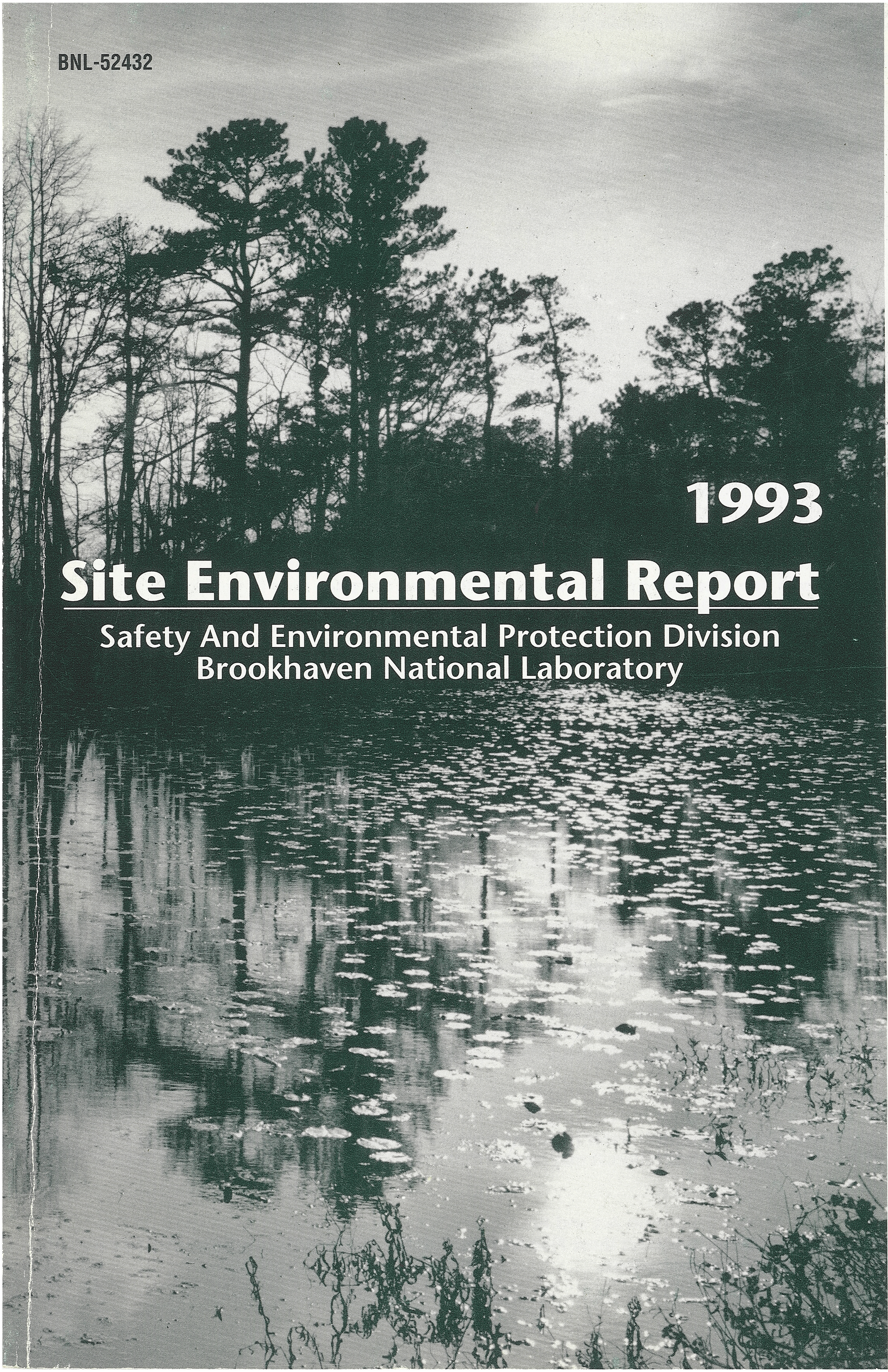
BNL-52432



1993
Site Environmental Report

Safety And Environmental Protection Division
Brookhaven National Laboratory

The Pine Barrens of Long Island

Some 60,000 years ago on Long Island, a glacial advance created a central chain of hills known today as the Ronkonkoma Moraine. When the ice retreated about 15,000 years ago, great deltas of sand and gravel washed down from the moraine and thus prepared the environment for the Pine Barrens that exist here now.

The low arctic tundra vegetation which followed the retreat of the glacier was soon replaced by boreal forests of jack pine (Pinus banksiana) and spruce (picea). As the climate continued to warm, oaks became dominant, reaching their peak 5,000 years ago. The jack pine diminished rapidly when the pitch pine (Pinus rigida), which predominates today, entered about 8,000 years ago.

Pine Barrens occur in only some twenty areas of the world, nearly all of them in the northeastern United States. Pine Barrens are a biota of unusual plants and animals, many of which occur rarely elsewhere. They survive in a harsh, desert-like environment, dominated by and dependent upon periodic wildfires to perpetuate their species.

Two major natural forces created the Pine Barrens and now maintain this region. The first is the soils on the Pine Barrens, which, in comparison with most deciduous forest soils, are very low or lacking in most necessary plant nutrients, very coarse or porous and therefore well-drained or poor at holding rain water, and very harsh or acid. These soils developed on loose sandy and gravelly layers of sediment which were deposited by two advances of glacial ice approximately 60,000 and 23,000 years ago respectively. Colonists, who tried to farm these porous, nutrient deficient soils, coined the contemptuous epithet "piney barrens" when their crops failed. The second major natural force shaping the Pine Barrens was fire. Periodic natural wildfires are the "lifeblood" of the Long Island Pine barrens. The right conditions for these fires - dry soil, ground layer of tinder (fallen leaves and twigs), and the acid nature of soil that prevents decomposition - results in fires that are hot and burn very rapidly. The Pine Barrens plants having adapted to fires are capable of surviving such fires and retain their dominance.

On Long Island, Pine Barrens originally covered some 250,000 acres. Today due mostly to the postwar housing and development boom, only about 80,000 acres and a few additional scattered parcels remain in a reasonably natural condition. Of this, only about 30% is presently protected by federal, state, or county ownership.

Pine Barrens, especially in New Jersey and on Long Island, form the protective cover and natural recharge system for vast reservoirs of pure fresh water lying just beneath the surface. Ideally, all Pine Barrens are rare and valuable enough for preservation. It may be well that the critical need for pure water will decide their fate.

The Long Island Pine Barrens Protection Act and Brookhaven National Laboratory's environmental protection programs are designed to protect these Pine Barrens and thereby assure that pristine groundwater is made available for future generations.

BNL-52432
FORMAL REPORT

BROOKHAVEN NATIONAL LABORATORY

SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1993

J.R. Naidu and B.A. Royce, Editors

May 1994

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

BROOKHAVEN NATIONAL LABORATORY, ASSOCIATED UNIVERSITIES, INC.
UPTON, NEW YORK 11973-5000

UNDER CONTRACT NO. DE-AC02-76CH00016 WITH THE
UNITED STATES DEPARTMENT OF ENERGY

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes:
Printed Copy: A12; Microfiche Copy: A01

Preface

The U. S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program", establishes the requirement for environmental protection programs. These programs ensure that DOE operations comply with applicable federal, state, and local environmental laws and regulations, executive orders, and department policies. Brookhaven National Laboratory (BNL) has established a plan for implementing this Order, Environmental Protection Implementation Plan, (EPIP); this plan is updated annually.

The BNL Site Environmental Report (SER) is prepared annually pursuant to DOE Order 5400.1 to summarize environmental data, characterize the BNL Site, demonstrate compliance status, provide an assessment of the impact of BNL's operations on the Environment, and document the efforts made by BNL Management to mitigate environmental impacts. More detailed environmental compliance, monitoring, surveillance, and study reports may be of value; therefore, to the extent practical, these additional reports have been referenced in the text.

This report is prepared for DOE by the Safety and Environmental Protection Division (SEPD) at BNL. The document is the responsibility of the Environmental Protection Section (EPS) of the SEPD. Within this Section, the Environmental Monitoring Group (EMG) is responsible for preparing the sampling plan, collecting environmental and facility samples, interpretation of the results, performing impact analysis of the emissions from BNL, and compiling this information presented here. In this effort, other groups of the Section: Compliance, Analytical, Ground Water, and Quality Assurance played key roles in addressing the regulatory aspects, the analysis of samples and documentation of data.

Although this report is written to meet DOE requirements and guidelines, it is also intended to meet the needs of the public. The Executive Summary has been written with a minimum of technical information. In addition, the Appendices provides a list of acronyms, abbreviations, and other useful information. Also, the accompanying tables in the text represents a summary of corresponding data, whereas the 1993 BNL SER Compendium presents the analytical data in full detail for those who need to review the data <u>in toto</u>.

Inquiries regarding this report may be directed to the Public Affairs Office, BNL, Upton, New York 11973 (516 282-2345).

Abstract

This report documents the results of the Environmental Monitoring Program at BNL and presents summary information about environmental compliance for 1993. To evaluate the effect of BNL operations on the local environment, measurements of direct radiation, and a variety of radionuclides and chemical compounds in ambient air, soil, sewage effluent, surface water, ground water and vegetation were made at the BNL site and at sites adjacent to the Laboratory.

Brookhaven National Laboratory's compliance with all applicable guides, standards, and limits for radiological and nonradiological emissions to the environment were evaluated. Among the permitted facilities, two instances, of pH exceedances were observed at recharge basins, possible related to rain-water run-off to these recharge basins. Also, the discharge from the Sewage Treatment Plant (STP) to the Peconic River exceeded on five occasions, three for residual chlorine and one each for iron and ammonia nitrogen. The chlorine exceedance were related to a malfunctioning hypochlorite dosing pump and ceased when the pump was repaired. While the iron and ammonia-nitrogen could be the result of disturbances to the sand filter beds during maintenance.

The environmental monitoring data has identified site-specific contamination of ground water and soil. These areas are subject to Remedial Investigation/Feasibility Studies (RI/FS) under the Inter Agency Agreement (IAG). Except for the above, the environmental monitoring data has continued to demonstrate that compliance was achieved with applicable environmental laws and regulations governing emission and discharge of materials to the environment, and that the environmental impacts at BNL are minimal and pose no threat to the public or to the environment.

This report meets the requirements of DOE Orders 5484.1, Environmental Protection, Safety, and Health Protection Information reporting requirements and 5400.1, General Environmental Protection Programs.

Acknowledgement

There are many individuals who assisted in the collection of data, and preparation of this report. The editors express their gratitude to all these individuals. However, the following individual efforts require special acknowledgement.

Monitoring and surveillance data were obtained through the combined efforts of the EMG, and the Analytical Groups, (Radiological and Nonradiological). Special recognition is reserved for the dedication and professionalism of the Environmental Monitoring Staff: R. Lagattolla, L. Lettieri, and M. Bero; the Analytical Laboratory Staff: R. Gaschott, M. Heine, A. Meier, C. Decker, P. Hayde, and M. Surico.

The editors are particularly indebted to R. Miltenberger for this technical review, and further extend their appreciation for the authors of the main sections of this report, which has included review of data, preparation of text, and in some cases, even participating in the collection of data. These individuals are:

Environmental Protection Section

S. Briggs	Quality Assurance
S. Chalasani	Nonradiological Analysis and Data
R. Lee	Compliance - Surface Water and Potable Water
D. Paquette	Ground Water Management
R. Pietrzak	Radiological Analyses and Data
G. Schroeder	Radiological Data Assay, National Emission Standards for Hazardous Air Pollutants (NESHAPs), and Radiological Surveys
T. Sperry	Compliance - National Environmental Policy Act (NEPA)
J. Williams	Compliance - Air
H. Bowen	Data Base and Data Reports
K. Cammarata	Data Base and Data Reports

Other SEPD Contributors:

M. Clancy	Hazardous Waste
G. Goode	Waste Minimization and Pollution Awareness Plans
R. Thompson	Thermo Luminescent Dosimeter (TLD) Assays

Contributors from other Departments:

A. Raphael and Staff, Office of Environmental Restoration (OER), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities

Finally, the Editors would like to extend a special thanks to B. Cox for her infinite patience and quality of work in typing, reviewing, and finalizing this report.

TABLE OF CONTENTS

FIGURES

TABLES

Executive Summary

The Environmental Monitoring (EM) Program is conducted by the EPS of the SEPD to determine whether operation of BNL facilities have met the applicable environmental standards and effluent control requirements and assess impact of BNL operations on the environment. This program includes monitoring for both radiological and nonradiological parameters. This report summarizes the data for external radiation levels; radioactivity in air, rain, potable water, surface water, ground water, soil, vegetation, fauna, and aquatic biota; water quality, metals, organic compounds in ground water, surface water, and potable water.

Analytical results are reviewed by the SEPD staff and when required by permit conditions are transmitted to the appropriate regulatory agencies through DOE. The data were evaluated using the appropriate environmental regulatory criteria. Data summaries for Calendar Year (CY) 1993 are presented in the text. Detailed information on analytical results, both radiological and nonradiological, are given in the 1993 BNL SER Compendium.

Airborne Effluents

Most of the airborne radioactive effluents at BNL originate from the High Flux Beam Reactor (HFBR), Brookhaven Linac Isotope Production (BLIP) Facility, and the Medical Research Reactor (MRR). Argon-41, oxygen-15, and tritium were the predominant radionuclides. In 1993, 2,080 Ci (76.9 TBq) of argon-41 were released from the MRR stack; a combined total of 668 Ci (24.7 TBq) of oxygen-15 were released from BLIP, and the Alternating Gradient Synchrotron (AGS) Booster which became operational in 1992; and 68 Ci (2.51 TBq) of tritium in the form of water vapor was released from the HFBR stack. Much smaller quantities of airborne radioactive effluents were released from the Chemistry Building, Bldg. 801 Hot Laboratory, and the Hazardous Waste Management Facility (HWMF).

Liquid Effluents

Liquid discharge limits for radiological and nonradiological parameters are subject to conditions listed in the BNL State Pollutant Discharge Elimination System (SPDES) Permit No. NY-0005835 as issued by the New York State Department of Environmental Conservation (NYSDEC). Radiological release concentrations for gross beta, radium, and Sr-90 are also prescribed by the SPDES permit limitations. Other radionuclide discharge concentrations are governed by the U.S. DOE specified Derived Concentration Guides (DCGs).[1] Since such liquid discharges have the potential of contaminating the "Sole Source Aquifer"[2] underlying the Laboratory site, administrative controls are in place to maintain all liquid discharges at or below concentrations prescribed by the Safe Drinking Water Act (SDWA)[3].

Operations at the STP were within (100%) the limits specified by the SPDES permit. Gross beta and Cs-137 concentrations in chlorine house effluent remained higher than concentrations found in the influent by a factor of 1.4. This condition is the result of continued low-level leaching of material adsorbed on the sand filter beds as a result of a 1988 unplanned release of Cs-137 and Sr-90 to the sanitary system. In 1993, discharges to the Peconic River met all radioactive discharge limits of the SPDES program. The principle radionuclides released to the Peconic River from liquid effluents discharged from the STP were: 3.51 Ci (130.2 GBq) of tritium, 1.68 mCi (62.2 MBq) of Cs-137, and 0.055 mCi (2.03 kBa) of Co-60. The annual average Cs-137 concentration was 0.09% of the DCG (1.41% of the SDWA). Releases of Co-60 were 0.001 of the DCG, 0.02 of the SDWA limit. The annual average tritium concentrations at the discharge point to the Peconic River was 17.5% of the DCG and 35.1 of the SDWA limit. This represents a factor of 1.1 increase in the tritium releases to the Peconic River from 1992 values.

Nonradiological parameters are monitored at the effluent of the STP in accordance with the conditions of the SPDES permit. These parameters include residual chlorine, metals, 1,1,1-trichloroethane (TCA), pH, temperature, Biochemical Oxygen Demand (BOD_5), flow, suspended and settleable solids, fecal and total coliform, and ammonia-nitrogen. Although the compliance rate exceeded 99.8%, there were five permit deviations; one each for iron and ammonia nitrogen and three for residual chlorine. The residual chlorine exceedances were attributable to a malfunctioning hypochlorite metering pump. These exceedances ceased with the repair of this pump. The cause of the iron and ammonia exceedances was determined to be the result of an investigation conducted by the Plant Engineering (PE) Division. This investigation consisted of excavating sections of the sand filter beds in order to study the characteristics of ground water (i.e., elevation). The consequence of this activity was the shut down of four of the six filter beds and the hydraulic overloading of the remaining two filters which yielded increased concentrations of iron and ammonia nitrogen.

Liquid effluent discharged to the on-site recharge basins contained only trace quantities of radioactivity that were all small fractions of the applicable guides or standards. If the recharge basin water were to be used as the sole source of drinking water, the resultant dose from direct ingestion at the concentrations detected would be equivalent to a dose of 0.019 mrem (0.00019 mSv) per year. The recharge basins function as conduits to the underlying aquifer system (i.e., ground-water recharge). Consequently the nonradiological water quality parameters used in assessing the discharges were the NYSDEC Ground-water Effluent Standards as promulgated by 6 New York Code of Rules and Regulations (NYCRR) Part 703.6.[4] With the exception of Recharge Basin HO and HS, discharges to the recharge basins met the NYSDEC Effluent Standards. Samples collected from Recharge Basin HO exhibited iron concentrations which exceeded the Standard and ranged from 0.49 mg/L to 1.65 mg/L (approximately 2.8 times the NYSDEC Effluent Standard of 0.6 ppm). This basin receives ground water which is used as non-contact cooling water at the AGS. The concentration of iron within the ground water used by the AGS typically exceeds the NYSDEC effluent standards and are comparable to the concentration exhibited in the discharge to Basin HO. A sample of water collected from Recharge Basin HS in April 1993 exhibited a pH value of 9.3 SU which exceeds the NYSDEC maximum effluent standard of 8.5 SU. This basin receives solely storm water run-off consequently the cause of the elevated pH is not readily apparent. However, the standing water in this basin is permitted to stagnate which may be a contributing factor to this observation.

Brookhaven National Laboratory continued to collect samples from the recharge basins for organic analyses during 1993. The analytical data for these samples showed all organic compounds to be below the NYSDEC Effluent Standard.

External Radiation Monitoring

Thermoluminescent dosimeters were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1993 was 66.2 +/- 7.1 mrem (0.66 +/- 0.07 mSv), while the off-site integrated dose was 63.5 +/- 6.9 mrem (0.64 +/- 0.07 mSv). These values are much lower than ambient exposure rates typically reported for the New York City area by the Environmental Protection Agency (EPA) which predict an annual dose of about 80 mrem (0.80 mSv). [5-8] The difference between the on-site and off-site integrated exposure is attributable to the higher terrestrial component of the natural background on site,[9] not BNL activities.

Atmospheric Radioactivity

Tritium was the radioactive effluent detected most frequently in environmental air samples. The maximum annual average tritium concentration at the site boundary was 5.7 pCi/m^3 (0.21 Bq/m^3). This concentration would result in a committed effective dose equivalent of 0.004 mrem (4E-5 mSv) to the maximally exposed individual residing at the site boundary for the entire year. The Cs-137 was detected only once during 1993 at Station 1601. Cobalt-60 was also detected only once at Station 1201. The Cs-137 may be attributed to atmospheric fallout and the Co-60 may have been identified in these samples due to background fluctuations in the detection equipment.

Soil and Vegetation

Soil and vegetation were collected from on-site locations as part of the Soil and Vegetation Sampling Program, and analyzed for radioactivity, organics, and metals (only in soil).

The results obtained from analysis of soil samples, in general, were consistent with values typically seen in soil samples collected through out Suffolk County for radioactivity assay, except in areas where contamination was known to have occurred from past events. The principal radionuclides seen were tritium, gross beta, and Cs-137. Since the vegetation samples were collected from areas adjacent to the soil sampling locations, the radionuclide content of the vegetation reflected the degree of soil contamination, except for the presence of Be-7 in the vegetation samples. There also seemed to be no preferential tree species that could be treated as an indicator species. These soil and vegetation samples were not analyzed for Sr-90.

The presence of organics in soil also confirmed the relationship to past spills or specific activities that led to the increase in organic contamination, such as, adjacent to the railroad tracks and sanitary systems. Among the metals, Fe was ubiquitous, whereas, Cu, Cr, Pb, Hg, Mn, and Zn varied in concentration levels over the site. This observation is being investigated.

An area adjacent to Bldg. 464, showed the presence of Hg and Polychlorinated Biphenyls (PCB) contamination. This was observed during construction in this area. Remediation of the site consisted of excavating and disposing all soils containing greater than 1 mg/Kg mercury and all soils with PCB concentrations greater than 10 mg/Kg. Disposal of soils containing less than

260 mg/Kg were sent to a Resource Conservation Recovery Act (RCRA) permitted Model City Landfill, while soils greater than 260 mg/Kg are temporarily stored at the BNL permitted hazardous waste storage facility pending disposal at the Bethlehem Apparatus Company Inc., proposed retort facility.

The off-site soil and vegetation sampling program is a cooperative effort between BNL and Suffolk County Department of Health Services (SCDHS). Local farms situated adjacent to BNL were sampled in June 1993. No radionuclides attributable to Laboratory operations were detected in any of these samples.

Terrestrial Ecology

Analysis of fauna samples, collected in the special fauna collection program of 1992, was continued in 1993 for radionuclide content. The results confirmed that the principal radionuclide detected was Cs-137, and was present in concentrations above background in those species collected from the Hazardous Waste Management Area (HWMA), recharge basins, and alongside the Peconic River. As these fauna were not part of the food chain pathway for man, dose assessments were not performed.

Surface Water - Radiological Analyses

Radiological results from samples collected at the former site boundary (Location HM) indicate that the annual average gross beta concentration was 7.99 pCi/L (0.31 Bq/L) or 16.5% of the New York State Drinking Water Standards (NYS DWS); the average Sr-90 concentration was 0.38 pCi/L (0.012 Bq/L) or <1% of the NYS DWS; the average Cs-137 concentration was 1.87 pCi/L (0.07 Bq/L) or 1.34% of the SDWA; and the average tritium concentration was 3027 pCi/L (112 Bq/L) or 15.1% of the NYS DWS. At the current site boundary (Location HQ), the annual average gross beta concentration was 12.26 pCi/L (0.44 Bq/L) or 25% of the NYS DWS and the average tritium concentration was 2546 pCi/L (94 Bq/L) or 12.87% of the NYS DWS. No nuclide specific gamma analyses were performed at this location.

The Carmans River at Yaphank and off-site locations in the Peconic River were sampled in the second and fourth quarters of 1993. In the Carmans River water samples, the average gross beta concentration was 1.35 pCi/L (0.050 Bq/L) and the average Sr-90 concentration was less than 0.1 pCi/L (0.0037 Bq/L). These values represent ambient background. Average gross beta concentrations in the Peconic River were uniform and ranged from 1.35 pCi/L to 2.56 pCi/L (0.050 Bq/L to 0.095 Bq/L) or 5% of the NYS DWS. Tritium concentrations decrease with distance from BNL with the closest off-site sampling point (Location HA) having an average concentration of 512 pCi/L (18.94 Bq/L), while the sample collected at the Riverhead sampling point (Location HR) had an average concentration of -23 pCi/L (-0.85 Bq/L). Nuclide specific analyses indicated that average Sr-90 concentrations were consistent with ambient levels and ranged from 0.18 pCi/L to 0.27 pCi/L (0.007 Bq/L to 0.01 Bq/L). Cesium-137 was detected periodically in downstream water samples. The observations did not follow site release patterns. The average Cs-137 concentrations detected ranged from below detection limits to 0.32 pCi/L (0.012 Bq/L), or 0.13% of the SDWA. Direct ingestion for one year of 2 liters of water per day containing the maximum observed Cs-137, Sr-90, and tritium concentration would result in a committed effective dose equivalent of 0.01 mrem (0.0001 mSv) at all locations.

Surface Water - Nonradiological Analyses

Surface water samples were collected from the Peconic River and from the Carmans River as an off-site control location. These samples were analyzed for water quality parameters (i.e., pH, temperature, conductivity, and dissolved oxygen), anions (i.e., chlorides, sulfates, and nitrates), metals, and Volatile Organic Compounds (VOCs) during CY 1993.

Review of this data indicates all water quality parameters to be consistent with the off-site control location and with historical data. Analytical data for metals showed all parameters to be consistent with historical data and all concentrations, with the exception of iron, to be below the NYS DWS. Iron is prevalent at or above the drinking water standard in all locations due to the high concentration of iron within native soils and ground water. Volatile Organic Compounds (i.e., TCA, Dichloroethane (DCA), and toluene) were detected in samples collected from the surface waters at Location HQ but at concentrations which are less than the BNL SPDES permitted concentrations. There were no other organic compounds detected in the surface water samples collected during CY 1993.

Aquatic Biological Surveillance

Fish samples were collected along the Peconic River at Donahue's Pond, and Forge Pond, at the upstream location of Swan Pond and at a control location along the Carmans River. In CY 1993, only gamma spectroscopy analysis was performed on these samples. Strontium-90 analyses were not performed but are scheduled for 1994, at which time the results will be reported in the SER. For dose assessment purposes the Cs-137 to Sr-90 ratio was calculated from past data from the same area and from endemic fish. These ratios varied with the type of fish and their feeding habits. This was taken into consideration to estimate the Sr-90 component of the fish-ingestion pathway. The Peconic River fish contained net Cs-137 concentrations which ranged from near background levels at Donahue's Pond (22 - 121 pCi/kg-wet [0.833-12.33 Bq/kg-wet]) to 894 pCi/kg-wet (33 Bq/kg-wet) at Donahue's Pond. The corresponding net Sr-90 concentrations, as determined by using the Cs-137: Sr-90 ratio, were 140 to 330 pCi/kg-wet (5.2 to 12.1 Bq/kg-wet) for fishes collected in Donahue's Pond and 130 pCi/kg-wet (4.7 Bq/kg-wet) in fishes collected from Forge Pond. Average concentrations found in control aquatic biota were subtracted from concentrations found in the Peconic River fish samples. Only fish collected at off-site locations were used to calculate the maximum individual and collective doses. Based on these results, the maximum individual dose was estimated to be 0.58 mrem (0.006 mSv) and the collective dose was estimated to be 0.362 person-rem (0.0036 person-Sv). Nonradiological analyses were not performed on these samples. No sediment or aquatic vegetation samples were collected in 1993.

Potable Water Supply

The Laboratory's potable water supply wells are screened from a depth of about 15m to about 26m, in the Upper Glacial aquifer. During 1993, Well Nos. 4, 6, 7, 10, 11, and 12 were used to supply drinking water at BNL; however, due to the shut down of the BNL Water Treatment Plant (WTP) for maintenance reasons, Wells 4, 6, and 7 were only operated during October through December. Water samples collected from these wells were analyzed for radioactivity, metals, organics, and water quality. These results are discussed in the following sections.

Radiological Analyses

Gross alpha, gross beta, and tritium concentrations in samples collected from on-site potable wells were generally at or below the Minimum Detection Limit (MDL). The daily grab sample of potable water collected from a central building on site exhibited the same results. Average tritium concentrations in on-site potable well water were at or below the MDL of 300 pCi/L (11 Bq/L). Strontium-90 concentrations were below the MDL of 0.1 pCi/L (0.004 Bq/L). Beryllium-7 was also detected above MDL levels at an annual average concentration of 1.82 pCi/L (0.067 Bq/L). These concentrations, if consumed for one year at a rate of two liters per day, would correspond to a committed effective dose equivalent to the on-site resident of 0.003 mrem (0.0003 mSv). These doses represent an upper limit to the dose actually received because the concentrations used to derive these doses were obtained from analyzing samples collected at individual well heads, and does not account for mixing that would occur when the water is distributed throughout the site.

Nonradiological Analyses

Metals analyses performed on potable water samples indicate that silver, cadmium, chromium, copper, and mercury were not detected in any sample analyzed. Trace quantities of lead (range <0.002 - 0.0025 mg/L), manganese (range <0.05 - 0.16 mg/L) and zinc (range <0.02 - 0.077 mg/L) were detected in potable well water collected at the well heads. All observed values of lead, manganese, and zinc were below their respective NYS DWS of 0.015 mg/L, 0.3 mg/L, and 5.0 mg/L, respectively. Iron was detected in water collected at the well head from Well Nos. 4, and 6. Water from these wells is treated to remove excess iron at the BNL WTP prior to use in the domestic water distribution system. Sodium was detected in all potable wells in concentrations ranging from 8.7 to 13.4 mg/L.

In order to demonstrate compliance with federal and state Drinking Water Standards for organic compounds, potable water is sampled quarterly and sent to an off-site New York State Department of Health (NYSDOH) certified laboratory for Principal Organic Compound (POC) and Synthetic Organic Compound (SOC) analysis. The POC analysis includes halogenated as well as nonhalogenated organic compounds while the SOC analysis includes chlorinated and non-chlorinated pesticides. The POC analyses indicate that organic compounds were detected in Wells 4, 10, 11, and 12. With the exception of Well 4, all concentrations of POCs were less than the NYSDOH prescribed drinking water standard. The maximum concentration of TCA in Well 4 (11 ppb) exceeded the NYSDOH standard of 5 ppb[10]. As previously discussed, Well 4 is treated at the WTP for the removal of iron. The WTP process includes flocculation and aeration which aids in the removal of iron. The aeration process coincidentally reduces the concentration of TCA in water obtained from Well 4 to below the NYS DWS.

Ground-water Surveillance

Ground-water surveillance data are compared to both DCGs and NYS DWS values in this report. The DCG for a given radionuclide represents the concentration which would yield a committed effective dose equivalent of 100 mrem (1 mSv) if an individual were to consume two liters of the liquid per day for one year. Comparison of data to these concentrations permits evaluation of discharge limit impacts and provides a historic framework to evaluate past practices. Comparison of surveillance well data to Environmental Protection Agency (EPA), NYSDEC, and NYSDOH reference levels provides a mechanism to evaluate the radiological and nonradiological levels of contamination relative to current standards.

Radiological Analyses

In 1993, 205 wells were sampled for radiological analysis. For ease of interpretation of the radiological activity in ground water, the BNL site has been divided into sectors. In the east sector of the site (Meadow Marsh-Upland Recharge Area; Peconic River on site including STP sand filter bed area and the Peconic River off-site), radionuclide concentrations in ground-water wells were at or below background levels except for tritium and Sr-90 being at 14% and 6% of the NYS DWS concentration limit,[11] respectively.

Along the north, northwest, west, south boundary of the site, and the Supply and Materiel areas, the only activity above background or significantly in excess of the system MDL were detected: Sr-90 in Well 18-01, a north boundary well, gross beta in Well 122-02, a south boundary well.

In the center of the site, radionuclides detected in ground-water samples that were attributable to BNL operations were found in the vicinity of AGS, Building 811, Building 830, Major Petroleum Facility (MPF), Central Steam Facility (CSF) and National Synchrotron Light Source (NSLS). The highest annual average concentrations detected for this area expressed as a percent of the NYS DWS concentration limit were: 12.5% gross beta; 3.7% tritium; and 22.6% Sr-90. Radionuclides that are not regulated by concentration are regulated by dose. The highest annual average concentration detected for the remaining radionuclides expressed in percent of the drinking water dose limit were: 0.005% Na-22; 0.003% Cs-137; and 0.002% Co-60.

At the landfill areas (Current, Former, and Ashfill), the single highest average gross beta concentration observed was 48% of the applicable standard; the single highest average tritium concentration and strontium-90 concentration observed were 77% and 39%, respectively of the NYS DWS. Other radionuclides were detected at small fractions of the NYS DWS concentration limit. No other monitoring wells that were sampled exhibited concentrations that exceeded the NYS DWS. Given the distance to the site boundary, decay and mixing that will occur in transit, the resulting radionuclide concentrations at the site boundary are expected to be substantially below the applicable standard. This area is subject to a RI/FS as part of the IAG.

The data from ground-water surveillance wells monitored in the vicinity of the HWMF indicated the presence of tritium, fission, and activation products. The single highest average concentration of tritium, gross beta, and Sr-90 were 14.7% 459%, and 562% respectively of the NYS DWS. The highest average annual concentration for the remaining radionuclides detected expressed in percent of the NYS DWS dose derived concentration limits were: 0.03% Co-60, 0.009% Na-22 and 0.006% Cs-137. Two of the monitoring wells that were sampled in this area exhibited concentrations that exceeded the NYS DWS for Sr-90; (Well Nos. 88-04; and 98-30). Given the distance to the site boundary decay and mixing that will occur in transit, the resulting radionuclide concentrations at the site boundary are expected to be substantially below the applicable standard. This area is subject to a RI/FS as part of the IAG.

In addition to the BNL on-site surveillance wells, 21 off-site private potable wells and two locations along the Peconic River near the site boundary were sampled and analyzed for gross alpha, gross beta, tritium, and gamma emitting radionuclides as part of a cooperative program with the SCDHS. Detectable quantities of tritium were found in eight off-site sampling locations: six private potable wells and two Peconic River sampling points. The annual average tritium concentrations at the six private well locations ranged from 0.006% - 21.8% of the NYS DWS.[12] Except for naturally occurring K-40 and Cs-137, no other gamma emitting radionuclides were detected in the private well water samples. Strontium-90 analysis could not be completed in time for inclusion in this report.

