E. B. WAGNER

Y/UB-19

MARTIN MARIETTA

ENVIRONMENTAL MONITORING REPORT
UNITED STATES
DEPARTMENT OF ENERGY

OAK RIDGE FACILITIES

Calendar Year 1983

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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MARTIN MARIETTA ENERGY SYSTEMS, INC.

*Work performed prior to April 1, 1984, by Union Carbide Corporation Nuclear Division for the U. S. Department of Energy under Contract W-7405-eng-26.

Environment, Safety, and Health
Post Office Box X
Oak Ridge, Tennessee 37830

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Each year since 1972, a report is prepared on the past calendar year's environmental monitoring activities for the DOE facilities in Oak Ridge, Tennessee. These reports are required by DOE Order 5484.1.

As in the past, environmental monitoring programs for the Oak Ridge area for calendar year 1983 includes sampling and analysis of air, water from surface streams, creek sediment, biota, and soil for both radioactive and nonradioactive materials. Certain additions to the measurement programs (such as adding high vol monitors in the vicinity of the Y-12 Plant) were made in 1983; other programs (such as groundwater monitoring) have been expanded. These changes are described. Certain special environmental studies which have been conducted in the area are also included in this report, primarily as abstracts or brief summaries. The annual report for 1983 on environmental monitoring and surveillance of the Oak Ridge community by Oak Ridge Associated Universities is also attached as an appendix. These special studies concentrate upon certain environmental matters (such as mercury) in which there has been considerable public interest in 1983.

A brief description of the topography and climate of the Oak Ridge area, as well as a very short description of the three DOE facilities, are provided below in order to assist the reader in the understanding of the thrust and contents of the environmental monitoring program for Oak Ridge.

Oak Ridge is located in East Tennessee in a broad valley which lies between the Cumberland Mountains on the northwest and the Great Smokey Mountains on the southeast. The Department of Energy (DOE) Reservation is located in the Valley and Ridge physiographic province which is characterized by parallel ridges of sandstone, shale, and cherty dolomite, separated by valleys of less weather-resistant limestone and shale. The ridges are oriented southwest-northeast. Topography of the area is due to differential erosion of severely folded and faulted rocks ranging in age from Early Cambrian to Early Mississippian. Elevations range from 226 to 415 meters above mean sea level with a maximum relief of 189 meters. The area includes gently sloping valleys and rolling to steep slopes and ridges. The Tennessee Valley Authority's (TVA) Melton Hill and Watts Bar Reservoirs on the Clinch River form the southern and western boundaries of the Reservation while the City of Oak Ridge (approximately 28,000 population) is on the northern boundary.

The local climate is noticeably influenced by topography. Prevailing winds are usually either up-valley, from west to southwest, or down-valley, from east to northeast. During periods of light winds, daytime winds are usually southwesterly and nighttime winds usually northeasterly. Wind velocities are somewhat decreased by the mountains and ridges, and tornadoes rarely occur. In winter, the Cumberland Mountains have a moderating influence on the local climate by retarding the flow of cold air from the north and west. Temperatures of 38°C or higher and -18°C or below are unusual. Low-level temperature inversions occur during approximately 56 percent of the hourly observations. Winter and early spring are the seasons of heaviest precipitation with the monthly maximum normally occurring during January to March. The mean annual precipitation is approximately 137 centimeters.

The topography of the Oak Ridge area is such that all drainage from the DOE Reservation flows into the Clinch River which has its headwaters in southwestern Virginia and flows southwest to its mouth near Kingston, Tennessee. The Clinch River flow is regulated by several dams which provide reservoirs for flood control, electric power generation, and recreation. The principal tributaries through which liquid effluents from the plant areas reach the Clinch River are White Oak Creek, East Fork Poplar Creek, and Poplar Creek.

With the exception of the City of Oak Ridge, the land within 8 kilometers of the DOE Reservation is predominantly rural being utilized largely for residences, small farms, and pasturage for cattle. Fishing, boating, water skiing, and swimming are favorite recreational activities in the area. The approximate location and population of the towns nearest the DOE Reservation are: Oliver Springs (pop. 3600) 11 kilometers to the northwest; Clinton (pop. 5400) 16 kilometers to the northeast; Lenoir City (pop. 5400) 11 kilometers to the southeast; Kingston (pop. 4400) 11 kilometers to the southwest; and Harriman (pop. 8300) 13 kilometers to the west. Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 kilometers to the east and has a population of approximately 183,000. A directional 80-kilometer population distribution, which is used for population dose calculations later in this report, is shown in Table 1.

The DOE Reservation contains three major operating facilities: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Y-12 Plant; all of which were operated by Union Carbide Corporation, Nuclear Division in this calendar year. In addition, two smaller DOE facilities are in the area: the Comparative Animal Research Laboratory, and the Oak Ridge Associated Universities, both of which are operated by Oak Ridge Associated Universities.

The Oak Ridge National Laboratory is a large multipurpose research laboratory whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, the Laboratory conducts research in all fields of modern science and technology. The Laboratory's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

The Oak Ridge Gaseous Diffusion Plant (ORGDP) is a complex of production, research, development, and support facilities located west of the city of Oak Ridge. While the primary function of ORGDP is the enrichment of uranium hexafluoride (UF_6) in the uranium-235 isotope, extensive efforts are also expended on research and development activities associated with both the gaseous diffusion and gas centrifuge processes. In addition, the barrier material used by all three Department of Energy-owned gaseous diffusion plants has been manufactured at ORGDP. Numerous other activities (maintenance, nitrogen production, steam production, uranium recovery, water treatment, laboratory analysis, administration, etc.) lend support to these primary functions and are thus essential to the operation of this plant.

The Oak Ridge Y-12 Plant which is located immediately adjacent to the City of Oak Ridge has five major responsibilities: (1) production of nuclear weapon components, (2) processing of source and special nuclear materials, (3) support to the weapon design laboratories, (4) support to other UCC-ND installations, and (5) support to other government agencies. Activities associated with these functions include the production of lithium compounds, the recovery of enriched uranium from scrap material, and the fabrication of uranium and other materials into finished parts and assemblies. Fabrication operations include vacuum casting, arc melting, powder compaction, rolling, forming, heat treating, machining, inspection, and testing.

Operations associated with the DOE research and production facilities in Oak Ridge give rise to several types of waste materials.

Radioactive waste are generated from nuclear research activities, reactor operations, pilot plant operations involving radioactive materials, isotope separation processes, uranium enrichment, and uranium processing operations. Nonradioactive wastes are generated by normal industrial-type support operations that include water demineralizers, air conditioning, cooling towers, acid disposal, sewage plant operations, and steam plant operations.

Nonradioactive solid wastes are buried in a centralized sanitary landfill or designated burial areas. Radioactive solid wastes are buried in solid waste storage areas and placed in retrievable storage either above or below ground depending upon the type and quantity of radioactive material present and the economic value involved.

Gaseous wastes generally are treated by filtration, electrostatic precipitation, and/or chemical scrubbing techniques prior to release to the atmosphere. The major gaseous waste streams are released through stacks to provide atmosphere dilution for materials which may remain in the stream following treatment.

Liquid radioactive wastes are not released but are concentrated and contained in tanks for ultimate disposal. Process water which may contain small quantities of radioactive or chemical pollutants is discharged, after treatment, to White Oak Creek, Poplar Creek, East Fork Poplar Creek, and Bear Creek, which are small tributaries to the Clinch River.

SUMMARY

The Environmental Monitoring Program for the Oak Ridge area includes sampling and analysis of air, water from surface streams, creek sediments, biota, and soil for both radioactive and nonradioactive materials. This report presents a summary of the results of the program for calendar year 1983.

Surveillance of radioactivity in the Oak Ridge environs indicates that atmospheric concentrations of radioactivity were not significantly different from other areas in East Tennessee. The levels of radioactivity were between 0.02 and 0.03 percent of the DOE concentration guides (CG) which has been the case since 1980. Levels of radioactivity in rainwater samples collected in the Oak Ridge area were not significantly different from those collected at remote locations. Concentrations of radioactivity in the Clinch River and in fish collected from the river were less than two percent of the permissible concentration and intake guides for individuals in the offsite environment. While some radioactivity was released to the environment from plant operations, the concentrations in all of the media sampled were well below established DOE standards, as has been the case since the inception of these reports.

The total body dose to a "hypothetical maximum exposed individual" at the site boundary was calculated to be 6.8 millirem/yr (68 microsieverts) which is about one percent of the DOE Order 5480.1A standard. The maximum possible dose commitment to the critical organ of an individual from the aquatic food chain was calculated to be 41 millirem (410 microsieverts) to the bone which is 2.7 percent of the allowable annual standard. The maximum equivalent dose commitment (weighted sum of doses to principle organs) to individuals living nearest the site boundary from airborne releases, assuming continuous residence, was 6.3 millirem (63 microsieverts) to the total body and 21 millirem (210 microsieverts) to the pulmonary tissues. These doses are 1.6 percent and 1.4 percent, respectively, of the annual standards. The average equivalent dose commitment to the total body of an Oak Ridge resident was estimated to be 1.3 millirem (13 microsieverts). The average dose commitment to the pulmonary tissues of an Oak Ridge resident was 4.2 millirem (42 microsieverts). The cumulative equivalent dose commitment to the total body (weighted sum of doses to principle organs) for the population within an 80-kilometer radius of the Oak Ridge facilities resulting from 1983 effluents was calculated to be 120 man-rem (1.2 man-sieverts). This dose may be compared to an estimated 87,000 man-rem (870 man-sieverts) to the same population resulting from natural background radiation.

Surveillance of nonradioactive materials in the Oak Ridge environs shows that established limits were not exceeded for those materials present in the air as a result of plant operations except for suspended particulates in the Y-12 Plant area.

The chemical water quality data in surface streams obtained from the water sampling program indicated that average concentrations resulting from plant effluents were in compliance with State Water Quality Criteria for fish and aquatic life with the exception of cadmium, copper, fluoride, lead, mercury, and zinc.

National Pollutant Discharge Elimination System (NPDES) permit compliance information has been included in this report. Just as in previous years, there has been a substantial number of noncompliances. These noncompliances were predominantly associated with the ORNL sewage plant operation and high pH values at one ORGDP release point.

During 1983 there was one spill of hazardous materials from the Oak Ridge installations reported to the National Response Center. Three quarts of 45 percent diazinon were inadvertently spilled onto an ORGDP inplant road from the back of a truck. Cleanup was effected immediately.

No major spills of oil and grease or PCB's occurred in 1983. No major releases of any radionuclides occurred. Prompted in part by Congressional hearings, thorough environmental reviews conducted in early 1984, in which some of the data in this report as well as the overall environmental programs were examined, concluded that there were no imminent hazards to the health and safety of the community due to environmental matters. The data reported herein support that conclusion.

MONITORING DATA COLLECTION, ANALYSIS, AND EVALUATION

Environmental monitoring data for calendar year 1983 are summarized in Tables 2 through 55. In general, the data tables show the number of samples collected at each location, the maximum concentration, the minimum concentration, the average concentration, the relevant standard, and percent of standard for the average of each parameter. Averages are usually accompanied by plus-or-minus ($\pm$) values which represent the 95 percent confidence limits. The 95 percent confidence limits which are calculated from the standard deviation of the average, assuming a normal frequency distribution, are predictions of the variability in the range of concentrations based on a limited number of measurements. They do not represent the conventional error in the average of repeated measurements on identical samples. Data which are below the minimum detectable limit are expressed as less than (<) the minimum detectable value. In computing average values, sample results below the detection limit are assigned the detection limit value with the resulting average value being expressed as less than (<) the computed value.

Average environmental concentrations are compared with applicable standards, where such standards have been established, as a means of evaluating the impact of effluent releases. Potential radiation dose to members of the public and/or environmental concentrations of radioactivity are compared with the dose standards and environmental concentration guides contained in DOE Order 5480.1A[1]

The concentration guide (CG) is a number derived for the most part from the dose standards recommended by the International Commission on Radiological Protection (ICRP) and the National Council on Radiological Protection (NCRP) and contained in DOE Order 5480.1A. The concentration guides for a particular radionuclide are those concentrations in air or water which

can be inhaled or ingested each day by a "standard man" for a period of 50 years without exceeding the committed dose equivalent specified in the dose standards.

The "standard man" is described by the ICRP in terms of body proportions of various elements found in the body; average consumption rates of food, air, and water; average excretion rates; weight of each body organ; and a number of other factors such as the size distribution of dust particles trapped in the respiratory tract and their fate in the body.

Stream concentrations of nonradioactive pollutants have been compared with the latest Tennessee Department of Health and Environment Water Quality Criteria for fish and aquatic life in fresh water streams.

Liquid effluent monitoring data have been compared to the limits specified in the National Pollutant Discharge Elimination System (NPDES) permits issued to the Oak Ridge facilities by the Environmental Protection Agency (EPA).

In some scientific communities the International System of Units (SI) for radioactive measurements is being considered or used. This report contains data in both units; the non-SI units used previously, followed by the SI units in parentheses.

Air Monitoring

Radioactive - Atmospheric concentrations of radioactive materials occurring in the general environment of East Tennessee are monitored by two systems of monitoring stations. One system, the Perimeter Air Monitoring System, consists of eleven stations (HP-31 through HP-41) which encircle the perimeter of the Oak Ridge area and provides data for evaluating releases from Oak Ridge facilities to the immediate environment, Figure 1. A second system, the Remote Air Monitoring System, consists of seven stations (HP-51 through HP-53 and HP-55 through HP-58) encircling the Oak Ridge area at distances of from 19 to 121 kilometers, Figure 2. This system provides background data to aid in evaluating local conditions. Eleven air monitors (No's. 1 through 11, Figure 3) have recently been installed around the perimeter of the Y-12 Plant, primarily for the measurement of uranium. Sampling for radioactive particulates is carried out by passing air continuously through filter papers. Filter papers from the perimeter and remote systems are evaluated weekly by gross beta and gross alpha counting techniques and composited by system quarterly for specific radionuclide analysis. The Y-12 plant air monitoring filters are removed weekly and evaluated for gross alpha and gross beta radioactivity. The filters are composited quarterly by station and evaluated for the uranium isotopes. More frequent detailed analyses are performed if concentrations in the environment are significantly above normal. Airborne radioactive iodine is monitored in the immediate environment at the perimeter stations (HP-31 through HP-41) by passing air continuously through cartridges containing activated charcoal. Charcoal cartridges are evaluated for radioactive iodine by gamma spectrometry.

As indicated above, a number of new air monitoring stations were added to the total system in 1983. There were no stations taken out of service.

Data on the concentrations of radioactive materials in air and the quantities of radioactive materials released to the atmosphere in the Oak Ridge and surrounding areas are given in Tables 2 through 7.

The average gross beta concentrations of radioactivity from particulates in air measured by both the perimeter and remote monitoring systems were 0.03 and 0.02 percent, respectively, of the applicable concentration guide (CG) as specified in the DOE Order 5480.1A, Chapter XI for

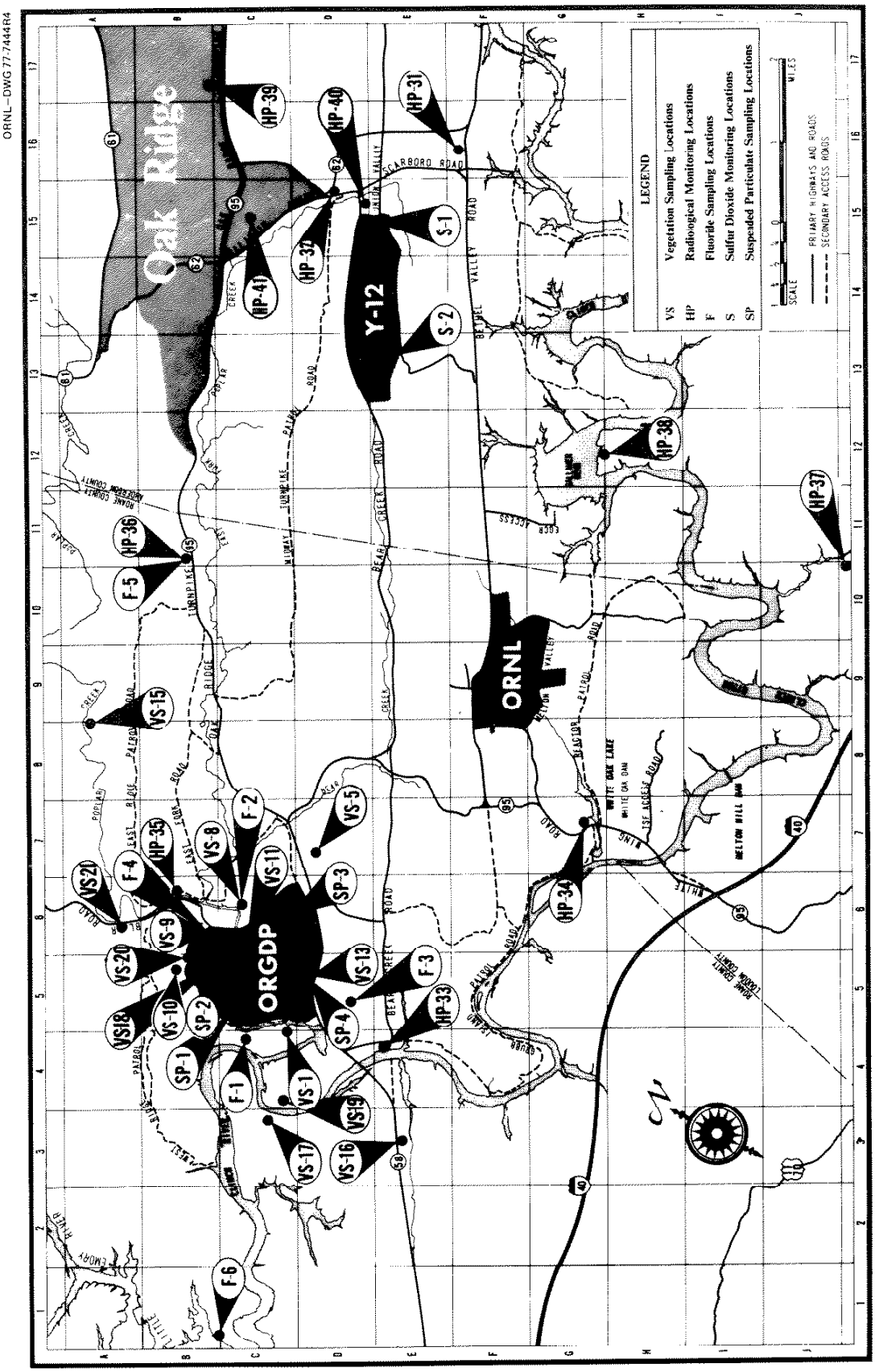

Figure 1
AIR, VEGETATION, AND SOIL SAMPLING LOCATIONS

ORNL-DWG 66-1719R2

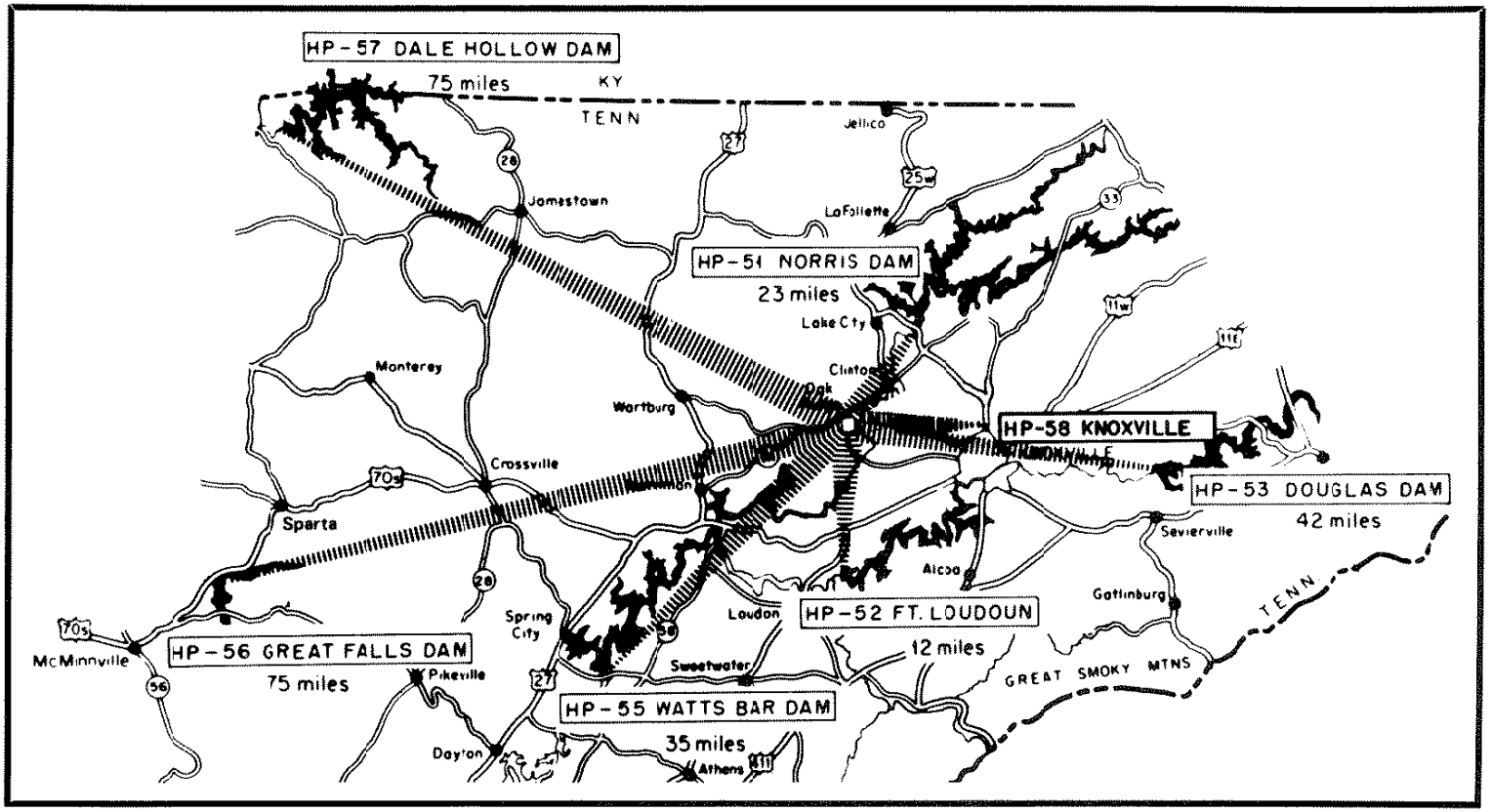

Figure 2
REMOTE AIR MONITORING LOCATIONS

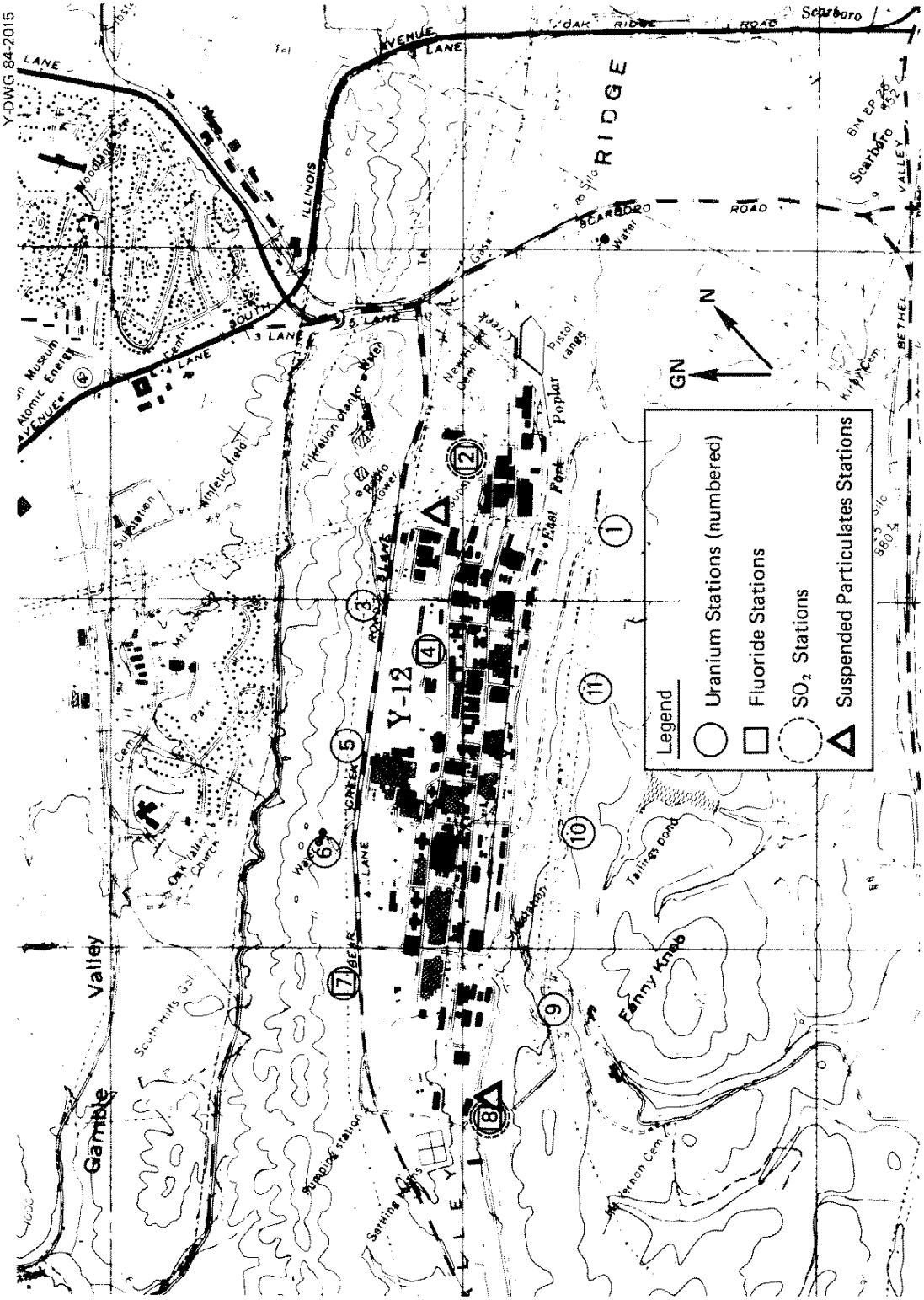

Figure 3
Y-12 AMBIENT AIR SAMPLING LOCATIONS

individuals in uncontrolled areas (Table 2). Because monitoring stations HP-40 and HP-41 were added in the summer of 1983, fewer samples were collected at these two stations than at the other perimeter stations. This was taken into account in the averaging process and accounts for the higher standard error obtained for the averages for these two stations. The activity levels measured have remained essentially constant (at 0.02 to 0.03 percent of the concentration guide) since 1980 except for the first half of 1981, in which the increase in activity that was measured (0.07 percent of the concentration guide) was attributed to the presence of weapons test debris in the atmosphere.

The average gross alpha concentrations in the perimeter and remote monitoring systems were 0.03 and 0.03 percent, respectively, of the CG for a mixture of uranium isotopes (Table 3). The activity levels measured have remained essentially constant (0.02 to 0.03 percent of the CG) since 1980.

The results of specific radionuclide analyses of composited filters are given in Table 4. The environmental concentrations tabulated are all at least a thousand times less than the applicable DOE concentration guides for the radionuclides detected. In general, activity levels of fission products were less than those of the previous year, this change being attributed to the decrease in world-wide fallout.

The concentrations of iodine as measured by the perimeter air monitoring system was <0.01 percent of the inhalation concentration guide for individuals in uncontrolled areas (Table 5). This level of measured activity has remained essentially unchanged since 1980.

The results of uranium analysis of the composited filters from the air monitoring stations around the Y-12 Plant are given in Table 6. The average concentrations for all uranium isotopes measured were less than 0.6 percent of the applicable concentration guide specified in DOE Order 5480.1A.

While some radioactivity was released to the atmosphere (Table 7), measurements in the Oak Ridge area show that environmental levels were well below established standards.

Nonradioactive - Environmental air samples are taken for the determination of fluorides, suspended particulates, and sulfur dioxide.

Sampling locations for fluorides around ORGDP are indicated by F-1 through F-6, Figure 1. The current sampling procedure is to obtain six-day samples collected on potassium carbonate treated paper and to analyze weekly by specific ion electrode. The six-day analyses are then averaged to obtain 30-day values. Four fluoride monitoring stations have been installed about the Y-12 Plant at air monitoring stations 2, 4, 7, and 8, Figure 3. Seven-day samples are collected at each station once each month.

Suspended particulates are measured in the ORGDP area at locations SP-1 through SP-4, Figure 1. Two suspended particulate monitoring stations have been installed at the East and West end of the Y-12 Plant, Figure 3. The method for the determination of suspended particulates is the high volume method recommended by EPA. Particulates are collected by drawing air through weighed filter paper. The filter paper is allowed to equilibrate in a humidity controlled atmosphere and the filter is reweighed. From the weight of particulates, the sampling time, and the air flow rate, the particulate concentration in micrograms per cubic meter is calculated.

The two continuous monitoring stations (S-1 and S-2) in the Y-12 Plant are used for measurement of ambient sulfur dioxide concentrations. Each station consists of a pulsed ultraviolet fluorescence analyzer and recorder with associated equipment located in a temperature-controlled shelter. Sulfur dioxide concentrations are read on an hourly basis and averaged for 24-hour, monthly, and annual periods.

Air monitoring data for fluorides, suspended particulates, and sulfur dioxide are presented in Tables 8 through 10. The data indicate that measured environmental concentrations of fluorides, and sulfur dioxide were in compliance with applicable standards.[2] However, suspended particulates at the Y-12 Plant have exceeded applicable standards. Baghouses are being installed on the Y-12 steam plant to correct this problem under a Federal Facilities Compliance Agreement between the Department of Energy and Environmental Protection Agency which was signed in April 1982. The compliance agreement schedule calls for completion of the project in December of 1985.

External Gamma Radiation Monitoring

External gamma radiation background measurements are made routinely at the perimeter air monitoring stations and at the remote monitoring stations using calcium fluoride thermoluminescent dosimeters suspended one meter above the ground. Two dosimeters are placed in each container at each site. Dosimeters at the perimeter stations are collected and analyzed monthly, whereas those at the remote stations are collected and analyzed semiannually.

Data on the average external gamma radiation background are given in Table 11. A considerable variation in background levels is normally experienced in East Tennessee depending upon elevation, topography, and geological character of the surrounding soil.[3]

External gamma radiation background measurements were performed along the stream course of East Fork Poplar Creek to evaluate potential external exposure from radioactivity which may be contained in the sediments as a result of effluent releases. Additionally, measurements were made along the bank of the Clinch River from the mouth of White Oak Creek several hundred yards downstream to evaluate gamma radiation levels resulting from effluent releases and "sky shine" from an experimental cesium plot located near the river bank. Measurements were made with thermoluminescent dosimeters suspended one meter above the ground surface and/or with handheld scintillation detectors. The average background level determined at the remote stations was subtracted from the measured gamma radiation levels to determine the incremental increases resulting from plant operations.

Gamma radiation levels along East Fork Poplar Creek ranged from 0.6 to 8.2 μR/h (0.2 E-09 to 2.1 E-09 C/kg/h) above background. The external gamma radiation levels along the bank of the Clinch River ranged from 5 to 30 μR/h (1.3 E-09 to 7.7 E-09 C/kg/h) above background. Potential doses to individuals in the environment from these elevated gamma radiation levels were calculated and are included, where significant, in the dose assessment section of the report.

Water Monitoring

Radioactive - Water samples are collected in the Clinch River for radioactivity analyses at Melton Hill Dam (Station C-2) 3.7 kilometers above White Oak Creek outfall, at the ORGDP sanitary water intake (Station C-3) 10 kilometers downstream from the entry of White Oak Creek, at the ORGDP recirculating water intake (Station C-4) downstream from the Poplar Creek outfall, and near Brashear Island (Station C-6). A sample is also collected from the Water Plant (Station C-5) near Kingston, Tennessee, Figure 4. Samples are collected continuously at Stations C-2, and C-3. A weekly 24-hour composite sample is collected at Station C-4 and a weekly grab sample is collected at Station C-6. A daily grab sample is collected at Station C-5. Samples are composited for monthly or quarterly analysis depending upon location.

