpH-07-6	6.02	6.01	0.01
BpH-07-7	7.46	7.30	0.16
BpH-07-8	8.05	8.00	0.05
BpH-09-1	8.11	8.00	0.11
BpH-09-2	8.18	8.00	0.18
BpH-09-3	5.06	5.01	0.05
BpH-09-4	6.01	6.00	0.01
BpH-09-5	9.02	8.95	0.07
BpH-10-1	8.05	8.00	0.05
BpH-10-2	5.02	5.00	0.02
BpH-10-3	5.00	5.00	0.00
BpH-10-4	6.02	6.00	0.02
BpH-10-5	9.10	9.00	0.10
BpH-11-1	5.03	5.01	0.02
BpH-11-2	6.00	6.00	0.00
BpH-11-3	8.02	8.00	0.02
BpH-11-4	8.04	8.00	0.04
BpH-11-5	9.13	9.00	0.13
BpH-12-1	9.25	9.00	0.25
BpH-12-2	5.00	5.04	0.04
BpH-12-3	6.01	6.00	0.01
BpH-12-4	9.08	9.00	0.08

TABLE 2-1
BLIND SAMPLE RESULTS FOR FIELD MEASUREMENTS, CONT'D.

Conductivity (μmhos/cm)

Sample Identification	Result	Actual Value	% Difference
BC-01-1	1,014	1,004	1.00
BC-01-3	830	828	0.24
BC-04-1	203	197	3.04
BC-04-2	214	205	4.39
BC-05-2	357	343	4.08
BC-05-3	138	134	2.99
BC-05-7	198	198	0.00
BC-06-3	192	196	2.04
BC-06-4	231	223	3.59
BC-06-5	254	263	3.42
BC-06-6	278	273	1.83
BC-07-2	215	214	0.47
BC-07-3	128	135	5.18
BC-07-4	194	195	0.51
BC-07-9	198	240	17.5
BC-09-1	251	252	0.40
BC-09-2	202	209	3.35
BC-09-3	241	233	3.43
BC-09-4	163	164	0.61
BC-09-1	132	133	0.75
BC-10-2	296	295	0.34
BC-10-3	274	280	2.14
BC-10-4	220	224	1.79
BC-10-5	232	240	3.33
BC-11-1	189	193	2.07
BC-11-2	210	228	7.89
BC-11-3	219	220	0.45
BC-11-4	237	230	3.04
BC-11-5	231	223	3.58
BC-12-1	198	188	5.31
BC-12-2	235	226	3.98

TABLE 2-2
EMS BLIND SAMPLE RESULTS FOR GROSS ALPHA AND NONVOLATILE BETA

Detector/ No. of Runs[a]	Found pCi/F[b]	Known pCi/F[b]	EPA Limits	
Gross Alpha[c]:				
Countmaster 4				
1st run	8.7 ± 1.7	8.0	2.2 to 13.77	WL
2nd run	8.6 ± 1.7	8.0	0.7 to 16.6	CL
Countmaster 5				
1st run	7.0 ± 1.6	8.0	2.2 to 13.77	WL
2nd run	8.5 ± 1.7	8.0	0.7 to 16.6	CL
Nonvolatile Beta[c]:				
Countmaster 4				
1st run	24.2 ± 2.3	29.0	23.2 to 34.7	WL
2nd run	25.1 ± 2.4	29.0	20.3 to 37.6	CL
Countmaster 5				
1st run	23.2 ± 2.3	29.0	23.2 to 34.7	WL
2nd run	23.8 ± 2.3	29.0	20.3 to 37.6	CL

[a] Each sample was run twice on two different gas-flow proportional counters.
[b] pCi per filter
[c] The expected laboratory precision from one sample with two determinations is 3.54.
WL=Warning limits; CL=Control limits

TABLE 2-3
EMS BLIND SAMPLE RESULTS FOR 1989

Gamma Spectrometry

Nuclide and HPGe Detector Number	EMS Found pCi/L	Actual Value pCi/L	Ratio Found/Actual
Co-60			
Detector 4	7.88 ± 2.00	10.65 ± 4.1	0.74 ± 0.34
Detector 4	7.39 ± 1.97	10.65 ± 4.1	0.70 ± 0.32
Detector 3	8.36 ± 1.98	10.65 ± 4.1	0.79 ± 0.36
Detector 3	9.21 ± 2.00	10.65 ± 4.1	0.86 ± 0.38
Detector 2	11.41 ± 1.43	10.65 ± 4.1	1.07 ± 0.43
Detector 2	11.08 ± 1.42	10.65 ± 4.1	1.04 ± 0.43
Zn-65			
Detector 4	155.02 ± 12	160.15 ± 23	0.97 ± 0.16
Detector 4	160.27 ± 12	160.15 ± 23	1.00 ± 0.16
Detector 3	151.73 ± 13	160.15 ± 23	0.95 ± 0.16
Detector 3	161.46 ± 13	160.15 ± 23	1.00 ± 0.17
Detector 2	174.29 ± 14	160.15 ± 23	1.09 ± 0.18
Detector 2	175.00 ± 14	160.15 ± 23	1.09 ± 0.18
Ru-106			
Detector 4	165.65 ± 23	171.19 ± 30	0.97 ± 0.22
Detector 4	145.31 ± 23	171.19 ± 30	0.85 ± 0.20
Detector 3	148.86 ± 23	171.19 ± 30	0.87 ± 0.20
Detector 3	161.31 ± 25	171.19 ± 30	0.94 ± 0.22
Detector 2	177.99 ± 22	171.19 ± 30	1.04 ± 0.22
Detector 2	174.29 ± 14	171.19 ± 30	1.02 ± 0.20
Cs-134			
Detector 4	8.10 ± 1.1	9.73 ± 3.7	0.83 ± 0.33
Detector 4	9.62 ± 1.1	9.73 ± 3.7	0.99 ± 0.42
Detector 3	8.48 ± 1.4	9.73 ± 3.7	0.87 ± 0.36
Detector 3	8.00 ± 2.4	9.73 ± 3.7	0.82 ± 0.40
Detector 2	10.04 ± 1.2	9.73 ± 3.7	1.03 ± 0.41
Detector 2	12.01 ± 1.9	9.73 ± 3.7	1.23 ± 0.51
Cs-137			
Detector 4	10.77 ± 1.9	10.74 ± 3.7	1.00 ± 0.38
Detector 4	9.62 ± 1.8	10.74 ± 3.7	0.90 ± 0.35
Detector 3	7.65 ± 2.3	10.74 ± 3.7	0.71 ± 0.32
Detector 3	8.00 ± 2.4	10.74 ± 3.7	0.75 ± 0.34
Detector 2	12.21 ± 1.9	10.74 ± 3.7	1.14 ± 0.42
Detector 2	12.01 ± 1.9	10.74 ± 3.7	1.12 ± 0.42

TABLE 2-4
EMS BLIND SAMPLE RESULTS FOR TRITIUM

Sample	Found pCi/mL	Actual Value pCi/mL	Ratio Found/Actual
Sample 36	4.30 ± 0.75	5.09	0.85
Sample 37	2.94 ± 0.74	3.44	0.85
Sample 38	2.54 ± 0.72	2.64	0.96
Sample 39	1.08 ± 0.80	1.20	0.90
Sample 40	1.08 ± 0.80	1.20	0.90
Sample 41	5.41 ± 0.96	5.02	1.07
Sample 43	3.96 ± 0.87	3.85	1.03
Sample 45	5.22 ± 0.80	4.97	1.05
Sample 47	3.85 ± 0.88	3.69	1.04
Sample 48	4.94 ± 0.80	5.92	0.83
Sample 50	1.55 ± 0.78	1.87	0.83
Sample 51	4.90 ± 0.84	4.90	1.00

TABLE 2-5
EMS BLIND SAMPLE RESULTS FOR STRONTIUM-90 AND SULFUR-35

Strontium-90

Sample	Found pCi/g	EML Value[a] pCi/mL	Ratio Found/Actual
Soil	1.30 ± 0.36	1.39 ± 0.60	0.93
Vegetation	3.80 ± 0.78	3.80 ± 0.98	1.00

Sulfur-35

Sample	Found pCi/mL	EML Value[a] pCi/mL	Ratio Found/Actual
Sample 27	0.84	1.00	0.84

[a] Environmental Measurements Laboratory (DOE)

TABLE 2-6
EMS BLIND SAMPLE RESULTS FOR CESIUM-137 IN WATER[a]

Sample Identification	Actual Values pCi/mL	EMS Found pCi/mL	Ratio Found/Actual
QA-1	11.26 ± 0.34	11.25 ± 2.17	0.99 ± 0.19
QA-2	22.25 ± 0.67	19.30 ± 4.07	0.86 ± 0.17
QA-3	33.78 ± 1.01	32.46 ± 7.42	0.96 ± 0.22
QA-4	45.00 ± 1.35	37.10 ± 8.09	0.82 ± 0.18
QA-5	225.22 ± 6.76	216.58 ± 20.03	0.96 ± 0.09

[a] The blind samples used were prepared by the Savannah River Laboratory (SRL) Analytical Development Division from a primary National Institute of Standards and Technology (NIST) ^{137}Cs standard with 3% uncertainty.

TABLE 2-7
QAD INTERLABORATORY COMPARISON OF ANALYTICAL RESULTS[a]

Samp. Date	Nuclide	SRS Value	QAD Value	QAD SRS Ratio	No. of Labs	Mean Value of Labs	Labs ±20% QAP Value[b]
		Water Samples, pCi/L					
01/20/89	Alpha	7 ± 3	8 ± 5	0.9	153	7.9 ± 2.2	98%
04/18/89	Alpha	21 ± 5	29 ± 7	0.7	124	25.8 ± 7.4	89%
05/12/89	Alpha	39.7 ± 5	30 ± 8	1.3	148	27.6 ± 7.5	90%
09/22/89	Alpha	2.3 ± 1.1	4 ± 5	0.6	151	4.4 ± 1.9	99%
10/06/89	Ba-133	62 + 5	59 ± 6	1.1	122	57.7 ± 5.1	89%
01/20/89	Beta	4.7 ± 1.0	4 ± 5	1.2	152	5.4 ± 1.8	97%
04/18/89	Beta	53 ± 5	57 ± 5	0.9	119	50 ± 7.4	62%
05/12/89	Beta	54.3 ± 4	50 ± 5	1.1	155	50.3 ± 8	68%
09/22/89	Beta	5.3 + 1.2	6 ± 5	0.9	153	6.7 ± 1.8	96%
02/10/89	Co-60	9 + 2.5	10 ± 5	0.9	122	10.6 ± 2.1	98%
06/09/89	Co-60	29.7 ± 2.4	31 ± 5	1.0	127	31 ± 2.9	90%
10/06/89	Co-60	31 ± 4	30 ± 5	1.0	125	30.5 ± 2.5	96%
02/10/89	Cr-51	206 ± 55	235 ± 24	0.9	124	233 ± 20	93%
02/10/89	Cs-134	9 ± 1.5	10 ± 5	0.9	123	10 ± 1.9	98%
04/18/89	Cs-134	17.7 ± 1.5	20 ± 5	0.9	101	19.1 ± 2.7	93%
06/09/89	Cs-134	34 ± 2.4	39 ± 5	0.9	127	37 ± 3.3	91%
10/06/89	Cs-134	28 ± 4	29 ± 5	1.0	125	27.3 ± 2.8	94%
02/10/89	Cs-137	10 ± 2.5	10 ± 5	1.0	125	11 ± 1.9	98%
04/18/89	Cs-137	19 ± 2.7	20 ± 5	1.0	101	20.2 ± 2.3	92%
06/09/89	Cs-137	19.7 ± 3.0	20 ± 5	1.0	125	21 ± 2.2	93%
10/06/89	Cs-137	67.7 ± 5	59 ± 5	1.1	125	61.4 ± 4.5	84%
02/24/89	H-3	2,786 ±210	2,754 ±356	1.0	119	2,723 ±275	93%
06/23/89	H-3	4,337 ±210	4,503 ±450	1.0	124	4,491 ±384	89%
10/20/89	H-3	3,100 ±190	3,496 ±364	0.9	126	3,471 ±369	83%
01/13/89	Pu-239	3.77 ± .2	4.2 ± .4	0.9	39	4.03 ± .43	77%
08/18/89	Pu-239	2.9 ± .3	2.8 ± .3	1.0	42	2.74 ± .21	88%
06/09/89	Ru-106	117 ± 18	128 ± 13	0.9	124	123 ± 14	82%
10/06/89	Ru-106	163 ± 20	161 ± 16	1.0	123	153 ± 14	85%
01/06/89	Sr-89	38.33 ± 11	40 ± 5	1.0	67	38 ± 7	77.6%
04/18/89	Sr-89	10 ± 6	8 ± 5	1.3	62	7.9 ± 1.9	100%
05/05/89	Sr-89	4.33 ± 4.5	6 ± 5	0.7	64	5.9 ± 1.48	100%
01/06/89	Sr-90	25.3 ± 5.3	25.0 ± 1.5	1.0	73	24.4 ± 2.0	74%
04/18/89	Sr-90	7 ± 2.9	8 ± 1.5	0.9	65	7.78 ± 1.16	94%
05/05/89	Sr-90	6.00 ± 2.70	6.00 ± 1.50	1.0	68	5.56 ± 0.86	88%
05/05/89	U	4 ± 2	5 ± 6	0.8	100	5 ± 1.6	98%
03/17/89	U	9 ± 3	3 ± 6	3.0	84	3.3 ± 1.7	96%
04/18/89	U	31 ± 8	41 ± 6	0.8	96	39 ± 6	83%
02/10/89	Zn-65	160 ± 12	159 ± 16	1.0	129	160 ± 12	92%
06/09/89	Zn-65	169 ± 14	165 ± 17	1.0	127	167 ± 11	93%
10/06/89	Zn-65	142 ± 15	129 ± 13	1.1	125	129 ± 9	94%

[a] Environmental Protection Agency Quality Assurance Division (QAD)

[b] Percentage of participating laboratories that fall between QAP values of 0.8-1.2.

TABLE 2-7
QAD INTERLABORATORY COMPARISON OF ANALYTICAL RESULTS, CONT'D.[a]

Samp. Date	Nuclide	SRS Value	QAD Value	QAD SRS Ratio	No. of Labs	Mean Value of Labs	Labs ±20% QAP Value[b]
		Air Filter Samples, pCi/Filter					
03/31/89	Alpha	22.3 ± 2.6	21 ± 5	1.1	128	22.6 ± 4.3	91%
09/25/89	Alpha	6 ± 1.4	6 ± 5	1.0	119	6.5 ± 1.6	99%
03/31/89	Beta	57.3 ± 3.5	62 ± 5	0.9	131	63.1 ± 8.2	73%
03/31/89	Cs-137	30.3 ± 2.1	20 ± 5	1.5	119	21.3 ± 3.9	89%
08/25/89	Cs-137	16 ± 2	10 ± 5	1.6	107	11 ± 2	95%
		Milk Samples, pCi/L					
04/28/89	Cs-137	49 ± 5	50 ± 5	1.0	79	49.9 ± 3.1	94%
04/28/89	Sr-90	115 ± 14	55 ± 3	2.1	39	53 ± 5.4	67%

[a] Environmental Protection Agency Quality Assurance Division (QAD)

[b] Percentage of participating laboratories that fall between QAP values of 0.8-1.2.

TABLE 2-8
QAP INTERLABORATORY COMPARISON
OF ANALYTICAL RESULTS[a]

Nuclide Sample	SRS Value	QAP Value	QAP SRS Ratio	No. of Labs	Mean Value of Labs	Labs±20% QAP Value[b]
		March-June 1989				
Air:						
Be-7	1841.000 ± 97.0000	1,950.000	0.94	35	1700.000	77%
Ce-144	327.000 ± 22.0000	327.000	1.00	30	317.000	70%
Co-60	130.000 ± 5.0000	126.000	1.03	38	123.000	86%
Cs-134	161.000 ± 4.0000	158.000	1.02	36	141.000	77%
Cs-137	212.000 ± 8.0000	189.000	1.12	38	186.000	84%
Mn-54	4.300 ± 1.7000	3.740	1.15	17	4.110	58%
Pu-239	0.281 ± 0.0420	0.270	1.04	21	0.258	64%
Sb-125	27.400 ± 3.0000	96.800	0.28	15	75.300	20%
Sr-90	2.920 ± 5.1500	2.390	1.22	17	2.700	55%
U-ug	0.450 ± 0.0100	0.268	1.68	5	0.454	0%
Soil:						
Cs-137	22.000 ± 1.2000	20.800	1.06	36	22.600	72%
K-40	25.600 ± 1.5000	24.100	1.06	29	25.600	79%
Pu-239	0.336 ± 0.0070	0.420	0.80	22	0.434	87%
Sr-90	1.120 ± 0.3000	1.090	1.03	20	1.310	50%
Vegetation:						
Cs-137	1.750 ± 0.0900	1.600	1.09	32	1.750	72%
K-40	28.600 ± 1.9000	26.100	1.10	26	28.500	88%
Pu-239	0.023 ± 0.0020	0.022	1.05	19	0.023	59%
Sr-90	1.600 ± 0.3700	3.750	0.43	16	4.010	76%
U-ug	0.007 ± 0.0004	0.033	0.21	2	0.036	40%
Water:						
Am-241	0.006 ± 0.0070	0.004	1.50	14	0.004	50%
Co-57	0.810 ± 0.0400	0.880	0.92	33	0.815	88%
Co-60	0.870 ± 0.0400	0.940	0.93	35	0.881	91%
Cs-134	2.340 ± 0.0700	2.730	0.86	37	2.490	91%
Cs-137	2.430 ± 0.1800	2.550	0.95	36	2.510	92%
H-3	11.650 ± 0.4600	6.310	1.85	31	6.070	81%
Mn-54	0.300 ± 0.0200	0.300	1.00	35	0.314	89%
Pu-239	0.006 ± 0.0001	0.006	1.00	26	0.006	82%
Sr-90	0.500 ± 0.1000	0.550	0.91	23	0.574	95%
U-ug	0.009 ± 0.0010	0.013	0.69	5	0.012	66%

[a] Quality Assessment Program (QAP) conducted by the DOE Environmental Measurements Laboratory (EML).

[b] Percentage of participating laboratories that fall between QAP values of 0.8-1.2.

TABLE 2-8
QAP INTERLABORATORY COMPARISON
OF ANALYTICAL RESULTS, CONT'D.[a]

Nuclide Sample	SRS Value	QAP Value	QAP SRS Ratio	No. of Labs	Mean Value of Labs	Labs ±20% QAP Value[b]
		September-December 1989				
Air:						
Be-7	125.800 ± 9.9000	123.000	1.02	35	118.000	83%
Ce-144	8.400 ± 1.8000	7.080	1.19	35	7.400	77%
Co-60	8.700 ± 1.1000	8.170	1.06	37	8.450	86%
Cs-134	9.100 ± 1.1000	9.330	0.98	37	8.390	72%
Cs-137	4.200 ± 0.4000	3.580	1.17	37	3.730	81%
Mn-54	4.600 ± 0.5000	4.170	1.10	37	4.300	72%
Pu-239	0.016 ± 0.0020	0.018	0.89	21	0.017	60%
Sr-90	0.190 ± 0.1500	0.200	0.95	10	0.233	43%
Soil:						
Am-241	2.700 ± 0.4000	2.220	1.22	10	2.810	16%
Cs-137	703.100 ± 20.4000	642.000	1.10	33	682.000	69%
K-40	616.000 ± 17.9000	561.000	1.10	28	574.000	65%
Pu-239	13.400 ± 0.4000	17.100	0.78	21	15.900	77%
Sr-90	9.600 ± 12.6000	5.730	1.68	11	6.280	12%
Vegetation:						
Cs-137	53.800 ± 3.9000	47.900	1.12	26	49.400	64%
K-40	1,486.000 ± 117.0000	1,290.000	1.15	23	1,430.000	55%
Pu-239	0.100 ± 0.0300	0.074	1.35	12	0.090	28%
Sr-90	1,360.000 ± 67.0000	1,830.000	0.74	14	1,560.000	52%
Water:						
Am-241	0.630 + 0.5600	0.333	1.89	17	0.327	70%
Ce-144	128.400 ± 6.5000	132.000	0.97	35	140.000	78%
Co-57	137.200 ± 7.2000	135.000	1.02	40	138.000	97%
Co-60	153.600 ± 2.5000	155.000	0.99	42	157.000	95%
Cs-134	62.900 ± 1.3000	68.300	0.92	41	64.300	95%
Cs-137	71.200 ± 1.7000	68.300	1.04	42	72.300	92%
H-3	286.000 ± 8.9000	395.000	0.72	34	347.000	76%
Mn-54	65.000 ± 1.8000	65.000	1.00	40	67.100	90%
Pu-239	0.250 ± 0.0200	0.350	0.71	24	0.260	8%
Sr-90	30.900 ± 3.3300	31.700	0.97	24	34.300	95%
U-ug	0.740 ± 1.1500	0.333	2.22	2	0.438	50%

[a] Quality Assessment Program (QAP) conducted by the DOE Environmental Measurements Laboratory (EML)

[b] Percentage of participating laboratories that fall between QAP values of 0.8-1.2.

TABLE 2-9
EPA INTERLABORATORY AUDIT RESULTS

Site	Analyzer	% Average Difference	Linear Regression Slope	Linear Regression Intercept
614-36G	SO_2	-0.7	1.0029	0.648152
614-39G	SO_2	0.2	1.0045	1.137484
614-40G	SO_2	1.0	0.9996	2.427802
614-36G	NO	7.09	1.0559	3.770697
614-36G	NO_2	10.55	1.0418	5.779527
614-38G	NO	7.85	1.0613	2.203227
614-38G	NO_2	20.62	1.0577	15.238592
614-39G	NO	7.13	1.0574	4.040695
614-39G	NO_2	5.05	1.0416	0.729979
614-40G	NO	6.84	1.0553	3.918970
614-40G	NO_2	22.54	1.0409	15.415892
614-41G	NO	6.62	1.0501	3.973340
614-41G	NO_2	10.55	1.0444	6.990431

TABLE 2-10
AMBIENT AIR MONITORING STATION
QA AUDIT RESULTS

QUARTER 1

Site	Analyzer	% Average Difference	Linear Regression Slope	Linear Regression Intercept	Correlation Coefficient
614-36G	NO_2	-2.2	0.9952	-0.0021	0.9999
614-38G	NO_2	4.1	1.0390	-0.0004	0.9999
614-39G	NO_2	1.2	1.0068	0.0007	0.9998
614-40G	NO_2	7.0	1.0431	0.0036	0.9998
614-41G	NO_2	4.1	1.0088	0.0054	0.9999
614-36G	SO_2	6.5	1.0216	0.0058	0.9999
614-39G	SO_2	4.0	1.0055	0.0037	0.9997
614-40G	SO_2	1.0	1.0010	0.0013	0.9998
614-36G	O_3	-9.8	0.9518	-0.0044	0.9996
614-39G	O_3	4.9	0.9808	-0.0025	0.9998

Total Suspended Particulates

Sampler	% Flow Difference
614-36G	4.2
614-38G	3.6
614-39G (Routine)	0.9
614-39G (Co-Location)	1.2
614-40G	2.3
614-41G	0.5

TABLE 2-10
AMBIENT AIR MONITORING STATION
QA AUDIT RESULTS, CONT'D.

QUARTER 2

Site	Analyzer	% Average Difference	Linear Regression Slope	Linear Regression Intercept	Correlation Coefficient
614-36G	NO_2	5.8	1.0922	-0.0019	0.9999
614-38G	NO_2	1.7	0.9805	0.0049	0.9999
614-39G	NO_2	0.6	1.0093	-0.0006	0.9999
614-40G	NO_2	2.1	1.0494	-0.0037	0.9999
614-41G	NO_2	0.9	1.0198	-0.0027	0.9999
614-36G	SO_2	3.6	1.0066	0.0036	0.9998
614-39G	SO_2	0.1	1.0318	-0.0034	0.9999
614-40G	SO_2	4.2	0.9491	0.002	0.9997
614-36G	O_3	1.0	1.0328	-0.0020	0.9999
614-39G	O_3	10.0	0.9426	-0.0039	0.9999

Total Suspended Particulates

Sampler	% Flow Difference
614-36G	2.8
614-38G	-0.7
614-39G (Routine)	1.3
614-39G (Co-Location)	0.7
614-40G	1.2
614-41G	3.9

TABLE 2-10
AMBIENT AIR MONITORING STATION
QA AUDIT RESULTS, CONT'D.

QUARTER 3

Site	Analyzer	% Average Difference	Linear Regression Slope	Linear Regression Intercept	Correlation Coefficient
614-36G	NO_2	5.8	1.0119	0.0072	0.9999
614-38G[a]	NO_2	-	-	-	-
614-39G	NO_2	0.1	1.0309	-0.0045	0.9999
614-40G	NO_2	-0.2	1.0050	-0.0013	0.9999
614-41G	NO_2	0.7	1.0338	-0.0040	0.9999
614-36G	SO_2	1.3	0.9819	0.0007	0.9999
614-39G	SO_2	-2.4	1.0007	-0.003	0.9999
614-40G	SO_2	2.8	1.0248	0.0002	0.9999
614-36G	O_3	4.8	1.0908	-0.0030	0.9999
614-39G	O_3	7.3	1.0509	0.0026	0.9999

Total Suspended Particulates

Sampler	% Flow Difference
614-36G	-1.0
614-38G[a]	-
614-39G (Routine)	0.2
614-39G (Co-Location)	2.5
614-40G	-0.5
614-41G	5.2

[a] Station 614-38G was temporarily taken out of service due to construction work in the vicinity.

TABLE 2-10
AMBIENT AIR MONITORING STATION
QA AUDIT RESULTS, CONT'D.

QUARTER 4

Site	Analyzer	% Average Difference	Linear Regression Slope	Linear Regression Intercept	Correlation Coefficient
614-36G	NO_2	-2.7	0.9952	-0.0030	0.9998
614-38G[a]	NO_2	-	-	-	-
614-39G	NO_2	4.7	0.9530	0.0130	0.9998
614-40G	NO_2	-3.9	1.0184	-0.0094	0.9999
614-41G	NO_2	8.2	1.0551	0.0021	0.9999
614-36G	SO_2	14.7	1.0674	0.0131	0.9999
614-39G	SO_2	4.3	1.0627	-0.0020	0.9998
614-40G	SO_2	11.7	1.0726	0.0056	0.9996
614-36G	O_3	0.7	1.025	-0.0011	0.9999
614-39G	O_3	6.5	1.0288	0.0034	0.9998

Total Suspended Particulates

Sampler	% Flow Difference
614-36G	-1.0
614-38G[a]	-
614-39G (Routine)	-2.0
614-39G (Co-Location)	-1.5
614-40G	-2.7
614-41G	1.8

[a] Station 614-38G was temporarily taken out of service due to construction work in the vicinity.