Nonradiological Analyses

During 1993, a total of 205 ground-water surveillance wells were sampled during 520 individual sampling events for nonradiological analyses. Nonradiological analyses consist of: 1) determining water quality parameters such as pH and conductivity, chloride, sulfate, and nitrate concentrations; 2) metals concentrations; and 3) VOC concentrations. Water quality analyses conducted on ground-water samples collected site wide indicate that the pH of ground water is typically within the range of 5.5 to 6.5 which is below the New York State Ambient Water Quality Standard (NYS AWQS) of 6.5 to 8.5. Additionally, chloride, sulfate, and nitrate concentrations in most areas of the site were typically below the NYS AWQS. Metals and VOCs in ground water, however, exceed NYS DWS in a number of areas across the site, and are usually traceable to known spill or chemical waste storage and former disposal areas. In several areas of the site, iron is detected at levels above NYS DWS. In some cases, high iron levels may be the result of natural background (or ambient) concentrations within the Upper Glacial aquifer. In other areas (such as the Sewage Treatment Plant/Peconic River area), high iron levels are possibly related to materials used to construct older wells that were installed in the 1950's and 1960's (i.e., carbon steel casings and brass screens). A summary of nonradiological analyses of ground-water samples collected during 1993 is described below.

East Sector: In the east sector of the site, two suspected contaminant source areas are monitored: the Meadow Marsh-Upland Recharge area and the Sewage Treatment Plant/Peconic River area.

In the Sewage Treatment Plant/Peconic River area, ground-water samples were collected from 27 surveillance wells for water quality, metals, and VOC analyses. The pH readings for ground water were typically below the NYS DWS of 6.5 to 8.5, but were consistent with values observed at upgradient locations. Other water quality parameters were below the applicable NYS DWS except for a nitrate-nitrogen concentration of 10.5 mg/L observed in a single well located near the STP filter bed area. Metals analyses indicate that iron concentrations exceeded NYS DWS in twelve wells, with maximum concentrations ranging from 0.32 to 63.44 mg/L, and lead levels exceeded DWS in three wells, with maximum concentrations ranging from 0.018 to 0.044 mg/L. Volatile organic compounds were not detected in any samples.

In the Meadow Marsh-Upland Recharge area, ground-water samples were collected from ten surveillance wells for water quality, metals, and VOC analyses. The pH readings for ground water were typically below the NYS AWQS of 6.5 to 8.5, but were consistent with values observed at upgradient locations. Other water quality parameters were below the applicable NYS AWQS. Metals analyses indicate that iron concentrations exceeded NYS DWS in two wells, with maximum concentrations ranging from 0.35 to 5.50 mg/L, and lead levels exceeded DWS in two wells, with maximum concentrations ranging from 0.025 to 0.035 mg/L. During 1993, 30 temporary ground-water profiling wells were installed under a cooperative agreement with the SCDHS to examine the extent of 1,2-dibromoethane (EDB) contamination in ground water. 1,2-dibromoethane was detected above the NYS DWS of 0.050 μg/L in nine temporary wells (six of which are located off site, south of the Long Island Expressway), one off-site supply well, and one on-site surveillance well. The maximum observed concentrations of EDB ranged from 0.06 to 3 μg/L.

Southeast-South Central Sector: In the southeast and south-central areas of the site, four contaminant source areas are monitored: the Hazardous Waste Management Facility, the Current Landfill, the Former Landfill, and Ash Repository area.

In the HWMF area, thirty-two ground-water surveillance wells were monitored for water quality, metals, and VOCs. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with values observed at upgradient (background) locations. Other water quality parameters were below the applicable NYS AWQS. Results of metals analyses performed on ground-water samples from this area indicated that iron levels exceeded the NYS DWS in three wells (maximum values ranging between 2.28 to 3.50 mg/L), lead levels exceeded DWS in one well (0.018 mg/L), and zinc levels exceeded DWS in two wells (maximum values of 16.3 and 24.8 mg/L). Analysis for VOCs in ground-water samples collected from the surveillance wells indicate that TCA, tetrachloroethylene (PCE), and DCA were detected at concentrations that exceeded the NYS DWS during at least one sampling event. The TCA was detected above NYS DWS in seven surveillance wells with maximum concentrations ranging from 6 to 45 μg/L; PCE was detected at or above NYS DWS in three surveillance wells with maximum concentrations ranging from 5 to 39 μg/L; and DCA was detected in one well above NYS DWS at a maximum concentration of 25 μg/L. The ground-water extraction wells, which are part of the Aquifer Restoration Spray Aeration Project, were not in service during 1993. Reactivation of these extraction wells will be reevaluated following the Operational Unit (OU) I RI/FS.

At the Current Landfill, water quality, metals, and VOC analyses were performed on ground-water samples collected from 20 surveillance wells. The pH readings for ground water were typically below the NYS AWQS of 6.5 to 8.5, but were consistent with values observed at upgradient (background) locations. Although most other water quality parameters were within NYS AWQS, conductivity and chloride measurements in wells located directly downgradient of the Current Landfill reflect the landfill's impact. Conductivity values directly downgradient of the Current Landfill ranged from 231 - 1,095 μmhos/cm whereas the maximum conductivity value in upgradient Well 87-09 was 162 μmhos/cm. Maximum observed chloride values in wells directly downgradient of the Current Landfill ranged from 16 to 153 mg/L, whereas the maximum upgradient value was 15 mg/L. At the Current Landfill, iron concentrations exceeded NYS DWS in eleven wells, with concentrations ranging from 0.80 mg/L to 114 mg/L. All other metals concentrations were below the NYS DWS. Volatile organic compound data for the Current Landfill area indicates that DCA was detected at concentrations above the NYS DWS in four wells, with maximum observed concentrations ranging from 5 to 110 μg/L; 1,1-dichloroethylene (DCE) was detected above NYS DWS in one well, with a maximum observed concentration of 6 μg/L; TCA was detected above NYS DWS in one well, with maximum concentration of 24 μg/L; benzene was detected in three wells above the NYS DWS at maximum concentrations ranging from 6 to 7 μg/L; ethylbenzene was detected at or above NYS DWS in two wells at maximum concentrations of 8 and 10 μg/L; toluene was detected above NYS DWS in one well at a maximum concentration of 5 μg/L; and chloroethane was detected above NYS DWS in one well at a maximum concentration of 6μg/L.

In the Former Landfill area, ten ground-water surveillance wells were sampled during 1993. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient locations. All other water quality parameters were below the applicable NYS AWQS. Most metals concentrations were below the applicable NYS DWS, except for iron which was detected in one downgradient well at a maximum concentration of 0.32 mg/L. Volatile organic compounds were detected above NYS DWS in one well; with PCE observed at a maximum concentration of 7.3 μg/L.

The Ash Repository is monitored by a single downgradient surveillance well. Water quality data indicate that the values were below the NYS DWS of 6.5 - 8.5, but were consistent with the values observed in upgradient areas. All other water quality parameters, metals, and VOC concentrations were below the applicable NYS DWS and NYS AWQS.

Central Sector: In the central part of the site, nine known or suspected contaminant source areas were monitored; the CSF/MPF, AGS area, Photography and Graphic Arts (PG&A) area, Supply and Material (S&M) area, Building 479, Waste Concentration Facility (WCF), Building 830, Linac, and Relativistic Heavy Ion Collider (RHIC). Areas where contaminant concentrations exceeded NYS DWS or water quality parameters exceeded NYS AWQS are discussed below.

At the CSF/MPF thirty-two ground-water surveillance wells were monitored for water quality, metals, and VOCs. The pH readings of ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient (background) locations. All other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground water from this area indicate that most metals were below the applicable NYS DWS except for iron levels in six wells near the 1977 spill site. Maximum iron concentrations in the six wells ranged from 0.37 to 10.10 mg/L. Volatile organic compound analyses of ground-water samples collected from the CSF/MPF area indicate that TCA, TCE, PCE, ethylbenzene, toluene, and xylene (total) were detected at concentrations that exceeded the NYS DWS in five wells. The maximum observed concentration for each of these compounds was: 21 μg/L for TCA; 28 μg/L for TCE; 47 μg/L for PCE; 590 μg/L for ethylbenzene; 2,700 μg/L for toluene, and 2,200 μg/L for xylene (total). As required by the MPF license, the five surveillance wells that monitor the MPF were examined for floating products (i.e., petroleum hydrocarbons) on a monthly basis. As with previous years, no floating product was observed during 1993.

Within the AGS area, eleven surveillance wells were monitored for water quality, metals, and VOCs. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient (background) locations. All other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground-water samples from this area indicate that most metals were below the applicable NYS DWS except for metals concentrations in two wells, in which iron was observed at a maximum concentration of 0.98 mg/L, and zinc at 8.55 mg/L. Volatile organic compound analyses indicate that the NYS DWS for TCA was exceeded in two downgradient surveillance wells at maximum concentrations of 8 μg/L and 32 μg/L, and DCA exceeded NYS DWS in one well at a maximum observed concentration of 9 μg/L.

Within the WCF area, six surveillance wells were monitored for water quality, metals, and VOCs. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient (background) locations. All other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground-water samples from this area indicated that all metals were below the applicable NYS DWS. Volatile organic compound analyses indicate that the NYS DWS for TCA was exceeded in one upgradient well and one downgradient well, at maximum concentrations of 18 μg/L in the upgradient well and 9 μg/L in the downgradient well.

Within the S&M area, eight ground-water surveillance wells were monitored for water quality, metals, and VOCs during 1993. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient (background) locations. All other water quality parameters were below the applicable NYS AWQS. Results from metals analyses indicate that all metals were below the applicable NYS DWS. Results from VOC analyses indicate that TCA was detected at concentrations above NYS DWS in three wells, at maximum observed concentrations of 30 μg/L, 54 μg/L, and 340 μg/L. Tetrachloroethylene (TCE) and DCE were detected, in one well, at a maximum concentration of 34 μg/L and 10 μg/L, respectively.

The P&GA area is monitored by two ground-water surveillance wells. The pH readings for ground water were typically below the NYS AWQS of 6.5 - 8.5, but were consistent with the values observed at upgradient (background) locations. All other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground water from this area indicated that all metals were below the applicable NYS DWS. Analysis of the ground-water samples for VOCs indicate that TCA was detected at or above the NYS DWS in both wells, at maximum observed concentrations of 5 μg/L and 6 μg/L.

North Boundary, West Sector, and South Boundary: In the North Boundary area, surveillance wells monitor background or ambient ground-water quality for the site. Contaminants entering the site from off-site source areas would be detected by the North Boundary wells. Surveillance wells in the West Sector of the site monitor ground-water quality in the vicinity of five BNL potable and process supply wells. South Boundary surveillance wells monitor ground-water quality downgradient of the main developed area of the site. Ground-water contaminants would be detected in the South Boundary wells prior to leaving the site.

The North Boundary area surveillance well network consists of twelve wells designed to monitor background or ambient ground-water quality. Ground-water contaminants released from off-site source areas would enter the BNL site along the Northern Boundary. The pH readings for shallow ground-water samples were typically below the NYS AWQS of 6.5 - 8.5, whereas readings from deep Upper Glacial aquifer and Magothy aquifer wells were typically within the range of 6.5 - 8.5. Nitrate concentrations exceeded NYS AWQS in one deep Upper Glacial aquifer well, at a concentration of 10.8 mg/L. Results from metals analyses of ground water from this area indicate that metals concentrations are below the applicable NYS DWS. Analysis of the ground-water samples for VOCs indicate that TCA and DCA were detected above NYS DWS in a single deep Upper Glacial aquifer well. The maximum concentration for TCA was 11 μg/L, and for DCA, the maximum concentration was also 11 μg/L. These contaminants have migrated on to BNL from an upgradient source area(s).

In the West Sector, seven surveillance wells were monitored for water quality, metals, and VOCs. The pH readings of ground water were typically below the NYS AWQS of 6.5 -8.5, but within the values observed in upgradient areas. Results of metals analyses indicate that all metals concentrations were below NYS DWS. Volatile organic results for ground-water samples collected from the West Sector area indicate that TCA and PCE were detected in concentrations that exceeded NYS DWS. The TCA and PCE were observed at maximum concentrations of 31 μg/L and 5 μg/L, respectively, in a middle Upper Glacial aquifer well designed to assess ground-water quality near BNL Supply Well 4. The TCA was also detected at a concentration of 10 μg/L in a well located near Process Supply Wells 104 and 105, which have been out of service due to TCA contamination.

The South Boundary wells (excluding those monitoring the HWMF and Current Landfill) consists of six surveillance wells designed to monitor ground water that is migrating off site. The pH readings of the south boundary ground-water samples were typically below the NYS AWQS of 6.5 - 8.5, but within the values observed in upgradient areas. Other water quality parameters were below the applicable NYS AWQS. Results from metals analyses indicate that above NYS DWS concentrations of iron (24.8 mg/L) and lead (0.024 mg/L) were detected in one middle Upper Glacial aquifer well. Analyses for VOCs in the South Boundary wells indicate that TCA was detected above NYS DWS in one well (Well 130-02), at a maximum concentration of 13 μg/L. Dichloroethylene (DCE) and TCE were also detected just below NYS DWS in the same well, at concentrations of 4 μg/L.

Off-site Dose Estimates

For the year 1993, the collective committed effective dose-equivalent attributable to Laboratory operations, for the population up to a distance of 80 Kilometers (km), was calculated to be 4.6 person-rem (0.046 person-Sv). This can be compared to a collective dose-equivalent to the same population of approximately 290,000 person-rem (2900 person-Sv) due to natural sources.

The committed effective dose-equivalent to the maximally exposed individual resident at the site boundary (NNE Sector) from the air pathway is 0.2 mrem (0.002 mSv). The maximum individual committed effective dose-equivalent from drinking water pathway is 0.20 mrem (0.002 mSv). The maximum individual committed effective dose-equivalent from the fish pathway is 0.58 mrem (0.006

mSv). The combined maximum individual dose equivalent is 0.98 mrem (0.0098 mSv). This dose represents 1.0% of the maximum individual annual dose limit of 100 mrem (1 mSv) and 1.6% of the annual cosmic plus terrestrial external dose of about 60 mrem (0.60 mSv).

Quality Assurance Program

Brookhaven National Laboratory has implemented DOE Order CH 5700.6C[13] by developing policies, responsibilities, and providing generic guidance procedures for the development of Quality Assurance (QA) programs that are appropriate to ensure the achievement of Laboratory objectives.[14] The elements of this program have been adopted and adapted, as necessary, by the SEPD in the development of the Division's QA program.[15] Established protocols that document the specific activities of the EM program are described in the SEPD EPS QA Manual. A designated QA Officer, with environmental expertise, reviews all activities within the EPS that are involved with the generation, collection, analysis, evaluation, and reporting of environmental data to ensure they comply with the SEPD, BNL, and DOE QA objectives.

The level of quality control and quality assurance activities depend on the nature of measurements and the intended use of the data. Checks on sample collection techniques, analysis methods, and instrument performance are incorporated into Standard Operating Procedures (SOP) and include the use of blanks, replicates, and spikes. In addition, the QA officer is responsible for establishing a program of internal assessments and external audits to verify the effectiveness of Environmental Protection (EP) sampling, analysis, and data base activities and their adherence to the QA program. The analytical laboratories participate in interlaboratory QA programs organized by DOE, EPA, and NYSDEC. Contract laboratories used to augment the capabilities of the in-house laboratory are required to maintain a comprehensive QA program and are subject to audits by S&EP personnel to ensure its implementation.

1.0 INTRODUCTION

J. R. Naidu

1.1 Site Mission

Brookhaven National Laboratory is managed by Associated Universities Inc. (AUI), under DOE Contract No. DE-AC02-76CH00016. Associated Universities, Inc. was formed in 1946 by a group of nine universities whose purpose was to create and manage a laboratory in the Northeast in order to advance scientific research in areas of interest to universities, industry, and government. On January 31, 1947, the contract for BNL was approved by the Manhattan District of the Army Corp of Engineers and BNL was established on the former Camp Upton Army camp.

The Laboratory carries out basic and applied research in the following fields: high-energy nuclear and solid state physics; fundamental material and structural properties and the interactions of matter; nuclear medicine, biomedical and environmental sciences; and selected energy technologies. In conducting these research activities, it is Laboratory policy to protect the health and safety of employees and the public, and to minimize the impact of BNL operations on the environment.

1.2 Site Characteristics

Brookhaven National Laboratory is a multidisciplinary scientific research center located close to the geographical center of Suffolk County on Long Island, about 97 km east of New York City. Its location with regard to the metropolitan area and local communities are shown in Figures 1 and 2, respectively. About 1.33 million persons reside in Suffolk County[16] and about 0.41 million persons reside in Brookhaven Township, within which the Laboratory is situated. Approximately eight thousand persons reside within a half km of the Laboratory boundary. The distribution of the resident population within 80 km of the BNL site is shown in Figure 1 and 1993 BNL SER Compendium, Table 1. The population distribution within 0.5 km of the BNL site is shown in Figure 2. Although much of the land area within a 16 km radius remains either forested or cultivated, there has been an increase in residential housing development in the rural areas surrounding BNL, though there have been no major construction projects in the vicinity since 1978. However, detailed plans for two shopping centers, a corporate park, and several thousand single and multiple family dwellings are proposed within a 15 km area of BNL, predominately on the north, south, and west boundaries.

The Laboratory site is shown in Figure 3. It consists of 21.3 square kilometers (2,130 hectares [ha]), most of which is wooded, except for a developed area of about 6.7 square kilometers (670 ha). The site terrain is gently rolling, with elevations varying between 36.6 and 13.3 m above sea level. The land lies on the western rim of the shallow Peconic River water shed. The marshy areas in the north and eastern sections of the site are a portion of the Peconic River headwaters. The Peconic River both recharges to, and receives water from, the ground-water aquifer depending on the hydrological potential. In times of drought the river water typically recharges to ground water (i.e., an influent

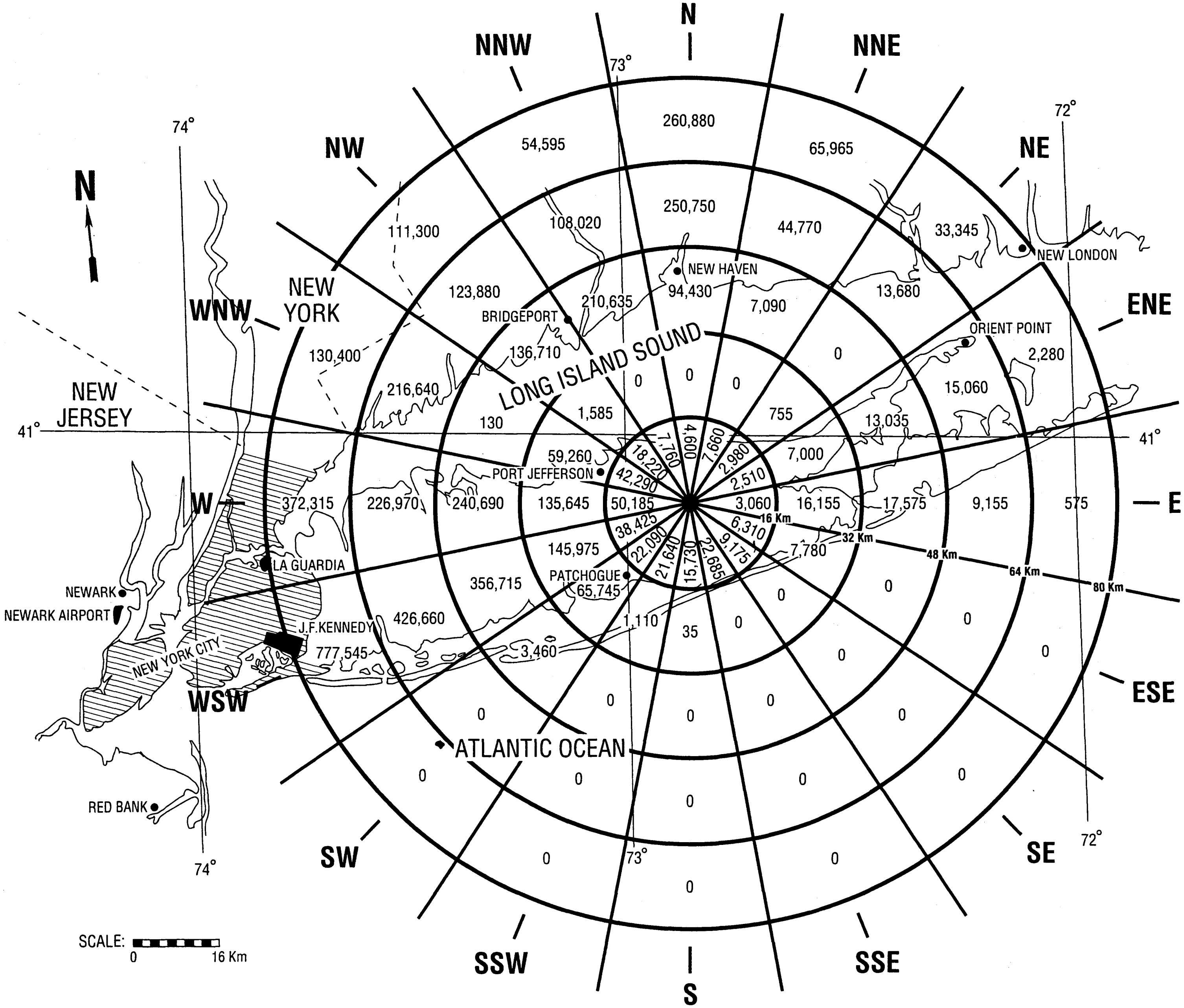


Figure 1: **RESIDENT POPULATION 1993 WITHIN A 80 Km RADIUS OF BNL**

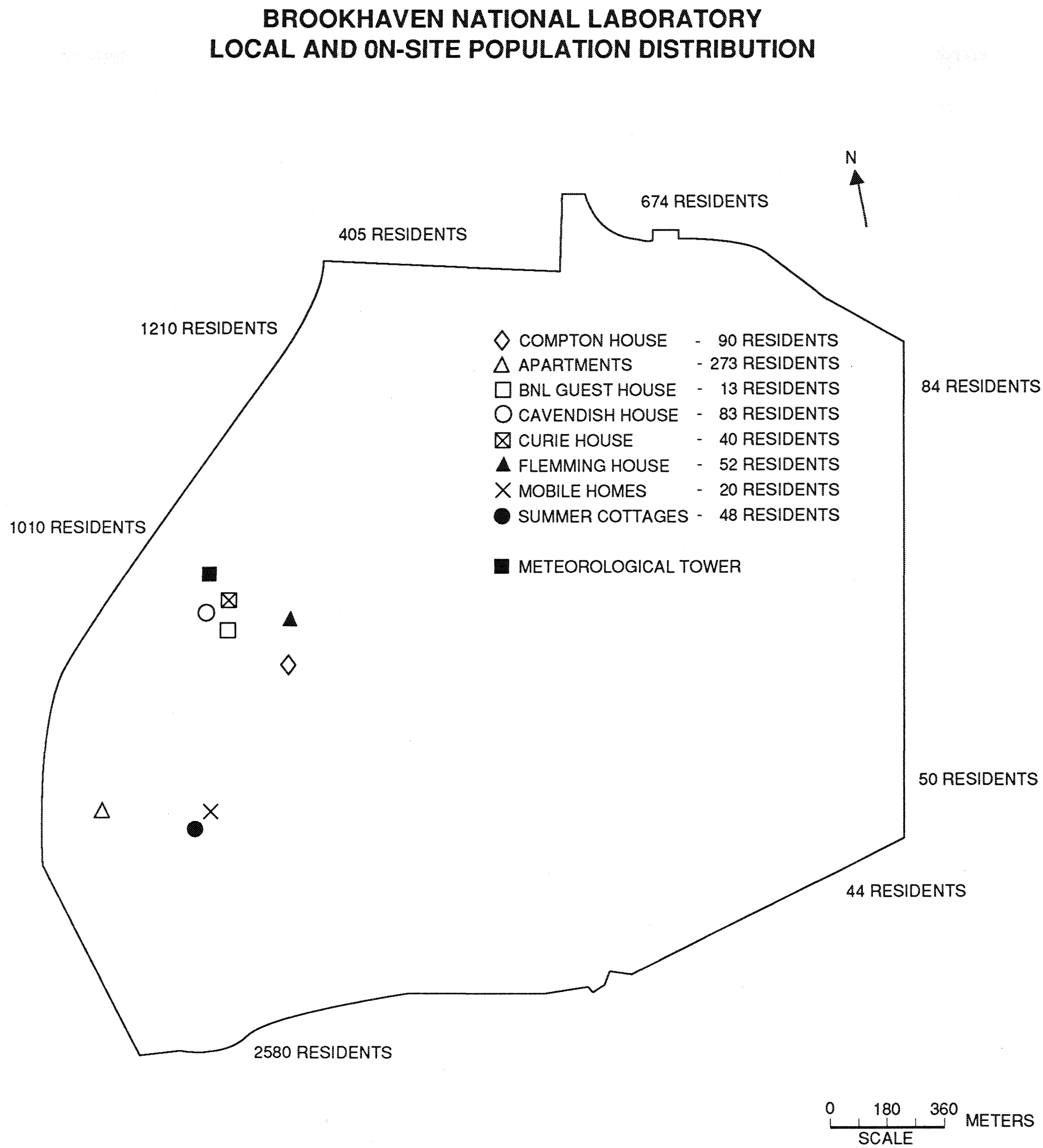


Figure 2: BNL Local and On-site Population Distribution.

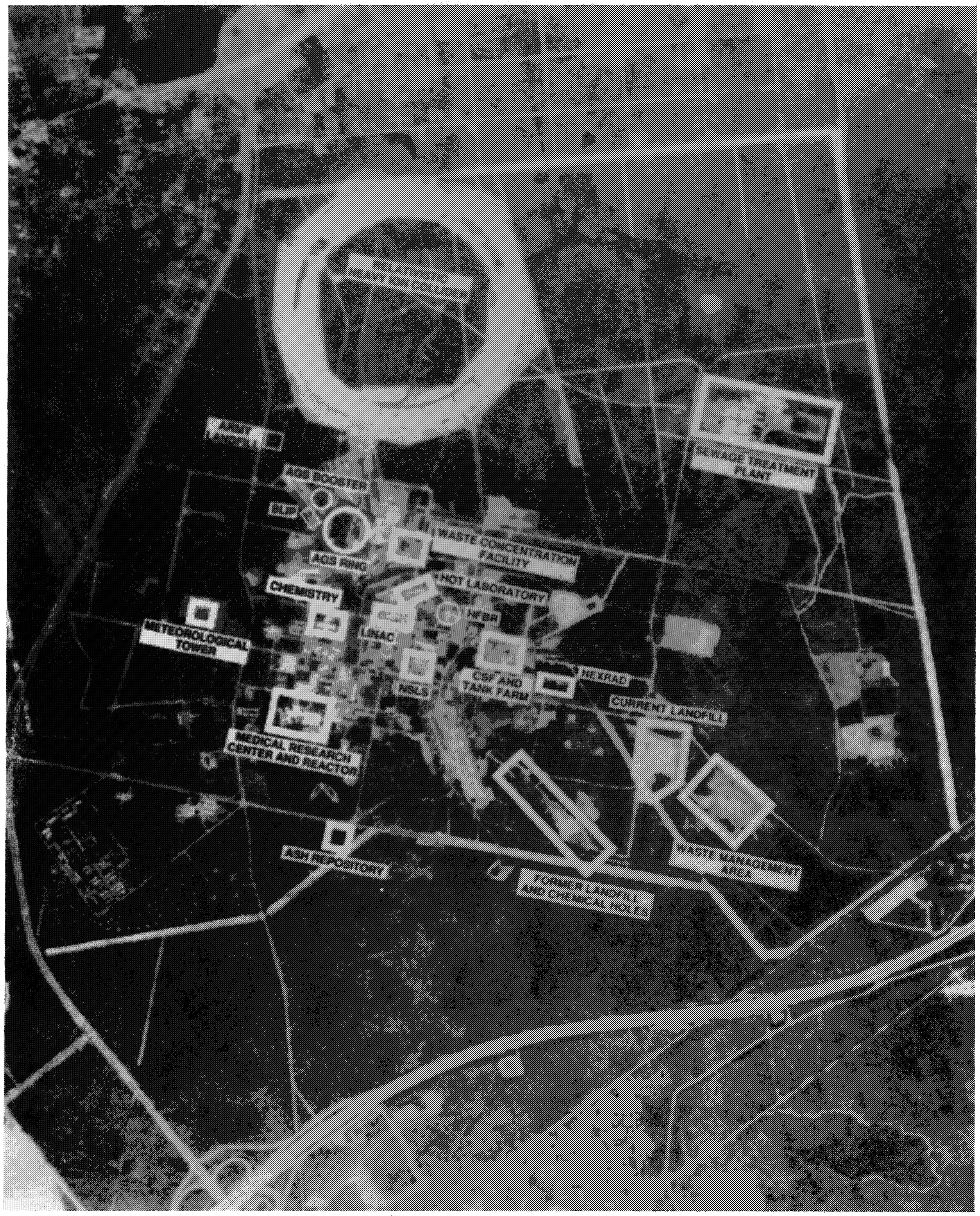


Figure 3: Major Facilities.

stream) while in times of normal to above normal precipitation, the river receives water from the aquifer (i.e., an effluent stream). The river on site is thus classified as an intermittent river. In 1993, for a significant period of the year, the Peconic River bed on site was in a recharge mode. Consequently, virtually no flow left the site.

The Laboratory uses approximately 14.0 million liters of ground water per day to meet potable water plus heating and cooling requirements. Approximately 43% of the total pumpage was returned to the aquifer through on-site recharge basins. About 18% is discharged into the Peconic River. Human consumption utilizes 4% of the total pumpage while evaporation (cooling tower and wind losses), cesspool plus line losses account for 30% and 10%, respectively. These latter percentages are estimates based on mass balance. Accuracy in such estimations is expected to be increased when flow measurement systems at the recharge basins are installed as part of the Environmental Monitoring upgrades.

In terms of meteorology, the Laboratory can be characterized, like most eastern seaboard areas, as a well-ventilated site. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall.[17,18] The 1993 annual wind rose for BNL is presented in Figure 4. The joint frequency distribution data for the period 1992 to 1993 is presented in the 1993 BNL SER Compendium, Table 2. The average temperature in 1993 was 10.29° C and the range was -8.89° C to 29.63° C. Monthly minimum, maximum, and average temperature data are presented in the Compendium, Table 3 and shown graphically in Figure 5.

Studies of Long Island hydrology and geology[19-22] in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are between 31 - 61 m thick, are generally composed of highly permeable glacial sands and gravels. Water penetrates these deposits readily and there is little direct run off into surface streams, except during periods of intense precipitation. The total precipitation for 1993 was 108.9 cm, which is about 14 cm below the 40 year annual average. The 1993 monthly and historic precipitation data are presented in Figure 6 and 7, respectively. The monthly and annual precipitation data are also presented in the Compendium, Table 4. On the average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge ground water. Run offs form a very insignificant portion of the total rainfall, usually less than 2%.[23]

Ground-water flow in the vicinity of BNL is controlled by many factors. The main ground-water divide lies approximately 2 - 3 km north of BNL, and runs parallel to the Long Island Sound. This divide is known to shift 1 - 2 km, north to south.[21] East of BNL is a secondary ground-water divide that defines the southern boundary of the area contributing ground water to the Peconic River.

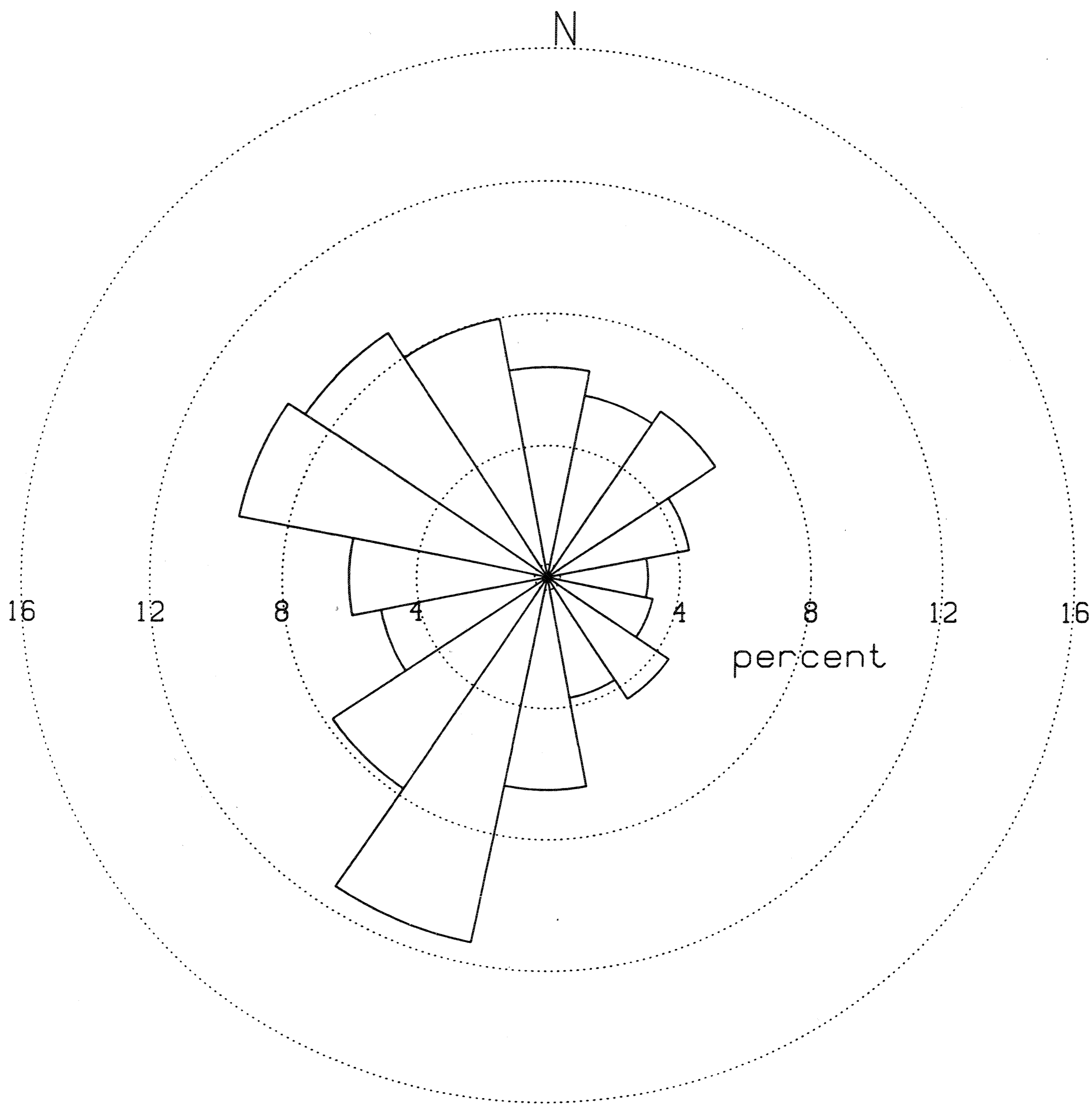


Figure 4: Annual Wind Rose for 1993.