Water samples also are collected for radioactivity analyses at the mouth of White Oak Creek (Station W-1), at the outlet of New Hope Pond on East Fork Poplar Creek (Station E-1), in Bear Creek (Station B-1), and in Poplar Creek (Stations P-1 and P-2), Figure 4. The samples collected

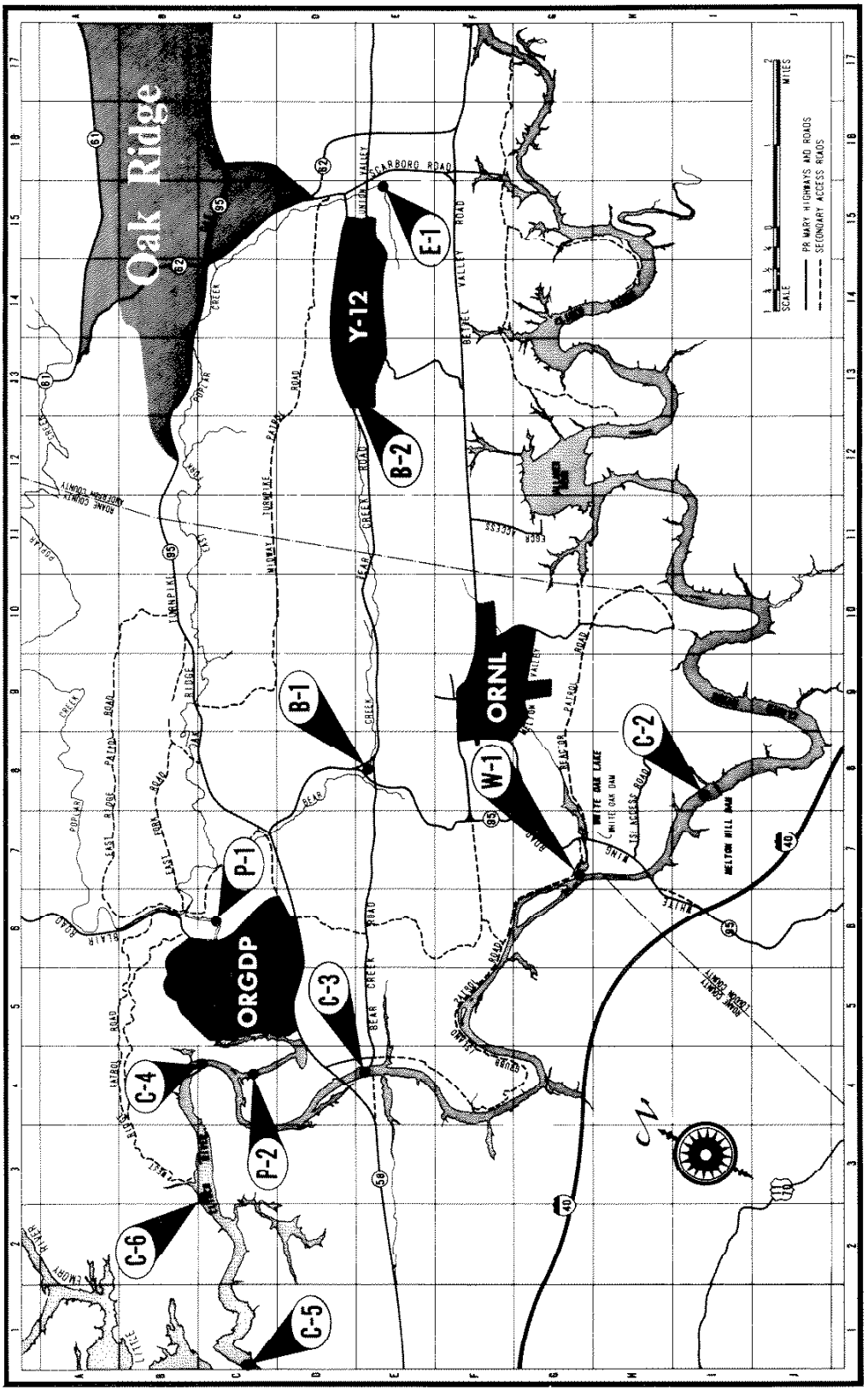

Figure 4
STREAM MONITORING LOCATIONS

at Station W-1 are continuous samples. Flow proportional samples are collected at Stations E-1 and B-1. Grab samples are collected at Stations P-1 and P-2 on a weekly basis. Water samples are collected also at White Oak Dam. All samples are composited for monthly analysis.

The concentrations of fission product radionuclides present in detectably significant amounts are determined by specific radionuclide analysis and gamma spectrometry. Uranium analysis is by the fluorometric method. Transuranic alpha emitters are determined by chemical chromatography and alpha spectrometry. The concentration of each radionuclide is compared with its respective concentration guide (CG) value as specified in the DOE Order 5480.1A and percent of concentration guide for a known mixture of radionuclides is calculated in accordance with the method given in the Order.

Data on the concentrations of radionuclides measured in the surface streams are given in Table 12. Data on the concentrations of uranium in surface streams and the quantities of radioactivity release to surface streams are given in Tables 13 and 14.

Analysis of water samples collected in the mouth of White Oak Creek (Station W-1) indicated that the yearly average concentration of radionuclides was approximately 22 percent of the applicable concentration guide for uncontrolled areas. The calculated average concentration of radionuclides in the Clinch River was determined to be 0.4 percent of the applicable concentration guide for uncontrolled areas. This value represents the yearly average of calculated monthly values based on the analysis of weekly water samples collected at White Oak Dam and the monthly dilution afforded by the river, assuming complete mixing. The measured average concentrations of radionuclides in the Clinch River upstream and downstream of White Oak Creek outfall were less than one percent of the applicable concentration guide.

The calculated average concentration of transuranic alpha emitters in the Clinch River resulting from effluent releases was 1.4 E-11 μCi/mL (0.53 mBq/L), which is about 0.05 percent of the concentration guide for water containing a known mixture of radionuclides.

Trends in water discharges and calculated percent concentration guide levels in the Clinch River are presented in Figures 5 and 6. Discharges of ^{90}Sr and ^{3}H are shown in Figure 5 as these nuclides contribute the majority of the radiological dose downstream.

The curies of ^{3}H discharged from White Oak Dam remained about the same as for 1982 and the curies of ^{90}Sr decreased slightly. Most of the discharges are due to seepage from waste disposal areas and not from current operations. The annual variation in discharges from White Oak Dam is primarily a function of the variation in annual precipitation patterns. The calculated percent of the concentration guide for the Clinch River increased slightly from 1982 and is mostly the result of the decrease in the ratio of the Clinch River flow to the White Oak Creek flow (dilution factor).

Rainwater - The gross beta activity in rainwater was analyzed; the results are shown in Table 15. The fluctuations among the stations for both the perimeter and remote networks are due to statistical random variation. It is noted that the average radioactivity is greater for the remote stations than the perimeter stations.

Nonradioactive - Water samples are collected for the analysis of nonradioactive substances at the same locations discussed previously under radioactive water sampling. All samples are composited for monthly analysis. The Y-12 Plant also collects weekly grab samples from Station E-1 for mercury analysis. In late June, the frequency of sampling for mercury was increased to daily sampling during regular working days. In June 1983, a program to collect weekly grab samples at Station B-2, Figure 4, was initiated. Station B-2 is located near the head waters of Bear Creek

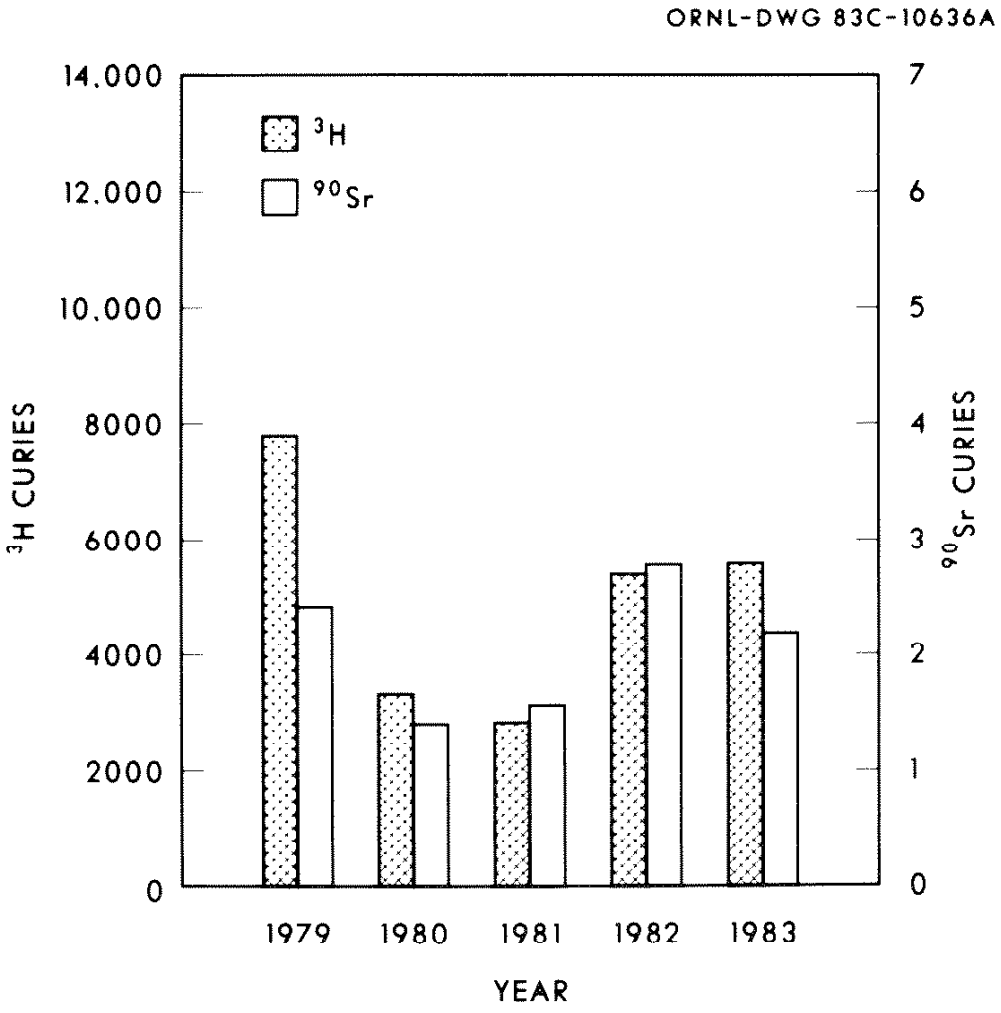

Figure 5
CURIES DISCHARGED OVER WHITE OAK DAM

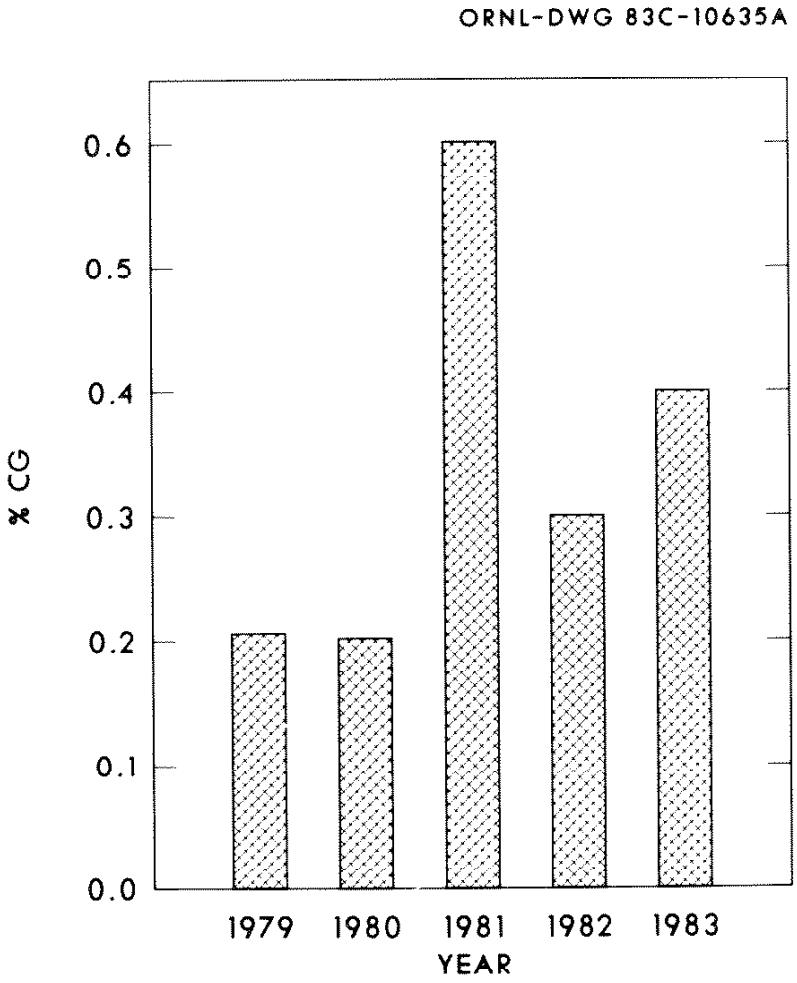

Figure 6
PERCENTAGE CONCENTRATION GUIDE LEVELS IN THE CLINCH RIVER (VALUES GIVEN ARE YEARLY AVERAGES OF CALCULATED MONTHLY VALUES BASED ON WEEKLY CONCENTRATIONS MEASURED AT WHITE OAK DAM AND THE MONTHLY DILUTION AFFORDED BY THE CLINCH RIVER)

where the groundwater is influenced by the S-3 Ponds discharges into the creek. Samples are analyzed for a variety of water quality parameters related to process release potential and background information needs by analytical procedures recommended by the Environmental Protection Agency.[4]

Data on chemical concentrations in surface streams are given in Tables 16 through 24. The average concentrations of all substances analyzed were in compliance with the latest Tennessee Water Quality Criteria[5] for fish and aquatic life except for cadmium, copper, fluoride, lead, mercury, and zinc.

In many cases, the current State of Tennessee Water Quality Criteria are significantly lower than the Tennessee Stream Guidelines used in earlier reports. EPA-approved analytical procedures are used to determine the concentration of the parameters specified by the State; however, the EPA analytical procedures are not sufficiently sensitive to determine compliance with the State criteria. As a result, a number of the parameters appear to be seriously out of compliance. An example of such a condition is the concentration of cadmium in the Clinch River which is reported to be less than 8,000 percent of the State standard. The actual concentration is not known, but is probably considerably closer to the State criteria than is indicated.

Figure 7 shows the concentration of mercury in East Fork Poplar Creek on a weekly basis. The data points from July on reflect the average of the daily samples. The high concentration of mercury starting in week 22 reflects a clean-up activity in the storm drain system in which some mercury contaminated sediments that were being removed from the drain system were stirred up and released. The peak at week 25 is the result of a water main break in the Alpha 4 Building which caused a significant release of mercury contaminated "dirt" from the basement of the building. Subsequently higher concentrations reflect an equilibrium upset resulting from this leak, clean-up, and other plant activities.

In September a marked beneficial change was noted in the waters collected from B-2. The pH of the water went from acidic to neutral and dissolved metallic ions were reduced sharply, Figures 8 and 9. This change may be the result of the neutralization and treatment of the S-3 Ponds, showing that when the ponds were neutralized there was a positive impact on the quality of groundwater.

National Pollution Discharge Elimination System (NPDES) permits were issued by the Environmental Protection Agency (EPA) for each of the Oak Ridge facilities operated by Union Carbide Corporation - Nuclear Division in 1975. The permits established a number of discharge locations at each installation and listed specific concentration limits and/or monitoring requirements for a number of parameters at each discharge location. Table 25 shows the discharge locations at each installation, the parameters at each location for which limits have been established, the permit limits for each parameter, and the percentage compliance experienced. A new permit for ORGDP was drafted in late 1983 and will be finalized in early 1984. Permits for the other plants will be drafted in the near future. Release limits will be more restrictive and a number of permit points will probably be added.

Biological Monitoring

Milk - Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from ten sampling stations located within a radius of 80 kilometers of Oak Ridge. Samples normally have been collected weekly at each of six stations located near the Oak Ridge area. Sampling at one station, number 5, was terminated in late 1982 because the owner of the dairy herd died and milk was no longer available at that location. Samples are now collected at five stations near the Oak

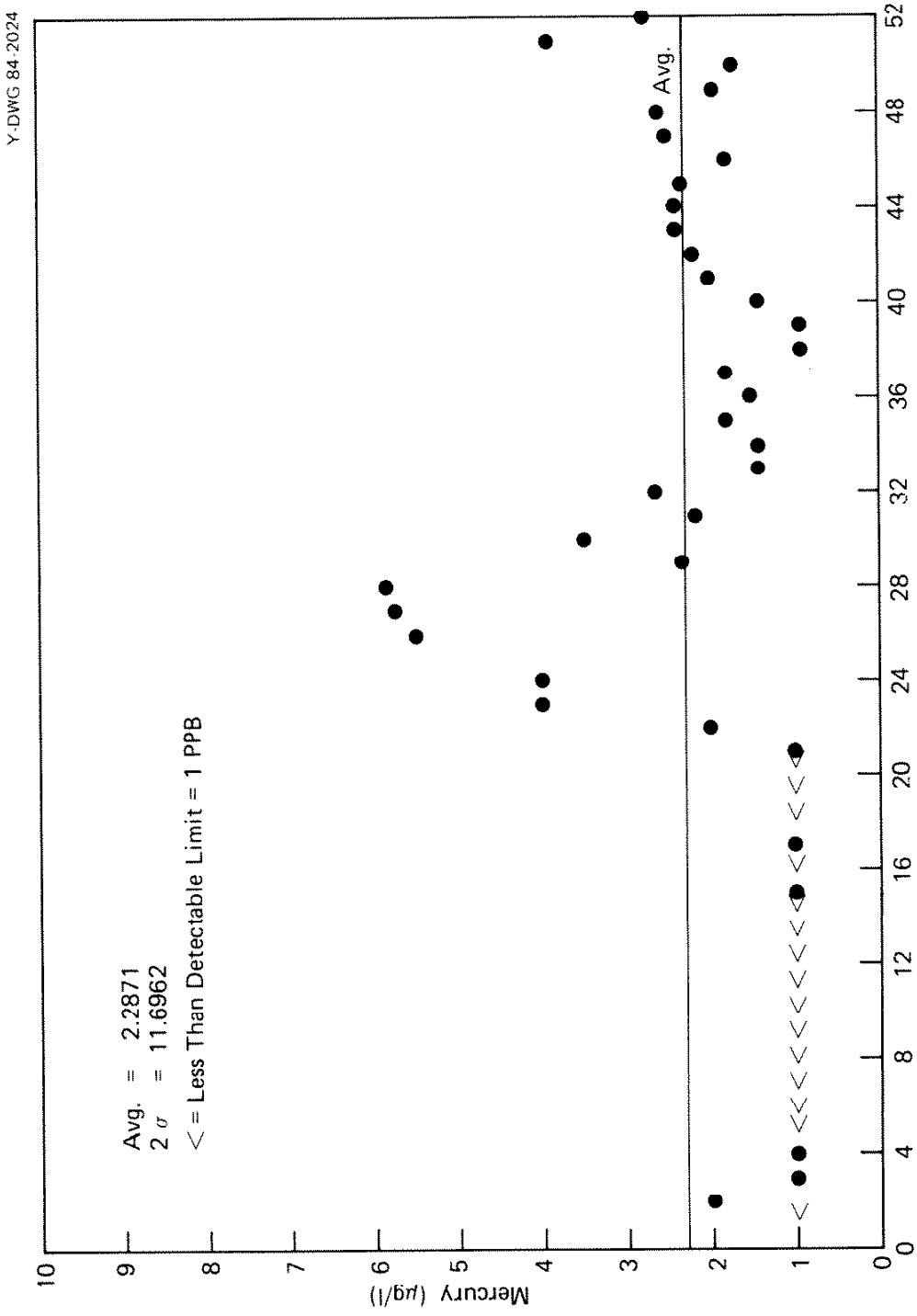

Figure 7
MERCURY CONCENTRATION IN WATER - NEW HOPE POND OUTLET

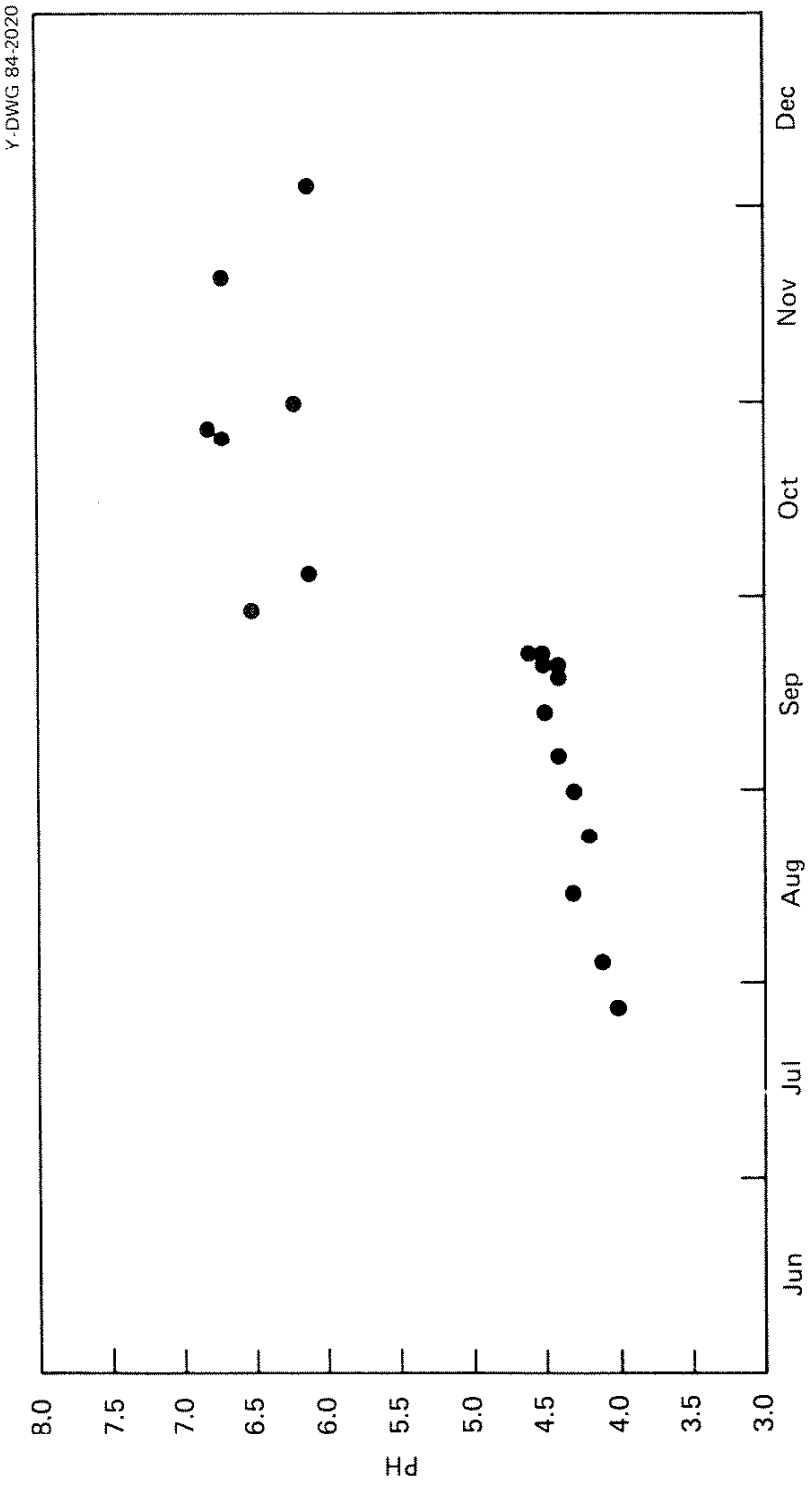

Figure 8
PH VS TIME - UPPER BEAR CREEK (STATION B-2)

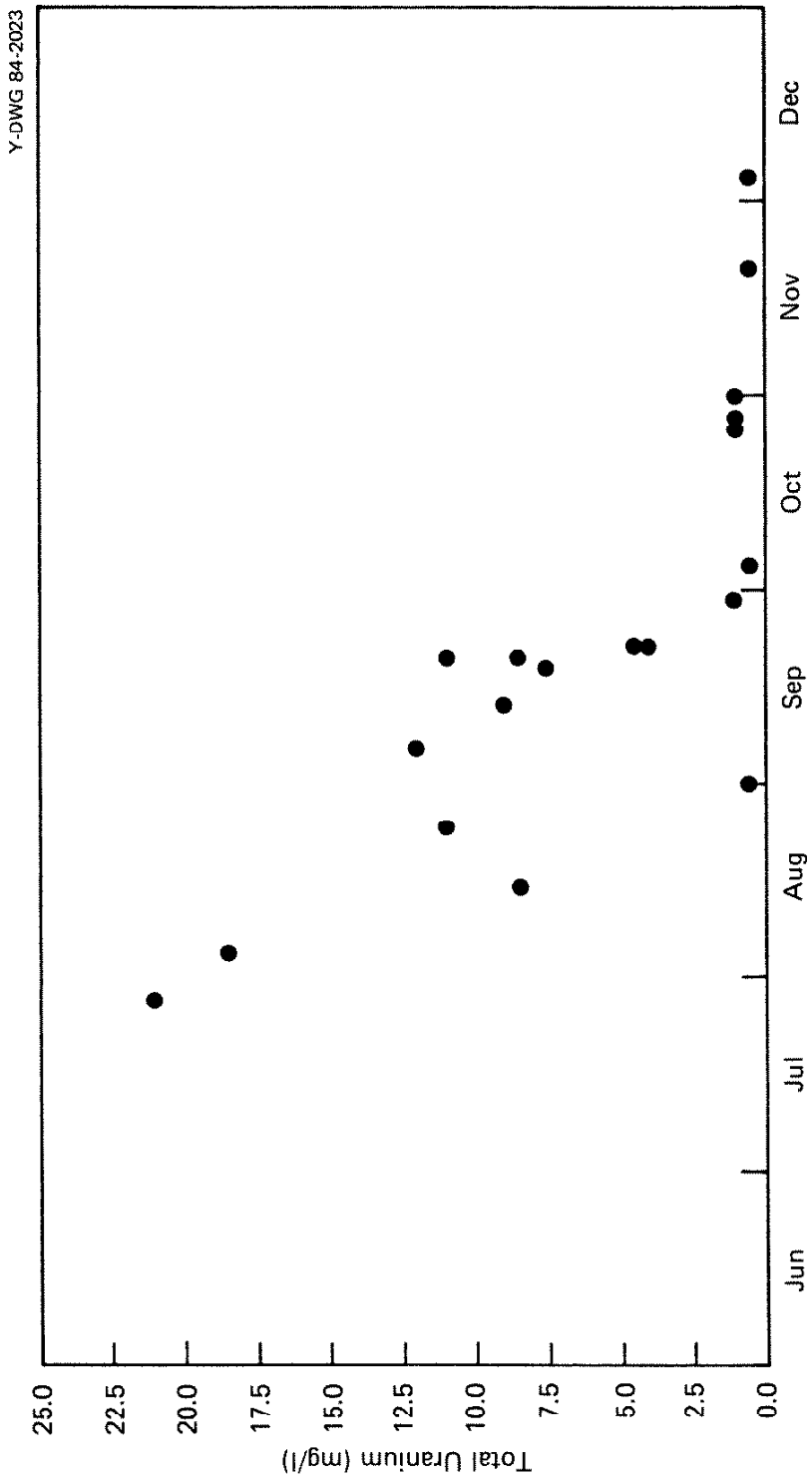

Figure 9
URANIUM CONCENTRATION VS TIME - UPPER BEAR CREEK - (STATION B-2)

Ridge area. Four stations, located more remotely with respect to Oak Ridge operations, are sampled at a rate of one station each week. Milk sampling locations for all stations are shown in Figures 10 and 11. Samples are analyzed by ion exchange and gamma spectrometry; results are compared to intake guides specified by the Federal Radiation Council (FRC).[6]

The average concentrations of ^{131}I and ^{90}Sr in raw milk are given in Tables 26 and 27, respectively. If one assumes the average intake of milk per individual to be one liter per day, the average concentrations of ^{131}I in milk in both the immediate environs of the Oak Ridge area and in the environs remote from Oak Ridge were below the detection limit for ^{131}I, 0.45 E-09 μCi/mL (0.017 Bq/L). The average concentrations of ^{90}Sr in milk from both the immediate and remote environs were within the FRC Range 1.

Fish Sampling - Several species of fish which are commonly caught are taken from the Clinch River each year. The scales, head, bones, and entrails are removed from the fish before ashing. Ten fish of each species are composited for each sample, and the samples are analyzed by gamma spectrometry and radiochemical techniques for the critical radionuclides which may contribute significantly to the potential radiation dose to man.

Data on the concentration of radionuclides in Clinch River fish are given in Tables 28 and 29. Consumption of 16.8 kilograms of carp per year[7] taken from the river near White Oak Creek outfall results in approximately 1.2 percent of the maximum permissible intake, which represents the highest dose potential to the public from fish consumption. The maximum permissible intake is calculated to be equal to a daily intake of 2.2 liters of water, over a period of one year, containing the concentration guide of the radionuclides in question.

Mercury concentrations in fish samples collected during 1983 were less than the Food and Drug Administration (FDA) proposed action level. In comparing the 1983 data to past data, it was discovered that values reported for mercury in fish in two previous reports (Y/UB-10, Table 27, CY 1978 and Y/UB-13, Table 26, CY 1979) were in error. Factors necessary to convert the radioanalyses from an "ashed weight" to a "wet weight" or original sample basis were inadvertently applied to the mercury data reported. This was an error in data handling since mercury data were already tabulated on a "wet weight" basis. Table 30 presents all mercury-in-fish data from CY 1978 through CY 1983 with the corrected data footnoted.

Deer - Frequently, deer are killed by automobiles on the DOE Reservation. Eighty-eight deer were analyzed during 1983, five of which were not killed on the Reservation. Summary data of the ^{137}Cs content in deer samples are presented in Table 31. The deer with the highest concentration of ^{137}Cs would result in a dose of 0.05 millirem (0.5 microsievert) to the total body and 0.07 millirem (0.7 microsieverts) to the liver (critical organ) if one assumes the consumption of one kilogram of meat. It should be noted that no hunting is allowed on the Reservation.

Vegetation - Samples of pine needles and grass are collected from 14 areas around ORGDP (Figure 1) and from 10 areas around the Y-12 Plant (Figure 12). These samples are analyzed for uranium and fluoride content. Fluorometric analysis is used for the determination of uranium and colorimetric analysis is used for the determination of fluorides.

Data on the uranium and fluoride content in vegetation are presented in Table 32 and 33. The fluoride concentration in grass at all sampling points was below the 30 μg/g level considered to produce no adverse effects when ingested by cattle.[8] Uranium concentrations were below levels of environmental concern.