TABLE 2-11
NPDES BLIND SAMPLE RESULTS

FIRST QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Blind Sample Result	Difference
A-005	Tetrachloroethylene	µg/L	<2	<2	<2
A-005	Trichloroethylene	µg/L	8.01	6.52	1.49
A-005	1,1,1-Trichloroethane	µg/L	<2	<2	<2
A-005	Fecal Coliform	#/100mL	20	10	10
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
D-003	Total Suspended Solids	mg/L	<1	<1	<1
D-003	Oil and Grease	mg/L	<1	<1	<1
H-012	Sulfate	$mgSO_4/L$	9.0	9.4	0.4
F-003	Biochemical Oxygen Demand	mg/L	1.5	1.1	0.4
SC-4	Lead	mg/L	<0.003	<0.003	<0.003
SC-4	Nitrates	mgN/L	0.13	0.13	0
SC-4	Phosphates	mgP/L	0.038	0.341	0.303

THIRD QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Blind Sample Result	Difference
A-001	Total Suspended Solids	mg/L	<1	<1	<1
A-001	Biochemical Oxygen Demand	mg/L	<1	<1	<1
A-001	Oil and Grease	mg/L	<1	<1	<1
A-005	Fecal Coliform	#/100mL	<2	4	<4
A-014	Tetrachloroethylene	µg/L	<2	<2	<2
A-014	Trichloroethylene	µg/L	<2	<2	<2
A-014	1,1,1-Trichloroethane	µg/L	<2	<2	<2
X-008	Iron	mg/L	1.67	1.63	0.04
X-008	Aluminium	mg/L	<0.05	0.051	<0.051
M-004	Nitrates	mgN/L	39.5	39.3	0.2

TABLE 2-12
NPDES DUPLICATE SAMPLE RESULTS

FIRST QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
A-005	1,1,1-Trichloroethane	µg/L	<2	<2	<2
H-016	Ammonia	mgN/L	0.063	0.057	0.0060
A-001	Biochemical Oxygen Demand	mg/L	<1	<1	<1
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
A-005	Fecal Coliform	#/100mL	20	60	40
A-001	Oil and Grease	mg/L	<1	<1	<1
A-003	Oil and Grease	mg/L	1.0	<1	<1
A-005	Oil and Grease	mg/L	<1	<1	<1
A-011	Oil and Grease	mg/L	1.1	<1	<1.1
A-005	Tetrachloroethylene	µg/L	<2	<2	<2
A-001	Total Suspended Solids	mg/L	<1	5	<5
A-003	Total Suspended Solids	mg/L	<1	<1	<1
A-005	Total Suspended Solids	mg/L	<1	1	<1
A-011	Total Suspended Solids	mg/L	<1	4	<4
A-005	Trichloroethylene	µg/L	<2	2.37	<2.37
D-001	Oil and Grease	mg/L	<1	<1	<1
D-001	Total Suspended Solids	mg/L	8	6	2
M-004	Nitrates	mgN/L	49.0	51.3	2.3
M-004	Uranium	mg/L	0.179	0.157	0.0220
D-006	Fecal Coliform	#/100mL	92	200	108
D-001C	Oil and Grease	mg/L	<1	<1	<1
D-001C	Total Suspended Solids	mg/L	4	5	1
H-016	Copper	mg/L	<0.01	<0.01	<0.01
H-016	Nitrates	mgN/L	41.1	42.1	1.0
A-014	1,1,1-Trichloroethane	µg/L	<2	<2	<2
A-014	Biochemical Oxygen Demand	mg/L	<1	<1	<1
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
A-003	Oil and Grease	mg/L	2.0	<1	<2.0
A-014	Oil and Grease	mg/L	<1	<1	<1
M-004	Phosphates	mgP/L	0.088	0.081	0.007
A-014	Tetrachloroethylene	µg/L	<2	<2	<2
A-014	Total Suspended Solids	mg/L	1	1	0
A-014	Trichloroethylene	µg/L	2.45	2.55	0.10
C-001	Oil and Grease	mg/L	<1	<1	<1
C-003	Oil and Grease	mg/L	<1	<1	<1
C-004	Oil and Grease	mg/L	<1	1.3	<1.3
C-001	Total Suspended Solids	mg/L	2	1	1
C-003	Total Suspended Solids	mg/L	<1	<1	<1
C-004	Total Suspended Solids	mg/L	<1	<1	<1
A-005	1,1,1-Trichloroethane	µg/L	<2	<2	<2
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
A-005	Fecal Coliform	#/100mL	20	4	16
A-005	Tetrachloroethylene	µg/L	<2	<2	<2
A-005	Trichloroethylene	µg/L	8.01	6.50	1.51
D-003	Oil and Grease	mg/L	<1	<1	<1
D-006	Oil and Grease	mg/L	1.4	<1	<1.4
H-012	Sulfate	$mgSO_4/L$	9.0	9.0	0
D-003	Total Suspended Solids	mg/L	<1	<1	<1
D-006	Total Suspended Solids	mg/L	1	<1	<1
F-003	Biochemical Oxygen Demand	mg/L	1.5	<1	<1.5
SC-4	Lead	mg/L	<0.003	<0.003	<0.003
SC-4	Nitrates	mgN/L	0.13	0.13	0

TABLE 2-12
NPDES DUPLICATE SAMPLE RESULTS, CONT'D.

FIRST QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
F-001	Oil and Grease	mg/L	<1	<1	<1
F-002	Oil and Grease	mg/L	<1	<1	<1
F-003	Oil and Grease	mg/L	<1	<1	<1
SC-4	Phosphates	mgP/L	0.038	0.042	0.004
F-001	Total Suspended Solids	mg/L	<1	<1	<1
F-002	Total Suspended Solids	mg/L	3	2	1
F-003	Total Suspended Solids	mg/L	1	1	0

SECOND QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
X-014	Benzene	µg/L	2.61	2.60	0.01
F-005	Oil and Grease	mg/L	<1	<1	<1
F-008	Oil and Grease	mg/L	<1	<1	<1
H-002	Oil and Grease	mg/L	<1	<1	<1
H-004	Oil and Grease	mg/L	1.3	1.4	0.1
H-008	Oil and Grease	mg/L	<1	<1	<1
F-005	Total Suspended Solids	mg/L	1	2	1
F-008	Total Suspended Solids	mg/L	1	2	1
H-002	Total Suspended Solids	mg/L	1	2	1
H-004	Total Suspended Solids	mg/L	<1	<1	<1
H-008	Total Suspended Solids	mg/L	1	1	0
M-004	Nitrates	mgN/L	160	160	0
M-004	Phosphates	mgP/L	0.053	0.053	0
H-016	Biochemical Oxygen Demand	mg/L	3.5	3.6	0.1
H-016	Mercury	mg/L	<0.0001	<0.0001	<0.0001
K-011	Biochemical Oxygen Demand	mg/L	1.2	1.3	0.1
K-011-3	Biochemical Oxygen Demand	mg/L	5.5	4.9	0.6
K-008	Oil and Grease	mg/L	<1	<1	<1
K-010	Oil and Grease	mg/L	<1	<1	<1
K-011	Oil and Grease	mg/L	<1	1.1	<1.1
K-011-3	Oil and Grease	mg/L	<1.0	<1.0	<1.0
K-008	Total Suspended Solids	mg/L	3	4	1
K-010	Total Suspended Solids	mg/L	2	2	0
K-011	Total Suspended Solids	mg/L	5	6	1
K-011-3	Total Suspended Solids	mg/L	7.8	3.1	4.7
A-005	1,1,1-Trichloroethane	µg/L	2.6	<2	<2.6
A-005-3	1,1,1-Trichloroethane	µg/L	<0.5	<0.5	<0.5
SC-4-3	Cadium	mg/L	<0.01	<0.01	<0.01
SC-4	Cadium	mg/L	<0.01	<0.01	<0.01
A-002-3	Chromium	mg/L	0.013	0.014	0.001
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
A-005	Fecal Coliform	#/100mL	2	<2	<2
SC-4-3	Nitrates	mgN/L	0.111	<0.100	<0.111
SC-4	Nitrates	mgN/L	0.07	0.06	0.01
SC-4-3	Phosphates	mgP/L	0.118	0.533	0.415
SC-4	Phosphates	mgP/L	0.067	0.066	0.001
H-012	Sulfates	mgSO4/L	12.2	11.4	0.8
H-012-3	Sulfates	mgSO4/L	11.3	10.8	1.5
A-005	Tetrachloroethylene	µg/L	<2	<2	<2
A-005-3	Tetrachloroethylene	µg/L	<0.5	<0.5	<0.5
A-005	Trichloroethylene	µg/L	6.3	6.1	0.02
A-005-3	Trichloroethylene	µg/L	3.48	3.50	0.02

TABLE 2-12
NPDES DUPLICATE SAMPLE RESULTS, CONT'D.

SECOND QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
DW-2	Oil and Grease	mg/L	2.4	<1	<2.4
L-007	Total Suspended Solids	mg/L	5	5	0
M-005	1,1,1-Trichloroethane	µg/L	<2	<2	<2
M-005	Tetrachloroethylene	µg/L	<2	<2	<2
M-005	Trichloroethylene	µg/L	<2	<2	<2
H-016	Biochemical Oxygen Demand	mg/L	7.4	6.0	1.4
H-016	Oil and Grease	mg/L	<1	<1	<1
H-016	Total Suspended Solids	mg/L	<1	<1	<1
H-016	Zinc	mg/L	0.016	0.054	0.038
L-007	Oil and Grease	mg/L	<1	<1	<1
P-007	Oil and Grease	mg/L	<1	<1	<1
P-013	Oil and Grease	mg/L	<1	<1	<1
P-019	Oil and Grease	mg/L	<1	<1	<1
L-007	Total Suspended Solids	mg/L	2	2	0
L-007	Total Suspended Solids	mg/L	4	4	0
P-013	Total Suspended Solids	mg/L	5	6	1
P-019	Total Suspended Solids	mg/L	3	2	1

THIRD QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
D-006	Fecal Coliform	#/100mL	250	160	90
X-004	Oil and Grease	mg/L	<1	<1	<1
X-008	Oil and Grease	mg/L	1.8	<1	<1.8
X-014	Oil and Grease	mg/L	1.1	1.8	0.7
X-014	Total Organic Carbon	mg/L	6.4	5.6	0.8
X-004	Total Suspended Solids	mg/L	<1	1	<1
X-008	Total Suspended Solids	mg/L	8	8	0
SC-4	Nitrates	mgN/L	0.07	0.07	0
SC-4	Phosphates	mgP/L	0.051	0.050	0.001
SC-4	Silver	mg/L	<0.0005	<0.0005	<0.0005
F-001	Oil and Grease	mg/L	<1	<1	<1
F-001	Total Suspended Solids	mg/L	1	1	0
A-001	Biochemical Oxygen Demand	mg/L	<1	<1	<1
A-005	Fecal Coliform	#/100mL	<2	<2	<2
A-001	Oil and Grease	mg/L	<1	<1	<1
A-011	Oil and Grease	mg/L	<1	<1	<1
A-001	Total Suspended Solids	mg/L	<1	<1	<1
A-011	Total Suspended Solids	mg/L	1	<1	<1
A-014	1,1,1-Trichloroethylene	µg/L	<2	<2	<2
A-014	Tetrachloroethylene	µg/L	<2	<2	<2
A-014	Trichloroethylene	µg/L	<2	<2	<2
X-008	Aluminium	mg/L	<0.05	0.051	<0.051
X-008	Iron	mg/L	1.67	1.58	0.09
M-004	Oil and Grease	mg/L	<1	<1	<1
M-004	Nitrates	mgN/L	39.5	39.7	0.2
C-001	Oil and Grease	mg/L	<1	<1	<1
C-003	Oil and Grease	mg/L	<1	<1	<1
C-001	Total Suspended Solids	mg/L	2	1	1
C-003	Total Suspended Solids	mg/L	1	1	0
D-001	Oil and Grease	mg/L	<1	<1	<1
D-006	Oil and Grease	mg/L	<1	1.2	<1.2

TABLE 2-12
NPDES DUPLICATE SAMPLE RESULTS, CONT'D.

THIRD QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
D-001	Total Suspended Solids	mg/L	6	7	1
D-006	Total Suspended Solids	mg/L	3	3	0
A-003	Chromium	mg/L	<0.02	<0.02	<0.02
A-003	Oil and Grease	mg/L	<1	<1	<1
A-003	Total Suspended Solids	mg/L	<1	<1	<1
M-005	1,1,1-Trichloroethylene	µg/L	<2	<2	<2
C-004	Oil and Grease	mg/L	3.9	2.0	1.9
M-005	Tetrachloroethylene	µg/L	<2	<2	<2
C-004	Total Suspended Solids	mg/L	1	3	2
M-005	Trichloroethylene	µg/L	<2	<2	<2
H-16	Biochemical Oxygen Demand	mg/L	3.6	2.2	1.4
H-16	Nickel	mg/L	<0.05	<0.05	<0.05
H-12	Oil and Grease	mg/L	<1	<1	<1
H-12	Sulfate	$mgSO_4/L$	11.1	11.3	0.2
H-12	Total Suspended Solids	mg/L	<1	<1	<1

FOURTH QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
X-014	Biochemical Oxygen Demand	mg/L	<1	<1	<1
F-002	Oil and Grease	mg/L	<1	1.4	<1.4
F-003	Oil and Grease	mg/L	1.8	1.6	0.2
F-005	Oil and Grease	mg/L	<1	1.1	<1.1
F-008	Oil and Grease	mg/L	<1	1.1	<1.1
F-002	Total Suspended Solids	mg/L	<1	<1	<1
F-003	Total Suspended Solids	mg/L	11	9	2
F-005	Total Suspended Solids	mg/L	16	11	5
F-008	Total Suspended Solids	mg/L	5	3	2
A-005	1,1,1-Trichloroethane	µg/L	<2	<2	<2
A-005	Tetrachloroethylene	µg/L	<2	<2	<2
A-005	Trichloroethylene	µg/L	<2	<2	<2
H-002	Oil and Grease	mg/L	<1	<1	<1
H-002	Total Suspended Solids	mg/L	8	5	3
SC-4	Nitrates	mgN/L	0.17	0.18	0.01
SC-4	Phosphates	mgP/L	0.043	0.045	0.002
SC-4	Selenium	mg/L	<0.006	<0.006	<0.006
F-001	Oil and Grease	mg/L	<1	<1	<1
F-001	Total Suspended Solids	mg/L	<1	<1	<1
H-004	Oil and Grease	mg/L	1.0	1.1	0.1
H-008	Oil and Grease	mg/L	<1	1.0	<1
H-004	Total Suspended Solids	mg/L	2	3	1
H-008	Total Suspended Solids	mg/L	2	2	0
D-001	Oil and Grease	mg/L	1.4	1.0	0.4
D-001	Total Suspended Solids	mg/L	7	6	1
K-011	Biochemical Oxygen Demand	mg/L	<1	<1	<1
M-004	Nitrates	mgN/L	42.2	42.2	0
K-011	Oil and Grease	mg/L	<1	<1	<1
L-008	Oil and Grease	mg/L	<1	<1	<1
P-007	Oil and Grease	mg/L	<1	<1	<1
P-013	Oil and Grease	mg/L	<1	<1	<1
SC-4	Chromium	mg/L	<0.02	<0.02	<0.02
K-011	Total Suspended Solids	mg/L	3	1	2

TABLE 2-12
NPDES DUPLICATE SAMPLE RESULTS, CONT'D.

FOURTH QUARTER

NPDES Site	Parameter Sampled	Unit	NPDES Site Result	Duplicate Sample Result	Difference
L-008	Total Suspended Solids	mg/L	1	2	1
M-004	Total Suspended Solids	mg/L	<1	<1	<1
P-007	Total Suspended Solids	mg/L	<1	<1	<1
P-013	Total Suspended Solids	mg/L	1	<1	<1

TABLE 2-13
QUALITY ASSURANCE DATA FOR METALS ANALYSIS ON SPLIT QUARTERLY COMPOSITES

First Quarter

Parameter	TB-5 ETI[a]	TB-5 Carr[b]	L3R-2 ETI[a]	L3R-2 Carr[b]
Aluminum	0.022	<0.5	<0.01	<0.05
Cadmium	<0.01	<0.01	<0.01	<0.01
Calcium	1.59	1.20	8.75	7.27
Chromium	<0.01	<0.05	<0.01	<0.05
Copper	<0.01	<0.05	<0.01	<0.05
Iron	0.112	).16	0.053	0.08
Lead	<0.10	<0.005	<0.10	<0.005
Magnesium	0.419	0.36	0.943	0.880
Manganese	<0.01	<0.05	<0.01	<0.05
Mercury	<0.0002	NA	<0.0002	NA
Nickel	<0.01	<0.05	<0.01	<0.05
Sodium	11.096	11.90	7.791	8.91
Zinc	<0.01	<0.05	<0.01	<0.05

Second Quarter

Parameter	River 10 ETI[a]	River 10 Carr[b]	4MA-7 ETI[a]	4MA-7 Carr[b]
Aluminum	0.067	<0.05	0.111	0.08
Cadmium	<0.01	<0.01	<0.01	<0.01
Calcium	5.552	5.00	3.774	3.40
Chromium	<0.01	<0.05	<0.01	<0.05
Copper	<0.01	<0.05	<0.01	<0.05
Iron	0.147	0.07	0.323	0.41
Lead	<0.10	<0.005	<0.01	<0.0005
Magnesium	1.313	1.38	0.639	0.690
Manganese	<0.01	<0.05	<0.01	<0.05
Mercury	<0.0002	<0.005	<0.0002	<0.0005
Nickel	<0.01	<0.05	<0.01	<0.05
Sodium	13.92	16.0	10.29	11.70
Zinc	<0.01	<0.05	<0.01	<0.05

[a] Environmental Testing, Inc., an independent subcontracted laboratory.
[b] James H. Carr & Associates, Inc., an independent subcontracted laboratory.

TABLE 2-13
QUALITY ASSURANCE DATA FOR METALS ANALYSIS ON SPLIT QUARTERLY COMPOSITES, CONT'D.

Third Quarter

Parameter	River 2		TB-5	
	ETI[a]	Carr[b]	ETI[a]	Carr[b]
Aluminum	0.087	0.08	0.06	9
Cadmium	<0.01	<0.01	<0.01	<0.01
Calcium	6.03	4.92	1.732	1.36
Chromium	<0.01	<0.05	<0.01	<0.05
Copper	<0.01	<0.05	<0.01	<0.05
Iron	0.037	0.14	0.16	0.09
Lead	<0.10	<0.005	<0.01	<0.005
Magnesium	1.175	1.59	0.368	0.49
Manganese	<0.01	<0.05	<0.01	<0.05
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	0.079	<0.05	0.068	<0.05
Zinc	<0.01	<0.05	<0.01	<0.05

Second Quarter

Parameter	U3R-278		PB-3	
	ETI[a]	Carr[b]	ETI[a]	Carr[b]
Aluminum	0.079	0.10	0.12	0.12
Cadmium	<0.01	<0.01	<0.01	<0.01
Calcium	0.639	0.71	5.84	5.24
Chromium	<0.01	<0.05	<0.01	<0.05
Copper	<0.01	<0.05	0.107	0.10
Iron	0.171	0.24	0.308	0.42
Lead	<0.10	<0.005	<0.10	<0.005
Magnesium	0.344	0.36	1.062	1.14
Manganese	<0.01	<0.05	0.016	<0.05
Mercury	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	0.078	<0.05	0.096	<0.05
Sodium	1.286	1.49	7.283	7.04
Zinc	<0.01	<0.05	0.03	<0.05

[a] Environmental Testing, Inc.., an independent subcontracted laboratory.
[b] James H. Carr & Associates, Inc., an independent subcontracted laboratory.

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES

General Engineering Laboratories and metaTRACE, Inc. conduct their own in-house replicates program by analyzing 5% of the samples in replicate. Additionally, for second quarter 1989, General Engineering received original samples and blind replicates for one group of wells and metaTRACE received original samples and blind replicates for a different group of wells. n third and fourth quarters 1989, EDP selected a group of wells which represented approximately 5% of the total samples for the quarter. These samples and blind replicates of these samples were then sent to both laboratories. All of these results are reported by the laboratories and are included in the "Field and Analytical Data" section of this report. The replicate analytical results are used to generate an index for comparison. This index is called the Mean Relation Difference (MRD); it is used along with T-test results to evaluate the laboratory's performance.Consult tables in the "Field and Analytical Data" section for blind replicate data from the following samples.

SECOND QUARTER

Original samples and blind replicates sent to General Engineering laboratory only.

Well	Sample Date	Well	Sample Date	Well	Sample Date
MSB 6A	06/10/89	HSS 2D	06/13/89	SRW 2	06/18/89
MSB 17A	06/10/89	CCB 4	06/17/89	SRW 11	06/18/89
MSB 43A	06/10/89	ARP 4	06/18/89	ASB 7	06/18/89

Original samples and blind replicates sent to metaTRACE laboratory only.

Well	Sample Date	Well	Sample Date	Well	Sample Date
HSB117A	06/11/89	HR3 11	06/13/89	LSB 3	06/17/89
HSB 65C	06/11/89	XSB 3A	06/14/89		
HSB122A	06/11/89	YSB 1A	06/14/89		
HSB134C	06/11/89	DOB 1	06/14/89		
LFW 21	06/13/89	FSB 76A	06/17/89		
LFW 10A	06/13/89	FSB101A	06/17/89		
LFW 34	06/13/89	FSB111C	06/17/89		

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

THIRD QUARTER

Original samples and blind replicates for the following wells were sent to both metaTRACE and General Engineering laboratories third quarter.

Well	Sample Date	Well	Sample Date	Well	Sample Date
ABP 4	08/09/89	HSB 65B	07/23/89	MSB 11C	07/25/89
AMB 5	08/06/89	HSB 85A	07/22/89	MSB 20A	07/25/89
ASB 2A	09/10/89	HSB105C	07/22/89	MSB 26	07/25/89
ASB 8B	08/08/89	HSB121A	07/22/89	MSB 43D	07/30/89
BGO 2D	07/29/89	HSB129D	09/03/89	MSB 35A	07/31/89
BGO 8D	07/29/89	KSS 1D	09/03/89	MSB 67B	08/05/89
BGO 27C	07/22/89	LFW 16	09/08/89	PAC 4	08/02/89

Well	Sample Date	Well	Sample Date	Well	Sample Date
DCB 2A	08/26/89	LFW 31	09/08/89	PSS 2D	09/03/89
FAC 4	08/06/89	LFW 35	09/08/89	RWM 7	08/14/89
FSB 76B	07/22/89	MSB 5A	08/22/89	SRW 12A	08/16/89
FSB 79B	07/22/89	MSB 5A	09/27/89	XSB 4D	09/09/89
FSB 88C	07/22/89	MSB 8A	07/25/89	YSB 2A	09/10/89
FSB 99A	07/22/89				

FOURTH QUARTER

Original samples and blind replicates were sent to both metaTRACE and General Engineering laboratories.

Well	Sample Date	Well	Sample Date	Well	Sample Date
HSB117A	10/17/89	MSB 31B	10/22/89	FNB 1	11/12/89
YSB 4A	12/06/89	HSB134C	10/18/89	MSB 29B	10/25/89
KAC 4	11/15/89	HSB122A	10/07/89	HSB 65C	10/21/89
BGO 27C	10/28/89	FNB 4	11/20/89	FSB 76A	10/10/89
BGO 35C	10/28/89	HSS 2D	11/27/89	FSB101A	10/11/89
BGO 6A	11/04/89	ZBG 1	12/05/89	FSB111C	10/14/89
BGO 11D	11/05/89	TBG 7	12/05/89	MSB 17B	10/17/89
PAC 1	11/12/89	XSB 3A	12/05/89		

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

Certain analytes did not show measurable concentrations above the detection limits at either laboratory. These analytes are not considered in further evaluation of the replicates programs.

In order to assess the measurement precision or reproducibility of identical chemical analyses, an index known as the Mean Relative Difference (MRD) was devised. The MRD index is defined as

$$MRD = \left\{ \sum_{j=1}^{n} \frac{(|X_j - Y_j|)/[(X_j+Y_j)/2])}{n} \right\} 100$$

where X_i and Y_i represent an analyte's concentrations in a water sample and its replicate for the i^{th} well, respectively. This index will be used for both interlaboratory and intralaboratory comparisons. For interlaboratory comparisons, the quantities X_i and Y_i represent the mean analyte concentrations for the i^{th} well, calculated from blind replicate and laboratory duplicate analyses from each laboratory. For intralaboratory comparisons, the quantities X_i and Y_i represent the original result and the lab duplicate rerun, respectively. For intralaboratory blind blank comparisons, X_i and Y_i represent the result for the real sample and the blind duplicate, respectively.

For intralaboratory comparisons, MRD_w is calculated as the average absolute difference between an original sample and its replicate expressed as a percentage of the mean of those two samples. For interlaboratory comparisons, MRD_b is calculated as the average absolute difference between labs for the ith well expressed as a percentage of the mean of both labs. Generally, the closer the original results and their replicate results are to each other, the lower the MRD.

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTERLABORATORY COMPARISONS

The MRD_W indexes for metaTRACE and General Engineering are tabulated below. The MRD_W of each set of lab replicates and the MRD_W of each set of blind replicates can be used for intralaboratory comparison. (# = number of analyses).

	General Engineering				metaTRACE			
	In-house		EMS (Blind)		In-house		EMS (Blind)	
Analyte	#	MRD	#	MRD	#	MRD	#	MRD
Acetone	6	25.93	6	0	0	-	5	15.76
Silver	92	1.00	62	1.104	41	6.93	65	1.32
Aluminum	32	9.66	16	23.62	10	6.03	19	10.03
Gross alpha	83	6.46	59	8.67	65	17.02	63	25.96
Arsenic	91	0.014	63	0	44	2.19	66	5.15
Barium	87	6.32	60	9.46	46	17.71	64	6.28
Butylbenzyl phthalate	11	0	10	0	0	-	5	0
Beryllium	10	0	9	0	4	0	8	22.87
Nonvolatile beta	81	13.38	54	15.18	63	7.82	59	11.96
Bis(2-ethylhexyl) phthalate	12	2.55	10	7.50	0	-	6	32.26
Calcium	66	4.54	46	9.90	44	10.79	50	16.30
Trichlorofluoromethane	69	4.66	45	4.10	0	-	52	0.96
Carbon tetrachloride	78	3.80	48	3.85	0	-	53	0
Cadmium	93	1.07	65	1.31	46	2.44	68	2.10
Chloroform	78	7.06	48	3.85	0	-	53	6.47
Methylene chloride	69	9.18	45	4.10	0	-	52	15.46
Chloride	86	5.25	58	3.84	63	0.968	62	6.04
Chlorobenzene	69	4.30	45	4.10	0	-	52	0
Cobalt	20	0.124	25	0	27	0.244	30	4.76
Specific conductance	87	0.565	58	1.638	63	7.03	61	7.07
Chromium	93	0.395	65	0	45	5.76	67	10.57
Copper	48	6.11	36	15.61	28	7.88	39	4.44
Cyanide	44	0.413	33	0	43	0.010	37	1.41
Chloroethane	69	4.30	45	4.10	0	-	52	0
Benzene	69	4.30	45	4.103	0	-	52	3.62
Diethyl phthalate	11	0	10	0	0	-	6	14.29
Di-n-octyl phthalate	11	0	10	0	0	-	6	33.33
Endrin	34	0	28	0	0	-	28	6.02
Fluoride	69	0.946	51	4.89	56	1.04	55	0
Iron	93	11.80	57	35.90	45	35.04	60	48.06
Mercury	93	1.48	64	9.35	52	4.94	67	2.44
Potassium	64	12.39	46	4.104	44	6.57	50	2.79

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTERLABORATORY COMPARISONS

The MRD_W indexes for metaTRACE and General Engineering are tabulated below. The MRD_W of each set of lab replicates and the MRD_W of each set of blind replicates can be used for intralaboratory comparison. (# = number of analyses).