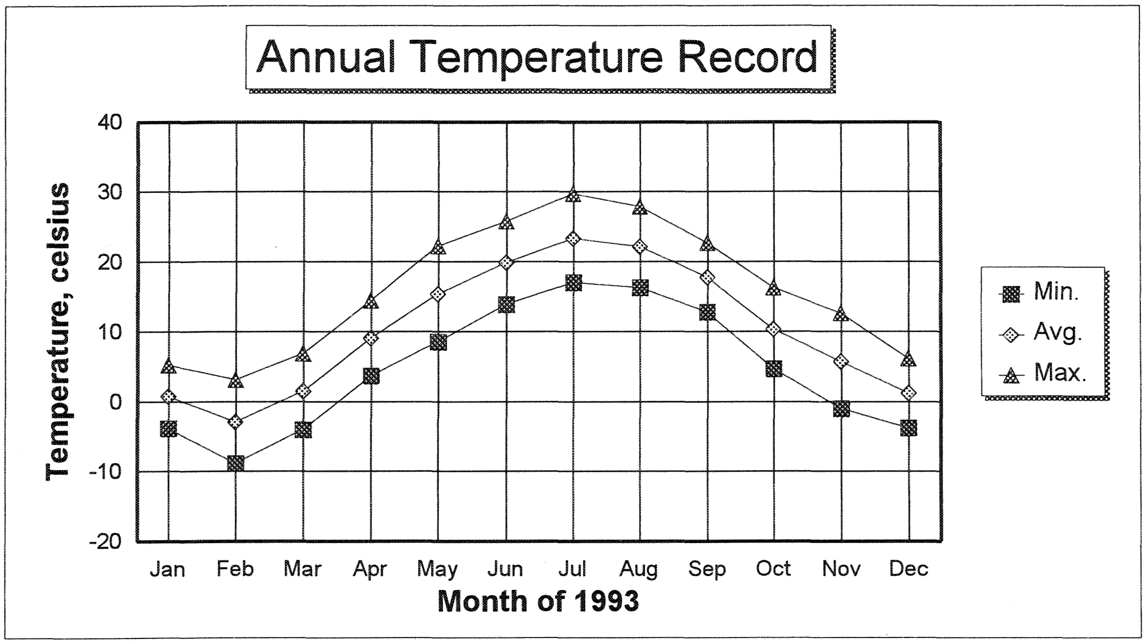


Figure 5: Climatology for the BNL Site - Temperature Data - 1993

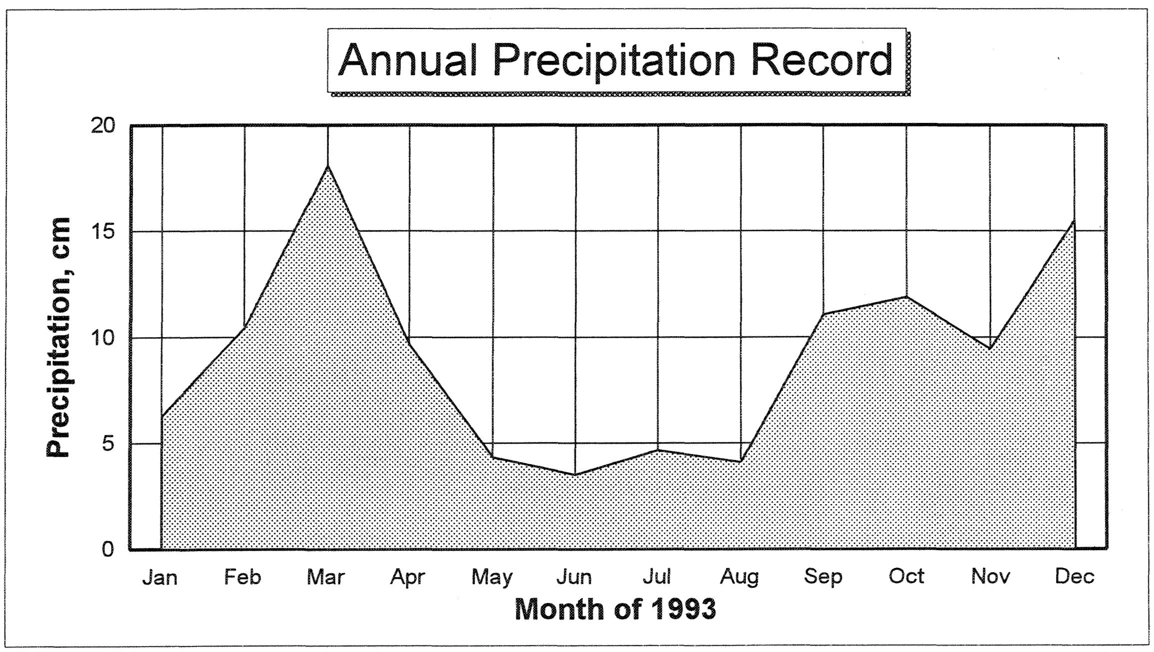


Figure 6: Climatology for the BNL Site: Precipitation for 1993.

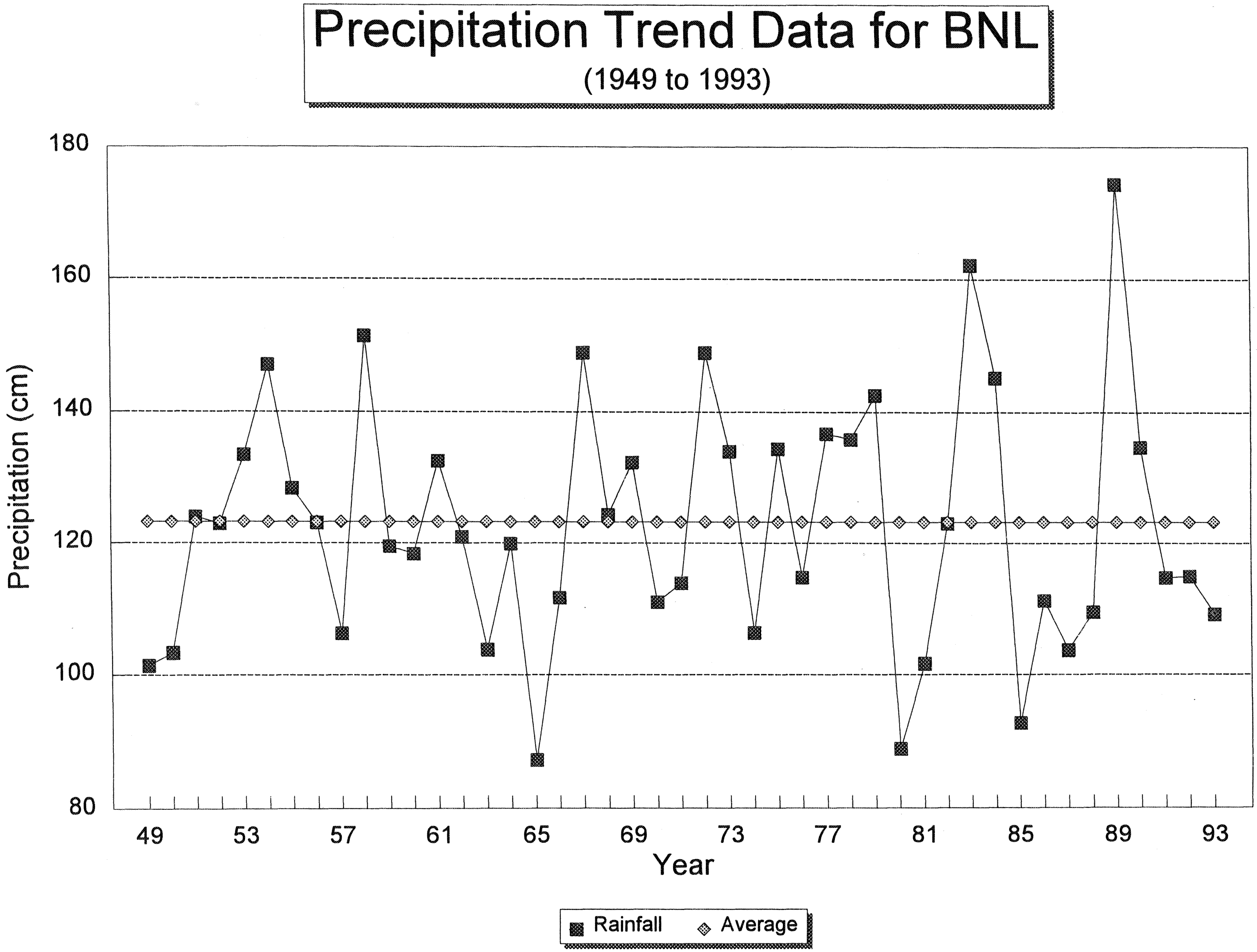


Figure 7: Precipitation Trend Data for BNL, 1949 - 1993.

The exact location of the triple-point intersection of these two divides is not known and may be under BNL. South of these divides the ground water moves southward to Great South Bay and to Moriches streams. In general, the ground water from the area between the two branches of the divide moves eastward to the Peconic River. North of the divide ground water moves northward to Long Island Sound. Pressure of a higher water table to the west of the BNL area generally inhibits movement towards the west. Variability in the direction of flow on the BNL site is a function of the hydraulic potential and is further complicated by the presence of near surface clay deposits that accumulate perched water at several places plus the pumping/recharge of ground water that are part of BNL daily operations. In general, ground water in the northeast and northwest sections of the site flows towards the Peconic River. On the western portion of the site, ground-water flow tends to be towards the south while along the southern and southeastern sections of the site the ground-water flow tends to be towards the south to southeast (Figure 8). In all areas of the site, horizontal ground-water velocity is estimated to range from 30 to 45 cm/d.[19-22] The site occupied by BNL has been identified by the Long Island Regional Planning Board[23] and Suffolk County as being over a deep flow recharge zone for Long Island. This implies that precipitation and surface water which recharges within this zone has the potential to replenish the lower aquifer systems (Magothy and Lloyd) which exist below the Upper Glacial Aquifer. The extent to which the BNL site contributes to deep flow recharge is currently under evaluation. However, it is estimated that up to two fifths of the recharge from rainfall moves into the deeper aquifers. In coastal areas, these lower aquifers discharge to the Atlantic Ocean or the Long Island Sound.[23]

The Laboratory is located in a section of the Oak/Chestnut forest region of the Coastal Plain. Because of the general topography and porous soil, there is little surface runoff or open water. Upland soils tend to be drained excessively, while depressions form small pocket wetlands. Hence, a mosaic of wet and dry areas on the site are correlated with variations in topography and depth to the water table. In the absence of fire or other disturbance, the vegetation normally follows the moisture gradient closely. In actuality, vegetation on site is in various stages of succession which reflects the history of disturbances to the area, the most important having been land clearing, fire, local flooding, and draining.

Mammals common to the site include species common to mixed hardwood forests and open grassland habitats. At least 180 species of birds have been observed at BNL, a result of its location within the Atlantic Flyway and the scrub/shrub habitats which offer food and resting opportunities to migratory songbirds. Open fields bordered by hardwood forests found at the recreation complex provide excellent hunting areas for hawks. Pocket wetlands with seasonal standing water provide breeding areas for amphibians. Permanently flooded retention basins and other watercourses support aquatic reptiles.

Except for occasional transient individuals, no Federal or New York State listed or proposed threatened or endangered species exist within the Laboratory area.[24,25] One New York State species of "special concern", which has been confirmed as an inhabitant of the Peconic River on site, is the banded sunfish (Eanneacanthus obesus). This species occurs in New York solely within the Peconic River system. That portion of the Peconic River which occurs on BNL

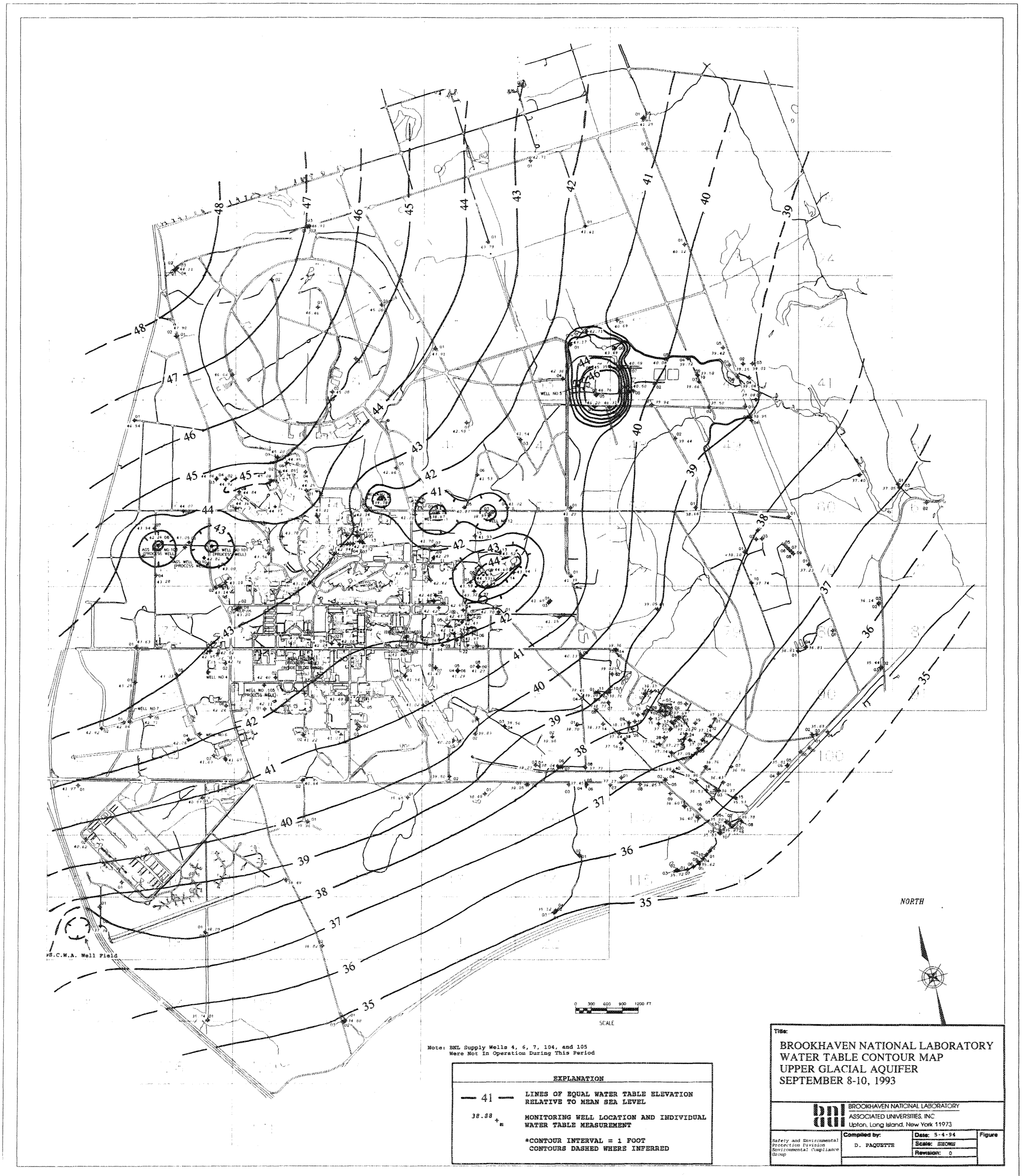


Figure 8: Site Water Table Map - September 1993.

property has been designated as "scenic" in accordance with the New York State's Wild, Scenic, and Recreational Rivers Act (WSRRSA). The wide variety of wildlife resources at BNL attest to Laboratory planning practices which have clustered development to minimize habitat fragmentation, particularly in environmentally sensitive areas such as the Peconic River corridor. Habitat fragmentation represents the greatest threat to wildlife habitats on Long Island today.

1.3 Existing Facilities

A wide variety of scientific programs are conducted at Brookhaven, including research and development in the following areas:

1. The fundamental structure and properties of matter;

2. The interactions of radiation, particles, and atoms with other atoms and molecules;

3. The physical, chemical, and biological effects of radiation;

4. The production of special radionuclides and their medical applications;

5. Energy and nuclear related technology; and

6. The assessment of energy sources, transmission and uses, including their environmental and health effects.

The major scientific facilities which are operated at the Laboratory to carry out the above programs are described below:

1. The HFBR is fueled with enriched uranium, moderated and cooled by heavy water. In the past, this facility operated at a routine power level ranging from 40 to 60 MW thermal. Since May 1991, it operated at a level of 30 MW thermal.

2. The Medical Research Reactor is an integral part of the Medical Research Center (MRC), is fueled with enriched uranium, moderated and cooled by light water, and is operated intermittently at power levels up to 3 MW thermal.

3. The Alternating Gradient Synchrotron is used for high energy physics research and accelerates protons to energies up to 30 GeV and heavy ion beams to 15 GeV/amu.

4. The 200 MeV Linear Accelerator (LINAC) serves as a proton injector for the AGS and also supplies a continuous beam of protons for radionuclide production by spallation reactions in the Brookhaven Linac Isotope Production Facility.

5. The Tandem Van de Graaff, Vertical Accelerator, Cyclotron, and research Van de Graaff are used in medium energy physics investigations, as well as for special nuclide production. The heavy ions from the Tandem Van de Graaffs can also be injected into the AGS for use in physics experiments.

6. The National Synchrotron Light Source utilizes a linear accelerator and booster synchrotron as an injection system for two electron storage rings which operate at energies of 750 MeV vacuum ultraviolet (VUV) and 2.5 GeV (x-ray). The synchrotron radiation produced by the stored electrons is used for VUV spectroscopy and for x-ray diffraction studies.

7. The Heavy Ion Transfer tunnel connects the coupled Tandem Van de Graaffs and the AGS. The interconnection of these two facilities permits the injection of intermediate mass ions into the AGS where the ions can be accelerated to an energy of 15 GeV/amu. These ions are then extracted and sent to the AGS experimental area for physics research.

8. The AGS Booster is a circular accelerator with a circumference of 200 meters that will receive either a proton beam from the Linac or heavy ions from the Tandem Van de Graaff. The Booster accelerates proton particles and heavy ions prior to injection into the AGS ring. This facility became operational in 1992.

9. The Radiation Therapy Facility operated jointly by the BNL Medical Department and State University of New York at Stony Brook, is a high energy dual x-ray mode linear accelerator for radiation therapy of cancer patients. This accelerator has been designed to deliver therapeutically useful beams of x-rays and electrons for conventional and advanced radiotherapy techniques.

Additional programs involving irradiations and/or the use of radionuclides for scientific investigations are carried out at other Laboratory facilities including those of the MRC, the Biology Department, the Chemistry Department, and the Department of Applied Technology (DAT). Special purpose radionuclides are developed and processed for general use under the joint auspices of the Department of Applied Science (DAS) and the Medical Department.

2.0 COMPLIANCE SUMMARY

B. A. Royce, G. W. Adams, S. L. K. Briggs, K. Geiger, G. A. Goode, R. J. Lee, R. P. Miltenberger, J. Naidu, D. E. Paquette, G. L. Schroeder, T. G. Sperry, and J. K. Williams

It is the policy of BNL to operate and maintain the site in compliance with applicable Federal, State, or local regulations and DOE Orders. This section provides a brief summary of the compliance status for existing facilities and operations during CY 1993.

2.1 Environmental Permits

There are a variety of processes and facilities at BNL which operate under regulatory permits. These permits include one SPDES permit, a MFP license, a RCRA permit, a certificate from NYSDEC registering tanks storing bulk quantities of hazardous substances, seven NESHAPS authorizations, 64 Certificates to Operate (CO) air emission sources from NYSDEC and 12 applications pending with NYSDEC either for renewals of existing COs, cancellations of existing COs, or COs for air emission sources. The type and status of all environmental permits issued to the DOE through December 31, 1993 is presented in Table 1.

Table 1
BNL Site Environmental Report for Calendar Year 1993
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
134	blueprint machine	NYSDEC-Air Quality	472200 3491 13401	11-29-96
197	blueprint machine	NYSDEC-Air Quality	472200 3491 19701	Canceled 3-92
197	degreaser tank	NYSDEC-Air Quality	472200 3491 19702	2-1-98
197	acid metal cleaning	NYSDEC-Air Quality	472200 3491 19703	3-22-96
197	welding shop	NYSDEC-Air Quality	472200 3491 19704	4-1-95
197	fiche duplicator	NYSDEC-Air Quality	472200 3491 19705	9-30-98
197	cleaning room hoods	NYSDEC-Air Quality	472200 3491 19706	1-7-98
197	cleaning room hoods	NYSDEC-Air Quality	472200 3491 19707	1-7-98
197	epoxy coating/curing exhaust	NYSDEC-Air Quality	472200 3491 19708	6-8-98
206	cyclone G-10	NYSDEC-Air Quality	472200 3491 20601	4-1-95
207	belt sander	NYSDEC-Air Quality	472200 3491 20701	4-1-95
208	lead melting	NYSDEC-Air Quality	472200 3491 20801	11-29-96
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802	11-29-96
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803	11-29-96
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804	11-29-96
244	cyclone collector	NYSDEC-Air Quality	472200 3491 24401	1-28-95
348	paint hood exhaust	NYSDEC-Air Quality	472200 3491 34801	Canceled 9-16-93
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202	11-29-96
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203	11-29-96
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42204	Canceled 4-90
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205	Canceled 4-90
423	combustion unit	NYSDEC-Air Quality	472200 3491 42304	Canceled 11-89
423	stage II vapor recovery	NYSDEC-Air Quality	472200 D365 WG	9-27-95
423	welding hood	NYSDEC-Air Quality	472200 3491 42305	2-1-98
444	incinerator	NYSDEC-Air Quality	472200 3491 44401	12-31-93
452	combustion unit	NYSDEC-Air Quality	472200 3491 45204	Canceled 11-89
452	parts cleaner tank	NYSDEC-Air Quality	472200 3491 45201	Canceled 3-92
457	combustion unit	NYSDEC-Air Quality	472200 3491 45704	Canceled 11-89
457	sulfite dispensing	NYSDEC-Air Quality	472200 3491 45705	Cancellation[1]
458	paint spray booth	NYSDEC-Air Quality	472200 3491 45801	4-23-97
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46201	11-29-96
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202	11-29-96
473	vapor degreaser	NYSDEC-Air Quality	472200 3491 47301	3-22-96
479	combustion unit	NYSDEC-Air Quality	472200 3491 47904	Canceled 11-89
479	cyclone G-10	NYSDEC-Air Quality	472200 3491 47905	4-1-95
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49001	12-7-90*
490	Inhalation Toxicology Facility	NYSDEC-Air Quality	472200 3491 49002	12-7-90*
490	lead alloy melting	NYSDEC-Air Quality	472200 3491 49003	11-11-96
490	milling machine/block cutter	NYSDEC-Air Quality	472200 3491 49004	11-11-96
493	combustion unit	NYSDEC-Air Quality	472200 3491 49304	Canceled 11-89
493	incinerator	NYSDEC-Air Quality	472200 3491 493AO	Cancellation[2]
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001	11-29-91*
510	metal cutting exhaust	NYSDEC-Air Quality	472200 3491 51002	9-30-98
510	calorimeter enclosure	U.S.EPA - NESHAPS	BNL-689-01	None
526	polymer mix booth	NYSDEC-Air Quality	472200 3491 52601	4-1-95
526	polymer weighing	NYSDEC-Air Quality	472200 3491 52602	4-1-95
535B	plating tank	NYSDEC-Air Quality	472200 3491 53501	4-1-95
535B	etching machine	NYSDEC-Air Quality	472200 3491 53502	4-1-95
535B	PC board process	NYSDEC-Air Quality	472200 3491 53503	4-1-95
535B	welding hood	NYSDEC-Air Quality	472200 3491 53504	9-30-98

Table 1 (Continued)
BNL Site Environmental Report for Calendar Year 1993
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
555	scrubber (1)	NYSDEC-Air Quality	472200 3491 55501	4-1-95
555	scrubber (2)	NYSDEC-Air Quality	472200 3491 55502	4-1-95
555	paint hood exhaust	NYSDEC-Air Quality	submitted 10-92	Exempt[3]
610	combustion unit	NYSDEC-Air Quality	472200 3491 6101A	2-22-93*
610	combustion unit	NYSDEC-Air Quality	472200 3491 61004	11-29-91*
610	combustion unit - ALF	NYSDEC-Air Quality	472200 3491 61005	11-29-91*
610	combustion unit	NYSDEC-Air Quality	472200 3491 61006	3-21-93*
610	combustion unit	NYSDEC-Air Quality	472200 3491 61007	9-30-94
630	stage II vapor recovery	NYSDEC-Air Quality	472200 D366 WG	9-27-95
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001	11-29-96
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002	11-29-96
703	machining exhaust	NYSDEC-Air Quality	472200 3491 70301	2-1-98
705	building ventilation	U.S. EPA - NESHAPS	BNL-288-01	None
725	blueprint machine	NYSDEC-Air Quality	472200 3491 72501	4-1-95
815	welding hood	NYSDEC-Air Quality	472200 3491 81501	Canceled 9-16-93
820	accelerator test facility	U.S.EPA - NESHAPS	BNL-589-01	None
901	tin lead solder	NYSDEC-Air Quality	472200 3491 90101	4-1-95
901	paint hood exhaust	NYSDEC-Air Quality	submitted 10-92	Exempt[3]
902	spray booth exhaust	NYSDEC-Air Quality	472200 3491 90201	9-30-98
902	belt sander	NYSDEC-Air Quality	472200 3491 90202	5-3-98
902	sanding, cutting, drilling	NYSDEC-Air Quality	472200 3491 90203	5-3-98
902	brazing/solder exhaust	NYSDEC-Air Quality	472200 3491 90204	5-3-98
902	painting/soldering exhaust	NYSDEC-Air Quality	472200 3491 90205	5-3-98
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301	11-29-96
903	cyclone G-10	NYSDEC-Air Quality	472200 3491 90302	4-1-95
903	brazing process exhaust	NYSDEC-Air Quality	472200 3491 90303	9-30-98
905	vapor degreaser	NYSDEC-Air Quality	472200 3491 90501	3-22-96
905	belt sander	NYSDEC-Air Quality	472200 3491 90502	6-18-95
905	machining exhaust	NYSDEC-Air Quality	472200 3491 90503	5-3-98
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101	11-29-96
911	paint spray hood	NYSDEC-Air Quality	submitted 12-90	Exempt[4]
919A	sandblasting	NYSDEC-Air Quality	472200 3491 91901	4-23-97
919A	sandblasting	NYSDEC-Air Quality	472200 3491 91902	4-23-97
919	solder exhaust	NYSDEC-Air Quality	472200 3491 91903	2-1-98
922	cyclone exhaust	NYSDEC-Air Quality	472200 3491 92201	4-1-95
923	electronic equip. cleaning	NYSDEC-Air Quality	submitted 3-93, status pending	
924	spray booth exhaust	NYSDEC-Air Quality	472200 3491 92401	9-30-98
924	magnet coil production press	NYSDEC-Air Quality	472200 3491 92402	2-1-98
924	machining exhaust	NYSDEC-Air Quality	472200 3491 92403	5-3-98
930	electroplating/acid etching	NYSDEC-Air Quality	472200 3491 93001	2-1-98
930	bead blaster	NYSDEC-Air Quality	472200 3491 93002	2-1-98
930	ultrasonic cleaner	NYSDEC-Air Quality	472200 3491 93003	2-1-98
930	paint hood exhaust	NYSDEC-Air Quality	submitted 10-92	Exempt[3]

Table 1 (Continued)
BNL Site Environmental Report for Calendar Year 1993
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number	Expiration Date
T30	combustion unit	NYSDEC-Air Quality	472200 3491 T3004	Canceled 11-89
	spray aeration project	NYSDEC-Air Quality	submitted 10-89, status pending	
AGS Booster	accelerator	U.S. EPA - NESHAPS	BNL-188-01	None
RHIC	accelerator	U.S. EPA - NESHAPS	BNL-389-01	None
	radiation therapy facility	U.S. EPA - NESHAPS	BNL-489-01	None
	radiation effects/neutral beam	U.S. EPA - NESHAPS	BNL-789-01	None
CSF(d)	major petroleum facility	NYSDEC-Water Quality	1-1700	3-31-95
STP(a) & RCB(b)	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005835	I.O.S.
HWMF(c)	waste management	NYSDEC-Hazardous Waste	NYS ID No. 1-4722-00032/00021-0	8-31-98
BNL Site	chem tanks-HSBSRC	NYSDEC	1-000263	7-27-95

(a) Sewage Treatment Plant
(b) Recharge basins
(c) Hazardous Waste Management Facility
(d) Central Steam Facility
I.O.S. = Interim Operating Status (under review for renewal)
HSBSRC = Hazardous Substance Bulk Storage Registration Certificate

*Note: Renewal application submitted more than 30 days prior to expiration date; process can continue to operate under provisions of the NYS Uniform Procedures Act.

[1] Cancellation requested 7-92, status pending.
[2] Process no longer in use, cancellation requested 11-13-90, status pending.
[3] Evaluated by NYSDEC; declared to be exempt 2-11-93.
[4] Evaluated by NYSDEC; declared to be exempt 9-16-93.

2.2 Ground-Water Contamination in Excess of the NYS DWS

Ground-water monitoring is performed at BNL to determine the impact of Laboratory operations on the uppermost aquifer underlying the site (Upper Glacial aquifer). Ground-water samples are routinely analyzed for water quality parameters (i.e., anions, pH, and conductivity), metals, VOCs, and radionuclides. The following provides information on locations where ground-water monitoring was performed in CY 1993. Where concentrations are reported in this section, they represent exceedances of the NYS DWS and are the maximum observed value for the calendar year.

Location	Status/Comments
North Boundary	Ground-water samples collected from the North Boundary surveillance wells reflect background (ambient) ground-water quality for the site. The TCA and DCA were detected in Well 18-03 at concentrations 11 $\mu g/L$ and 11 $\mu g/L$, respectively. Nitrates were detected in Well 17-03 at 10.8 mg/L. No metals or radionuclides were detected above NYS DWS during 1993. The extent of ground-water contamination entering the site from off-site source areas will be investigated under the IAG.
West Sector	Ground-water samples collected from surveillance wells located in the west sector of the site, monitor water quality near potable and process supply well fields. 1,1,1-trichloroethane was detected in Wells 83-02 (31 $\mu g/L$), 84-01 (10 $\mu g/L$) and 103-02 (11 $\mu g/L$); TCE was detected in Well 103-02 (5 $\mu g/L$); and DCE was detected in Well 83-02 (5 $\mu g/L$). No metals or radionuclides were detected above NYS DWS during 1993. Ground-water contamination in the west sector is probably the result of VOC releases in the Paint Shop and AGS experimental areas, and will be investigated under the IAG as part of the OU III RI/FS (SubAOC 15A), which is scheduled to begin in CY 1995, depending on funding availability.
Southwest Boundary	Surveillance wells located near the southwest boundary of the site monitor ground-water quality downgradient of the main developed area of BNL. Ground-water samples collected at Well 130-02 indicated that TCA is present at 13 $\mu g/L$. Metals were detected in Well 122-02 with Iron (Fe) at 24.79 mg/L and Lead (Pb) at 0.024 mg/L. No radionuclides were detected above NYS DWS during 1993. Ground-water contamination in the southwest boundary area is likely to be the result of VOC releases in the central, developed area of the site, and will be investigated under the IAG as part of the OU III RI/FS (SubAOC 15B) scheduled to begin in CY 1995, depending on funding availability.

Potable Wells	See Section 2.6: Safe Drinking Water Act. Potable water supply wells that are impacted by ground-water contamination will be examined as part of the OU III RI/FS (Area of Concern [AOC] 15A), which is scheduled to begin in CY 1995, depending on availability.
AGS Area	Ground-water surveillance wells located in the AGS area monitor a number of suspected contaminant source areas associated with cesspools and known or suspected spill areas. 1,1,1-trichloroethane was detected in ground-water samples collected from Wells 54-07 and 64-03 (8 μg/L and 32 μg/L, respectively), and DCA was detected in Well 64-03 at 6 μg/L. Iron was detected in Wells 54-01 (0.98 mg/L) and 54-02 (0.39 mg/L). No radionuclides were detected above NYS DWS during 1993. Ground-water contamination in this area will be investigated under the IAG as part of the OU III RI/FS (AOC 14), which is scheduled to begin in CY 1995, depending on funding availability.
Waste Concentration Facility Area	Ground-water surveillance wells located in the WCF area monitor this facility and suspected contaminant source areas located directly upgradient of the WCF. During 1993, TCA was detected in Wells 65-02 and 65-06 (an upgradient well) at concentrations of 9 μg/L and 18 μg/L, respectively. No radionuclides were detected above NYS DWS during 1993. Further remedial investigation of this area will be conducted under the IAG as part of the OU III RI/FS (AOC 10), which is scheduled to begin in CY 1995, depending on funding availability.
Building T-111 Area	Ground-water surveillance wells located in the former Building T-111 area were installed to monitor for VOC contamination which may have been the result of past spills near this building. During 1993, TCA was detected in Wells 75-01 (5 μg/L) and 75-02 (6 μg/L). No radionuclides were detected above NYS DWS during 1993. Further remedial investigation of this area will be conducted under the IAG as part of the OU III RI/FS (AOC 19), which is scheduled to begin in CY 1995, depending on funding availability.
Building 830	Ground-water samples collected from surveillance wells installed to monitor the Building 830 pipe leak area did not exceed NYS DWS for VOCs, metals, or radioactivity during 1993. Further remedial investigation of this area will be conducted under the IAG as part of the OU III RI/FS (AOC 11), which is scheduled to begin in CY 1995, depending on funding availability.