Additionally, samples of grass were collected semiannually from the perimeter and annually from the remote air-sampling stations (see Figures 1 and 2). At each station, all the grass from five 1/5

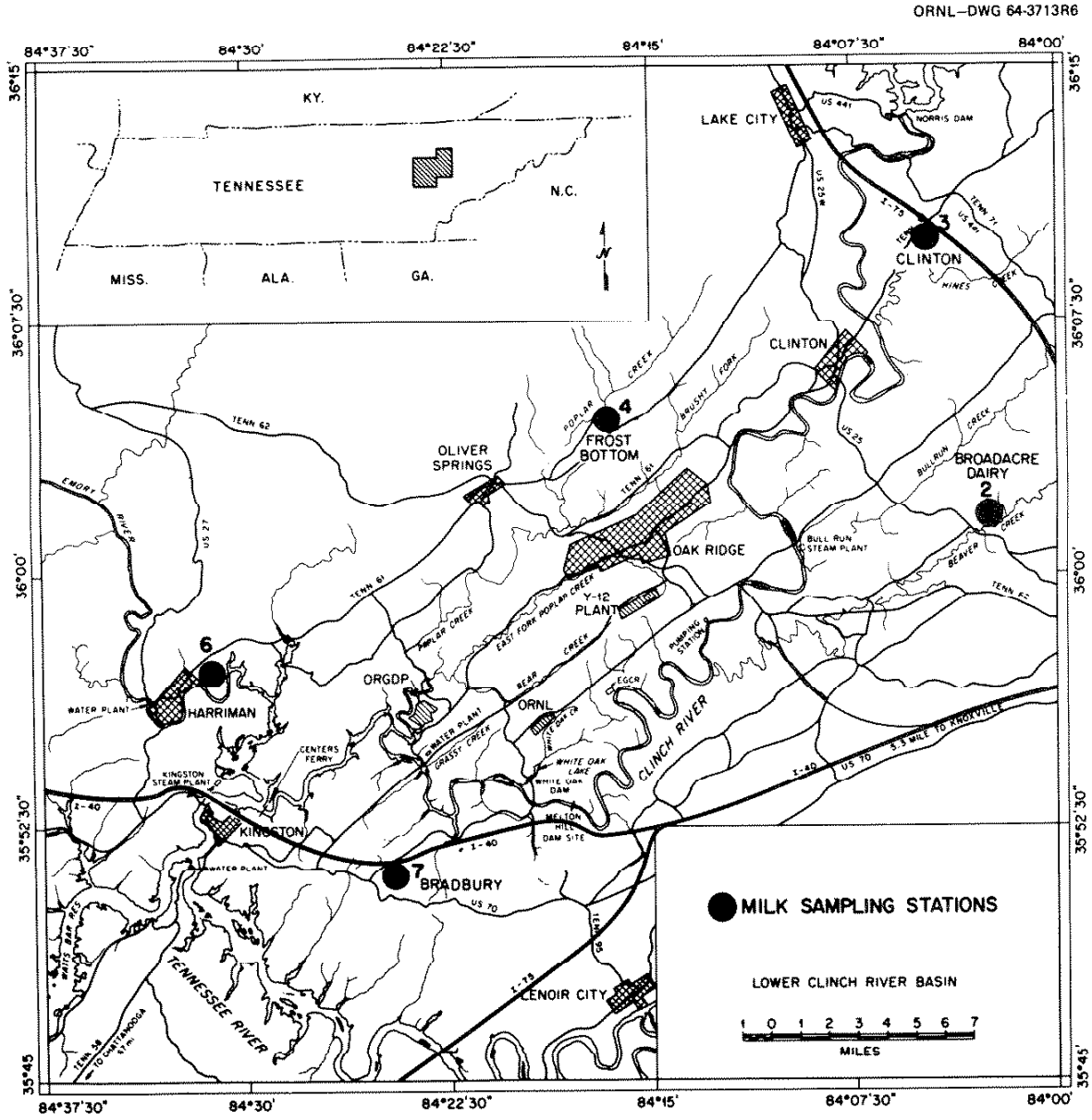

Figure 10
IMMEDIATE ENVIRONS MILK SAMPLING LOCATIONS

ORNL-DWG 83-10730

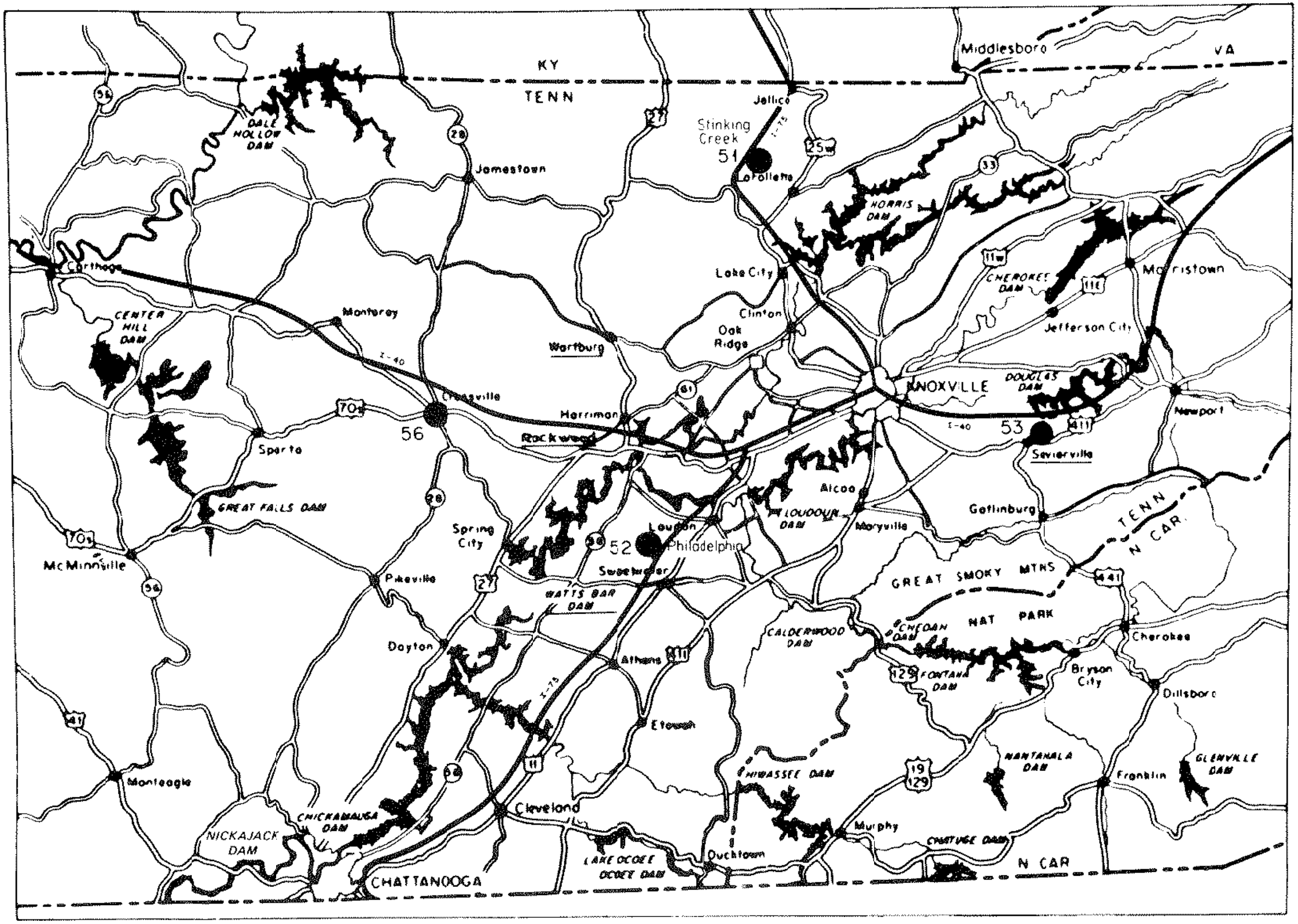

Figure 11
REMOTE ENVIRONS MILK SAMPLING LOCATIONS

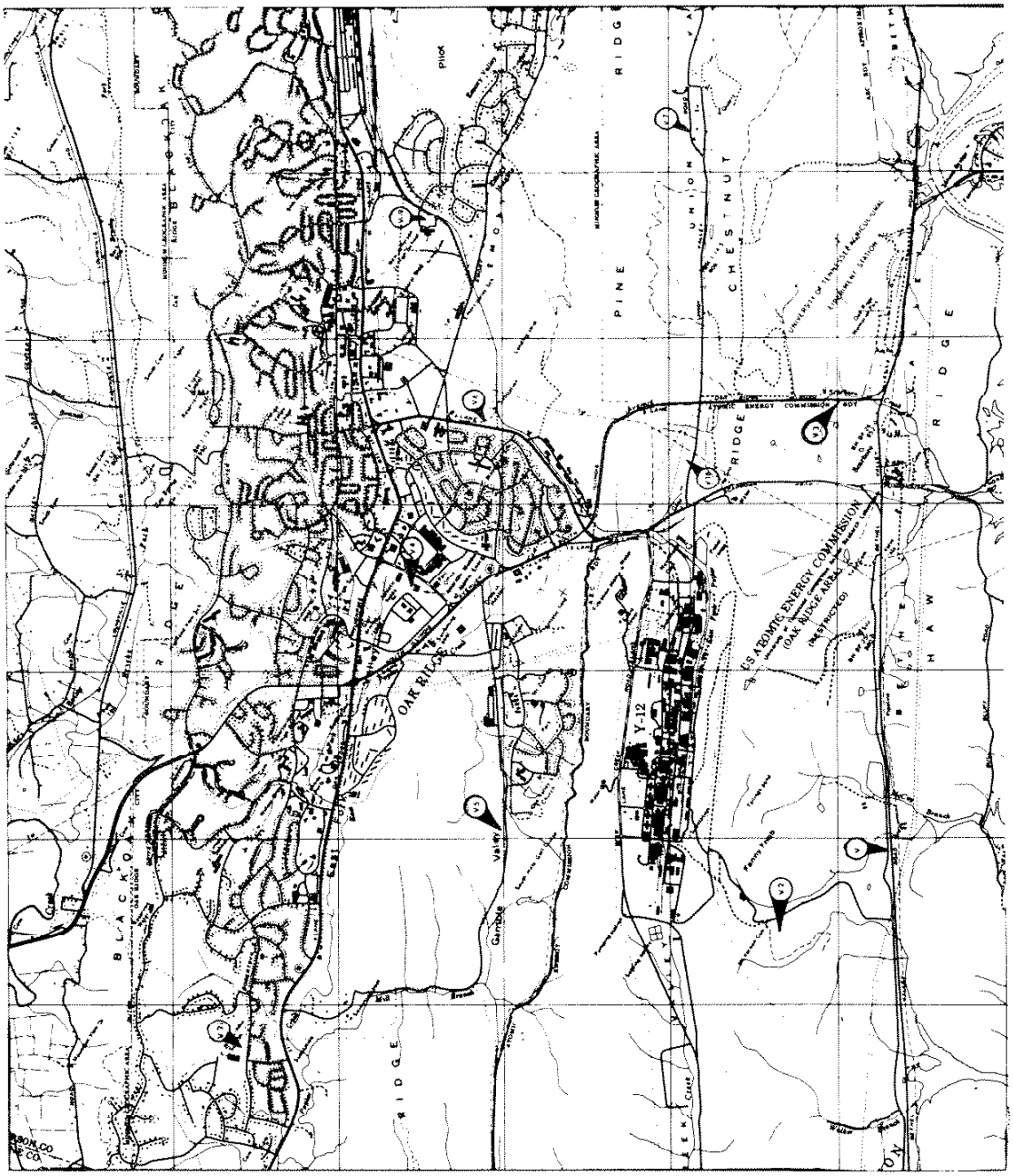

Figure 12
VEGETATION SAMPLING LOCATIONS - Y-12 PLANT

meter-squared plots was collected. One plot was taken beside the station, and the other four were taken at 15 m from the station at 90° directions from each other. The grass from each station was then composited and analyzed by gamma spectrometry and radiochemical techniques for a variety of radionuclides. Data on the radionuclide concentrations in grass are presented in Table 34.

Soil and Sediment Monitoring

Soil - Soil samples are collected semiannually from near the perimeter and annually from the remote stations. The same five 1/5 meter-squared plots used for grass analysis were used for soil determinations. Two cores, 8 cm in diameter and 5 cm in depth, were taken from each plot; a composite of 10 cores was used for each station. These samples were analyzed by gamma spectrometry and radiochemical techniques.

Soil sampling is conducted also around ORGDP to determine concentrations of uranium and fluoride present at the 14 areas (Figure 1) where samples of pine needles and grass are collected. Fluorometric analysis is used for the determination of uranium and colorimetric analysis is used for the determination of fluorides.

Data on specific radionuclide concentrations in soil are given in Table 35. The plutonium concentrations found were comparable to the value of 0.05 pCi/g (0.002 Bq/g) considered to be a representative concentration of plutonium in U.S. surface soil.[9] Data on the fluoride and uranium content of the soil around ORGDP are given in Table 36.

Sediment - A sediment sampling program was initiated at ORGDP in 1975 to determine the concentrations of various metallic ions in the sediment of Poplar Creek. The current sampling program consists of eight sampling locations (Figure 13) which should be generally representative of plant effluents. Samples are collected during the year and analyzed by atomic absorption.

The concentrations of metals in the stream sediment samples, Table 37, generally exceed background levels for metals in remote streams. An examination of the effluent sources indicates that only very small quantities of any of these metals are currently being released, suggesting that present concentrations found in sediment samples are residual metals from earlier Oak Ridge plant operations.

Groundwater Monitoring

Groundwater monitoring programs within the Oak Ridge facilities complex were expanded in 1983 to meet the requirements of the groundwater monitoring rules outlined in the Resource, Conservation and Recovery Act (RCRA) regulations and, in the case of the Y-12 Plant, to comply with the requirements of a 1983 Memorandum of Understanding (MOU) between DOE, EPA, and the State of Tennessee. The expanded program at Y-12 included the initiation of groundwater studies by outside contractors (Law Engineering and Bechtel), addition of new wells, and an increase in the number of parameters analyzed in groundwater samples.

The Y-12 Plant has been routinely monitoring groundwater since 1975 at which time 17 wells were used to characterize groundwater in Bear Creek Valley. New wells have been added bringing the current monitoring well network to 29 wells located around six disposal areas (Figure 14). The well depths range from 18.5 to 181 feet and, in general, each well has been drilled through the saturated zone and extends partially into weathered bedrock.

The analytical parameters chosen for each disposal facility have been selected to reflect the applicable State and Federal regulations and the nature of the materials being disposed. While

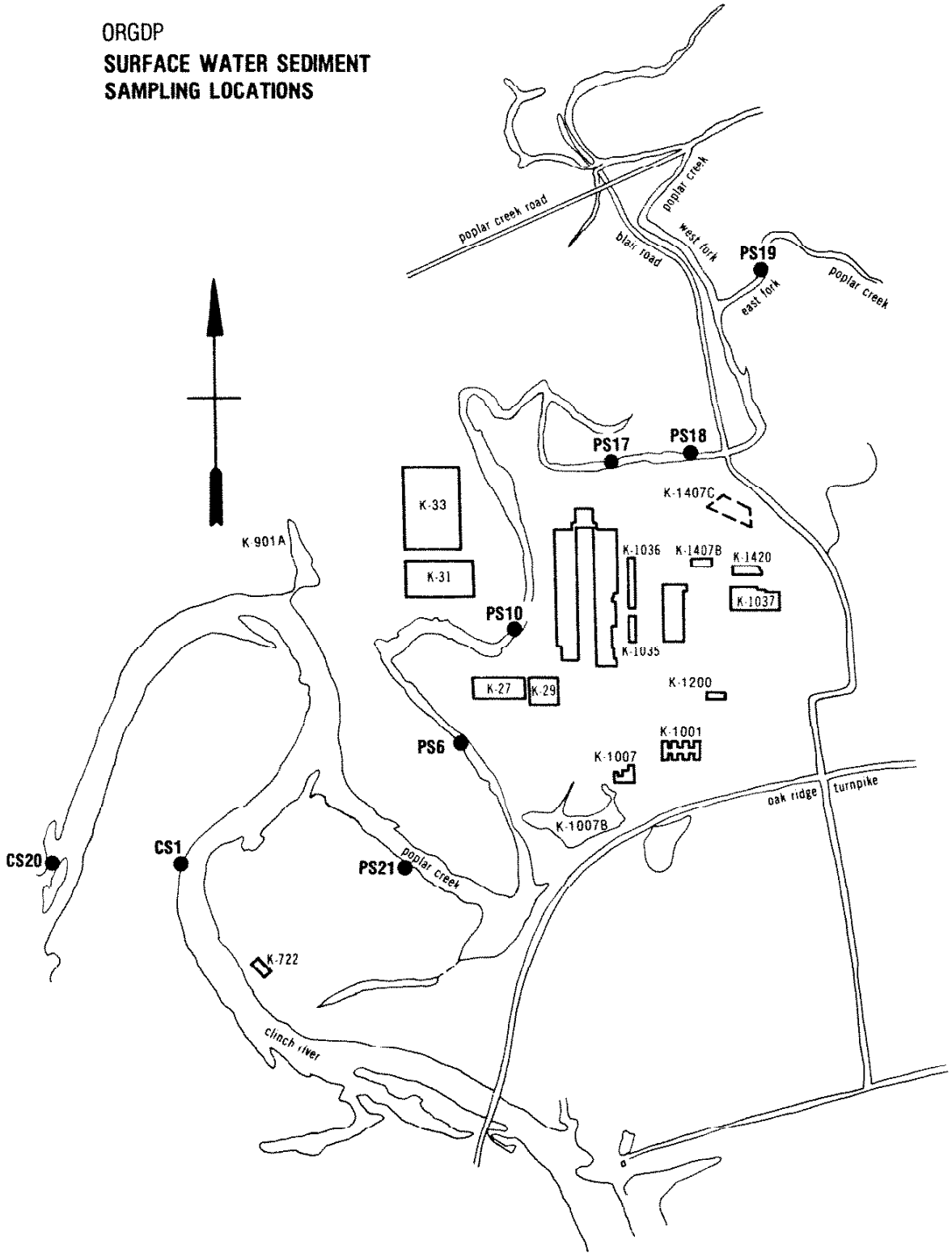

Figure 13
OAK RIDGE GASEOUS DIFFUSION PLANT SEDIMENT SAMPLING LOCATIONS

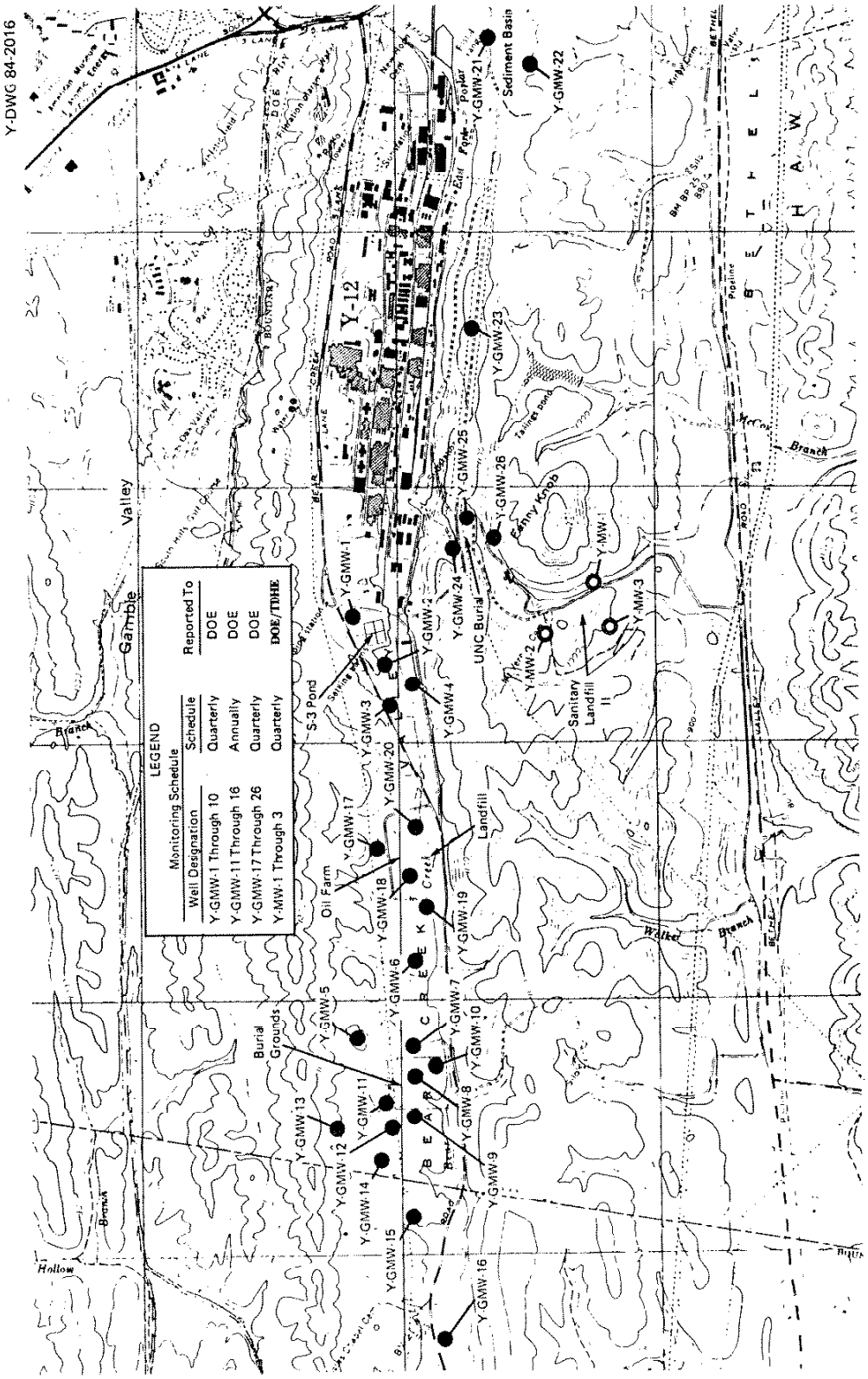

Figure 14

Y-12 PLANT GROUNDWATER MONITORING WELL LOCATIONS

some parameters are included strictly as precautionary measures, others are indicator parameters for groundwater quality. Once the analytical results data base is sufficiently established, the list of parameters will be reevaluated and amended as necessary.

During 1983, 3838 measurements were made by the Y-12 plant on water from the 29 wells to determine if contaminants were present and to indicate water quality conditions. Approximately 72 percent of these measurements were less than the analytical reporting limit. The majority of the measurements that were above the reporting limit included water quality parameters such as pH, specific conductance, color, coliform, total nitrogen, Kjeldahl nitrogen, nitrate-nitrogen, chlorine, iron, manganese, and magnesium.

Data relative to the Y-12 groundwater monitoring program are presented in Tables 38 through 48. Table 38 lists the parameters for which analyses are conducted. Not all parameters are monitored in each disposal area. Tables 39 through 46 present the maximum and minimum values found in the wells of each disposal area for those parameters with concentrations greater than the reporting limits. Tables 39 and 40 represent data from upslope wells in two disposal areas and are labeled background wells. Table 47 summarizes the number of parameters for which analyses were conducted on the well water from each area and the number of parameters whose values were less than the analytical reporting limits. Selenium, MBAS, methyl bromide, methyl chloride, xylene, chloroethane, endrin, lindane, methoxychlor, toxaphene, 2,4,5-T silvex, and 2,4-D were below detection limits in all wells for all sampling periods.

The measured concentrations of certain metals in the wells were tested against EPA primary drinking water standards. Table 48 lists the wells, dates of sampling, and parameters where the concentration exceeded the EPA standard. The analytical reporting limits for arsenic and selenium (0.06 and 0.02 mg/L, respectively) exceed the EPA standard. Only those concentrations exceeding the reporting limits for these parameters are included in the table.

Groundwater monitoring at ORGDP for calendar year 1983 consisted of sample collection around the classified burial ground and the K-1407-C holding pond (Figure 15). Samples were collected during November from both "shallow" wells and "deep" wells situated to provide monitoring for the unsaturated and saturated zones, respectively. Inorganic parameters are determined by atomic absorption spectroscopy and organic constituents are identified by gas chromatography.

Groundwater data for ORGDP are presented in Tables 49 through 52. The data from shallow wells indicate higher maximum and average concentrations for most parameters compared to the deep wells suggesting some possible contamination of the unsaturated zone. Too little data have been collected thus far to determine trends or to identify the direction of contaminant migration, if any is occurring, from the areas being monitored. The program is being expanded to address needs for additional information.

Extensive geological studies have been conducted for many years at ORNL. This is in contrast to the situations at Y-12 or ORGDP, where such studies have been started only recently. Consequently, it is possible to present an interpretation of the groundwater flow at ORNL; in future reports, such interpretations will be available for other facilities.

Groundwater analyses, 465 total, were performed at ORNL in 1983 on groundwater samples in Solid Waste Storage Areas (SWSA) 4, 5, 6, and the trench areas. Wells were selected for sampling on a quarterly basis from a group of approximately 100 monitoring wells. In 1983, the samples were analyzed for one or more of the following: gamma emitters, gross alpha activity, plutonium, ^{3}H, ^{90}Sr, ^{241}Am, ^{244}Cm, and ^{99}Tc. Well locations for sample and control wells are shown in Figures 16 and 17. Data on the concentrations of selected radionuclides measured in the sample

ORGDP

GROUNDWATER MONITORING WELLS

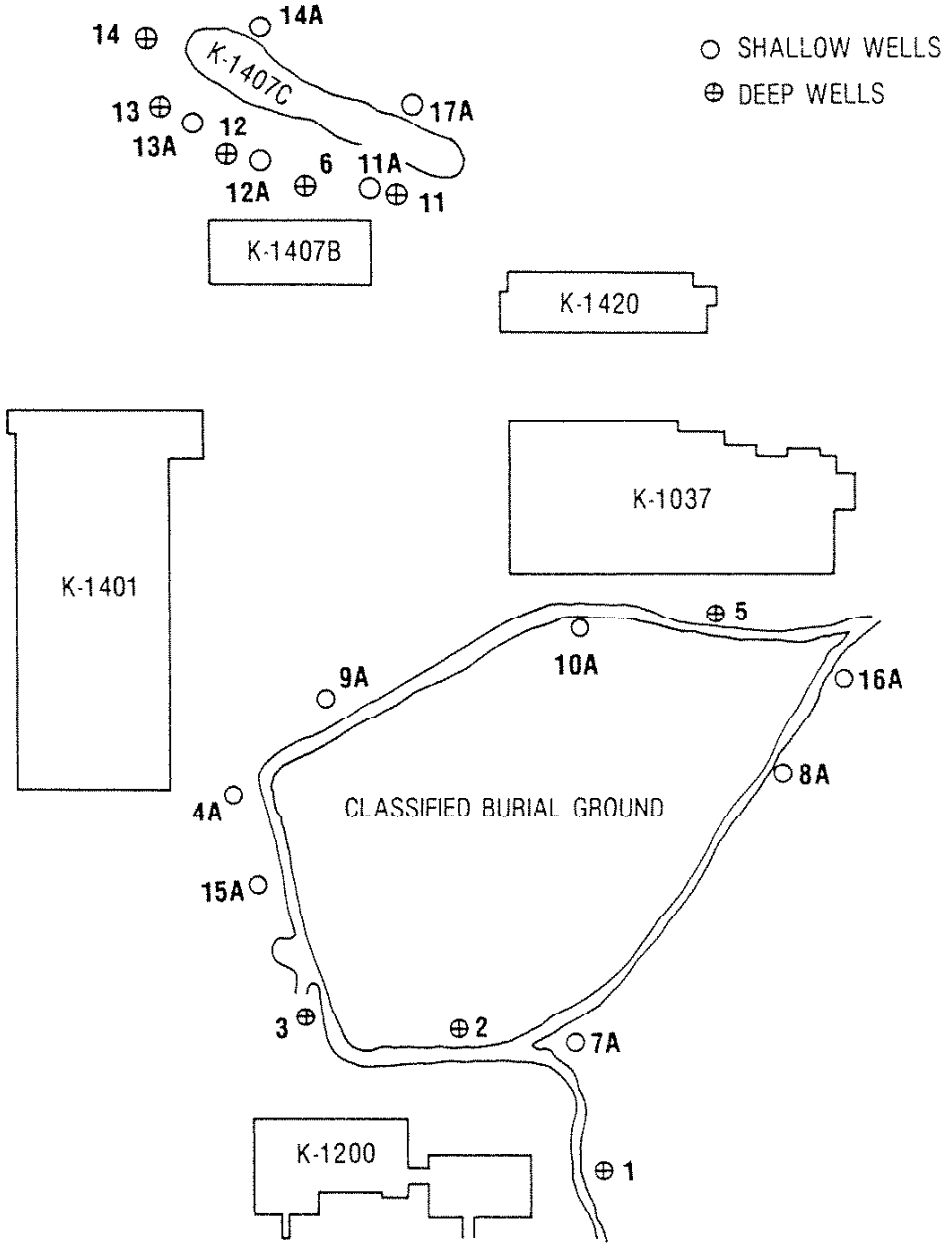

Figure 15
ORGDP GROUNDWATER MONITORING WELL LOCATIONS

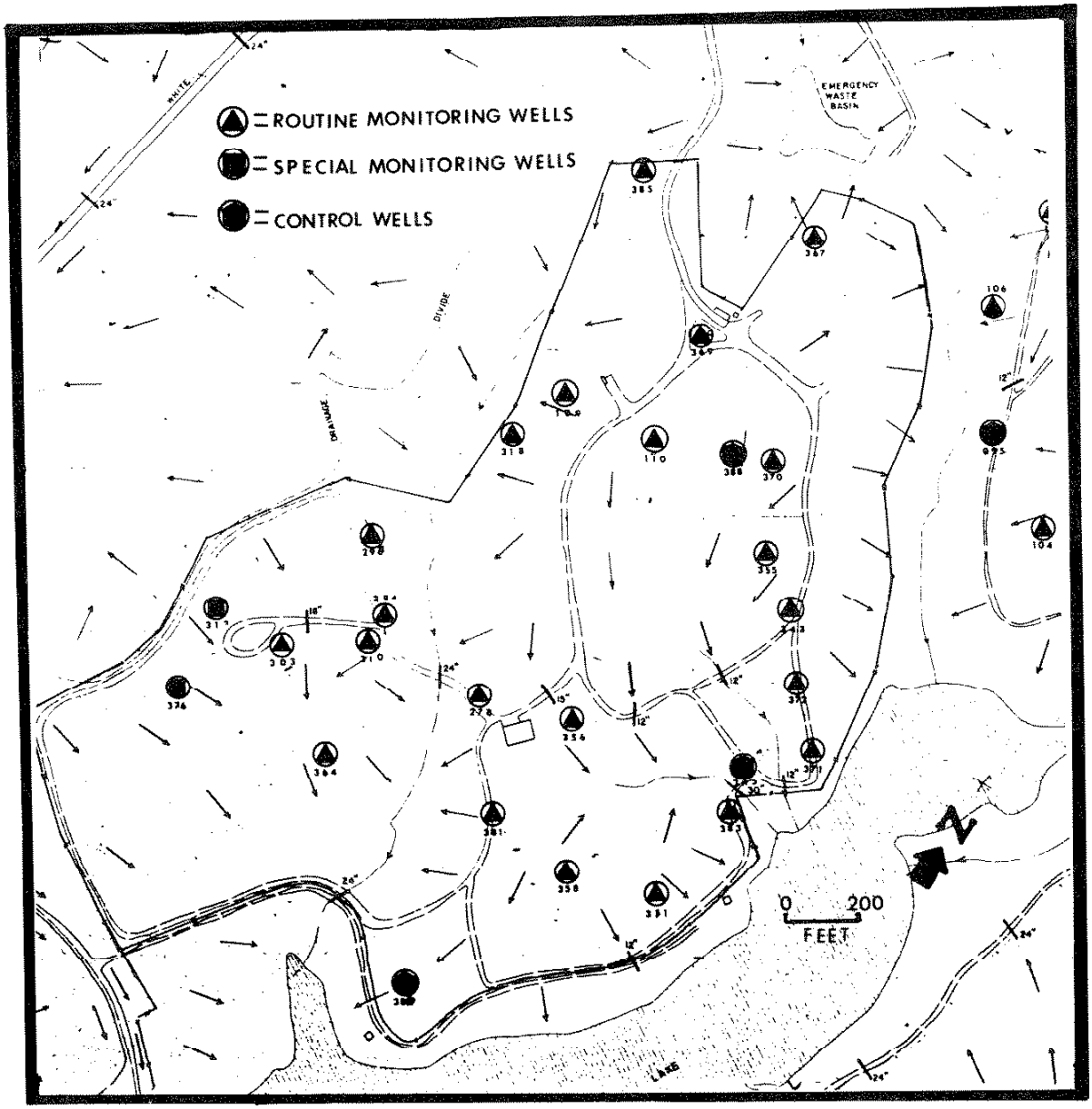

Figure 16
ORNL GROUNDWATER MONITORING WELL LOCATIONS - SWSA 6

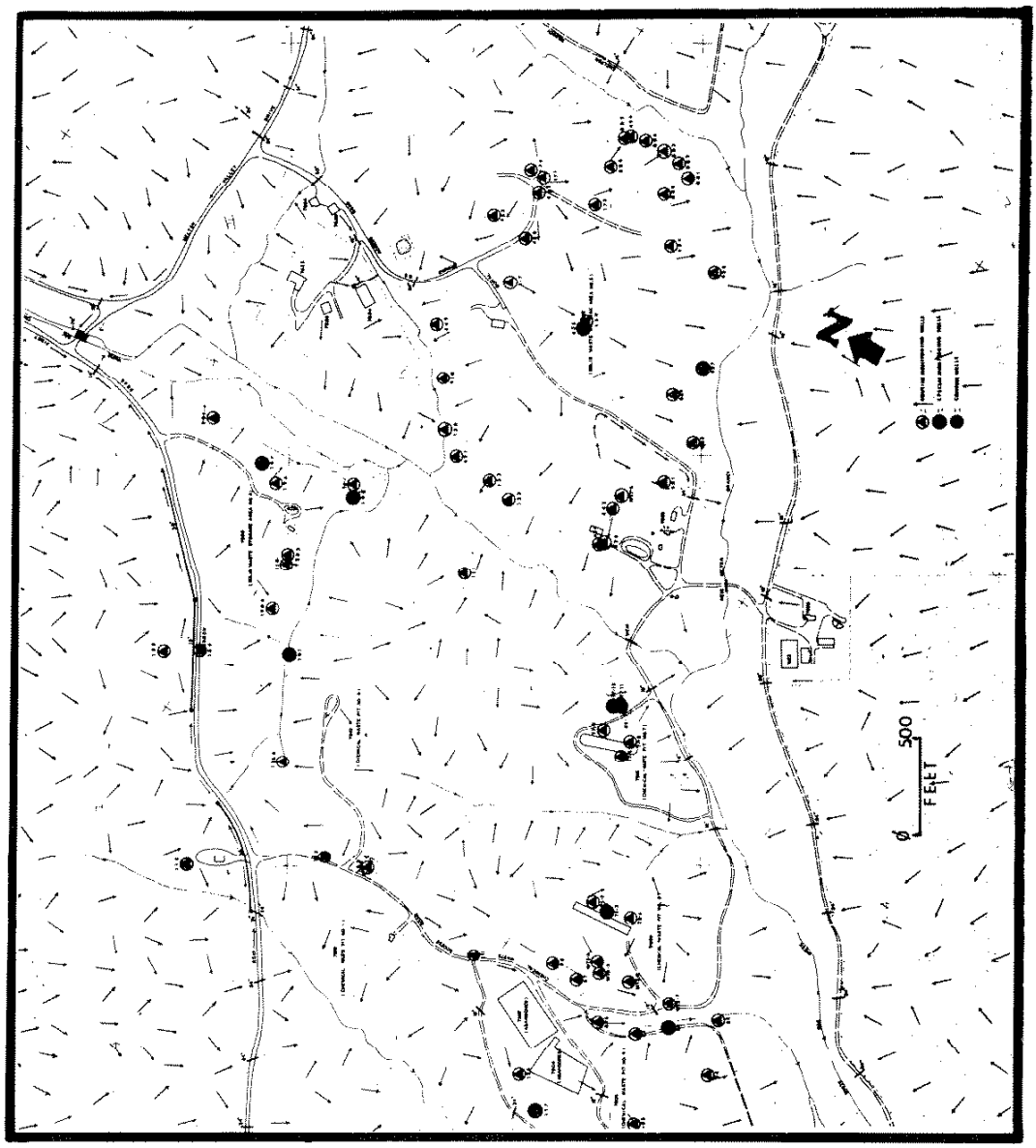

Figure 17
ORNL GROUNDWATER MONITORING WELL LOCATIONS - SWSA 4 AND 5, PITS, TRENCHES

and control wells are presented in Table 53. In addition to the analyses presented in Table 53, there were 15 samples each analyzed for ^{241}Am, ^{244}Cm, ^{238}Pu, ^{239}Pu and ^{99}Tc. The concentrations of all of these samples were less than their respective CGs, usually by more than an order of magnitude. Analyses equalling or exceeding the CG are presented in Table 54. The highest concentrations of ^{60}Co, ^{99}Tc, ^{241}Am, ^{244}Cm, ^{239}Pu, ^{238}Pu, and gross alpha were found in the trench areas. Levels of ^{3}H significantly above the controls were also found in the trench areas. The highest concentrations of ^{3}H were found in SWSA 5, and the highest concentrations of ^{90}Sr were found in SWSA 4 and 5. SWSA 5 also contained concentrations of ^{60}Co and ^{99}Tc significantly above background. In addition to ^{90}Sr, SWSA 4 contained ^{3}H and gross alpha activity above the level of the controls. Results indicated SWSA 6 contained concentrations of ^{90}Sr and ^{3}H above control concentrations. With the exception of the trench areas, very few concentrations significantly above background were found for ^{241}Am, ^{244}Cm, ^{238}Pu, ^{239}Pu, and ^{99}Tc. In no instance did the average ^{137}Cs concentration within the various areas exceed the average ^{137}Cs concentration of the control samples. Samples were not analyzed for parameters other than radionuclides during 1983.

The groundwater system in Melton Valley basically has a very shallow active zone. The system is characterized by highest permeability for groundwater flow near the surface, and declining permeability with depth. Although quantitative studies of near-surface groundwater flow during storm events are still in progress, it appears that most subsurface flow occurs in a near-surface region that extends to a depth of less than about 5 meters. The general hydrologic picture is that of a rather closely coupled surface water and groundwater system, where circulation is rather shallow and much of the movement occurs in the near-surface zone during the wetter part of the year (late November through April). The more traditional concept of a subsurface contamination plume as a primary pathway for contaminant migration is not appropriate. The hydraulic conductivity of the less-weathered material is about 2 cm/day, while the near-surface zone is characterized by 20 to 40 cm/day or higher hydraulic conductivities. Furthermore, the distribution coefficients for most radionuclides in the Conasauga Group (shales) are rather high, suggesting that any deep migration would occur at a very slow rate. The primary pathway for contaminant migration, where it occurs, is thought to be via the bathtub effect, where a trench collects enough water that the downstream end overflows. Subsequent movement is thus over the surface and vertically downward along the flow path. Preliminary data gathered by D. Webster of the USGS also suggests that for the deeper subsurface flow system, radionuclide penetration has not extended beyond 30-45 meters in SWSA 5, and most transport would be expected in the zone above those limits. A variation of that process is movement of shallow subsurface flow in fill material along and just above the interface with native materials underlying the fill. Thus, the nature of the groundwater system suggests that long-range subsurface flow is not likely for most areas because of low permeability of formations.