	General Engineering				metaTRACE			
	In-house		EMS (Blind)		In-house		EMS (Blind)	
Analyte	#	MRD	#	MRD	#	MRD	#	MRD
Lithium	2	0.585	0	-	-	-	-	-
Lindane	28	0	20	0	0	-	16	0
Toluene	69	6.23	45	9.88	0	-	52	1.65
Methoxychlor	24	0	17	0	0	-	16	0
Magnesium	66	4.43	46	11.011	44	8.66	50	5.70
Manganese	94	11.42	59	17.467	47	7.04	63	15.54
Sodium	88	7.66	58	10.198	48	3.69	63	5.89
Nickel	44	1.63	36	3.29	30	12.66	44	2.61
Nitrite as nitrogen	4	3.33	6	0	1	-	4	0
Nitrate as nitrogen	89	8.68	63	8.91	69	6.96	64	6.98
Lead	107	8.09	66	6.04	42	3.37	68	19.93
pH	92	1.03	59	2.75	67	0.570	63	4.49
Phenols	92	1.58	59	3.97	57	4.18	61	4.02
Antimony	16	0	22	0	28	4.67	28	5.54
Selenium	89	0.13	60	0	43	0.211	62	0.703
Silica	64	5.36	46	7.01	-	-	-	-
Silicon	-	-	-	-	43	9.64	50	6.92
Silvex	17	0.36	10	0	0	-	14	4.95
Tin	8	0.99	6	0	4	0	5	4.55
Sulfate	85	1.03	58	0.71	65	1.64	62	9.11
Sulfide	6	0	6	0	8	0.706	5	5.07
Tetrachloroethylene	78	5.60	48	21.07	0	-	53	7.13
Total dissolved solids	64	11.84	45	12.33	53	5.58	48	27.85
Total organic carbon	74	3.80	51	41.3	72	4.25	54	7.66
Total radium	89	27.12	59	17.38	55	8.86	64	7.55
Total organic halogens	94	9.24	55	37.58	52	13.56	55	20.82
Total phosphorus	52	11.72	31	52.02	-	-	-	-
Total phosphates	29	3.71	23	13.36	58	28.52	54	24.52
Trichloroethylene	78	9.81	48	7.25	0	-	53	8.88
Tritium	72	4.04	51	9.31	118	3.02	54	3.28
Turbidity	16	2.55	11	26.59	14	1.64	11	33.70
trans-1,2-Dichloroethene	69	4.59	45	4.10	0	-	47	0.203
Vanadium	15	0	21	0	27	1.63	27	4.76
1,1-Dichloroethylene	69	4.95	45	7.07	0	-	52	3.92
1,1-Dichloroethane	69	3.34	45	4.10	0	-	52	0
1,1,1-Trichloroethane	78	6.82	48	8.68	0	-	53	0.057
1,1,2-Trichloroethane	69	4.74	45	4.10	0	-	52	0
1,2-Dichloroethane	69	4.30	45	4.10	0	-	52	0
cis-1,3-Dichloropropene	69	4.30	45	4.100	-	52	0	
Zinc	43	10.74	35	32.67	28	23.44	38	55.75

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTERLABORATORY COMPARISONS

Choosing a Reference Detection Limit

For interlaboratory comparisons, it is necessary to establish a reference detection limit (RDL) for calculation of the MRD. The RDL is chosen from the detection limits in the analytical data from both laboratories. Since some detection limits may be anomalously high (due to dilution or other effects), the RDL for the laboratories is chosen as the value which is greater than or equal to at least 90% of the results from both laboratories.

Normalizing Data to the RDL

All of the results less than the RDL are adjusted to the new RDL value. By definition, less than ten percent of the analyses may be above the RDL. Results that are detection limit values and above the RDL are eliminated from the MRD index comparison process and from the T-tests.

In addition to the MRD_b calculations, paired T-tests (Steel and Torrie, 1980) were performed to see if the analyte concentrations at the same well reported by each lab is significantly different. The MRD_b and T-test results for a comparison of the two laboratories for the analytes with at least one result above the RDL are listed below. The T-test is a valuable tool to test the null hypothesis that there is no significant difference in the concentrations given by the two labs.

Analyte	MRD_b	Significance of Probability[a]
Acetone	9.81	0.374
Silver	0	-
Aluminum	22.57	0.050
Gross alpha	33.60	0.009
Arsenic	2.73	0.022
Barium	3.92	0.937
Butylbenzyl phthalate	0	-
Beryllium	11.67	0.351
Nonvolatile beta	27.97	0.292
Bis(2-ethylhexyl) phthalate	43.81	0.460
Calcium	19.09	0.006
Trichlorofluoromethane	0	-
Carbon tetrachloride	0.643	0.321
Cadmium	1.65	0.323
Chloroform	5.00	0.321
Methylene chloride	6.51	0.238
Chloride	8.79	1.00
Chlorobenzene	0	-
Cobalt	4.21	0.678
Specific conductance	11.84	0.050
Chromium	2.81	0.151
Copper	3.21	0.867
Cyanide	0.506	0.325
Chloroethane	0	-
Benzene	3.65	0.323
Diethyl phthalate	0	-

[a] This number represents the probability that the two laboratories, on the average, reported different concentration measurements for the same analyte at the same well. Values <0.05 indicate significant difference between the labs at the 95% confidence interval.

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

Analyte	MRD[b]	Significance of Probability[a]
Di-n-octyl phthalate	0	-
Endrin	0	-
Fluoride	0.158	0.253
Iron	58.82	0.996
Mercury	12.19	0.237
Potassium	3.91	0.323
Lindane	0	-
Toluene	0.329	0.323
Methoxychlor	0	-
Magnesium	9.87	0.521
Manganese	13.91	0.120
Sodium	0.31	0.321
Nickel	2.49	0.813
Nitrite as nitrogen	0	-
Nitrate as nitrogen	23.24	0.009
Lead	16.90	0.001
pH	8.87	0.0004
Phenols	2.03	0.162
Antimony	9.48	0.329
Selenium	0.299	0.321
Silvex	16.67	0.347
Tin	48.24	0.391
Sulfate	8.85	0.181
Sulfide	14.87	0.183
Tetrachloroethylene	12.78	0.234
Total dissolved solids	40.01	0.002
Total organic carbon	50.77	0.002
Total radium	16.60	0.950
Total organic halogens	50.97	0.162
Total phosphates	22.69	0.949
Trichloroethylene	14.91	0.608
Tritium	19.86	0.001
Turbidity	83.95	0.142
trans-1,2-Dichloroethene	1.73	0.323
Vanadium	0.208	0.330
1,1-Dichloroethylene	3.59	0.950
1,1-Dichloroethane	0.741	0.323
1,1,1-Trichloroethane	0.967	0.464
1,1,2-Trichloroethane	2.136	0.323
1,2-Dichloroethane	0	-
cis-1,3-Dichloropropene	0	-
Zinc	54.43	0.0001

[a] This number represents the probability that the two laboratories, on the average, reported different concentration measurements for the same analyte at the same well. Values <0.05 indicate significant difference between the labs at the 95% confidence interval.

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTRALABORATORY COMPARISON

For some analytes, the MRD for in-house duplication is significantly different than the corresponding MRD for EMS Blind Blanks. This reflects the differences in reproducibility between lab duplicates and blind replicates with the former having better reproducibility. The decreased reproducibility of the blind replicates reflects variability introduced by sampling, transport, sample preparation, and/or analysis. In-house duplicate variations reflect variability in analysis.

General Engineering

Analytes with significant differences between in-house MRD and Blind MRD for General Engineering include the following: acetone, aluminum, iron, tetrachloroethylene, total organic carbon, total organic halogens, total phosphorous, turbidity, and zinc.

The following wells had very different results for blind duplicates as compared to results from regular samples. These differences contribute to the high MRD value.

Analyte	Well	Sample date
Acetone	ASB 6A	11/15/89
Aluminum	HSB 65B	07/23/89
	MSB	07/25/89
Iron	AMB 5	08/06/89
	ARP 4	06/18/89
	FNB 4	11/20/89
	FSB 88C	07/22/89
	HSB117A	10/17/89
	LFW 31	09/08/89
	MSB 6A	06/10/89
	MSB 8A	07/25/89
	PSS 2D	09/03/89
	YSB 2A	09/10/89
Tetrachloroethylene	MSB 17A	06/10/89
	MSB 31B	10/22/89
Total organic carbon	KRP 2	06/17/89
	PAC 1	11/12/89
	YSB 4A	12/06/89
Total organic halogens	ABP 4	08/09/89
	FAC 4	08/06/89
	HSB 65C	10/21/89
	MSB 17B	10/17/89
	MSB 31B	10/22/89

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTRALABORATORY COMPARISON
General Engineers

Analyte	Well	Sample date
Total phosphorous	AMB 5	08/06/89
	ARP 4	06/18/89
	BGO 8D	07/29/89
	FSB 88C	07/22/89
	HSB 65B	07/23/89
	MSB 6A	06/10/89
	MSB 17A	06/10/89
	MSB 20A	07/25/89
Turbidity	BGO 2D	07/29/89
	HSB 85A	07/22/89
Zinc	BGO 6A	11/04/89
	FNB 4	11/20/89
	MSB 5A	08/22/89
	MSB 8A	07/25/89

Some analytes have a high MRD for blind replicates as well as in-house replicates. These include nonvolatile beta, manganese, and total radium. The following samples have very different original results as compared to lab duplicate results which contributes to the high in-house MRD.

Analyte	Well	Sample
Nonvolatile beta	ACB 1A	04/05/89
	FTF 7	08/10/89
	MSB 10A	04/08/89
Manganese	ABP 1A	04/02/89
	CSA 2	04/09/89
	CSA 3	04/09/89
	CSA 4	04/09/89
	HWS 2	04/12/89
	HXB 1	04/12/89
	HXB 3	04/12/89
	LRP 1	04/09/89
	LRP 3	04/09/89
	LRP 4	04/09/89
	MSB 10B	04/08/89
	MSB 11A	04/08/89
	MSB 11B	04/08/89
	MSB 11C	04/08/89
	MSB 11D	04/08/89
	MSB 11F	04/08/89
	MSB 18A	04/08/89
	MSB 18B	04/08/89
	MSB 18C	04/08/89
	PAC 1	04/11/89
	PAC 2	04/11/89
	PAC 3	04/11/89
	PAC 4	04/11/89

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTRALABORATORY COMPARISON
General Engineers

Analyte	Well	Sample date
Manganese	PAC 6	04/11/89
	RAC 1	04/11/89
	RAC 2	04/11/89
	RAC 3	04/11/89
	RAC 4	04/11/89
	RRP 1	04/11/89
	RRP 2	04/11/89
	RRP 3	04/11/89
Total radium	KCB 3	05/06/89
	MSB 12C	07/12/89
	PAC 6	04/11/89

The blind replicate high MRD values for nonvolatile beta and total radium are caused by the low magnitude of the results; since small differences are a large percentage of the average of the two analyses, the MRD is elevated. The blind replicate high MRD for manganese reflects variable results for samples from well FSB 101A (sample date 10/11/89).

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTRALABORATORY COMPARISON

For some analytes, the MRD for in-house duplication is significantly different than the corresponding MRD for EMS Blind Blanks. This reflects the differences in reproducibility between lab duplicates and blind replicates with the former having better reproducibility. The decreased reproducibility of the blind replicates reflects variability introduced by sampling, transport, sample preparation, and/or analysis. In-house duplicate variations reflect variability in analysis.

metaTRACE, Inc.

For metaTRACE, in-house and/or blind replicate MRDs are significantly elevated for the following analytes: acetone, gross alpha, barium, beryllium, bis(2-ethylhexyl) phthalate, calcium, methylene chloride, di-n-octyl phthalate, iron, manganese, lead, total dissolved solids, total organic halogens, total phosphates, turbidity, and zinc.

The following results for metaTRACE blind replicates were significantly different than results from regular samples. These differences contribute to a blind replicate high MRD for the lab.

Analyte	Well	Sample
Acetone	YSB 4A	12/06/89
Beryllium	MSB 5A	09/27/89
bis(2-ethylhexyl) phthalate	HSB115C	04/12/89
	YSB 4A	12/06/89
Calcium	BGO 8D	07/29/89
	BGO 11D	11/05/89
	FAC 4	08/06/89
	FSB 88C	07/22/89
	PAC 1	11/12/89
	PSS 2D	09/03/89
Methylene chloride	MSB 31B	10/22/89
Iron	ASB 8B	08/08/89
	BGO 2D	07/29/89
	BGO 11D	11/05/89
	BGO 35C	10/28/89
	FSB 76A	10/10/89
	FSB111C	10/14/89
	HSB105C	07/22/89
	HSB134C	10/18/89
	KSS 1D	09/03/89
	PAC 1	11/12/89
Lead	FSB 76A	10/10/89
Total dissolved solids	AMB 5	08/06/89
	BGO 7D	06/11/89
	BGO 11D	06/11/89
	BGO 11D	11/05/89
	BGO 27C	07/22/89
	BGO 35C	10/28/89
	HSB 65C	06/11/89
	HSB 65C	10/21/89
	HSB117A	06/11/89

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTRALABORATORY COMPARISON
metaTRACE, Inc.

Analyte	Well	Sample
Total organic halogens	BGO 6A	11/04/89
	LFW 21	06/13/89
Total phosphates	BGO 27C	07/22/89
	DOB 1	06/14/89
	MSB 20A	07/25/89
Turbidity	PAC 4	08/02/89
Zinc	BGO 6A	11/04/89
	BGO 11D	11/05/89
	FNB 1	11/12/89
	FNB 4	11/20/89
	HSB117A	10/17/89
	HSB134C	10/18/89
	YSB 4A	12/06/89

Blind replicate high MRD values for gross alpha, methylene chloride, total organic halogens, turbidity, and di-n-octyl phthalate are primarily due to the low magnitude of the results.

In-house duplicate high MRD values for gross alpha, barium, iron, total phosphates, and zinc are caused by variable results for samples from the following wells.

Analyte	Well	Sample date
Gross alpha	FSB 91D	07/02/89
	FSB 92D	07/02/89
	FTF 7	08/10/89
	FTF 27	05/13/89
	TBG 3	06/14/89
	TBG 4	06/13/89
Barium	BGO 16A	11/15/89
	FSB111C	07/08/89
	HSB135C	07/15/89
Iron	BGO 8A	07/30/89
	BGO 26A	07/23/89
	HSB 68	05/31/89
	HSB 86A	07/11/89
	HSB110D	07/02/89
	LFW 34	06/13/89
Total phosphates	BGO 10A	07/30/89
	BGO 16A	07/26/89
	HSB122A	07/05/89
	HSB135D	04/11/89
	HSB136C	07/18/89
	NBG 1	05/14/89
Zinc	BGO 9D	11/07/89
	HSB110D	07/02/89

TABLE 2-14
REPLICATE ANALYSES OF GROUNDWATER SAMPLES,CONT'D

INTERLABORATORY COMPARISON

The interlaboratory MRD reflects variability in sample results which may be introduced by sampling, shipping, sample preparation, or analysis. High MRD for aluminum, gross alpha, beryllium, nonvolatile beta, calcium, iron, nitrate, antimony, total dissolved solids, total organic carbon, total organic halogens, turbidity, and zinc show that for these analytes interlaboratory differences are significant.

Other artificially inflated MRD values are due to the concentrations of the analytes which are near the lower limits of detection.

TABLE 2-15
INTERLABORATORY QUALITY ASSESSMENT PROGRAM, TEST #1

Parameter	Units	Theoretical Value	Acceptance Range	NAI[a] Result	ETI[b] Result
Nonmetals Analysis					
pH	mg/L	9.1	8.9 - 9.3	8.94	
Conductivity	μmohs/cm	1,430.0	1,290 -1,570	1,470	
Alkalinity	mg/L			152	
Chlorine	mg/L			246	
Biochemical Oxygen Demand	mg/L	36.0	27 - 45	26.7	32.9
Cyanide	mg/L	0.057	0.046 - 0.068	0.056	
Chemical Oxygen Demand	mg/L	60.0	50 - 70	53.2	
Total Phosphorus	mg/L	6.0	4.9 - 7.1	5.76	6.7
Nitrate	mg/L	3.8	3.4 - 4.2	4.12	4.01
Ammonia	mg/L	9.1	7.9 - 10.3	9.32	
Total Nonfilterable Residue	mg/L				
Sulfate	mg/L	147.0	132 - 162	143	144
Suspended Solids	mg/L	96.0	80 - 112	62	
Calcium	mg/L	79.0	63 - 95	75.2	
Hardness as CaCO3	mg/L	273	246 - 300	296	
Dissolved Solids	mg/L	1,070.0	960 -1,180	762	
Total Kjeldahl	mg/L	2.6	2.1 - 3.1	2.41	2.50
P-Phosphate	mg/L	2.9	2.6 - 3.2	2.89	
Phenol	mg/L	0.080	0.56 - 0.104	0.083	
Metals Analysis					
Aluminum	μg/L	300	225 -375	331	347
Arsenic	μg/L	86.1	64 -108	74	
Barium	μg/L	278	208 -348	298	
Beryllium	μg/L	51.8	38 - 65	52	
Boron	μg/L	178	133 -222	182	
Cadium	μg/L	79.4	60 - 99	86.3	76
Chromium	μg/L	162	121 -202	184	161
Copper	μg/L	73	55 - 91	76.3	74
Iron	μg/L	280	210 -350	291	256
Lead	μg/L	172	129 -215	182	176
Mercury	μg/L	6.4	4.8 - 8.0	6.34	7.1
Magnesium		30	24 - 36	26.4	
Manganese	μg/L	123	92 -154	133	106
Nickel	μg/L	145	108 -181	150	131
Selenium	μg/L				
Silver	μg/L				
Zinc	μg/L	227	170 -284	232	208

[a] Normandeau Associates, Inc., an independent subcontracted laboratory.
[b] Environmental Testing, Inc., an independent subcontracted laboratory.

TABLE 2-15
INTERLABORATORY QUALITY ASSESSMENT PROGRAM, TEST #1, CONT'D.

Parameter	Units	Theoretical Value	Acceptance Range	NAI[a] Result	ETI[b] Result
Organics					
Chloroform	µg/L	18.3	12 - 23	16	
Bromodichlor-methane	µg/L	37.9	25 - 50	40	
Chlorodibromo-methane	µg/L	15.1	11 - 19	15.9	
Bromoform	µg/L	29.0	19 - 38	36.9	
Total Organic Carbon	mg/L	23.0	18 - 28	22	21.2
Oil & Grease	mg/L	49.0	39 - 59	42.1	37.5
Volatiles					
1,1,1-Trichloroethane	µg/L	7.36	3.8 - 11	8.51	8.64
Trichloroethene	µg/L	4.37	3.1 - 6.0	5.61	
Benzene	µg/L	10.2	3.8 - 13	12.8	
Carbon Tetrachloride	µg/L	6.41	4.5 - 7.5	8.64	
Pesticides					
Aldrin	µg/L	0.865	0.38 - 1.1	0.773	
Alpha-BHC	µg/L	1.29	0.47 - 1.7	1.434	
Endrin	µg/L	0.075	0.023 - 0.11	0.103	0.59
Endrin Aldehyde	µg/L	0.31	0.11 - 0.45	0.363	

[a] Normandeau Associates, Inc., an independent subcontracted laboratory.
[b] Environmental Testing, Inc., an independent subcontracted laboratory.

TABLE 2-16
INTERLABORATORY QUALITY ASSESSMENT PROGRAM, TEST #2

Parameter	Units	Theoretical Value	Acceptance Range	Carr[a] Result	NAI[b] Result	ETI[c] Result
Nonmetals Analysis						
pH	pH	9.0	8.8 - 9.2	NA	9.12	NA
Conductivity	µmohs/cm	1,940	1,750 -2,130	NA	1,660	NA
Alkalinity	mg/L	215	200 - 230	NA	200	NA
Chloride	mg/L	369	343 - 395	NA	367	NA
Biochemical Oxygen Demand	mg/L	62	46 - 78	66.2	36.3	58.2
Cyanide	mg/L	0.140	0.112 - 0.168	0.134	0.138	NA
Chemical Oxygen Demand	mg/L	103	86 - 120	88	88.7	NA
Total Phosphorus	mg/L	7.1	5.8 - 8.4	6.5	6.82	6.98
Nitrate	mg/L	5.6	5.0 - 6.2	NA	5.89	6.0
Ammonia	mg/L	5.3	4.6 - 6.0	NA	4.87	NA
Oil & Grease	mg/L	37	29 - 45	28.5	31.9	29
Total Organic Carbon	mg/L	40	31 - 49	41	37.5	37.72
Phenol	mg/L	0.265	0.185 - 0.345	0.259	0.224	NA
Dissolved solids	mg/L	1,540	1,390 -1,690	NA	1,490	NA
Total Kjeldahl nitrogen	mg/L	4.6	3.7 - 5.5	4.9	4.42	6.24
Sulfate	mg/L	219	197 - 241	NA	367	NA
Suspended Solids	mg/L	64	46 - 82	NA	78	77.6
Calcium	mg/L	74	59 - 89	NA	67.3	75.3
Magnesium	mg/L	27	22 - 32	NA	24.8	21.44
Hardness as $CaCO_3$	mg/L	296	266 - 326	NA	270	276.13
Metals Analysis						
Aluminum	µg/L	112	84 - 140	120	124	133
Arsenic	µg/L	43.6	33 - 54	44.4	41.4	NA
Barium	µg/L	117	88 - 146	110	114	NA
Beryllium	µg/L	37.6	28 - 47	39.1	24.6	NA
Boron	µg/L	167	125 - 209	220	192	NA
Cadmium	µg/L	230	172 - 288	220	231	231
Chromium	µg/L	172	129 - 215	170	172	171
Copper	µg/L	200	150 - 250	190	196	198
Iron	µg/L	152	114 - 190	150	144	135
Lead	µg/L	160	121 - 200	152	155	141
Manganese	µg/L	210	158 - 262	200	205	500
Mercury	µg/L	3.4	2.6 - 4.2	3.17	3.49	3.4
Nickel	µg/L	74.1	56 - 93	65	60.3	71
Zinc	µg/L	260	195 - 325	210	213	213

[a] James H. Carr & Associates, Inc., an independent subcontract laboratory.
[b] Normandeau Associates, Inc., an independent subcontract laboratory.
[c] Environmental Testing, Inc., an independent subcontract laboratory.

TABLE 2-16
INTERLABORATORY QUALITY ASSESSMENT PROGRAM, TEST #2, CONT'D.

Parameter	Units	Theoretical Value	Acceptance Range	Carr[a] Result	NAI[b] Result	ETI[c] Result
Pesticides						
Aldrin	µg/L	0.865	0.38 - 1.1	NA	0.890	NA
Alpha-BHC	µg/L	1.29	0.47 - 1.7	NA	1.43	NA
Endrin	µg/L	0.075	0.023 - 0.11	NA	0.081	0.16
Endrin Aldehyde	µg/L	0.310	0.11 - 0.45	NA	0.360	NA
Halomethanes						
Chloroform	µg/L	18.3	12 - 23	NA	17.8	NA
Bromo-dichlormethane	µg/L	37.9	25 - 50	NA	41.8	NA
Chloro-dibromomethane	µg/L	15.1	11 - 19	NA	17.2	NA
Bromoform	µg/L	29.0	19 - 38	NA	32.0	NA
Volatiles						
1,1,1 -trichloroethene	µg/L	7.36	3.8 - 11	NA	10.4	4.10
Trichloroethene	µg/L	4.37	3.1 - 6.0	NA	7.33	7.27
Benzene	µg/L	10.2	3.8 - 13	NA	11.0	NA
Carbon tetrachloride	µg/L	6.41	4.5 - 7.5	NA	9.08	NA

[a] James H. Carr & Associates, Inc., an independent subcontract laboratory.
[b] Normandeau Associates, Inc., an independent subcontract laboratory.
[c] Environmental Testing, Inc., an independent subcontract laboratory.

Chapter 3

Methods for Calculating Offsite Radiation Dose

TABLE 3-1
PARAMETERS FOR LIQUID AND ATMOSPHERIC DOSE CALCULATIONS

Pathway	Atmospheric: Average Individual Adult	Atmospheric: Maximum Individual Adult
Fruits, vegetables, and grains (kg/yr)	190	520
Leafy vegetables (kg/yr)	30	64
Milk (L/yr)	110	310
Meat and poultry (kg/yr)	95	110
Inhalation (m^3/yr)	8,000	8,000
External exposure transmission factor	0.5	0.7

Pathway	Liquid: Average Individual Adult	Liquid: Maximum Individual Adult
Water consumption (L/yr)	370	370(730)[a]
Fish consumption (kg/yr)[b]	11.3	34
Other seafood (kg/yr)[b]	1.0	5
Boating (person-hr)[c]	232,000	
Boating (hr/yr)[b]		60
Swimming (person-hr)[c]	1,080	
Swimming (hr/yr)[b]		10
Shoreline recreation (man-hr)[c]	108,400	
Shoreline recreation (hr/yr)[b]		20

[a] Value shown in parentheses are those used to calculate dose from maximized water consumption by Beaufort-Jasper and Port Wentworth water treatment plant customers.

[b] Values determined by SRL for the Savannah River.

[c] For collective dose calculations. Values developed by SRL were used for the Savannah River.