Central Steam Facility and Building 650 Area

Ground water in the vicinity of the CSF and Building 650 area is contaminated with VOCs which were released to the environment during a 1977 fuel oil/solvent spill. Additionally, low level VOCs and radionuclides have been released from the Building 650 area, a decontamination facility located directly upgradient of the CSF. In 1993, 23 new surveillance wells were installed in these areas as part of the OU IV RI/FS. The following VOCs were observed in ground-water samples from new and existing surveillance wells in the CSF area: TCA in Wells 76-04 (21 μg/L), 76-08 (7 μg/L), and 76-21 (5 μg/L); TCE in Wells 76-04 (28 μg/L), 76-08 (5 μg/L), 76-21 (6 μg/L); 76-26 (8.5 μg/L), and 76-28 (5 μg/L); PCE in Wells 76-04 (47 μg/L), 76-05 (17 μg/L), 76-08 (28 μg/L), 76-18 (6 μg/L), 76-21 (35 μg/L), and 76-23 (21 μg/L); 1,2-dichloroethane (total) in Wells 76-04 (64 μg/L), 76-08 (9.3 μg/L), and 76-21 (23 μg/L); Toluene in Well 76-04 (2,700 μg/L); Ethylbenzene in Wells 76-04 (590 μg/L), 76-08 (12 μg/L), and 76-21 (150 μg/L); Xylene (total) in Wells 76-08 (110 μg/L) and 76-21 (470 μg/L); 1,2-dichlorobenzene in Well 76-04 (12 μg/L); and Naphthalene in Well 76-04 (59 μg/L). Metals concentrations were: Fe in Wells 76-04 (10.40 mg/L), 76-06 (2.27 mg/L), 76-21 (5.62 mg/L), 76-29 (0.37 mg/L), 77-03 (0.79 mg/L), 86-02 (0.64 mg/L), 86-03 (0.36 mg/L), and 86-06 (0.95 mg/L). Radionuclides were detected in the following wells: Strontium-90 (Sr-90) in Wells 66-19 (53 pCi/L), and gross beta in Well 66-19 (110 pCi/L) and gross beta in Wells 76-09 (88 pCi/L) and 76-20 (120 pCi/L).

Hazardous Waste Management Area

Ground-water surveillance wells have been installed within and downgradient of the HWMF to monitor VOC and radionuclide contamination that resulted from past spills and waste handling practices. Analysis of ground-water samples collected during 1993 indicated that the following VOCs were observed: TCA in Wells 88-04 (8 μg/L), 98-21 (45 μg/L), 108-12 (10 μg/L), 108-13 (11 μg/L), and 108-14 (19 μg/L); PCE in Wells 88-04 (39 μg/L), 98-21 (8 μg/L), and 98-22 (8 μg/L); and Methylene Chloride in Wells 98-01 (7 μg/L), and 98-21 (6 μg/L). The following metals were present in ground-water samples: Iron (Fe) in Wells 98-01 (3.48 mg/L), 98-04 (2.23 mg/L), 98-10 (0.80 mg/L), 99-01 (3.50 mg/L), and 99-02 (3.20 mg/L); Silver (Ag) in Wells 98-30 (0.075 mg/L) and 98-32 (0.075 mg/L), Lead (Pb) in Wells 98-32 (0.175 mg/L), 98-36 (180 mg/L), and 99-02 (0.018 mg/L); and Zinc (Zn) in Wells 98-36 (6.68 mg/L) and 99-02 (24.80 mg/L). Radionuclides were observed in the following wells: gross beta in Wells 88-04 (291 pCi/L) and 88-10 (131 pCi/L). The full extent of ground-water contamination in this area will be investigated under the IAG as part of the OU I RI/FS (AOC 1), which will begin in CY 1994, depending on funding availability.

Current Landfill

Ground-water from surveillance wells were installed at the Current Landfill and downgradient areas to monitor VOCs. During 1993, the following VOCs were detected: TCA in Wells 107-09 (6 μg/L), 107-13 (10 μg/L), 115-04 (24 μg/L); DCA in Wells 87-07 (6 μg/L), 107-08 (5.5 μg/L), and 115-05 (120 μg/L); DCE in Well 115-05 (6 μg/L); Benzene in Wells 87-05 (7 μg/L), 87-07 (6 μg/L), and 87-11 (6 μg/L); Toluene in Well 87-11 (5 μg/L); Chloroethane in Well 87-10 (6 μg/L); and Methylene Chloride in Wells 107-09 (6 μg/L) and 115-05 (22 μg/L). The following metals were present in ground-water samples at concentrations above NYS DWS: Fe in Wells 87-04 (74.90 mg/L), 87-05 (85.25 mg/L), 87-06 (57.08 mg/L), 87-07 (53.83 mg/L), 87-10 (134.00 mg/L), 87-11 (62.56 mg/L), 87-12 (24.00 mg/L), 88-01 (0.56 mg/L), and 88-02 (6.47 mg/L). No radionuclides were detected above NYS DWS during 1993. The full extent of ground-water contamination in this area will be investigated under the IAG as part of the OU I RI/FS (AOC 3), which will begin in CY 1994, depending on funding availability.

Former Landfill

During 1993, PCE was detected in Well 97-02 at a concentration of 7.3 μg/L. Ground-water surveillance wells were installed at the Former Landfill area to monitor VOC, metals, and radionuclide contamination resulting from past disposal practices. Iron was detected in Well 97-08 (0.32 mg/L). No radionuclides were detected above NYS DWS during 1993. The full extent of ground-water contamination in this area will be investigated under the IAG as part of the OU I RI/FS (AOC 2), which will begin in CY 1994, depending on funding availability.

Supply and Material Warehouse Area

Ground-water surveillance wells were installed in the Supply and Material Warehouse area to assess potential ground-water contamination resulting from underground storage tanks and past chemical spills. During 1993, TCA was detected in Wells 83-03 (30 μg/L), 96-06 (54 μg/L), and 105-02 (7 μg/L); and PCE was detected in Well 105-02 (36 μg/L). During 1993, three new surveillance wells were installed near Building 208, which is one of several potential source areas for the TCA detected in this area. The TCA was detected in a ground-water sample collected from one of the new downgradient wells (temporary Well ID Number 3), at a concentration of 340 μg/L. Iron was detected above NYS DWS in Well 105-02 (1.34 mg/L). No radionuclides were detected during 1993. Further investigation of this area will be conducted under the IAG as part of the OU III RI/FS (AOC 26), which is scheduled to begin in CY 1995, depending on funding availability.

Peconic River/ Sewage Treatment Plant Area	Surveillance wells in the STP area monitor ground-water quality near the STP's sand filter beds and along the Peconic River which receives SPDES regulated discharges from the STP. During 1993, 15 new wells were installed in an effort to upgrade BNL's ground- water monitoring capabilities in the STP/Peconic River area. Ground-water samples from new and existing wells did not exceed NYS DWS for VOCs. However, the following metals were present in ground-water samples: Fe in Wells 39-03 (1.01 mg/L), 39-04 (3.56 mg/L), 39-05 (0.69 mg/L), 39-06 (1.53 mg/L), 40-01 (13.95 mg/L), 40-02 (5.02 mg/L), 40-04 (0.97 mg/L), 47-01 (3.96 mg/L), 47-02 (6.30 mg/L), and 48-01 (0.32 mg/L); Pb in Well 40-02 (0.021 mg/L); and Zn in Well 40-04 (8.2 mg/L). Most of these high metals concentrations are from samples collected from older, deteriorating wells that are constructed of carbon steel casings and brass screens, and may not truly represent a degradation in ground-water quality. Nitrates were also detected at elevated concentrations in Well 39-05 (10.5 mg/L). No radionuclides were detected above NYS DWS during 1993. Further remedial investigation of this area will be conducted under the IAG as part of the OU V RI/FS (AOC 23), which is scheduled to begin in CY 1994, depending on funding availability.
Meadow Marsh, Upland Recharge, and Biology Agriculture Field Area	Ground-water samples collected from permanent surveillance wells and from temporary wells installed during a cooperative investigation with the SCDHS indicate that ethylene dibromide (EDB) was detected in the following wells: in permanent Well 99-06 (0.18 μg/L); and in temporary Wells SC-2 (1.0 μg/L), SC-3 (3 μg/L), SC-4 (0.13 μg/L), SC-5 (0.12 μg/L), SC-12 (0.25 μg/L), SC-13 (0.06 μg/L), SC-23 (1.15 μg/L), SC-24 (0.59 μg/L), and SC-27 (0.07 μg/L). The following metals have been detected: Fe in Wells 89-01 (0.36 mg/L) and 100-04 (5.5 mg/L); Pb in Well 100-03 (0.025 mg/L); and Cr in Well 100-03 (0.052 mg/L). Radionuclides that exceeded NYS DWS were detected in the following well: Gross alpha was detected in Well 100-04 at 19.6 pCi/L. Further remedial investigation of this area will be conducted under the IAG as part of the OU VI RI/FS (AOC 8), which is expected to be combined with OU I RI/FS field work and will be initiated in CY 1994.

2.3 Clean Water Act (CWA)

2.3.1 SPDES Permit

Sanitary and process waste waters discharged from the operations conducted at BNL are regulated by a SPDES permit which is issued by the NYSDEC. Specifically, effluents discharged to five recharge basins and the Peconic River are currently governed by monitoring requirements and effluent limitations contained in the SPDES Permit (NY-0005835). Deviations from the permit limitations or monitoring requirements which occurred during 1993 are described in the subsequent sections of this chapter.

During 1993 the Laboratory continued to negotiate its' SPDES permit renewal with the NYSDEC. Redrafts of the SPDES permit were issued by the NYSDEC on July 9, 1993 and October 22, 1993. These permits were reviewed with regard to their impact on Laboratory operations by the PE and SEPD and comments were transmitted to the NYSDEC. The proposed SPDES permit will drastically change the BNL compliance sampling requirements. Increases in sampling frequency and analytical parameters for the STP discharge, biomonitoring of the STP effluent, monthly sampling and analysis for discharges to the recharge basins, and several engineering evaluations are just some of the proposed changes to the existing permit. As of December 1993 a few issues remain which must still be negotiated. The most important of these issues is the relaxation of permit limitations for cooling water discharges to the local recharge basins. Other issues concern modification of the biomonitoring requirements and extensions to project schedules. These requested changes should not prolong the issuance of the SPDES permit and a final permit is expected to be received during the first half of 1994.

In addition to the routine compliance requirements conducted during 1993, storm water was also sampled. As stipulated in the EPA (National Pollutant Discharge Elimination System (NPDES) Storm Water Regulations, storm water discharges to surface waters were sampled and analyzed for conventional and process specific analytical parameters. A copy of the final report, which outlined the results of this sampling effort, was transmitted to the NYSDEC in August 1993.

2.3.1.1 Recharge Basins

The BNL maintains seven recharge basins for the discharge of process cooling waters, storm water runoff, and in the case of Recharge Basin HX, water filter backwash from the WTP. Cooling water is discharged to Basins HN, HO, HP, HS, and HT and storm water is discharged to Basins HN, HO, HS, HT, and HW. Presently only five of these discharges are included on the existing BNL SPDES permit (Recharge Basins HN, HO, HP, HS, and HT); however, the remaining two basins (i.e., Recharge Basins HW and HX) have been included with the proposed SPDES permit. The proposed SPDES permit contains numerous additional monitoring requirements for discharges to the recharge basins including measurement and monthly reporting of flow, pH, oil, grease, and quarterly monitoring for numerous analytical parameters. Storm water has also been identified as a contributor to the recharge basin discharges.

Discharges of waters to recharge basins (i.e., Class GA ground-water discharges) are regulated by the NYSDEC as stipulated in 6NYCRR Part 703.6. The existing BNL SPDES permit requires that BNL maintain records of flow and pH to the five permitted recharge basins. These discharges are monitored quarterly for pH by the SEPD EM group and records of flow are maintained by facility operators. Ground-water discharge regulations limit the pH for these effluents to the range of 6.5 to 8.5 SU. On April 19, 1993, the pH of a grab sample collected from Recharge Basin HS was recorded at 9.3 SU and on July 8, 1993, the pH of a grab sample collected at Basin HW measured 8.7 SU. These recharge basins receive predominantly rain water run-off although Recharge Basin HS receives small amounts of cooling water from the NSLS. All other pH values recorded for the remaining recharge basins were within NYS limitations. Due to the high ambient iron concentration within the ground water, which is utilized for once-through cooling, water containing elevated iron concentrations was discharged to Recharge Basin HO in concentrations greater than the NYS ground-water discharge limitation of 0.6 mg/L.

Recharge Basin HP, which receives once-through cooling water from the MRR, remained out of service during CY 1993 due to TCA contamination of the process wells which previously supplied this cooling water. During 1993 all cooling water used by the MRR was supplied by the BNL central chilled water plant. Construction of an activated carbon adsorption system for the process well serving the MRR was completed in 1993. This is anticipated to be placed back in service sometime in early 1994.

2.3.1.2 STP Effluent

In accordance with the conditions of the BNL SPDES permit, twenty (20) parameters are reported in the monthly Discharge Monitoring Report (DMR) which is submitted to both the NYSDEC and SCDHS. Samples are collected by BNL personnel in accordance with BNL SOPs and QA protocols. Eleven parameters (nitrogen, metals, organics, BOD_5, total suspended solids, fecal coliform, and total coliform) are analyzed by contractor laboratories. Gross alpha, gross beta, Sr-90, and tritium are analyzed by the SEPD Radiological Laboratory which is certified by the NYSDOH for these analyses. The remaining parameters are recorded/analyzed by the STP operators. The analytical data for the DMRs submitted in 1993 have been summarized in Tables 2 and 3.

Review of data presented in Tables 2 and 3, indicates that five exceedances of the SPDES permit discharge limits were observed at the STP effluent during 1993; three for residual chlorine and one each for iron and ammonia nitrogen. Three grab samples collected between March 5, 1993 and March 8, 1993 exhibited residual chlorine concentrations ranging from 0.08 mg/L to 0.45 mg/L which exceed the SPDES permit limitation of 0.05 mg/L. These exceedances were attributed to a malfunctioning hypochlorite dosing pump which was replaced on March 8, 1993.

The iron and ammonia exceedances occurred in November and December 1993, respectively. The direct cause of these exceedances was not evident; however it is speculated that construction disturbances to the sand filter beds which resulted in the overloading of two of the beds, may have contributed to these exceedances. The BNL STP is a primary treatment system consisting of prechlorination, a primary clarifier for the separation of settleable solids and floatable materials and intermittent sand filters for the separation of suspended particulate matter. In an effort to improve the effluent water quality, the PE Division completed preliminary design plans for upgrading the STP to an activated sludge treatment system in 1993. Design and construction of the STP upgrade is to be conducted in two phases. Phase 1 of the proposed plant consists of constructing two modular aeration tanks and installation of a UV disinfection system: Phase 2 consists of installing rapid sand filters. During the design phase of this project, ground-water was encountered at higher than expected levels. Dewatering costs associated with the increase in ground-water elevation proved prohibitive to the overall project. In November and December 1993, in an effort to investigate the cause of the increased ground-water elevation, test holes were dug within the existing sand filters and pumps installed to study the hydraulic characteristics of the surrounding soils. This investigation resulted in four of the six filter beds being removed from service leaving only two beds for treatment of the waste water. All filter beds are expected to be returned to service during the first quarter of 1994.

Table 2
BNL Site Environmental Report for Calendar Year 1993
SPDES Compliance for Sewage Treatment Plant Effluent (Outfall 001)

Parameter	Permitted Frequency of Sample/Yr	Actual Frequency of Sample/Yr	Maximum Effluent Value		SPDES Permit Limit		No. of Exceedances (per yr)
Temperature	250	250	79	°F	90	°F	0
Gross β	250	365	18.9	pCi/L	1000	pCi/L	0
BOD_5	12	12	18	mg/L	20	mg/L	0
pH (Min)	365	365	5.9	SU	5.8	SU	0
pH (Max)	365	365	7.2	SU	9.0	SU	0
Suspended Solids	12	12	<5.0	mg/L	10.0	mg/L	0
Settleable Solids	250	250	0.0	ml/L	0.1	ml/L	0
Ammonia-Nitrogen	12	12	5.27	mg/L	2.0	mg/L	1
Cu (concentration)	12	12	0.114	mg/L	0.4	mg/L	0
Cu (loading)	12	12	0.58	#/day		#/day	0
Fe (concentration)	12	12	0.85	mg/L	0.6	mg/L	1
Pb (concentration)	12	12	<0.05	mg/L*	0.067	mg/L	0
Pb (loading)	12	12	<0.28	#/day	0.75	#/day	0
Ag (concentration)	12	12	0.034	mg/L	0.05	mg/L	0
Ag (loading)	12	12	0.14	#/day	0.75	#/day	0
Zn (concentration)	12	12	0.13	mg/L	0.3	mg/L	0
Zn (loading)	12	12	0.73	#/day	4.5	#/day	0
Gross α	250	365		pCi/L		pCi/L	0
Strontium-90	12	12	0.33	pCi/L	10.0	pCi/L	0
Flow	365	365	0.838	MGD	1.8	MGD	0
Chlorine (residual)	250	255	0.45	mg/L	0.05	mg/L	3
Fecal Coliform	12	13	1600	MPN/100ml	2000	MPN/100ml	0
Total Coliform	12	13	2400	MPN/100ml	10000	MPN/100ml	0
Tritium	250	365	17.0	nCi/L	NA		0
1,1,1-TCA	12	12	<5.0	μg/L	50	μg/L	0
Total	2787	3139					5

*The minimum detection limit (MDL) for lead varied from 0.003 mg/L to 0.05 mg/L. The maximum reported detected concentration of lead discharged during 1993 was 0.007 mg/L.

NA: SPDES permit limit not specified.

Table 3
BNL Site Environmental Report for Calendar Year 1993
Summary of Monthly DMR Values for the STP Discharge

PARAMETER	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	UNITS
Max. Temp.	52	48	55.4	63	69.8	75	79	79	77	71.6	64	59	°F
Gross β	12.4	15.9	15.9	11.4	11.0	18.9	11.1	12.1	11.7	17.2	17.2	15.6	pCi/L
BOD5	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	6.0	5.0	18.0	mg/L
pH (min.)	5.9	6.3	5.9	6.1	5.9	6.0	6.0	6.0	6.1	5.9	6.0	6.0	SU
pH (max.)	6.9	6.8	7.2	6.8	7.2	6.6	6.6	6.6	6.8	6.6	6.8	7.0	SU
Suspended Solids	<5.0	4.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	mg/L
Settleable Solids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ml/L
Ammonia	0.3	1.9	0.96	0.14	<0.05	0.13	0.18	1.14	<0.05	0.7	0.63	5.27	mg/L
Cu (max conc)	0.061	0.112	0.111	0.056	0.038	0.038	0.04	0.043	0.052	0.012	0.046	0.114	mg/L
Cu (load)	0.3	0.513	0.583	0.31	0.17	0.24	0.28	0.23	0.33	0.075	0.26	0.46	#/day
Fe (max conc)	0.29	0.302	0.217	0.232	0.207	0.18	0.186	0.152	0.17	0.28	0.85	0.31	mg/L
Pb (max conc)	0.004	0.045	0.003	<0.05	<0.003	<0.003	<0.003	0.004	0.0035	0.004	0.007	0.005	mg/L
Pb (load)	0.021	0.021	0.017	<0.28	<0.014	<0.019	<0.021	0.026	0.022	0.025	0.039	0.02	#/day
Ag (max conc)	0.005	0.081	0.004	<0.01	<0.006	<0.006	<0.006	0.013	<0.006	0.011	0.004	0.034	mg/L
Ag (load)	0.024	0.037	0.021	<0.06	<0.027	<0.038	<0.042	0.085	<0.038	0.069	0.022	0.14	#/day
Zn (max conc)	0.053	0.069	0.05	0.045	0.024	0.031	0.041	0.092	0.039	0.031	0.13	0.042	mg/L
Zn (load)	0.25	0.32	0.26	0.25	0.108	0.20	0.29	0.6	0.25	0.19	0.73	0.17	#/day
Gross α	2.5	2.98	2.98	1.64		2.26	2.55	2.4	2.73	2.79	2.8	ND	pCi/L
Sr 90	<0.14	0.33	<0.27	<1.93	<0.14	<0.13	<0.123	<0.117	0.13	0.09	0.08	0.31	pCi/L
Flow	0.681	0.667	0.765	0.836	0.838	0.827	0.843	0.783	0.806	0.763	0.692	0.538	MGD
Cl(res)	0.0	0.0	0.45	0.0	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	mg/L
Fecal Coliform	170	49	<2	540	79	23	1600	1600	220	461	26	80	MPN/100ml
Total Coliform	220	240	70	2400	110	23	1600	1700	280	335	220	300	MPN/100ml
Tritium (max.)	11.8	5.05	5.05	7.42	9.74	17	6.1	6.6	6.7	13.6	14.7	1.9	nCi/L
TCA	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	µg/L

ND: Not Detected

The redrafted SPDES permits received in July and October 1993 contained numerous modifications to the monitoring requirements for the STP discharge including: reduced effluent limitations, deletion of radiological monitoring, deletion of mass load limitations, increases in monitoring frequency and analytical parameters, and requirements for a biomonitoring program. The biomonitoring program specified in the proposed SPDES permit is a Tier II seven day chronic test using fathead minnows and ceriodaphnia as the test organisms. Preliminary biomonitoring tests conducted in 1993 have shown there were no acute toxicity associated with the STP effluent and that there was no chronic toxicity exhibited for the fathead minnows. Chronic toxicity tests for the ceriodaphnia did indicate a negative effect on the reproduction of these organisms. In two of the three tests conducted, the rate of reproduction was markedly lower in the STP effluent than in the control. Investigation into the cause of the reduced reproduction rate has revealed that the hardness of the STP effluent and consequently that of the Peconic River, was much less than the water used to raise the organisms. According to the NYSDEC and the contract laboratory, Cosper Environmental Services Inc., the shock caused by the reduced hardness will result in reduced reproduction. In order to negate the effect of the water hardness, organisms acclimated to a hardness similar to the Peconic River will be used in future tests.

In addition to the modifications to the STP effluent parameters, monitoring of specific process discharges will also be conducted under the condition of the new SPDES permit. Specifically the effluents from the Photography and Graphic Arts Division, NSLS Acid Cleaning Facility, and the Instrumentation Division Printed Circuit Board Laboratory will be monitored quarterly for contaminants specific to these operations.

2.3.2 SPDES Inspections and Audits

On November 23, 1993, the NYSDEC Region 1 Division of Water conducted an inspection of the BNL permitted SPDES outfalls. This consisted of a walk-through inspection of the STP, recharge basins, and inspections of process specific discharges. During this inspection, waste water samples were collected from the STP effluent and the recharge basins. As of December 31, 1993, the analytical results for these samples were not received from the NYSDEC.

Up until January 1993, the operations of the STP were routinely monitored by the SCDHS. Due to reduced state funding for monitoring and inspections of local sewage treatment plants, the SCDHS conducted only one inspection of the STP in 1993. This inspection found the STP operations to be satisfactory and all analytical data was found to be within the SPDES permit limitations. Due to the reduction in the SCDHS budget, inspections of the STP are not expected to occur in CY 1994.

2.3.3 National Pollutant Discharge Elimination System (NPDES) Analytical Quality Assurance

The Laboratory participates in the NPDES Laboratory Performance Evaluation Program administered by the EPA. On March 2, 1993, proficiency check samples were received from the EPA and subsequently forwarded to the two laboratories responsible for the specific analyte. The respective parameters performed by

Laboratory Name and Address	Analytical Parameters
H2M Labs Inc. 575 Broadhollow Rd. Melville, N.Y.	Copper, Lead, Iron, Zinc, BOD5, Total Suspended Solids, Ammonia-N, Nitrate-N, and TKN
BNL STP Operations Lab Upton, N.Y.	pH, Total Residual Chlorine

The analytical data for the proficiency check samples was forwarded to the EPA designated facility on April 21, 1993. With the exception of total suspended solids (TSS), all analytical data was found to be within acceptable performance limits. The concentration reported for TSS was 45.9 mg/L which was outside the acceptance limits established by the EPA. Investigation of the TSS value showed that the contractor laboratory had modified the analytical data by adding a correction factor of 5.0 mg/L to account for blank value of -5 mg/L. Correction of the analytical data should not have been performed and in the future will not be conducted unless the blank data proves greater than the method detection limit. The uncorrected result of 40.9 mg/L lies within the established acceptable range of results.

2.3.4 Major Petroleum Facility

The BNL CSF supplies steam for heating and cooling to all major areas of the Laboratory through an underground distribution system. The MPF is the storage area for the fuels used at the CSF. Brookhaven National Laboratory operates its MPF under a license (No. 01-1700) issued by the NYSDEC which has been renewed annually. The current MPF license was issued by NYSDEC on April 14, 1993, and has an expiration date of March 31, 1995.

The NYSDEC is required by Article 12 of the Navigation Law[26] to protect and preserve the lands and waters of New York State from all discharges of petroleum and specifically from major petroleum storage facilities. In order to fulfill this responsibility, all major petroleum storage facilities are required to be registered with the NYSDEC and must have a license to operate. The license is contingent on several conditions. In addition to general ground-water monitoring conditions, additional conditions may be included from year to year.

All major petroleum storage facilities are required to install ground-water monitoring wells. The license has general conditions which include regular testing of monitoring wells for floating and dissolved product. Typically the testing for floating product can be performed by the owner of the facility; however, testing for dissolved product is required to be performed by a NYSDEC certified laboratory.

Five ground-water wells, one upgradient and four downgradient, are used for regulatory compliance monitoring of the BNL CSF. The well authorized for use by the NYSDEC as upgradient of the CSF is designated as Well ID 66-08 and is located approximately 1100 feet north of CSF Tank 611A. The four downgradient wells are designated as 76-16, 76-17, 76-18, and 76-19. Their approximate locations are shown in Figure 33. The well casings are constructed of polyvinyl chloride (PVC) and are four inches in diameter. These wells have PVC screens which are 20 feet in length and straddle the water table.

In accordance with conditions of the MPF license, regulatory compliance samples were collected from these wells twice during 1993 and submitted to a NYSDEC certified laboratory. The NYSDEC requested analyses for these wells are to include purgeable aromatics, purgeable halocarbons, and polynuclear aromatics listed in EPA Methods 601/602 and 610. The analytical results were transmitted to the NYSDEC. Another condition of the MPF license is that these wells be monitored monthly for floating product. This condition was fulfilled during CY 1993 and no floating product was found in any of these wells.

In addition to these compliance samples, these wells are also monitored several times a year as part of the BNL routine EM program. Analytical results from the routine monitoring program are discussed in Chapter 5 of this report.

One final condition of the BNL MPF license was that the Laboratory update its Spill Prevention, Control, and Countermeasures (SPCC) Plan by the fall of 1993. This condition was met and efforts associated with it are described below.

2.3.4.1 Spill Prevention, Control, and Countermeasures (SPCC) Plan

Brookhaven National Laboratory has had an SPCC Plan since the early 1980's. The early Plans contained a complete listing of all oil storage tanks with capacity and building numbers. In the mid 1980s direction from NYSDEC led to including only those storage tanks associated with the CSF and the Motor Pool Fuel Storage area (Building 326) on the SPCC storage tank listing. This Plan was revised in 1982, 1983, 1985, 1987, and 1990. All revisions have been submitted to the NYSDEC.

As a direct result of the Exxon Valdez, the American Trader and other waterway disasters, Congress enacted the Oil Pollution Act of 1990 (OPA-90). This Act contains significant modifications to many of the provisions of the CWA. One of these requirements is that facility owners/operators must prepare response plans outlining response capability to a "worst-case" discharge which is defined as the "largest foreseeable discharge in adverse weather conditions". These terms have been described in the legislative history to mean "a case that is worse than either the largest spill to date or the maximum probable spill for the facility type". Congress mandated that regulations implementing facility response plan requirements be issued not later than August 18, 1992. The statutory deadline for submission of the Facility Response Plans was February 18, 1993.

Although regulations implementing facility response plan requirements were not issued until February 17, 1993, BNL had contracted with an engineering consulting firm to prepare a facility response plan. This plan was submitted to EPA on February 18, 1993.

In accordance with the MPF license condition, the Laboratory revised its SPCC Plan to reflect the current methods, mechanisms, and equipment available to address a spill at the facility. A description of oil spill occurrences and corrective actions is discussed. In addition, the compliance status with NYSDEC regulations is provided. The revised SPCC Plan was submitted to NYSDEC in October 1993.

2.3.5 Oil/Chemical Spills

During 1993, members of the S&EP EP Section responded to a total of 40 incidents where the potential existed for a release of oil or chemicals to the environment. Table 4 provides a summary of these incidents which include the date each incident occurred, the material involved, the amount of material released, and a brief explanation of the corrective actions taken. Seven of these incidents involved releases which were completely contained within the building and did not reach the environment. Eight of these incidents required EPA, NYSDEC, and SCDHS notifications. These spills were cleaned up and the associated contaminated absorbent and affected soil were sent off site for disposal in an approved manner. As can be seen from Table 4, the remainder of these incidents involved very small quantities of material which were typically contained on asphalt, concrete, or other impervious surfaces. Cleanup procedures were implemented and there were no environmental impacts as a result of these occurrences.

Table 4
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
1/12	Antifreeze	< 1 gal	No	Private auto radiator; collected using a wet vacuum and placed into containers for off-site disposal.
1/20	Transformer Oil	5 gal	Yes	High voltage power supply; polysorb pigs were placed around the power supply as well as a nearby storm drain. Speedi-dry was used to absorb spilled product. The power supply was hoisted into an overpack.
1/29	Diesel Fuel	< 1 qt	No	Cracked gate valve on storage tank; valve was replaced. Spillage was within secondary containment structure; oil absorbent pads were used remove the oil from the surface of the rainwater within the berm.
2/9	Oil	< 2 qt	No	Electrical equipment; samples were collected using the standard EPA wipe test to determine whether PCBs were present. PCB contaminated areas were decontaminated using kerosene.
2/19	TEMED	3 oz	No	Lab reagent bottle; spilled material and glass were immediately removed from the floor area using kimwipes and all materials were placed in an operating fume hood.
2/26	Gasoline	1.5 gal	No	Pick up truck; a pan was placed under the truck to collect additional leakage. The gas tank was plugged. Spillage was on asphalt. Speedi-dri was applied to spillage and placed in a drum for off-site disposal.
3/19	Ethylene Glycol	1.5 gal	Yes	Container fell off contractors vehicle; absorbent material was applied to spillage and placed in a drum for off-site disposal.
4/5	No. 2 Waste Fuel	20 gal	Yes	Piping to outdoor above ground storage tank; exterior of tank was cleaned using a degreasing agent and by steam cleaning. Rinsate was collected for appropriate disposal. Contaminated gravel within containment area was drummed for off-site disposal.

Table 4 (Continued)
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
4/14	Gear Oil	< 1 qt	No	Contractor drill rig; Speedi-dry was applied to spillage and placed in a drum for off-site disposal.
4/14	PCBs	1 gal	Yes	Capacitor; Capacitor was placed in a drum for off-site disposal. Visibly stained areas were sampled using the standard EPA wipe test and double washed/rinsed using kerosene. Analytical results from resampling indicated PCBs were still present above EPA cleanup limits. The area was then encapsulated using an epoxy resin based paint.
4/20	PCBs	3 oz.	No	Capacitor: Capacitor was placed in a drum for off-site disposal. An oil stain was visible on the wood pallet upon which the capacitor sat and the concrete floor beneath the capacitor. The stained area was sampled; double washed and rinsed using kerosene, and resampled. Although the double wash/rinse removed some of the PCBs from the concrete floor, the concentrations were still significantly above the EPA cleanup criteria. Rather than continue the double wash/rinse procedure, it was decided to remove the contaminated concrete (approximately 1 square foot).
4/22	Hydraulic Fluid	< 1 qt	No	Truck hydraulic line; a temporary berm was constructed to prevent the spill from entering a nearby stormdrain. Absorbent pads were used to clean up the spillage.
5/1	Cooling Water	500 gal	No	AGS Main Magnet cooling system; all water was contained within the building sump. The water was sampled and pumped from the sump for appropriate disposal.