Based on the above, it is believed that there is no significant potential for groundwater contamination of the sixteen public groundwater supplies within a 32.3 km radium of ORNL from operations at ORNL. The hydrogeologic structure is such that any groundwater flow that occurs is most probably in an east or west direction (along strike) rather than across formations. Thus, the most likely direction for any deep groundwater flow would be to the west, towards the Clinch River from ORNL disposal areas and then into the Clinch, which would be the discharge point for groundwater flow in the areas. Finally, the most significant factor to consider is the rate of movement of groundwater and radionuclides in the Conasauga Group formations underlying ORNL disposal areas. Using the measured hydraulic conductivity of 2 cm/day (or less) and an average gradient of 0.01 m/m with an effective porosity of 0.10, the expected water velocity would be 0.2 cm/day or about 0.73 m/yr. At that rate, about 1370 years would be required for water to travel 1 km underground. Considering the fact that most radionuclides have retardation factors of the order of 100 or greater (retardation factor refers to the ratio of water velocity to radionuclide velocity),

calculations have shown that movement of groundwater contaminants with even minimal sorption in the Conasauga Group formations would require in excess of 10,000-100,000 years for travel distances of 1 km. Furthermore, decay, adsorption, dilution, and dispersion of contaminants would reduce original concentrations by many orders of magnitude over the first 1 km of travel. Since there are no public groundwater supplies within 1 km of any of the disposal areas, it is concluded that there is no reasonable probability of groundwater contaminants moving from ORNL disposal sites to public groundwater supplies in detectable concentrations.

Calculation of Potential Radiation Dose to the Public

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations.

The site boundary for the Oak Ridge Complex was defined as the perimeter of the DOE controlled area.

Gaseous effluents are discharged from several locations within each of the three Oak Ridge facilities. For calculational purposes, the gaseous discharges are assumed to occur from only one vent from each site. Since the release points at the Y-12 Plant does not physically approximate an elevated stack, their discharges are assumed to be from 8 meters above ground level; releases from ORNL and ORGDP are through elevated stacks. The meteorological data collected at the ORNL site in 1983 were used for dispersion calculations. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 80 kilometers from the Oak Ridge facilities with the Gaussian plume model developed by Pasquill[10] and Gifford[11] incorporated in a computer program.[12-15] The deposition velocities used in the calculations were 0.0 cm/s for krypton and xenon, 0.2 cm/s for iodine, and 0.1 cm/s for particulates.[16] Meteorological data are shown in Figures 18 and 19.

Potential pathways of exposure to man from radioactive effluents released by the Oak Ridge operations that are considered in the dose estimates are presented in Figure 20. The pathways shown in the figure are not exhaustive, but they include the principal pathways of exposure based on experience.

Exposures to radionuclides that originate in the effluents released from the Oak Ridge facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection,[17-24] other recognized literature on radiation protection,[25-27] personal communication,[28] and computer programs incorporating some of these models and data.[29,30] Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until removed by processes of metabolism and radioactive decay; thus the estimates for internal dose are called "dose commitments," they are obtained by integrating over the assumed remaining lifetime of the exposed individual.

The radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal, but they may vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, and gastrointestinal tract were considered for various pathways of exposure. These estimates were based on parameters applicable to an average adult.[24] The population dose estimate in man-rem (man-sieverts) is the sum of the total body doses to exposed individuals within an 80-kilometer radius of the Oak Ridge facilities.

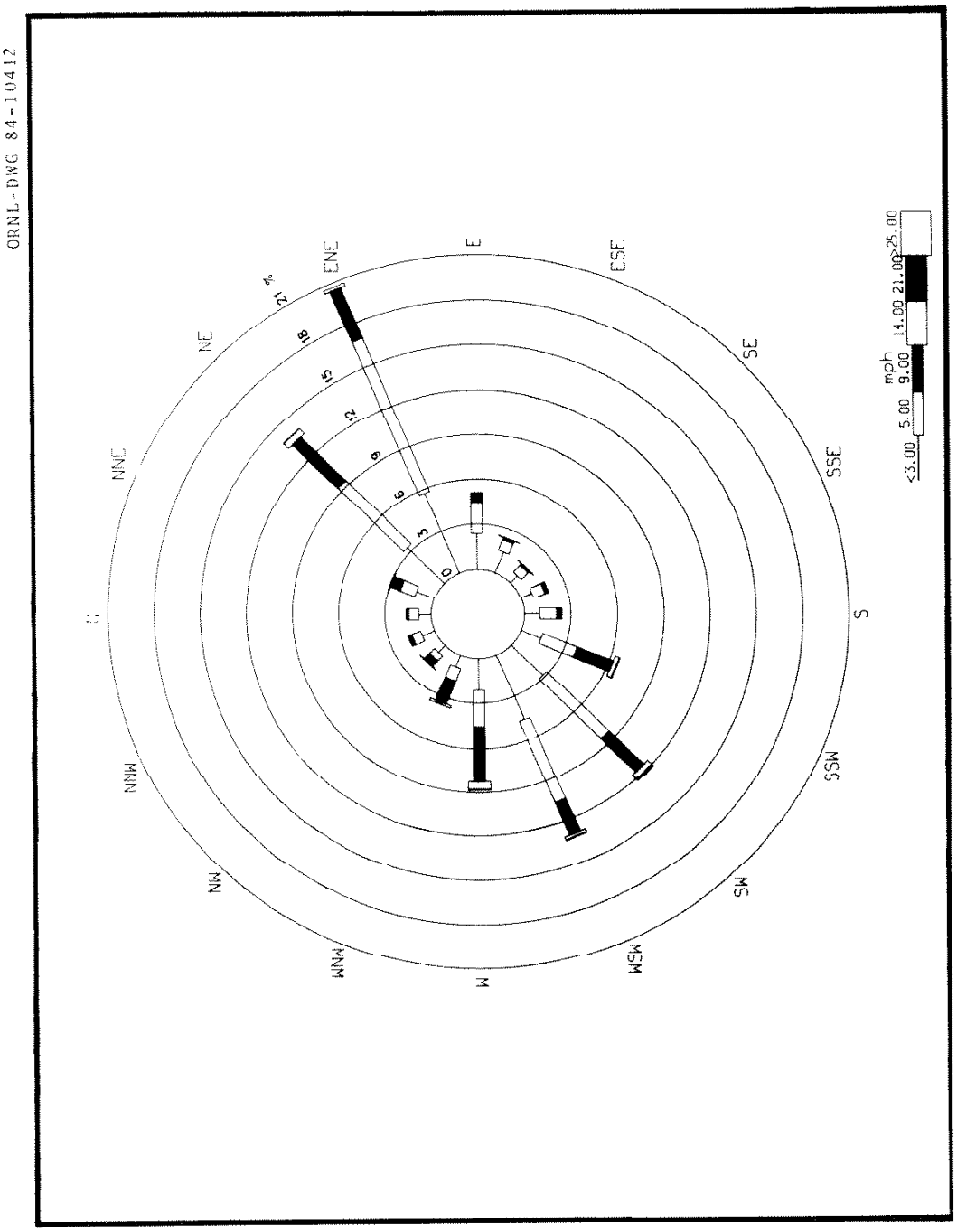

Figure 18
METEOROLOGICAL DATA FOR THE OAK RIDGE RESERVATION
30 METER TOWER

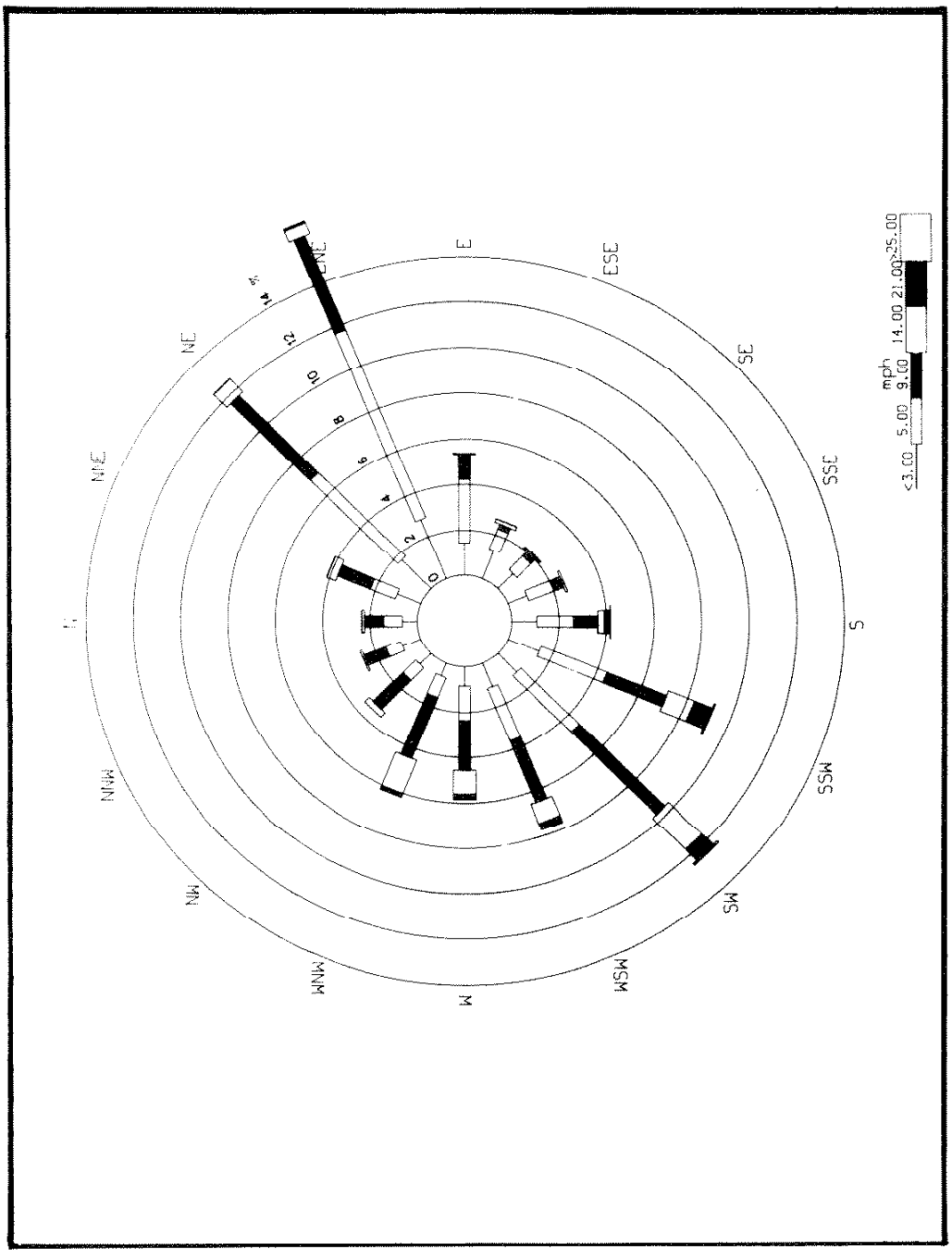

Figure 19
METEOROLOGICAL DATA FOR THE OAK RIDGE RESERVATION
100 METER TOWER

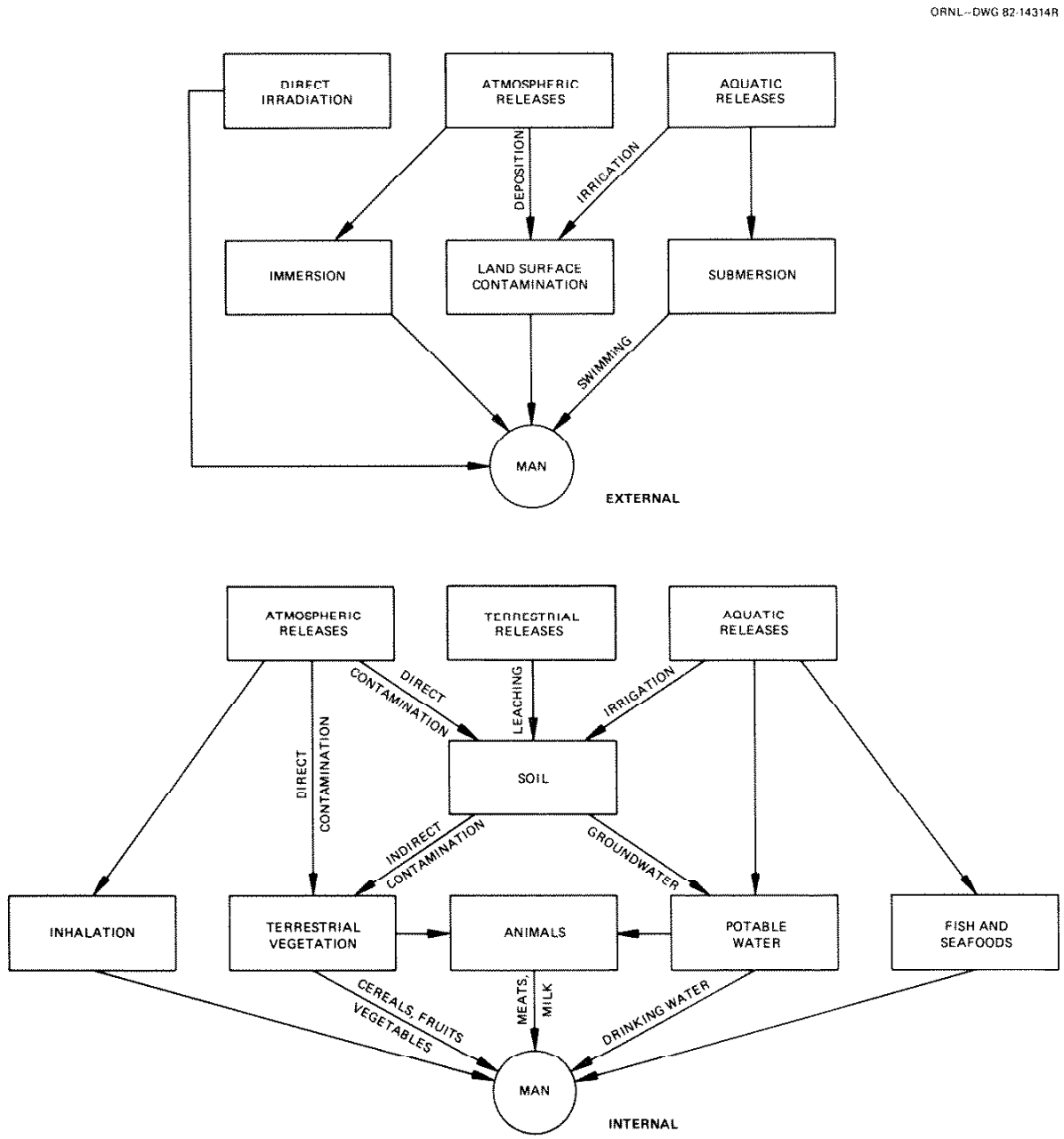

Figure 20
EXPOSURE PATHWAYS

Maximum Potential Exposure - The point of maximum potential ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky-shine" from the plot. A maximum potential total body exposure of 250 millirem/yr (2500 microsieverts/yr) was calculated for this location assuming that an individual remained at this point for 24 hours/day for the entire year. The calculated maximum potential exposure is 50 percent of the allowable standard.[1] This is an atypical exposure location and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total body dose to a "hypothetical maximum exposed individual" at the same location was calculated using a more realistic upper limit residence time of 240 hours/yr. The calculated dose under these conditions was 6.8 millirem/yr (68 microsieverts) which is 1.4 percent of the allowable standard[1] and represents what is considered a probable upper limit of exposure.

A more probable exposure might be considered to occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The equivalent dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and is based on an inhalation rate for the average adult of 2 E+04 liters/day. The calculated dose commitment at this location was 21 millirem (210 microsieverts) to the pulmonary tissues (the critical organ) and the equivalent dose commitment (weighted sum of doses to the principle organs) to the total body was 6.3 millirem (63 microsieverts). ^{234}U is the important radionuclide contributing to this dose. These levels are 1.4 percent and 1.3 percent, respectively, of the allowable annual standard.

An important contribution to dose from radioactivity within the terrestrial food-chain is by the atmosphere-pasture-cow-milk food-chain pathway. Measurements of the two principal radionuclides entering into this pathway, ^{131}I and ^{90}Sr (see Tables 26 and 27), indicate that the maximum dose to an individual in the immediate environs from ingestion of one liter of milk per day is less than 0.02 millirem (0.2 microsieverts) to the thyroid and 0.3 millirem (3 microsieverts) to the bone. The average concentrations for the remote stations were assumed to be background and were subtracted from the perimeter station data in making the calculations.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located approximately 26 kilometers downstream at Kingston, Tennessee. The intake to the water filtration plant is located on the Tennessee River approximately one-half mile upstream from the confluence of the Clinch and Tennessee Rivers. Normally, Tennessee River water is used for the Kingston water supply but under certain conditions backflow can occur. Under backflow conditions, Clinch River water may move upstream in the Tennessee River and be used as the source of water for the Kingston filtration plant. Measurements of treated river water samples taken at the Kingston filtration plant indicate that the maximum dose commitment resulting from the ingestion of the daily adult requirement (about two liters per day) is 3.0 millirem (30 microsieverts) to the bone and 0.13 millirem (1.3 microsieverts) to the total body. Untreated water from Melton Hill Lake (background) contained about the same levels of radioactivity as the Kingston treated water.

Estimates of the dose commitment to an adult were calculated for consumption of 16.8 kilograms of fish per year from the Clinch River. The consumption of 16.8 kilograms[7] is about 2.5 times the national average fish consumption[31] and is used because of the popularity of fishing in East Tennessee. From the analysis of edible parts of the fish examined (see Table 28 and 29), the maximum possible organ dose commitment to an individual from the highest quarterly carp sample taken from Clinch River Mile (CRM) 20.8 is estimated to be 41 millirem (410 microsieverts) to the bone from ^{90}Sr. The maximum total body dose to an individual was calculated to be 0.15 millirem (1.5 microsieverts).

A more probable dose commitment, based on the annual average concentration of ^{90}Sr in carp samples taken from CRM 20.8, was calculated to be 23 millirem (230 microsieverts) to the bone and 1.4 millirem (14 microsieverts) to the total body. These dose commitments are about 1.5 percent and 0.3 percent, respectively, of the allowable annual standards. Fish samples taken from Melton Hill Lake were analyzed to determine background conditions. Fish caught and consumed from other locations in the Clinch River would result in significantly less dose than the maximum calculated for CRM 20.8, see Tables 28 and 29. As shown in Table 29, shad at CRM 20.8 had the highest levels of the most significant isotopes. These fish are not normally consumed by humans but the maximum hypothetical doses were calculated to be 59 millirem (590 microsieverts) to the bone and 3.9 millirem (39 microsieverts) to the total body.

Summaries are given in Table 55 of the potential radiation doses to adult members of the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

Dose to the Population - The Oak Ridge population received the largest average individual equivalent dose commitment (weighted sum of doses to principle organs) to the total body as a population group. The average equivalent dose commitment to the total body dose of an Oak Ridge resident was estimated to be 1.3 millirem (13 microsieverts). The average dose commitment to the pulmonary tissues of an Oak Ridge resident was 4.2 millirem (42 microsieverts). The maximum potential dose commitment to an Oak Ridge resident was calculated to be 21 millirem (210 microsieverts) to the pulmonary tissues. This calculated dose is 1.4 percent of the allowable annual standard.[1]

The cumulative equivalent dose commitment (weighted sum of doses to principle organs) to the total body of the population within an 80-kilometer radius of the Oak Ridge facilities resulting from 1983 plant effluents was calculated to be 120 man-rem (1.2 man-sieverts). This cumulative dose was calculated using the population distribution given in Table 1 for ORNL atmospheric effluents; similar population distributions were used for the Y-12 and ORGDP releases. This dose may be compared to an estimated 87,000 man-rem (870 man-sieverts) to the same population resulting from natural background radiation. About 25 percent of the collective dose from the effluents of the Oak Ridge facilities is estimated to be to the Oak Ridge population.

SPECIAL STUDIES

This section of the report contains abstracts or brief summaries of special studies that have been conducted or are ongoing which are related to the environmental monitoring activities of the Oak Ridge plants. References are provided for completed studies in which additional details may be found.

Oak Ridge Task Force

On May 26, 1983, a Memorandum of Understanding (MOU) was signed by the U.S. Department of Energy, the Tennessee Department of Health and Environment, and the U.S. Environmental Protection Agency, for the purpose of investigating environmental contamination at the Oak Ridge Reservation. An interagency task force identified as the Oak Ridge Task Force (ORTF) was then organized to develop and execute a work program in accordance with the MOU. Four study groups were established by the ORTF on August 18, 1983, to consider the technical requirements involving investigations of fisheries, groundwater, soils, in-stream water, sediment, and floodplain. On November 3, 1983, the ORTF determined that an additional group concerned with the integration of findings and preparation of a public health assessment was required. The Oak Ridge National Laboratory was subsequently requested to submit a plan to address these latter considerations.

The ORTF also arranged for collection of sediment samples from streams and floodplains within and contiguous to the Oak Ridge Reservation. A total of 18 samples were collected. Tennessee Valley Authority analyzed each sample for more than 130 different compounds and elements, including organic materials, trace metals, and radionuclides. The purpose of this sediment screening study is to identify contaminants whose concentration in sediments is sufficient to warrant further study. Results are now being analyzed.

Environmental Monitoring and Surveillance of the Oak Ridge Community

A second activity was initiated by the ORTF to better define the potential problem of residual contamination. This involves a sampling program to respond to citizens' requests to determine if their soil, vegetables, or well water were contaminated, and to define the extent of contamination in areas of the community where sediments were used as fill. Oak Ridge Associated Universities is implementing the program and results of analyses of 1,432 samples are summarized in Appendix C. These results will be included as part of the public health assessment activity of ORTF.

Mercury Contamination in East Fork Poplar Creek and Bear Creek[32]

A one-month study was performed at the request of Y-12 Plant management to determine the concentration of mercury in sediment, fish, moss, and pasture grass in the East Fork Poplar Creek (EFPC) and Bear Creek drainages and to determine whether mercury is still being released from the Y-12 Plant.

Total mercury concentration in a sediment core from New Hope Pond was 100 μg/g dry wt at the surface and up to 300 μg/g dry wt in subsurface sediments, relative to background concentrations of less than 0.3 μg/g dry wt. There has been an apparent decrease since 1973 in mercury concentration of sediment entering New Hope Pond. The decrease since 1977 may be due to the absence to high runoff-producing storms since 1977, although one or more intermediate layers in the core need to be dated to establish the absolute chronology of mercury deposition in New Hope Pond over the period 1973-1982. Mercury concentration in sediment of EFPC immediately below New Hope Pond is similar to the concentration in the surface sediment of New Hope Pond, thus suggesting a common and currently active source for the mercury in the creek and the pond. Mercury concentration in the sediment decreases with distance downstream, indicating dilution of the contaminated sediment with uncontaminated sediment from tributary drainages entering East Fork Poplar Creek. Mercury concentration at all stations of EFPC exceeded background by a factor of 60 or more.

Total mercury concentration in muscle tissue of bluegill from EFPC was positively correlated with body weight, as expected. Although there was a decrease in concentration with distance downstream, mercury concentration in 87% of the bluegill collected at the three upstream locations exceeded the Food and Drug Administration (FDA) action level for mercury in the edible portion of fish of 1.0 μg/g fresh wt. Total mercury concentration in moss, as in sediments and bluegill, decreased with distance downstream in EFPC. Total mercury concentration averaged 3.5 and 0.2 μg/g fresh wt for dead and live foliage in pasture grass, respectively, on the flood plain of EFPC. Calculations indicate that mercury concentration in milk from cows grazing along EFPC presents no health hazard, but calculations indicate that mercury concentration in beef may exceed 1.0 μg/g fresh wt.

Results for Bear Creek indicate that this drainage is considerably less contaminated with mercury than East Fork Poplar Creek. The concentration in the sediment was 13 μg/g dry wt near the

settling basins at the west end of the Y-12 Plant area, but decreased to background concentrations before the confluence of Bear Creek with EFPC. Total mercury concentration in fish, except for one rock bass, did not exceed the FDA action level. The concentration in moss was slightly above background, but was more than a factor of 10 lower than that for moss from EFPC.

Lake Sediment Studies

To provide some verification of both the chronology and quantity of estimated mercury losses to East Fork Poplar Creek during the time the Lithium Isotope Separation Process was operating, a limited sediment sampling program was conducted during July 1983 in Watts Bar and Chickamauga Lakes.[33] A finely divided suspension of mercuric oxide, or a soluble form of mercury can be adsorbed on fine particles of silt which would settle slowly and resuspend readily. Experience with mercury contamination from chlor-alkali plants shows that mercury can be transported considerable distances (hundreds of miles) down stream.

Cores were taken at six locations, Figure 21. The sediment was sectioned and each layer was analyzed for mercury. The results of core analyses are shown in Figure 22. Both radioisotope release dating methods and calculation methods, based on the length of time reservoirs have been collecting sediments, have been used to date the sections. Both techniques showed peak mercury concentrations in Watts Bar sediments corresponded to silts laid down from 1955 to 1960, about the time of the peak discharges from the Lithium Isotope Separation Process. These layers of sediment showing high mercury levels are covered with 12 or more inches of sediment laid down since that time. The core in Chickamauga Lake above the confluence with the Hiawassee River did not reveal a subsurface peak in mercury, and all values were close to natural background levels. The second core just above Chickamauga Dam shows a small mercury peak. Interpretation of this peak is complicated by two upstream sources of mercury, the Y-12 Plant and a chlor-alkali plant (operating since 1963) on the Hiawassee River. Preliminary evaluation of these core data suggest that the sharp increase in mercury that begins at 25 inches can be traced to the chlor-alkai plant.

Y-12 Plant Subsurface Mercury Investigation

This study was initiated in July 1983 to determine if mercury contamination occurs in the earth materials and the groundwater in the vicinity of known mercury spills at the Y-12 Plant, and to determine the extent of any mercury contamination found. This was accomplished by field mapping, core drilling, geophysical logging, construction of monitoring wells and the use of preconstruction as well as current topographic maps.

The study is not yet completed; however, preliminary results indicate that groundwater beneath the Y-12 Plant is not significantly contaminated with mercury and that there are no widespread areas where mercury concentrations in the soil exceed 12 parts per million. Mercury contamination of soils appears to be localized.

Y-12 Plant Drain Line Tracking Program

A program to identify and characterize the sources of mercury entering East Fork Poplar Creek was undertaken in order to find out where the mercury is coming from, and if remedial actions to reduce this mercury release are feasible.

The sources of mercury were tracked to the building areas which housed the Lithium Isotope Separation Process equipment and the development laboratories for these processes. Specific point sources that could be readily addressed were not found, but releases appear to be coming from

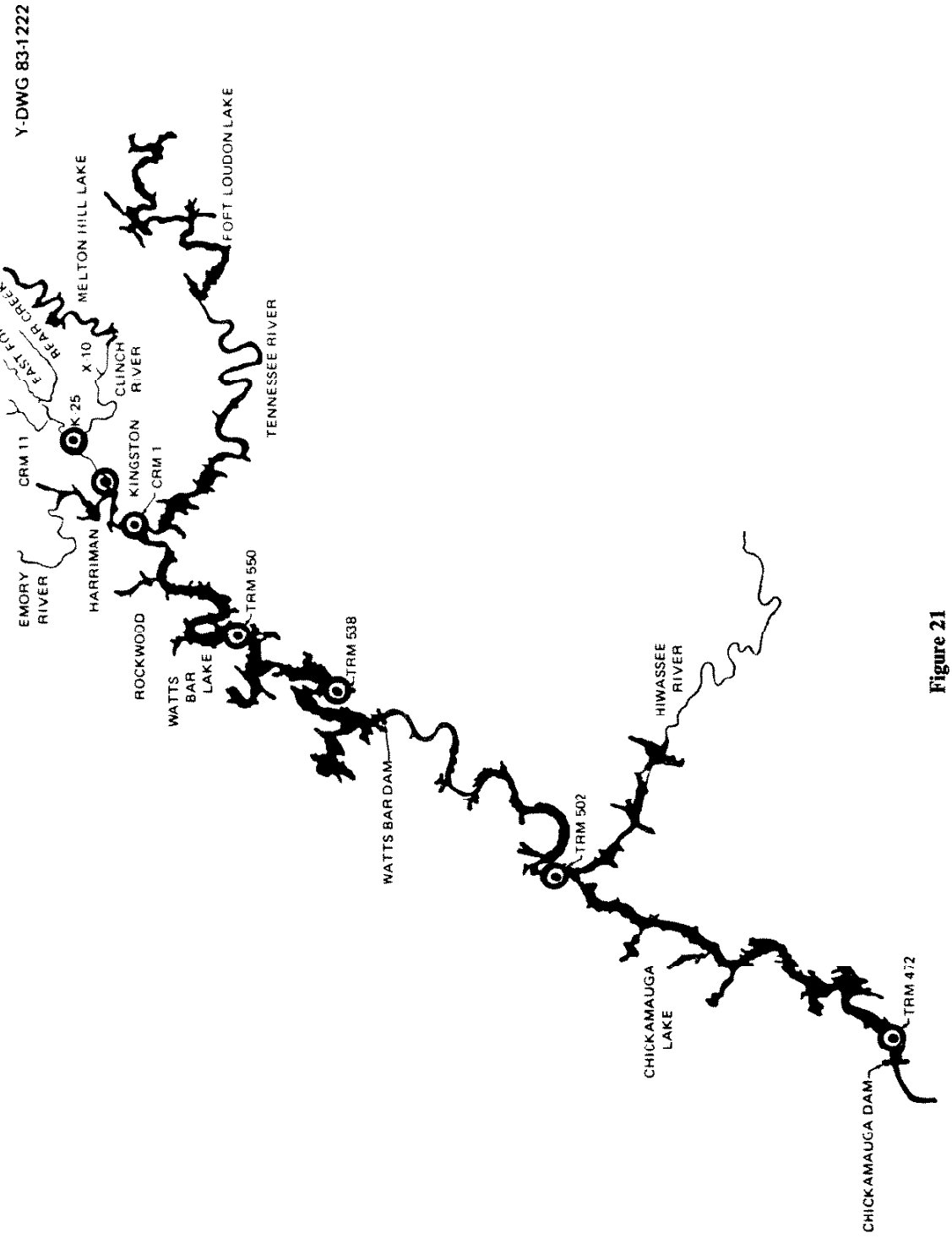

Figure 21
LAKE CORING STUDY SAMPLE SITES - WATTS BAR AND CHICKAMAUGA

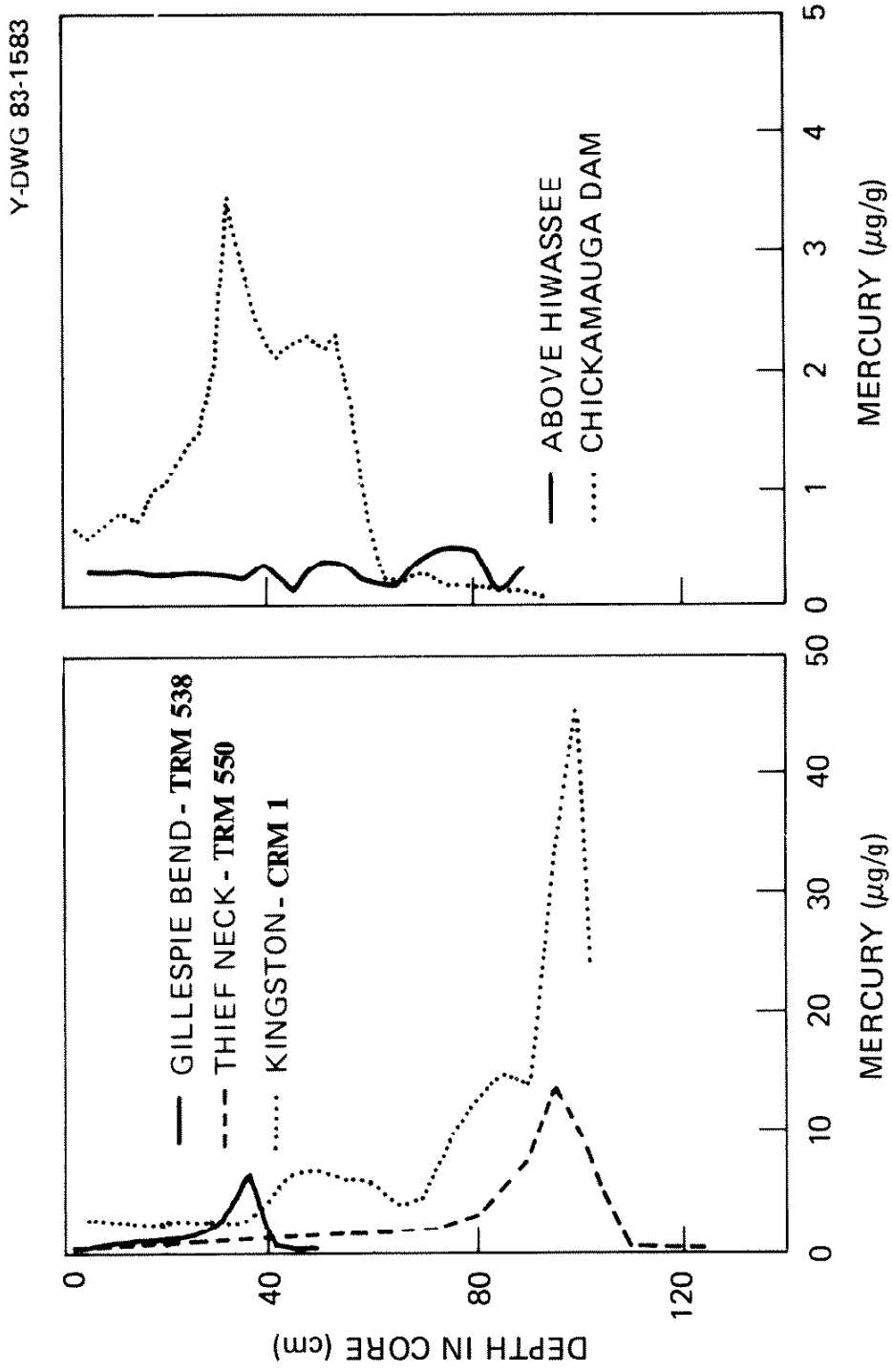

Figure 22
SEDIMENT CORE ANALYSES FOR MERCURY; CORES TAKEN FROM WATTS BAR AND CHICKAMAUGA LAKES

"area sources" such as the basement of buildings and the storm drain system itself. Mercury contaminated sediments were found in building sumps and the storm drain junction boxes and a clean-up program was initiated.