TABLE 3-2
METEOROLOGICAL DATA FOR 1982 - 1986

USNRC COMPUTER CODE - XOQDOQ, VERSION 2.0 RUN DATA: 87.072 (SRL 6/29/83 VERSION)
38193 WIND STATS H-AREA 60 MIN 62M 82-86 STABILITY FROM SIGMA A

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS A

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.372	0.317	0.356	0.372	0.361	0.249	0.275	0.275	0.296	0.306	0.351	0.374	0.382	0.388	0.335	0.291	5.299
4.00	0.450	0.589	0.751	0.783	0.728	0.573	0.482	0.495	0.521	0.636	0.780	1.008	0.825	0.683	0.466	0.382	10.154
6.00	0.105	0.094	0.126	0.181	0.128	0.136	0.071	0.099	0.110	0.162	0.217	0.241	0.249	0.160	0.134	0.097	2.309
8.00	0.008	0.010	0.003	0.008	0.008	0.003	0.008	0.016	0.013	0.008	0.026	0.010	0.029	0.013	0.018	0.016	0.196
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.003	0.010	0.003	0.000	0.005	0.005	0.000	0.003	0.034
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.008
TOTAL	0.93	1.01	1.24	1.34	1.23	0.96	0.84	0.89	0.94	1.12	1.38	1.64	1.49	1.25	0.95	0.79	18.00

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS B

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.055	0.071	0.065	0.094	0.055	0.055	0.058	0.050	0.058	0.097	0.073	0.092	0.094	0.081	0.079	0.073	1.149
4.00	0.178	0.291	0.390	0.450	0.312	0.272	0.230	0.199	0.325	0.278	0.414	0.602	0.419	0.330	0.189	0.141	5.019
6.00	0.115	0.162	0.330	0.278	0.152	0.128	0.102	0.073	0.170	0.217	0.278	0.422	0.377	0.233	0.110	0.086	3.234
8.00	0.016	0.000	0.018	0.010	0.003	0.010	0.010	0.010	0.024	0.026	0.047	0.034	0.097	0.084	0.071	0.016	0.477
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.003	0.013	0.013	0.008	0.010	0.055
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.36	0.52	0.80	0.83	0.52	0.47	0.40	0.33	0.58	0.63	0.81	1.15	1.00	0.74	0.46	0.33	9.93

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS C

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.073	0.076	0.113	0.162	0.065	0.050	0.052	0.055	0.063	0.102	0.126	0.123	0.115	0.144	0.071	0.063	1.453
4.00	0.285	0.539	0.817	0.791	0.479	0.374	0.319	0.356	0.429	0.474	0.597	0.681	0.566	0.458	0.319	0.202	7.687
6.00	0.173	0.471	0.966	0.542	0.306	0.241	0.225	0.223	0.388	0.537	0.490	0.649	0.566	0.424	0.244	0.144	6.588
8.00	0.050	0.079	0.207	0.052	0.037	0.031	0.037	0.034	0.079	0.170	0.157	0.204	0.319	0.275	0.084	0.092	1.906
12.00	0.003	0.003	0.005	0.003	0.000	0.000	0.008	0.010	0.016	0.016	0.018	0.081	0.110	0.126	0.024	0.021	0.442
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.003
TOTAL	0.58	1.17	2.11	1.55	0.89	0.70	0.64	0.68	0.97	1.30	1.39	1.74	1.68	1.43	0.74	0.52	18.08

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS D

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.068	0.071	0.086	0.063	0.060	0.045	0.031	0.063	0.079	0.089	0.079	0.102	0.183	0.102	0.060	0.047	1.228
4.00	0.380	0.631	1.136	0.940	0.717	0.600	0.513	0.683	0.712	0.717	0.728	0.723	0.751	0.626	0.361	0.322	10.541
6.00	0.304	0.741	1.351	0.785	0.547	0.505	0.644	0.869	0.945	0.859	0.780	0.861	0.961	1.089	0.442	0.244	11.929
8.00	0.110	0.178	0.278	0.123	0.050	0.139	0.186	0.249	0.317	0.270	0.207	0.267	0.432	0.364	0.152	0.065	3.385
12.00	0.031	0.031	0.042	0.000	0.005	0.013	0.058	0.050	0.029	0.050	0.071	0.115	0.202	0.165	0.034	0.013	0.909
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.003	0.000	0.000	0.008
TOTAL	0.89	1.65	2.89	1.91	1.38	1.30	1.43	1.91	2.08	1.99	1.86	2.07	2.53	2.35	1.05	0.69	28.00

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS E

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.031	0.026	0.050	0.037	0.021	0.037	0.042	0.068	0.047	0.047	0.050	0.050	0.063	0.050	0.042	0.050	0.710
4.00	0.262	0.333	0.503	0.469	0.442	0.437	0.495	0.634	0.529	0.442	0.463	0.372	0.461	0.327	0.304	0.191	6.664
6.00	0.372	0.655	1.089	0.851	0.702	0.552	0.833	1.066	1.060	0.940	1.050	0.827	0.751	0.702	0.385	0.223	12.057
8.00	0.029	0.052	0.058	0.063	0.071	0.055	0.029	0.060	0.141	0.120	0.123	0.152	0.081	0.039	0.018	0.018	1.110
12.00	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.008
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.69	1.07	1.70	1.42	1.24	1.09	1.40	1.83	1.78	1.55	1.69	1.40	1.36	1.12	0.75	0.48	20.55

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS F

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.003	0.008	0.008	0.000	0.003	0.003	0.005	0.042	0.013	0.024	0.010	0.005	0.005	0.003	0.010	0.013	0.154
4.00	0.037	0.063	0.084	0.052	0.050	0.089	0.071	0.126	0.086	0.097	0.073	0.052	0.034	0.045	0.016	0.045	1.019
6.00	0.194	0.372	0.374	0.317	0.204	0.173	0.144	0.293	0.275	0.259	0.301	0.275	0.131	0.063	0.063	0.071	3.508
8.00	0.005	0.037	0.042	0.063	0.058	0.037	0.016	0.031	0.055	0.037	0.034	0.042	0.024	0.008	0.000	0.003	0.490
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.24	0.48	0.51	0.43	0.31	0.30	0.24	0.49	0.43	0.42	0.42	0.37	0.19	0.12	0.09	0.13	5.17

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS G

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.005	0.016	0.000	0.003	0.010	0.000	0.005	0.013	0.005	0.005	0.005	0.000	0.000	0.000	0.005	0.073
4.00	0.008	0.000	0.003	0.000	0.003	0.003	0.003	0.000	0.005	0.000	0.000	0.003	0.003	0.000	0.000	0.003	0.031
6.00	0.000	0.034	0.029	0.008	0.008	0.005	0.008	0.013	0.003	0.008	0.010	0.005	0.005	0.000	0.000	0.000	0.136
8.00	0.000	0.003	0.003	0.005	0.003	0.003	0.000	0.003	0.000	0.000	0.005	0.003	0.000	0.000	0.000	0.000	0.026
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.01	0.04	0.05	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.00	0.00	0.001	0.27

TABLE 3-3
50-MILE-RADIUS (80 KM) POPULATION DISTRIBUTION AROUND SRS

Site Population Data

Dir(miles)	0.0-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.0	1.000E+00	3.689E+03	8.272E+03	4.836E+03	1.261E+04	2.941E+04
NNE	0.0	2.000E+00	6.880E+02	1.521E+03	3.794E+03	9.094E+03	1.510E+04
NE	0.0	0.0	4.355E+03	2.790E+03	4.797E+03	9.300E+03	2.124E+04
ENE	0.0	2.000E+00	1.125E+03	5.798E+03	5.096E+03	4.009E+04	5.211E+04
E	0.0	1.000E+00	7.572E+03	6.334E+03	7.831E+03	4.792E+03	2.653E+04
ESE	0.0	3.500E+01	1.665E+03	1.946E+03	2.366E+03	2.463E+03	8.475E+03
SE	0.0	4.400E+01	6.500E+02	5.709E+03	5.723E+03	7.559E+03	1.969E+04
SSE	0.0	4.200E+01	4.130E+02	1.072E+03	1.071E+03	3.288E+03	5.886E+03
S	0.0	4.000E+00	5.040E+02	1.337E+03	6.682E+03	3.387E+03	1.191E+04
SSW	0.0	0.0	1.066E+03	2.139E+03	6.143E+03	2.925E+03	1.227E+04
SW	0.0	0.0	9.270E+02	1.855E+03	2.031E+03	2.735E+03	7.548E+03
WSW	0.0	0.0	8.710E+02	7.273E+03	1.480E+03	7.775E+03	1.740E+04
W	0.0	6.000E+01	6.440E+02	7.705E+03	2.534E+03	7.138E+03	1.808E+04
WNW	0.0	2.690E+02	2.220E+03	1.029E+05	3.444E+04	9.105E+03	1.490E+05
NW	0.0	9.700E+01	5.676E+03	8.846E+04	1.487E+04	1.580E+03	1.107E+05
NNW	0.0	2.610E+02	9.546E+03	2.708E+04	6.341E+03	6.636E+03	4.987E+04
TOTAL	0.0	8.180E+02	4.161E+04	2.722E+05	1.100E+05	1.305E+05	5.551E+05

DENSITY (/M**2) = 2.87E-05

TABLE 3-4
50-MILE-RADIUS (80 KM) MILK, MEAT, AND VEGETATION PRODUCTION

50-Mile-Radius (80 km) Milk Production Around SRS

Site Annual Milk Production, (L)

Dir (miles)	0.0-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.0	1.639E+04	1.032E+05	1.720E+05	1.410E+06	5.574E+06	7.276E+06
NNE	0.0	1.306E+04	1.032E+05	1.720E+05	3.676E+05	6.061E+05	1.262E+06
NE	0.0	5.732E+03	1.217E+05	1.325E+06	2.147E+06	1.388E+06	4.987E+06
ENE	0.0	1.577E+03	1.802E+05	1.918E+06	4.823E+06	5.458E+06	1.238E+07
E	0.0	1.848E+03	1.802E+05	1.739E+06	4.145E+06	5.755E+06	1.182E+07
ESE	0.0	4.507E+01	1.802E+05	9.313E+05	2.839E+06	1.459E+06	5.410E+06
SE	0.0	0.0	1.212E+05	4.516E+04	1.803E+05	3.996E+05	7.463E+05
SSE	0.0	0.0	9.384E+04	2.406E+05	3.521E+05	5.643E+05	1.251E+06
S	0.0	0.0	3.305E+05	5.740E+05	7.696E+05	9.972E+05	2.671E+06
SSW	0.0	0.0	3.582E+05	1.890E+06	6.404E+06	7.609E+06	1.626E+07
SW	0.0	7.653E+03	3.871E+05	6.711E+05	3.070E+06	2.835E+06	6.971E+06
WSW	0.0	2.467E+03	3.528E+05	6.678E+05	1.050E+06	2.398E+06	4.471E+06
W	0.0	1.161E+04	1.813E+05	3.788E+05	1.009E+06	1.744E+06	3.355E+06
WNW	0.0	1.381E+04	1.793E+05	3.456E+05	6.128E+05	8.552E+05	2.007E+06
NW	0.0	1.745E+04	1.032E+05	4.236E+05	1.160E+06	7.811E+05	2.485E+06
NNW	0.0	1.794E+04	1.032E+05	2.949E+05	1.481E+06	3.140E+06	5.037E+06
TOTAL	0.0	1.096E+05	3.079E+06	1.179E+07	3.182E+07	4.159E+07	8.839E+07

DENSITY (/M**2) = 4.42E-03

50-Mile-Radius (80 km) Meat Production Around SRS

Site Annual Meat Production, (kg)

Dir (miles)	0.0-5.	5.-10.	10.-20	20.-30.	30.-40.	40.-50.	TOTAL
N	0.0	8.321E+04	5.240E+05	8.733E+05	1.414E+06	3.154E+06	6.049E+06
NNE	0.0	6.630E+04	5.240E+05	8.733E+05	2.286E+06	4.059E+06	7.809E+06
NE	0.0	2.374E+04	4.707E+05	7.797E+05	1.707E+06	3.013E+06	5.994E+06
ENE	0.0	2.645E+03	3.022E+05	5.502E+05	8.868E+05	1.058E+06	2.800E+06
E	0.0	3.099E+03	3.022E+05	4.743E+05	6.889E+05	1.034E+06	2.502E+06
ESE	0.0	7.558E+01	3.022E+05	4.657E+05	6.140E+05	7.099E+05	2.092E+06
SE	0.0	0.0	2.740E+05	3.819E+05	6.559E+05	1.002E+06	2.314E+06
SSE	0.0	0.0	2.349E+05	4.352E+05	6.192E+05	9.877E+05	2.277E+06
S	0.0	0.0	1.753E+05	4.583E+05	7.318E+05	1.020E+06	2.385E+06
SSW	0.0	0.0	1.568E+05	3.930E+05	1.131E+06	1.581E+06	3.262E+06
SW	0.0	2.289E+03	1.332E+05	2.007E+05	5.756E+05	7.566E+05	1.668E+06
WSW	0.0	1.060E+04	1.747E+05	1.998E+05	3.093E+05	6.652E+05	1.360E+06
W	0.0	5.897E+04	1.657E+05	1.189E+05	2.907E+05	5.110E+05	1.145E+06
WNW	0.0	7.010E+04	1.749E+05	1.089E+05	1.763E+05	2.448E+05	7.750E+05
NW	0.0	8.858E+04	5.240E+05	6.984E+05	5.833E+05	7.014E+05	2.596E+06
NNW	0.0	9.107E+04	5.240E+05	8.197E+05	7.138E+05	1.450E+06	3.599E+06
TOTAL	0.0	5.007E+05	4.963E+06	7.831E+06	1.338E+07	2.195E+07	4.863E+07

DENSITY (/M**2) = 2.43E-03

TABLE 3-4
50-MILE-RADIUS (80 KM) MILK, MEAT, AND VEGETATION PRODUCTION, CONT'D.

50-Mile-Radius (80 km) Vegetation Production Around SRS

Site Annual Vegetation Production, (kg)

Dir (miles)	0.0-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.0	7.385E+04	4.650E+05	7.751E+05	2.158E+06	3.106E+06	6.578E+06
NNE	0.0	5.885E+04	4.650E+05	7.751E+05	1.177E+06	1.609E+06	4.085E+06
NE	0.0	4.126E+04	9.712E+05	1.082E+06	1.586E+06	1.931E+06	5.611E+06
ENE	0.0	2.253E+04	2.574E+06	2.885E+06	2.205E+06	2.783E+06	1.047E+07
E	0.0	2.639E+04	2.574E+06	3.010E+06	2.718E+06	3.030E+06	1.136E+07
ESE	0.0	6.438E+02	2.574E+06	3.818E+06	3.443E+06	9.655E+05	1.080E+07
SE	0.0	0.0	2.731E+06	4.967E+06	4.699E+06	2.893E+06	1.529E+07
SSE	0.0	0.0	2.653E+06	3.712E+06	5.011E+06	3.160E+06	1.454E+07
S	0.0	0.0	1.355E+06	1.694E+06	2.501E+06	3.266E+06	8.816E+06
SSW	0.0	0.0	1.151E+06	1.330E+06	1.861E+06	2.511E+06	6.893E+06
SW	0.0	1.511E+04	9.195E+05	1.325E+06	1.807E+06	1.970E+06	6.037E+06
WSW	0.0	1.010E+04	7.213E+05	1.314E+06	1.857E+06	2.406E+06	6.308E+06
W	0.0	5.234E+04	1.863E+05	3.170E+05	1.184E+06	2.768E+06	4.508E+06
WNW	0.0	6.222E+04	1.935E+05	1.698E+05	4.890E+04	1.355E+06	1.829E+06
NW	0.0	7.862E+04	4.650E+05	1.585E+06	4.197E+06	2.265E+06	8.591E+06
NNW	0.0	8.083E+04	4.650E+05	1.249E+06	5.695E+06	6.379E+06	1.387E+07
TOTAL	0.0	5.227E+05	2.046E+07	3.001E+07	4.215E+07	4.244E+07	1.356E+08

DENSITY (/M**2) = 6.78E-03

Agricultural Productivity

Product	Cap use	Production	Export	Total Population Served
Vegetation	1.97E+02	1.36E+08	2.74E+07	6.87E+05
Milk	1.31E+02	8.84E+07	1.65E+07	6.74E+05
Meat	8.02E+01	4.86E+07	4.68E+07	6.06E+05

TABLE 3-5
SITE PARAMETERS USED IN LIQUID DOSE CALCULATIONS

River flow rate at SRS, cfs (1989)	7,832
River dilution in estuary	3
Transit time, process areas to river (hr)	24
Transit time, SRS to water treatment plants (hr)	72
Water treatment time (hr)	24
Aquatic food harvest (kg/hr)	
Fish - sport	103,700
Fish - commercial	31,800
Invertebrates - salt water	299,000
Irrigation	None
Shore width factor	0.2
Fish bioaccumulation factor for cesium	3,000

Chapter 5

Surface Water Monitoring Program

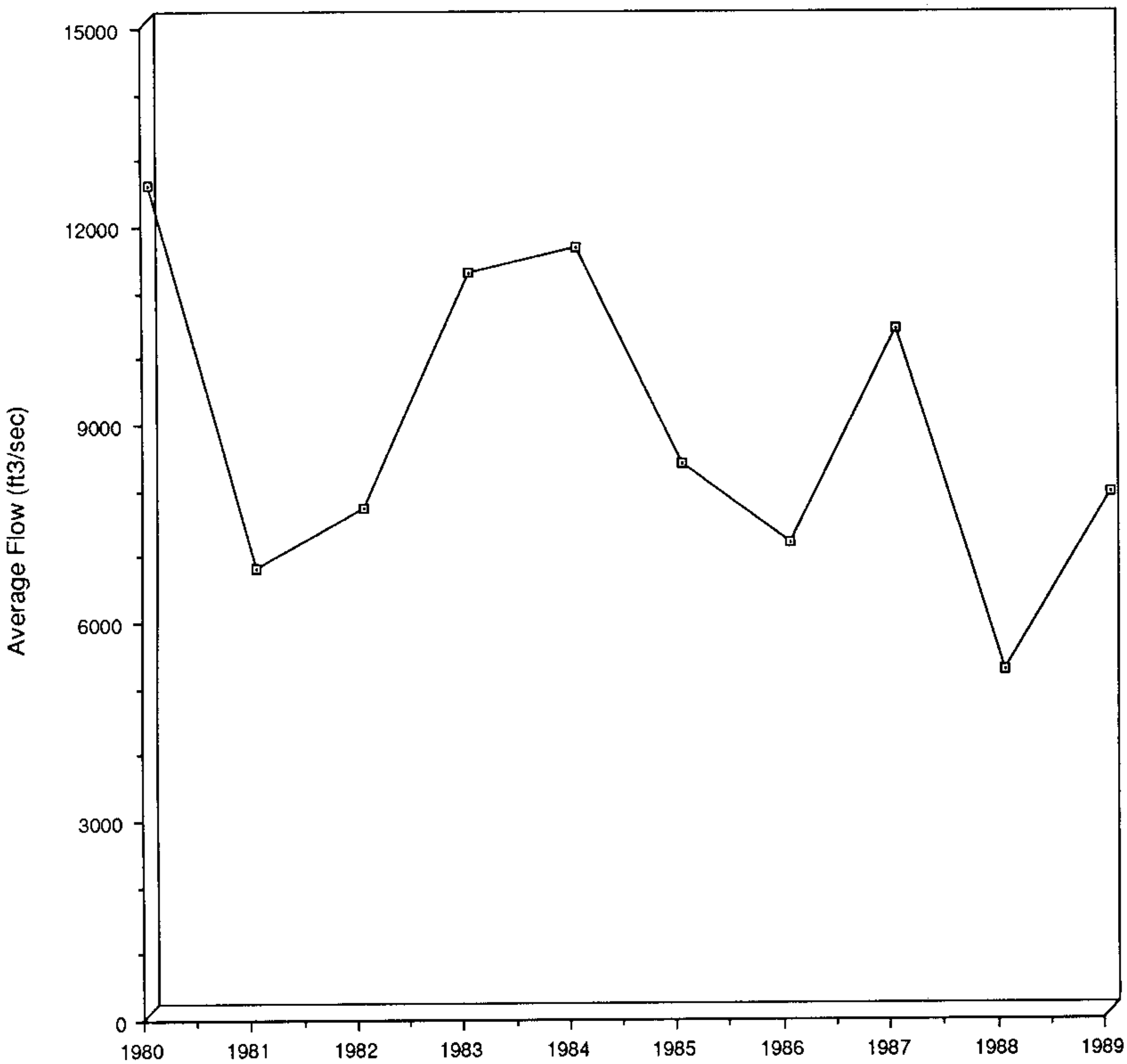

Figure 5-1. Average annual flow rates of the Savannah River

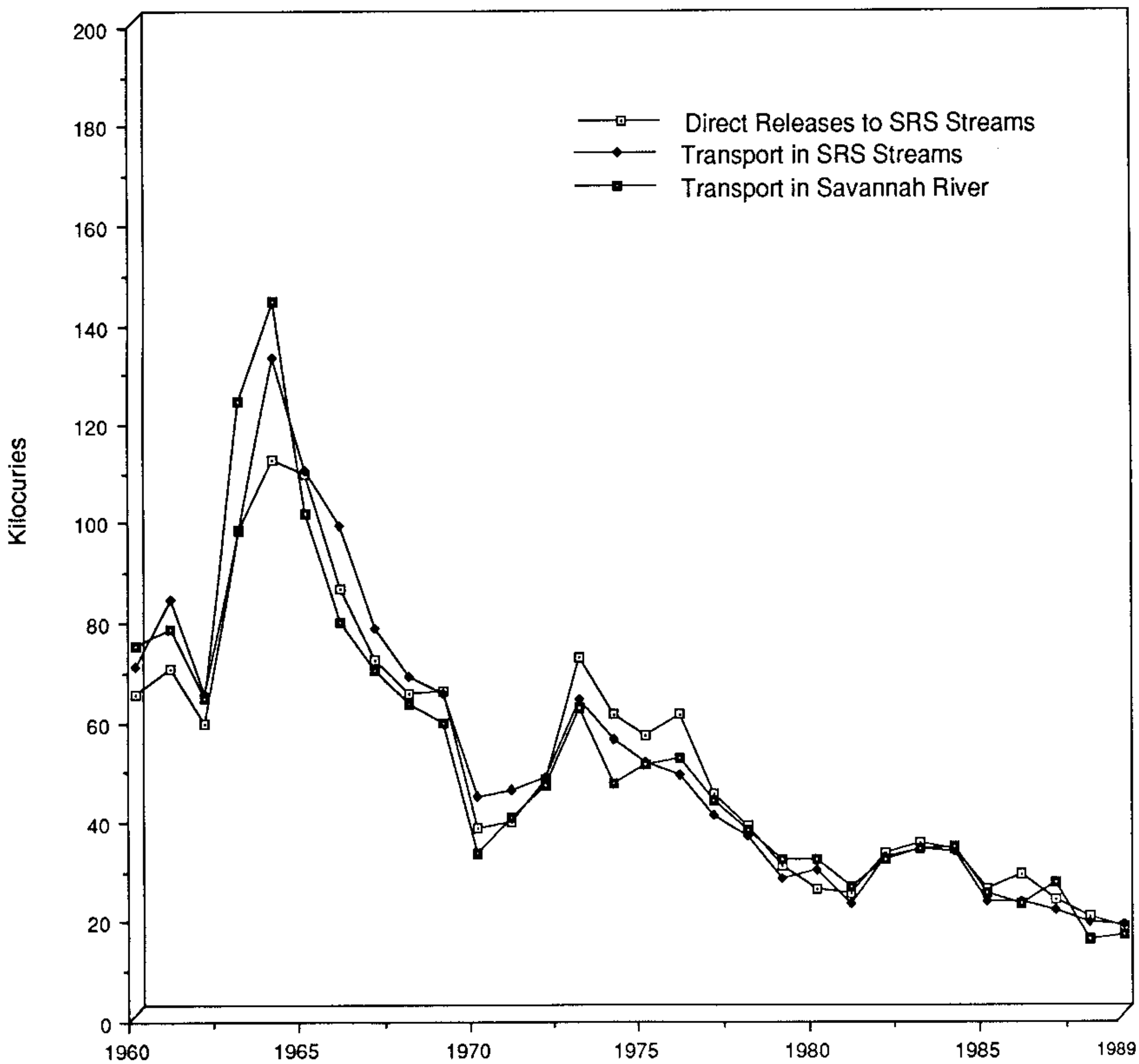

Figure 5-2. Tritium release summary, 1960–1989

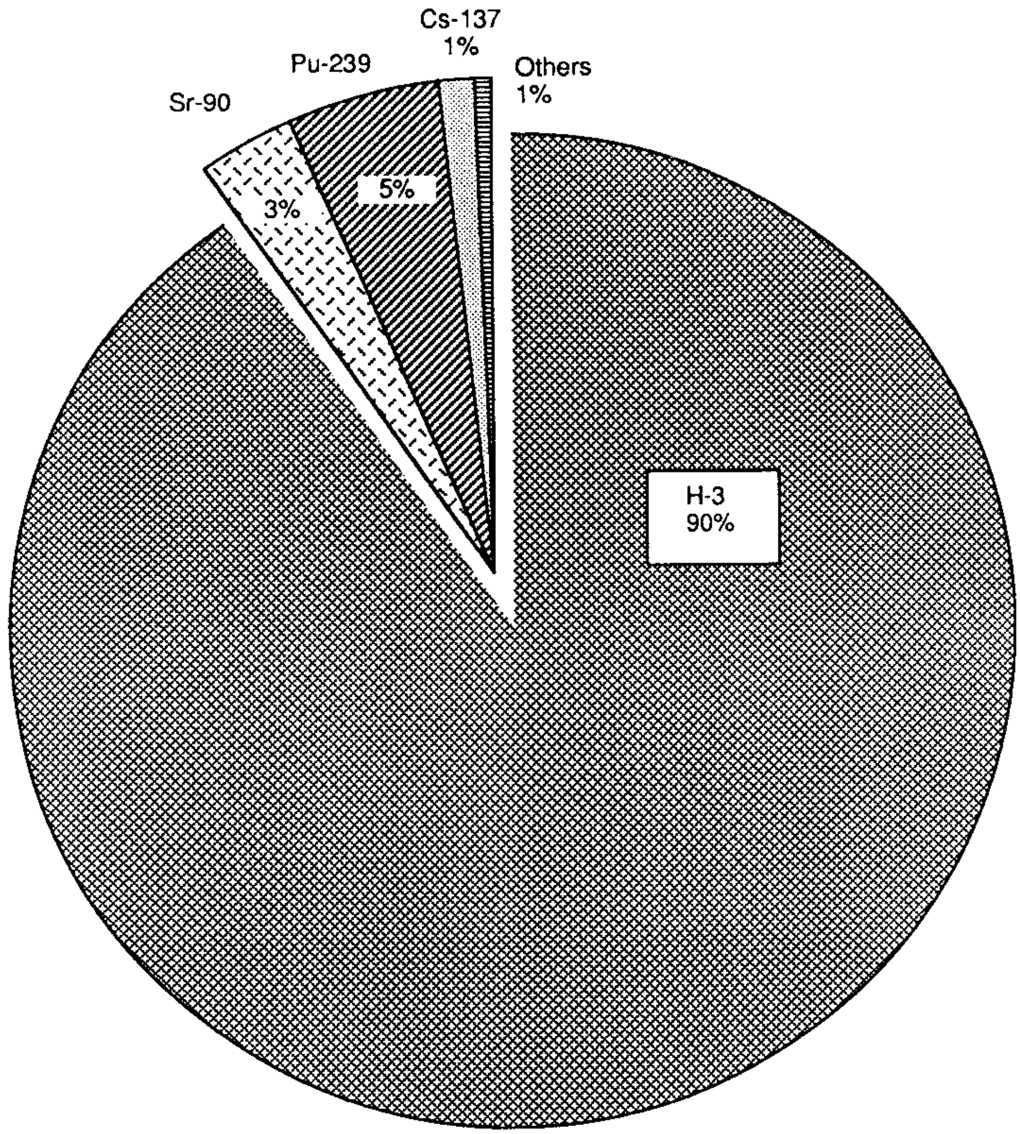

Figure 5-3. Committed dose from public water supplies at Beaufort-Jasper and Port Wentworth