Table 4 (Continued)
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
4/27	PCB Oil	4 oz	No	Capacitor; Leaking capacitor was put in a plastic container temporarily and later transferred to an acceptable container for disposal. Speedi-dry was used to absorb the standing oil and later placed into a container for off-site disposal. The spill area was sampled using the EPA standard wipe test, cleaned with LPS-Presolve Cleaner, and resampled. Results from resampling indicated no further cleaning was required.
5/14	Transformer Oil	1 gal	Yes	Tank truck; contaminated soil was placed into four drums for off-site disposal.
5/13	Oil/Tar	2 oz	No	Fluorescent light ballast; samples were collected using the standard EPA wipe test to determine whether PCBs were present. Analytical results indicated PCBs were not present above EPA cleanup limits.
5/19	Cleaning Solvent	< 8 oz	No	Leaking container; while unloading a delivery truck, it was noticed that one box was wet apparently from a leaking container inside the box. Upon further examination, it was determined that the leak occurred in transit and there was no sign of an active leak. There were no cleanup efforts other than the disposal of the box.
7/6	No. 6 Oil	< 0.5 gal	No	Piping to outdoor above ground storage tank; oil absorbent pads were applied to the water surface to remove the oil sheen.
7/6	Antifreeze	1 gal	No	Private auto; absorbent material was applied to spillage and placed in a drum for off-site disposal.

Table 4 (Continued)
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
7/13	Anhydrous Ammonia	Unknown	No	Unopened case of anhydrous ammonium hydroxide; a strong odor of ammonia was noticed when a case containing six two-liter bottles of the product was opened. An inspection of the bottles revealed no signs of cracks or other physical damage. Due to the extended period of hot weather over the weekend, it is believed that internal building temperatures caused ammonia vapors to be released and accumulate within the box.
6/14	PCB Oil	2 oz	No	Capacitor; leaking equipment was placed into a drum for off-site disposal. Contaminated asphalt was removed and placed into a separate drum for off-site disposal.
8/23	No. 2 Oil	1 qt	No	Feed line to 275 gal. storage tank; lines were disconnected and removed. Speedi-dry was used to absorb spillage on the asphalt and placed into a drum for off-site disposal. Piping was replaced prior to start of the heating season.
9/8	Hydraulic Fluid	1 qt	No	Fork lift hydraulic line; Speedi-dry was applied to spillage and placed into a drum for off-site disposal.
9/10	Contact Adhesive	2-3 gal	No	Container fell off vehicle; a Speedi-dry berm was formed to prevent down gradient movement of the spilled product. Sorbent pads which were used to collect spilled product were placed in a plastic bag and 55 gallon drum for disposal.
9/15	Motor Oil/ Diesel Fuel	2-3 gal	No	Overturned vehicle; A combination Speedi-dry and sorbent sock berm was formed to prevent movement of the spilled product downgradient and onto the adjacent soil. Contaminated soil and sorbent materials were placed into 55 gallon drums for off-site disposal.
9/16	No. 6 Oil	60 gal	Yes	Fuel vendor transport vehicle; pooled oil was pumped into storage tank; Speedi-dry was used to absorb residual oil.

Table 4 (Continued)
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity		Rpt*	Source/Cause; Corrective Actions
9/27	Glycol	2	qt	No	Private automobile; absorbent material was applied to spillage and containerized for off-site disposal.
10/01	Acid	1	qt	No	Electric Cart battery; neutralizing agent was applied to spillage and resultant material was containerized for off-site disposal.
10/07	Acid	1	qt	No	Forklift battery; neutralizing agent was applied to spillage and resultant material was containerized for off-site disposal.
10/07	Hydraulic Oil	30	gal	Yes	Vehicle hydraulic system; absorbent material was was applied to spillage and containerized for off-site disposal.
10/08	Drewsperse 744	1	gal	No	Portable storage tank; during transport, the cover of a 400 gallon tank loosened allowing approximately one gallon to splash out of the tank. The tank and forklift were rinsed off resulting in a puddle of approximately ten gallons. A submersible pump was used to collect the standing liquid and Speedi-dry was applied to absorb any residual spillage. A small section of soil which had come in contact with the spilled chemical was also removed.
10/08	Freon-12	50	lbs	No	Piping to refrigeration compressor; the copper refrigeration piping on the high pressure side of the system burst. Affected piping was repaired/replaced.
10/13	Ultima-Gold	1	gal	No	Container fell off forklift; absorbent material was applied to the spillage and disposed as conventional trash since this product is not a hazardous waste.
10/15	Transite Board	5	lbs	No	Building construction material; the material was moistened by the BNL Fire Group and the BNL asbestos response team rebagged the material.
10/29	PCBs	3	oz	No	Electronic equipment; samples were collected using the EPA standard wipe test. PCBs were found to be present. Equipment was placed in drums for off-site disposal.
11/16	Hydraulic Oil	< 1	qt	No	Hydraulic line on backhoe; absorbent material applied to spillage and containerized for off-site disposal.

Table 4 (Continued)
BNL Site Environmental Report for Calendar Year 1993
Summary of Chemical and Oil Spill Reporting Record

Date	Material	Quantity	Rpt*	Source/Cause; Corrective Actions
11/18	Petroleum Products	3-5 gals	Yes	Old transfer pipe; during remediation of an old spill area, an abandoned petroleum transfer piping was encountered. While manually removing a section of this pipe, approximately three to five gallons of petroleum was released to the ground. Affected soil was removed and will be disposed along with the other contaminated soils being removed.
11/19	Sulfuric Acid	1 pt	No	Vehicle battery; acid was neutralized and resultant material was containerized for off-site disposal.
11/29	Diesel Fuel	0.5 gal	No	SCDHS drill rig fuel line; SCDHS was responsible for containerizing all contaminated soil and grass and for appropriate disposal of contaminated materials.
12/21	H.K. Rapid Dry Primer	< 5 gal	No	Five gallon container blown over by heavy winds; contaminated rocks and soil were placed in drums for off-site disposal.

* Reported to Off-site Regulatory Agencies.

2.3.5.1 Investigation of Mercury Contaminated Soils at Building 464

On May 7, 1993, mercury contaminated soils were unearthed during construction of an office addition to Building 464. The construction project required that a storm water catch basin located within the construction zone be relocated. During excavation for the new basin, metallic mercury was discovered in the excavated soil. Construction activities were immediately suspended to allow for investigation and remediation of the mercury source. Examination and careful excavation of the area indicated that a storm water catch basin, which had previously existed, had been backfilled and a piece of transite pipe installed in its place. Excavation of the bottom of the former storm basin revealed the presence of additional metallic mercury.

The construction site was within the footprint of the former chemistry complex which was operated from 1947 through 1966. In 1966, construction of the present chemistry building was completed and all chemistry operations transferred to the new facility. During the period from 1966 to 1970, the former chemistry complex was razed and the area reverted to a grass field. Interviews with chemistry department personnel and inspection of old photographs of the former chemistry complex and storm water utility maps revealed that the former chemistry complex and adjacent buildings were serviced by a series of storm water catch basins. One of these basins, the basin containing the metallic mercury, was located immediately outside a room where metallic mercury was purified and recovered by distillation.

During the week of May 10, 1993, the discovery of mercury was reported to the IAG Project Managers and to the DOE. A clean-up standard of 1 mg/Kg was proposed and accepted by the IAG. The cleanup was concluded as a time critical removal action under the IAG.

A total of four concrete block basins and interconnecting piping were unearthed during the course of the ensuing investigation; two of the basins were equipped with steel grates and were visible from grade. During the period of May 7, 1993 and June 23, 1993, a total of 111 soil samples were collected from the subject site and analyzed for mercury. The mercury concentration exhibited in these samples ranged from less than 0.1 mg/Kg to 17,000 mg/Kg. The highest concentration of mercury appeared to be concentrated within the catch basins with lower concentrations along the interconnecting piping. In addition, low concentrations of PCBs (i.e., less than 50 mg/Kg) were discovered in one of the concrete block basins.

Remediation of the site consisted of excavating and disposing all soils containing greater than 1 mg/Kg mercury and all soils with PCB concentrations greater than 10 mg/Kg. Disposal of contaminated soils containing mercury at concentrations less than 260 mg/Kg was accomplished via bulk shipment to the RCRA permitted Model City Landfill operated by Chemical Waste Management, Inc. In total approximately 265 tons of contaminated soils were disposed in this fashion. Soils containing greater than 260 mg/Kg mercury were segregated and placed into 55 gallon drums for eventual disposal via retort reclamation. Due to a backlog in shipments to the disposal facility, these materials are being held temporarily at the BNL permitted hazardous waste storage facility. Eight drums of soils containing greater than 260 mg/Kg are being stored pending disposal at Bethlehem Apparatus Co. Inc., the proposed retort facility.

Once remediation was deemed complete, final soil samples were collected from the bottom of each of the four concrete block structures and analyzed for the list of Target Compounds and Target Analytes contained in the EPA Contract Laboratory Protocol. These analyses showed the remaining soils to contain near ambient concentrations of inorganic parameters and no detectable concentrations of organic contaminants. The concentration of mercury exhibited in these samples ranged from 0.21 mg/Kg to 1.5 mg/Kg. All remedial activities were completed on October 7, 1993. An Action Memorandum, which was formally documented in the cleanup of this area, was approved by the IAG agencies in December 1993.

2.4 Clean Air Act (CAA)

2.4.1 Conventional Air Pollutants

During 1993, a variety of BNL emission sources were evaluated with respect to NYS and Federal permitting requirements. The applicable regulations for these sources are the Codes, Rules, and Regulations of the State of New York, Title 6, Chapter III, Part 200, NYS Air Pollution Control Regulations and the Federal CAA. A summary of the sources reviewed and their current permit status is provided below:

No. of Actions	Status/Comments
2	Requests were submitted to NYSDEC in January and February, respectively, to renew the COs for the CSF Boiler No. 1A and Boiler No 6 (Emission ID Nos. 6101A and 61006). The NYSDEC had not reissued COs for these sources by the end of CY 1993. Both sources continue to operate under the provisions of the Uniform Procedures Act.[27]
1	In February 1993, NYSDEC issued a Permit to Construct (PC) the exhaust system for a magnet coil epoxy coating operation (Emission ID No. 19708). After the system was constructed, a representative from NYSDEC inspected the source in April to verify the accuracy of information provided in the application. Following the inspection, the NYSDEC issued a CO for the source in June 1993.
12	In February 1993, COs were issued by NYSDEC for seven existing emission sources (Emission ID Nos. 42305, 70301, 91903, 93001 to 93003, and 92402). In addition, an application to modify a CO for an existing degreasing operation (Emission ID No. 19702) was approved. Applications for these sources were submitted to NYSDEC in a package of 12 applications in October 1992. Three aerosol spray painting hoods were considered to be exempt from 6NYCRR Part 201 permit filing requirements by NYSDEC and therefore COs for these sources were not issued.
7	In March 1993, applications for COs for seven existing emission sources were submitted to NYSDEC (Emission ID Nos. 90202 to 90205, 90503, 92301, and 92403). In addition, an application to modify the CO for a printed circuit board

cleaning, etching, and plating process was submitted (Emission ID No. 53503). The processes covered by the applications included one belt sander, a fiberglass and micarta parts machining operation, the exhaust hoods for two brazing, soldering, and silverplating areas, two central vacuum systems which service parts machining equipment and one electronic equipment cleaning booth. The COs for all of these process exhaust systems, with the exception of the electronic equipment cleaning booth (Emission ID No. 92301), were issued by NYSDEC in May 1993.

9 In September 1993, COs were issued by NYSDEC for six existing emission sources (Emission ID Nos. 19705, 51002, 53504, 90201, 90303, and 92401). Applications for these sources were submitted to NYSDEC in December of 1990. Applications for two sources which had been removed from service in the period after the applications were submitted were withdrawn. Finally, a CO for an exhaust hood used for aerosol spray can painting was not issued because the NYSDEC deemed the source to be exempt from 6 NYCRR Part 201 permit filing requirements.

3 The NYSDEC approved applications to modify the existing COs for three emission sources (Emission ID Nos. 45801, 52601, and 90501) in September 1993.

1 In September 1993, a permit was issued to construct a new boiler at the CSF (Emission ID No. 61007). Construction of the new boiler (designated as Boiler No. 7) is expected to be completed in March 1995. The new boiler, which will replace existing Boiler No. 4, will be fitted with low NO_x burners capable of meeting the NYS Subpart 227-2 NO_x emissions limit of 0.3 lbs/MMBtu. In accordance with the special conditions of the Permit to Construct (PC), a stack test will be performed to measure emissions of NO_x, carbon monoxide, total particulates, PM_{10} particulates, and volatile organic compounds while the boiler is firing #6 residual oil. In accordance with NYS Subpart 227-2 and 40 CFR 60 NSPS Subpart Db requirements, the boiler will also be equipped with a continuous emissions monitoring system to measure and record NO_x levels and stack gas opacity.

2 Certificates to Operate cleaning room hoods located in Building 197 (Emission ID Nos. 19706 and 19707) were renewed by NYSDEC in November 1993.

In February 1993, a request was prepared by S&EP to obtain funding for a fire protection engineer to: conduct a survey of existing fixed Halon 1301 systems; evaluate the need for alternative systems; estimate the costs for those systems needing replacement; and make recommendations on the disposal of the halon inventory. During CY 1993, fourteen fixed Halon 1301 systems accounting for 920 pounds of product were decommissioned, one fixed system was converted to manual operation to reduce the potential for an accidental release, and portable equipment containing 306 pounds of Halon 1211 was replaced with extinguishers with non-halon agents.

The burning of PCB contaminated fuel in the CSF Boiler No. 5 which commenced on July 7, 1992 was officially completed on April 4, 1993 after the combustion of a total of 285,698 gallons of fuel. A final report on monthly combustion activity was submitted to EPA in April 1993. This is discussed in more detail in Section 2.7.2.

In August 1993, certification was provided to EPA that refrigerant recovery and recycling equipment had been purchased and was being utilized by PE in accordance with the requirements of Title VI Section 608 of the CAA Amendments. During the CY 1993, approximately 1900 pounds of R-11 and 1000 pounds of R-12 has been recovered and reclaimed for future use from existing equipment during servicing or during decommissioning. Refrigerant charges were recovered from five centrifugal chillers decommissioned in Buildings 701, 801, and 490 when these buildings were connected to the Central Chilled Water Facility.

Other efforts to manage existing inventories and ensure adequate supplies of refrigerants targeted to be phased out by the CAA Amendments, included the installation of ten of twelve high efficiency purge units purchased by PE for use on R-11 centrifugal systems, the purchase of sixteen 55 gallon drums of R-11 and ten 125 pound cylinders of R-12, and plans to order eight safety pallets and one 40 foot container for the storage of R-11 and R-12 containers. The primary task assigned to the BNL Refrigerant Phaseout Committee which met twice during the year, is to develop a Refrigerant Management and Phaseout Plan for the Laboratory. The Committee which began working on the plan in CY 1993, intends to follow the guidelines prepared by the DOE Office of Environmental Guidance in further preparation of this plan.

In September 1993, BNL representatives from PE and S&EP met with representatives from the NYSDEC Division of Air Resources in Albany to discuss the requirements of 6 NYCRR Subpart 227-2 and to ascertain the state's position on accepting various fuel switching compliance options that were being considered by the Laboratory. The information acquired during the meeting helped BNL to decide the approach it must take to comply with the NO_x Reasonable Available Control Technology (RACT) requirements of Subpart 227-2.

Effective October 1, 1993, 40 CFR Part 80.29 prohibited the sale, supply, transport, and dispensing of diesel fuel which had a sulfur content in excess of 0.05 percent (by weight) and which fails to meet a cetane index of 40 or greater. In addition, the fuel must not have any visible evidence of the dye 1,4-dialkylamino-anthraquinone. The diesel fuel supplier for the Laboratory has provided certification that as of October 1, 1993, all diesel fuel supplied meets these requirements. Furthermore, to ensure that all future purchases of diesel fuel comply with the requirements, PE has modified its fuel procurement specifications to include the requirements.

During the week of November 30, 1993, a relative accuracy test audit (RATA) of the continuous emission monitoring systems for Boilers No. 5 and No. 6 was conducted by York Services Corporation in accordance with the requirements of the Federal Facilities Compliance Agreement (EPA Docket No. II, TSCA PCB-85-0255), the BNL Order on Consent Agreement with NYSDEC to incinerate fuel oil containing PCB's and the QA requirements of 40 CFR 60 Appendix F and 40 CFR 60 NSPS Subpart Db. The report on the RATA had not been received before the end of CY 1993.

To address the 1993 Progress Assessment Team recommendation for improved record keeping of paint usage in the spray booth located in Building 457, PE now maintains a paint usage logbook of daily accounts of the types of paints and thinners used, the substrates coated and the VOC content of the coatings utilized.

In December 1993, a workgroup was formed to address the New York State Department of Transportation (NYSDOT) rules which require employers of 100 or more employees that reside in severe ozone non-attainment areas of the state to reduce the number of single occupant vehicles entering the worksite during the morning rush hours. The workgroup has been tasked with the preparation and the implementation of an Employee Trip Reduction Compliance Plan for the laboratory. In December, an initial draft employee commute option survey was prepared and a database to handle survey responses was developed. In addition, the workgroup submitted a request for funding from a NYSDOT sponsored grant program designed to provide financial assistance to nonprofit and government owned facilities. Grant monies awarded through the program are to be used to develop and implement innovative employee trip reduction programs.

2.4.2 National Emissions Standard for Hazardous Air Pollutants (NESHAPs)

2.4.2.1 Radioactive Airborne Effluent Emissions Governed by NESHAPs

In 1993, BNL emissions complied with 40 CFR 61 regulations regarding radioactive airborne effluent releases. The site boundary dose resulting from BNL airborne emissions as calculated using the CAP88 model was 0.120 mrem. The radionuclide contributing the largest fraction to both the site boundary and population dose was argon-41. The total released source term of this nuclide was about 1.4 times that released in 1992. The 1992 effluent release data and dosimetric impact of these releases were transmitted to both DOE and EPA in compliance with the June 30, 1993 reporting requirements specified in 40 CFR 61, Subpart 94. Also, BNL received a facility compliance inspection in 1993 with no deficiencies reported. There were no new emission sources in 1993 that required formal NESHAPs permitting.

Because of the Brookhaven Medical Research Reactor's (BMRR) status as a "major" source (as defined by NESHAPs), it requires equipment to perform continuous monitoring of its radioactive air effluent. Funding for such an upgrade was received in FY 1993 and a vendor was selected. The upgrade will provide the capability to conduct isokinetic sampling of particulate radionuclides, monitor Ar-41 releases in real-time, and conduct continuous stack flow measurements. This equipment is scheduled to be installed in June of 1994.

2.4.2.2 Asbestos Emissions

Since 1992, BNL emissions have complied with 40 CFR 61 regulations regarding airborne fiber releases. The EPA Region II was notified on one occasion that operations required NESHAPs formal notification. Formal annual notification for nonscheduled small renovation operations for 1993 was made indicating an estimated amount of total friable asbestos material projected to be removed in small removal operations at 1,326 square feet of surface material, and 2,507 linear feet of pipe insulation. This information was transmitted to both DOE and EPA in compliance with the reporting requirements specified in 40 CFR 61.

2.5 Suffolk County Sanitary Codes

There are over 200 storage facilities at BNL which are regulated under the Suffolk County Sanitary Code Articles 7 and 12. Since the signing of an agreement between Suffolk County and BNL in 1987, the Laboratory has made significant progress toward bringing all storage facilities into compliance with these requirements. A description and status of the activities conducted during 1993 is provided below:

No.	Status/Comments
1	A 6000 gallon outdoor underground tank (BNL ID# 535-01; SCDHS ID# 97) used to store diesel fuel at Building 535 was removed on May 21, 1993. The removal was witnessed by a representative from the SCDHS. Since no evidence of contamination was observed, approval was granted to backfill the excavation.
2	Two existing outdoor aboveground tanks at Building 811 (BNL ID#s 811-04 & 811-05; SCDHS ID#s 184 & 185) were to be removed and replaced with one tank as part of Phase III of BNL's tank upgrade program. Design documents were prepared and submitted to the SCDHS for their review and comment.
12	A project to bring twelve existing indoor tanks used to store water treatment chemicals into compliance with SCDHS requirements is currently in the design phase. The work will include the removal of eight tanks (BNL ID#s 490-13, 490-14, 490-15, 490-16, 576-01, 576-02, 576-03, & 634-01), installation of two new storage tanks (BNL ID#s 576-04 & 634-03), and equipping four tanks with secondary containment and overfill protection (490-11, 490-12, 635-01, & 637-01). It is anticipated to be initiated during CY 1994.

2.6 Safe Drinking Water Act (SDWA)

2.6.1 Applicability to BNL

The Laboratory maintains six wells and two water storage tanks for supplying potable water to the Laboratory community. Regulations pertaining to the distribution and monitoring of public water supplies are promulgated under Part 5 of the New York State Sanitary Code which is enforced by the SCDHS as agent for the NYSDOH. These regulations are applicable to any water supply which has at least five service connections or regularly serves at least 25 individuals. The Laboratory supplies water to a population of approximately 3,500 and must therefore comply with the provisions of these regulations.

2.6.2 Potable Water Monitoring Requirements

The potable water supply used at BNL was obtained from six wells during 1993. Annual minimum monitoring requirements for potable water suppliers are specified by the SCDHS. In response to these requirements, the Laboratory prepares a Potable Water System Sampling and Analysis Plan which outlines and provides a schedule for annual monitoring of the BNL potable water system. The content of the BNL monitoring program was reviewed and found acceptable by the SCDHS. Routine monitoring of the potable wells and the potable water distribution system by BNL exceeded the minimum monitoring requirements prescribed by the SCDHS. Monitoring requirements for 1993 included: monthly bacteriological analyses, quarterly analyses for POCs, SOCs, and Pesticides, semi-annual inorganic chemicals analyses and annual micro-extractables, asbestos and radiological analyses. Potable water samples were collected by BNL personnel and analyzed by a NYSDOH certified contractor laboratory using standard methods of analysis. All analytical data was submitted to the SCDHS as required by Chapter I, Part 5, of the NYS Sanitary Code. Bacteriological, inorganic, radiological, and asbestos analytical data has been summarized in Table 5; POCs, SOCs, Pesticides and Micro-extractables analytical data has been summarized in Table 6.

Review of Tables 5 and 6 reveals that all reported bacteriological, SOCs, Pesticides, Micro-extractables, radiological, and asbestos analytical data collected during CY 1993 were within the NYS DWS. Water obtained from Wells 4, 6, and 7 contains elevated levels of iron and consequently is treated for the removal of iron at the WTP. The WTP uses a calcium hydroxide water softening process for precipitating iron from the water received from these wells. The potable water effluent from the WTP met all NYS DWS in CY 1993.

Further review of Table 6 shows the water obtained from Well 4 to exceed the NYS DWS for TCA. Volatile organic compounds particularly TCA, have become problematic at BNL and have caused the shutdown of Potable Wells No. 4, 10, and 11 in the past. During 1991, Potable Well 4 was returned to service after submission of satisfactory data to the SCDHS showing that the WTP treatment process was adequate for the removal of this compound. As a condition for authorization to use Potable Well 4, BNL is required to collect treated water samples from the effluent of the WTP and analyze these samples for POCs. All analytical results for samples collected from the WTP effluent were found to meet the NYS DWS.

Table 5
BNL Site Environmental Report for Calendar Year 1993
Potable Water Wells and Potable Distribution System,
Bacteriological, Inorganic Chemical and Radiological Analytical Data*

Compound	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	Potable Distribution Sample	NYS Drinking Water Standard
Total Coliform	ND	ND	ND	ND	ND	ND	ND	0 MPN/100 ml
Color	5	30	<5	<5	<5	<5	<5	15 Units
Odor	0	0	0	0	0	0	0	3 Units
Cyanide	<10	<10	<10	<10	<10	<10	<10	NS µg/L
Conductivity	75	72	95	84	89	88	120	NS µmhos
Chlorides	17	12	14	12	15	16	16	250 mg/L
Sulfates	9.1	5.9	9.4	9.7	10.0	10.7	10.0	250 mg/L
Nitrates	0.1	0.1	0.4	0.5	0.5	0.4	0.5	10 mg/L
Ammonia	0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	NS mg/L
pH	6.1	6.1	6.5	6.3	6.1	6.6	8.5	NS mg/L
MBAS	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.5 mg/L
Antimony	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	NS µg/L
Arsenic	<10	<10	<10	<10	<10	<10	<10	50 µg/L
Barium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.0 mg/L
Beryllium	< <	<	< <	<	<		NS µg/L	
Cadmium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	10 µg/L
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/L
Fluoride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2.2 mg/L
Iron	0.78†	3.6†	0.52†	<0.02	<0.02	<0.02	<0.02	0.3 mg/L
Lead	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	15 µg/L
Manganese	0.04	0.21	0.04	<0.01	<0.01	<0.01	<0.01	0.3 mg/L
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2.0 µg/L
Nickel	<0.04	0.43	0.05	<0.04	<0.04	<0.04	<0.04	NS mg/L
Selenium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	10 µg/L
Sodium	9.1	7.9	10.4	9.6	10.2	11.9	20.3	NS mg/L
Thallium	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	NS µg/L
Zinc	0.03	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	5.0 mg/L
Gross α Activity	NR	NR	NR	NR	NR	NR	2.24	15 pCi/L
Asbestos	NR	NR	NR	NR	NR	NR	0	7.0 10^6 Fibers/L

*This table contains the maximum concentration (minimum pH value) reported by the contractor laboratory.
†Due to the high concentration of iron within the water produced by Wells 4, 6, and 7, this water is treated at the Water Treatment Plant for removal of iron.
ND: None detected
NS: DWS Not Specified
NR: Analysis Not Required

Table 6
BNL Site Environmental Report for Calendar Year 1993
Potable Water Wells,
Analytical Data for
Principal Organic Compounds, Synthetic Organic Compounds
Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<------			μg/L			------>	
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	5.
Chloromethane	ND	ND	ND	ND	ND	ND	ND	5.
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	2.
Bromomethane	ND	ND	ND	ND	ND	ND	ND	5.
Chloroethane	ND	ND	ND	ND	ND	ND	ND	5.
Fluorotrichloromethane	ND	ND	ND	ND	ND	ND	ND	5.
1,1-dichloroethene	ND	0.8	ND	ND	ND	ND	ND	5.
Dichloromethane	ND	ND	ND	ND	ND	ND	ND	5.
trans-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND	5.
1,1-dichloroethane	1.0	0.5	ND	ND	0.7	1.9	ND	5.
cis-1,2-dichloroethene	ND	ND	ND	ND	ND	ND	ND	5.
2,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5.
Bromochloromethane	ND	ND	ND	ND	ND	ND	ND	5.
1,1,1-trichloroethane	1.6	11.0	ND	0.9	4.3	3.7	1.8	5.
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	5.
1,1-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5.
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	5.
trichloroethene	ND	0.6	ND	ND	ND	ND	ND	5.
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5.
Dibromomethane	ND	ND	ND	ND	ND	ND	ND	5.
trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5.
cis-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	5.
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND	5.
Trihalomethanes	ND	48.5	8.8	33.7	8.8	1.5	22.6	100.
1,1,2,2-tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	5.
1,3-dichloropropane	ND	ND	ND	ND	ND	ND	ND	5.
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	5.
Bromobenzene	ND	ND	ND	ND	ND	ND	ND	5.

Table 6 (cont.)
BNL Site Environmental Report for Calendar Year 1993
Potable Water Wells,
Maximum Principal Organic Compound Data

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<--------	--------	--------	μg/L	--------	--------	-------->	
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	5.
1,2,3-trichloropropane	ND	ND	ND	ND	ND	ND	ND	5.
2-chlorotoluene	ND	ND	ND	ND	ND	ND	ND	5.
4-chlorotoluene	ND	ND	ND	ND	ND	ND	ND	5.
1,3-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,4-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,2-dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,2,4-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	5.
1,2,3-trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
Benzene	ND	ND	ND	ND	ND	ND	ND	5.
Toluene	ND	ND	ND	ND	ND	ND	ND	5.
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
m-xylene	ND	ND	ND	ND	ND	ND	ND	5.
p-xylene	ND	ND	ND	ND	ND	ND	ND	5.
o-xylene	ND	ND	ND	ND	ND	ND	ND	5.
Styrene	ND	ND	ND	ND	ND	ND	ND	5.
Isopropylbenezene	ND	ND	ND	ND	ND	ND	ND	5.
n-propylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,3,5-trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
tert-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
1,2,4-trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
sec-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5.
p-isopropyltoluene	ND	ND	ND	ND	ND	ND	ND	5.
n-butylbenzene	ND	ND	ND	ND	ND	ND	ND	5.

Table 6 (cont.)
BNL Site Environmental Report for Calendar Year 1993
Potable Water Wells,
Analytical Data for
Principal Organic Compounds, Synthetic Organic Compounds
Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<----------			μg/L			---------->	
Alachlor	ND	ND	ND	ND	ND	ND	ND	2.
Simazine	ND	ND	ND	ND	ND	ND	ND	50.
Atrazine	ND	ND	ND	ND	ND	ND	ND	3.
Metolachlor	ND	ND	ND	ND	ND	ND	ND	50.
Metribuzin	ND	ND	ND	ND	ND	ND	ND	50.
Butachlor	ND	ND	ND	ND	ND	ND	ND	50.
Lindane	ND	ND	ND	ND	ND	ND	ND	0.2
Heptaclor	ND	ND	ND	ND	ND	ND	ND	0.4
Aldrin	ND	ND	ND	ND	ND	ND	ND	5.
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	0.2
Dieldrin	ND	ND	ND	ND	ND	ND	ND	5.
Endrin	ND	ND	ND	ND	ND	ND	ND	0.2
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	40.
Toxaphene	ND	ND	ND	ND	ND	ND	ND	3.
Chlordane	ND	ND	ND	ND	ND	ND	ND	2.
Total PCB's	ND	ND	ND	ND	ND	ND	ND	0.5
Propachlor	ND	ND	ND	ND	ND	ND	ND	50.
2,4,-D	ND	ND	ND	ND	ND	ND	ND	50.
2,4,5,-TP (Silvex)	ND	ND	ND	ND	ND	ND	ND	10.
Dinoseb	ND	ND	ND	ND	ND	ND	ND	50.
Dalapon	ND	ND	ND	ND	ND	ND	ND	50.
Pichloram	ND	ND	ND	ND	ND	ND	ND	50.
Dicamba	ND	ND	ND	ND	ND	ND	ND	50.
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	1.
Hexachlorcyclopentadiene	ND	ND	ND	ND	ND	ND	ND	5.
Di(2-ethylhexyl)Phthalate	ND	ND	ND	ND	ND	ND	ND	50.
Di(2-ethylhexyl)Adipate	ND	ND	ND	ND	ND	ND	ND	50.
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	5.
Benzo(A)Pyrene	ND	ND	ND	ND	ND	ND	ND	50.
Aldicarb Sulfone	ND	ND	ND	ND	ND	ND	ND	NS

Table 6 (cont.)
BNL Site Environmental Report for Calendar Year 1993
Potable Water Wells,
Analytical Data for
Principal Organic Compounds, Synthetic Organic Compounds
Pesticides and Micro-Extractables

Compound	WTP Effluent (F2)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No.10 (FO)	Well No. 11 (FP)	Well No. 12 (FQ)	NYS Drinking Water Standard
	<-----			μg/L			----->	
Aldicarb Sulfoxide	ND	ND	ND	ND	ND	ND	ND	NS
Aldicarb	ND	ND	ND	ND	ND	ND	ND	NS
Oxamyl	ND	ND	ND	ND	ND	ND	ND	50.
Methomyl	ND	ND	ND	ND	ND	ND	ND	50.
3-Hydroxycarbofuran	ND	ND	ND	ND	ND	ND	ND	50.
Carbofuran	ND	ND	ND	ND	ND	ND	ND	40.
Carbaryl	ND	ND	ND	ND	ND	ND	ND	50.
Total Aldicarbs	ND	ND	ND	ND	ND	ND	ND	NS
Glyphosate	ND	ND	ND	ND	ND	ND	ND	50.
Diquat	ND	ND	ND	ND	ND	ND	ND	50.
Ethylene Dibromide	ND	ND	ND	ND	ND	ND	ND	0.05
Dibromochloropropane	ND	ND	ND	ND	ND	ND	ND	0.2

ND: Not detected at minimum detection limit.
NS: DWS Not Specified
Notes: For compliance determination with NYSDOH standards, potable wells were analyzed quarterly during the year by H_2M Labs, Inc., a NYS certified contract Laboratory.

The minimum detection limits for POC analytes are 0.5 μg/L. Minimum detection limits for SOCs, Pesticides and Micro-extractables are compound specific and in all cases are less than the NYSDOH drinking water standard.

All concentrations contained in Table 6 are the maximum values reported by the contractor laboratory.

Potable Wells 10 and 11 have been equipped with activated carbon adsorption devices for abatement of POCs. While all analytical data for untreated water samples collected from Wells 10 and 11 showed the POC concentrations to be less than the NYS DWS, replacement of the carbon within the device installed at Well 11 was required due to breakthrough of TCA and DCA. All treated water analytical data met the NYS DWS for POCs.

The SCDHS conducted an inspection of the BNL potable water supply system on October 14, 1993. This consisted of walk-through inspections of the WTP, WTP support facilities and potable well support facilities. The SCDHS inspector only noted the unavailability of an adequate sampling tap down stream of the carbon treatment system at Well 10 in the final report. A new sampling tap will be installed in early 1994. Analysis of water samples collected during this visit showed all analytical parameters met the NYS DWS.

The collection of first draw water samples for subsequent lead and copper analysis as required by the Federal Lead and Copper Rule, continued during 1993. This program required the collection of tap water samples from bathroom or kitchen faucets which had been unused for a period of six to twelve hours. The objective of this program was to determine the aggressiveness of the potable supply to the plumbing fixtures. If the water was found to be aggressive, as evidenced by increased concentrations of lead and copper, treatment alternatives, such as the addition of corrosion inhibitors to the potable supply, were to be evaluated. The Laboratory collected water samples from forty sites during the period beginning January 1, 1993 and ending June 30, 1993, and analyzed each of these samples for lead and copper. The results of this program showed the lead and copper concentration of the ninetieth percentile samples to be below the regulatory action levels (i.e., 15 μg/L for lead and 1.3 mg/L for copper) promulgated by the EPA; consequently, treatment was deemed not necessary. In accordance with the provisions of the Federal Lead and Copper program, since two series of tests (i.e., July - December 1992 and January - June 1993) have shown the potable water supply to meet the Federal action levels for lead and copper, the number and frequency of samples collected and analyzed will be reduced in CY 1994.