The source tracking, identification and clean-up are ongoing programs to attempt to reduce or eliminate mercury losses to East Fork Poplar Creek.

Y-12 Plant Radionuclide Emission and Control Study

Proposed EPA regulations will reduce substantially the current limit of airborne emissions of radionuclides as measured by the annual dose calculated to the nearest resident, and places a requirement for best available emission control technology on each source even though such treatment may not be necessary to achieve the proposed limits. The annual dose to the nearest resident would be calculated from measured stack effluents and meteorological data using a specified dispersion model.

In anticipation of these rules, the Y-12 Plant initiated a program to evaluate current stack sampling practices and establish new sampling methods and equipment in order to ensure the intent of EPA air sampling criteria is being met. In addition, new meteorological towers are being installed to collect data at the plant site rather than using data from a remote location where topographical influences differ.

Results of Groundwater Monitoring Studies[34]

Three active waste disposal areas at the Y-12 Plant were evaluated with respect to hydrogeology and potential contamination of groundwater and surface water resources. The Union Carbide Corporation - Nuclear Division (UCC-ND) monitoring program was compared with technical requirements of the Resource Conservation and Recovery Act (RCRA) Rules and Regulations. Data were provided by UCC-ND and supplemented with data collected by Law Engineering. A computerized data base was developed to aid in the evaluation of the disposal areas and provide a framework for managing subsequent data.

Selected monitoring wells could continue to be used in the monitoring program for measuring water levels and water quality parameters indicative of the waste constituents. The construction characteristics of the existing wells may not provide representative samples for all parameters of interest or required by RCRA.

The geologic setting has an integral part in controlling the occurrence and movement of water resources at the site. The aquifer system developed within the Conasauga Group is semiconfined and anisotropic although groundwater generally follows the topography at the site. Bear Creek is the ultimate discharge point for groundwater west of the plant area. Less is known about groundwater flow in the vicinity of the plant and in the area of the New Hope Pond sludge disposal basin.

The Conasauga sustained a yield of a few gallons per minute and can be considered a usable aquifer. Background water quality data indicate this aquifer would supply potable water.

Groundwater contamination has occurred in most areas immediately downgradient of the waste disposal facilities. Contamination has migrated into Bear Creek west of the plant area. Seepage from the S-3 waste ponds has resulted in groundwater and surface water contamination characterized by a high specific conductance, total organic carbon, nitrate, uranium and a low pH. Disposal operations in the burial grounds have resulted in groundwater and surface water contamination characterized by elevated concentrations of nitrate, tetrachloroethylene, and high specific conductance.

For general predictive purposes, the groundwater velocities provided by this study probably represent conservative estimates of contaminant transport. The results of this study should be used by the Y-12 Plant in development of a comprehensive monitoring and assessment program for groundwater and surface water. Recommendations are provided regarding potential sampling-station locations and monitoring well design.

Preliminary Report of the Concentrations of Mercury, PCBs, and Uranium in Aquatic Organisms From Upper East Fork Poplar Creek and Environs

A short-term study was conducted in June of 1983 to evaluate the concentrations of mercury, uranium, and polychlorinated biphenyl (PCB) contamination in selected biota from several sites in the vicinity of upper East Fork Poplar Creek (EFPC). The edible portions of the biota were analyzed for total mercury, PCBs of the following Aroclor species (1016, 1221, 1232, 1242, 1248, 1254, and 1260) and three isotopes of uranium (^{238}U, ^{235}U, and ^{234}U).

Fish collected from South Hills Golf Course Pond, Scarboro Pond, and lower Tuskegee Creek had concentrations of total mercury less than the current FDA "action level" (1.0 $\mu g/g$) in fish. Mercury levels in bluegill from the two ponds were similar and were approximately 20 to 30% of the FDA limits. The mean concentration of mercury in largemouth bass from Scarboro Pond was approximately double that in bluegill but was still less than 50% of the FDA limit. Mercury contamination (0.56 $\mu g/g$ maximum concentration) was found in fish collected from lower Tuskegee Creek. Although the exact source of this contamination to the fish is unknown, it is likely that fish from EFPC move in and out of the lower reaches of Tuskegee Creek.

In addition to fish, other biota were found to have elevated levels of mercury. Levels of mercury above 1.0 $\mu g/g$ were found in samples of bullfrogs from upper EFPC. Low mercury concentrations were observed in bullfrogs from South Hills Golf Course and Scarboro Pond; however, most of the individuals were small. High mercury concentrations were also found in crayfish collected from the upper reach of EFPC. The levels ranged from 2.20-3.05 $\mu g/g$ total mercury which is similar to the levels reported for bluegill from this reach of the stream.

The mean concentration of PCBs (Aroclor 1254) in bluegill collected from South Hills Golf Course Pond (1.9 $\mu g/g$) was just below the proposed FDA tolerance level of 2 $\mu g/g$ in fish. The maximum concentration was 3.89 $\mu g/g$, fresh weight. These levels exceeded those found in bluegill from the upper reach of EFPC between New Hope Pond and Bear Creek Road. Elevated levels were also found in a single turtle from South Hills Golf Course Pond, but concentrations in small bullfrogs from this pond were below the detection limit of 0.01 $\mu g/g$. Very low PCB concentrations, predominantly Aroclor 1260, were found in largemouth bass from Scarboro Pond; however, because PCBs do not occur naturally, any detectable level is an indication of contamination.

Sixteen samples were analyzed for isotopes of uranium. Because of the sample size required for isotopic analysis (50 g), many of the fish and frog samples were composite samples. The concentration of the isotopes of uranium appear to be relatively low. In all but three samples, the concentrations of the isotopes of ^{234}U and ^{235}U indicated that the isotopes were not in equilibrium with ^{238}U. In other words, the uranium is not from a natural source but appears to be enriched in ^{234}U and ^{235}U as a result of human activities.

CONCLUDING STATEMENT

In this report, environmental monitoring data for calendar year 1983 have been presented. The value of this data depends upon the care with which it is taken. Quality assurance programs for environmental data are briefly discussed in Appendix A. A useful listing of units, prefixes, and

abbreviations--in addition to the discussions of units in the text--are provided for the reader in Appendix B.

As can be seen from the tables which follow, a large amount of data has been collected and summarized in this report. Continuous efforts are made to assure that the data are correct; if material errors have been made, corrections will be reported in the next issues of this annual report (see the section on fish sampling for an example of corrections to past data). The year for this report (1983) is the last full year in which Union Carbide Corporation will have been the prime contractor to DOE for the Oak Ridge facilities. On April 1, 1984, Martin Marietta Energy Systems, Inc. became the prime contractor. Nevertheless, it is planned that this Environmental Monitor Report will be continued, and that the results of 1984 will be reported in a manner consistent with the results reported here and in the past reports.

Table 1
INCREMENTAL POPULATION TABLE IN THE VICINITY OF ORNL[a]

DISTANCE, MILES DISTANCE, KM	0-1 0-1.6	1-2 1.6-3.2	2-3 3.2-4.8	3-4 4.8-6.4	4-5 6.4-8.0	5-10 8-16	10-20 16-32	20-30 32-48	30-40 48-64	40-50 64-80
Direction										
E	0	0	0	0	0	2,615	50,183	113,337	16,826	16,354
ENE	0	0	0	0	0	0	39,418	79,791	18,513	15,796
NE	0	0	0	0	0	7,336	13,865	9,518	7,239	7,152
NNE	0	0	0	0	874	14,789	7,922	11,412	16,554	9,100
N	0	0	0	0	1,887	4,793	1,971	3,732	5,106	6,545
NNW	0	0	0	0	0	3,187	2,426	2,246	6,830	6,156
NW	0	0	0	0	0	1,964	2,717	2,340	3,303	6,315
WNW	0	0	0	0	0	1,364	4,559	2,336	3,385	4,431
W	0	0	0	0	0	1,804	13,807	5,707	10,627	9,922
WSW	0	0	0	0	0	2,078	9,447	6,387	6,808	4,690
SW	0	0	0	0	0	1,066	2,257	3,422	6,691	13,983
SSW	0	0	0	0	0	1,307	3,321	10,843	24,040	13,900
S	0	0	0	0	0	4,704	7,719	7,810	6,861	3,750
SSE	0	0	0	0	329	4,554	5,451	4,180	1,461	2,590
SE	0	0	0	0	0	3,519	6,739	20,096	1,000	1,689
ESE	0	0	0	0	0	3,740	12,447	37,001	6,319	10,958
TOTAL	0	0	0	0	3,090	58,820	184,249	320,158	141,563	133,331
CUMULATIVE TOTAL	0	0	0	0	3,090	61,910	246,159	566,317	707,880	841,211

[a]Based on 1980 Census Data.

Table 2
CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Beta Activity of Particulates in Air
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF E-13 μCi/mL (mBq/m^3) MAXIMUM[a]	MINIMUM[b]	AVERAGE	% CG[c]
		Perimeter Area[d]			
HP-31	39	0.50 (1.8)	0.15 (0.56)	0.27 (1.0) ± 0.01	0.03
HP-32	52	1.6 (6.0)	0.11 (0.41)	0.40 (1.5) ± 0.04	0.04
HP-33	52	1.3 (4.8)	0.15 (0.56)	0.35 (1.3) ± 0.03	0.03
HP-34	50	0.56 (2.1)	0.13 (0.48)	0.28 (1.0) ± 0.01	0.03
HP-35	52	0.57 (2.1)	0.11 (0.41)	0.28 (1.0) ± 0.02	0.03
HP-36	52	0.41 (1.5)	0.07 (0.26)	0.20 (0.74) ± 0.01	0.02
HP-37	52	0.54 (2.0)	0.05 (0.19)	0.22 (0.81) ± 0.01	0.02
HP-38	52	0.79 (2.9)	0.07 (0.26)	0.30 (1.1) ± 0.02	0.03
HP-39	52	0.49 (1.8)	0.10 (0.37)	0.26 (0.96) ± 0.01	0.03
HP-40	22	1.1 (4.1)	0.12 (0.44)	0.44 (1.6) ± 0.06	0.04
HP-41	22	1.2 (4.4)	0.12 (0.44)	0.37 (1.4) ± 0.06	0.04
Average				0.30 (1.1) ± 0.01	0.03
		Remote Area[e]			
HP-51	30	1.2 (4.4)	0.13 (0.48)	0.28 (1.0) ± 0.04	0.03
HP-52	49	0.59 (2.2)	0.08 (0.28)	0.21 (0.78) ± 0.01	0.02
HP-53	40	0.68 (2.5)	0.11 (0.42)	0.25 (0.94) ± 0.02	0.03
HP-55	50	0.57 (2.1)	0.07 (0.26)	0.25 (0.94) ± 0.02	0.03
HP-56	51	0.54 (2.0)	0.05 (0.19)	0.21 (0.77) ± 0.01	0.02
HP-57	52	0.58 (2.2)	0.09 (0.34)	0.26 (0.96) ± 0.01	0.03
HP-58	36	0.72 (2.7)	0.09 (0.32)	0.24 (0.89) ± 0.02	0.02
Average				0.24 (0.89) ± 0.01	0.02

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 1 E-15 μCi/mL (0.037 mBq/m^3).

[c]CG is 1 E-10 μCi/mL (3.7 E+03 mBq/m^3) for unidentified radionuclides (DOE Order 5480.1A, Chapter XI, Attachment XI-1, Table II).

[d]See Figure 1.

[e]See Figure 2.

Table 3
CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Alpha Activity of Particulates in Air
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF E-15 μCi/mL (μBq/m^3)			% CG[c]
		MAXIMUM[a]	MINIMUM[b]	AVERAGE	
		Perimeter Area[d]			
HP-31	39	2.8 (100)	0.28 (10)	0.93 (34) ± 0.11	0.02
HP-32	52	5.8 (210)	0.34 (13)	1.4 (52) ± 0.14	0.03
HP-33	52	3.8 (140)	0.36 (13)	1.3 (48) ± 0.11	0.03
HP-34	50	2.0 (74)	0.31 (11)	0.93 (34) ± 0.08	0.02
HP-35	52	2.9 (110)	0.28 (10)	1.0 (37) ± 0.10	0.03
HP-36	52	3.4 (130)	0.27 (10)	0.87 (32) ± 0.10	0.02
HP-37	52	1.8 (67)	0.26 (10)	0.66 (24) ± 0.06	0.02
HP-38	52	2.7 (100)	0.29 (11)	1.0 (37) ± 0.10	0.03
HP-39	52	2.9 (110)	0.29 (11)	0.98 (36) ± 0.09	0.02
HP-40	22	5.8 (210)	0.67 (25)	2.2 (81) ± 0.31	0.05
HP-41	22	5.8 (210)	0.73 (27)	2.0 (74) ± 0.30	0.05
Average				1.1 (41) ± 0.04	0.03
		Remote Area[e]			
HP-51	30	3.1 (110)	0.27 (10)	1.1 (41) ± 0.14	0.03
HP-52	49	2.5 (92)	0.27 (10)	0.97 (36) ± 0.10	0.02
HP-53	40	3.2 (120)	0.32 (12)	1.0 (37) ± 0.11	0.03
HP-55	50	5.5 (200)	0.34 (13)	1.2 (44) ± 0.16	0.03
HP-56	51	2.8 (100)	0.32 (12)	1.1 (41) ± 0.10	0.03
HP-57	52	3.6 (130)	0.31 (11)	1.2 (44) ± 0.11	0.03
HP-58	36	3.5 (130)	0.29 (11)	0.71 (26) ± 0.12	0.02
Average				1.0 (37) ± 0.05	0.03

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 1 E-16 μCi/mL (3.7 μBq/m^3)

[c]CG is 40 E-13 μCi/mL (1.48 E+05 μBq/m^3) for a mixture of uranium isotopes (DOE Order 5480.1A, Chapter XI, Attachment XI-1, Table II).

[d]See Figure 1.

[e]See Figure 2.

Table 4
CONTINUOUS AIR-MONITORING DATA
Specific Radionuclides in Air
(Composite Samples)
1983
Units of E-15 μCi/mL (μBq/m^3)

NUCLIDE	PERIMETER STATIONS						REMOTE STATIONS					
	Quarterly Maximum		Quarterly Minimum		Yearly Average		Quarterly Maximum		Quarterly Minimum		Yearly Average	
^{90}Sr	0.141	(5.23)	0.037	(1.37)	0.075	(2.79)	0.856	(31.71)	0.043	(1.60)	0.276	(10.22)
^{106}Ru	0.133	(4.94)	0.105	(3.88)	0.119	(4.41)	0.197	(7.30)	0.085	(3.16)	0.141	(5.23)
^{137}Cs	0.134	(4.95)	0.061	(2.28)	0.100	(3.71)	0.112	(4.14)	0.068	2.54)	0.091	(3.37)
^{228}Th	0.058	(2.15)	0.025	(0.93)	0.042	(1.57)	0.072	(2.68)	0.020	(0.75)	0.046	(1.69)
^{230}Th	0.028	(1.05)	0.021	(0.77)	0.025	(0.93)	0.031	(1.14)	0.016	(0.61)	0.023	(0.87)
^{232}Th	0.035	(1.31)	0.026	(0.98)	0.030	(1.12)	0.037	(1.38)	0.021	(0.77)	0.030	(1.10)
^{234}U	0.399	(14.76)	0.264	(9.79)	0.321	(11.89)	0.162	(6.01)	0.052	(1.92)	0.093	(3.44)
^{235}U	0.074	(2.73)	0.019	(0.71)	0.040	(1.48)	0.005	(0.19)	0.003	(0.11)	0.004	(0.17)
^{238}U	0.209	(7.75)	0.111	(4.12)	0.158	(5.86)	0.053	(1.95)	0.043	(1.60)	0.049	(1.81)
^{238}Pu	0.0002	(0.02)	0.0002	(0.01)	0.0002	(0.01)	0.0002	(0.02)	0.0002	(0.01)	0.0002	(0.01)
^{239}Pu	0.002	(0.07)	0.0002	(0.01)	0.001	(0.04)	0.002	(0.06)	0.0002	(0.01)	0.001	(0.03)

NOTE: All concentrations are at least a thousand times less than the DOE concentration guide for the radionuclides listed.

Table 5
CONCENTRATION OF ^{131}I IN AIR MEASURED BY THE PERIMETER AIR MONITORING STATIONS[a]
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF E-14 μCi/mL (μBq/m^3)			% CG[d]
		MAXIMUM[b]	MINIMUM[c]	AVERAGE	
HP-31	39	0.17 (64)	0.02 (7.4)	0.10 (37) ± 0.01	<0.01
HP-32	52	0.24 (88)	0.02 (7.4)	0.12 (44) ± 0.01	<0.01
HP-33	52	0.56 (210)	0.02 (7.4)	0.12 (44) ± 0.01	<0.01
HP-34	50	1.50 (550)	0.02 (7.4)	0.14 (52) ± 0.03	<0.01
HP-35	52	1.20 (450)	0.02 (7.4)	0.11 (41) ± 0.02	<0.01
HP-36	52	0.18 (66)	0.02 (7.4)	0.08 (30) ± 0.01	<0.01
HP-37	52	0.32 (120)	0.02 (7.4)	0.08 (30) ± 0.01	<0.01
HP-38	52	0.33 (120)	0.02 (7.4)	0.10 (37) ± 0.01	<0.01
HP-39	52	0.32 (120)	0.02 (7.4)	0.10 (37) ± 0.01	<0.01
HP-40	22	0.35 (130)	0.04 (15.0)	0.20 (74) ± 0.02	<0.01
HP-41	22	0.35 (130)	0.04 (15.0)	0.18 (67) ± 0.02	<0.01
AVERAGE				0.12 (44) ± 0.01	<0.01

[a]See Figure 1.

[b]Maximum weekly average concentration.

[c]Minimum weekly average concentration-minimum detectable amount of ^{131}I is 1 E-16 μCi/mL (3.7 μBq/m^3).

[d]CG is 1 E-10 μCi/mL (3.7 E+06 μBq/m^3) (DOE Order 5480.1A, Chapter XI, Attachment XI-1, Table II).

Table 6
Y-12 Plant Air Monitoring Data —
(Composite Samples)
1983
Units of E-15 μCi/mL (μBq/m^3)

Station Number[a]	Quarterly Maximum	Quarterly Minimum	Yearly Average	% CG[b]
1	6.95	3.14	5.15	0.1
2	6.25	2.52	4.52	0.1
3	12.24	8.45	10.17	0.3
4	14.04	1.76	10.69	0.3
5	26.59	9.94	18.41	0.5
6	17.96	9.27	12.21	0.3
7	22.79	8.70	12.58	0.3
8	15.60	1.04	8.55	0.2
9	10.77	5.51	7.66	0.2
10	7.24	3.67	5.93	0.1
11	6.71	2.81	5.11	0.1

[a]See Figure 3.

[b]CG is 40 E-13 μCi/mL (1.48 E-05 μBq/m^3) for a mixture of uranium isotopes (DOE Order 5480.1A, Chapter XI, Attachment XI-1, Table II).

Table 7
DISCHARGES OF RADIOACTIVITY TO THE ATMOSPHERE
1983

RADIONUCLIDE	QUANTITY DISCHARGED Ci	QUANTITY DISCHARGED UNITS OF E+10 Bq
Uranium[a]	0.12	0.44
^{131}I	0.05	0.19
^{3}H	22,200	82,140
^{133}Xe[b]	<57,700	<213,490
^{85}Kr[b]	<11,900	< 44,030
^{99}Tc	0.015	0.06
Alpha[c]	< 4.3 E-06	< 1.6 E-05
^{220}Rn	813	3000
^{222}Rn	13.7	50.69
^{212}Pb	1.2	4.44

[a]Uranium of varying enrichments - curie quantities calculated using the appropriate specific activity for material released.

[b]Upper limit values based on direct radiation measurements in the stack gas stream and an assumed mixture of noble gases.

[c]Unidentified alpha.

Table 8
AIR MONITORING DATA - FLUORIDES
1983

Location	Number of Samples	Maximum Concentration for Averaging Interval $\mu g/m^3$		Number of Times Standard Exceeded[b]		Annual Average $\mu g/m^3$
	Weekly	7 Day	30 Day	7 Day	30 Day	
F-1[a]	49	0.1	< 0.1	0	0	< 0.1 ± 0.01
F-2[a]	49	0.2	0.1	0	0	< 0.1 ± 0.02
F-3[a]	40	0.2	0.1	0	0	< 0.1 ± 0.02
F-4[a]	39	0.1	< 0.1	0	0	< 0.1 ± 0.01
F-5[a]	49	0.1	< 0.1	0	0	< 0.1 ± 0.01
F-6[c]	48	<0.1	< 0.1	0	0	< 0.1 ± 0.01
Y-2[e]	12	<0.1	--	0	--	< 0.1 ± 0.01
Y-4[e]	12	0.2	--	0	--	< 0.1 ± 0.06
Y-7[e]	12	<0.1	--	0	--	--[d]
Y-8[e]	12	<0.1	--	0	--	< 0.1 ± 0.02

[a]See Figure 1.

[b]Tennessee Air Pollution Control Regulations (gaseous) -

3.7 $\mu g/m^3$ for 12-hour averaging interval
2.9 $\mu g/m^3$ for 24-hour averaging interval
1.6 $\mu g/m^3$ for 7-day averaging interval
1.2 $\mu g/m^3$ for 30-day averaging interval

All values are maximum--not to be exceeded more than once per year.

[c]Station F-6 approximately 8 kilometers from ORGDP upwind of the predominant prevailing wind direction, thus may be considered representative of general ambient background concentration.

[d]Changed sample location in fourth quarter.

[e]See Figure 3.

NOTE: Data not amendable to comparison with 12-hour or 24-hour standard. Six-day or seven-day sample period compared to seven-day averaging interval. See text for method of measurement.

Table 9
AIR MONITORING DATA - SUSPENDED PARTICULATES
1983

LOCATION[a]	NUMBER OF SAMPLES	CONCENTRATION, $\mu g/m^3$)			% STD.[b]
		MAXIMUM	MINIMUM	GEOMETRIC AVERAGE	
SP-1	44	122	1	28 x/÷ 1.4	37
SP-2	55	131	2	26 x/÷ 1.3	33
SP-3	58	139	3	34 x/÷ 1.3	45
SP-4	55	95	1	22 x/÷ 1.5	29
Y-12 East	36	261[d]	3[c]	61 x/÷ 1.4	81
Y-12 West	23	276[d]	8[c]	66 x/÷ 1.7	88

[a]See Figure 1.

[b]Tennessee Ambient Air Standards:

		Primary Standard	Secondary Standards
Maximum 24 hr. Average	—	260 $\mu g/m^3$	150 $\mu g/m^3$
Annual Geometric Mean	—	75 $\mu g/m^3$	60 $\mu g/m^3$

All values other than the annual values are maximum concentrations not to be exceeded more than once per year.

[c]Three samples for Y-12 East and four samples for Y-12 West showed zero concentrations due to filter media loss. These values were excluded from the average.

[d]Second highest concentrations (Y-12 East - 148 $\mu g/m^3$; Y-12 West - 228 $\mu g/m^3$).

Table 10
SULFUR DIOXIDE MONITORING DATA
1983

MONTH	MAXIMUM 24 HR. AVERAGE (ppm)		MONTHLY AVERAGE (ppm)	
	STATION S-1	STATION S-2	STATION S-1	STATION S-2
January	0.016	0.036	0.008	0.007
February	0.022	0.027	0.004	0.006
March	0.012	0.033	0.004	0.005
April	0.026	0.007	0.007	0.003
May	0.025	0.022	0.006	0.004
June	0.012	0.006	0.005	0.003
July	0.012	0.017	0.004	0.005
August	0.017	0.015	0.004	0.005
September	0.012	0.015	0.004	0.003
October	0.036	0.021	0.020	0.012
November	0.020	0.013	0.006	0.004
December	0.020	0.004	0.006	0.003
Annual Arithmetic Mean			0.007	0.005

Tennessee Ambient Standards
Maximum 24 hr. Average — 0.14 ppm
Annual Arithmetic Mean — 0.03 ppm

All values other than the annual value are maximum concentrations not to be exceeded more than once per year.

Minimum Detectable Limit — 0.002 ppm

Table 11
EXTERNAL GAMMA RADIATION MEASUREMENTS
1983

STATION NUMBER	NUMBER OF MEASUREMENTS[a]	BACKGROUND UNITS OF μR/h	BACKGROUND UNITS OF E-09 C/kg/h
		Perimeter Stations[b]	
HP-31	16	11.0 ± 1.1	2.9 ± 0.28
HP-32	22	14.0 ± 1.0	3.5 ± 0.26
HP-33	22	10.0 ± 1.0	2.6 ± 0.26
HP-34	22	17.0 ± 1.3	4.4 ± 0.33
HP-35	22	9.8 ± 0.94	2.5 ± 0.24
HP-36	22	9.4 ± 1.0	2.4 ± 0.26
HP-37	22	8.7 ± 0.84	2.2 ± 0.22
HP-38	22	9.7 ± 0.88	2.5 ± 0.23
HP-39	22	9.9 ± 0.88	2.6 ± 0.23
HP-40[d]	2	8.7 ± 0.38	2.2 ± 0.10
HP-41[d]	1	11.0	2.9
Average		11.0 ± 0.68	2.9 ± 0.17
		Remote Stations[c]	
HP-51	4	7.1 ± 1.6	1.8 ± 0.41
HP-52	4	7.3 ± 0.63	1.9 ± 0.16
HP-53	4	8.0 ± 0.64	2.1 ± 0.16
HP-55	4	6.8 ± 0.17	1.8 ± 0.04
HP-56	4	6.9 ± 1.5	1.8 ± 0.39
HP-57	4	7.9 ± 1.1	2.0 ± 0.28
HP-58	4	11.0 ± 0.44	2.9 ± 0.11
Average		7.8 ± 1.6	2.0 ± 0.41

[a]Two measurements are taken per location for each time interval by placing two dosimeters in each container.

[b]See Figure 1.

[c]See Figure 2.

[d]Stations HP-40 and HP-41 were added in the summer of 1983; also, one of the dosimeters in the container at station HP-41 was found to be defective.

Table 12
RADIONUCLIDES OF PRIMARY CONCERN IN SURFACE STREAMS
1983

SAMPLING LOCATION	NUMBER OF SAMPLES	RANGE	UNITS OF E-09 μCi/mL (Bq/L)			UNITS OF E-06 μCi/mL (kBq/L)	%
			^{90}Sr	^{137}Cs	^{60}Co	^{3}H	CG[a]
C-2	4	Max.	2.4 (0.090)	0.14 (0.005)	0.11 (0.004)	35 (1.3)	
		Min.	0.22 (0.008)	0.054 (0.002)	0.054 (0.002)	0.60 (0.022)	
		Avg.	0.93 (0.035)	0.088 (0.003)	0.081 (0.003)	12 (0.43)	0.70
C-3	4	Max.	4.9 (0.18)	0.51 (0.019)	0.24 (0.009)	8.4 (0.31)	
		Min.	0.19 (0.007)	0.11 (0.004)	0.11 (0.004)	1.3 (0.048)	
		Avg.	2.0 (0.075)	0.28 (0.010)	0.16 (0.006)	3.8 (0.14)	0.80
C-5[b]	4	Max.	0.73 (0.027)	0.11 (0.004)	0.11 (0.004)	3.9 (0.14)	
		Min.	0.19 (0.007)	0.054 (0.002)	0.054 (0.002)	0.34 (0.013)	
		Avg.	0.41 (0.015)	0.068 (0.002)	0.074 (0.003)	1.8 (0.068)	0.20
W-1[c]	12	Max.	120 (4.5)	160 (6.0)	26 (0.96)	350 (13)	
		Min.	6.8 (0.25)	8.1 (0.30)	2.1 (0.078)	9.1 (0.34)	
		Avg.	53 (1.9)	34 (1.3)	8.6 (0.32)	140 (5.0)	22
White Oak Dam	53	Max	260 (9.8)	650 (24)	120 (4.4)	1600 (60)	
		Min	97 (3.6)	11 (0.4)	4.3 (0.16)	65 (2.4)	
		Avg	190 (7.0)	120 (4.4)	27 (1.0)	460 (17)	94[d]

[a]Most restrictive concentration guide for each isotope used for calculating percent concentration guide. The method for calculating percent of concentration guide for a known mixture of radionuclides is given in DOE Order 5480.1A, Chapter XI, Attachment XI-1.

[b]Kingston Water Plant (treated water).

[c]Mouth of White Oak Creek.

[d]Transuranics, avg. concentration 0.46 E-08 μCi/mL (0.17 Bq/L), were a significant contributor to the percentage concentration guide.

Table 13
URANIUM CONCENTRATION IN SURFACE STREAMS
1983

STATION NUMBER[a]	NUMBER OF SAMPLES	UNITS OF E-08 μCi/mL (Bq/L)			% CG[b]
		MAXIMUM	MINIMUM	AVERAGE	
P-1	12	1.10 (0.41)	< 0.07 (0.03)	< 0.39 (0.14) ± 0.20	< 0.7
P-2	12	1.10 (0.41)	< 0.07 (0.03)	< 0.39 (0.14) ± 0.17	< 0.7
C-3	12	0.40 (0.15)	< 0.07 (0.03)	< 0.17 (0.06) ± 0.07	< 0.3
C-4	12	0.81 (0.30)	< 0.07 (0.03)	< 0.25 (0.09) ± 0.13	< 0.4
C-6	12	0.54 (0.20)	< 0.07 (0.03)	< 0.16 (0.06) ± 0.08	< 0.3
E-1	12	3.70 (1.40)	0.98 (0.36)	2.90 (1.10) ± 1.80[c]	4.8
B-1	12	9.30 (3.40)	0.80 (0.30)	3.00 (1.10) ± 1.80[c]	5.0

[a]See Figure 4.

[b]CG used 6 E-07 μCi/mL (22.2 Bq/L) for soluble ^{238}U (DOE Order 5480.1A, Chapter XI, Attachment XI-1, Table II).

[c]Standard error.

Table 14
DISCHARGES OF RADIOACTIVITY TO SURFACE STREAMS
1983

RADIONUCLIDE	QUANTITY DISCHARGED	
	Ci	UNITS OF E+10 Bq
^{137}Cs	1.2	4.44
^{60}Co	0.29	1.07
^{3}H	5,570	20,600
^{131}I	0.004	0.015
^{106}Ru	0.18	0.67
^{90}Sr	2.1	7.77
^{99}Tc	17.0	63
Uranium[a]	0.42	1.55
^{232}Th	0.007	0.026
Transuranics[b]	0.048	0.18
^{237}Np	0.0004	0.001

[a]Uranium of varying enrichments - curie quantities calculated using the appropriate specific activity for material released.

[b]Value based on gross transuranic alpha emitter analysis.

Table 15
LONG-LIVED GROSS BETA ACTIVITY IN RAINWATER
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF	
		E-08 μCi/mL[a]	Bq/L
		Perimeter Area[b]	
HP-31	31	0.46 ± 0.08	0.17 ± 0.03
HP-32	42	0.50 ± 0.06	0.19 ± 0.02
HP-33	45	0.47 ± 0.06	0.17 ± 0.02
HP-34	44	0.87 ± 0.13	0.32 ± 0.05
HP-35	45	0.59 ± 0.05	0.22 ± 0.02
HP-36	47	0.68 ± 0.11	0.25 ± 0.04
HP-37	44	0.62 ± 0.08	0.23 ± 0.03
HP-38	46	0.79 ± 0.08	0.29 ± 0.03
HP-39	47	0.56 ± 0.08	0.21 ± 0.03
HP-40	14	0.76 ± 0.16	0.28 ± 0.06
HP-41	3	1.3 ± 0.63	0.47 ± 0.23
Average		0.63 ± 0.03	0.23 ± 0.01
		Remote Area[c]	
HP-51	48	1.4 ± 0.20	0.51 ± 0.07
HP-52	36	1.2 ± 0.15	0.43 ± 0.06
HP-53	36	1.2 ± 0.15	0.43 ± 0.05
HP-55	43	0.95 ± 0.13	0.35 ± 0.05
HP-56	44	1.3 ± 0.16	0.49 ± 0.06
HP-57	41	0.95 ± 0.14	0.35 ± 0.05
HP-58	23	0.89 ± 0.12	0.33 ± 0.05
Average		1.1 ± 0.06	0.42 ± 0.02

[a]Weekly average concentration.

[b]See Figure 1.

[c]See Figure 2.

Table 16
CHEMICAL WATER QUALITY DATA - WHITE OAK DAM
(Location W-1, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	11	0.030	< 0.020	< 0.021 ± 0.002	0.05	< 42
Zn	10	0.070	< 0.020	< 0.038 ± 0.0051	0.05	< 76
NO_3(N)	8	13	2.7	6.6 ± 1.2	10	66
Hg	11	< 0.001	< 0.001	< 0.001	0.00005[b]	< 2000

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$.