TABLE 5-1
RADIOACTIVITY IN SAVANNAH RIVER WATER

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Gross Alpha, pCi/L				
CONTROL							
R-2 DISSOLVED	52	0.77	±0.84	-0.3	±1.2	0.07	±0.38
R-2 SUSPENDED	52	0.77	±0.54	-0.18	±0.89	0.09	±0.34
GDNR-RIVER-2	13	0.5	±1.2	-0.16	±0.29	0.12	±0.40
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	51	0.9	±1.5	-0.16	±0.31	0.09	±0.38
R-3B BELOW VOGTLE	52	0.82	±0.61	-0.23	±0.72	0.13	±0.44
R-8 BELOW STEEL CREEK	27	2.1	±1.9	-0.17	±0.34	0.11	±0.84
R-8B	26	0.62	±0.74	-0.17	±0.40	0.06	±0.32
R-8C BELOW LITTLE HELL	26	0.99	±0.64	-0.16	±0.33	0.10	±0.52
R-10 DISSOLVED	52	0.64	±0.62	-0.17	±0.58	0.09	±0.34
R-10 SUSPENDED	51	0.73	±0.53	-0.13	±0.30	0.05	±0.28
R-10B HIGHWAY 301	52	0.35	±0.58	-0.2	±1.2	0.07	±0.24
GDNR-RIVER-3B	13	0.56	±0.65	-0.15	±0.29	0.11	±0.44
GDNR-RIVER-10A	13	0.85	±0.82	-0.19	±0.26	0.18	±0.68
			Nonvolatile Beta, pCi/L				
CONTROL							
R-2 DISSOLVED	52	3.80	±0.72	0.92	±0.79	2.2	±1.1
R-2 SUSPENDED	52	1.24	±0.77	-0.46	±0.41	0.17	±0.66
GDNR-RIVER-2	13	3.34	±0.82	1.00	±0.74	2.1	±1.4
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	51	3.7	±1.1	0.40	±0.58	2.1	±1.2
R-3B BELOW VOGTLE	52	5.11	±0.80	1.07	±0.69	2.3	±1.4
R-8 BELOW STEEL CREEK	27	3.2	±1.0	1.07	±0.75	2.2	±1.3
R-8B	26	3.9	±1.2	0.93	±0.68	2.1	±1.5
R-8C BELOW LITTLE HELL	26	3.5	±1.1	0.61	±0.62	2.1	±1.3
R-10 DISSOLVED	52	3.1	±1.1	0.50	±0.67	2.0	±1.1
R-10 SUSPENDED	51	1.36	±0.61	-0.48	±0.39	0.24	±0.68
R-10B HIGHWAY 301	52	4.1	±1.2	1.02	±0.74	2.3	±1.4
GDNR-RIVER-3B	13	3.5	±1.2	1.42	±0.81	2.4	±1.3
GDNR-RIVER-10A	13	3.5	±1.0	1.43	±0.85	2.6	±1.2
			H-3, pCi/mL				
CONTROL							
R-2 ABOVE PLANT	52	0.91	±0.32	-0.21	±0.18	0.23	±0.38
GDNR-RIVER-2	13	0.38	±0.21	-0.24	±0.18	0.14	±0.32
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	52	11.9	±0.4	-0.12	±0.20	1.0	±3.2
R-3B BELOW VOGTLE	52	6.72	±0.34	-0.01	±0.20	1.2	±2.0
R-8 BELOW STEEL CREEK	26	3.62	±0.34	0.45	±0.19	1.9	±1.4
R-8C BELOW LITTLE HELL	26	5.26	±0.21	1.30	±0.20	2.9	±1.9
R-10 HIGHWAY 301	52	7.69	±0.37	1.02	±0.19	2.9	±2.4
R-10B HIGHWAY 301	52	6.36	±0.30	0.77	±0.17	2.9	±2.3
GDNR-RIVER-3B	13	2.13	±0.21	-0.15	±0.20	0.6	±1.2
GDNR-RIVER-10A	13	4.71	±0.22	1.46	±0.20	3.1	±1.9

TABLE 5-1
RADIOACTIVITY IN SAVANNAH RIVER WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Sr-89, 90, pCi/L				
CONTROL							
R-2 ABOVE PLANT IC	12	0.75	±0.53	-0.23	±0.72	0.14	±0.54
SAVANNAH RIVER							
R-8 BELOW STEEL CREEK	12	0.90	±0.92	0.0	±2.0	0.36	±0.72
R-8B	12	0.80	±0.88	0.0	±1.7	0.34	±0.56
R-8C BELOW LITTLE HELL	12	1.14	±0.93	0.0	±1.7	0.35	±0.84
R-3A ABOVE VOGTLE	12	1.2	±2.6	-0.18	±0.73	0.19	±0.72
R-3B BELOW VOGTLE	12	1.0	±2.7	-0.43	±0.63	0.10	±0.68
R-10 HIGHWAY 301 IC	12	0.36	±0.56	-0.16	±0.94	0.01	±0.28
			Mn-54, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±9.9	0	±2	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±41	0	±2	0	-
R-3B BELOW VOGTLE	51	0	±81[b]	0	±2	0	-
R-10 HIGHWAY 301 IC	50	0	±34	0	±2	0	-
			Cr-51, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±150	0	±18	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±110	0	±18	0	-
R-3B BELOW VOGTLE	51	0	±1200[b]	0	±18	0	-
R-10 HIGHWAY 301 IC	50	0	±420	0	±18	0	-
			Co-60, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±13	0	±2	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±7.7	0	±2	0	-
R-3B BELOW VOGTLE	51	0	±85[b]	0	±2	0	-
R-10 HIGHWAY 301 IC	50	0	±33	0	±2	0	-
			Zn-65, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±29	0	±4	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±19	0	±4	0	-
R-3B BELOW VOGTLE	51	0	±210[b]	0	±4	0	-
R-10 HIGHWAY 301 IC	50	0	±75	0	±4	0	-

[a] Average detection limits for conditions given in Table 1-6, Volume II were used to report minimum values.

[b] Higher detection limits are attributed to use of a smaller sample aliquot than the normal aliquot used for detecting gamma-emitting radionuclides.

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-1
RADIOACTIVITY IN SAVANNAH RIVER WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Zr-95, Nb-95, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±52	0	±5	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±28	0	±5	0	-
R-3B BELOW VOGTLE	51	0	±350[b]	0	±5	0	-
R-10 HIGHWAY 301 IC	50	0	±100	0	±5	0	-
			Ru-103,106, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±120	0	±17	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±97	0	±17	0	-
R-3B BELOW VOGTLE	51	0	±1000[b]	0	±17	0	-
R-10 HIGHWAY 301 IC	50	0	±300	0	±17	0	-
			I-131, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±95	0	±5	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±48	0	±5	0	-
R-3B BELOW VOGTLE	51	0	±500[b]	0	±5	0	-
R-10 HIGHWAY 301 IC	50	0	±130	0	±5	0	-
			Cs-134, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±11	0	±2	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±9.5	0	±2	0	-
R-3B BELOW VOGTLE	51	0	±95[b]	0	±2	0	-
R-10 HIGHWAY 301 IC	50	0	±36	0	±2	0	-
			Cs-137, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	21	0.0279	±0.0083	0.0052	±0.0043	0.012	±0.011
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	8.1[c]	±1.9	0	±0.01	0.24	±2.5
R-3B BELOW VOGTLE	51	3.9[c]	±1.2	0	±0.03	0.08	±1.1
R-10 HIGHWAY 301 IC	27	0.101	±0.011	0.0257	±0.0081	0.058	±0.039

[a] Average detection limits for conditions given in Table 1-6, Volume II were used to report minimum values.

[b] Higher detection limits are attributed to use of a smaller sample aliquot than the normal aliquot used for detecting gamma-emitting radionuclides.

[c] Based on concentration measured upriver and downriver from SRS, these measurements are suspected to be anamolous.

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-1
RADIOACTIVITY IN SAVANNAH RIVER WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Ce-141,144, pCi/L[a]				
CONTROL							
R-2 ABOVE PLANT IC	49	0	±120	0	±0	0	-
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	48	0	±94	0	±14	0	-
R-3B BELOW VOGTLE	51	0	±620[b]	0	±14	0	-
R-10 HIGHWAY 301 IC	50	0	±300	0	±14	0	-
			Sr-90, pCi/L				
CONTROL							
R-2 ABOVE PLANT IC	12	0.33	±0.85	-0.11	±0.14	0.11	±0.42
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	12	0.22	±0.22	-0.06	±0.84	0.08	±0.47
R-3B BELOW VOGTLE	12	0.35	±0.22	-0.19	±0.26	0.09	±0.42
R-10 HIGHWAY 301 IC	12	0.76	±0.92	-0.16	±0.94	0.23	±0.49
			Pu-238, fCi/L				
CONTROL							
R-2 ABOVE PLANT IC	8	1.2	±1.6	-0.29	±0.64	0.3	±1.2
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	8	1.5	±1.7	-0.47	±0.83	0.2	±1.1
R-3B BELOW VOGTLE	8	4.6	±1.8	-1.7	±1.9	0.3	±1.8
R-10 HIGHWAY 301 IC	8	0.7	±2.5	-0.47	±0.02	0.6	±1.9
			Pu-239, fCi/L				
CONTROL							
R-2 ABOVE PLANT IC	8	3.1	±2.7	-0.55	±0.77	0.6	±2.2
SAVANNAH RIVER							
R-3A ABOVE VOGTLE	8	0.56	±0.56	-1.2	±1.8	-0.1	±1.5
R-3B BELOW VOGTLE	8	2.9	±1.9	-0.3	±1.7	1.1	±2.0
R-10 HIGHWAY 301 IC	8	2.1	±1.2	-0.8	±2.1	0.4	±1.7

[a] Average detection limits for conditions given in Table 1-6, Volume II were used to report minimum values.

[b] Higher detection limits are attributed to use of a smaller sample aliquot than the normal aliquot used for detecting gamma-emitting radionuclides.

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Alpha, pCi/L				
TIMS BRANCH							
TB-2 A EFFLUENT	52	5.7	±1.8	-0.05	±0.67	0.8	±1.9
TB-3 M EFFLUENT	52	7.9	±4.1	1.0	±1.4	3.8	±3.6
TB-5 NEAR ROAD C	26	2.11	±0.96	0.29	±0.45	1.4	±1.1
700-A1 OUTFALL	11	1.9	±2.1	-0.25	±0.67	1.0	±1.3
U3R CONTROL							
U3R-278	51	5.58	±0.92	0.67	0.96	2.6	±2.5
UPPER THREE RUNS CREEK							
U3R-2A	52	29	±23	-6.9	±4.3	1	±10
U3R F-3	52	5.5	±4.6	-0.08	±0.96	1.8	±2.8
HP-15	26	2.42	±0.81	-0.02	±0.19	0.7	±1.2
U3R-2F STORM SEWER	52	20	±22	0.38	±0.72	3.3	±5.7
CROUCH BRANCH	26	3.0	±3.8	-0.04	±0.46	0.7	±1.3
MCQUEEN BRANCH	52	1.71	±0.81	-0.04	±0.70	0.51	±0.82
U3R-3 ROAD C	26	4.2	±2.8	0.16	±0.26	1.4	±1.6
U3R-4 ROAD A	26	3.2	±2.4	0.50	±0.44	1.4	±1.4
BEAVER DAM CREEK							
400-D EFFLUENT	52	1.3	±3.5	-0.39	±0.58	0.15	±0.78
FOUR MILE CREEK							
BURIAL GROUND DITCH	11	6.2	±2.0	0.5	±3.7	2.1	±3.7
FM-1B COOL TOWER EFF	51	5.3	±5.5	-0.10	±0.32	1.3	±2.2
HP 52 PADDLE WHEEL	27	9.0	±4.4	0.25	±0.73	3.2	±4.6
H H-3 FAC OUTFALL 50	26	6.1	±1.6	0.71	±0.52	2.8	±2.7
FM-1C H EFFLUENT	52	4.8	±1.6	0.16	±0.26	1.7	±2.1
FM-2 ROAD 4	26	1.7	±1.1	-0.01	±0.57	0.61	±0.88
FM-2B ABOVE F EFF	26	0.82	±0.85	-0.12	±0.90	0.38	±0.58
FM-3 F EFFLUENT	52	7.7	±2.2	0.31	±0.57	2.1	±2.7
FM-3A BELOW F EFF	26	2.2	±1.9	-0.04	±0.35	0.9	±1.1
FM-A7 ROAD A-7	26	2.1	±1.8	-0.04	±0.30	0.7	±1.1
FM-6 ROAD A	26	0.86	±0.77	-0.34	±0.16	0.20	±0.54
INDIAN GRAVE BRANCH							
IGB-7	2	0.50	±0.56	0.31	±0.60	0.41	-
IGB-21 800' S OF 6-1	3	0.59	±0.60	0.19	±0.43	0.38	-
PEN BRANCH							
PB-1 K SEC EFFLUENT	52	3.1	±2.7	-0.10	±0.19	0.4	±1.1
PB-3 ROAD A	26	0.6	±1.3	-0.22	±0.31	0.16	±0.42
STEEL CREEK							
SC 2A	26	0.9	±1.1	-0.04	±0.16	0.35	±0.50
SC-4 ROAD A	26	0.8	±1.4	-0.19	±0.25	0.09	±0.42
SC-1 P SEC EFFLUENT	19	1.4	±1.7	-0.24	±0.69	0.24	±0.76
PAR POND							
R-AREA EFFLUENT	50	1.7	±2.6	-0.25	±0.14	0.26	±0.64
PP-2 PUMPHOUSE	52	0.33	±0.83	-0.3	±1.3	0.02	±0.22
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	26	0.8	±1.0	-0.20	±0.80	0.16	±0.46
L3R-1A ROAD B	26	0.59	±0.43	0.17	±0.53	0.06	±0.32
L3R-3 ROAD A	12	0.8	±2.0	-0.11	±0.22	0.21	±0.46
SAVANNAH RIVER SWAMP							
TNX 1	26	3.5	±2.8	-0.03	±0.36	1.1	±1.5
BACKGROUND							
EDISTO RIVER	52	3.7	±4.6	-0.02	±0.50	1.2	±1.3

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Nonvolatile Beta, pCi/L				
TIMS BRANCH							
TB-2 A EFFLUENT	52	6.0	±1.5	0.16	±0.58	1.8	±2.5
TB-3 M EFFLUENT	52	13.8	±4.0	0.5	±2.3	4.9	±5.5
TB-5 NEAR ROAD C	26	6.9	±1.6	1.65	±0.83	2.9	±2.3
700-A1 OUTFALL	11	32.2	±2.6	2.5	±1.3	8	±16
U3R CONTROL							
U3R-278	51	4.80	±0.77	0.43	±0.58	1.9	±1.9
UPPER THREE RUNS CREEK							
U3R-2A	52	1720	±150	-18	±51	200	±670
U3R F-3	52	58.7	±6.1	2.8	±2.3	11	±18
HP-15	26	6.8	±1.5	0.71	±0.68	2.2	±2.4
U3R-2 F STORM SEWER	52	24.3	±3.0	2.28	±0.88	7.7	±7.8
CROUCH BRANCH	26	11.9	±2.0	1.39	±0.80	3.8	±4.1
MCQUEEN BRANCH	52	50.6	±6.5	0.49	±0.61	7	±24
U3R-3 ROAD C	26	4.4	±1.3	0.44	±0.60	1.8	±1.8
U3R-4 ROAD A	26	3.4	±1.1	0.55	±0.44	1.7	±1.5
BEAVER DAM CREEK							
400-D EFFLUENT	52	5.6	±1.3	0.8	±1.3	2.7	±2.0
FOUR MILE CREEK							
BURIAL GROUND DITCH	11	48.2	±5.6	11.2	±2.6	20	±23
FM-1B COOL TOWER EFF	51	27.7	±2.0	5.8	±1.4	13.7	±9.1
HP 52 PADDLE WHEEL	27	28.9	±3.0	6.0	±1.4	12	±10
H H-3 FAC OUTFALL 50	26	10.1	±1.5	2.44	±0.75	6.3	±4.5
FM-1C H EFFLUENT	52	301	±21	6.4	±2.0	40	±130
FM-2 ROAD 4	26	94.3	±8.2	14.7	±2.1	37	±44
FM-2B ABOVE F EFF	26	69.5	±6.1	34.2	±4.1	48	±17
FM-3 F EFFLUENT	52	42.1	±4.3	3.6	±1.2	11	±13
FM-3A BELOW F EFF	26	14.1	±1.9	4.29	±0.96	8.0	±4.5
FM-A7 ROAD A-7	26	65.2	±4.0	36.0	±3.9	50	±14
FM-6 ROAD A	26	50.6	±4.3	18.9	±3.5	31	±17
INDIAN GRAVE BRANCH							
IGB-7	2	1.32	±0.59	0.85	±0.70	1.1	-
IGB-21 800' S OF 6-1	3	1.74	±0.66	1.01	±0.72	1.3	-
PEN BRANCH							
PB-1 K SEC EFFLUENT	52	10.0	±1.4	1.47	±0.81	2.9	±2.6
PB-3 ROAD A	26	5.35	±0.84	1.10	±0.75	2.4	±2.0
STEEL CREEK							
SC 2A	26	12.6	±1.7	4.7	±1.5	7.3	±4.0
SC-4 ROAD A	26	4.29	±0.72	1.21	±0.83	2.3	±1.7
SC-1 P SC EFFLUENT	19	7.6	±1.3	2.06	±0.90	3.9	±3.0
PAR POND							
R-AREA EFFLUENT	50	50.4	±3.2	10.1	±2.2	23	±21
PP-2 PUMPHOUSE	52	12.0	±1.2	3.7	±1.2	6.1	±3.8
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	26	6.89	±0.94	3.2	±1.2	4.8	±2.2
L3R-1A ROAD B	26	8.8	±1.1	3.5	±1.2	5.5	±2.5
L3R-3 ROAD A	12	7.52	±0.91	2.11	±0.99	4.5	±3.5
SAVANNAH RIVER SWAMP							
TNX 1	26	39.8	±4.1	2.4	±1.5	6	±14
BACKGROUND							
EDISTO RIVER	52	5.68	±0.81	0.65	±0.69	1.9	±1.5

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			H-3 pCi/mL				
TIMS BRANCH							
TB-2 A EFFLUENT	52	3.47	±0.83	-1.11	±0.69	0.3	±1.2
TB-5 NEAR ROAD C	26	1.92	±0.70	0.65	±0.78	1.12	±0.78
700-A1 OUTFALL	11	1.36	±0.83	-0.28	±0.64	0.7	±1.1
U3R CONTROL							
U3R-278	52	1.73	±0.67	-0.48	±0.71	0.59	±0.76
UPPER THREE RUNS CREEK							
U3R-2A	52	80100	±700	3490	±140	17000	±26000
STREAM U3R F-3	52	22.4	±1.2	0.45	±0.73	3.7	±7.4
HP-15	24	111	±3	2.02	±0.67	24	±46
U3R-2 F STORM SEWER	52	335	±4	-0.52	±0.38	9	±93
STREAM CROUCH BRANCH	26	40.5	±1.0	7.87	±0.89	17	±14
STREAM MCQUEEN BRANCH	53	31.7	±1.5	5.23	±0.47	14.8	±6.8
U3R-3 ROAD C	26	24.4	±1.0	3.32	±0.80	13	±13
U3R-4 ROAD A	26	26.2	±1.3	3.29	±0.69	12	±12
BEAVER DAM CREEK							
400-D EFFLUENT	52	364	±3	0.77	±0.70	20	±100
FOUR MILE CREEK							
BURIAL GROUND DITCH	11	420	±9	15.4	±1.3	220	±280
FM-1B COOL TOWER EFF	52	28.2	±1.4	1.33	±0.70	5.7	±8.8
HP 52 PADDLE WHEEL	26	22.0	±1.2	0.94	±0.41	6	±10
H H-3 FAC OUTFALL 50	26	68.4	±1.9	5.11	±0.81	20	±31
FM-1C H EFFLUENT	52	123	±3	3.06	±0.23	23	±47
FM-2 ROAD 4	26	173	±2	78.6	±2.1	115	±52
FM-2B ABOVE F EFF	26	1130	±20	420	±15	650	±390
FM-3 F EFFLUENT	52	8.58	±0.94	0.09	±0.73	2.4	±3.0
FM-3A BELOW F EFF	26	2200	±40	1450	±30	1770	±390
FM-A7 ROAD A-7	26	1290	±20	618	±18	960	±350
FM-6 ROAD A	26	690	±4	370	±4	480	±140
TWIN LAKES	52	37.4	±1.8	18.9	±1.1	28.8	±8.3
CASTER CREEK	52	5.97	±0.55	3.75	±0.80	4.80	±0.98
INDIAN GRAVE BRANCH							
IGB-7	2	88.7	±5.1	43.3	±9.0	66	-
IGB-21 800' S OF 6-1	52	10900	±100	2030	±30	5200	±3600
PEN BRANCH							
PB-1 K SEC EFFLUENT	52	27.4	±1.2	0.61	±0.41	5	±10
PB-3 ROAD A	28	222	±2	24.5	±1.2	56	±77
STEEL CREEK							
SC-2A	26	132	±3	92.0	±2.1	116	±19
SC-4 ROAD A	26	5.70	±0.93	2.96	±0.79	4.5	±1.5
SC-1 P SEC EFFLUENT	18	427	±5	2.23	±0.41	50	±200
PAR POND							
R-AREA EFFLUENT	52	145	±3	3.29	±0.73	27	±65
PP-2 PUMPHOUSE	52	7.15	±0.50	2.85	±0.70	4.6	±2.0
P019	52	11.2	±1.1	0.95	±0.70	3.3	±4.0
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	26	4.98	±0.53	1.99	±0.77	3.5	±1.6
L3R-1A ROAD B	26	6.18	±0.55	2.90	±0.77	4.5	±1.8
L3R-3 ROAD A	12	2.96	±0.41	0.75	±0.64	2.1	±1.4
SAVANNAH RIVER SWAMP							
TNX 1	26	0.74	±0.81	-0.77	±0.65	0.04	±0.54
BACKGROUND							
EDISTO RIVER	52	0.85	±0.19	-0.34	±0.20	0.28	±0.38

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Sr-89, 90, pCi/L				
UPPER THREE RUNS CREEK							
U3R-2A	51	11.1	±9.7	-10	±150	3.7	±7.1
U3R F-3	10	1.1	±1.1	0.0	±1.8	0.33	±0.70
HP-15 STREAM	4	0.82	±0.75	0.0	±2.5	0.38	-
U3R-2	10	2.0	±1.2	0.0	±2.2	1.1	±1.4
U3R-3	12	1.5	±1.6	0.0	±1.5	0.26	±0.96
FOUR MILE CREEK							
FM-1B COOL TOWER EFF	12	2.4	±1.2	-10	±29	0.2	±2.7
HP 52 PADDLE WHEEL	12	1.2	±1.2	-8	±19	0.2	±1.3
FM-1C H EFFLUENT	12	3.1	±1.4	0.0	±2.1	1.1	±1.7
FM-2 ROAD 4	12	7.5	±2.0	1.35	±0.83	4.2	±3.4
FM-2B ABOVE F EFF	12	19.3	±3.0	4	±16	12.1	±8.5
FM-3 F EFFLUENT	12	3.2	±1.4	0.00	±0.89	0.8	±1.8
FM-3A BELOW F EFF	11	3.2	±1.5	0.2	±1.1	1.1	±1.8
FM-A7 ROAD A-7	12	18.8	±2.9	7	±22	15.2	±6.1
FM-6 ROAD A	12	9.9	±2.6	3.3	±1.2	7.4	±4.1
INDIAN GRAVE BRANCH							
IGB-7	2	0.51	±0.85	0.0	±2.4	0.26	-
IGB-21 800' S OF 6-1	3	0.59	±0.85	0.0	±1.1	0.20	-
PEN BRANCH							
PB-3 ROAD A	12	0.9	±2.3	-0.39	±0.77	0.14	±0.78
STEEL CREEK							
SC-2A	12	2.2	±1.6	0.00	±0.92	0.5	±1.3
SC-4 ROAD A	12	1.7	±1.3	-0.3	±1.4	0.3	±1.1
PAR POND							
PP-2 PUMPHOUSE	12	0.78	±0.79	0.0	±2.1	0.24	±0.60
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	12	1.0	±1.3	-0.2	±1.4	0.25	±0.82
L3R-1A ROAD B	12	2.3	±2.0	0.0	±2.0	0.5	±1.3
L3R-3 ROAD A	12	1.33	±0.99	0.1	±1.9	0.47	±0.82
			Sr-90, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	12	10.5	±1.4	4.58	±0.60	7.5	±1.3
PEN BRANCH							
PB-3 ROAD A	12	0.56	±0.76	-0.39	±0.47	0.17	±0.51
STEEL CREEK							
SC-4 ROAD A	12	0.47	±0.82	-0.36	±0.55	0.08	±0.57
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	12	0.65	±0.63	-0.30	±0.46	0.29	±0.50

-Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			U/Pu, pCi/L				
TIMS BRANCH							
TB-2 A EFFLUENT	50	7.8	±4.3	-0.15	±0.57	0.4	±2.4
TB-3 M EFFLUENT	52	8	±15	-4.9	±8.8	0.3	±6.6
UPPER THREE RUNS CREEK							
U3R F-3	52	3.1	±1.7	-0.16	±0.37	0.8	±1.4
H-15	6	0.08	±0.31	-0.12	±0.34	0.03	±0.15
U3R-2 F STORM SEWER	46	14.6	±3.9	1.08	±0.89	4.2	±6.1
U3R-4 ROAD A	26	0.49	±0.59	-0.22	±0.07	0.03	±0.32
FOUR MILE CREEK							
FM-6 ROAD A	26	0.44	±0.49	-0.22	±0.49	0.03	±0.28
PEN BRANCH							
PB-3 ROAD A	26	0.48	±0.59	-0.23	±0.49	0.06	±0.32
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	29	0.39	±0.81	-0.23	±0.49	0.06	±0.30
L3R-2 DIP	47	0.40	±0.94	-0.19	±0.33	0.05	±0.26
SAVANNAH RIVER SWAMP							
TNX 1	26	1.8	±2.1	-0.14	±0.35	0.17	±0.78
			Mn-54, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±20	0	±16	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±19	0	±14	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±21	0	±16	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±20	0	±17	0	-
			Cr-51, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±410	0	±160	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±400	0	±140	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±410	0	±150	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±480	0	±170	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Co-60, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±23	0	±17	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±21	0	±14	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±23	0	±16	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±23	0	±16	0	-
			Zn-65, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±47	0	±34	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±49	0	±30	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±48	0	±33	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±48	0	±35	0	-
			Zr-95, NB-95, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±91	0	±44	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±90	0	±29	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±83	0	±35	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±88	0	±20	0	-
			Ru-103, 106, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±200	0	±160	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±230	0	±34	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±210	0	±140	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±230	0	±150	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-2
RADIOACTIVITY IN SRS STREAM WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			I-131, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±820	0	±35	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±750	0	±29	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±740	0	±27	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±760	0	±36	0	-
			Cs-134, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±21	0	±15	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±20	0	±11	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±19	0	±14	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±20	0	±16	0	-
			Cs-137, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	9.1	±5.2	0	±17	0.7	±4.9
PEN BRANCH							
PB-3 ROAD A	17	0	±21	0	±15	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±21	0	±16	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	18	0	±24	0	±19	0	-
			Ce-141, 144, pCi/L				
FOUR MILE CREEK							
FM-6 ROAD A	14	0	±200	0	±140	0	-
PEN BRANCH							
PB-3 ROAD A	17	0	±260	0	±79	0	-
STEEL CREEK							
STEEL CREEK 4	17	0	±220	0	±63	0	-
LOWER THREE RUNS CREEK							
L3R-2 PATTERSON MILL	17	0	±210	0	±65	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-3
RADIOACTIVITY IN SEEPAGE BASIN WATER