2.7 Toxic Substance Control Act (TSCA)

2.7.1 TSCA Program at BNL

The use and disposal of specific substances, such as PCBs, is regulated under TSCA. The requirements under this Act include labeling, inspections, record keeping, immediate notification and cleanup upon discovery of spills, and proper disposal. The Laboratory issued a Safety, Environment, and Administrative Procedures Manual (SEAPPM) for PCB management in 1992. This SEAPPM formalized the BNL policy and identified specific responsibilities to ensure that PCBs are managed in accordance with TSCA requirements. The SEPD maintains a database of all Department and Division PCB equipment to ensure proper tracking and record keeping. This database is updated as information is supplied by the various Departments and Divisions. In addition, the annual PCB Report for CY 1993 was prepared in accordance with the requirements of TSCA. This report is retained on file at the SEPD. A copy was also submitted to the DOE-Brookhaven Area Office (BHO).

The Laboratory has also been working on developing an Environment Safety and Health (ES&H) Standard on PCB management. This Standard has been reviewed by the Laboratory ES&H Committee: It is being revised to clarify specific issues and is anticipated to be issued during CY 1994.

2.7.2 <u>PCB Consent Order</u>

During the operation of the alternate liquid fuel program, the Laboratory received a one-time off-specification military jet fuel which contained PCBs in excess of 50 ppm in October 1984. The Laboratory blended this material with other fuel resulting in 286,000 gallons of material with a PCB concentration above the required ppm. On January 21, 1986, the EPA Region II formally approved BNL's plan to incinerate this material at a 10% firing rate (concentration of 8 ppm) in BNL's high-efficiency Boilers 4 and 5.[28] The material remained in storage at BNL while negotiations continued with the NYSDEC. A final NYSDEC Order on Consent was submitted to and signed by DOE on March 12, 1992. It was then returned to NYS and signed by the Commissioner of NYSDEC on May 15, 1992. This Order on Consent authorized and required DOE to ensure that BNL burn the PCB contaminated fuel in high-efficiency Boiler 5 without obtaining permits from NYSDEC provided that the burn be performed in accordance with all conditions of the Order. In addition, a report providing information on the operation of the boiler during the PCB burn was required to be submitted to NYSDEC and EPA each month.

The Laboratory commenced burning of the PCB contaminated jet fuel on July 7, 1992. Approximately 164,365 gallons of this fuel were burned in Boiler 5 from the initial start up until the end of CY 1993. The burn was completed on April 4, 1993. Approximately 117,000 gallons of this material was burned during CY 1993. Upon completion of the burn, the Laboratory prepared a Performance Report in accordance with the conditions of the Order on Consent. This report was submitted to the regulatory agencies in June 1993. It was revised to reflect comments from the NYSDEC and EPA and resubmitted in December 1993. In addition, the Laboratory prepared a plan for the decontamination of CSF Tank No. 5 as required by the conditions of the Order on Consent. This plan was submitted to the regulatory agencies in April, 1993. The Laboratory submitted the revised plan, after two rounds of review and revision, to the regulatory agencies in December 1993. Approval of the plan is anticipated to be received during the first quarter of 1994.

2.7.3 <u>EPA Authorized PCB Research</u>

In 1991, EPA conducted a multi-media inspection of BNL. One of the findings from the TSCA portion of the inspection was that research involving PCBs was being performed without the EPA authorization. The work in question was bench-top research on biodegradation of PCBs. The Laboratory prepared the paperwork necessary to request EPA authorization to continue this work. In 1992, EPA issued a two-year approval which was subject to various conditions including marking, storage, record keeping, reporting, and disposal requirements as well as limits to the quantity of material to be used. In 1993, the Laboratory requested that the existing agreement be modified to extend the research time period and to increase the amount of material held in stock for the research. The EPA granted approval of this request in August 1993.

2.8 NYSDEC Bulk Chemical Storage Registration

Because improper storage and handling of hazardous substances are serious threats to New York's water supplies and to public safety, the New York State Legislature passed Article 40 of the Environmental Conservation Law (ECL), (the Hazardous Substances Bulk Storage Act of 1986). This law required the NYSDEC to develop and enforce State regulations governing the sale, storage, and handling of hazardous substances, as needed to prevent leaks and spills in New York State. A closely related law, ECL Article 37, requires the NYSDEC to issue a list of substances defined as hazardous.

The NYSDEC has implemented these hazardous substances bulk storage laws through five sets of Chemical Bulk Storage (CBS) regulations as follows:

- 6 NYCRR 595 - Releases of Hazardous Substances - Reporting, Response, and Corrective Action.
- 6 NYCRR 596 - Registration of Hazardous Substance Bulk Storage Tanks.
- 6 NYCRR 597 - List of Hazardous Substances.
- 6 NYCRR 598 - Standards for Storing and Handling Hazardous Substances.
- 6 NYCRR 599 - Standards for Constructing New Hazardous Substance Storage Facilities.

Owners of regulated tanks were responsible for registering these storage tanks with the NYSDEC by July 15, 1989. In accordance with Part 596,[29] BNL submitted application forms for the registration of Hazardous Substance Bulk Storage Tanks on July 13, 1989. The regulated tanks are used primarily to store water treatment chemicals. The NYSDEC issued a Hazardous Substance Bulk Storage Registration (HSBSR) Certificate in August of 1989. In accordance with the NYS regulations, this certificate has been renewed every two years. The Laboratory submitted its most recent renewal request to NYSDEC on July 13, 1993. The Certificate was issued by NYSDEC on July 21, 1993 and has an expiration date of July 27, 1995. A total of 18 tanks are included in this Certificate.

2.9 Resource Conservation and Recovery Act (RCRA)

2.9.1 Facility Upgrades

Work is continuing on the design and planning of a new Hazardous Waste Management Facility. During 1993, the project entered the Title I design phase. Brookhaven National Laboratory's Plant Engineering Division is providing project management services. The architecture and engineering firm of Merrick & Company has been selected. The facility will provide BNL with state of the art storage and management capabilities for radioactive, mixed, and hazardous wastes. Incorporated into the design are several decontamination processes for removal of radioactive surface contamination. A major modification of the RCRA Part B Permit is underway in order to transfer the permit from the existing hazardous waste management facility to the new facility.

In response to the DOE Waste Moratorium, BNL refurbished one of the buildings at the existing hazardous waste management facility to create a non-radiological area at the facility. The building was insulated and heated and equipped with new waste storage cabinets and secondary containment trays for storage of clean labpack wastes. The building has been segregated from the rest of the facility, and allows storage and shipment of wastes which have been determined to be free of added radioactivity by the BNL Process Knowledge Program (described in more detail in Section 2.9.4).

2.9.2 90-Day Accumulation Areas and Satellite Areas

In 1993, the Hazardous Waste Management Group (HWMG) prepared an Environment, Safety and Health Standard entitled "Accumulating RCRA Hazardous Waste". The Standard is intended to clearly communicate the NYSDEC regulations governing hazardous waste storage. The standard is currently in draft and is being reviewed and revised in cooperation with a Laboratory user group. As part of this effort, the Hazardous Waste Control Form was revised and new hazardous waste labels were designed and procured.

Inspections of hazardous waste accumulation areas were conducted by the NYSDEC in June 1993. The inspection required the preparation of Closure Plans for 90-Day areas, a NYSDEC requirement for storage of hazardous waste in Suffolk County due to the sole source aquifer. The closure plans were prepared by BNL and accepted by NYSDEC on September 1, 1993.

2.9.3 RCRA Part B Permit (6NYCRR Part 373 Permit)

The RCRA Part B Permit, Permit Number 1-4722-00032/00021-0, was issued to BNL on 9/27/93 by the NYSDEC. The permit has a five year term and expires on August 31, 1998. The major modification of the permit is underway, to transfer the permit to the new Hazardous Waste Management Facility described above in Section 2.9.1.

2.9.4 RCRA/TSCA Waste Moratorium

The Process Knowledge Program, a combination of documented generator knowledge, certification, and radiological survey, was approved by DOE on August 24, 1993. During 1993, BNL began the process of implementing the program by requiring the use of the Process Knowledge Certification Form, development and performance of training, and modification of the Quality Assurance Program Plan. The process knowledge program has enabled the HWMG to identify those wastes which meet the criteria of the EM document "Performance Objective for the Certification of Non-radioactive Hazardous Wastes" and to ship those wastes. Wastes which are determined to have potential for added radioactivity are held by the HWMG and are managed as mixed wastes pending the approval of the final stage of BNL's response to the Moratorium, the radioanalytical program for hazardous wastes.

The development of radioanalytical procedures (Phase III) to assay wastes suspected of containing added radioactivity is proceeding. The cooperative forum established by the DOE Chicago Field Office, the Research and Development Working Groups (RADWG), have completed their work. Brookhaven National Laboratory intends to utilize the work products of the RADWG teams to establish the lower limits of detection to be specified. Brookhaven National Laboratory intends to utilize the commercial laboratory sector to perform the required analysis. A team has been established to develop a BNL specific proposal for submittal to DOE.

2.9.5 Pollution Prevention Program

Brookhaven National Laboratory has begun implementation of a comprehensive waste minimization and pollution prevention program to reduce the quantity and toxicity of wastes generated on site. The program is described in the BNL Waste Minimization and Pollution Prevention Program Plan.

The program is structured to evaluate waste generation, including radioactive, mixed, hazardous, and solid waste on a department by department basis. An interdisciplinary team, made up of waste management and compliance specialists together with departmental process specialists, performs Process Waste Opportunity Assessments. Ideas generated by the team are documented and an economic and technical feasibility analysis is performed. Ideas that are feasible, will be identified for future funding and implementation.

2.10 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

On November 21, 1989, BNL was included on the National Priorities List of the USEPA. This is a list of hazardous waste sites that are considered high priority for cleanup under the federal Superfund Program officially known as the Comprehensive Environmental Response, Compensation, and Liability Act.

In 1991, BNL established the Office of Environmental Restoration to oversee the Laboratory's Superfund activities. It is the responsibility of this office to remediate areas of known contamination, as well as identify, mitigate, and eliminate other areas of potential contamination.

In May 1992, an IAG between the DOE, the USEPA and the NYSDEC, became effective to insure compliance with CERCLA, the corrective action requirements of the RCRA, the NEPA, as well as corresponding New York State regulations. In particular, the IAG is intended to insure that environmental impacts associated with past and present activities at BNL are thoroughly and adequately investigated so that appropriate response actions can be formulated, assessed, and implemented.

There are currently twenty-seven "Areas of Concern" (AOC) at the BNL site to be addressed through the IAG. The AOCs consist of both active facilities, such as the STP, the HWMF, and potable wells, and inactive facilities, such as the former landfills, cesspools, and radioactive waste storage tanks. The AOCs have been grouped and prioritized into OUs and Removal Actions (RA). This prioritized grouping is documented in the BNL Response Strategy Document (RSD).

In accordance with the IAG milestone schedules, during 1993, the following field activities have been conducted and reports have been prepared and submitted to the USEPA and the NYSDEC for their review:

April 1993

- Removal Action II (Underground Storage Tanks [UST]) - Work Plan for Phase I of the Waste Treatment and Tank Removal Project.

May 1993

- Removal Action II (UST) - Sampling and analysis of tank sludges and soils.

July 1993

- Removal Action I ("D" Tanks) - Engineering Evaluation/Cost Analysis finalized.
- Removal Action V - Spray Aeration Ground-water Investigation Report; Suffolk County Department of Health Services Cooperative Ground-water Investigation of off-site monitoring wells initiated.
- Removal Action VI (Landfills)- Fieldwork initiated.

August 1993

- Historical Site Review - Historical Site Review Report issued and follow-up study initiated.

September 1993

- Removal Action I ("D" Tanks) - Final Action Memorandum.
- Removal Action VII (Bldg. 464) - Conducted cleanup of mercury contaminated soil.

October 1993

- Operable Unit I (HWMF) - Remedial Investigation/Feasibility Study Work Plan finalized.
- Operable Unit IV (CSF) - Underground Storage Tank removal initiated.
- Operable Unit V (STP) - Draft Remedial Investigation/Feasibility Study Work Plan submitted.
- Removal Action V - Sampling and Analysis Plan for Spray Aeration RA Project finalized.
- Removal Action VI - Sampling and Analysis Plan for Landfills Closure RA Project finalized.

November 1993

- Operable Unit I - Remedial Investigation fieldwork initiated.
- Removal Action III - Cesspools Engineering Evaluation/Cost Analysis.
- Removal Action V - Fieldwork initiated.
- Removal Action VIII - Bldg. 208 Soil and ground-water sampling and analysis.

December 1993

- Removal Action VII (Bldg. 464) - Draft Action Memorandum.
- Site-wide Hydrogeological Characterization - Conducted Phase I Physical Characterization and installation of piezometers.

2.11 Superfund Amendments and Reauthorization Act (SARA) of 1986

The SARA regulations require that BNL compile and submit Tier I (or the more detailed Tier II) reports to the State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), and the responding fire organization. For BNL, the responding fire organization is the S&EP Fire and Rescue Group. Under federal SARA regulations, BNL is required to submit the Tier II report only if requested by the SERC, LEPC, or fire response group. In 1991, the SERC requested that BNL submit the Tier II report for 1990 and each year thereafter. The report lists the average and maximum daily amounts of each chemical on site which exceeds the threshold listed in the current EPA List of Lists. The Tier II report for CY 1992 was submitted in February 1993, and the CY 1993 will be submitted in February 1994, to the Fire Response Group and to DOE-BHO office for transmittal to the SERC and LEPC.

2.12 National Environmental Policy Act (NEPA)

In October 1993, DOE-Chicago (CH) NEPA Compliance Officer issued draft DOE-CH Order 5440.1E to provide detailed Operations Office guidance on DOE Order 5400.1E. A workshop to review this draft order and DOE guidance (May 1993) on the preparation of environmental assessments was held October 18 - 20, 1993 and was attended by BNL's NEPA Coordinator. The Laboratory NEPA Coordinator also continued participation in quarterly meetings with other Energy Research facility NEPA coordinators in which ended with a meeting at Lawrence Berkeley Laboratory (LBL) in March 1993. The information transfer with other facility NEPA coordinators has been beneficial to all involved.

During CY 1993, environmental evaluations were completed for 174 proposed projects in accordance with DOE Order 5440.1E. Of these, 46 were considered minor actions requiring no additional documentation and 128 had Environmental Evaluation forms completed and submitted to DOE. Environmental assessments were revised for a proposed new Radiation Calibration Facility, a proposed Booster Application Facility, an underground vault addition to Chemistry to conduct radiation chemistry activities, the construction of a new HWMF, and continued operations of the AGS.

2.13 Federal Insecticide, Fungicide, and Rodenticide Act

Brookhaven National Laboratory has two programs where insecticides, herbicides, and pesticides are used. As per regulatory requirements, both users, the Biology Department and PE Division (Grounds Section) maintain a log of applications made and a log of the inventory at each facility. Key personnel are trained and certified by the NYSDEC for handling and application of these chemicals. Annual updating of training is required. The log books are available for inspection and verification by the regulatory agencies when required.

In 1992 the Laboratory was notified by the NYSDEC Region I Office that due to the on-site application of pesticides/herbicides by certified applicators, registration as a Pesticide Business Agency was required. In May 1993, the applications for registration were completed and submitted to the NYSDEC in accordance with directives received by the NYSDEC. The Laboratory was, however, notified in September 1993 by the NYSDEC Central Office, that federal facilities did not fall under the definition of "agency" and was not required to register. While the Laboratory has been deemed exempt from the registration requirements, annual reports indicating the types and quantities of pesticides used must still be submitted to the NYSDEC by each certified applicator.

2.14 Endangered Species Act

Brookhaven National Laboratory received notification from the U. S. Fish and Wildlife Service and the NYSDEC on December 13, 1993 and December 7, 1993, respectively, that no Federal or NYS endangered or threatened species occur within the Laboratory's impact area. No species have been added to these respective lists and no new projects are imminently proposed which would require an update of this information.

2.15 National Historic Preservation Act

The Deputy Commissioner for Historic Preservation of the New York State Office of Parks, Recreation, and Historic Preservation issued a determination April 2, 1991 that only activities which would impact the Old Reactor Building (Building 701), the Old Cyclotron Enclosure (Building 902), and on-site World War I era trenches require additional consultation. All other activities would have no effect upon cultural resources in or eligible for inclusion in the National Register of Historic Places. No activities affecting these facilities were conducted during CY 1993.

2.16 Floodplain Management

No construction was conducted within the 100 year floodplain during CY 1993. Activities are proposed within the 100 year floodplain as part of the installation of new environmental monitoring sheds, installation of Parshall flumes within the Peconic River, and demolition of the existing environmental monitoring sheds. A freshwater wetlands permit was obtained for the construction of the new sheds effective January 20, 1993. Construction contracts have not been issued pending approval of flume construction. Application to modify berms around RHIC was made to NYSDEC on February 17, 1993. This action would involve encroachment near the 100 year floodplain but no effect on present conditions.

2.16.1 New York Wild, Scenic, and Recreational River Systems Act

That portion of the Peconic River that flows through BNL is classified as "Scenic" under New York's Wild, Scenic, and Recreational River Systems Act (WSRRSA). The Laboratory currently has two projects proposed, RHIC and the upgrade of environmental monitoring stations, subject to WSRRSA legislation which regulates activities up to 0.5 miles from the river bank. On May 28, 1992, NYSDEC determined that the RHIC project met the requirements of "actual and substantial lawful commencement of the land use or development" under New York Code 666.9(b)(4) and was therefore exempt from requirements under the WSRRSA. Authorization for construction of the environmental monitoring stations was authorized on January 20, 1993. Application for completion of the RHIC tunnel system was submitted to the NYSDEC by DOE-BHO on February 17, 1993. Permit issuance is pending. In addition, an application for the STP upgrades was submitted in November 1993, following which the NYSDEC issued a permit notification on December 10, 1993 and a public notice was published on December 20, 1993.

2.17 Protection of Wetlands

Other than the permitting actions described in Sections 2.16 and 2.16.1 above, no activities conducted during CY 1993 impacted wetlands or their buffer zones. As part of the settlement of a Notice of Violation received by BNL from EPA for RCRA and TSCA violations, the Laboratory has proposed to conduct surveys of wetland habitats and develop protection, preservation, and possibly enhancement activities. The extent of activities to be conducted are still being negotiated. A biological inventory of wetlands at BNL commenced in November 1993 as part of an effort to establish up-to-date knowledge on site resources to conduct impact analyses of BNL environmental remediation efforts.

2.18 Environmental Compliance Audits

2.18.1 Tiger Team Issues

In March and April of 1990, the DOE conducted a comprehensive ES&H and waste operations assessment of BNL. This effort, known as the Tiger Team Assessment (TTA), was conducted in response to Secretary of Energy Admiral James D. Watkins, Ret., 10-point initiative to strengthen ES&H programs and waste management operations in the DOE community. The purpose of the TTA was to develop concise information regarding the site's status on ES&H compliance issues, root causes for noncompliance, and the adequacy of response actions needed to address identified problems. In addition, the assessment included an evaluation of the adequacy and effectiveness of the DOE and site contractor, AUI, management, organization, and administration of the ES&H programs failed to identify at BNL.[30] A complete documentation of the findings of this assessment has been published. The BNL Action Plan for the Tiger Team Assessment was completed and published in October 1990.[31]

In the area of compliance with environmental and waste management concerns, there were 37 findings dealing with the lack of conformance to Federal and State laws and regulations, County codes, DOE Orders, and 27 findings in which best management practices were not attained. By the end of 1993, 34 of the 37 environmental compliance issues were addressed. One of the unresolved compliance issue is scheduled for closure in 1994. The remaining two require substantial resources and are being addressed on a schedule determined by a risk based prioritization system. A brief description of the status on each unresolved compliance issue is listed below:

Finding	Description of Progress
SW/CF-1	In 1992, a survey was distributed to the departments requesting identification of the liquid effluents discharged from the operations conducted within their facilities. In order to verify and characterize the effluent discharges, a program was implemented in 1993 to sample and analyze the discharges. During the period beginning August 10 and ending August 26, samples were collected from various facilities and analyzed for pollutants identified by the departments in the effluent survey response. The analytical data for the samples

	collected and analyzed under this program failed to identify contaminants not already governed under the Laboratory SPDES permit. Consequently, no modification to the SPDES permit is expected as a result of this program.
TS/CF-3	The BNL SEAPPM 6. was issued in June 1992. The ES&H standard is schedule for publication by the end of the second quarter in 1994.
TS/CF-4	This project requires upgrades to existing tanks. Funding for this task is expected in Fiscal Year 1994.
RAD/CF-1	The issues of thick targets, DOE guidance on no addition of radioactivity to hazardous waste, and identification of secure areas have yet to be resolved.

Addressing best management practice concerns has received a lower priority due to funding and resource constraints. Several best management practice improvements are associated with upgrades to the compliance strategy. Continued improvement in this area is dependent on available resources and subject to reprioritization based on on-going audits and appraisals by DOE and EPA.

2.18.2 EPA Audits

2.18.2.1 NESHAPs Audit (1993)

On April 28, 1993, EPA inspectors conducted a 40 CFR, Subpart H (NESHAPs) compliance inspection. The inspection team interviewed BNL and the DOE staff and conducted a tour of selected facilities. Major issues covered during this inspection were a review of BNL NESHAPs QA/QC documentation, the status of the Building 705 evaporator and the Building 811 "D" Tank area, and the effort by New York State to assume responsibility from EPA Region II for enforcing radioactive NESHAPs regulations. The Laboratory's plan for conducting periodic confirmatory measurements of radioactive-use lab hoods was also discussed. At the time of the inspection, no final decision had yet been made to accept or request modification to the plan, which was submitted October 1992. No deficiencies were found during the inspection.

2.18.3 DOE Chicago ES&H Appraisals

2.18.3.1 DOE Chicago 1991 Appraisal

From July 8 through July 26, 1991, DOE Chicago conducted an ES&H Appraisal. The areas of the environmental protection program that were audited included the general administration of the program, compliance with the regulatory requirements of TSCA, RCRA, CERCLA, SDWA, NEPA, and compliance with applicable DOE orders. The audit team identified several areas of noncompliance with TSCA and RCRA regulations. Recommendations for improvements in the implementation of TSCA, RCRA, CERCLA, SDWA, and NEPA programs were also made. A total of 25 findings and 16 recommendations were made. At the conclusion of 1993, BNL had completed or closed 24 of these issues. The remaining item is issuance of an ES&H standard for handling PCBs. In 1993, a draft standard was written and reviewed by the ES&H Committee. A completed version of this standard is expected during the second quarter of 1994.

2.18.3.2 DOE Chicago 1993 Appraisal

The DOE Chicago Environmental Protection appraisal took place from March 24 to April 1, 1993. During this appraisal, the areas audited included RCRA, SDWA, USTs, NESHAPs, CWA, CAA, DOE Orders on environmental protection, and the Ground-water Protection Management Program. The results of this appraisal indicated that there were six issues where the assessors would like to see additional improvements in the program. Three of these issues dealt with waste management operations, and three were associated with environmental compliance. Listed below is a brief statement of the issue and BNL's current status.

Finding Number	DOE Chicago Comment	BNL Position
HW-1	Drum storage area should have all four sides enclosed.	Brookhaven National Laboratory's drum storage area is a three sided, roofed structure that has secondary containment in excess of the rated loading of the building. While it is possible for some precipitation to enter the contained area, there is little potential for precipitation to preempt secondary containment capacity. Because BNL is in the process of building a new HWMF, no action is expected on this issue.
HW-2	The backlog of radioactive waste should be shipped at an expedited schedule.	The shipping schedule is determined by compliance status and cost. Currently, radioactive waste shipments do not have the time constraints that apply to hazardous materials. Consequently, shipment of hazardous waste has taken priority.
HW-3	The Waste Analysis Plan relies too heavily on process knowledge.	The current Waste Analysis Plan utilizes generator process knowledge to classify the waste. This practice has been accepted by the New York State and EPA. The Waste Management Group has instituted verification of generator supplied information by sample analysis for certain waste charac-

		teristics. In addition, profile analyses performed by waste disposal contractors provide another check on process knowledge.
EC-1	The monitoring of argon-41 at the BMRR needs to be upgraded to meet current monitoring standards.	This capital upgrade received authorization in March 1993. The equipment has been received. Installation is expected in the second quarter of 1994.
EC-2	The method used to dispose of purge water generated in the process of sampling ground-water surveillance wells needs to receive formal concurrence with the IAG.	Currently, BNL discharges purge water to the ground about 6 meters down gradient of the well. This approach has received written concurrence from one party of the IAG and the sampling protocols which specify this method of disposal have been reviewed by all participants of the IAG. No further action is anticipated.
EC-3	Spray paint booth record keeping may not be adequate.	Records are maintained by the S&EP Division on the types of paints used in paint spray applications subject to 6NYCRR Part 228 VOC limits. Operations did not have an equivalent inventory nor did they have readily available the quantity of material used. The operators were advised of the records that they need to maintain.

2.19 Quality Assurance (QA) Program

The objectives of the EP Section QA Program are to ensure that management provides planning, organization, direction, control, and support to achieve environmental program objectives; that the line managers achieve quality in their product or services; and that the Sections overall performance is reviewed and evaluated using a rigorous assessment process. This program has been developed to ensure full compliance with QA requirements established by DOE in Orders 5700.6C,[13] Quality Assurance, and 5400.1, General Environmental Protection Program.[32]

The QA Program developed by BNL to achieve Laboratory objectives provides policies, responsibilities, and guidance procedures for the Divisions and Departments based on DOE Order 5700.6C. The S&EP Division has adopted or adapted these program elements into the S&EP Division Management System Manual[14] and established responsibilities, methods, and controls for conducting its operations. The EP Section has integrated these elements with the additional environmental QA requirements of DOE Order 5400.1 into the sampling, analysis, and data handling activities. The implementing procedures of the EP Section Standard Operating Procedure Manuals on Environmental Monitoring, Radiation Measurements, Analytical Chemistry, and Regulatory Programs, in conjunction with the S&EP Division Management System Manual and the S&EP QA Procedures,[15] comprise the EP QA Program for the environmental surveillance and effluent monitoring programs.

Responsibility for quality at BNL starts at the top with the Laboratory Director and permeates down through the entire organization with individuals at each level assuming their appropriate share. The BNL QA organization is headed by the BNL QA Manager who coordinates and evaluates the quality activities for the entire laboratory, and provides professional assistance and guidance to the departments and divisions. The S&EP Division has appointed a QA Coordinator to assist, assess, advise, and improve the implementation of the Division-wide QA program. The Division has chartered an Improvement Committee, with membership from all S&EP sections and various position levels, responsible for encouraging, reviewing, and evaluating employee suggestions for improvements and making recommendations to the Division Head. The EP Section, because of its emphasis on quality issues, has established an EP QA Group directed by a full time QA Officer with environmental expertise and technical ASQC certification. This group is responsible for reviewing, advising, assessing, and improving EP activities.

One of the major activities in the EP QA Group is ensuring that sampling and analysis of environmental media are conducted in such a way as to provide representative defensible data. The QA program fulfills this by incorporating QA elements such as field sampling plan designs, documented procedures, chain of custody, calibration/standardization program, acceptance criteria, statistical data analysis, software QA, and data handling systems into the environmental surveillance and effluent monitoring programs.

Lastly, the EP QA Group is responsible for establishing a program of internal assessments and external audits to verify the effectiveness of EP sampling, analysis, and data base activities and their adherence to the QA program. Self assessments of the EP activities are performed annually by the EP group leaders to identify areas needing attention. The EP QA Officer performs internal audits, as in 1993 with audits of the EP Program Management and Program Design. The analytical laboratories participate in interlaboratory performance evaluation programs organized by DOE, EPA, and NYSDOH. Contract laboratories used to augment the capabilities of the in-house laboratory are required to maintain a comprehensive QA program and are subject to audits by S&EP personnel to ensure its implementation. In addition to the internal reviews, the BNL QA Office, DOE-CH, and other regulatory agencies periodically audit the EP Section.

3.0 ENVIRONMENTAL PROGRAM INFORMATION

J. R. Naidu

Brookhaven National Laboratory is committed to environmental compliance and accountability. The Laboratory conducts an extensive program to monitor the environment in and around the BNL site. This program, required by DOE Orders 5400.1 and 5484.1, has five major objectives:

1. To demonstrate the effectiveness of pollution control programs;
2. To demonstrate compliance with applicable environmental laws and regulations;
3. To confirm adherence to the DOE and BNL Environmental Protection policies;
4. To estimate the impact of operations on the environment; and
5. To support environmental management decisions.

3.1 Program Organization

The Laboratory has three organizations involved in carrying out the tasks outlined above. These are:

a. The Office of Environmental Restoration was established in response to BNL being listed on the National Priority List (NPL) on December 21, 1989 and reports directly to the Director's Office. The OER has prime responsibility for environmental restoration of areas contaminated during past spills and storage and disposal of hazardous and radioactive wastes.

b. The Hazardous Waste Management Section operates under the aegis of the SEPD and is responsible for the management of hazardous wastes produced by the Laboratory as a result of its operations.

c. Environmental Protection Section operates under the aegis of SEPD and is responsible for interacting with Laboratory research and support programs to ensure that operations are conducted in a manner that limits environmental impact and that facility emissions are consistent with regulatory guidelines. This Section also interacts directly with representatives from local, state, and federal regulatory agencies.

Summary description of the activities conducted by the above groups are given below.

3.1.1 Environmental Restoration

As indicated in Sections 2.10 and 3.1.a, the OER has full responsibility to conduct environmental restoration activities as per the IAG. A summary of the OER's activities are provided in Section 2.10, Compliance Summary.

3.1.2 Hazardous Waste Management

Hazardous Waste Management activities are carried out at BNL under the direction of the Hazardous Waste Management Section. Radioactive, hazardous, and mixed wastes generated at BNL are transported to the HWMF for processing, storage, packaging, and preparation prior to off- site disposal. The HWMF has areas dedicated to the safe storage of each type of waste. In addition, all waste tracking and documentation is maintained at the HWMF.

The Hazardous Waste facilities at the HWMF received the final Part B Permit on September 27, 1993.

In addition to the operational aspects of maintaining facilities sufficient to store wastes, the Environmental Management Section supports the hazardous waste management program in the following areas;

a. Regulatory Compliance Program
b. Waste Minimization and Pollution Program
c. Quality Assurance Program
d. Training and Procedures Program

3.1.2.1 Waste Minimization and Pollution Prevention Programs

The BNL Waste Minimization and Pollution Prevention (Wmin/P2) Program Plan establishes the Wmin/P2 program at BNL. The plan has been prepared to combine the requirements for a Wmin Plan and a Pollution Prevention Awareness Plan. The plan lays out a strategy for implementation of a formal waste minimization and pollution prevention program at BNL and contains information on Wmin accomplishments.

The program plan calls for the establishment of "Waste Minimization Working Groups" within each Department/Division at BNL. The working groups combine the expertise of facility personnel and environmental professionals to evaluate waste generating processes within each department. The end result of each working group will be a Department Specific Waste Minimization Plan that can be used for planning, budgeting, and implementation. During 1993, two Wmin Working Groups were established in the Central Shops Division and the Alternating Gradient Synchrotron Department. The groups have begun process waste assessments and will document their activities, recommending implementation of technically and economically feasible waste reduction options identified.

3.1.3 Environmental Protection Section

The Environmental Protection Section, is comprised of six groups: Environmental Compliance, Environmental Monitoring, Ground Water, Radioanalytical Laboratory, Nonradioactive Laboratory, and Quality Assurance. Although the monitoring activities of the EM Group are quite comprehensive to address the regulatory mandates, the role played by the remaining five is closely inter-linked to provide the laboratory with a framework that assures environmental compliance and accountability. The Compliance Group provides the Division and Laboratory with assistance and guidance in all regulatory compliance areas, and submits appropriate reports to the Regulatory Agencies. The Analytical

Laboratories, both radioactive and nonradioactive, perform the required analysis of facility effluent and environmental samples as required for assessment of environmental impact or report submission. The Ground-water Group provides technical overview and assistance in conducting ground-water monitoring and review of data for determining impact and revisions of the Environmental Monitoring Program. The Quality Assurance Group oversees the functions of the Section in terms of the directives on Quality Assurance, such as pertaining to environmental sampling, analytical processes and documentation, which includes review of data. The Section, in its entirety, also reviews projects for environmental impacts and provides audit support to the Laboratory's Environment Safety and Health (ES&H) and environmental restoration programs. These safety and environmental reviews are performed on new construction projects as well as modifications to existing facilities. These reviews are performed from conceptual design through completion of construction and prior to final occupancy to assure that basic safety and environmental protection requirements are provided. As part of the review team, the SEPD EP staff members review these proposals and plans to assure that potential hazards are identified and potential environmental impacts are evaluated. In addition, these reviews are conducted to ensure that all necessary permits are obtained and that new construction or modifications comply with federal, state, and local regulations. Approximately 90 of these types of reviews were performed during CY 93.

Summary information on monitoring activities can be found in the Executive Summary. Complete details regarding individual monitoring activities, as mandated by DOE Orders and implemented by BNL, can be found in specific Sections 4.0 to 5.0. The activities that are required by environmental statutes are described in Section 2 (Compliance Summary).