[b]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 17
CHEMICAL WATER QUALITY DATA - MELTON HILL DAM
(Location C-2, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	8	< 0.02	< 0.020	< 0.02	0.05	< 40
Zn	8	0.04	< 0.020	< 0.022 ± 0.005	0.05	< 44
NO_3(N)	6	2.20	< 0.010	< 1.5 ± 0.63	10	< 15
Hg	9	< 0.001	< 0.001	< 0.001	0.00005[b]	< 2000

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$.

[b]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 18
CHEMICAL WATER QUALITY DATA - ORGDP SANITARY WATER PUMPING STATION
(Location C-3, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cr	12	0.037	< 0.010	< 0.012 ± 0.005	0.05	< 24
CN	12	< 0.002	< 0.002	< 0.002	0.005	< 40
$NO_3(N)$	12	1.8	0.19	0.55 ± 0.26	10	6
Pb	12	< 0.010	< 0.010	< 0.010	0.0038[b]	< 263
$SO_4^=$	11	30	13	20 ± 3	250	8
T.D.S.	11	169	135	151 ± 8	500	30
Zn	12	0.13	< 0.020	< 0.050 ± 0.023	0.05[b]	< 100
F^-	12	0.30	< 0.10	< 0.14 ± 0.04	1	< 14
Hg	12	< 0.001	< 0.001	< 0.001	0.00005[c]	< 2000
Ni	12	0.030	< 0.010	< 0.015 ± 0.005	0.1	< 15

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 19
CHEMICAL WATER QUALITY DATA - ORGDP RECIRCULATING WATER PUMPING STATION
(Location C-4, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cr	12	0.030	< 0.010	< 0.012 ± 0.003	0.05	< 24
CN	12	0.003	< 0.002	< 0.002 ± 0.0002	0.005	< 40
NO_3(N)	12	1.8	0.28	0.52 ± 0.26	10	5
Pb	12	< 0.010	< 0.010	< 0.010	0.0038[b]	< 263
$SO_4^=$	12	27	12	22 ± 3	250	9
T.D.S.	11	181	91	148 ± 20	500	30
Zn	12	0.080	< 0.020	< 0.035 ± 0.010	0.05[b]	< 70
F^-	12	0.30	< 0.010	< 0.14 ± 0.04	1	< 14
Hg	12	< 0.001	< 0.001	< 0.001	0.00005[c]	< 2000
Ni	12	0.031	< 0.010	< 0.012 ± 0.003	0.1	< 12

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 20
CHEMICAL WATER QUALITY DATA - CLINCH RIVER DOWNSTREAM OF ORGDP
(Location C-6, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cr	12	< 0.01	< 0.01	< 0.01	0.05	< 20
CN	12	< 0.002	< 0.002	< 0.002	0.005	< 40
NO_3(N)	12	1.6	0.2	0.47 ± 0.24	10	5
Pb	12	0.03	< 0.01	< 0.012 ± 0.0039	0.0038[b]	< 316
$SO_4^{=}$	12	36	15	23 ± 3.7	250	9
T.D.S.	12	176	105	146 ± 16	500	29
Zn	12	0.03	< 0.02	< 0.02 ± 0.001	0.05[b]	< 40
F^-	12	0.30	< 0.1	< 0.15 ± 0.05	1.0	< 15
Hg	12	< 0.001	< 0.001	< 0.001	0.00005[c]	< 2000
Ni	12	0.03	< 0.01	< 0.012 ± 0.003	0.1	< 12

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 21
CHEMICAL WATER QUALITY DATA - EAST FORK POPLAR CREEK
(Location E-1, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cl^-	12	21	14	16 ± 6	250	6
Cr	12	0.01	< 0.01	< 0.01	0.05	< 20
Cu	12	0.014	< 0.005	< 0.010 ± 0.018	0.02	< 50
F^-	12	1.2	0.7	1.0 ± 2.2	1	100
$NO_3(N)$	12	6.0	1.9	3.5 ± 2.2	10	35
Pb	12	< 0.01	< 0.01	< 0.01	0.0038[b]	< 263
$SO_4^=$	12	67	34	47 ± 22	250	19
T.D.S.	12	270	160	230 ± 58	500	46
Zn	12	0.07	< 0.02	< 0.03 ± 0.04	0.05[b]	< 60
Hg	52	0.025	< 0.001	< 0.002 ± 0.012	0.00005[c]	< 4000

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed Hardness = 100 mg/L as $CaCO_3$

[b]Monthly Average (Daily maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 22
CHEMICAL WATER QUALITY DATA - BEAR CREEK
(Location B-1, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cl^-	12	20	2	8 ± 14	250	3
Cr	12	0.08	< 0.01	< 0.01 ± 0.04	0.05	< 20
Cu	12	1.10	0.012	0.13 ± 0.62	0.02	650
F^-	12	0.3	< 0.1	< 0.2 ± 0.2	1	< 20
Hg	12	< 0.001	< 0.001	< 0.001	0.00005[c]	< 2000
$NO_3(N)$	12	37	0.8	12 ± 22	10	120
Pb	12	0.07	< 0.01	< 0.01 ± 0.04	0.0038[b]	< 263
$SO_4^=$	12	31	< 10	< 13 ± 16	250	< 5
TDS	12	370	140	237 ± 176	500	47
Zn	12	0.06	< 0.02	< 0.03 ± 0.04	0.05[b]	< 60

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 23
CHEMICAL WATER QUALITY DATA - POPLAR CREEK ABOVE BLAIR BRIDGE
(Location P-1, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.004	< 0.002	< 0.002 ± 0.0004	0.000025[b]	< 8000
Cr	12	< 0.010	< 0.010	< 0.010	0.05	< 20
CN	12	< 0.002	< 0.002	< 0.002	0.005	< 40
$NO_3(N)$	12	4.9	0.3	1.3 ± 0.8	10	13
Pb	12	< 0.010	< 0.010	< 0.010	0.0038[b]	< 263
$SO_4^{=}$	12	54	27	39 ± 6	250	16
T.D.S.	12	251	87	167 ± 36	500	33
Zn	12	0.040	< 0.020	< 0.022 ± 0.004	0.05[b]	< 44
F^-	12	0.90	< 0.10	< 0.33 ± 0.18	1	< 33
Hg	12	< 0.001	< 0.001	< 0.001	0.00005[c]	< 2000
Ni	12	0.17	< 0.010	< 0.011 ± 0.001	0.1	< 11

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 24
CHEMICAL WATER QUALITY DATA - POPLAR CREEK NEAR CLINCH RIVER
(Location P-2, Figure 4)
1983

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/L				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.002	< 0.002	< 0.002	0.000025[b]	< 8000
Cr	12	0.029	< 0.010	< 0.012 ± 0.003	0.05	< 24
CN	12	< 0.002	< 0.002	< 0.002	0.005	< 40
$NO_3(N)$	12	1.9	0.30	0.71 ± 0.28	10	7
Pb	12	0.020	< 0.010	< 0.011 ± 0.001	0.0038[b]	< 289
$SO_4^=$	12	60	20	32 ± 7	250	13
T.D.S.	11	238	96	163 ± 25	500	33
Zn	12	0.024	< 0.02	< 0.020 ± 0.007	0.05[b]	< 40
F^-	12	0.50	< 0.10	< 0.26 ± 0.08	1	< 26
Hg	12	0.003	< 0.001	< 0.001 ± 0.0004	0.00005[c]	< 2000
Ni	12	0.034	< 0.010	< 0.012 ± 0.004	0.1	< 12

[a]Tennessee Water Quality Criteria for Fish and Aquatic Life. Assumed hardness = 100 mg/L as $CaCO_3$.

[b]Monthly Average (Daily Maximum is Cd 0.003 mg/L, Pb 0.17 mg/L, Zn 0.32 mg/L).

[c]Current EPA Water Quality Criteria for Fish and Aquatic Life (FR August 13, 1981) is 0.0002 mg/L 24 hour average and 0.0041 mg/L maximum.

Table 25
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) EXPERIENCE
1983

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/L	EFFLUENT LIMITS DAILY MAXIMUM mg/L	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
ORNL				
001				
(White Oak Creek)	Dissolved Oxygen (min.)	5	--	100
	Dissolved Solids	--	2000	100
	Oil and Grease	10	15	92
	Chromium (Total)	--	0.05	100
	pH (pH units)	--	6.0 - 9.0	100
002				
(Melton Branch)	Chromium (Total)	--	0.05	100
	Dissolved Solids	--	2000	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0 - 9.0	100
003				
(Main Sanitary Treatment Facility)	Ammonia (N)	--	5	52
	BOD	--	20	65
	Chlorine Residual	--	0.5 - 2.0	95
	Fecal Coliform Bact. (No/100 mL)	200[b]	400[c]	100
	pH (pH units)	--	6.0 - 9.0	100
	Suspended Solids	--	30	85
	Settleable Solids (mL/L)	--	0.5	98
004				
(7900 Area Sanitary Treatment Facility)	BOD	--	30	No Discharges From This Facility
	Chlorine Residual	--	0.5 - 2.0	
	Fecal Coliform Bact. (No/100 mL)	200[b]	400[c]	
	pH (pH units)	--	6.0 - 9.0	
	Suspended Solids	--	30	
	Settleable Solids (mL/L)	--	0.5	
Y-12 PLANT				
001				
(Kerr Hollow Quarry)	Dissolved Solids	--	2000	100
	Lithium	--	5	100
	pH (pH units)	--	6.0 - 9.0	100
	Suspended Solids	--	50	100
	Zirconium	--	3	100

Table 25
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/L	EFFLUENT LIMITS DAILY MAXIMUM mg/L	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
002				
(Rogers Quarry)	pH (pH units)	--	6.0 - 9.0	100
	Suspended Solids[a]	30	50	100
	Settleable Solids (mL/L)[a]	--	0.5	100
003				
(New Hope Pond)	Ammonia (N)	--	1.6	100
	Chromium	0.05	0.08	100
	Dissolved Oxygen (min.)	5	--	100
	Dissolved Solids	--	2000	100
	Fluoride	1.5	2.0	100
	Lithium	--	5	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0 - 9.0	100
	Phosphate (as MBAS)	5	8	100
	Suspended Solids[a]	--	20	100
	Settleable Solids (mL/L)[a]	--	0.5	100
	Total Nitrogen (N)	--	20	100
	Zinc	0.1	0.2	90
004				
(Bear Creek)	Oil and Grease	10	15	100
	pH (pH units)	--	6.0 - 8.5	100
ORGDP				
001				
(K-1700 Discharge)	Aluminum	--	1.0	100
	Chromium (Total)	0.05	0.08	100
	Nitrate	--	20	100
	Suspended Solids	30	50	100
	Oil and Grease	10	15	100
	pH(pH units)	--	6.0 - 9.0	99
002				
005				
(K-1203 Sanitary Treatment Facility)	Ammonia (N)	5[b]	7[c]	100
	BOD	15[b]	20[c]	100
	Chlorine Residual	--	0.5 - 2.0	99
	Dissolved Oxygen (min.)	5	--	100
	Fecal Coliform Bact. (No/100mL)	200[b]	400[c]	100
	pH (pH units)	--	6.0 - 9.0	100
	Suspended Solids	30[b]	45[c]	99
	Settleable Solids (mL/L)	--	0.5	99

Table 25
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/L	EFFLUENT LIMITS DAILY MAXIMUM mg/L	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
006				
(K-1007B Holding	COD	20	25	99
Pond)	Chromium	--	0.05	100
	Dissolved Oxygen (min.)	5	--	100
	Fluoride	1.0	1.5	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0 - 9.0	89
	Suspended Solids[a]	30	50	100
007				
(K-901A Holding	Chromium (Total)	--	0.05	99
Pond)	Fluoride	1.0	1.5	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0 - 10	100
	Suspended Solids	30	50	100
008[d]				
(K-710 Sanitary	BOD	30[b]	45[c]	No Discharges
Treatment Facility)	Suspended Solids	30[b]	45[c]	From This
	Fecal Coliform Bact. (No/100 mL)	200[b]	400[c]	Facility
	pH (pH units)	--	6.0 - 9.0	
	Chlorine Residual	--	0.5 - 2.0	
	Settleable Solids (mL/L)	--	0.1	
009				
(Sanitary Water	Suspended Solids[a]	30	50	100
Plant)	Aluminum	--	250	100
	Sulphate	--	1400	100
	pH (pH units)	--	6.0 - 9.0	100

[a]Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface run-off resulting from precipitation.

[b]Monthly Average.

[c]Weekly Average.

[d]Due to the small flow rates at the K-710 Sanitary Treatment Facility, a rapid sand filter was installed May 1, 1978 eliminating the surface discharge and monitoring requirements.

Table 26
CONCENTRATION OF ^{131}I IN MILK[a]
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF E-09 μCi/mL (Bq/L)			COMPARISON WITH STANDARD[c]
		MAXIMUM	MINIMUM[b]	AVERAGE	
		Immediate Environs[d]			
2	48	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
3	47	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
4	48	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
6	43	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
7	47	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
Average				<0.45 (0.017)	
		Remote Environs[e]			
51	4	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
52	3	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
53	5	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
56	3	<0.45 (0.017)	<0.45 (0.017)	<0.45 (0.017)	Range I
Average				<0.45 (0.017)	

[a]Raw milk samples, except for Station 2 which is a dairy.

[b]Minimum detectable concentration of ^{131}I is 0.45 E-09 μCi/mL (0.017 Bq/L).

[c]Applicable FRC standard, assuming 1 liter per day intake:
Range I 0 to 1 E-08 μCi/mL (0.37 Bq/L) —Adequate surveillance required to confirm calculated intakes.
Range II 1 E-08 μCi/mL (0.37 Bq/L) to 1 E-07 μCi/mL (3.7 Bq/L) —Active surveillance required.
Range III 1 E-07 μCi/mL (3.7 Bq/L) to 1 E-06 μCi/mL (37 Bq/L) —Positive control action required.
Note: Upper limit of Range II can be considered the concentration guide.

[d]See Figure 10.

[e]See Figure 11.

Table 27
CONCENTRATION OF ^{90}Sr IN MILK[a]
1983

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF E-09 μCi/mL (Bq/L)			COMPARISON WITH STANDARD[c]
		MAXIMUM	MINIMUM[b]	AVERAGE	
		Immediate Environs[d]			
2	48	1.9 (0.072)	0.53 (0.020)	1.1 (0.042) ± 0.080	Range I
3	47	1.6 (0.061)	0.53 (0.020)	1.0 (0.038) ± 0.079	Range I
4	48	3.4 (0.13)	0.79 (0.030)	1.5 (0.057) ± 0.16	Range I
6	43	2.1 (0.079)	0.53 (0.020)	1.2 (0.045) ± 0.12	Range I
7	46	3.7 (0.14)	0.79 (0.030)	1.4 (0.053) ± 0.15	Range I
Average				1.2 (0.045) ± 0.058	
		Remote Environs[e]			
51	5	2.1 (0.079)	1.6 (0.061)	1.9 (0.072) ± 0.24	Range I
52	6	1.3 (0.049)	0.53 (0.020)	0.84 (0.032) ± 0.25	Range I
53	6	1.1 (0.042)	0.53 (0.020)	0.84 (0.032) ± 0.26	Range I
56	5	1.3 (0.049)	0.79 (0.030)	1.1 (0.042) ± 0.20	Range I
Average				1.1 (0.042) ± 0.20	

[a]Raw milk samples, except for Station 2 which is a dairy.

[b]Minimum detectable concentration of ^{90}Sr is 0.5 E-09 μCi/mL (0.019 Bq/L).

[c]Applicable FRC standard, assuming 1 liter per day intake:
Range I 0 to 2 E-08 μCi/mL (0.74 Bq/L) —Adequate surveillance required to confirm calculated intakes.
Range II 2 E-08 μCi/mL (0.74 Bq/L) to 2 E-07 μCi/mL (7.4 Bq/L) —Active surveillance required.
Range III 2 E-07 μCi/mL (7.4 Bq/L) to 2 E-06 μCi/mL (74 Bq/L) —Positive control action required.
Note: Upper limit of Range II can be considered the concentration guide.

[d]See Figure 10.

[e]See Figure 11.

Table 28
SIGNIFICANT RADIONUCLIDE CONTENT IN CLINCH RIVER FISH
ALPHA EMITTERS
1983
pCi/kg (mBq/kg) Wet Weight

LOCATION	Species[a]	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
CRM 5.0	Bass	< 0.049 (1.8)	< 0.041 (1.5)	0.90 (33)	0.059 (2.2)	0.81 (30)
	Blue Gill	0.013 (0.48)	0.075 (2.8)	2.0 (74)	0.12 (4.4)	1.0 (37)
	Carp	< 0.017 (0.63)	0.006 (0.22)	5.4 (200)	0.71 (26)	2.5 (92)
	Shad	0.036 (1.3)	0.19 (7.0)	12 (440)	1.1 (41)	6.8 (250)
CRM 10.0	Bass	0.008 (0.30)	< 0.055 (2.0)	2.3 (85)	< 0.16 (5.9)	0.94 (35)
	Blue Gill	0.037 (1.4)	0.037 (1.4)	1.0 (37)	0.16 (5.9)	0.50 (18)
	Carp	0.007 (0.26)	< 0.020 (0.74)	2.0 (74)	0.13 (4.8)	1.1 (41)
	Shad	< 0.023 (0.85)	< 0.023 (0.85)	5.2 (190)	0.30 (11)	4.3 (160)
	Crappie	< 0.025 (0.92)	< 0.025 (0.92)	0.59 (22)	< 0.084 (3.1)	0.11 (4.1)
CRM 12.0	Bass	0.030 (1.1)	0.12 (4.4)	0.89 (33)	< 0.11 (4.1)	0.48 (18)
	Blue Gill	0.15 (5.5)	0.83 (31)	4.0 (150)	0.14 (5.2)	1.7 (63)
	Carp	< 0.013 (0.48)	0.051 (1.9)	1.8 (67)	0.11 (4.1)	1.1 (41)
	Shad	0.089 (3.3)	< 0.31 (11.0)	3.1 (110)	< 0.040 (1.5)	2.2 (81)
	Crappie	< 0.015 (0.55)	0.056 (2.1)	0.52 (19)	0.090 (3.3)	0.34 (13)
CRM 20.8[b]	Bass	< 0.038 (1.4)	< 0.21 (7.8)	0.60 (22)	0.092 (3.4)	0.35 (13)
	Blue Gill	< 0.045 (1.7)	< 0.15 (5.5)	1.0 (37)	< 0.13 (4.8)	0.34 (13)
	Carp	< 0.018 (0.67)	< 0.14 (5.2)	0.94 (35)	0.098 (3.6)	0.41 (15)
	Shad	< 0.13 (4.8)	< 0.94 (35)	3.5 (130)	< 0.080 (3.0)	2.2 (81)
CRM 25.0	Bass	< 0.018 (0.67)	< 0.018 (0.67)	0.46 (17)	0.009 (0.33)	0.32 (12)
	Blue Gill	< 0.023 (0.85)	< 0.023 (0.85)	0.88 (33)	< 0.14 (5.2)	0.46 (17)
	Carp	0.15 (5.5)	0.80 (30)	0.58 (21)	0.036 (1.3)	0.34 (13)
	Shad	0.28 (10)	2.5 (92)	4.3 (160)	0.33 (12)	2.7 (100)

[a]Composite of ten fish in each species.

[b]Average of quarterly samples.

Table 29
SIGNIFICANT RADIONUCLIDE CONTENT IN CLINCH RIVER FISH
BETA-GAMMA EMITTERS
1983
pCi/kg (Bq/kg) Wet Weight

LOCATION	Species[a]	^{137}Cs			^{60}Co		^{90}Sr		% MPI[b]
CRM 5.0	Bass	180	(6.7)	<	8.2	(0.30)	13	(0.48)	0.11
	Blue Gill	45	(1.7)	<	4.7	(0.17)	23	(0.85)	0.17
	Carp	13	(0.48)	<	3.4	(0.13)	11	(0.41)	0.09
	Shad	72	(2.7)	<	4.8	(0.18)	24	(0.89)	0.20
CRM 10.0	Bass	200	(7.4)	<	7.1	(0.26)	14	(0.52)	0.12
	Blue Gill	100	(3.7)		4.1	(0.15)	12	(0.44)	0.10
	Carp	40	(1.5)	<	3.4	(0.13)	15	(0.55)	0.12
	Shad	110	(4.1)	<	5.6	(0.21)	17	(0.63)	0.15
	Crappie	80	(3.0)	<	2.9	(0.11)	5.5	(0.20)	0.05
CRM 12.0	Bass	82	(3.0)	<	3.7	(0.14)	3.0	(0.11)	0.03
	Blue Gill	30	(1.1)	<	4.1	(0.15)	5.4	(0.20)	0.05
	Carp	470	(17)		8.8	(0.33)	28	(1.0)	0.25
	Shad	120	(4.4)		4.5	(0.17)	11	(0.41)	0.10
	Crappie	41	(1.5)	<	3.7	(0.14)	1.9	(0.07)	0.02
CRM 20.8[c]	Bass	670	(25)		11	(0.41)	74	(2.7)	0.58
	Blue Gill	660	(24)		28	(1.0)	120	(4.4)	0.90
	Carp	1300	(49)		49	(1.8)	160	(5.9)	1.2
	Shad	2100	(78)		110	(4.1)	160	(5.9)	1.4
CRM 25.0	Bass	14	(0.48)	<	2.1	(0.08)	3.5	(0.13)	0.03
	Blue Gill	3.1	(0.11)	<	3.8	(0.14)	9.5	(0.35)	0.07
	Carp	1.9	(0.070)	<	1.4	(0.052)	3.6	(0.13)	0.03
	Shad	23	(0.85)	<	3.0	(0.11)	6.5	(0.24)	0.06

[a] Composite of ten fish in each species.

[b] Percent maximum permissible intake for all radionuclides in both Tables 28 and 29. See text for definition of maximum permissible intake.

[c] Average of quarterly samples.

Table 30
MERCURY CONTENT IN CLINCH RIVER FISH
1983

LOCATION	Species[a]	CONCENTRATION (ng/g - Wet Weight) 1978[e]	1979[e]	1980	1981	1982	1983	% A.L.[b] 1983
CRM 4.0	Bass	113						
	Blue Gill	158						
	Carp	225						
	Shad	22						
CRM 5.0	Bass	215	195	157	133	120	120	12
	Blue Gill	265	173	220	86	170	240	24
	Carp	357	430	199	289	280	340	34
	Shad	40	41	25	73	30	30	3
	Crappie		152	65	401	59		
CRM 10.0	Bass				237	200	340	34
	Blue Gill				257	150	170	17
	Carp				487	210	280	28
	Shad				44	29	50	5
	Crappie				131	99	160	16
CRM 12.0	Bass	110	370	430	43	220	190	19
	Blue Gill	123	380	470	18	560	350	35
	Carp	740	1530	102	575	530	340	34
	Shad	70	100	18	23	190	20	2
	Crappie	53	320	122	102	180	270	27
CRM 20.8[c]	Bass	233	113	99	144	99	135	14
	Blue Gill	78	232	219	117	160	110	11
	Carp	278	197	193	108	240	220	22
	Shad	32	30	24	44	19	35	4
	Crappie	77	201	45	253[d]	43		
CRM 22.0	Bass	223						
	Blue Gill	99						
	Carp	106						
	Shad	27						
	Crappie	28						
CRM 24.0	Bass	71						
	Blue Gill	69						
	Carp	126						
	Shad	7						
CRM 25.0	Bass		103	11	16	13	100	10
	Blue Gill		56	59	57	34	30	3
	Carp		120	109	124	97	90	9
	Shad		14	7	12	7	10	1
	Crappie			21	30			

[a] Composite of ten fish in each species.

[b] Percent of proposed FDA mercury in fish action level of 1000 ng/g or 1 ppm.

[c] Average of quarterly samples.

[d] Average of three quarterly samples. Crappie were not collected in the second quarter.

[e] Corrected data - data in the 1978 and 1979 Environmental Monitoring Reports were too low due to an error in converting data to the proper

Table 31
SUMMARY OF ^{137}Cs CONCENTRATIONS
IN DEER SAMPLES
1983

Location	Sample Type	Number of Samples	Units of pCi/g (Bq/kg) - Wet Weight		
			Maximum	Minimum	Mean
Reservation					
	Muscle	82	1.1 (41)	0.004 (0.15)	0.059 (2.2) ± 0.016
	Liver	75	1.1 (41)	0.002 (0.074)	0.035 (1.3) ± 0.015
Off-Site					
	Muscle	6	1.2 (44)	0.013 (0.48)	0.38 (14) ± 0.19
	Liver	6	0.27 (10)	0.005 (0.18)	0.084 (3.1) ± 0.046

Table 32
VEGETATION SAMPLING DATA - ORGDP
1983

STATION NUMBER[a]	F^- CONCENTRATION[b] μg/g (ppm)		U (TOTAL) CONCENTRATION[b] μg/g (ppm)	
	GRASS	PINE NEEDLES	GRASS	PINE NEEDLES
VS-1	3.1	-	0.21	-
VS-5	3.5	4.6	0.20	0.32
VS-8	4.1	< 3.0	0.08	0.24
VS-9	< 3.0	4.9	0.06	0.10
VS-10	3.3	4.8	0.05	0.16
VS-11	3.9	8.5	0.08	0.20
VS-13	5.5	-	0.63	-
VS-15	3.6	-	0.08	-
VS-16	5.3	7.7	0.12	0.13
VS-17	4.3	< 3.0	0.11	0.05
VS-18	6.1	-	0.20	-
VS-19	12.2	-	1.00	-
VS-20	4.3	-	0.12	-
VS-21	< 3.0	-	0.45	-

[a]See Figure 1.

[b]Concentration based on one sample collection in June. Analytical results are on a dry weight basis.

NOTE: Applicable guides for flora have not been established. However, for comparison the **American Industrial Hygiene Association Journal** for January-February 1969 (pp. 98-101) states that dairy cattle is the species of livestock most sensitive to fluorides in grasses. For comparative purposes the following fluoride concentrations and their effect on dairy cattle are given.

30 ppm	-	no adverse effects
30 to 40 ppm	-	borderline chronic
40 to 60 ppm	-	moderate chronic
60 to 110 ppm	-	severe chronic
above 250 ppm	-	acute

Table 33
VEGETATION SAMPLING DATA - Y-12 PLANT
1983

STATION NUMBER[a]	F^- CONCENTRATION[b] μg/g (ppm)		U (TOTAL) CONCENTRATION[b] μg/g (ppm)	
	GRASS	PINE NEEDLES	GRASS	PINE NEEDLES
V-1	3.3	5.9	0.07	0.08
V-2	2.8	2.7	0.07	0.11
V-3	6.4	5.8	0.09	0.15
V-4	14.3	3.6	0.14	0.11
V-5	4.3	3.8	0.19	0.16
V-6	3.3	-	0.08	-
V-7	12.2	6.6	0.19	0.12
V-16	3.5	5.0	0.09	0.09
V-19	3.0	2.8	0.27	0.10
V-25	2.8	5.8	0.07	0.08

[a]See Figure 12.

[b]Concentration based on one sample collection. Analytical results are on a dry weight basis.

NOTE: Applicable guides for flora have not been established. However, for comparison the **American Industrial Hygiene Association Journal** for January-February 1969 (pp. 98-101) states that dairy cattle is the species of livestock most sensitive to fluorides in grasses. For comparative purposes the following fluoride concentrations and their effect on dairy cattle are given.

30 ppm	-	no adverse effects
30 to 40 ppm	-	borderline chronic
40 to 60 ppm	-	moderate chronic
60 to 110 ppm	-	severe chronic
above 250 ppm	-	acute

Table 34
RADIOACTIVITY IN GRASS SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS
1983
Units of pCi/g (Bq/kg) - Dry Weight

SAMPLING LOCATION[a]	^{90}Sr	^{137}Cs	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U
			Perimeter[b]				
HP-31	0.23 (8.5)	0.062 (2.3)	0.0002 (0.0074)	0.0008 (0.030)	0.053 (2.0)	0.019 (0.70)	0.096 (3.6)
HP-32	0.20 (7.4)	0.029 (1.1)	0.0005 (0.018)	0.0012 (0.044)	0.11 (4.1)	0.015 (0.56)	0.30 (11)
HP-33	0.12 (4.4)	0.032 (1.2)	0.0006 (0.022)	0.0004 (0.015)	0.038 (1.4)	0.015 (0.56)	0.065 (2.4)
HP-34	0.18 (6.7)	0.034 (1.3)	0.0004 (0.015)	0.0008 (0.030)	0.025 (0.93)	0.0045 (0.17)	0.055 (2.0)
HP-35	0.089 (3.3)	0.025 (0.93)	0.0006 (0.022)	0.0006 (0.022)	0.017 (0.63)	0.0028 (0.10)	0.034 (1.3)
HP-36	0.18 (6.7)	0.015 (0.56)	0.0004 (0.015)	0.0003 (0.011)	0.025 (0.93)	0.0045 (0.17)	0.047 (1.7)
HP-37	0.20 (7.4)	0.012 (0.44)	0.0004 (0.015)	0.0006 (0.022)	0.0085 (0.31)	0.0034 (0.13)	0.042 (1.6)
HP-38	0.11 (4.1)	0.016 (0.59)	0.0026 (0.096)	0.0042 (0.16)	0.016 (0.59)	0.0069 (0.26)	0.055 (2.0)
HP-39	0.15 (5.6)	0.019 (0.70)	0.0005 (0.018)	0.0004 (0.015)	0.035 (1.3)	0.0065 (0.24)	0.12 (4.4)
HP-40[c]	0.11 (4.1)	0.036 (1.3)	0.0024 (0.089)	0.0008 (0.030)	0.21 (7.8)	0.073 (2.7)	0.62 (23)
HP-41[c]	0.11 (4.1)	0.021 (0.78)	0.0038 (0.14)	0.0018 (0.067)	0.027 (1.0)	0.0049 (0.18)	0.068 (2.5
Average	0.16 (5.9)	0.027 (1.0)	0.0009 (0.033)	0.0011 (0.041)	0.045 (1.7)	0.012 (0.44)	0.12 (4.4)
			Remote[c]				
HP-51	0.19 (7.0)	0.028 (1.0)	0.0003 (0.011)	0.0003 (0.011)	0.023 (0.85)	0.0043 (0.16)	0.025 (0.93)
HP-52	0.78 (29)	0.095 (3.5)	0.0001 (0.0037)	0.00003 (0.0011)	0.024 (0.89)	0.0084 (0.31)	0.038 (1.4)
HP-53	0.11 (4.1)	0.010 (0.37)	0.0005 (0.018)	0.0005 (0.018)	0.015 (0.56)	0.0024 (0.089)	0.070 (2.6)
HP-55	0.30 (11)	0.038 (1.4)	0.0003 (0.011)	0.0001 (0.0037)	0.0076 (0.28)	0.0012 (0.044)	0.015 (0.56)
HP-56	0.59 (22)	0.031 (1.1)	0.0002 (0.0074)	0.0001 (0.0037)	0.0081 (0.30)	0.0038 (0.14)	0.022 (0.81)
HP-57	0.54 (20)	0.033 (1.2)	0.0002 (0.0074)	0.0002 (0.0074)	0.0059 (0.22)	0.0012 (0.044)	0.022 (0.81)
HP-58	0.20 (7.4)	0.024 (0.89)	0.0009 (0.033)	0.0003 (0.011)	0.017 (0.63)	0.0035 (0.13)	0.022 (0.81)
Average	0.39 (14)	0.037 (1.4)	0.0003 (0.011)	0.0002 (0.0074)	0.014 (0.52)	0.0035 (0.13)	0.031 (1.1)

[a]See Figures 1 and 2.

[b]Average of two samples.

[c]One sample.

Table 35
RADIOACTIVITY IN SOIL SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS
1983
Units of pCi/g (Bq/kg) - Dry Weight

SAMPLING LOCATION[a]	^{90}Sr	^{137}Cs	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U
			Perimeter[b]				
HP-31	0.19 (7.0)	1.0 (37)	0.012 (0.44)	0.0002 (0.007)	0.34 (13)	0.090 (3.3)	0.55 (20)
HP-32	0.17 (6.3)	1.4 (52)	0.018 (0.67)	0.0009 (0.033)	0.97 (36)	0.18 (6.7)	1.5 (56)
HP-33	0.22 (8.1)	1.6 (59)	0.022 (0.81)	0.0016 (0.059)	0.24 (8.9)	0.026 (0.96)	0.34 (13)
HP-34	0.49 (18.0)	1.4 (52)	0.018 (0.67)	0.0015 (0.056)	0.24 (8.9)	0.042 (1.6)	0.41 (15)
HP-35	0.11 (4.1)	0.43 (16)	0.008 (0.30)	0.0002 (0.007)	0.30 (11)	0.054 (2.0)	0.59 (22)
HP-36	0.31 (11.0)	0.77 (29)	0.010 (0.37)	0.0006 (0.022)	0.26 (9.6)	0.046 (1.7)	0.38 (14)
HP-37	0.24 (8.9)	0.96 (36)	0.014 (0.52)	0.0006 (0.022)	0.28 (10)	0.083 (3.1)	0.36 (13)
HP-38	0.26 (9.6)	1.4 (52)	0.022 (0.81)	0.0007 (0.026)	0.36 (13)	0.034 (1.3)	0.51 (19)
HP-39	0.15 (5.6)	1.9 (70)	0.013 (0.48)	0.0005 (0.019)	0.50 (19)	0.10 (3.7)	0.78 (29)
HP-40[c]	0.22 (8.1)	1.1 (41)	0.013 (0.48)	0.0046 (0.17)	1.8 (67)	0.76 (28)	6.2 (230)
HP-41[c]	0.14 (5.2)	0.20 (7.4)	0.0032 (0.12)	0.0003 (0.011)	0.30 (11)	0.040 (1.5)	0.35 (13)
Average	0.23 (8.5)	1.1 (41)	0.014 (0.52)	0.0009 (0.033)	0.46 (17)	0.11 (4.1)	0.87 (32)
			Remote[c]				
HP-51	0.15 (5.6)	0.81 (30)	0.0078 (0.29)	0.0005 (0.019)	0.26 (9.6)	0.030 (1.1)	0.32 (12)
HP-52	0.17 (6.3)	1.7 (63)	0.015 (0.56)	0.0005 (0.019)	0.51 (19)	0.16 (5.9)	0.73 (27)
HP-53	0.11 (4.1)	1.6 (59)	0.024 (0.89)	0.0010 (0.037)	0.78 (29)	0.10 (3.7)	0.86 (32)
HP-55	0.23 (8.5)	1.6 (59)	0.020 (0.74)	0.0022 (0.081)	0.30 (11)	0.017 (0.63)	0.35 (13)
HP-56	0.14 (5.2)	1.8 (67)	0.019 (0.70)	0.0006 (0.022)	0.43 (16)	0.081 (3.0)	0.51 (19)
HP-57	0.16 (5.9)	2.1 (78)	0.020 (0.74)	0.0019 (0.070)	0.49 (18)	0.032 (1.2)	0.54 (20)
HP-58	0.057 (2.1)	2.5 (93)	0.0070 (0.26)	0.0019 (0.070)	0.40 (15)	0.03 (1.1)	0.51 (19)
Average	0.15 (5.6)	1.7 (63)	0.016 (0.59)	0.0013 (0.048)	0.45 (17)	0.065 (2.4)	0.55 (20)

[a]See Figures 1 and 2.