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Alpha, pCi/mL				
200 F							
F SEEPAGE BASIN 1	3	0.47	±0.52	-0.10	±0.22	0.12	-
F SEEPAGE BASIN 2	3	0.36	±0.48	0.06	±0.22	0.19	-
F SEEPAGE BASIN 3	4	0.83	±0.68	-0.03	±0.23	0.34	-
200 H							
H SEEPAGE BASIN 1	3	0.07	±0.22	-0.10	±0.21	0.01	-
H SEEPAGE BASIN 2	2	-0.01	±0.22	-0.13	±0.22	0.01	-
H SEEPAGE BASIN 3	3	0.16	±0.27	-0.10	±0.22	0.01	-
H SEEPAGE BASIN 4	1	0.41	±0.56	0.41	±0.56	0.41	-
			Alpha, pCi/L				
700 A							
A AREA 1	1	72	±30	72	±30	72	-
TNX							
TNX 904-102G	13	9.7	±7.0	-6	±22	1.1	±6.9
REACTOR AREAS							
100-P SEEPAGE BASIN	4	5.8	±5.3	-0.2	±2.2	2.0	-
100-C SEEPAGE BASIN	4	3.2	±5.3	0.1	±3.2	1.7	-
100-L SEEPAGE BASIN	3	0	±0	-1.0	±2.1	0.47	-
BURIAL GROUND							
BG SEEPAGE BASIN	5	0.00	±0.01	0	±0.01	0.00	±0.0
			Nonvolatile Beta, pCi/mL				
200 F							
F SEEPAGE BASIN 1	3	2.84	±0.95	-0.17	±0.51	1.3	-
F SEEPAGE BASIN 2	3	5.8	±1.3	3.15	±0.95	4.3	-
F SEEPAGE BASIN 3	4	7.1	±1.4	2.85	±0.92	4.2	-
200 H							
H SEEPAGE BASIN 1	3	5.2	±1.1	2.30	±0.88	3.4	-
H SEEPAGE BASIN 2	2	4.3	±1.1	4.20	±0.99	4.3	-
H SEEPAGE BASIN 3	3	1.49	±0.77	0.96	±0.73	1.2	-
H SEEPAGE BASIN 4	1	10.1	±1.5	10.1	±1.5	10.1	-
			Nonvolatile Beta, pCi/L				
700 A							
A AREA 1	1	9880	±630	9880	±630	9880	-
TNX							
TNX 904-102G	13	32	±14	0	±12	180	±20
REACTOR AREAS							
100-P SEEPAGE BASIN	4	110	±20	64	±13	85	-
100-C SEEPAGE BASIN	4	410	±40	76	±15	18	-
100-L SEEPAGE BASIN	3	32	±8.9	17.0	±8.3	23.7	-
BURIAL GROUND							
BG SEEPAGE BASIN	5	0.56	±0.07	0.00	±0.01	0.13	±0.48

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-3
RADIOACTIVITY IN SEEPAGE BASIN WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			H-3, pCi/mL				
200 F							
F SEEPAGE BASIN 1	3	3110	±110	1430	±170	2200	-
F SEEPAGE BASIN 2	3	9100	±200	6550	±210	7400	-
F SEEPAGE BASIN 3	4	19300	±300	1020	±100	8400	-
200 H							
H SEEPAGE BASIN 1	3	870	±200	445	±35	590	-
H SEEPAGE BASIN 2	3	1260	±60	489	±17	850	-
H SEEPAGE BASIN 3	3	4550	±50	609	±20	2700	-
H SEEPAGE BASIN 4	1	830	±110	830	±110	830	-
700 A							
A AREA 1	1	22.0	±1.4	22.0	±1.4	22.0	-
TNX							
TNX 904-102G	12	8.7	±1.3	0.70	±0.81	2.8	±4.2
REACTOR AREAS							
100-P SEEPAGE BASIN	4	22000	±500	300	±140	6500	-
100-C SEEPAGE BASIN	4	42	±10	4.0	±7.0	20	-
100-L SEEPAGE BASIN	3	20200	±100	8.9	±9.3	8800	-
BURIAL GROUND							
BG SEEPAGE BASIN	5	128	±3	24.3	±1.3	67	±83
			Sr-89, 90, pCi/mL				
200 F							
F SEEPAGE BASIN 1	3	0.02	±0.05	0.01	±0.03	0.01	-
F SEEPAGE BASIN 2	3	0.10	±0.05	0.00	±0.07	0.05	-
F SEEPAGE BASIN 3	4	0.20	±0.08	0.00	±0.08	0.09	-
200 H							
H SEEPAGE BASIN 1	3	0.25	±0.08	0.08	±0.06	0.15	-
H SEEPAGE BASIN 2	3	0.10	±0.05	0.08	±0.05	0.09	-
H SEEPAGE BASIN 3	3	0.10	±0.05	0.07	±0.06	0.08	-
H SEEPAGE BASIN 4	1	0.05	±0.05	0.05	±0.05	0.05	-
REACTOR AREAS							
100-L SEEPAGE BASIN	3	0.12	±0.06	0.00	±0.04	0.04	-
			Cr-51, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±8.5	0	±4.4	0	-
F SEEPAGE BASIN 2	2	0	±9.2	0	±4.7	0	-
F SEEPAGE BASIN 3	3	0	±9.4	0	±1.6	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±11	0	±1.6	0	-
H SEEPAGE BASIN 2	3	0	±11	0	±1.6	0	-
H SEEPAGE BASIN 3	2	0	±4.3	0	±1.6	0	-
H SEEPAGE BASIN 4	1	0	±5.6	0	±5.6	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±8.1	0	±1.5	0	-
100-C SEEPAGE BASIN	4	0	±4.5	0	±1.5	0	-
100-L SEEPAGE BASIN	2	0	±7.8	0	±4.3	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-3
RADIOACTIVITY IN SEEPAGE BASIN WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Co-58, 60, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±0.41	0	±0.39	0	-
F SEEPAGE BASIN 2	2	0	±0.39	0	±0.36	0	-
F SEEPAGE BASIN 3	3	0	±0.37	0	±0.08	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±0.38	0	±0.09	0	-
H SEEPAGE BASIN 2	3	0	±0.38	0	±0.08	0	-
H SEEPAGE BASIN 3	2	0	±0.40	0	±0.08	0	-
H SEEPAGE BASIN 4	1	0	±0.46	0	±0.46	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±0.38	0	±0.09	0	-
100-C SEEPAGE BASIN	4	0.29	±0.08	0	±0.03	0.07	-
100-L SEEPAGE BASIN	2	0	±0.43	0	±0.42	0	-
			Zr-95, Nb-95, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±1.9	0	±1.1	0	-
F SEEPAGE BASIN 2	2	0	±1.7	0	±1.1	0	-
F SEEPAGE BASIN 3	3	0	±1.7	0	±0.17	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±1.9	0	±0.18	0	-
H SEEPAGE BASIN 2	3	0	±11	0	±0.17	0	-
H SEEPAGE BASIN 3	2	0	±1.1	0	±0.17	0	-
H SEEPAGE BASIN 4	1	0	±1.2	0	±1.2	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±1.6	0	±0.20	0	-
100-C SEEPAGE BASIN	4	0	±1.1	0	±0.08	0	-
100-L SEEPAGE BASIN	2	0	±1.7	0	±1.2	0	-
			Ru-103, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±0.72	0	±0.48	0	-
F SEEPAGE BASIN 2	2	0	±0.79	0	±0.53	0	-
F SEEPAGE BASIN 3	3	0	±0.80	0	±0.15	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±0.85	0	±0.14	0	-
H SEEPAGE BASIN 2	3	0	±0.94	0	±0.15	0	-
H SEEPAGE BASIN 3	2	0	±0.45	0	±0.12	0	-
H SEEPAGE BASIN 4	1	0	±0.63	0	±0.63	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±0.75	0	±0.13	0	-
100-C SEEPAGE BASIN	4	0	±0.42	0	±0.03	0	-
100-L SEEPAGE BASIN	2	0	±0.75	0	±0.45	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-3
RADIOACTIVITY IN SEEPAGE BASIN WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Ru-106, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±3.5	0	±3.5	0	-
F SEEPAGE BASIN 2	2	0	±4.2	0	±3.7	0	-
F SEEPAGE BASIN 3	3	0	±4.4	0	±0.88	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±4.0	0	±0.75	0	-
H SEEPAGE BASIN 2	3	0	±4.3	0	±0.80	0	-
H SEEPAGE BASIN 3	2	0	±3.8	0	±0.77	0	-
H SEEPAGE BASIN 4	1	3.2	±1.5	3.2	±1.5	3.2	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±3.8	0	±0.72	0	-
100-C SEEPAGE BASIN	4	0	±3.7	0	±0.24	0	-
100-L SEEPAGE BASIN	2	0	±3.8	0	±3.5	0	-
			Sb-124, 125, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±1.1	0	±1.1	0	-
F SEEPAGE BASIN 2	2	0	±1.3	0	±1.2	0	-
F SEEPAGE BASIN 3	3	0	±1.4	0	±0.29	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±1.3	0	±0.26	0	-
H SEEPAGE BASIN 2	3	0	±1.5	0	±0.27	0	-
H SEEPAGE BASIN 3	2	0	±1.2	0	±0.23	0	-
H SEEPAGE BASIN 4	1	0	±1.7	0	±1.7	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±1.2	0	±0.22	0	-
100-C SEEPAGE BASIN	4	0	±1.0	0	±0.07	0	-
100-L SEEPAGE BASIN	2	0	±1.1	0	±1.0	0	-
			I-131, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±11	0	±1.3	0	-
F SEEPAGE BASIN 2	2	0	±12	0	±1.2	0	-
F SEEPAGE BASIN 3	3	0	±12	0	±1.3	0	-
200 H							
H SEEPAGE BASIN 1	2	0	±19	0	±1.4	0	-
H SEEPAGE BASIN 2	3	0	±20	0	±1.4	0	-
H SEEPAGE BASIN 3	2	0	±1.3	0	±1.2	0	-
H SEEPAGE BASIN 4	1	0	±1.6	0	±1.6	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±11	0	±1.2	0	-
100-C SEEPAGE BASIN	4	0	±1.8	0	±0.11	0	-
100-L SEEPAGE BASIN	2	0	±10	0	±1.1	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-3
RADIOACTIVITY IN SEEPAGE BASIN WATER, CONT'D.

Location	No. of Samples	Maximum	CT ERR 2σ or LLD	Minimum	CT ERR 2σ or LLD	Arithmetic Mean	2 Std Dev
			Cs-134, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±3.9	0	±0.41	0	-
F SEEPAGE BASIN 2	2	0	±0.40	0	±0.38	0	-
F SEEPAGE BASIN 3	3	0	±0.42	0	±0.09	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±0.47	0	±0.09	0	-
H SEEPAGE BASIN 2	3	0	±0.47	0	±0.09	0	-
H SEEPAGE BASIN 3	2	0	±0.40	0	±0.08	0	-
H SEEPAGE BASIN 4	1	0	±0.46	0	±0.46	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±0.39	0	±0.08	0	-
100-C SEEPAGE BASIN	4	0	±0.37	0	±0.02	0	-
100-L SEEPAGE BASIN	2	0	±0.36	0	±0.36	0	-
			Cs-137, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	2.48	±0.37	0.29	±0.15	1.4	-
F SEEPAGE BASIN 2	2	6.57	±0.66	4.05	±0.49	5.3	-
F SEEPAGE BASIN 3	3	8.64	±0.76	1.80	±0.16	5.2	-
200 H							
H SEEPAGE BASIN 1	3	5.51	±0.61	1.0	±0.11	4.0	-
H SEEPAGE BASIN 2	3	8.24	±0.82	1.6	±0.14	5.5	-
H SEEPAGE BASIN 3	2	0.87	±0.23	0.32	±0.06	0.60	-
H SEEPAGE BASIN 4	1	15.2	±1.2	15.2	±1.2	15.2	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0.70	±0.21	0.11	±0.04	0.48	-
100-C SEEPAGE BASIN	4	0.03	±0.01	0	±0.08	0.01	-
100-L SEEPAGE BASIN	2	0	±0.44	0	±0.38	0	-
			Ce-141, 144, pCi/mL				
200 F							
F SEEPAGE BASIN 1	2	0	±3.2	0	±3.1	0	-
F SEEPAGE BASIN 2	2	0	±3.4	0	±3.0	0	-
F SEEPAGE BASIN 3	3	0	±3.4	0	±0.67	0	-
200 H							
H SEEPAGE BASIN 1	3	0	±3.4	0	±0.68	0	-
H SEEPAGE BASIN 2	3	0	±3.1	0	±0.73	0	-
H SEEPAGE BASIN 3	2	0	±2.9	0	±0.64	1	-
H SEEPAGE BASIN 4	1	0	±3.3	0	±3.3	0	-
REACTOR AREAS							
100-P SEEPAGE BASIN	3	0	±3.0	0	±0.31	0	-
100-C SEEPAGE BASIN	4	0	±3.0	0	±0.17	0	-
100-L SEEPAGE BASIN	2	0	±3.2	0	±3.0	0	-

- Insufficient data; standard deviation not calculated for <5 samples.

TABLE 5-4
CALCULATED MIGRATION OF RADIOACTIVITY FROM SEEPAGE BASINS

Measurement Location	Source Description	Curies	
		Tritium	Sr-89,90
FMA7-(FM3A+FM2B)	200-F Seepage Basins to Four Mile Creek	4.443E+03 ± 9%	9.952E-02 ± 72%
FM2B-FM1C	200-H Seepage Basins to Four Mile Creek	3.310E+03 ± 3%	9.425E-02 ± 26%
FM3A-FM3	200-H Seepage Basin 4 and Burial Ground to Four Mile Creek	3.599E+03 ± 2%	-
IGB21	K Containment Basin to Indian Grave Branch	2.256E+03 ± 1%	-
SC2A	100-P Seepage Basin to Steel Creek	1.367E+02 ± 2%	6.444E-04 ± 236%

- Not detected

Note: The ± value represents the total 2σ uncertainty of individual releases based on counting error.

TABLE 5-5
RADIOACTIVITY IN TRANSPORT AT SAMPLE POINTS ON FOUR MILE CREEK

ID	Location	Curies Tritium	 Sr-89,90	 Cs-137[a]
FM3	F-Area effluent at Road E	8.382E+00 ± 29%	2.827E-03 ± 133%	5.507E-03 ± 1061%
FM1C	H-Area effluent at Road E	1.994E+01 ± 5%	9.614E-04 ± 111%	6.001E-02 ± 531%
FM1B	H-Area effluent below H-Area Retention Basin	8.174E+00 ± 18%	3.020E-03 ± 206%	9.165E-03 ± 294%
FM2	Below H-Area effluent at Road 4	5.296E+02 ± 2%	2.057E-02 ± 48%	1.284E-01 ± 48%
FM2B	Above F-Area effluent at Road C	3.330E+03 ± 3%	9.521E-02 ± 25%	7.092E-02 ± 74%
FM3A	Below F-Area effluent 0.3 mile downstream from Road E	3.607E+03 ± 2%	2.170E-03 ± 102%	2.851E-03 ± 1272%
FMA7	Downstream at Road A-7	1.138E+04 ± 2%	1.969E-01 ± 23%	6.081E-02 ± 285%
FM6	Downstream at Road A-13	1.108E+04 ± 1%	1.648E-01 ± 39%	1.778E-02 ± 2479%

[a] There was no ^{137}Cs desorption from the Four Mile Creek bed detected in 1989. Increased analytical error terms are due in part to the elimination of a specific chemical cesium procedure in the routine monitoring program. Gamma spectroscopy, providing a cesium detection level at 10% of the drinking water limit, is now used to analyze the Four Mile Creek samples.

Note: The ± value represents th total 2σ uncertainty of individual releases based on counting error.

TABLE 5-6
ESTIMATED TRITIUM RELEASES IN SRS STREAMS AND SAVANNAH RIVER

Area	Release Point	Quantity, Curies 1986	1987	1988	1989	1989 % of Total To River
	Direct Releases					
Reactor						
100 P	Par Pond overflow to Lower Three Runs Creek	470	490	327	a	
	Process Sewer to Par Pond				164	
	Reactor HX Cooling Water to Par Pond				464	
100 L	L-Lake overflow to Steel Creek	311	520	502	b	
	Process Sewer to L Lake				24	
	Reactor HX Cooling Water to L Lake				98	
100 K	Process Sewer to Pen Branch	130	68	264	100	
	Reactor HX Cooling Water to Pen Branch	2,080	1,640	2,470	112	
100 C	Process Sewer to Four Mile Creek	32	4	11	16	
	Reactor HX Cooling Water to Four Mile Creek	250	c	c	c	
	Subtotal	**3,273**	**2,722**	**3,570**	**978**	**6**
Separations						
200 F	Effluent to Four Mile Creek	13	13	14	8	
	Effluent to Upper Three Runs				2	
200 H	Effluent to Four Mile Creek	55	204	12	20	
	Effluent to Upper Three Runs				1	
	Effluent Treatment Facility			101	2,070	
	Subtotal	**68**	**217**	**127**	**2,100**	**12**
400 D						
420 D	Effluent to Beaver Dam Creek	3,350				
421 2D	Effluent to Beaver Dam Creek	470				
772 D	Effluent to Beaver Dam Creek	170				
400 D	Process Sewer to Beaver Dam Creek		1,380[d]	1,740[d]	562[d]	
	Subtotal	**3,990**	**1,380**	**1,740**	**562**	**3**
	Total Direct Release	**7,330**	**4,320**	**5,440**	**3,640**	**21**

[a] Due to better flow measurements and increased analytical sensitivity, direct release totals from P Area in 1989 were taken closest to the source.

[b] Due to better flow measurements and increased analytical sensitivity, direct release totals from L Area in 1989 were taken closest to the source.

[c] C-Area heat exchanger cooling water releases in Four Mile Creek were discontinued in 1987.

[d] In 1987, the 400-D process sewer sample replaced the 420-D, 421-2D, and 772-D samples.

TABLE 5-6
ESTIMATED TRITIUM RELEASES IN SRS STREAMS AND SAVANNAH RIVER, CONT'D.

Area	Release Point	Quantity, Curies 1986	1987	1988	1989	1989 % of Total To River
	Migration					
200 F&H	Burial Ground and H-Seepage Basin to Four Mile Creek	5,210	6,150	3,670	3,600	
	200-F Seepage Basin to Four Mile Creek	1,770	2,760[a]	3,330	4,440	
	200-H Seepage Basin to Four Mile Creek	7,360	5,630[a]	3,980	3,310	
100 K	904-88G to Indian Grave Branch	6,130[b]	3,600	2,780	2,220	
100 P	Seepage Basin to Steel Creek	c	130	133	137	
	Subtotal	**20,470**	**18,270**	**13,900**	**13,700**	**79**
Total Direct Releases and Migration		**27,800**	**22,590**	**19,300**	**17,300**	**100**
	Stream Transport					
400 D	Beaver Dam Creek at Swamp	4,100	1,270	2,510	879	5
200 F&H	Four Mile Creek at Road A13	11,640	12,960	11,200	11,200	65
100 K	Pen Branch at Road A	5,720[d]	4,450	3,220	2,700	16
100 L	Steel Creek at Road A	390	640	502	556	3
100 P	Lower Three Runs at Road B	470	490	327	321	2
ETF	Upper Three Runs at Road A	-	720	535	2,160	12
	Subtotal	**22,320**	**20,530**	**18,300**	**17,800**	**103**
	River Transport					
Tritium measured in the Savannah River below SRS					17,110	99
Tritium measured in the Savannah River above SRS					1,480	
Tritium measured in the Savannah River below SRS (downriver minus upriver)		22,120	26,150	14,600	15,600	90

[a] Flow measurements for FM-2B were estimated from FM2X.17 for entire year because flow measurements at FM-2B were affected by presence of beaver dams.

[b] Flow measurements were estimated for 10/28-12/30 due to an inoperative USGS gauge.

[c] USGS flow gauge moved due to construction of L Lake. Gauge inoperative during most of the year.

[d] Flow measurements estimated for month of December due to inoperative equipment.

TABLE 5-7
TRITIUM RELEASES SUMMARY 1960 - 1989

	Curies (Ci)		
Year	Tritium Available for Transport to River Measured at Source[a]	Tritium in Transport in Streams Before Entry into River	Tritium in Transport Downriver of SRS Minus Ambient Upriver Contribution
1960	64,000[b]	69,600	73,700
1961	69,000[b]	83,000	77,000
1962	58,000[b]	64,000	63,000
1963	97,000[b]	96,900	122,800
1964	111,000[b]	131,600	143,000
1965	108,400	109,200	100,200
1966	84,900	97,800	78,300
1967	70,600	77,000	68,500
1968	63,800	67,200	61,800
1969	64,600	64,000	58,100
1970	36,900	43,200	31,800
1971	38,200	44,700	39,100
1972	46,800	47,300	45,300
1973	71,100	62,800	61,100
1974	59,900	54,600	46,000
1975	55,600	50,000	49,500
1976	59,600	47,400	51,100
1977	43,800	39,700	42,500
1978	37,600	35,300	36,600
1979	29,400	27,100	30,600
1980	24,900	28,800	30,700
1981	23,900	22,100	25,100
1982	32,200	31,300	30,600
1983	34,200	33,000	33,000
1984	32,800	32,600	33,200
1985	25,000	22,300	24,100
1986	27,800	22,300	22,100
1987	22,700	20,500	26,200
1988	19,300	18,300	14,600
1989	17,300	17,800	15,600

[a] Includes direct releases to streams and migration from F-, H-, K-, and P-Area seepage basins and Radioactive Waste Burial Ground to streams.

[b] Includes heat exchanger cooling water released from P Area (of Par Pond origin) to Steel Creek.

TABLE 5-8
COLLECTIVE COMMITTED DOSE FROM LIQUID RELEASES

By Pathway

Pathway	Population Dose person-rem[a]	% of Total Dose
Sport fish	5.87E-01	12.21
Commercial fishing	2.93E-02	0.61
Beaufort-Jasper	3.03E+00	63.02
Port Wentworth	1.16E+00	24.13
Salt water invert.	2.54E-04	0.01
Recreation-river	1.21E-03	0.03
Total	4.81E+00	

By Radionuclide

Radionuclide	Population Dose person-rem[a]	% of Total Dose
H-3	3.49E+00	72.49
Sr-90	1.75E-02	0.36
Zr-95, Nb-95	2.18E-09	0.00000005
Ru-103, 106	1.47E-05	0.0003
I-129	1.43E-03	0.03
Cs-137	5.79E-01	12.04
Ce-141, 144	1.36E-08	0.0000003
Pm-147	1.20E-07	0.0000025
U-235,238	3.28E-06	0.00007
Pu-239	7.38E-01	15.35
Total	4.81E+00	

[a] Committed effective dose equivalent.

TABLE 5-9
POTENTIAL DOSES FROM IRRIGATION PATHWAY

	Effective Dose Equivalent	
Food Type[a]	Maximum Individual mrem	Population person-rem
Vegetation	1.63E-01	2.53E+00
Leafy vegetables	2.01E-02	2.54E+00
Milk	5.99E-02	5.48E-01
Meat	2.05E-02	6.08E-03
Total	2.64E-01	5.62E+00

[a] Acreage for each food type assumed to be 1,000 acres.