3.2 Environmental Programmatic Changes in 1993

There were twelve significant modifications to the Site Environmental Monitoring Program in 1993. These were:

a. Since the goals of the environmental sampling programs of the OER and the SEPD, especially in the sampling of ground water from wells on-site and off-site, were the same, it was decided to coordinate the sampling schedule so that unnecessary duplication of effort was eliminated. This also provided for independent verification of sampling by collecting duplicate samples by either organization as per the monitoring schedule.

b. In order to isolate the tritium contribution of the HFBR effluent to the sanitary system, a sampling point was set up at Manhole #232. This is the point at which the HFBR effluent connects with the sanitary system. An integrated sampler was set up and sampled on each working day and analyzed for tritium. Results are being plotted by the reactor staff in relation to the tritium levels at the STP effluent discharge point.

c. In an effort to characterize the effluents discharged into the headworks of the Sewage Treatment Plant, a sampling and characterization project was initiated. This project consisted of collecting three daily composite samples from the discharges emanating from 30 locations site-wide and analyzing these samples for contaminants expected to be present. The list of analytes for each sampling location was based on information received from the departments in response to a liquid effluent questionnaire distributed in May 1992. This program is expected to continue in 1994.

d. In accordance with the conditions set forth in the BNL Draft SPDES permit, a biomonitoring program was initiated. Although the requirements for this program do not become effective until the issuance of the final permit, biomonitoring was conducted in order to ascertain the toxicity of the BNL STP effluent.

e. As stipulated in the EPA NPDES Storm Water Regulations, storm water discharges to surface waters were sampled and analyzed for conventional and process specific analytical parameters.

f. In anticipation of the numerous permit modifications in the revised SPDES requirements, the Laboratory conducted a technical and economic impact analysis on Laboratory operations. Since the SPDES permit has not been finalized, review of the sampling and analytical requirements are in progress.

g. Pursuant to the observation of an above standard concentration of TCA in an unscheduled grab sample from the STP effluent, it was decided to install a continuous monitor for VOCs at the point where the STP effluent discharges into the Peconic River. This system underwent a number of tests to establish its capability to record and to initiate an alarm when the levels exceeded the SPDES permit limits. These confirmatory tests are in progress and it is expected that the monitoring system will be on line in 1994.

h. Since the Peconic River is an intermittent river, an additional sampling of fish from the river was initiated in spring. The results from this program will define the impact of the increased spring flow on the ecology of the river. The normal sampling program is during the summer, when there is no effluent being discharged at the site boundary due to restriction of flow caused by heavy vegetation growth in the river.

i. In 1992, as part of the DOE Order 5400.1 requirement to do dose estimates on aquatic organisms, TLDs were used to estimate doses to mussels endemic to area receiving the STP effluent. In 1993, mussels from uncontaminated areas were transferred to the STP discharge point and were monitored for radionuclide uptake. This project will be continued in 1994, and data so derived will be used to estimate doses using computer models.

j. The collection of first draw water samples for subsequent lead and copper analysis as required by the Federal Lead and Copper Rule, was continued in 1993. This program required the collection of tap water samples from bathroom or kitchen faucets which had been unused for a period of six to twelve hours. The object of the program was to determine the aggressiveness of the potable supply to the plumbing fixtures.

k. A Weakness E/W-2, Terrestrial Monitoring program, was identified by the Tiger team. To address this, in 1992, International Technology (IT) Corporation was contracted to develop a soil and vegetation sampling plan for the BNL site, and in the same year, the laboratory initiated a fauna sampling program. In 1993, this was followed by a site-wide soil and vegetation sampling program for the BNL Site. The ITC document served as a basis for implementation of the first phase of the sampling plan, where 25 sites were selected and sampled for soil and vegetation.

l. On May 7, 1993, mercury contaminated soils were unearthed during construction of an office addition to Building 464. During the period, May 7, 1993 to June 23, 1994, a total of 111 soil samples were collected from the subject site and analyzed for mercury. This program had a significant impact on the ground-water monitoring program, in that the routine sampling schedule during the later part of the second quarter was disrupted.

3.3 Tier III Assessment

Brookhaven National Laboratory is committed to conducting a number of independent audits of the ES&H program areas for the Office of the Associate Director for Reactor, Safety, and Security. Such an audit of the Radiological and Non-Radiological Laboratories was conducted between September 15th and 23rd, 1993. The laboratories were evaluated using a formal checklist based on pertinent requirements. In addition, the operations were compared to CERCLA Region II QA requirements in order to assess the level of effort needed to upgrade the laboratories. Three problem areas were noted; both laboratories lacked space and had information management deficiencies while the Radiological Laboratory needed to formalize additional procedures. Ten improvements were also suggested by the auditors as well as noting 20 of 90 checklist items which were not addressed. Management has been attempting to resolve the space and information management issues through various channels. It was the opinion of the groups audited that the recommendations made were scientifically sound, provide constructive criticism, and when addressed, should improve the program.

4.0 ENVIRONMENTAL PROGRAM DESCRIPTION

J. R. Naidu, R. J. Lee, G. L. Schroeder, and B. A. Royce

It is DOE policy to conduct its operations in an environmentally responsible manner and comply with applicable environmental standards. At BNL, a wide variety of environmental activities are performed to comply with federal, state, and local laws and regulations, enhance environmental quality, and monitor the impact of effluent emission from site facility operations.

Section 2.0 summarized the status of BNL's compliance with applicable regulations, activities under way to achieve compliance, and programs to manage and improve environmental quality.

This section summarizes significant activities conducted in 1993 under Environmental Monitoring, which consists of:

1. Effluent monitoring, and
2. Environmental Surveillance.

Effluent monitoring is performed as appropriate by the facility operators and/or the SEPD EM Group environmental sampling team at the point of release to the environment. Environmental surveillance consists of sampling and analyzing environmental media on and off the BNL site to detect and quantify potential contaminants, and to assess their environmental and human health significance.

The sampling program includes collection of airborne effluents, ambient air, sewage and facility liquid effluent, ground water, surface water, soil, vegetation, fish, fauna, and sediment. The type of samples collected at a specific location depends on the site and the potential pollutants to be monitored. Added to this are the requirements mandated by specific permits.

A detailed description of the rationale and design criteria for the environmental surveillance and the effluent monitoring program is given in the BNL Environmental Monitoring Plan.[33] This plan also discusses the extent and frequency of monitoring and measurements, procedures for laboratory analyses, quality assurance requirements, and program implementation procedures.

Complete details regarding individual monitoring activities can be found in specific subsections grouped by environmental media.

4.1 Effluent Emissions and Environmental Surveillance

The primary purpose of the BNL effluent monitoring program is to determine whether:

1. Facility operations, waste treatment, and control systems functioned as designed to contain environmental pollutants; and

2. The applicable environmental standards and effluent control requirements were met.

The primary purpose of the BNL environmental surveillance program is to:

1. Quantify the presence of potential contaminants in the environment as a result of BNL operations; and

2. Assess environmental and human health impacts from BNL operations.

This annual report for CY 1993 follows the recommendations given in the DOE Order 5400.1, General Environmental Protection Program.[32]

4.1.1 Airborne Effluent Emissions - Radioactive

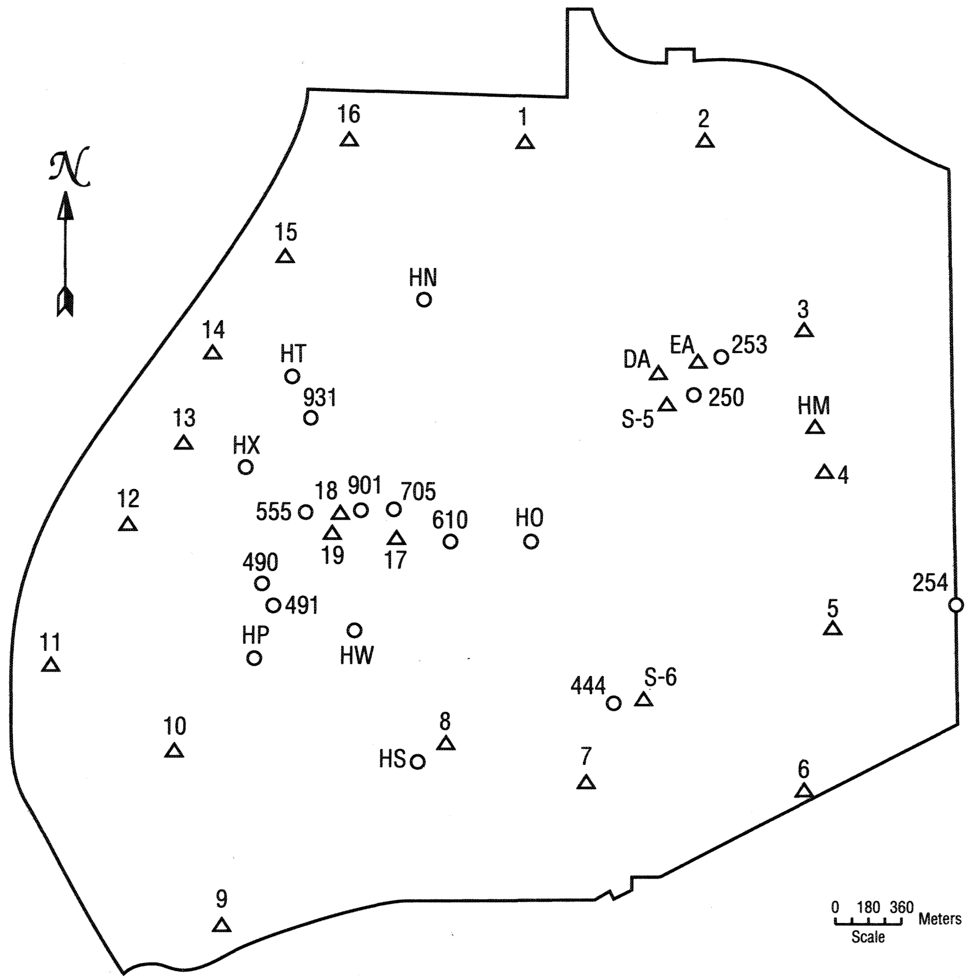
The locations of principal Laboratory facilities from which radioactive airborne effluents were released during 1993 are shown in Figure 9. Tritium was the only radionuclide detected routinely at the site boundary which was attributable to Laboratory operations, although Co-60 and Cs-137 were detected on a sporadic basis. There were no unusual effluent releases or processes that would explain the presence of these radionuclides during the sample interval. The presence of Cs-137 is most likely attributed to atmospheric fallout and the Co-60 is most likely on artifact as a result of background fluctuations in the detection equipment.

Oxygen-15, which has a two minute half-life, is produced at the BLIP facility by the interaction of protons and water or air in the beam tubes and is generated at an estimated rate of approximately 3 mCi per microampere-hour (0.11 GBq/uA-hr).[34] Due to scheduled maintenance at the Linac and AGS, BLIP did not operate during the months of September through December 1993. Annual effluent emissions are listed in Table 7. Oxygen-15 is also generated as an air activation product at the AGS Booster Facility, which became operational in March of 1992. Due to the nature of production, and the diffuse release characteristics of the Booster, the total O-15 source term must also be calculated based on a knowledge of building air exchange rates and particle beam characteristics. The estimated O-15 source term attributed to Booster in 1993 was 310 Ci (11.5 TBq).

In addition to radionuclides released during the processing of targets from the BLIP facility, other radionuclides, in addition to O-15 are produced at the BLIP facility and are periodically emitted into the environment. Table 7 summarizes the gamma emitting radionuclides released from this facility. The predominant radionuclide released in 1993 was tritium (47.7 mCi [1.76 GBq]).

Argon-41, which has a 110-minute half-life, is produced at the MRR by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the Building 491 stack at an estimated rate of 2.2 Ci $MW^{-1}h^{-1}$ (81.4 GBq $MW^{-1}h^{-1}$). The estimated release for the MRR stack during 1993 was 2,080 Ci (76.9 TBq) of argon-41. Monthly effluent emissions are listed in the Compendium. Although emissions of argon-41 are currently estimated from empirical data, the Reactor Division has purchased a new continuous emissions monitor system that will record radioactive effluent concentrations on a real time basis. The system features a beta scintillator, particulate, and radioiodine collectors, and isokinetic sampling. Installation is scheduled for July of 1994.

Brookhaven National Laboratory
Effluent Release Points and On-site Environmental Monitoring Stations



△ Environmental Monitoring Stations

Air

1 thru 16 Perimeter Stations
S-6 Waste Management Area
S-5 Sewage Treatment Plant
17, 18, 19 Center of Site

Water

DA Sewage Treatment Plant Influent
EA Sewage Treatment Plant Effluent
HM Peconic River, 0.5 mi. Downstream From Treatment Plant

o Designation	Effluent Release Point
250	Sand filter Beds
253	Peconic R. Stream Bed
254	Site Boundary
490	MRC Stack
491	MRR Stack
555	Chemistry Stack
705	HFBR Stack
901	Van De Graff Stack
931	BLIF Stack
444	Waste Management Incinerator
610	Steam Plant
HN	Recharge Basin
HO	Recharge Basin
HP	Recharge Basin
HS	Recharge Basin
HT	Recharge Basin
HX	Recharge Basin
HW	Recharge Basin

Figure 9: Brookhaven National Laboratory Effluent Release Points and On-site Environmental Monitoring Stations.

Table 7
BNL Site Environmental Report for Calendar Year 1993
Atmospheric Effluent Release Locations and Radionuclide Activity

Release Pt. Bldg. No.	Facility	Release Ht. (m)	Nuclide	uCi Released CY 1993	Annual Avg Stack Conc. (uCi/cc)	DOE Order 5400.5 Limit (uCi/cc)
750	HFBR	100	Be-7	2.39E+00	1.4226E-14	4E-08
			Br-82	1.59E+02	9.4643E-13	9E-09
			Cs-137	6.35E-01	3.7774E-15	4E-10
			H-3	6.78E+07	4.0357E-07	1E-07
931	BLIP	813	As-72	5.44E+01	7.1768E-12	3E-09
			As-74	2.97E-01	3.9182E-14	2E-09
			Be-7	6.56E+02	8.6544E-11	4E-08
			Co-57	1.46E+01	1.9261E-12	2E-09
			Co-58	5.89E+01	7.7704E-12	2E-09
			Co-60	5.74E+00	7.5726E-13	8E-11
			Cs-132	5.86E-01	7.7309E-14	1E-08
			Cs-137	8.56E-01	1.1293E-13	4E-10
			H-3	4.77E+04	6.2929E-09	1E-07
			Mn-54	6.81E+01	8.9842E-12	2E-09
			Na-22	2.68E+00	3.5356E-13	1E-09
			O-15	4.10E+08	5.41E-05	2E-08*
			Sc-46	1.18E+00	1.5567E-13	6E-10
801	Acid Line	100	As-72	3.01E+00	9.4953E-14	3E-09
			As-74	1.29E+01	4.0694E-13	2E-09
			Be-7	6.89E+00	2.1735E-13	4E-08
			Co-57	2.78E+00	8.7697E-14	2E-09
			Co-58	2.35E+01	7.4132E-13	2E-09
			Co-60	3.15E+00	9.9369E-14	8E-11
			Cs-132	1.28E+00	4.0379E-14	4E-10
			Cs-137	2.71E+00	8.5489E-14	4E-10
			H-3	1.15E+00	3.6278E-14	1E-07
			Mn-54	7.63E-01	2.4069E-14	2E-09
			Na-22	7.01E-02	2.2114E-15	1E-09
801	Non-Acid Line	100	As-74	4.50E+02	1.4658E-12	2E-09
			Au-199	6.31E+01	2.0554E-13	8E-09
			Bi-213	2.81E+02	9.1531E-13	7E-10
			Br-77	1.18E+04	3.8567E-11	5E-08
			Br-82	2.03E+02	6.6124E-13	9E-09
			Co-57	1.41E+01	4.5896E-14	2E-09
			Co-58	3.85E+00	1.2541E-14	2E-09
			Co-60	6.42E+00	2.0912E-14	8E-11
			Cs-132	9.10E+00	2.9642E-14	4E-10
			Cs-137	1.82E+01	5.9381E-14	4E-10
			Ga-68	2.47E+03	8.0358E-12	1E-07
			Mn-54	3.84E+01	1.2508E-13	2E-09
			Se-75	6.50E+02	2.1173E-12	1E-09
			Na-22	1.22E+01	3.9739E-14	1E-09
			Be-7	3.39E+01	1.1042E-13	4E-08
			V-48	8.85E+00	2.8827E-14	2E-09
491	BMRR	46	Ar-41	2.08E+09	9.43E-05	1E-08*
555	Chemistry	16	H-3	1.48E+04	4.28E-11	1E-07

Note: All 5400.1 Derived Concentration Guides are for inhaled air except for air immersion DCGs denoted by "*".

The total tritiated water vapor released from the Laboratory research facilities during 1993 was 67.9 Ci (2.5 TBq). This is almost identical to values recorded in 1992. High Flux Beam Reactor operations accounted for 99.9% of the total released by the site. Table 7 and the Compendium present summaries of annual tritium release data.

The Building 705, 100-meter stack receives airborne effluents from three separate exhaust systems: The HFBR (Building 750) and the Hot Laboratory (Building 801) acid and non-acid lines. Gamma emitting nuclides released from the 100-meter stack are shown in Table 7. Tritium is the major radionuclide released from the HFBR. The Building 801 Hot Laboratory Complex air effluent release from the acid and non-acid off-gas systems are reported in Table 7. These releases are the result of processing BLIP targets for the recovery of the radioisotopes used by medical health practitioners. In 1993, releases from the Building 801 Hot Laboratory acid line decreased from 1992 values by a factor of six, while the non-acid line emissions decreased by the same factor. Releases from this facility were not detected by air sampling at the site boundary.

The Laboratory incinerates certain low-level radioactive wastes at the HWMF incinerator, Building 444 (Figure 9). The total quantities of the individual radionuclides in the incinerated materials during 1993 was 16.2 Ci (0.60 TBq). Tritium was the predominant radionuclide released from the incinerator of an annual rate of 16 Ci (0.59 TBq). Site meteorological characteristics and administrative limits on the amount of material incinerated ensure that airborne concentrations at the site boundary are small fractions of the applicable standards.

4.1.2 Airborne Effluent Emissions - Nonradioactive

Nonradioactive airborne emissions result from a variety of processes at BNL. The majority of these are defined by NYS air laws as minor sources and include processes such as blueprint machines, welding/soldering activities, degreasers, sandblasters, machining exhausts, painting operations and small package combustion units. There are four large boilers at BNL, located at the CSF, which generate the largest amount of nonradioactive airborne emissions. The CSF is located along the eastern perimeter of the developed portion of the BNL site. The CSF supplies steam for heating and cooling to all major facilities through the underground steam distribution and condensate grid.

The combustion units at the CSF are designated as Boiler Nos. 1A, 4, 5, and 6. Boiler 1A is a Babcock & Wilcox FM unit which was installed in 1962 and has a heat input of 56.7 MMBtu/hr. Boiler No. 4 is a Combustion Engineering VU-10 unit, installed in 1961, which has a heat input of 75 MMBtu/hr. Boiler No. 5 is a Combustion Engineering VU-60 unit which was installed in 1965 and has a heat input of 75 MMBtu/hr. Boiler No. 6 is a Combustion Engineering 28-A-14 unit, installed in 1984, which has a heat input of 147 MMBtu/hr. All of these units are monitored for opacity, O_2, and CO_2. In addition, Boiler No. 6 has low excess air burners and has a continuous emissions monitor for NO_x. Emissions from these boilers are reported on a quarterly basis to the NYSDEC.

Boiler No. 4 is scheduled for demolition during CY 1994. It will be replaced with Boiler No 7, a Babcock & Wilcox FM-117-97 unit, which has a 147 MMBtu/hr heat input. Boiler No. 7 is currently anticipated to be available for operation in the spring of 1995. This unit will be equipped with low NOx burners, secondary air combustion equipment, and a continuous emissions monitor for NO_x.

4.1.3 Liquid Effluents

The basic policy of liquid effluent management at the Laboratory is to minimize the volume of liquids requiring processing prior to on-site release or solidification for off-site burial at a licensed facility.[35] Accordingly, liquid effluents are segregated by the generator at the point of origin on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

4.1.4 Liquid Waste Management

Liquid chemical wastes are collected by the HWMG, and subsequently packaged in accordance with Department of Transportation (DOT), EPA, and NYSDEC regulations and DOE Orders for licensed off-site disposal.

The HWMG also collects small quantities of low-level liquid radioactive wastes from waste accumulation areas throughout the site. Depending on the radionuclide and its concentration, these wastes are either directly solidified at the HWMF or processed at the WCF. Buildings where large volumes (up to several hundred liters) of low-level liquid radioactive waste are generated have dual waste handling systems. These systems are identified as "active" (D) and "inactive" (F). The D-waste liquid stream is always collected for disposal through the WCF. The F-waste liquid stream is sampled, analyzed, and compared to DOE, BNL, and SPDES release criteria. If concentration meets release criteria, the liquid waste may be released to the sanitary waste stream. Otherwise, the liquid waste is transferred to the WCF for processing. In 1993, authorized releases of F-waste to the sanitary system totaled 0.62 million liters with a total gross beta activity of 0.49 mCi (18.2 MBq) and a total tritium activity of 14.9 mCi (0.6 GBq). The volume of material released in 1993 represents a nine fold decrease over 1992. The gross beta activity released increased by a factor of 2.0, while the tritium activity released decreased by a factor of 2.2. These releases are significantly lower than pre-1989 values.

At the WCF, liquid waste is distilled to remove particulate, suspended, and dissolved solids. The solidified residues from the evaporator are transferred to the HWMF for subsequent shipment and disposal at an authorized off-site disposal facility. The distillate, which contains tritium, is collected and transported to the STP. It is released into a lined hold-up pond where it mixes with precipitation and effluent diverted from the STP (Figure 10). This water is then pumped back to the STP at a controlled rate where it is added to the dosing tanks of the sand filter beds. This process permits a controlled release of liquid effluents and aids the Laboratory in achieving its administrative discharge concentration limit of 20,000 pCi/L (740 Bq/L) and the goal of 10,000 pCi/L (370 Bq/L). By comparison, the DCG[1] for tritium is 2,000,000 pCi/L (0.074 MBq/L). In 1993, approximately 53 mCi (1.96 GBq) of tritium was placed into the lined holding pond.

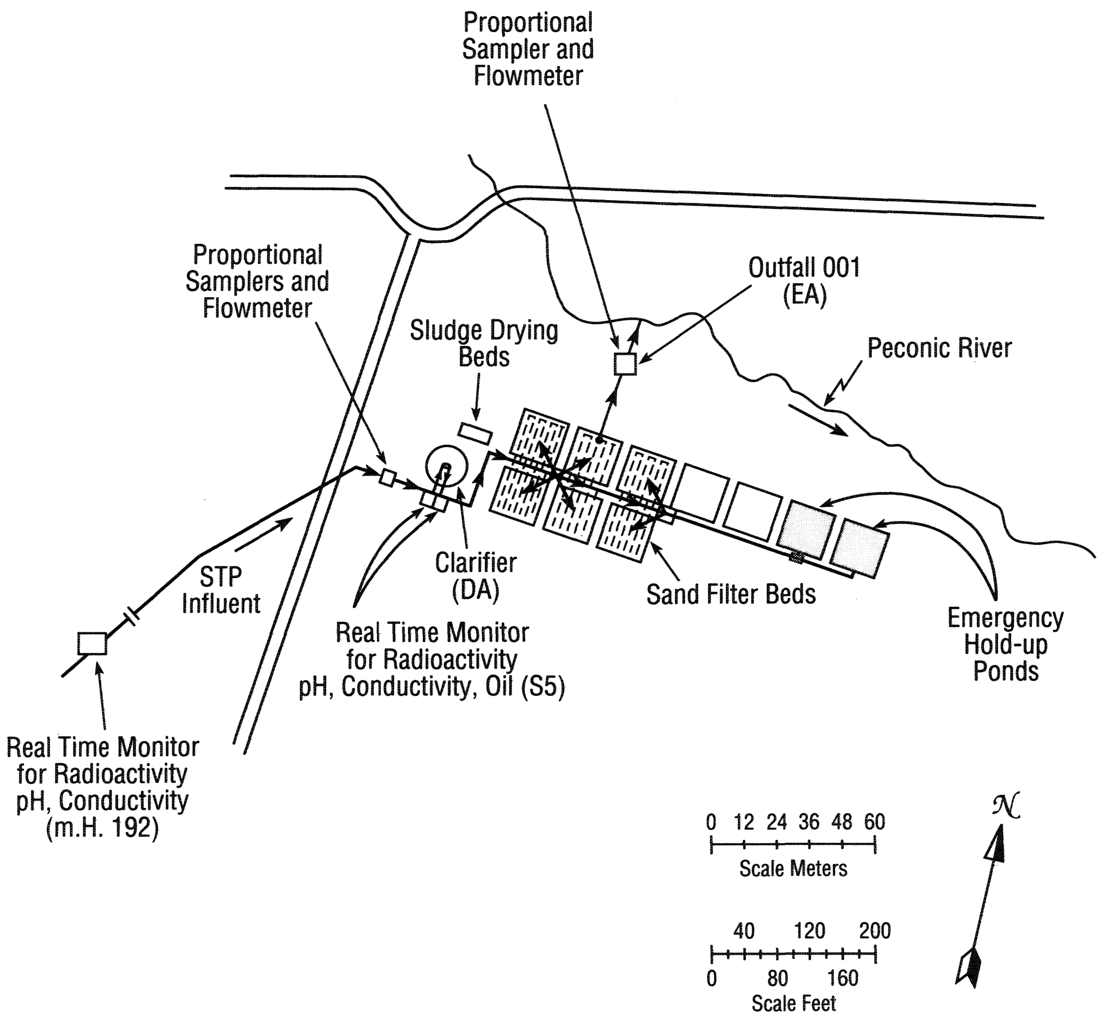


Figure 10: Sewage Treatment Plant - Sampling Stations.

4.1.4.1 Sanitary System Effluents

Primary treatment of the sanitary waste stream to remove suspended solids is provided by a 950,000 liter clarifier. The liquid effluent flows from the clarifier onto sand filter beds, from which about 85% of the water is recovered by an underlying tile field. This recovered water is then released into a small stream that contributes to the headwaters of the Peconic River. This release is a permitted discharge under SPDES. The Peconic River is an intermittent stream within the BNL site. From the mid 1980's until April of 1989, virtually all water released to this channel recharged to ground water prior to reaching the site boundary. Beginning in April 1989 and continuing throughout 1990, heavy rains produced sufficient upstream contribution to result in the Peconic tributary on the BNL site to once again leave the site. However, since 1991, the majority of the flow reverted back to the recharge regime with little to no flow being recorded during 1993.

The effluent not collected by the tile fields, approximately 10 - 15%, is assumed to percolate to the ground water under the beds and/or evaporate. A schematic of the STP and its related sampling arrangements is shown in Figure 10. Real time monitoring of the clarifier influent for radioactivity, pH and conductivity, takes place at two locations: about 1.8 km upstream of the STP and as the influent is about to enter the clarifier. The upstream station provides about one hour of advanced warning that liquid effluents which may exceed BNL effluent release criteria or SPDES limits have entered the system. At the clarifier, an oil monitor examines STP influent for the presence of oil. Effluent leaving the clarifier is monitored a third time for radioactivity. Effluent that does not meet BNL and/or SPDES effluent release criteria are diverted to one of two lined holding ponds, with a total capacity of 26.5 million liters, until the effluent meets the release criteria. The effluent diverted to the holding pond is evaluated for treatment and released when the addition of this material will not result in exceeding BNL SPDES or administrative release criteria.[36] In addition to real time monitoring, the clarifier effluent (Location DA) and the outfall to the Peconic River (Location EA) are monitored for radiological and nonradiological parameters through a combination of volume proportional and grab samples.

4.1.4.2 Radiological Analyses

The proportional samples collected at Location DA, the effluent from the STP clarifier, and Location EA, the STP discharge point into the Peconic River, are analyzed daily for gross alpha, beta, and tritium activities. An aliquot is composited for monthly strontium-90 and gamma spectroscopy analyses. The results of these measurements are reported in Tables 8 and 9. Seven year trend plots of gross beta and tritium concentrations that were released to the Peconic River are presented in Figures 11 and 12. A total tritium activity trend plot from 1971 to the present is presented in Figure 13.

The gross alpha data at the STP are consistent with prior year's data. All results are essentially less than the system detection limit and have a mean value which approaches zero. This means that alpha concentration measurements for these locations are at background levels. The tritium concentrations decreased in 1993 by a factor of about 2.2 compared to 1992 levels.

Table 8
BNL Site Environmental Report for Calendar Year 1993
Radiological Analysis Results of Sewage Treatment Plant Influent and Effluent

	Flow (liters)	Gross Alpha Avg. (pCi/L)	Gross Alpha Max. (pCi/L)	Gross Beta Avg. (pCi/L)	Gross Beta Max. (pCi/L)	Tritium Avg. (pCi/L)	Tritium Max. (pCi/L)
Sample Location DA - Clarifier Effluent							
January	7.39E+07	0.68	3.76	5.61	9.15	1044.33	3408.22
February	7.18E+07	0.72	2.72	4.95	10.30	833.29	2441.61
March	7.55E+07	0.75	2.41	5.78	13.62	850.33	1553.85
April	9.49E+07	0.54	2.69	5.84	11.35	2037.14	6416.16
May	9.03E+07	1.20	4.02	5.94	12.10	3272.36	8856.39
June	9.84E+07	1.10	4.32	6.24	10.23	5157.72	23685.41
July	9.61E+07	1.44	3.61	6.67	15.24	2895.75	5393.64
August	9.53E+07	0.91	2.36	6.00	13.24	3312.10	5923.31
September	9.15E+07	1.08	4.77	5.82	9.12	4260.98	7197.32
October	8.23E+07	0.65	3.41	6.00	10.41	4340.52	16014.34
November	8.40E+07	0.83	3.09	5.91	13.95	920.00	5125.74
December	6.23E+07	1.22	2.62	5.05	9.94	2710.99	44277.57
Annual Avg.		0.93		5.82		2636.29	
Total Rel. (L or mCi)	1.02E+09	0.91		5.72		2797.34	
Sample Location EA - Chlorine House Effluent							
January	5.28E+07	1.13	4.71	8.17	12.39	5344.78	11827.66
February	5.32E+07	0.49	2.98	8.14	15.93	3215.07	5046.43
March	6.20E+07	0.51	3.23	9.06	16.67	2482.25	3295.01
April	7.63E+07	0.06	1.64	8.26	11.36	3159.12	7423.44
May	5.82E+07	0.45	3.04	7.57	10.97	4959.66	9743.48
June	1.15E+08	0.80	2.26	9.74	18.93	5549.01	17041.22
July	9.55E+07	0.80	2.55	8.26	11.05	3074.67	6111.26
August	9.28E+07	0.86	3.44	7.85	12.08	3544.46	6621.47
September	7.49E+07	1.00	3.67	8.33	11.70	4174.63	6729.04
October	8.28E+07	0.59	2.79	8.54	17.23	4529.59	14656.64
November	6.17E+07	0.40	2.42	9.44	37.92	1204.14	5810.83
December	5.46E+07	1.81	12.34	7.16	15.56	860.49	1898.22
Annual Avg.		0.74		8.38		3508.16	
Total Rel. (L or mCi)	8.80E+08	0.61		7.52		3245.20	
SPDES Limit		3.00 (Ra-226)		1000		Not Listed	
NYS Drinking Water Std		155		50		20000	
Typical MDL		2.3		6		1000	

Table 9
BNL Site Environmental Report for Calendar Year 1993
Sewage Treatment Plant Influent and Effluent
Gamma Spectroscopy and Sr-90 Results

	Flow (liters)	Be-7 (pCi/L)	Na-22 (pCi/L)	Mn-54 (pCi/L)	Co-57 (pCi/L)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Sr-90 (pCi/L)
Sample Station DA - Clarifier Influent								
January	7.39E+07	0.432	0.040	0.062	0.033	0.051	0.124	-0.070
February	7.18E+07	----	----	0.045	----	0.027	0.103	-0.510
March	7.55E+07	----	0.149	----	----	----	0.897	-0.210
April	9.49E+07	----	----	----	----	----	0.081	0.090
May	9.03E+07	----	----	----	----	----	0.099	-0.540
June	9.84E+07	----	----	----	----	----	0.060	0.151
July	9.61E+07	----	----	----	----	----	----	0.215
August	9.53E+07	----	----	----	----	----	0.081	0.015
September	9.15E+07	----	----	----	----	----	0.220	0.104
October	8.23E+07	----	----	----	----	----	0.045	0.049
November	8.40E+07	----	----	----	----	----	----	0.052
December	6.23E+07	----	----	----	----	----	----	0.197
Annual Avg.		0.031	0.014	0.008	0.002	0.006	0.136	0.074
Totals (L or mCi)	1.02E+09	0.032	0.014	0.008	0.002	0.006	0.138	0.076
Sample Station EA - Discharge to Peconic River								
January	5.28E+07	----	----	----	----	----	1.120	-0.140
February	5.32E+07	----	----	----	----	----	0.892	0.330
March	6.20E+07	----	----	----	----	0.054	1.560	0.090
April	7.63E+07	----	----	----	----	0.064	2.290	-2.630
May	5.82E+07	----	----	----	----	0.168	2.270	0.108
June	1.15E+08	----	----	----	----	0.110	2.280	0.287
July	9.55E+07	----	----	----	----	0.066	1.010	0.245
August	9.28E+07	----	----	----	----	0.043	1.960	0.091
September	7.49E+07	----	----	----	----	0.066	1.599	0.128
October	8.28E+07	----	----	----	----	0.047	2.628	0.099
November	6.17E+07	----	----	----	----	0.086	2.130	0.088
December	5.46E+07	----	----	----	----	----	2.854	0.309
Annual Avg.		0	0	0	0	0.063	1.904	0.153
Totals (L or mCi)	8.80E+08	0	0	0	0	0.055	1.676	0.134
DOE Order 5400.5 DCGs* (pCi/L)		1,000,000	10,000	50,000	100,000	5,000	3,000	1,000
SDWA Annual Dose** (pCi/L)		40,000	400	2,000	4,000	200	120	40
SPDES Limit (pCi/L)		----	----	----	----	----	----	10
NYS DWS		----	----	----	----	----	----	8
Typical MDL		1.60	0.20	0.18	0.14	0.23	0.20	0.10

*DCG: Derived Concentration Guide. The DCG value represents the concentration of a radionuclide in water that would cause a committed effective dose equivalent (CEDE) of 100 mrem if 2 liters a day were ingested for one year.
** Concentration required to produce the Safe Drinking Water Act (SDWA) annual dose limit of 4 mrem.