[b]Average of two samples.

[c]One sample.

Table 36
Soil Sampling Data
(Upper 1 cm of Soil Column)
1983

Station Number[a]	F - Concentration[b] μg/g (ppm)	U (Total) Concentration[b] μg/g (ppm)
VS-1	288	4.2
VS-5	647	4.7
VS-8	—	4.6
VS-9	95	2.4
VS-10	606	2.3
VS-11	264	6.0
VS-13	196	3.7
VS-15	169	3.8
VS-16	295	2.8
VS-17	133	1.6
VS-18	274	10.6
VS-19	170	22.6
VS-20	105	4.4
VS-21	214	3.5

[a]See Figure 1.

[b]Concentration of one sample collection, June. Analytical results are on a dry weight basis.

Table 37
STREAM SEDIMENT SAMPLES
September 1983
Concentration (μg/g dry weight basis)

STATION[a]	U	Hg	Pb	Ni	Cu	Zn	Cr	Mn	Al	Th
CS1	4	1	29	32	18	78	38	1603	37,000	<20
PS6	9	12	30	52	36	113	60	421	35,000	<20
PS10	9	16	33	54	19	85	54	318	23,000	<20
PS17	65	14	56	256	96	168	71	752	38,000	<20
PS18	9	12	27	54	31	100	47	499	34,000	<20
PS19	13	48	49	34	37	90	53	295	28,000	<20
PS21	13	39	35	85	71	103	79	492	53,000	<20
CS20	1	1	18	18	9	38	26	253	25,000	<20

[a]See Figure 13.

Table 38
ANALYTICAL PARAMETERS FOR GROUNDWATER MONITORING - Y-12 PLANT
1983

PARAMETER	PARAMETER
Aluminum (Al)	Spec. Conductance
Arsenic (As)	Color
Cadmium (Cd)	Coliform
Chromium (Cr)	Chloroform
Copper (Cu)	Methyl Bromide
Iron (Fe)	Methyl Chloride
Mercury (Hg)	Methylene Chloride
Manganese (Mn)	Tetrachloroethylene
Lead (Pb)	Toluene
Selenium (Se)	Xylene
Zinc (Zn)	Chloroethane
Chlorine (Cl)	Dichloroethane
Cyanide (CN)	Trichloroethane
Fluorine (F)	Endrin
Foaming Agents (MBAS)	Lindane
Total Kjeldahl Nitrogen (TKN)	Methoxychlor
Nitrate Nitrogen [NO_3(N)]	Toxaphene
Total Nitrogen (Total N)	2,4,5-T Silvex
Phenol (Total)	2,4-D
Sulfate (SO_4)	Tetrahydrofuran
Polychlorinated Biphenyls (PCB)	2-Butanone
pH	Freon-113
Total Organic Carbon (TOC)	Dibromomethane
Thorium (Th)	Trichloroethylene
Uranium (U)	Dichloroethylene
Alpha Activity	Methyl Ethylbutanone
Beta Activity	Chloroethylene
U-235 (%)	Carbon Tetrachloride
Silver (Ag)	Benzene
Barium (Ba)	
Beryllium (Be)	

Table 39
GROUNDWATER MONITORING DATA - Y-12 PLANT
S-3 Ponds — Background[a]
Well YGMW1
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM		MINIMUM
Al	7	200		0.05
Hg	4	0.002	<	0.001
Pb	4	0.03	<	0.01
TKN	4	0.3	<	0.2
NO_3(N)	4	0.3		0.2
Total N	4	0.5	<	0.3
pH (pH units)	4	7.3		6.3
TOC	4	21		4.0
Th	4	0.020	<	0.005
U	4	0.001	<	0.001
U-235 (%)	4	2	<	1.06
SPEC. CONDUCTANCE (μmhos/cm)	4	290		190
CHLOROFORM	4	0.06	<	0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 40
GROUNDWATER MONITORING DATA - Y-12 PLANT
BEAR CREEK BURIAL GROUNDS - Background[a]
Wells YGMW5, YGMW13, YGMW17
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L	
		MAXIMUM	MINIMUM
Al	7	200	10
Cr	9	0.02	< 0.01
Fe	5	2.0	0.11
Mn	5	0.97	0.01
Pb	9	0.01	< 0.01
Zn	5	0.03	< 0.02
Cl	5	18	< 2
F	5	0.2	< 0.1
TKN	9	0.5	< 0.02
NO_3(N)	9	0.3	< 0.1
Total N	9	0.5	< 0.3
Phenol	5	0.002	< 0.001
SO_4	5	18.0	< 5.7
pH (pH units)	9	7.9	6.1
TOC	9	17	< 2.0
Th	9	0.200	< 0.002
U	9	0.002	< 0.001
Alpha Activity (pCi/L)	2	200	< 200
Beta Activity (pCi/L)	9	400	< 4
U-235 (%)	9	2.85	< 0.62
Ba	9	0.3	< 0.2
SPEC. CONDUCTANCE (μmhos/cm)	9	500	96
COLOR	5	6	< 5
COLIFORM (COLONIES/100 mL)	9	11	< 1
CHLOROFORM	9	0.24	< 0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 41
GROUNDWATER MONITORING DATA - Y-12 PLANT
BEAR CREEK BURIAL GROUNDS[a]
Wells YGMW6-YGMW12, YGMW14-YGMW16, YGMW18-YGMW20
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM	MINIMUM	
Al	25	210	<	1
As	32	0.080	<	0.005
Cd	32	0.004	<	0.002
Cr	32	0.02	<	0.01
Cu	16	0.022	<	0.004
Fe	16	19.00		0.11
Mn	16	4.80		0.03
Pb	32	0.03	<	0.01
Zn	16	5.60	<	0.02
Cl	16	76	<	2
F	16	0.2	<	0.1
TKN	32	3.2	<	0.2
$NO_3(N)$	32	7.7	<	0.1
Total N	32	7.70	<	0.22
Phenol	15	0.003	<	0.001
SO_4	16	56.0	<	2.9
pH (pH units)	32	12.0		6.1
TOC	32	32	<	2
Th	32	0.032	<	0.003
U	32	0.014	<	0.001
Alpha Activity (pCi/L)	7	200	<	200
Beta Activity (pCi/L)	32	400	<	4
U-235 (%)	32	4.12	<	0.36
Ba	32	0.5	<	0.2
Be	32	0.007	<	0.0005
SPEC. CONDUCTANCE (μmhos/cm)	32	1500		110
COLOR	16	2500	<	5
COLIFORM (COLONIES/100 mL)	35	30	<	1
CHLOROFORM	31	1.60	<	0.01
METHYLENE CHLORIDE	31	0.02	<	0.01
TETRACHLOROETHYLENE	31	10.50	<	0.01
TOLUENE	31	0.02	<	0.01
DICHLOROETHANE	31	0.21	<	0.01
TRICHLOROETHANE	31	0.34	<	0.01
TRICHLOROETHYLENE	5	2.50		0.02
DICHLOROETHYLENE	4	10.00		0.03

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 42
GROUNDWATER MONITORING DATA - Y-12 PLANT
S-3 Ponds[a]
Wells YGMW2-YGMW4
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM		MINIMUM
Al	21	510	<	0.2
As	12	0.060	<	0.005
Cd	12	0.100	<	0.002
Cr	12	0.01	<	0.01
Pb	12	0.03	<	0.01
CN	12	0.013	<	0.002
TKN	12	2.50	<	0.06
$N0_3(N)$	12	730		0.4
Total N	12	730		0.5
pH (pH units)	12	7.2		3.6
TOC	12	51		5
Th	12	0.065	<	0.020
U	12	0.718		0.003
Alpha Activity (pCi/L)	3	4500	<	200
Beta Activity (pCI/L)	12	2000	<	4
U-235 (%)	12	0.88		0.28
Ag	12	0.01	<	0.01
Ba	12	3.2	<	0.2
Be	12	0.040	<	0.0005
SPEC. CONDUCTANCE (μmhos/cm)	12	15000		1100
CHLOROFORM	13	0.09	<	0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 43
GROUNDWATER MONITORING DATA - Y-12 PLANT
NEW SANITARY LANDFILL[a]
Wells YMW1-YMW3
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM		MINIMUM
Al	9	200		38
Cu	12	0.068	<	0.004
Fe	12	1.70		0.12
Mn	12	0.07	<	0.01
Pb	12	0.03	<	0.01
Zn	12	0.03	<	0.02
Cl	12	8	<	2
F	12	0.2	<	0.1
TKN	12	0.2	<	0.2
$N0_3(N)$	12	0.7	<	0.1
Total N	12	0.8	<	0.3
Phenol	12	0.002	<	0.001
SO_4	12	10.0	<	1.3
pH (pH units)	12	8.5		7.3
TOC	12	17	<	2
Th	11	0.020	<	0.002
U	12	0.005	<	0.001
Alpha Activity (pCi/L)	3	200	<	200
Beta Activity (pCi/L)	12	440		10
U-235 (%)	12	2.21	<	0.73
Be	12	0.006	<	0.0005
SPEC. CONDUCTANCE (μmhos/cm)	12	340		210
COLOR	12	10	<	5
COLIFORM (COLONIES/100 mL)	12	22	<	1
CHLOROFORM	11	0.05	<	0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 44
GROUNDWATER MONITORING DATA - Y-12 PLANT
UNC SITE[a]
Wells YGMW24-YGMW26
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM		MINIMUM
Al	2	15		13
As	12	0.060	<	0.005
Cd	12	0.006	<	0.002
Cr	12	0.04	<	0.01
Pb	12	0.08	<	0.01
TKN	12	0.6	<	0.2
$N0_3$(N)	12	1.1	<	0.1
Total N	12	1.4	<	0.3
PCB	12	0.005	<	0.0005
pH (pH units)	12	10.0		6.7
TOC	12	81	<	2
Th	12	0.020	<	0.002
U	12	0.008	<	0.001
Alpha Activity (pCi/L)	10	200		66
Beta Activity (pCi/L)	12	400	<	4
U-235 (%)	12	2.63	<	0.20
Be	12	0.0007	<	0.0005
SPEC. CONDUCTANCE (μmhos/cm)	12	480		110
CHLOROFORM	12	0.15	<	0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 45
GROUNDWATER MONITORING DATA - Y-12 PLANT
CLASSIFIED BURIAL GROUND[a]
Well YGMW23
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L	
		MAXIMUM	MINIMUM
Pb	4	0.44	0.03
TKN	4	1.3	0.2
$N0_3(N)$	4	0.7	< 0.1
Total N	4	1.3	0.7
pH (pH units)	4	7.6	7.1
TOC	4	34	3
Th	4	0.020	< 0.005
U	4	0.005	0.001
U-235 (%)	4	3.69	2.36
SPEC. CONDUCTANCE (μmhos/cm)	4	370	310
CHLOROFORM	4	0.03	< 0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 46
GROUNDWATER MONITORING DATA - Y-12 PLANT
NHP Sludge Basin[a]
Wells YGMW21, YGMW22
1983

PARAMETER	NUMBER OF SAMPLES	CONCENTRATION, mg/L		
		MAXIMUM	MINIMUM	
As	8	0.280	<	0.005
Cd	8	0.003	<	0.002
Cr	8	0.130	<	0.007
Pb	8	0.50	<	0.01
Zn	8	1.50	<	0.02
TKN	8	0.5	<	0.2
$N0_3(N)$	8	0.9		0.4
Total N	8	1.0		0.5
pH (pH units)	8	11.0		5.5
TOC	8	25		3
Th	8	0.028	<	0.006
U	8	0.007	<	0.001
Alpha Activity (pCi/L)	7	200	<	200
Beta Activity (pCi/L)	8	400		15
U-235 (%)	8	2.13	<	0.20
Be	8	0.001	<	0.0005
SPEC. CONDUCTANCE (μmhos/cm)	8	690		16
CHLOROFORM (mg/L)	8	0.02	<	0.01

NOTE: Parameters listed are only those whose concentrations were above the analytical detection limit and where more than one sample was obtained.

[a]See Figure 14.

Table 47
GROUNDWATER MONITORING DATA - Y-12 PLANT
Number of Parameters Analyzed vs Number of Parameters Below Reporting Limits
1983

Area	Number of Parameters	Number of Parameters Below Reporting Limits
S-3 Ponds - Background	41	26
S-3 Ponds	40	18
NHP Sludge Basin	42	30
Bear Creek Burial Grounds - Background	49	25
Bear Creek Burial Grounds	55	16
New Sanitary Landfill	52	23
UNC Site	39	19
Classified Burial Ground	33	21

Table 48
GROUNDWATER MONITORING DATA - Y-12 PLANT
Wells Where Parameters Exceeded EPA Primary Drinking Water Standards[a]
1983

Well	Date	Parameter	Concentration (mg/L)	EPA Standard (mg/L)
YGMW2	5/12/83	Ba	2.6	1.0
YGMW2	9/28/83	Ba	1.5	1.0
YGMW2	11/01/83	Ba	2.2	1.0
YGMW21	2/16/83	Pb	0.23	0.05
YGMW22	2/16/83	As	0.28	0.05
YGMW22	2/16/83	Cr	0.13	0.05
YGMW22	2/16/83	Pb	0.5	0.05
YGMW23	5/18/83	Pb	0.44	0.05
YGMW23	8/23/83	Pb	0.22	0.05
YGMW23	10/03/83	Pb	0.2	0.05
YGMW25	8/24/83	Pb	0.08	0.05
YGMW26	8/24/83	Pb	0.06	0.05
YGMW3	9/28/83	Cd	0.075	0.01
YGMW3	9/28/83	Ba	3.1	1.0
YGMW3	11/01/83	Cd	0.074	0.01
YGMW3	11/01/83	Ba	3.2	1.0
YGMW4	2/17/83	Cd	0.1	0.01
YGMW4	5/12/83	Cd	0.077	0.01
YGMW4	5/12/83	Ba	2.72	0.01
YGMW7	9/20/83	As	0.08	0.05
YGMW3	10/12/83	Cd	0.02	0.01

[a]Table does not include wells whose concentrations for arsenic or selenium were less than the reporting limit.

Table 49
GROUNDWATER MONITORING DATA - ORGDP
CLASSIFIED BURIAL GROUND[a] - SHALLOW WELLS
1983

PARAMETER	CONCENTRATION, mg/L		
	MAXIMUM	MINIMUM	AVERAGE[b]
Ag	0.07	< 0.01	< 0.019 ± 0.021
Al	1365	8.9	331 ± 451
As	0.42	0.007	0.076 ± 0.142
Ba	60	< 0.1	< 14 ± 20
Ca	62	28	41 ± 13
Cd	0.050	< 0.002	< 0.018 ± 0.020
Cl^-	9.8	3.2	5.4 ± 2.2
Cr	0.46	0.06	0.27 ± 0.16
Cu	1.9	0.020	0.88 ± 0.79
Fe	3980	51	839 ± 1306
F^-	< 0.5	< 0.5	< 0.5
Hg	< 0.001	< 0.001	< 0.001
Mg	836	34	266 ± 322
Mn	72	1.5	18 ± 23
Ni	4.8	0.03	1.1 ± 1.6
NO_3^-	7.7	< 0.4	< 1.7 ± 2.5
Pb	0.20	< 0.01	< 0.063 ± 0.067
Se	< 0.005	< 0.005	< 0.005
$SO_4^=$	730	7.9	137 ± 242
TOC	30	3	9.6 ± 8.7
U	0.011	0.003	0.007 + 0.003
Zn	21	0.25	6.7 ± 8.9
pH	7.8 units	7.0 units	—
Methyl Ethyl Ketone	0.03	none detected	—
Freon - 113	0.16	none detected	—
Freon - 123	0.8	none detected	—
Trichloroethylene	0.002	none detected	—

[a]See Figure 15.

[b]Average concentration of samples taken from seven wells, November

Table 50
GROUNDWATER MONITORING DATA - ORGDP
CLASSIFIED BURIAL GROUND[a] - DEEP WELLS
1983

PARAMETER	CONCENTRATION, mg/L		
	MAXIMUM	MINIMUM	AVERAGE[b]
Ag	< 0.01	< 0.01	< 0.01
Al	1.4	2.0	1.7 ± 0.4
As	0.008	< 0.005	< 0.007 ± 0.003
Ba	< 0.10	< 0.10	< 0.10
Ca	79	13	44 ± 44
Cd	< 0.002	< 0.002	< 0.002
Cl^-	75	2.8	38 ± 55
Cr	0.24	0.01	0.11 ± 0.19
Cu	0.013	0.006	0.008 ± 0.005
Fe	13	2.2	6.8 ± 8.0
F^-	< 0.5	< 0.5	< 0.5
Hg	< 0.001	< 0.001	< 0.001
Mg	36	16	25 ± 13
Mn	5.3	0.12	1.6 ± 4.0
Ni	0.36	< 0.01	< 0.11 ± 0.27
NO_3^-	1.7	< 0.4	< 0.73 ± 1.03
Pb	0.03	< 0.01	< 0.018 ± 0.015
Se	< 0.005	< 0.005	< 0.005
$SO_4^=$	37	1.4	15 ± 25
TOC	81	18	40 ± 45
U	0.003	0.001	0.002 ± 0.002
Zn	0.08	0.03	0.050 ± 0.034
pH	7.8 units	7.3 units	—
1,1 - Dichloroethane	0.03	none detected	—
Tetrachloroethylene	0.01	none detected	—
Freon 123	0.4	none detected	—
Freon 113	0.48	none detected	—
1,1.1 - Trichloroethane	0.05	none detected	—
Benzene	0.01	none detected	—
1,2 - Dichloroethane	0.03	none detected	—

[a]See Figure 15.

[b]Average concentration of samples taken from four wells, November.

Table 51
GROUNDWATER MONITORING DATA - ORGDP
K-1407-C HOLDING POND[a] - SHALLOW WELLS
1983

PARAMETER	CONCENTRATION, mg/L		
	MAXIMUM	MINIMUM	AVERAGE[b]
Ag	< 0.01	< 0.01	< 0.01
Al	467	4.8	100 ± 255
As	0.13	< 0.005	< 0.032 ± 0.065
Ba	5.7	< 0.1	< 1.2 ± 3.1
Ca	420	63	211 ± 201
Cd	0.007	< 0.002	< 0.003 ± 0.003
Cl^-	22	4	16 ± 11
Cr	0.41	0.03	0.12 ± 0.20
Cu	0.84	< 0.004	< 0.18 ± 0.46
Fe	1274	16	293 ± 682
F^-	1.3	< 0.5	< 0.66 ± 0.44
Hg	< 0.001	< 0.001	< 0.001
Mg	215	16	74 ± 101
Mn	35	0.68	11 ± 19
Ni	1.2	0.04	0.28 ± 0.65
NO_3^-	14	< 0.4	< 0.4.5 ± 7.1
Pb	0.01	< 0.01	< 0.01
Se	0.024	< 0.005	< 0.009 ± 0.011
$SO_4^{=}$	103	13	33 ± 49
TOC	30	10	17 ± 10
U	0.003	< 0.001	< 0.001 ± 0.001
Zn	4.2	0.06	0.92 ± 2.25
pH	7.8 units	7.2 units	—
Trichloroethylene	< 0.01	none detected	—
1,2 - Dichloroethane	< 0.01	none detected	—
Methylene Chloride	< 0.01	none detected	—
1,1.1 - Trichloroethane	< 0.01	none detected	—
Tetrachloroethylene	< 0.01	none detected	—
Other Halomethanes	< 0.01	none detected	—

[a]See Figure 15.

[b]Average concentration of samples taken from five wells, November.

Table 52
GROUNDWATER MONITORING DATA - ORGDP
K-1407-C HOLDING POND[a] - DEEP WELLS
1983

PARAMETER	CONCENTRATION, mg/L		
	MAXIMUM	MINIMUM	AVERAGE[b]
Ag	< 0.01	< 0.01	< 0.01
Al	82	2.6	21 ± 43
As	0.025	0.008	0.013 ± 0.008
Ba	1.3	< 0.1	< 0.60 ± 0.65
Ca	150	54	112 ± 54
Cd	< 0.002	< 0.002	< 0.002
Cl^-	41	9.4	23 ± 14
Cr	0.19	0.02	0.08 ± 0.09
Cu	0.10	0.006	0.030 ± 0.050
Fe	206	9.1	65 ± 101
F^-	0.8	< 0.5	< 0.56 ± 0.17
Hg	< 0.001	< 0.001	< 0.001
Mg	44	17	32 ± 14
Mn	7.0	1.0	3.2 ± 3.2
Ni	0.19	0.02	0.058 ± 0.092
NO_3^-	0.59	< 0.4	< 0.44 ± 0.11
Pb	0.07	< 0.01	< 0.028 ± 0.031
Se	< 0.005	< 0.005	< 0.005
$SO_4^=$	81	4	32 ± 38
TOC	143	14	51 ± 65
U	0.005	< 0.001	< 0.002 ± 0.002
Zn	1.8	0.02	0.44 ± 0.97
pH	7.9 units	7.3 units	—
Freon 113	0.01	none detected	—
Freon 123	0.01	none detected	—
Trichloroethylene	0.04	none detected	—
1,2 - Dichloroethane	0.001	none detected	—
Methylene Chloride	< 0.01	none detected	—
Trans - 1,2 - Dichloroethylene	0.02	none detected	—
1,1.1 - Trichloroethane	< 0.01	none detected	—
Tetrachloroethylene	< 0.01	none detected	—
Other Halomethanes	< 0.01	none detected	—

[a]See Figure 15.

[b]Average concentration of samples taken from five wells, November.

Table 53
GROUNDWATER MONITORING DATA - ORNL
1983

ANALYSIS	NUMBER OF SAMPLES	Units of E-08 μCi/mL (Bq/L) MAXIMUM	MINIMUM	MEAN[a]	95% CONFIDENCE LIMITS UPPER	LOWER
Solid Waste Storage Area 4						
^{137}Cs	16	110 (41)	< 0.14 (0.05)	*	*	*
^{60}Co	16	3.2 (1.2)	< 0.22 (0.08)	*	*	*
^{3}H	5	35000 (13000)	270 (100)	5400 (2000)	30000 (11000)	950 (350)
^{90}Sr	8	4100 (1500)	240 (90)	1100 (410)	2000 (740)	570 (210)
Gross Alpha	4	13 (4.9)	5.9 (2.2)	8.6 (3.2)	12 (4.5)	6.2 (2.3)
Solid Waste Storage Area 5						
^{137}Cs	20	160 (61)	< 0.24 (0.09)	2.5 (0.93)	5.9 (2.2)	1.1 (0.41)
^{60}Co	20	6.2 (2.3)	< 0.27 (0.10)	1.0 (0.37)	1.5 (0.57)	0.65 (0.24)
^{3}H	22	27000000 (10000000)	3000 (1100)	200000 (73000)	680000 (250000)	57000 (21000)
^{90}Sr	18	4900 (1800)	1.4 (0.51)	40 (15)	150 (56)	11 (4.1)
Gross Alpha	18	7.3 (2.7)	< 0.11 (0.04)	0.97 (0.36)	1.7 (0.62)	0.57 (0.21)
Solid Waste Storage Area 6						
^{137}Cs	12	5.1 (1.6)	< 0.19 (0.07)	0.54 (0.20)	0.84 (0.31)	0.32 (0.12)
^{60}Co	12	0.81 (0.30)	< 0.22 (0.08)	0.51 (0.19)[b]	0.62 (0.23)	0.41 (0.15)
^{3}H	5	2500 (910)	57 (21)	810 (300)	3200 (1200)	210 (77)
^{90}Sr	7	510 (190)	0.43 (0.16)	6.2 (2.3)	40 (15)	0.92 (0.34)
Gross Alpha	6	2.2 (0.81)	< 0.08 (0.03)	0.41 (0.15)	1.0 (0.37)	0.16 (0.06)
Trench Areas						
^{137}Cs	51	150 (54)	< 0.08 (0.03)	2.7 (1.0)	4.9 (1.8)	1.5 (0.57)
^{60}Co	51	9400 (3500)	< 0.19 (0.07)	26 (9.5)	12 (4.6)	5.7 (2.1)
^{3}H	17	19000 (7000)	350 (130)	9200 (3400)	12000 (4400)	6500 (2400)
^{90}Sr	21	300 (110)	0.62 (0.23)	*	*	*
Gross Alpha	25	250 (91)	< 0.05 (0.02	3.2 (1.2)	10 (3.7)	1.1 (0.41)
Control Wells						
^{137}Cs	7	68 (25)	< 0.16 (0.06)	3.8 (1.4)	26 (9.6)	0.51 (0.19)
^{60}Co	7	1.5 (0.55)	< 0.03 (0.01)	0.19 (0.07)	0.49 (0.18)	0.08 (0.03)
^{3}H	7	400 (150)	< 57 (21)	130 (48)	240 (88)	73 (27)
^{90}Sr	7	59 (22)	0.54 (0.20)	6.8 (2.5)	26 (9.8)	1.7 (0.64)
Gross Alpha	7	2.4 (0.90)	0.32 (0.12)	0.73 (0.27)	1.1 (0.41)	0.46 (0.17)

[a]Derived mean (= geometric mean)

[b]Arithmetic mean.

*Data could not be normalized.

Table 54
GROUNDWATER ANALYSES EQUALING OR EXCEEDING CG_w — ORNL
1983

Area	Number of Samples	Analysis	Percent of Values ⩾ CG[a]
Solid Waste Storage Area 4	8	^{90}Sr	100
	4	Gross Alpha	100
Solid Waste Storage Area 5	22	H-3	45
	18	^{90}Sr	44
	18	Gross Alpha	28
Solid Waste Storage Area 6	7	^{90}Sr	29
	6	Gross Alpha	17
Trench Areas	51	^{60}Co	2
	21	^{90}Sr	10
	25	Gross Alpha	52
Control Wells	7	^{90}Sr	29
	7	Gross Alpha	14

[a]DOE Order 5480.1A Chapter XI, Attachment XI-1, Table II.

Table 55
SUMMARY OF THE ESTIMATED RADIATION DOSE TO AN ADULT INDIVIDUAL DURING 1983 AT LOCATIONS OF MAXIMUM EXPOSURE

PATHWAY	LOCATION	DOSE IN MILLIREM (μSv) TOTAL BODY		CRITICAL ORGAN	
Gaseous Effluents					
Inhalation plus direct radiation from air, ground, and food chains	Nearest resident to site boundary	6.3[c]	(63)	21	(210) (pulmonary)
Terrestrial food chain (milk only)	Milk sampling stations (^{90}Sr)	0.01	(0.1)	0.3	(3) (bone)
Liquid Effluents					
Aquatic food chain (fish)	Clinch-Tennessee River System (^{90}Sr)	1.4	(14)	23	(230) (bone)
Drinking water[b]	Kingston, Tennessee (^{90}Sr)	0.13	(1.3)	3.0	(30) (bone)
Direct radiation along water, shores, and mud flats[c]	Downstream from White Oak Creek near experimental Cs field plots	6.8	(68)	6.8	(68) (total body)

[a]Weighted sum dose commitment. The weighted sum is obtained by summing the weighted doses to each of a set of selected principle organs and obtaining the equivalent uniform total body dose which would produce the equivalent amount of risk.

[b]Based on the analysis of treated water.

[c]Assuming a residence time of 240 h/yr.

NOTE: Average background total body dose in the U.S.[35] is 106 mrem/yr (1060 μSv/yr).

REFERENCES

(1) DOE Order 5480.1A.

(2) Tennessee Air Pollution Control Regulations, Department of Public Health, Division of Air Pollution, Nashville, Tennessee, June 1974 and amendments.

(3) T. W. Oakes, K. E. Shank, and C. E. Easterly, "Natural and Man-Made Radionuclide Concentrations in Tennessee Soil" in *Proceedings of the Health Physics Society Tenth Midyear Topical Symposium,* Saratoga Springs, New York, October 11-13, 1976, pp. 322-333.

(4) Methods for Chemical Analysis of Water and Wastes, EPA Methods Development and Quality Assurance Laboratory, NERC, Cincinnati, Ohio, Second Printing, 1983.

(5) Letter: Paul E. Davis, Manager, Permit Section, Division of Water Management, Tennessee Department of Health and Environment to Stan Stief, Acting Chief, Environmental Protection Branch, Safety and Environmental Control Division, Oak Ridge Operations, U.S. Department of Energy, September 30, 1983.

(6) Background Material for the Development of Radiation Protection Standards, Staff Report of the Federal Radiation Council, Report No. 2, U.S. Government Printing Office, Washington, September 1961.

(7) P. Bryan and C. E. White, "An Economic Evaluation of the Commercial Fishing in the TVA Lakes of Alabama during 1956," *Proc. Twelfth Annual Conference Southeastern Assoc. of Game and Fish Commissioners,* 1958 (pp. 128-132).

(8) American Industrial Hygiene Association Journal, January - February 1969 (pp. 98-101).

(9) Plutonium and Other Transuranium Elements; Sources, Environmental Distribution and Biomedical Effects, U.S. AEC, WASH-1359, December 1974.

(10) F. Pasquill, *Atmospheric Diffusion,* D. V. Nostrand Co., Ltd., London, 1962.

(11) F. A. Gifford, Jr., *The Problem of Forecasting Dispersion in the Lower Atmosphere,* U.S. AEC, DTI, 1962.

(12) R. E. Moore et al., *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides,* EPA 520/1-79-009, December 1979.

(13) C. L. Begovich et al., *DARTAB: A Program to Combine Airborne Radionuclide Environmental Exposure Data with Dosimetric and Health Effects Data to Generate Tabulations of Predicted Health Impacts,* ORNL-5692, Oak Ridge National Laboratory, 1981.

(14) D. E. Dunning, R. W. Leggett, and M. G. Yalcintas, *A Combined Methodology for Estimating Dose Rates and Health Effects from Exposure to Radioactive Pollutants,* ORNL/TM-7105, 1980.

(15) R. E. Sullivan et al., *Estimates of Health Risk from Exposure to Radioactive Pollutants,* ORNL/TM-7745, 1981.

(16) (a) P. Voilleque, D. R. Adams, and J. B. Echo, "Transfer of Krypton-85 from Air to Grass," *Health Physics,* 19, 1970 (p. 835).

(b) D. F. Bunch (ed.), *Controlled Environmental Radioiodine Tests, Progress Report 2,* IDO-12053, August 1966.

(17) Recommendations of the International Commission on Radiological Protection, ICRP Publication 2, Report of Committee II on Permissible Dose for Internal Radiation, Pergamon Press, London, 1959.

(18) Recommendations of the International Commission on Radiological Protection, ICRP Publication 6, Pergamon Press, London, 1964.

(19) Recommendations of the International Commission on Radiological Protection, ICRP Publication 10, Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure, Pergamon Press, London, 1968.

(20) Recommendations of the International Commission on Radiological Protection 10A, Report of Committee II on the Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes, Pergamon Press, London, 1971.

(21) Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, Oxford: New York: Frankfurt, 1977.

(22) Recommendations of the International Commission on Radiological Protection, ICRP Publication 30, *Limits for Intakes of Radionuclides by Workers,* Pergamon Press, Oxford: New York: Frankfurt, 1978.

(23) Metabolism of Plutonium and Other Actinides, ICRP Publication 19, Report of Committee II, Pergamon Press, London, 1972.

(24) Report on Reference Man, ICRP Publication 23, Report of ICRP Task Group, W. S. Snyder, Chairman, Pergamon Press, London, 1975.

(25) G. J. Hine ad G. L. Brownell (eds.), *Radiation Dosimetry,* Academic Press, New York, 1956.

(26) K. Z. Morgan and J. E. Turner (eds.), *Principles of Radiation Protection,* Wiley, New York, 1967.

(27) W. S. Snyder, L. T. Dillman, M. R. Ford, and J. W. Poston, "Calculations of Absorbed Dose to a Man Immersed in an Infinite Cloud of Krypton-85," *Noble Gases Symposium,* Las Vegas, Nevada, September 24-28, 1973.

(28) M. R. Ford, Metabolism and Dosimetry Group, Oak Ridge National Laboratory, personal communication, March 1978.

(29) W. D. Turner, S. V. Kaye, and P. S. Rohwer, *EXREM and INREM Computer Codes for Estimating Radiation Doses to Populations from Construction of a Sea-Level Canal With Nuclear Explosives,* K-1752, CTC and ORNL, Oak Ridge, Tennessee, September 1968.

(30) D. K. Trubey and S. V. Kaye, *The EXREM III Computer Code for Estimating External Radiation Doses to Populations from Environmental Releases,* ORNL/TM-4322, Oak Ridge National Laboratory, December 1973.

(31) Agricultural Statistics 1969, U.S. Department of Agriculture, U.S. Government Printing Office, Washington, 1971 (p. 588).

(32) W. Van Winkle, R. W. Counts, J. G. Dorsey, J. W. Elwood, V. W. Lowe, Jr., R. McElhaney, S. D. Schlotzhaur, F. G. Taylor, Jr., and R. R. Turner, *Mercury Contamination in East Fork Poplar Creek and Bear Creek,* ORNL/TM-8894, Oak Ridge National Laboratory, 1982.

(33) Mercury at the Y-12 Plant, A Summary of the 1983 UCC-ND Task Force Study, Y/EX-23, Oak Ridge Y-12 Plant, November 1983.