TABLE 5-10
NPDES OUTFALL LOCATIONS

Outfall Identification	No. of Outfalls Permitted	Location
A	6	700-A Administration Area
C	4	100-C Reactor Area
D	7	400 D
DW	3	200-S Defense Waste Processing Facility
F	10	200-F Separations Area
FS	2	Flowing Streams Laboratory (SREL Laboratory on Upper Three Runs Creek)
H	12	200-H Separations Area
K	6	100-K Reactor Area
L	4	100-L Reactor Area
M	2	300-M Fuel Fabrication Facility
P	5	100-P Reactor Area
PP	1	Par Pond (SRL Environmental Laboratory)
S	4	Central Shops (Construction Shops)
T	3	TC-Area (Wackenhut Service Inc. Headquarters)
X	5	TNX - Semiworks Experimental Facility
Y	1	Classification Yard (Railroad Repair Shop)
SC-4	1	L-Lake Overflow to Steel Creek

TABLE 5-11
NPDES MONITORING DATA

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall A-1			
Flow	MGD	14	0.432	0.288	0.324
pH	pH	14	8.7	7.2	
Temperature	°F	14	80	68	74
Total Nonfilterable Residue	mg/L	14	20	<1	2.6
Oil & Grease	mg/L	14	2.1	<1	<1
Biochemical Oxygen Demand	mg/L	14	2.7	<1	<1
Tetrachloroethylene	µg/L	6	<2	<2	<2
Trichloroethylene	µg/L	6	6.3	<2	2.6
1,1,1-Trichloroethane	µg/L	6	<2	<1	<2
		Outfall A-3			
pH	pH	15	8.9	7.6	
Temperature	°F	15	78	54	67
Total Nonfilterable Residue	mg/L	15	1.0	<1	<1
Oil & Grease	mg/L	15	2.6	<1	<1
Tetrachloroethylene	µg/L	6	<2	<2	<2
Trichloroethylene	µg/L	6	5.5	<2	<2
1,1,1-Trichloroethane	µg/L	6	<2	<2	<2
Chromium	mg/L	24	<0.02	<0.02	<0.02
		Outfall A-5			
Flow	MGD	14	0.180	0.108	0.123
pH	pH	15	8.8	7.2	
Temperature	°F	15	76	58	68
Fecal Coliform	#/100	15	40	<2	11
Total Nonfilterable Residue	mg/L	15	2.0	<1	<1
Oil & Grease	mg/L	15	8.9	<1	1.4
Biochemical Oxygen Demand	mg/L	15	2.8	<1	1.2
Tetrachloroethylene	µg/L	15	2.8	<1	1.1
Trichloroethylene	µg/L	15	11	<2	3.6
1,1,1-Trichloroethane	µg/L	15	58	<2	5.0
		Outfall A-11			
pH	pH	15	8.8	7.6	
Temperature	°F	15	84	60	70
Total Nonfilterable Residue	mg/L	15	8.0	<1	2.0
Oil & Grease	mg/L	15	3.1	<1	1.0
Biochemical Oxygen Demand	mg/L	15	36	<1	3.6
Tetrachloroethylene	µg/L	6	<2	<2	<2
Trichloroethylene	µg/L	6	<2	<2	<2
1,1,1-Trichloroethane	µg/L	6	<2	<2	<2

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall A-14			
Flow	MGD	15	2.84	1.19	1.70
pH	pH	24	8.1	6.7	
Temperature	°F	15	75	56	68
Total Nonfilterable Residue	mg/L	14	10	<1	1.9
Oil & Grease	mg/L	15	4.6	<1	1.0
Biochemical Oxygen Demand	mg/L	14	4.5	<1	<1
Tetrachloroethylene	µg/L	15	<2	<2	<2
Trichloroethylene	µg/L	15	12	<2	3.1
1,1,1-Trichloroethane	µg/L	15	2.6	<2	1.1
		Outfall A-15			
Flow	MGD	12	0.154	0.098	0.128
pH	pH	15	7.5	6.4	
Fecal Coliform	#/100	18	8.0	<2	2.1
Total Nonfilterable Residue	mg/L	15	9.0	2.0	4.7
Biochemical Oxygen Demand	mg/L	15	6.8	2.2	3.8
		Outfall C-1			
pH	pH	12	8.8	6.6	
Temperature	°F	11	80	49	65
Total Nonfilterable Residue	mg/L	12	2.0	<1	1.5
Oil & Grease	mg/L	12	2.7	<1	<1
		Outfall C-3			
pH	pH	14	7.8	6.6	
Temperature	°F	14	78	69	73
Total Nonfilterable Residue	mg/L	14	4.0	<1	1.6
Oil & Grease	mg/L	14	3.9	<1	1.0
		Outfall C-4			
pH	pH	12	7.6	6.8	
Temperature	°F	9	86	54	75
Total Nonfilterable Residue	mg/L	12	4.0	<1	1.6
Oil & Grease	mg/L	12	1.0	<1	<1
		Outfall C-4A			
Flow	MGD	14	0.33	0.016	0.021
pH	pH	12	7.7	6.6	
Fecal Coliform	#/100	16	6.0	<2	1.4
Total Nonfilterable Residue	mg/L	14	25	<1	5.7
Biochemical Oxygen Demand	mg/L	14	9.4	<1	3.7

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall D-1			
pH	pH	19	7.5	6.8	
Temperature	°F	19	89	57	71
Total Nonfilterable Residue	mg/L	19	17	3.0	7.5
Oil & Grease	mg/L	19	1.5	<1	<1
		Outfall D-1A			
Flow	MGD	12	0.026	0.010	0.013
pH	pH	15	7.9	7.1	
Fecal Coliform	#/100	17	<2	<2	<2
Total Nonfilterable Residue	mg/L	15	15	1.0	6.0
Biochemical Oxygen Demand	mg/L	15	9.4	<1	3.7
		Outfall D-1B			
Flow	MGD	52		no flow	
		Outfall D-1C			
Flow	MGD	16	5.3	2.69	4.04
pH	pH	16	7.6	6.8	
Total Nonfilterable Residue	mg/L	16	25	<1	3.3
Oil & Grease	mg/L	16	2.1	<1	<1
		Outfall D-3			
pH	pH	16	7.8	6.9	
Total Nonfilterable Residue	mg/L	16	55	<1	4.6
Oil & Grease	mg/L	16	1.9	<1	<1
		Outfall D-5			
Flow	MGD	12		no flow	
		Outfall D-6			
pH	pH	16	7.7	6.5	
Temperature	°F	16	80	53	65
Fecal Coliform	#/100	17	3000	20	319
Total Nonfilterable Residue	mg/L	17	37	1.0	5.6
Oil & Grease	mg/L	16	1.4	<1	<1
		Outfall DW-1			
Flow	MGD	7	0.412	0.328	0.383
pH	pH	7	8.8	7.1	
Total Nonfilterable Residue	mg/L	7	47	4.0	16
		Outfall DW-2			
Flow	MGD	22	0.036	0.003	0.016
pH	pH	14	8.0	6.8	
Oil & Grease	mg/L	25	34	<1	5.5

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall DW-3			
Flow	MGD	12	0.019	0.009	0.016
pH	pH	14	7.6	7.1	
Fecal Coliform	#/100	16	76	<2	6.9
Total Nonfilterable Residue	mg/L	14	193	4.0	24
Biochemical Oxygen Demand	mg/L	14	66	<1	8.8
		Outfall F-1			
Flow	MGD	14	0.18	0.072	0.117
pH	pH	14	8.4	6.9	
Temperature	°F	14	84	70	78
Total Nonfilterable Residue	mg/L	14	16	<1	2.8
Oil & Grease	mg/L	14	12	<1	1.6
		Outfall F-2			
Flow	MGD	14	0.144	0.022	0.08
pH	pH	14	8.0	6.6	
Temperature	°F	14	75	52	65
Total Nonfilterable Residue	mg/L	14	3.0	<1	<1
Oil & Grease	mg/L	14	1.1	<1	<1
		Outfall F-3			
Flow	MGD	14	0.058	0.029	0.043
pH	pH	14	8.3	6.9	
Temperature	°F	14	79	60	72
Total Nonfilterable Residue	mg/L	14	11	<1	3.8
Oil & Grease	mg/L	14	1.9	<1	<1
Biochemical Oxygen Demand	mg/L	14	3.1	<1	<1
		Outfall F-3A			
Flow	MGD	12	0.027	0.007	0.010
pH	pH	17	7.8	6.8	
Fecal Coliform	#/100	20	<2	<2	<2
Total Nonfilterable Residue	mg/L	17	6.0	<1	2.6
Biochemical Oxygen Demand	mg/L	17	6.0	<1	2.7
		Outfall F-5			
Flow	MGD	14	0.144	0.058	0.090
pH	pH	14	8.4	7.2	
Temperature	°F	14	79	67	74
Total Nonfilterable Residue	mg/L	14	16	<1	2.8
Oil & Grease	mg/L	14	2.2	<1	<1
		Outfall F-7			
Flow	MGD	12		no flow	

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall F-8			
pH	pH	14	7.7	6.8	
Temperature	°F	14	86	66	78
Total Nonfilterable Residue	mg/L	14	5.0	<1	2.0
Oil & Grease	mg/L	17	<1	<1	<1
		Outfall F-8A			
Flow	MGD	12	0.094	0.066	0.08
pH	pH	17	7.5	6.7	
Fecal Coliform	#/100	20	6.0	<2	<2
Total Nonfilterable Residue	mg/L	17	7.0	<1	3.3
Biochemical Oxygen Demand	mg/L	17	32	<1	4.4
		Outfall F-12			
Flow	MGD	12	0.72	0.43	0.70
pH	pH	12	9.2	7.4	
Nitrate	mg/L	12	0.05	<0.01	<0.01
Ammonia	mg/L	12	0.14	<0.01	0.05
Total Nonfilterable Residue	mg/L	12	17	2.0	6.1
Manganese	mg/L	12	0.02	<0.005	0.01
Uranium	mg/L	12	0.61	<0.02	<0.02
Lead	mg/L	12	0.05	<0.003	0.005
Nickel	mg/L	12	<0.05	<0.05	<0.05
Silver	mg/L	11	<0.0005	<0.0005	<0.0005
Chromium	mg/L	4	<0.02	<0.02	<0.02
Aluminum	mg/L	12	0.73	0.16	0.27
Copper	mg/L	12	0.014	<0.01	<0.01
Mercury	mg/L	11	<0.0001	<0.0001	<0.0001
Zinc	mg/L	12	0.07	0.02	0.05
		Outfall F-13			
Flow	MGD	1	0.29	-	-
pH	pH	1	8.9	-	-
Nitrate	mg/L	1	0.02	-	-
Ammonia	mg/L	1	0.03	-	-
Total Nonfilterable Residue	mg/L	1	6.0	-	-
Manganese	mg/L	1	0.006	-	-
Uranium	mg/L	1	0.033	-	-
Lead	mg/L	1	<0.003	-	-
Nickel	mg/L	1	<0.05	-	-
Chromium	mg/L	1	<0.02	-	-
Aluminum	mg/L	1	0.17	-	-
Copper	mg/L	1	<0.01	-	-
Mercury	mg/L	1	<0.0001	-	-
Zinc	mg/L	1	0.09	-	-
		Outfall FS-1			
Flow	MGD	12		no flow	

- Insufficient data
MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall FS-2			
Flow	MGD	4	0.058	0.029	0.051
Fecal Coliform	#/100	4	2000	54	558
		Outfall H-2			
Flow	MGD	14	0.36	0.036	0.102
pH	pH	14	7.8	6.3	
Temperature	°F	14	79	61	72
Total Nonfilterable Residue	mg/L	14	26	<1	4.4
Oil & Grease	mg/L	14	2.2	<1	<1
		Outfall H-4			
Flow	MGD	14	0.23	0.058	0.13
pH	pH	14	8.4	6.4	
Temperature	°F	14	81	67	74
Total Nonfilterable Residue	mg/L	14	26	<1	7.1
Oil & Grease	mg/L	14	3.0	<1	<1
		Outfall H-6			
Flow	MGD	13		no flow	
		Outfall H-7			
Flow	MGD	11	0.115	0.014	0.055
pH	pH	11	7.8	6.5	
Temperature	°F	11	79	46	64
Total Nonfilterable Residue	mg/L	11	14	<1	3.9
Oil & Grease	mg/L	11	<1	<1	<1
Residual Chlorine	mg/L	7	<0.1	<0.1	<0.1
		Outfall H-8			
pH	pH	14	7.6	5.3	
Temperature	°F	14	79	61	69
Total Nonfilterable Residue	mg/L	14	49	1.0	6.4
Oil & Grease	mg/L	14	1.5	<1	<1
		Outfall H-8A			
Flow	MGD	14	0.315	0.009	0.08
pH	pH	14	7.8	5.1	
Total Nonfilterable Residue	mg/L	14	7.0	<1	2.3
Oil & Grease	mg/L	14	<1	<1	<1
		Outfall H-12			
Flow	MGD	12	2.33	0.646	1.51
pH	pH	14	8.1	5.4	
Temperature	°F	14	81	65	72
Total Nonfilterable Residue	mg/L	14	13	<1	2.7
Oil & Grease	mg/L	14	1.7	<1	<1
Sulfate	mg/L	6	14	11	12

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall H-13			
Flow	MGD	12	0.081	0.037	0.057
pH	pH	14	8.2	6.7	
Fecal Coliform	#/100	16	<2	<2	<2
Total Nonfilterable Residue	mg/L	14	32	1.0	6.8
Biochemical Oxygen Demand	mg/L	14	12	<1	4.2
		Outfall H-16			
Temperature	°F	49	85	58	73
Biochemical Oxygen Demand	mg/L	48	17	<1	3.9
Nitrate	mg/L	50	301	1.6	48
Ammonia	mg/L	50	3.9	<0.1	0.31
Total Nonfilterable Residue	mg/L	50	5.0	<1	<1
Oil & Grease	mg/L	48	6.9	<1	<1
Uranium	mg/L	12	<0.02	<0.02	<0.02
Lead	mg/L	52	0.014	<0.003	0.006
Nickel	mg/L	13	<0.05	<0.05	<0.05
Mercury	mg/L	50	0.0007	<0.0001	<0.0001
Chromium	mg/L	50	6.9	<0.02	0.21
Aluminum	mg/L	12	<0.05	<0.05	<0.05
Copper	mg/L	50	0.034	<0.01	<0.01
Zinc	mg/L	50	0.21	<0.01	0.03
Manganese	mg/L	48	0.053	<0.005	<0.01
Total Chlorine	mg/L	12	<0.1	<0.1	<0.1
		Outfall H-17			
Flow	MGD	8	0.72	0.43	0.67
pH	pH	8	8.7	6.8	
Nitrate	mg/L	8	0.33	<0.01	0.18
Ammonia	mg/L	8	0.25	<0.01	0.10
Total Nonfilterable Residue	mg/L	8	38	5.0	20
Manganese	mg/L	8	<1	<1	<1
Uranium	mg/L	7	<0.02	<0.02	<0.02
Lead	mg/L	8	0.23	<0.003	0.02
Nickel	mg/L	8	<0.05	<0.05	<0.05
Silver	mg/L	6	<0.0005	<0.0005	<0.0005
Chromium	mg/L	8	<0.02	<0.02	<0.02
Aluminum	mg/L	8	1.9	0.31	0.91
Copper	mg/L	8	0.01	<0.01	<0.01
Mercury	mg/L	8	<0.0001	<0.0001	<0.0001
Zinc	mg/L	8	0.18	0.05	0.13

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall H-18			
Flow	MGD	11	1.0	0.72	0.95
pH	pH	11	8.4	4.3	
Nitrate	mg/L	11	0.76	<0.01	0.08
Manganese	mg/L	11	<0.005	<0.005	<0.005
Total Nonfilterable Residue	mg/L	11	3.0	<1	1.4
Ammonia	mg/L	11	0.03	<0.01	0.02
Uranium	mg/L	11	<0.02	<0.02	<0.02
Lead	mg/L	11	0.06	<0.003	<0.003
Nickel	mg/L	11	<0.05	<0.05	<0.05
Silver	mg/L	11	<0.001	<0.0005	<0.0005
Chromium	mg/L	11	<0.02	<0.02	<0.02
Aluminum	mg/L	11	0.21	<0.05	0.08
Copper	mg/L	11	<0.01	<0.01	<0.01
Mercury	mg/L	11	<0.0001	<0.0001	<0.0001
Zinc	mg/L	11	0.08	<0.01	0.04
		Outfall K-1			
Flow	MGD	11	1.01	0.022	0.125
pH	pH	11	7.4	6.6	
Temperature	°F	11	85	66	75
Total Nonfilterable Residue	mg/L	11	31	<1	7.5
Oil & Grease	mg/L	11	7.4	<1	1.5
Sulfate	mg/L	7	13	8.5	11
		Outfall K-6			
Flow	MGD	12	0.648	0.029	0.176
pH	pH	12	8.0	6.0	
Temperature	°F	12	80	57	69
Total Nonfilterable Residue	mg/L	12	53	1.0	8.7
Oil & Grease	mg/L	12	2.2	<1	<1
		Outfall K-8			
Flow	MGD	14	0.648	0.029	0.159
pH	pH	14	7.6	6.9	
Temperature	°F	14	82	58	71
Total Nonfilterable Residue	mg/L	14	103	<1	14
Oil & Grease	mg/L	14	4.5	<1	1.1
		Outfall K-10			
Flow	MGD	14	0.72	0.029	0.20
pH	pH	14	9.8	6.8	
Temperature	°F	14	86	60	73
Total Nonfilterable Residue	mg/L	14	65	<1	11
Oil & Grease	mg/L	14	1.9	<1	<1

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall K-11			
pH	pH	14	7.4	7.0	
Temperature	°F	12	83	54	70
Total Nonfilterable Residue	mg/L	14	8.0	1.0	3.6
Oil & Grease	mg/L	14	2.6	<1	<1
Biochemical Oxygen Demand	mg/L	14	1.4	<1	<1
		Outfall K-12			
pH	pH	13	8.3	7.0	
Fecal Coliform	#/100	14	4.0	<2	<2
Total Nonfilterable3 Residue	mg/L	13	12	<1	3.6
Biochemical Oxygen Demand	mg/L	13	16	<1	3.0
		Outfall L-7			
pH	pH	14	8.4	7.0	
Temperature	°F	13	89	55	70
Total Nonfilterable Residue	mg/L	14	14	2.0	4.6
Oil & Grease	mg/L	14	1.8	<1	<1
		Outfall L-7A			
Flow	MGD	12	0.033	0.016	0.020
pH	pH	13	8.4	7.2	
Fecal Coliform	#/100	14	<2	<2	<2
Total Nonfilterable Residue	mg/L	13	3.0	<1	2.0
Biochemical Oxygen Demand	mg/L	13	16	<1	3.4
		Outfall L-8			
Flow	MGD	14	1.73	0.432	0.997
pH	pH	13	7.7	7.1	
Temperature	°F	14	80	58	71
Total Nonfilterable Residue	mg/L	15	15	1.0	2.0
Oil & Grease	mg/L	16	2.6	<1	<1
		Outfall L-10			
Flow	MGD	1	0.432	-	-
pH	pH	1	6.8	-	-
Oil & Grease	µg/L	1	5.0	-	-

- Insufficient data
MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall M-4			
Flow	MGD	22	0.095	0.007	0.068
pH	pH	21	8.2	7.0	
Nitrate	mg/L	12	257	38	99
Phosphate	mg/L	12	9.1	0.008	1.5
Total Nonfilterable Residue	mg/L	22	3.0	<1	1.5
Oil & Grease	mg/L	23	6.2	<1	<1
Uranium	mg/L	22	0.49	<0.02	0.04
Lead	mg/L	22	0.07	<0.003	0.02
Nickel	mg/L	22	0.05	<0.05	<0.05
Silver	mg/L	1	<0.0005	-	-
Chromium	mg/L	1	<0.02	-	-
Aluminum	mg/L	22	2.9	0.09	0.61
Copper	mg/L	22	0.12	<0.01	0.02
Cyanide	mg/L	1	<0.005	-	-
Cadmium	mg/L	1	<0.01	-	-
Zinc	mg/L	1	0.06	-	-
		Outfall M-5			
Flow	MGD	50	0.59	0.49	0.564
pH	pH	28	7.1	4.8	
Tetrachloroethylene	µg/L	52	<2.7	<2	<2
Trichloroethylene	µg/L	52	<2	<2	<2
1,1,1-Trichloroethane	µg/L	52	<2	<2	<2
		Outfall P-5			
Flow	MGD	12		no flow	
		Outfall P-7			
pH	pH	11	8.0	6.9	
Temperature	°F	11	86	57	67
Total Nonfilterable Residue	mg/L	11	53	<1	7.0
Oil & Grease	mg/L	11	2.0	<1	<1
Aluminum	mg/L	11	2.8	<1	0.42
Iron	mg/L	11	3.0	0.20	0.93
		Outfall P-13			
pH	ph	14	7.6	6.8	
Temperature	°F	8	80	53	68
Total Nonfilterable Residue	mg/L	14	15	<1	2.1
Oil & Grease	mg/L	14	2.2	<1	<1
		Outfall P-19			
pH	pH	14	8.0	7.0	
Temperature	°F	12	84	55	71
Total Nonfilterable Residue	mg/L	14	18	2.0	4.3
Oil & Grease	mg/L	14	1.9	<1	<1

\- Insufficient data
MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall P-20			
pH	pH	13	8.4	6.8	
Fecal Coliform	#/100	15	4.0	<2	<2
Total Nonfilterable Residue	mg/L	13	8.0	<1	3.3
Biochemical Oxygen Demand	mg/L	13	15	<1	4.5
		Outfall PP-1			
Flow	MGD	2	0.288	0.094	0.0191
Oil & Grease	mg/L	2	<1	<1	<1
		Outfall S-2			
Flow	MGD	30	0.864	0.014	0.119
pH	pH	10	8.0	6.2	
Temperature	°F	10	74	47	63
Total Nonfilterable Residue	mg/L	10	32	<1	9.1
Oil & Grease	mg/L	10	2.7	<1	<1
Biochemical Oxygen Demand	mg/L	10	2.7	<1	1.2
Aluminum	mg/L	10	1.5	0.27	0.67
Iron	mg/L	10	2.0	0.48	1.2
		Outfall S-8			
Flow	MGD	13		no flow	
		Outfall S-11			
Flow	MGD	12	0.071	0.030	0.045
pH	pH	13	7.4	6.7	
Fecal Coliform	#/100	14	4.0	<2	<2
Total Nonfilterable Residue	mg/L	13	13	2.0	4.6
Biochemical Oxygen Demand	mg/L	13	14	<1	2.0
		Outfall S-14			
Flow	MGD	13		no flow	
		Outfall SC-4			
pH	pH	12	7.7	6.8	
Arsenic	mg/L	12	<0.003	<0.003	<0.003
Chromium	mg/L	12	<0.02	<0.02	<0.02
Lead	mg/L	12	0.008	<0.003	0.003
Mercury	mg/L	12	<0.0001	<0.0001	<0.0001
Selenium	mg/L	12	<0.006	<0.006	<0.006
Cadmium	mg/L	12	<0.01	<0.01	<0.01
Silver	mg/L	12	<0.0005	<0.0005	<0.0005
Barium	mg/L	12	0.039	<0.01	0.02
Nitrate	mg/L	12	0.20	0.05	0.07
Phosphate	mg/L	12	0.40	0.02	0.13

MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall T-1			
Flow	MGD	1	0.007	-	-
		Outfall T-5			
Flow	MGD	13		no flow	
		Outfall T-7			
pH	pH	23	8.0	6.8	
Fecal Coliform	#/100	26	12	<2	<2
Total Nonfilterable Residue	mg/L	24	29	<1	5.4
Biochemical Oxygen Demand	mg/L	24	20	<1	3.2
		Outfall X-4			
pH	pH	15	7.4	6.8	
Temperature	°F	15	84	71	75
Total Nonfilterable Residue	mg/L	15	10	<1	2.2
Oil & Grease	mg/L	15	2.8	<1	<1
		Outfall X-8			
Flow	MGD	15	0.324	0.032	0.223
pH	pH	15	7.2	6.8	
Temperature	°F	15	82	68	76
Total Nonfilterable Residue	mg/L	15	37	1.0	8.1
Oil & Grease	mg/L	15	1.8	<1	<1
Aluminum	mg/L	15	0.45	<0.05	0.15
Iron	mg/L	15	11	0.81	2.3
		Outfall X-11			
Flow	MGD	7	0.003	0.001	0.002
		Outfall X-13			
pH	pH	15	8.1	6.7	
Fecal Coliform	#/100	16	10	<2	2.1
Total Nonfilterable Residue	mg/L	15	12	<1	5.1
Biochemical Oxygen Demand	mg/L	15	3.6	<1	1.8
		Outfall X-14			
Biochemical Oxygen Demand	mg/L	55	72	<1	5.5
Total Suspended Solids	mg/L	55	60	1.0	7.7
Oil & Grease	mg/L	55	4.2	<1	1.0
Total Organic Carbon	mg/L	55	99	<1	8.7
Benzene	µg/L	55	11	<1	<1
Phenol	mg/L	55	0.06	<0.002	<0.01
Mercury	µg/L	55	2.1	<0.1	0.34

- Insufficient data
MGD=Million gallons per day

TABLE 5-11
NPDES MONITORING DATA, CONT'D.

Measurement	Units	Freq/Year	Maximum	Minimum	Average
		Outfall Y-1			
Flow	MGD	1	0.036	-	-
pH	pH	1	7.0	-	-
Temperature	°F	1	70	-	-
Biochemical Oxygen Demand	mg/L	1	2.2	-	-
Total Suspended Solids	mg/L	1	13	-	-
Oil and Grease	mg/L	1	2.0	-	-

- Insufficient data
MGD=Million gallons per day

TABLE 5-12
SAVANNAH RIVER WATER QUALITY

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
River 3B Below Plant Vogtle[a]						
Water Volume	L		7.877E+12 (total)			
Temperature[b]	°C	12	27	10	19	± 12
pH[b]	pH	12	7.6	5.8		
Dissolved Oxygen[b]	mg/L	12	11	4.5	7.4	± 4.7
Alkalinity	mg/L	12	31	20	25	± 7.5
Hardness	mg/L	4	21	18	-	-
Conductivity[b]	µmho/cm	12	141	84	116	± 40
Turbidity	NTU	12	12	2.1	3.9	± 5.4
Suspended Solids	mg/L	12	34	4.0	12	± 15
Volatile Solids	mg/L	12	6.0	1.0	2.6	± 2.6
Total Dissolved Solids	mg/L	12	97	50	76	± 32
Total Solids	mg/L	12	112	66	87	± 33
Fixed Residue	mg/L	12	28	3.0	10	± 13
COD	mg/L	12	14	8.0	12	± 3.7
Chloride	mg/L	12	13	5.0	10	± 5.4
Nitrogen (as NO_2/NO_3)	mg/L	12	0.58	0.13	0.38	± 0.24
Sulfate	mg/L	12	22	6.0	13	± 12
Phosphorus (as PO_4)	mg/L	12	0.25	0.06	0.21	± 0.57
Aluminum	mg/L	3	0.14	0.07	-	-
Nitrogen (as NH_3)	mg/L	12	0.27	0.06	0.15	± 0.12
Calcium	mg/L	4	6.5	5.1	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	1.4	1.2	-	-
Manganese	mg/L	4	0.04	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.87	<0.01	-	-
Sodium	mg/L	3	14	10	-	-
Iron	mg/L	4	0.42	0.08	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-
River 2 Above SRS[a]						
Water Volume	L		7.158E+12 (total)			
Temperature[b]	°C	12	27	10	19	± 13
pH[b]	pH	12	7.8	5.8		
Dissolved Oxygen[b]	mg/L	12	9.9	4.8	7.0	± 3.7
Alkalinity	mg/L	12	31	20	25	± 7.1
Hardness	mg/L	4	20	18	-	-
Conductivity[b]	µmho/cm	12	137	85	114	± 33
Turbidity	NTU	12	12	2.1	3.9	± 5.3
Suspended Solids	mg/L	12	26	5.0	14	± 13
Volatile Solids	mg/L	12	4.0	1.0	2.9	± 2.0
Total Dissolved Solids	mg/L	12	103	47	73	± 35
Total Solids	mg/L	12	122	52	87	± 38
Fixed Residue	mg/L	12	22	3.0	11	± 12
COD	mg/L	12	13	8.0	11	± 2.8
Chloride	mg/L	12	13	5.8	9.7	± 4.2
Nitrogen (as NO_2/NO_3)	mg/L	12	0.63	0.17	0.38	± 0.26

[a] Metals are analyzed quarterly from a continuous flow composite.
[b] Field measurement.
- Insufficient data; mean not calculated for<5 samples.

TABLE 5-12
SAVANNAH RIVER WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
River 2 Above SRS, Cont'd.[a]						
Sulfate	mg/L	12	22	6.0	12	± 11
Phosphorus (as PO_4)	mg/L	12	0.25	0.06	0.13	± 0.13
Aluminum	mg/L	3	0.09	0.04	-	-
Nitrogen (as NH_3)	mg/L	12	0.34	0.07	0.17	± 0.15
Calcium	mg/L	4	6.0	5.0	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	1.5	1.2	-	-
Manganese	mg/L	4	0.14	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.01	<0.01	-	-
Sodium	mg/L	3	14	12	-	-
Iron	mg/L	4	0.78	0.04	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	0.01	<0.01	-	-
River 10 Below SRS[a]						
Water Volume	L		7.078E+12 (total)			
Temperature[b]	°C	12	27	10	19	± 13
pH[b]	pH	12	8.0	6.0		
Dissolved Oxygen[b]	mg/L	12	10	4.5	6.9	± 3.9
Alkalinity	mg/L	12	31	19	25	± 69
Hardness	mg/L	4	19	18	-	-
Conductivity[b]	µmho/cm	12	136	70	114	± 33
Turbidity	NTU	12	8.5	2.0	3.4	± 3.5
Suspended Solids	mg/L	12	21	5.0	13	± 11
Volatile Solids	mg/L	12	5.0	1.0	2.8	± 2.1
Total Dissolved Solids	mg/L	12	100	54	74	± 29
Total Solids	mg/L	12	113	59	87	± 33
Fixed Residue	mg/L	12	21	3.0	10	± 9.6
COD	mg/L	12	14	8.0	11	± 3.2
Chloride	mg/L	12	12	6.0	10	± 3.8
Nitrogen (as NO_2/NO_3)	mg/L	12	0.61	0.06	0.39	± 0.38
Sulfate	mg/L	12	22	7.0	11	± 10
Phosphorus (as PO_4)	mg/L	12	0.32	0.05	0.16	± 0.18
Aluminum	mg/L	3	0.10	0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.17	<0.01	0.10	± 0.09
Calcium	mg/L	4	6.1	5.4	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	1.4	0.63	-	-
Manganese	mg/L	4	0.09	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.04	<0.01	-	-
Sodium	mg/L	3	14	9.0	-	-
Iron	mg/L	4	0.90	0.05	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-

[a] Metals are analyzed quarterly from a continuous flow composite.
[b] Field measurement.
- Insufficient data; mean not calculated for <5 samples.