(34) Results of Ground-Water Monitoring Studies, Report No. Y/Sub/83-47936/1, Law Engineering Testing Company, September 1983.

(35) The Effects on Populations of Exposures to Low Levels of Ionizing Radiation, Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, U.S. National Academy of Sciences, National Research Council, Washington, 1972.

APPENDIX A
QUALITY ASSURANCE

Radiological

All the analytical laboratories at the Oak Ridge plants maintain internal control programs which involve the use of known solutions of radionuclides for calibration, instrument checks and general procedure control. Certified standards from other Department of Energy laboratories or from the National Bureau of Standards are often used in such control work.

A very significant externally operated program is the Quality Assurance Program administered by the DOE Environmental Measurements Laboratory (EML) in New York. All the plant laboratories participate in this program, which presently provides quarterly samples of five types of environmental media: soil, water, air filters, vegetation, and animal tissue--each containing from five to nine radionuclides at established levels, known by EML. Analytical results are returned each quarter to EML, where statistical evaluation is made and periodic reports are issued to each participant showing how its results compare with the established values and with the results of other participants. Participation is mandatory for those parameters of concern to the plant and optional for other parameters.

Chemical

All the analytical laboratories have established internal programs designed to provide reliable calibration of instruments and evaluation of analyst performance in the measurement of a wide range of chemical pollutants in environmental media.

An effective external quality control program is also in place, utilizing certified solutions purchased from a commercial source. Monthly samples are sent to each laboratory quality control officer; these contain a host of common pollutants, including trace metals, residual chlorine, cyanide, phenol, nitrogen, organic carbon, grease and oil, minerals and other impurities--all at environmental levels certified by the vendor. Obtained as from unknown samples in the laboratory, the analytical results are transmitted to the Y-12 Plant Quality Division for statistical review. Periodic reports are sent to all of the four laboratories, to show how their results compare with the certified values and with each other.

General

A Four-Plant Committee on Environmental Analysis was established in 1977 to provide a uniform basis for measuring environmental pollutants and to ensure that measurement sensitivity, quality, and methodology are in accord with the federal and state requirements for environmental monitoring. A unified Environmental and Effluent Analysis Manual was initiated with emphasis on laboratory procedures used for measuring parameters which appear on the NPDES permits or air discharge permits of any of the four plants. The 111 analytical procedures currently in the manual cover water, air, sediment and soil, biota, and miscellaneous media such as oil under test for reuse. Both radiological and nonradiological parameters are included. EPA-approved analytical methods are used wherever possible.

The Four-Plant Environmental Analysis Committee also coordinates special quality control programs of interest to all plants, such as the measurement of fluorides in air or PCB's in oil. It is

also instrumental in the generation and evaluation of proposed analytical control standards, such as PCB in transformer oil or technetium-99 in grass.

Quality Assurance in environmental monitoring has become a well accepted responsibility at all the plants. The program at ORNL is especially developed to keep pace with the broad surveillance responsibilities assumed by that facility for both radiological and nonradiological monitoring in the Oak Ridge area. The Department of Environmental Management (DEM) at ORNL has initiated a quality assurance program to ensure that a high degree of accuracy and reliability is maintained in its surveillance activities. The program in effect at ORNL consists of quality control of techniques and procedures, and includes the establishment of a detailed written description of all activities pertaining to the DEM. This includes:

1. Operating procedures for each activity.
2. Inspection lists of operating and maintenance activities.
3. Check-off frequency lists for all quality assurance steps, such as schedules for equipment inspection and test control.
4. Documentation of compliance of quality assurance procedures.
5. Participation in intralaboratory and interlaboratory sample-exchange programs.
6. Evaluation of the adequacy of sample preparation work and data analysis.
7. Identification of the role, responsibilities, and authority of each staff member as related to quality assurance.

A schematic diagram showing a flow chart of this quality assurance program is given in Figure A1. A more detailed discussion of the ORNL QA program is given in Reference (A1).

A1. T. W. Oakes, K. E. Shank, and J. S. Eldridge, "Quality Assurance Applied to an Environmental Surveillance Program," Conference Proceedings of the 4th Joint Conference on Sensing of Environmental Pollutants, New Orleans, La., Nov. 6-11, 1977, p. 226.

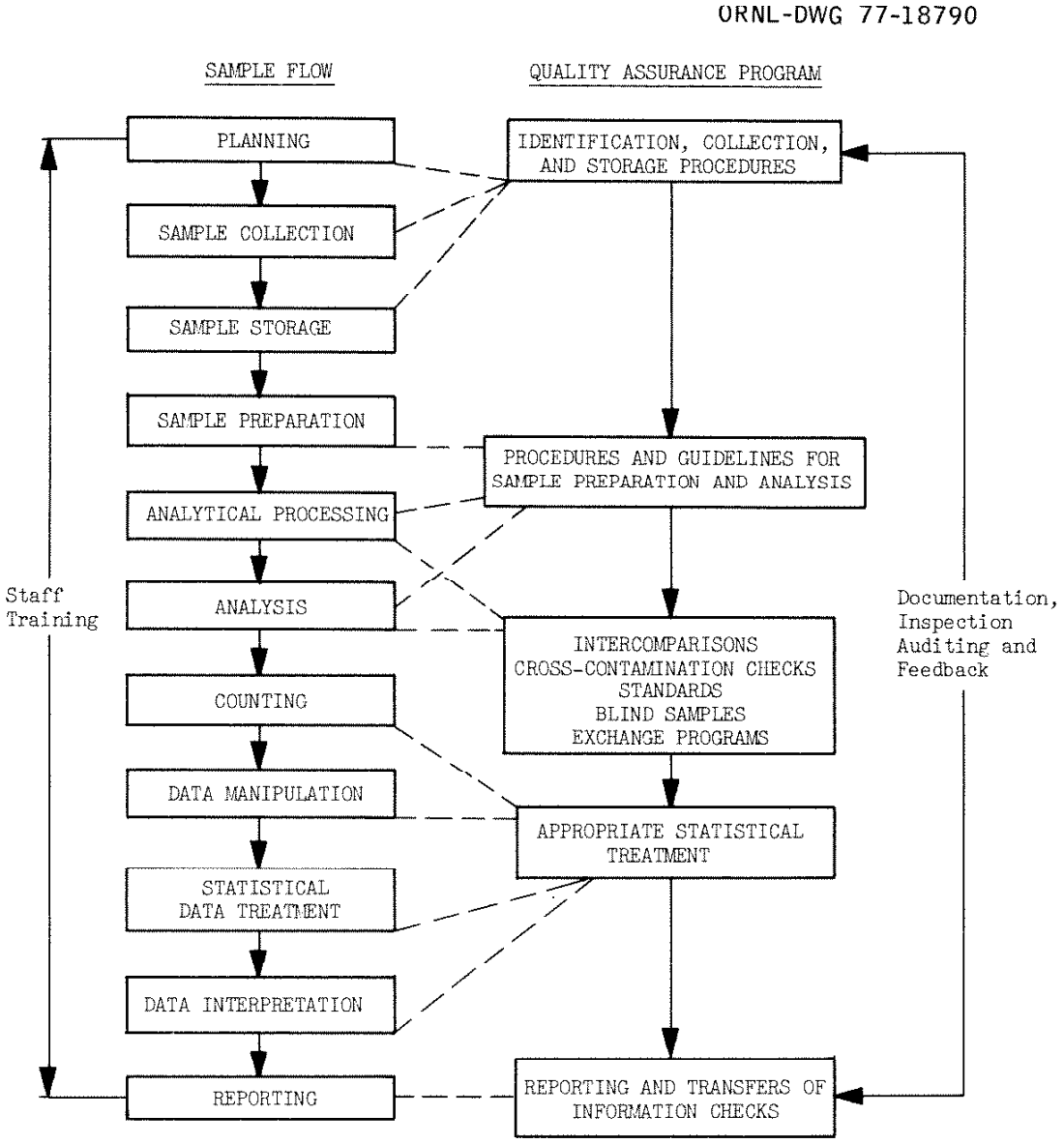

Figure A1
FLOW CHART OF QA PROGRAM

APPENDIX B

UNITS, PREFIXES, AND ABBREVIATIONS

Radiation Units

Curie (Ci) and Becquerel (Bq) - Units of radioactivity which are a measure of those spontaneous, energy-emitting, atomic tranformations that involve changes in the state of the nuclei of radioactive atoms.
1 Ci = 3.7 E+10 Bq

Roentgen (R) and Coulombs per kilogram (C/kg) - Units of exposure to radioactivity.
1 R = 2.58 E-04 C/kg

Rad (rad) and Gray (Gy) - Units of absorbed dose in any medium.
1 rad = 1 E-02 Gy

Roentgen Equivalent Man (rem) and Sievert (Sv) - Units of dose equivalent which account for the relative biological effectiveness of a given absorbed dose. 1 rem = 1 E-02 Sv

Table of Unit Prefixes

Factor	Prefix	Symbol
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

Abbreviations

Elements and Compounds

Ag	Silver
Al	Aluminum
As	Arsenic
Ba	Barium
Ca	Calcium
Cd	Cadmium
Ce	Cerium
Cl^-	Chloride
CN	Cyanide
Co	Cobalt
Cr	Chromium
Cs	Cesium
Cu	Copper
F^-	Fluoride
Fe	Iron
^3H	Tritium
Hg	Mercury
I	Iodine
Kr	Krypton
Mg	Magnesium
Mn	Manganese
Nb	Niobium
Np	Neptunium
$NH_3(N)$	Ammonia Nitrogen
$NO_3(N)$	Nitrate Nitrogen
NO_3^-	Nitrate
Ni	Nickel
Pb	Lead
Pu	Plutonium
Rn	Radon
Ru	Ruthenium
Sb	Antimony
Se	Selenium
SO_4^-	Sulfate
Sr	Strontium
Tc	Technetium
Th	Thorium
U	Uranium
Xe	Xenon
Zn	Zinc
Zr	Zirconium

Radiation Units

Bq	Becquerel
C/kg	Coulombs per kilogram
Ci	Curie
R	Roentgen
rem	Roentgen Equivalent Man
Sv	Sievert

Other

A.L.	Allowable limit
BOD	Biological Oxygen Demand
CG	Concentration Guide
COD	Chemical Oxygen Demand
cm	Centimeter
CRM	Clinch River Mile
d	Day
g	Gram
h	Hour
L	Liter
m	Meter
m^3	Cubic Meter
MGD	Million gallons per day
min	Minute
MPI	Maximum permissible intake
pH	Hydrogen ion concentration
ppm	Parts per million
s	Second
STD	Standard
TOC	Total Organic Carbon
T.D.S.	Total Dissolved Solids
yr	Year

APPENDIX C

ENVIRONMENTAL MONITORING AND SURVEILLANCE OF THE OAK RIDGE COMMUNITY

ANNUAL REPORT FOR 1983

Oak Ridge Associated Universities

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Historical Perspective

As a result of long-term wastewater discharges from the Y-12 Plant, East Fork Poplar Creek and its floodplain have become contaminated with materials such as mercury, uranium, thorium, chromium, and zinc, well above normal background levels. In addition, since the full extent of this contamination was not known, particularly by the City administration and the general public, considerable quantities of floodplain soils and creek sediments were used throughout the community, primarily in 1982 as topsoil for portions of the new Oak Ridge sewer system. While the bulk of the mercury discharges were before 1960 and before the mid-1970's for uranium, thorium, chromium, and zinc, other pollutants have also been discharged in smaller amounts throughout the Plant's operation and have also accumulated in sediments and soils to a lesser extent.

In addition to this contamination of soils and sediments, East Fork Poplar Creek fish have been found to exceed the Food and Drug Administration's action level for mercury. The State Department of Health and Environment has posted the streams, warning against fishing and swimming.

Current Activities

Potential public health concerns are being addressed by various means. On July 11, 1983, the Subcommittee on Energy, Research and Production and the Subcommittee on Investigations and Oversight convened in Oak Ridge for a hearing regarding the earlier mercury losses. The hearing report found that, although the discharged mercury is present in significant concentrations in several environmental media in the Oak Ridge area, mercury contamination does not present an immediate danger to the public health.

In 1983, two activities were initiated to better define the potential problem with this residual contamination. The first was a sampling program in the community to respond to citizens' requests to determine if their soil, vegetables, or well water were contaminated. At the same time, this effort was directed toward defining the extent of contamination in the community, particularly along the sewer beltway. Oak Ridge Associated Universities, ORAU, is implementing this program, and the results of which are summarized in the next section of this appendix.

The second activity initiated in 1983 is the interagency Oak Ridge Task Force, ORTF. This group includes representatives from DOE, the U.S. Environmental Protection Agency, TVA, the U.S. Geological Survey, and the City of Oak Ridge. It is chaired by a representative of the Tennessee Department of Health and Environment. The ORTF is collecting toxicological and environmental data with which to evaluate the potential long-term public health impact of the residual contamination and the cost versus benefit of remedial measures. While the task force field work, with the exception of the ORAU effort just described, did not begin until early 1984, 19 sediment and floodplain samples were taken and analyzed for over 150 chemicals and radionuclides. These preliminary data provide information needed to help scope the task force study.

Oak Ridge Program

ORAU collected 1432 samples which can be divided into three general categories:

1. East Fork Poplar Creek floodplain: creek sediments, vegetation, and water sampling.

2. Oak Ridge Community
   a) Private residence soil, vegetation, and well water sampling.

   b) Soil sampling on the sewer beltway.

3. Government Lands

East Fork Poplar Creek

The sampling effort in the East Fork Poplar Creek (Table 1) consisted of grab samples at locations assigned by DOE. The assigned locations were behind Dean Stallings Ford, behind Greens Honda, behind the YWCA, the creek area of Greenview Estates, and the confluence with Poplar Creek on the DOE reservation. Sixteen soil samples were collected from the stream bank and floodplain. From the total soil samples collected, twelve showed mercury concentrations greater than the State soil mercury guideline of 12 ppm. The six stream water samples resulted in all but one exceeding the maximum of the normal range, and all four of the stream sediment samples exceeded the mean normal concentration by at least one order of magnitude.

Due to the small sample size in this area, any conclusions or observed trends from this data set should be considered tenuous. However, additional measurements of the creek sediments and creek water have been made by Oak Ridge National Laboratory and TVA which will appear in other reports.

Oak Ridge Community

Oak Hills Area (Table 2) - All samples were collected from private residence garden areas, and the vegetable samples were collected at the same time and in the same place as the soil samples. The vegetable samples were lettuce and carrots.

Country Club Area (Table 2) - Sampling in this area consists of private residence gardens and properties on the edge of the East Fork Poplar Creek floodplain. The vegetable samples were paired with soil samples and consisted of green beans, tomatoes, lettuce, chard, and corn. The water samples were collected from private springs and wells.

Only soil samples collected at the edge of the East Fork Poplar Creek floodplain exceeded the State guideline levels.

Linden School Area (Table 2) - All of the samples collected in this area were from private residences. The vegetation samples were paired with soil samples and consisted of yellow squash, green cucumber, green tomatoes, green pepper, mint, okra, beets, green beans, and chard. The water sample was collected from a seep near a private home.

Five soil samples showed elevated mercury levels (>12 ppm) and were collected from two private residences believed to have brought in soils and sediments from East Fork Poplar Creek. A mint

sample with a concentration of 160 ppb was the only vegetable sample collected in this area which showed a mercury concentration greater than the normal range. The sampled mint plant grew in soil with a mercury concentration of 29 ppm.

Wiltshire Estates Area (Table 2) - Sampling in this area consisted of private residences, Big Turtle Park, and the sewage treatment plant. Vegetable samples from the private residences were squash, onion, green beans, tomatoes, corn, walnuts, watermelon, and pears.

Eleven soil samples collected from two different residences showed mercury concentrations greater than the State guideline level of 12 ppm. In both cases, the contaminated areas were either next to or in the East Fork Poplar Creek floodplain. One corn sample with a concentration of 310 ppb exceeded the upper limit of the normal mercury range in vegetation. This corn was grown on the floodplain perimeter. The mercury concentrations in horse hair and horse feces were .012 ppm and .03 ppm respectively.

A sludge sample from the sewage treatment plant behind Big Turtle Park showed mercury concentrations of 15 ppm and 22 ppm.

Robertsville Junior High Area (Table 2) - Soil samples only were collected in this area. Of the 280 total samples collected, 277 were samples taken from the Robertsville Junior High School athletic fields. The remaining samples were taken from a storage area for dredged stream sediments and an old garden plot next to East Fork Poplar Creek behind the YWCA.

A total of 108 samples showed mercury levels above the State guidelines. One hundred and four of the total contaminated samples came from the Robertsville Junior High School athletic field. Historically, this field has been inundated by East Fork Poplar Creek several times. The four samples collected at the storage area for dredged sediments were contaminated.

Scarboro Area (Table 2) - Sampling in this area consisted of the stream bank and floodplain of Scarboro Creek and private residences. Soil, vegetation, sediment, and water samples were collected in this area. The vegetable samples were cucumbers, onions, tomatoes, beets, yellow squash, and green peppers. All samples collected in this area showed mercury levels within the natural ranges and below State guideline levels.

High School Area (Table 2) - All samples collected in this area were from private residences except for the water samples collected from the City pool. The vegetable samples collected were green beans and tomatoes. At the time the water samples were collected, the minimum detectable concentration for our procedure was .1 ppb. This has since improved by one order of magnitude.

All samples from this area were within the natural ranges and below the State soil guideline levels.

Woodland Area (Table 2) - Of the 672 soil samples collected in this area, 666 were collected on the new sewer line right-of-way near the Civic Center and Municipal Building. The remaining samples were collected on Union Valley Road and in an industrial area at the intersection of Midway and Mitchell Roads. No private residences were sampled in this area. One water sample and one sediment sample were collected from a small creek draining the industrial area. Six sediment samples were collected from the creek passing between the Civic Center and Municipal Building and in close proximity to the sewer line right-of-way.

Two hundred and forty-three samples exceeded the State guideline level of 12 ppm. All of the contaminated samples were collected from the sewer beltway near the Civic Center. Water values were within the normal ranges. Four of the sediment values exceeded the natural mean level. The highest sediment sample exceeded the mean value by four times.

Elm Grove Area (Table 2) - Five soil samples were taken from a single residence. No samples from this area exceeded the State guideline levels.

East Village Area (Table 2) - All samples collected in this area were from a land parcel at the intersection of the Oak Ridge Turnpike and Athens Road. This land is under consideration for public housing. No samples collected exceeded the State guideline level.

Fairbanks Road Area (Table 2) - The new sewer right-of-way and private residences were sampled in this area. The most intense soil sampling took place on the sewer right-of-way in front of Jefferson Junior High School. Sediment samples were collected from a small drainage ditch where it first passes between two private homes. This drainage ditch carries runoff from the sewer line right-of-way in front of Jefferson Junior High School. Vegetable samples collected in this area were broccoli, spinach, carrots, zucchini squash, and tomatoes.

From a total of 62 soil samples collected in this area, 37 showed levels exceeding the State guideline levels. The sewer right-of-way in front of Jefferson Junior High School accounted for 35 of the contaminated samples. One of the remaining contaminated samples was collected on Warehouse Road near the intersection with Fairbanks Road. The remaining contaminated sample was collected from the bank of the drainage ditch previously described in this section.

Both sediment values are above the mean natural concentration. The maximum sediment value exceeds the natural mean concentration by almost 400 times. The elevated mercury levels are a reflection of the runoff from the sewer right-of-way in front of Jefferson Junior High School.

All the vegetable samples showed mercury concentrations within the normal range.

In addition to the previously mentioned samples, a sample from the old sewage plant on Cairo Road was collected and showed a mercury concentration of 13 ppm.

Government Land

The sampling effort in this area consisted of grab samples and are summarized in Table 2. The soil samples collected were to be used for baseline comparison; therefore, sites were selected that were unlikely to be contaminated with mercury. The soil sample sites selected were Black Oak Ridge, Freels Bend, Raccoon Creek, and Gallaher Quarry. Sediment and water samples from Gallaher Quarry were collected to be used as baseline values also. In addition, wells from Freels Bend, Bethel Valley Road, and Chestnut Ridge were also sampled.

All samples collected in this area were within the natural range and below State guideline levels.

Multi-parameter Analysis

Because of concerns that other contaminants besides mercury were released from the Y-12 plant, multi-parameter analyses were begun. These additional analyses included uranium, barium, lead arsenic, chromium, thorium, silver, selenium, beryllium, polychlorinated biphenyls, and methylmercury. In addition, soil gross alpha, gross beta, and radionuclide measurements were made.

Robertsville Junior High School (Table 3) - It was assumed that Y-12 through East Fork Poplar Creek was the sole source for mercury and other contamination. Therefore, it was believed that elevated soil mercury levels would be a reasonable indicator or the presence of the other contam-

inants. Thirteen samples with mercury concentrations equal to or greater than 10 ppm were selected for multi-parameter analysis. One sample with a mercury concentration of less than 1 ppm was also chosen as a control.

Civic Center (Table 4) - The logic used to select soil samples for multi-element analysis was the same as that used for Robertsville Junior High except the soil samples selected were 100 ppm or greater.

Sewage Sludge (Table 5) - The City of Oak Ridge expressed concern that the Y-12 releases contaminated their sewage treatment plants. This concern initiated multi-element analysis of the Oak Ridge sewage sludge. In order to relate the results to surrounding communities, sludge samples from Lenoir City and Knoxville were collected and analyzed.

Table 1
SUMMARY OF THE EAST FORK POPLAR CREEK SAMPLING EFFORT

Water Concentration Range (ppb)	NAS* Normal Range for Water (ppb)	Sediment Concentration Range (ppm)	NAS* Normal Concentration Range for Sediments (ppm)	Vegetation Concentration Range (ppb)	NAS* Normal Range for Vegetation (ppb)	Floodplain & Streambank Soils Concentration Range (ppm)	State Guidelines for Public Access Soils (ppm)
[9]		[4]		[7]		[16]	
<0.05-1.4	.02-.06	13-18	.01-1200 mean = .3	<2-24	1-123	2.3-440	12

*NAS - National Academy of Sciences. 1978. An Assessment of Mercury in the Environment. Printing Office, National Academy of Sciences, Washington, DC 20418

[ ] - Sample Size

Table 2
SUMMARY OF THE MERCURY SAMPLING EFFORT IN THE OAK RIDGE COMMUNITY

Area	Water Concentration Range (ppb)	*NAS Normal Range for Water (ppb)	Sediment Concentration Range (ppm)	*NAS Normal Range for Sediments (ppm)	Vegetables Concentration Range (ppb)	*NAS Normal Range for Vegetables (ppb)	**Soils Concentration Range (ppm)
Oak Hills	—	—	—	—	[2] 20-50	1-123	[4] .04-.25
Country Club	[7] .02-.06	.02-.06	[6] .03-45	.01-1200 mean = .3	[13] <.002-30	1-123	[26] <.01-76
Linden School	[1] <.05	.02-.06	—	—	[14] .007-160	1-123	[30] <.01-150
Wiltshire Estates	—	—	—	—	[17] <.02-310	1-123	[33] .05-65
Robertsville Jr. Hi.	—	—	—	—	—	—	[288] .02-346
Scarboro	[7] <.05	.02-.06	[6] <.05-.08	.01-1200 mean = .3	[13] .7-22	1-123	[44] <.05-10
High School	[3] <.1	.02-.06	—	—	[5] 3-30	1-123	[6] .02-.12
Woodland	[1] .04	.02-.06	[7] .07-1.2	.01-1200 mean = .3	—	—	[672] .05-450

Table 2 (Continued)
SUMMARY OF THE MERCURY SAMPLING EFFORT IN THE OAK RIDGE COMMUNITY

Area	Water Concentration Range (ppb)	*NAS Normal Range for Water (ppb)	Sediment Concentration Range (ppm)	*NAS Normal Range for Sediments (ppm)	Vegetables Concentration Range (ppb)	*NAS Normal Range for Vegetables (ppb)	**Soils Concentration Range (ppm)
Elm Grove	—	—	—	—	—	—	[5] .18-2.5
East Village	—	—	—	—	—	—	[16] .04-.67
Fairbanks Road	—	—	[2] 24-116	.01-1200 mean = .3	[6] 3-20	1-123	[62] .05-436
Government Lands	[5] .02-.07	.02-.06	[1] .02	.01-1200 mean = .3	—	—	[9] .004-.2

*NAS - National Academy of Sciences. 1978. An Assessment of Mercury in the Environment. Printing Office, National Academy of Sciences, Washington, DC 20418

[ ] - Sample Size

** - State guideline for mercury in soils is 12 ppm.

Table 3
SUMMARY OF MULTI-PARAMETER ANALYSIS FOR ROBERTSVILLE JUNIOR HIGH SCHOOL (ppm)

Sample #	Hg	U	Ba	Pb	As	Cr	Th	PCB's	Methyl-mercury
83-0375	17	12	—	68	14	340	—	.2	< .1
83-0379	22	11	—	110	17	320	—	.8	< .1
83-0380	.09	8.1	430	720	27	65	12	—	< .1
83-0395	10	8.3	—	100	17	340	—	.2	< .1
83-0398	24	12	—	91	8	370	—	.2	< .1
83-0400	18	17	400	140	6	53	10	.2	< .1
83-0401	31	18	—	220	37	370	—	.3	< .1
83-0402	26	30	370	1300	8	48	12	.4	< .1
83-0403	20	20	300	93	6	58	12	.3	< .1
83-0432	26	23	460	83	7	62	10	.1	< .1
83-0434	26	16	—	170	31	320	—	< .1	< .1
83-0455	22	6	—	31	8	350	—	.1	< .1
83-0457	67	14	350	180	5	55	—	.3	< .1
83-0526	26	8	400	160	8	350	—	.1	< .1

Table 4
CIVIC CENTER SOILS
CONCENTRATIONS IN PPM

Log. No.	Grossα *pCi/g*	Grossβ *pCi/g*	Hg	U	Th	Ba	Cr	As	Se	Cd	Ag	Pb	Be
83-0733	12.2	36	285 ± 17	45 ± 3	24 ± 2	400 ± 60	85 ± 10	4.9 ± 0.4	< 3	11	< 3	85	1.8
83-0734	10.1	35	400 ± 25	43 ± 3	25 ± 2	420 ± 70	70 ± 10	9.6 ± 0.7	< 3	13	< 3	75	1.9
83-0735	7.7	33	270 ± 16	30 ± 2	18 ± 1	380 ± 70	70 ± 10	8.3 ± 0.6	< 3	11	< 3	85	1.7
83-0736	6.3	23	125 ± 8	17 ± 1	16 ± 1	300 ± 70	54 ± 8	8.3 ± 0.6	< 3	7.8	< 3	60	1.6
83-0737	9.7	3.2	330 ± 20	38 ± 2	20 ± 1	550 ± 80	62 ± 5	9.0 ± 0.6	< 3	11	< 3	75	4.5
83-0738	6.5	24	190 ± 12	25 ± 2	18 ± 1	320 ± 70	50 ± 9	7.8 ± 0.5	< 3	8.1	< 3	50	1.5
83-0739	5.4	23	170 ± 10	18 ± 1	16 ± 1	225 ± 50	55 ± 8	7.2 ± 0.5	< 3	7.4	< 3	50	1.5
83-0740	6.4	30	210 ± 12	25 ± 2	16 ± 1	320 ± 60	63 ± 8	8.0 ± 0.6	< 3	7.8	< 3	50	1.5
83-0764	4.8	26	120 ± 7	15 ± 1	17 ± 1	340 ± 60	67 ± 9	8.2 ± 0.5	< 3	7.5	< 3	45	3.0
83-0766	5.6	23	235 ± 15	24 ± 2	19 ± 1	340 ± 60	78 ± 9	7.8 ± 0.6	< 3	9.3	< 3	70	1.6
83-0767	5.7	20	97 ± 6	15 ± 1	14 ± 1	330 ± 40	62 ± 8	6.8 ± 0.5	< 3	7.2	< 3	45	1.5
83-0768	6.1	20	125 ± 7	17 ± 1	15 ± 1	320 ± 60	50 ± 6	7.0 ± 0.5	< 3	7.1	< 3	50	1.4
83-0776	7.4	36	350 ± 20	30 ± 2	22 ± 1	440 ± 50	80 ± 5	9.9 ± 0.6	< 3	< 6	9.3 ± 1.7	80	—
83-0796	6.6	34	270 ± 16	23 ± 1	19 ± 1	400 ± 50	80 ± 6	7.8 ± 0.5	< 3	< 6	< 3	54	—
83-0815	8.5	43	440 ± 30	37 ± 2	22 ± 1	440 ± 50	87 ± 6	8.8 ± 0.6	< 3	< 6	11 ± 1	87	—
83-0822	12	40	510 ± 30	42 ± 3	25 ± 1	570 ± 50	84 ± 6	9.2 ± 0.6	< 3	< 6	12 ± 2	90	—
83-0823	8.5	44	420 ± 25	38 ± 2	23 ± 1	530 ± 60	89 ± 6	9.2 ± 0.6	< 3	< 7	10 ± 2	90	—
83-0837	12	34	380 ± 22	38 ± 2	22 ± 1	490 ± 50	86 ± 6	8.2 ± 0.5	< 3	< 6	8.5 ± 1.4	75	—
83-0838	12	36	410 ± 25	43 ± 3	23 ± 1	500 ± 50	92 ± 6	9.5 ± 0.6	< 3	< 6	12 ± 2	87	—
83-0839	12	43	390 ± 23	39 ± 2	21 ± 1	500 ± 50	84 ± 5	7.9 ± 0.5	< 3	< 6	15 ± 2	72	—
83-0840	13	46	450 ± 27	44 ± 3	24 ± 1	590 ± 60	92 ± 6	9.6 ± 0.6	< 3	< 6	11 ± 2	80	—

Table 4 (Continued)
CIVIC CENTER SOILS
CONCENTRATIONS IN PPM

Log. No.	Grossα *pCi/g*	Grossβ *pCi/g*	Hg	U	Th	Ba	Cr	As	Se	Cd	Ag	Pb	Be
83-0841	11	45	480 ± 28	46 ± 3	23 ± 1	500 ± 50	92 ± 6	9.3 ± 0.6	< 2	< 7	8.8 ± 1.5	87	-
83-0842	8.7	41	390 ± 24	36 ± 2	21 ± 1	520 ± 50	83 ± 6	8.9 ± 0.6	< 3	< 7	7.4 ± 1.8	80	-
83-0845	9.2	35	330 ± 20	27 ± 2	21 ± 1	380 ± 60	80 ± 6	8.9 ± 0.6	< 3	< 9	10 ± 2	80	-
83-0978	11	43	420 ± 25	42 ± 3	23 ± 1	440 ± 60	79 ± 6	9.0 ± 0.6	< 3	< 7	6.7 ± 1.8	92	-
83-0981	12	37	300 ± 18	38 ± 2	23 ± 1	560 ± 60	94 ± 6	9.6 ± 0.6	< 2	< 7	10 ± 2	75	-
83-0983	6.4	27	150 ± 10	15 ± 1	15 ± 1	330 ± 50	62 ± 4	6.7 ± 0.5	< 2	< 6	< 2	50	-
83-0984	6.1	27	150 ± 10	15 ± 1	15 ± 1	375 ± 50	78 ± 5	7.5 ± 0.5	< 2	< 7	4.4 ± 1.4	50	-
83-0985	7.7	30	180 ± 11	20 ± 1	16 ± 1	270 ± 50	69 ± 5	8.0 ± 0.5	< 2	< 7	< 2	70	-
83-0986	4.4	25	100 ± 7	12 ± 1	16 ± 1	400 ± 40	66 ± 5	8.8 ± 0.6	< 3	< 8	< 3	45	-
83-0989	9.7	31	230 ± 13	21 ± 1	17 ± 1	460 ± 40	70 ± 5	8.2 ± 0.6	< 2	< 8	5.5 ± 1.3	50	-
83-0997	9.7	37	260 ± 15	33 ± 2	21 ± 1	520 ± 50	89 ± 6	9.0 ± 0.6	< 2	< 6	11 ± 1	65	-
83-0998	12	44	240 ± 15	31 ± 2	22 ± 1	540 ± 50	93 ± 6	9.2 ± 0.6	< 2	< 8	6.2 ± 1.3	65	-
83-1000	7.2	31	180 ± 10	20 ± 1	17 ± 1	430 ± 50	66 ± 4	7.4 ± 0.5	< 2	< 6	4.8 ± 1.2	63	-
Back-ground Soils	1.6	7.7	<.05	4.5 ± 0.4	6.5 ± 0.4	200 ± 30	30 ± 5	5.0 ± 0.4	< 3	< 6	< 3	30	-

Table 5

	Oak Ridge			Outside Oak Ridge	
	Sewage Treatment Plant	Old Sewage Treatment Plant West End	Cairo Rd Old Sewage Treatment Plant	Lenoir City Sewage Treatment Plant	Knoxville Kuwahee Sewage Treatment Plant
Log No.	83-0295	83-0296	83-0299	83-0297	83-0298
Na	3900	750	610	1030	2900
Mg(%)	< 1	1.5	< 1	1.4	1.8
Al(%)	3.4	2.8	3.2	2.7	3.8
K	7250	6500	4700	4300	8300
Ca(%)	4.0	5.2	2.7	4.9	7.3
Ti	4000	3300	3100	4200	3000
Cr	530	350	280	660	360
Mn	980	250	225	384	750
Fe(%)	2.0	2.1	2.3	2.9	1.9
Ni	300	100	1100	75	125
Cu	2200	650	1000	780	1300
Zn	2400	1000	3100	2600	1100
Ga	6	4.9		7.3	
As	4		5	6.8	6
Br	32	6	18	20	60
Sr	140	100	140	90	110
Zr	190	180	570	170	160
Ag	< 30	36	400	< 30	< 30
Sb	5	3	6	120	5
Ba	1300	370	3200	550	615
La	18	15	12	2.4	20
W	4	4	—	—	—
Au	1.1	0.7	1.5	0.8	0.4
Hg	15	22	13	6.6	1.8
Pb	— 70	160	220	520	150
Bi	—	—	~ 40	—	—
U	55	30	7	< 1	< 2
Th	< 3	< 3	< 2	< 3	< 5

NOTES: All concentrations are in PPM's unless otherwise noted.

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