TABLE 5-13
FECAL COLIFORM BACTERIA IN SRS STREAMS AND THE SAVANNAH RIVER

		Colonies/100 mL				
	No. of	Weekly Values		Monthly Geometric Mean[a]		
Location	Samples	Maximum	Minimum	Maximum	Minimum	Average
River 2, above SRS	52	23,000	20	683	55	253
River 3B, Plant Vogtle Discharge	52	9,800	4	332	13	144
River 10, below SRS	52	2,200	4	144	18	76
Upper Three Runs Creek at Road F	52	2,600	36	244	64	117
Upper Three Runs Creek at Road A	52	2,100	6	188	66	112
Beaver Dam Creek near Swamp	52	1,400	16	229	22	91
Four Mile Creek at Road A	52	1,400	<2.0	107	28	53
Pen Branch at Road A	52	920	<2.0	178	34	92
Steel Creek at Road A	12	58	2	16[b]	8[b]	14[b]
Lower Three Runs Creek at Road A	52	4,100	<2.0	220	54	134
Lower Three Runs Creek at Tabernacle Church Road	52	1,700	50	281	116	182

[a] Maximum, minimum and average of monthly geometric mean of weekly values. The standard for South Carolina states that the fecal coliform count should not exceed a geometric mean of 1,000 colonies/100 mL based on five consecutive samples during any 30-day period; nor exceed 2,000 colonies/100 mL in more than 20% of the samples examined during such period (not applicable during or following periods of rainfall).

[b] Quarterly results.

TABLE 5-14
SRS STREAM WATER QUALITY

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Tims Branch 5 SCDHEC[a]						
Water Volume	L		5.902E+9 (total)			
Temperature[b]	°C	12	22	7.1	15	± 11
pH[b]	pH	12	8.3	6.2		
Dissolved Oxygen[b]	mg/L	12	12	6.6	8.7	± 3.4
Alkalinity	mg/L	12	19	13	16	± 4.9
Hardness	mg/L	4	5.9	5.0	-	-
Conductivity[b]	µmho/cm	12	82	38	57	± 26
Total Organic Carbon	mg/L	12	12	<1.0	3.2	± 6.1
Turbidity	NTU	12	12	3.1	5.4	± 6.3
Suspended Solids	mg/L	12	15	4.0	7.2	± 7.6
Volatile Solids	mg/L	12	5.0	1.0	2.6	± 2.2
Total Dissolved Solids	mg/L	12	61	33	43	± 15
Total Solids	mg/L	12	72	37	50	± 19
Fixed Residue	mg/L	12	10	2.0	4.8	± 5.8
Total COD	mg/L	12	10	1.0	5.9	± 5.6
Organic Nitrogen	mg/L	12	1.6	0.17	0.46	± 0.80
Chloride	mg/L	12	6.4	0.91	2.9	± 2.7
Nitrogen (NO_2/NO_3)	mg/L	12	0.87	0.04	0.49	± 0.62
Sulfate	mg/L	12	15	1.0	4.1	± 7.3
Phosphorus (as PO_4)	mg/L	12	0.44	0.03	0.09	± 0.23
Aluminum	mg/L	3	0.23	0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.12	<0.01	0.05	± 0.08
Calcium	mg/L	4	1.7	1.4	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.46	0.37	-	-
Manganese	mg/L	4	0.04	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.07	<0.01	-	-
Sodium	mg/L	3	11	7.8	-	-
Iron	mg/L	4	0.80	0.11	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	0.01	<0.01	-	-
Steel Creek at Road A SCDHEC[a]						
Water Volume	L		1.278E+11 (total)			
Temperature[b]	°C	12	22	7.1	15	± 11
pH[b]	pH	12	8.3	6.2		
Dissolved Oxygen[b]	mg/L	12	12	6.6	8.7	± 3.4
Alkalinity	mg/L	12	19	15	17	± 3.1
Hardness	mg/L	4	13	11	-	-
Conductivity[b]	µmho/cm	12	82	38	57	± 26
Total Organic Carbon	mg/L	12	12	1.3	4.3	± 5.7
Turbidity	NTU	12	2.5	1.2	1.6	± 0.74
Suspended Solids	mg/L	12	10	3.0	5.8	± 4.3
Volatile Solids	mg/L	12	4.0	1.0	2.3	± 1.8

[a] Metals are analyzed quarterly from a monthly grab composite.
[b] Field measurements.
- Insufficient data, mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Steel Creek at Road A SCDHEC, Cont'd.[a]						
Total Dissolved Solids	mg/L	12	66	40	58	± 15
Total Solids	mg/L	12	74	44	64	± 17
Fixed Residue	mg/L	12	7.0	2.0	3.6	± 3.1
COD	mg/L	12	14	5.0	10	± 4.9
Organic Nitrogen	mg/L	12	1.9	0.27	0.57	± 0.86
Chloride	mg/L	12	9.6	7.6	8.7	± 1.5
Nitrogen (NO_2/NO_3)	mg/L	12	0.39	0.05	4.6	± 8.9
Sulfate	mg/L	12	56	5.0	12	± 28
Phosphorus (as PO_4)	mg/L	12	0.36	0.02	0.06	± 0.19
Aluminum	mg/L	3	0.01	<0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.15	<0.01	0.08	± 0.08
Calcium	mg/L	4	3.3	2.7	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	1.2	1.0	-	-
Manganese	mg/L	4	<0.01	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.07	<0.01	-	-
Sodium	mg/L	3	11	9.9	-	-
Iron	mg/L	4	0.10	<0.02	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.02	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-
Upper Three Runs at Road A SCDHEC[a]						
Water Volume	L		9.856E+11 (total)			
Temperature[b]	°C	12	23	7.7	16	± 11
pH[b]	pH	12	8.0	6.0		
Dissolved Oxygen[b]	mg/L	12	11	6.6	8.3	± 2.5
Alkalinity	mg/L	12	7.0	3.0	5.2	± 2.6
Hardness	mg/L	4	7.0	2.4	-	-
Conductivity[b]	µmho/cm	12	41	23	31	± 12
Total Organic Carbon	mg/L	12	7.0	<1.0	3.2	± 3.5
Turbidity	NTU	12	4.8	1.2	2.4	± 2.0
Suspended Solids	mg/L	12	15	2.0	7.2	± 7.5
Volatile Solids	mg/L	12	6.0	<1.0	2.8	± 3.1
Total Dissolved Solids	mg/L	12	57	17	31	± 2.0
Total Solids	mg/L	12	66	21	38	± 22
Fixed Residue	mg/L	12	10	1.0	4.7	± 4.9
COD	mg/L	12	31	4.0	11	± 14
Organic Nitrogen	mg/L	12	2.8	0.16	0.51	± 1.5
Chloride	mg/L	12	2.5	0.54	1.8	± 1.2
Nitrogen (NO_2/NO_3)	mg/L	12	0.91	0.04	0.22	± 0.46
Sulfate	mg/L	12	5.0	1.0	2.9	± 2.3
Phosphorus (as PO_4)	mg/L	12	0.04	0.01	0.02	± 0.02
Aluminum	mg/L	3	0.10	0.05	-	-
Nitrogen (as NH_3)	mg/L	12	0.11	<0.01	0.03	± 0.07
Calcium	mg/L	4	2.3	0.69	-	-

[a] Metals are analyzed quarterly from a monthly grab composite.

[b] Field measurements.

\- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Upper Three Runs at Road A SCDHEC, Cont'd.[a]						
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.36	0.17	-	-
Manganese	mg/L	4	<0.01	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.08	<0.01	-	-
Sodium	mg/L	3	2.0	1.6	-	-
Iron	mg/L	4	0.71	0.07	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.02	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-
Four Mile Creek Road at A-7 SCDHEC[a]						
Water Volume	L		1.342E+10 (total)			
Temperature[b]	°C	12	26	7.7	16	± 13
pH[b]	pH	12	8.1	6.6		
Dissolved Oxygen[b]	mg/L	12	11	6.2	8.3	± 3.2
Alkalinity	mg/L	12	24	9.0	16	± 9.6
Hardness	mg/L	4	12	11	-	-
Conductivity[b]	µmho/cm	12	112	74	87	± 26
Total Organic Carbon	mg/L	12	5.8	<1.0	2.6	± 2.6
Turbidity	NTU	12	5.5	1.0	3.0	± 2.9
Suspended Solids	mg/L	12	13	2.0	5.2	± 6.9
Volatile Solids	mg/L	12	4.0	1.0	1.8	± 1.9
Total Dissolved Solids	mg/L	12	73	43	62	± 20
Total Solids	mg/L	12	80	46	67	± 22
Fixed Residue	mg/L	12	9.0	1.0	3.2	± 5.4
COD	mg/L	12	12	0.04	6.0	± 6.8
Organic Nitrogen	mg/L	12	2.7	0.10	0.53	± 1.4
Chloride	mg/L	12	3.8	2.2	3.2	± 1.1
Nitrogen (NO_2/NO_3)	mg/L	12	4.0	0.78	1.9	± 1.9
Sulfate	mg/L	12	15	5.0	9.2	± 5.4
Phosphorus (as PO_4)	mg/L	12	0.14	0.01	0.03	± 0.07
Aluminum	mg/L	3	0.11	0.01	-	-
Nitrogen (as NH_3)	mg/L	12	0.11	<0.01	0.02	± 0.06
Calcium	mg/L	4	3.9	3.5	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.66	0.27	-	-
Manganese	mg/L	4	0.07	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.05	<0.01	-	-
Sodium	mg/L	3	14	9.6	-	-
Iron	mg/L	4	0.95	0.04	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	0.02	<0.01	-	-

[a] Metals are analyzed quarterly from a monthly grab composite.

[b] Field measurements.

\- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Crouch Branch						
Water Volume	L		8.127E+08 (total)			
Temperature[a]	°C	12	27	5.9	16	± 14
pH[a]	pH	12	6.9	6.0		
Dissolved Oxygen[a]	mg/L	12	11	3.6	6.4	± 4.3
Turbidity	NTU	12	127	3.3	42	± 82
Suspended Solids	mg/L	12	71	3.0	26	± 49
Lower Three Runs at Patterson Mill[b]						
Water Volume	L		9.622E+10 (total)			
Temperature[a]	°C	12	26	5.9	17	± 14
pH[a]	pH	12	7.3	6.2		
Dissolved Oxygen[a]	mg/L	12	10	6.2	8.2	± 3.1
Alkalinity	mg/L	12	40	24	31	± 9.8
Hardness	mg/L	4	32	26	-	-
Conductivity[a]	µmho/cm	12	103	94	98	± 5.1
Turbidity	NTU	12	1.9	<1.0	2.5	± 3.9
Suspended Solids	mg/L	12	29	2.0	5.7	± 15
Volatile Solids	mg/L	12	13	1.0	3.0	± 6.6
Total Dissolved Solids	mg/L	12	75	45	61	± 19
Total Solids	mg/L	12	97	47	67	± 27
Fixed Residue	mg/L	12	15	<1.0	2.9	± 8.4
COD	mg/L	12	14	6.0	11	± 5.1
Chloride	mg/L	12	8.4	5.5	7.8	± 8.8
Nitrogen (NO_2/NO_3)	mg/L	12	0.15	<0.02	0.06	± 0.09
Sulfate	mg/L	12	12	4.0	6.6	± 5.4
Phosphorus (as PO_4)	mg/L	12	0.16	<0.02	0.03	± 0.08
Aluminum	mg/L	3	0.01	<0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.16	<0.01	0.06	± 0.10
Calcium	mg/L	4	11	8.8	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.94	0.73	-	-
Manganese	mg/L	4	<0.01	<0.01	-	-
Mercury	µg/L	4	0.40	<0.20	-	-
Nickel	mg/L	3	0.06	<0.01	-	-
Sodium	mg/L	3	7.8	6.2	-	-
Iron	mg/L	4	0.21	0.03	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-

[a] Field measurements.

[b] Metals are analyzed quarterly from a continuous flow composite.

- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
McQueen Branch						
Water Volume	L		7.091E+08 (total)			
Temperature[a]	°C	12	24	6.3	15	± 12
pH[a]	pH	12	7.6	6.2		
Dissolved Oxygen[a]	mg/L	12	10	6.4	8.7	± 2.1
Turbidity	NTU	12	8.0	3.0	5.2	± 3.4
Suspended Solids	mg/L	12	7.0	<1.0	3.2	± 3.5
Pen Branch Road at A-17[b]						
Water Volume	L		6.130E+10 (total)			
Temperature[a]	°C	12	27	7.8	17	± 13
pH[a]	pH	12	7.4	6.3		
Dissolved Oxygen[a]	mg/L	12	10	8.2	8.9	± 1.2
Alkalinity	mg/L	12	25	16	22	± 6.6
Hardness	mg/L	4	19	18	-	-
Conductivity[a]	µmho/cm	12	171	66	105	± 50
Turbidity	NTU	12	8.4	1.7	3.9	± 3.9
Suspended Solids	mg/L	12	10	2.0	5.6	± 4.0
Volatile Solids	mg/L	12	3.0	1.0	1.9	± 1.6
Total Dissolved Solids	mg/L	12	120	49	73	± 39
Total Solids	mg/L	12	126	55	79	± 39
Fixed Residue	mg/L	12	7.0	1.0	3.8	± 2.9
COD	mg/L	12	14	8.0	11	± 3.2
Chloride	mg/L	12	27	4.5	9.4	± 12
Nitrogen (NO_2/NO_3)	mg/L	12	0.56	0.10	0.36	± 0.28
Sulfate	mg/L	12	20	<5.0	9.9	± 11
Phosphorus (as PO_4)	mg/L	12	0.15	0.04	0.09	± 0.08
Aluminum	mg/L	3	0.06	0.04	-	-
Nitrogen (as NH_3)	mg/L	12	0.03	<0.01	0.02	± 0.02
Calcium	mg/L	4	5.8	5.2	-	-
Copper	mg/L	4	0.11	0.03	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	1.2	1.0	-	-
Manganese	mg/L	4	0.02	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.08	<0.01	-	-
Sodium	mg/L	3	12	7.3	-	-
Iron	mg/L	4	0.31	0.09	-	-
Lead	mg/L	4	<0.01	<0.01	-	-
Chromium	mg/L	4	<0.01	<0.01	-	-
Zinc	mg/L	4	0.03	<0.01	-	-

[a] Field measurements.

[b] Metals are analyzed quarterly from a continuous flow composite.

- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Four Mile Creek at Road A[a]						
Water Volume	L		2.519E+10 (total)			
Temperature[b]	°C	12	27	6.2	17	± 14
pH[b]	pH	12	7.2	6.3		
Dissolved Oxygen[b]	mg/L	12	12	7.0	8.9	± 2.7
Alkalinity	mg/L	12	32	9.0	17	± 12
Hardness	mg/L	4	13	12	-	-
Conductivity[b]	µmho/cm	12	81	33	70	± 27
Turbidity	NTU	12	5.5	1.0	1.8	± 2.6
Suspended Solids	mg/L	12	47	1.0	5.8	± 26
Volatile Solids	mg/L	12	6.0	<1.0	1.6	± 2.9
Total Dissolved Solids	mg/L	12	58	36	50	± 12
Total Solids	mg/L	12	83	46	56	± 19
Fixed Residue	mg/L	12	41	<1.0	4.6	± 23
COD	mg/L	12	12	2.0	6.2	± 6.3
Chloride	mg/L	12	4.8	3.2	3.6	± 1.6
Nitrogen (NO_2/NO_3)	mg/L	12	5.1	0.25	1.4	± 2.8
Sulfate	mg/L	12	22	3.0	7.5	± 9.8
Phosphorus (as PO_4)	mg/L	12	0.08	0.01	0.03	± 0.05
Aluminum	mg/L	3	0.14	0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.14	<0.01	0.03	± 0.08
Calcium	mg/L	4	4.1	3.7	-	-
Copper	mg/L	4	0.30	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.67	0.54	-	-
Manganese	mg/L	4	0.02	<0.01	-	-
Mercury	µg/L	4	0.40	<0.20	-	-
Nickel	mg/L	3	0.07	<0.01	-	-
Sodium	mg/L	3	8.6	7.8	-	-
Iron	mg/L	4	0.26	0.07	-	-
Lead	mg/L	4	<0.10	<0.10	-	-
Chromium	mg/L	4	0.01	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-
Upper Three Runs at Highway 278[a]						
Water Volume	L		1.006E+11 (total)			
Temperature[b]	°C	12	24	9.6	16	± 10
pH[b]	pH	12	7.6	5.2		
Dissolved Oxygen[b]	mg/L	12	9.7	7.2	8.5	± 1.4
Alkalinity	mg/L	12	4.0	1.0	2.4	± 0.90
Hardness	mg/L	4	3.0	2.4	-	-
Conductivity[b]	µmho/cm	12	42	16	23	± 15
Turbidity	NTU	12	1.3	<1.0	1.0	± 0.63
Suspended Solids	mg/L	12	5.0	3.0	3.4	± 1.3
Volatile Solids	mg/L	12	3.0	1.0	1.9	± 1.6
Total Dissolved Solids	mg/L	12	25	6.0	19	± 12
Total Solids	mg/L	12	28	11	22	± 11

[a] Metals are analyzed quarterly from a continuous flow composite.
[b] Field measurements.
- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Upper Three Runs at Highway 278, Cont'd.[a]						
Fixed Residue	mg/L	12	3.0	<1.0	1.6	± 1.4
COD	mg/L	12	8.0	<1.0	4.7	± 3.9
Chloride	mg/L	12	2.4	1.2	1.8	± 0.67
Nitrogen (NO_2/NO_3)	mg/L	12	0.30	0.17	0.24	± 0.09
Sulfate	mg/L	12	11	1.0	3.3	± 5.7
Phosphorus (as PO_4)	mg/L	12	0.07	0.01	0.02	± 0.04
Aluminum	mg/L	3	0.05	0.02	-	-
Nitrogen (as NH_3)	mg/L	12	0.03	<0.01	0.02	± 0.02
Calcium	mg/L	4	0.69	0.50	-	-
Copper	mg/L	4	<0.01	<0.01	-	-
Cadmium	mg/L	4	<0.01	<0.01	-	-
Magnesium	mg/L	4	0.34	0.17	-	-
Manganese	mg/L	4	<0.01	<0.01	-	-
Mercury	µg/L	4	<0.20	<0.20	-	-
Nickel	mg/L	3	0.08	<0.01	-	-
Sodium	mg/L	3	1.4	1.2	-	-
Iron	mg/L	4	0.71	0.03	-	-
Lead	mg/L	4	<0.01	<0.01	-	-
Chromium	mg/L	4	<0.02	<0.01	-	-
Zinc	mg/L	4	<0.01	<0.01	-	-

[a] Metals are analyzed quarterly from a continuous flow composite.
- Insufficient data; mean not calculated for <5 samples.

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Beaver Dam Creek Water Quality Data Summary

Quarter 1, January 1–March 31, 1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	75	48	58
pH	pH	10.9	4.9	
Dissolved Oxygen	mg/L	11.9	6.4	9.6
Conductivity	µmhos/cm	181	74	131
Oxidation/Reduction Potential	mV	322	229	279

Quarter 2, April 1–June 30,1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	88	57	76
pH	pH	8.6	6.2	
Dissolved Oxygen	mg/L	9.9	5.9	7.4
Conductivity	µmhos/cm	154	72	122
Oxidation/Reduction Potential	mV	381	227	306

Quarter 3, July 1–September 30,1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	88	72	80
pH	pH	6.9	5.9	
Dissolved Oxygen	mg/L	7.6	5.3	6.6
Conductivity	µmhos/cm	302	54	105
Oxidation/Reduction Potential	mV	465	314	353

Quarter 4, October 1–December 31,1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	80	46	64
pH	pH	9.0	5.4	
Dissolved Oxygen	mg/L	10	6.0	8.1
Conductivity	µmhos/cm	155	54	88
Oxidation/Reduction Potential	mV	513	244	359

TABLE 5-14
SRS STREAM WATER QUALITY, CONT'D.

Steel Creek Water Quality Data Summary

Quarter 1, January 1–March 31, 1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	65	53	56
Dissolved Oxygen	mg/L	11.2	8.8	9.7

Quarter 2, April 1–June 30, 1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	83	58	71
Dissolved Oxygen	mg/L	10	6.0	7.8

Quarter 3, July 1–September 30, 1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	86	71	79
Dissolved Oxygen	mg/L	8.5	5.4	6.7

Quarter 4, October 1–December 31, 1989

Parameter	Units	Hourly Maximum	Hourly Minimum	Hourly Average
Temperature	°F	72	49	61
Dissolved Oxygen	mg/L	11	6.7	9.0

TABLE 5-15
SRS STREAM WATER QUALITY: PESTICIDES, HERBICIDES AND VOLATILE ORGANICS

Parameter	Units	No. of Analyses	Maximum	Minimum	Arithmetic Mean	2 Std Dev
Tims Branch-5						
2, 4-D	µg/L	12	<1.0	<0.2	-	-
Silvex	µg/L	12	<1.0	<0.05	-	-
Methoxychlor	µg/L	12	<5.0	<0.02	-	-
Toxaphene	µg/L	12	<2.5	<1.0	-	-
Lindane	µg/L	12	<0.1	<0.05	-	-
Endrin	µg/L	12	<0.1	<0.05	-	-
Tetrachloroethylene	µg/L	12	<2.0	<0.5	-	-
Trichloroethylene	µg/L	12	<2.0	<0.5	-	-
I,I,I-Trichloroethane	µg/L	12	<2.0	<0.5	-	-
Four Mile Creek-A7						
2, 4-D	µg/L	12	<1.0	<0.2	-	-
Silvex	µg/L	12	<1.0	<0.05	-	-
Methoxychlor	µg/L	12	<5.0	<0.2	-	-
Toxaphene	µg/L	12	<2.5	<1.0	-	-
Lindane	µg/L	12	<0.1	<0.05	-	-
Endrin	µg/L	12	<0.1	<0.05	-	-
Tetrachloroethylene	µg/L	12	<2.0	<0.05	-	-
Trichloroethylene	µg/L	12	0.73	<0.5	-	-
I,I,I-Trichloroethane	µg/L	12	1.4	<0.5	-	-
Steel Creek-4						
2, 4-D	µg/L	12	<1.0	<0.2	-	-
Silvex	µg/L	12	<1.0	<0.05	-	-
Methoxychlor	µg/L	12	<5.0	<0.2	-	-
Toxaphene	µg/L	12	<2.5	<1.0	-	-
Lindane	µg/L	12	<0.1	<0.05	-	-
Endrin	µg/L	12	<0.1	<0.05	-	-
Tetrachloroethylene	µg/L	12	<2.0	<0.5	-	-
Trichloroethylene	µg/L	12	<2.0	<0.5	-	-
I,I,I-Trichloroethane	µg/L	12	4.4	<0.5	-	-
Upper Three Runs Creek-4						
2, 4-D	µg/L	12	<1.0	<0.2	-	-
Silvex	µg/L	12	<1.0	<0.05	-	-
Methoxychlor	µg/L	12	<5.0	<0.2	-	-
Toxaphene	µg/L	12	<2.5	<1.0	-	-
Lindane	µg/L	12	<0.1	<0.05	-	-
Endrin	µg/L	12	<0.1	<0.05	-	-
Tetrachloroethylene	µg/L	12	<2.0	<0.5	-	-
Trichloroethylene	µg/L	12	<2.0	<0.5	-	-
I,I,I-Trichloroethane	µg/L	12	8.0	<0.5	-	-

- Insufficient data.

TABLE 5-16
PESTICIDES AND HERBICIDES DETECTION LIMITS

Constituents[a]	Detection Limit (μg/L)
Methoxychlor	10
Toxaphene	1
Lindane	1
Endrin	0.1
2,4-D	10
2,4,5-TP (Silvex)	1

[a] Analytes reported by subcontracted offsite laboratory Environmental Testing, Inc.

TABLE 5-17
PESTICIDES AND HERBICIDES IN STREAM AND RIVER WATER

Constituents (µg/L)[a]	River 2 Above SRS[b]	River 10 Below SRS[b]	Upper Three Runs at Road F[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
2,4-D	<1	<1	<1
2,4,5-TP (Silvex)	<1	<1	<1

Constituents(µg/L)[a]	Steel Creek at Road A[b]	Par Pond Pumphouse[b]	Lower Three Runs at Road A[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<1	<1	<1
Endrin	<1	<1	<1
2,4-D	<1	<1	<1
2,4,5-TP (Silvex)	<1	<1	<1

Constituents (µg/L)[a]	Upper Three Runs at Road A[b]	Four Mile Creek at Road A[b]	Pen Branch at Road A[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<1	<1	<1
Endrin	<1	<1	<1
2,4-D	<1	<1	<1
2,4,5-TP (Silvex)	<1	<1	<1

[a] Results reported by subcontracted offsite laboratory Environmental Testing, Inc.
[b] Samples collected June 19 and June 20, 1989.

TABLE 5-18
PESTICIDES AND HERBICIDES IN STREAM AND RIVER SEDIMENT

Constituents (µg/L)[a]	River 2 Above SRS[b]	River 10 Below SRS[b]	Upper Three Runs at Road F[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
2,4-D	<9	<1	<25
2,4,5-TP (Silvex)	<2	<1	<5

Constituents(µg/L)[a]	Steel Creek at Road A[b]	Par Pond Pumphouse[b]	Lower Three Runs at Road A[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
2,4-D	<9	<9	<1
2,4,5-TP (Silvex)	<2	<2	<1

Constituents (µg/L)[a]	Upper Three Runs at Road A[b]	Four Mile Creek at Road A[b]	Pen Branch at Road A[b]
Methoxychlor	<5	<5	<5
Toxaphene	<1	<1	<1
Lindane	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
2,4-D	<9	<1	<9
2,4,5-TP (Silvex)	<2	<1	<2

[a] Results reported by subcontracted offsite laboratory Environmental Testing, Inc.
[b] Samples collected June 19 and June 20, 1989.

TABLE 5-19
TEMPERATURE PROFILE SURVEYS ON BEAVER DAM CREEK AND STEEL CREEK

Date	Location	Maximum Temperature Above Ambient[a] (°C)	Consent Order 84-4-W Maximum Temperature Above Ambient (°C)
02/16/89	Beaver Dam	3.3	17.5
06/22/89		3.2	17.5
09/28/89		2.9	17.5
11/30/89		0.4	17.5
02/16/89	Steel Creek	4.0	16.6
06/22/89		3.2	16.6
09/28/89		b	16.6
11/30/89		b	16.6

[a]The ambient temperature was determined from a temperature profile 100 yds upriver from Beaver Dam Creek. Ambient temperatures for each survey were: 2/16/89 –14.1°C; 6/22/89 – 14.1°C; 9/28 – 19.6°C; 11/30/89 –15.3°C.

[b] The maximum temperature was below ambient.