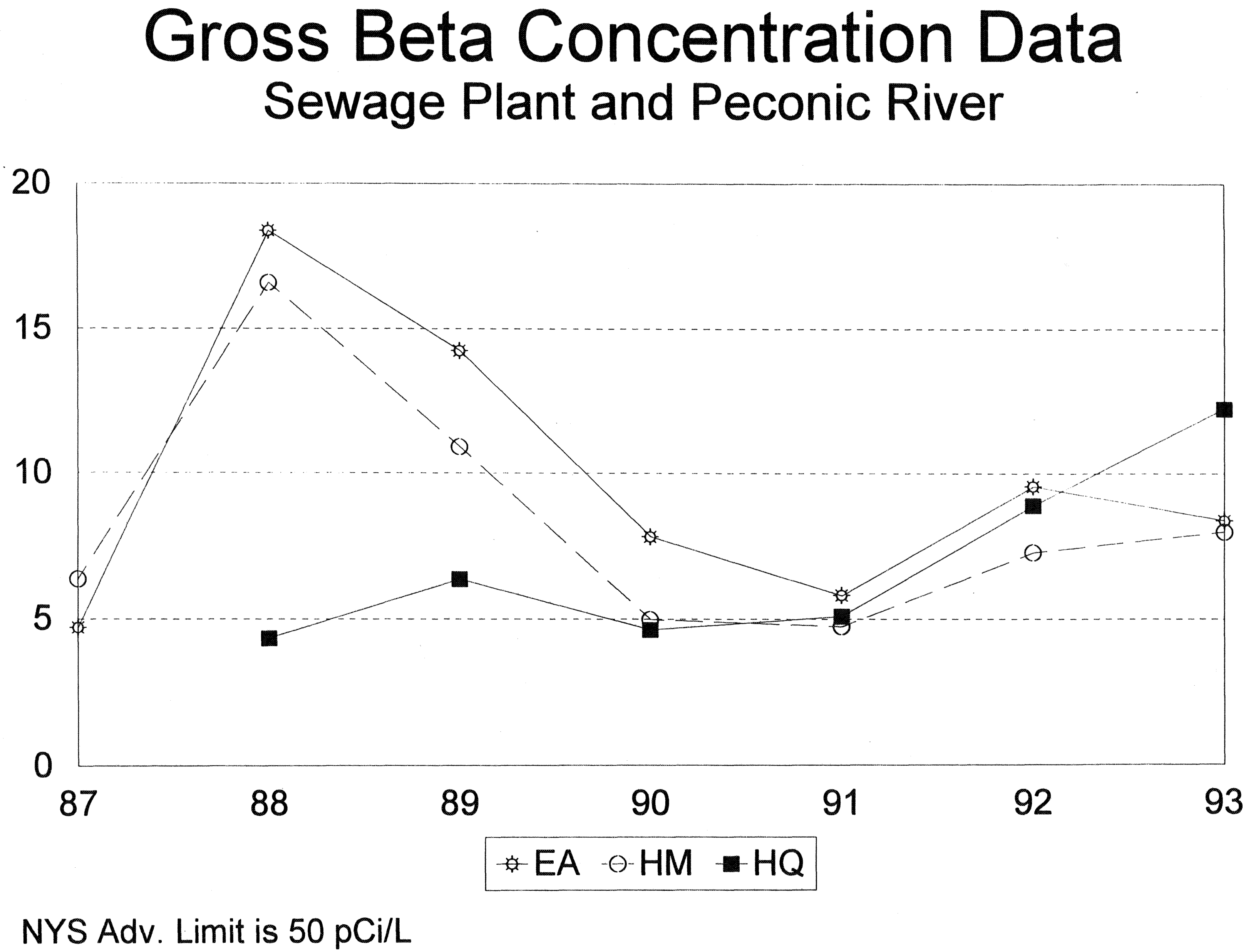


Figure 11: Gross Beta Concentration Data: Sewage Treatment Plant and Peconic River 1987 - 1993.

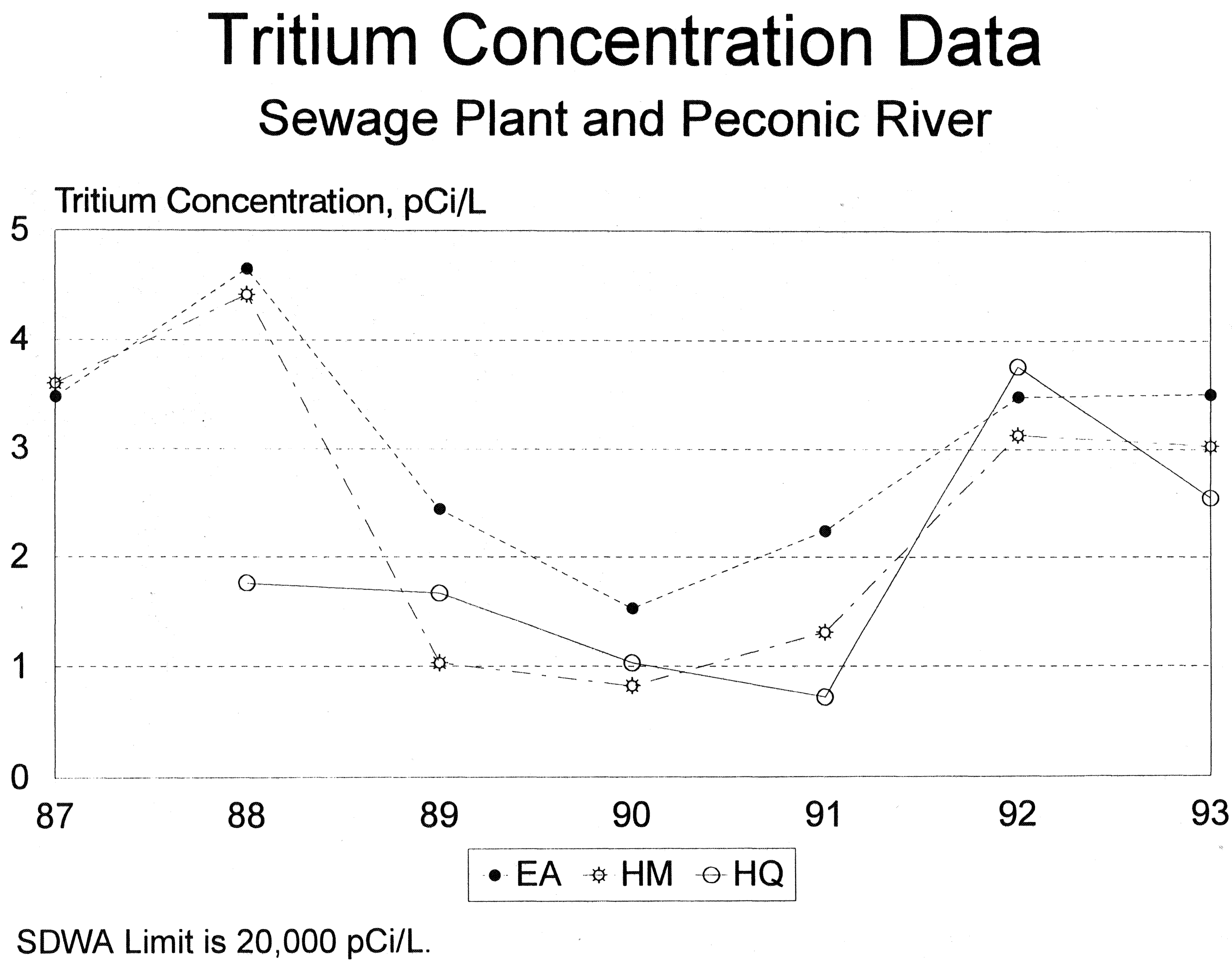


Figure 12: Tritium Concentration Data: Sewage Plant and Peconic River - 1987 - 1993.

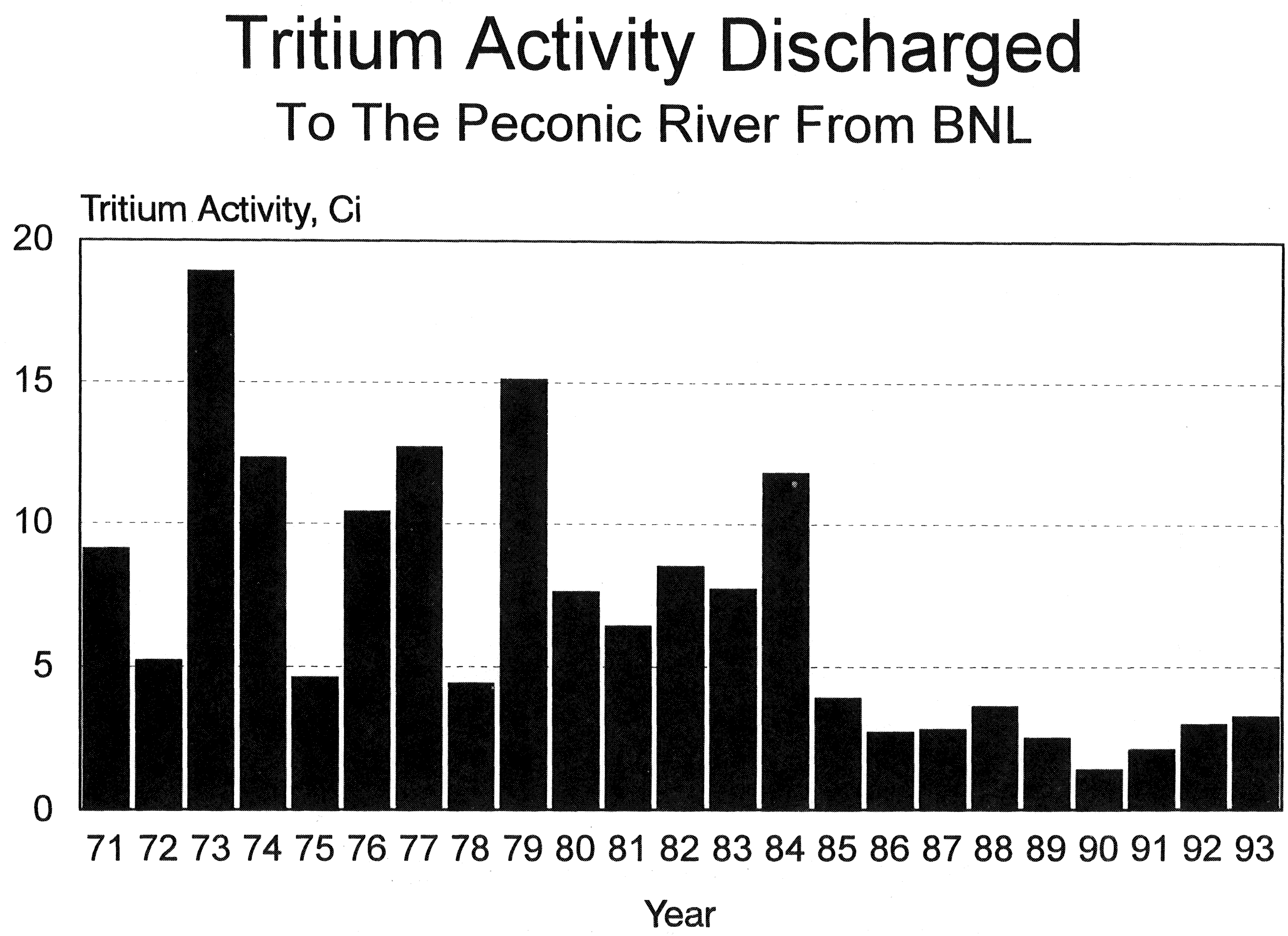


Figure 13: Tritium Activity Discharged to the Peconic River from BNL - 1971 - 1993.

Controlled releases of WCF distillate from the STP emergency holding ponds continued in 1993. The 1993 tritium concentrations discharged to the Peconic River were below regulatory standards and were within BNL administrative controls (10,000 pCi/L).[36] The total tritium activity released into the sanitary system was 2.8 Ci (103 GBq) as compared to 3.9 Ci (144 GBq) in 1992. The tritium activity discharged from Location EA was 3.2 Ci (118 GBq), essentially the same value as in 1992. The concentrations of Sr-90 and gamma emitting radionuclides entering the STP remained at their pre-1988 levels. At Location DA, all radionuclide concentrations were at or below pre-1988 levels. At Location EA concentrations are essentially constant with the data from prior years.[9] Although Cs-137 concentrations remain slightly elevated as compared to pre-1988 values, they have almost returned to their historically typical levels. Cesium-137 continues to leach out of the sand filter beds from a deposit that occurred during an unplanned release on June 14 - 15, 1988. A discussion of the incident can be found in the 1988 BNL SER.[9]

In 1993, gross beta concentrations at Location EA were approximately 1.4 times the influent concentrations, which is consistent with previous years. Cesium-137 concentrations in water collected from Location EA were 14 times the concentration found in the clarifier. This ratio is 1.4 times lower than in 1992, indicating a steady annual decrease. Strontium-90 concentrations at Location EA averaged out to be near MDL concentrations (Sr-90 MDL = 0.1 pCi/L). None of the monthly values that were positive resulted in any violation of SPDES permit. If the BNL administrative policy dose criteria of 4 mrem/yr were used for comparison, daily ingestion of water, discharged by BNL to the Peconic River, would result in an annual dose of 1.5E-3 mrem (1.5E-5 mSv) or less than 0.001% of BNL's current discharge policy.

4.1.4.3 Sanitary System Nonradiological Analyses

The effluent from the Laboratory STP discharges into the Peconic River at Location EA (Outfall 001) and is subject to the conditions of the SPDES Permit No. NY-0005835, which is issued by the NYSDEC. Monthly DMRs are submitted to the NYSDEC and SCDHS which provide detailed analytical results and performance information regarding the operational activities at the STP. Table 2 (see Chapter 2) contains the maximum concentration of contaminants observed within the STP discharge during 1993. The data collected during 1993 indicates a compliance rate of greater than 99.8% for all parameters monitored. A complete monthly summary of DMR data is presented in Table 3.

Five permit limitation exceedances were observed during CY 1993. The contaminants responsible for these exceedances were iron (1), ammonia nitrogen (1) and chlorine residual (3). The chlorine residual exceedances occurred during the period March 5 to March 8, 1993 and were attributable to a malfunctioning hypochlorite dosing pump. Replacement of the defective pump on March 8, 1993 effectively rectified the problem. The cause of elevated concentrations of iron and ammonia in the STP discharge was not clearly evident and it is speculated that construction activities conducted within the sand filters may be the cause of these exceedances. In November 1993, the PE Division initiated an investigation into the cause of elevated ground water in the vicinity of the STP. This increase in ground-water elevation resulted in increased cost estimates for construction of STP upgrades. The investigation consisted of rerouting all the

STP waste water to the eastern most filterbeds and the installation of dewatering pits within the two western most beds. During this activity waste water was permitted to accumulate within the beds and the western most beds were completely removed from service. While the concentration of iron has since resumed to less than the SPDES permit limits, the concentration of ammonia has continued to exceed permit levels. It is surmised that due to the accumulation of water on the sand filters and the harsh winter, a loss of nitrifying bacteria in the sand filters has occurred. The outcome of this loss has been an increase in ammonia concentration within the STP discharge. Repopulation of the nitrifying bacteria is anticipated with the on-set of warmer weather and restoration of the sand filters.

In addition to the collection and analysis of the STP effluent samples for compliance purposes, the EM Group monitored the STP influent and effluent routinely during 1993. Daily influent and effluent samples were collected, composited by the SEP analytical laboratory, and analyzed monthly for metals. In addition, the effluent was monitored daily for pH, conductivity, temperature, dissolved oxygen, and chlorine residual; and weekly for water quality parameters. Daily influent and effluent logs were also maintained by the STP operators for the parameters of flow, pH, temperature, settleable solids, and chlorine residual.

The analytical results for the samples collected from the STP by the EM Group have been summarized in Table 10. Comparison of the effluent data to the SPDES effluent limitations shows that exceedances for the parameters of iron and residual chlorine were observed. While the maximum concentration of iron and residual chlorine exhibited in the effluent exceeded the SPDES permit limitation, the average concentration was well below this limit. This data corresponds well with the compliance data reported in Chapter 2.

Table 10
BNL Site Environmental Report for Calendar Year 1993
Sewage Treatment Plant (a)
Average Water Quality and Metals Data

	Sewage Treatment Plant Influent				Sewage Treatment Plant Effluent			
	N	Minimum	Maximum	Average	N	Minimum	Maximum	Average
pH (SU) (b)	NA	3.1	8.9	NA	NA	5.9	7.2	NA
Conductivity (umhos/cm)				(c)	250	148	417	224
Temperature (C)	NA	13.0	26.0	NA	250	2.3	27.2	16.3
Results in mg/L								
Dissolved Oxygen	NA	NA	NA	NA	250	4.8	14.9	8.1
Chlorides	NA	NA	NA	NA	46	25.5	91.9	49.8
Nitrate (as N)	NA	NA	NA	NA	46	2.8	27.8	6.35
Sulfates	NA	NA	NA	NA	46	<4.0	30.5	16.3
Chlorine Residual	NA	NA	NA	NA	253	0.00	0.45	0.02
Silver	12	<0.025	<0.025	<0.025	12	<0.025	<0.025	<0.025
Cadmium	12	<0.0005	<0.0005	<0.0005	12	<0.0005	<0.0005	<0.0005
Chromium	12	<0.005	<0.005	<0.005	12	<0.005	<0.005	<0.005
Copper	12	<0.05	0.12	0.05	12	<0.05	0.104	<0.05
Iron	12	0.11	1.33	0.42	12	0.106	0.727	0.27
Manganese	12	<0.5	<0.5	<0.5	12	<0.05	0.151	<0.05
Mercury	12	<0.0002	<0.0002	<0.0002	12	<0.0002	0.0002	<0.0002
Sodium	12	27.30	32.00	29.70	12	27.35	31.36	29
Lead	12	<0.002	0.01	<0.002	12	<0.002	0.0064	0.0025
Zinc	12	0.03	0.06	0.05	12	0.026	0.066	0.04

NA: Analysis not performed.
(a): The locations of the monitoring stations are shown in Figure 10.
(b): The pH and temperature values reported are those recorded on the strip chart recorder operated by the sewage treatment plant operators.
(c): Metered.

The indicated average metal concentration has been calculated by summing all detectable concentrations and dividing this value by the total number of sampl reported as less than the minimum detection limit (MDL) has been evaluated as zero. If the average is less than the MDL, then the average is reported as less MDL.

The expiration date for the current BNL SPDES permit was May 1, 1988. Efforts to renew the SPDES permit continued during CY 1993. On November 30, 1992, the NYSDEC issued the first draft of the BNL SPDES permit. The draft permit contained numerous permit modifications including: an increase in parameters requiring monitoring at the STP, an increase in monitoring frequency at the STP, addition of monitoring and reporting requirements for discharges to the recharge basins, requirements for biomonitoring of the STP discharge, addition of two recharge basins, process specific monitoring requirements, preparation of best management practices for site runoff, preparation of an engineering report regarding the upgrade of the STP process, and additional short term monitoring requirements. This permit was reviewed with regard to its technical and economical impact on Laboratory operations and comments were prepared and submitted to the NYSDEC in January 1993. A redraft of the subject permit was issued by the NYSDEC on July 9, 1993. While the redraft sought to incorporate many of the previously BNL requested modifications, many issues remained which, if not negotiated, would result in persistent violations of the SPDES permit. Comments were again prepared and submitted to the NYSDEC in August 1993. On October 22, 1993, an unofficial copy of a second redraft was received by BNL for subsequent review. In an effort to expedite issuance of a final permit, a meeting with BNL and NYSDEC personnel was held on November 23, 1993. During this meeting the Laboratory expressed its concerns regarding the permit, and at the request of the NYSDEC, submitted formal comments on January 20, 1994. According to the NYSDEC, the latest round of comments are being evaluated at the present time and it is speculated that a final draft will be issued before June 1994. Issues still requiring resolution include a request for the relaxation of effluent limitations for tolyltriazole and hydroxyethylidene diphosphonic acid, corrosion control compounds present in cooling water discharges, and minor modifications to the STP biomonitoring program.

Figures 14 through 22 present five year trend plots for the maximum monthly concentrations and the average loading of copper, iron, lead, silver, and zinc in the effluent of the STP. Plotted along with the observed concentrations are the current SPDES permit limits and the October 1993 proposed limits for the SPDES permit renewal. Review of the trend plots show that the majority of the discharges comply with the existing and proposed permit conditions; however, the lower effluent limitations established under the proposed permit may require stricter source controls in order to assure compliance.

Process Specific Waste Water Assessments

In order to prevent violation of SPDES permit limitations and the release of waste waters which exceed ground-water effluent standards, the Laboratory requires that process waste waters suspected of containing contaminants at concentrations which may exceed one or both of these standards be held, characterized, and authorized by the SEPD prior to disposal.

Process waste waters which have not been evaluated for incorporation into the SPDES permit, or are not expected to be of consistent quality, are held for characterization and evaluation by S&EP prior to sewer disposal. Typical waste waters which are routinely evaluated are ion exchange column regeneration wastes, primary closed loop cooling water systems, and other industrial waste waters. In order to determine the means for disposal of these wastes, samples are collected and analyzed for contaminants specific to the process. The analyses are then reviewed and the concentrations and mass loads compared to the SPDES effluent limitation. If the concentration and/or mass load are within the effluent standard, sewer disposal authorization is granted; if not, alternate means of disposal are evaluated. In all instances, any waste which contains hazardous levels of chemical contaminants or elevated radiological contamination is remanded to the HWM operations group for disposal guidance.

The draft SPDES permit includes requirements for the quarterly sampling and analysis of process specific waste waters discharged from the photographic developing operations conducted within Buildings 118 and 197, the electroplating operations conducted in Building 535, and the metal cleaning operations conducted within Building 197. These operations will be sampled and analyzed for chemical contaminants specific to these operations and include parameters such as heavy metals, cyanide, and volatile and semi-volatile organic compounds.

In an effort to further characterize the effluents discharged into the headworks of the sewage treatment plant, a sampling and characterization project was initiated in 1993. This project consisted of collecting three daily composite samples from the discharges emanating from 30 locations site wide and subsequently analyzing these samples for contaminants expected to be present. The list of analytes for each sampling location was generated based upon information received from the departments in response to a liquid effluent questionnaire distributed in May 1992. The data generated during this program showed that the majority of the facility effluents complied with the provisions of the BNL SPDES permit. Several effluent samples did, however, contain elevated concentrations of organic and inorganic compounds. Efforts to mitigate these discharges will be undertaken during 1994. In addition, it is speculated that this program will be continued during 1994 with the collection of effluent samples from facilities not previously sampled during 1993.

4.1.4.4 Recharge Basins

Figure 23 depicts the locations of BNL recharge basins within the physical complex. An overall schematic of water use at the Laboratory is shown in Figure 24. After use in "once through" heat exchangers and process cooling, approximately 5.85 million liters per day (MLD) of water was returned to the aquifer through on-site recharge basins; 1.71 MLD to Basin HN (Outfall 002) located about 610 m northeast of the AGS; 3.99 MLD to Basin HO (Outfall 003) about 670 m east of the HFBR; 0.06 MLD to Basins HS (Outfall 005) and HT (Outfall 006) and 0.20 MLD to recharge basin HX. There was no recharge to Basin HP (Outfall 004) in 1993 because the MRR operated using cooling water from the Chilled Water Facility.

A polyelectrolyte and dispersant was added to the AGS cooling and process water supply to keep the ambient iron in solution. Of the total AGS pumpage, approximately 0.40 MLD was discharged to the HN Basin, and 3.39 MLD to the HO Basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and was treated with inorganic polyphosphate and tolytriazole to control corrosion and deposition of solids. The blowdown from this system (0.60 MLD) was also discharged to the HO Basin. During 1993, water samples were collected from Recharge Basins HN, HO, HS, HT, and HW. No samples were collected at Recharge Basin HP due to a lack of flow at this location. These locations are scheduled to be sampled quarterly, but due to unscheduled sampling requests, they were sampled three times during 1993. Recharge Basin HX, which receives WTP filter backwash, was not sampled during CY 1993 due to the shut down of the WTP for maintenance purposes for the majority of 1993. This discharge will be sampled monthly under the provisions of the proposed SPDES permit. Samples collected at all recharge basins were analyzed for radiological and nonradiological parameters.

Figure 14: MAXIMUM EFFLUENT CONCENTRATION OF COPPER DISCHARGED FROM BNL'S STP, 1989 - 1993

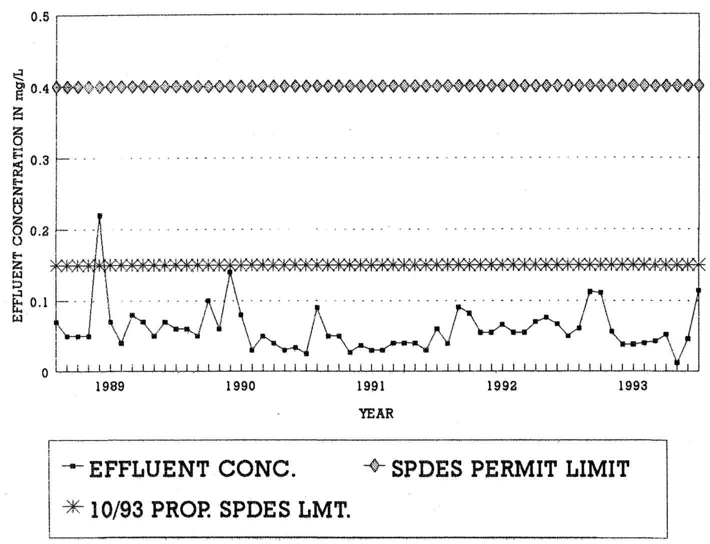


Figure 15: DAILY AVERAGE LOADING OF COPPER AT BNL'S STP, 1989- 1993

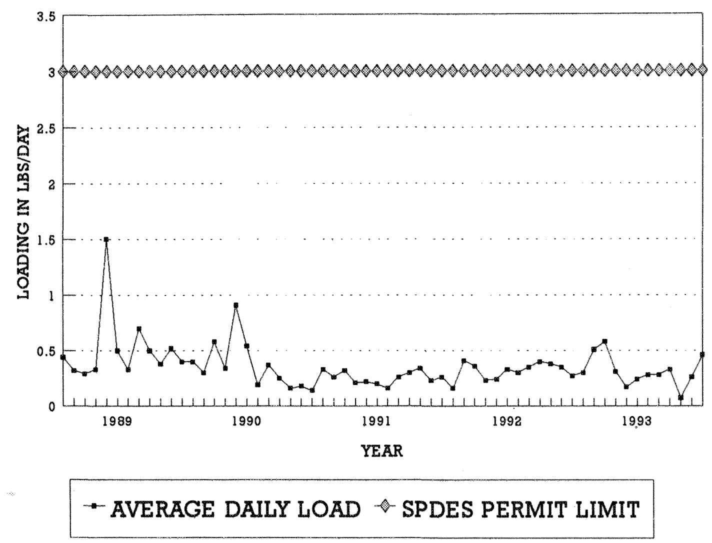


Figure 16: MAXIMUM EFFLUENT CONCENTRATION OF LEAD DISCHARGED FROM BNL'S STP, 1989- 1993

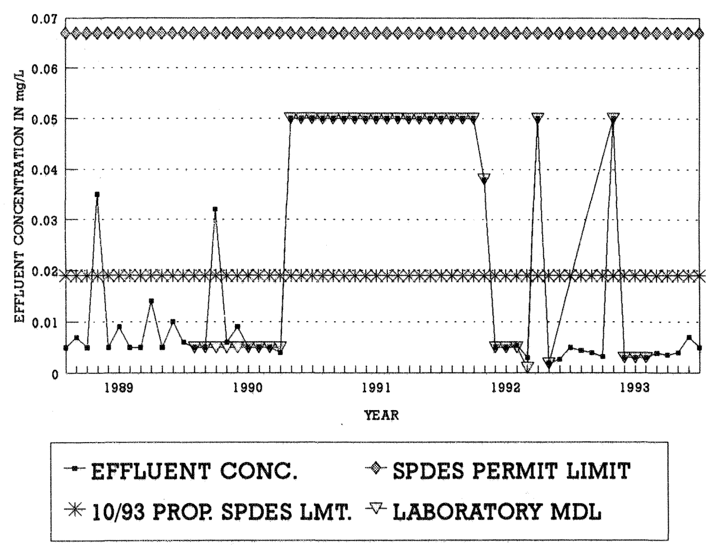


Figure 17: DAILY AVERAGE LOADING OF LEAD AT BNL'S STP, 1989 - 1993

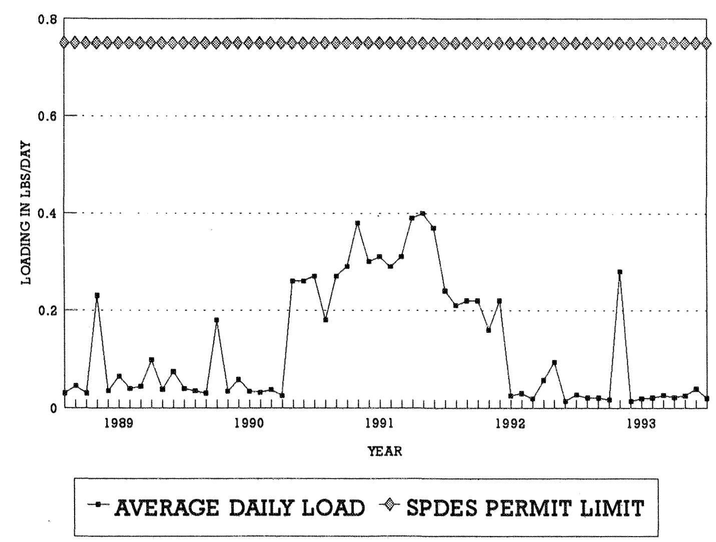


Figure 18: MAXIMUM EFFLUENT CONCENTRATION OF SILVER DISCHARGED FROM BNL'S STP, 1989 - 1993

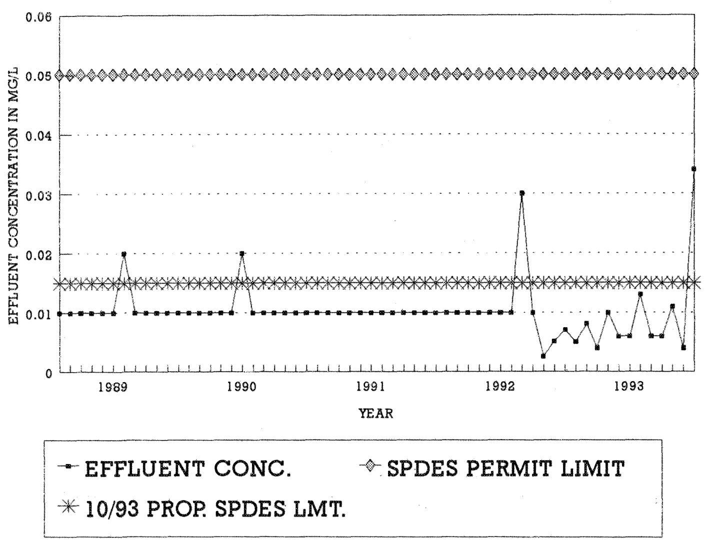


Figure 19: DAILY AVERAGE LOADING OF SILVER AT BNL'S STP, 1989 - 1993

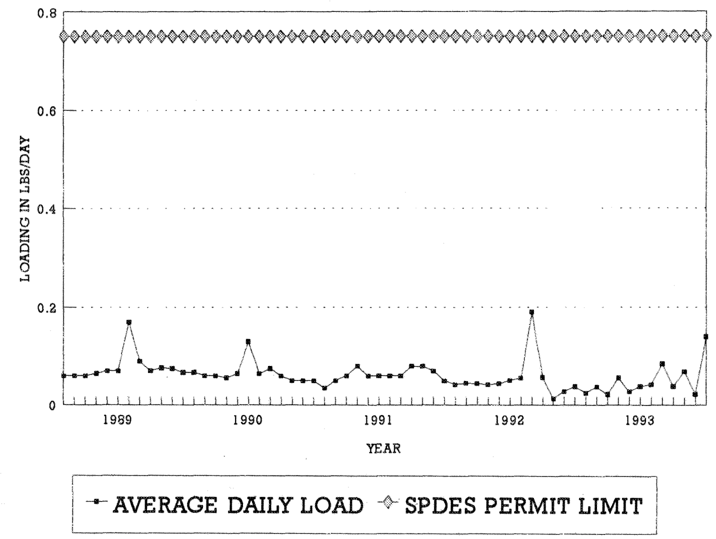


Figure 20: MAXIMUM EFFLUENT CONCENTRATION OF ZINC DISCHARGED FROM BNL'S STP, 1989 - 1993

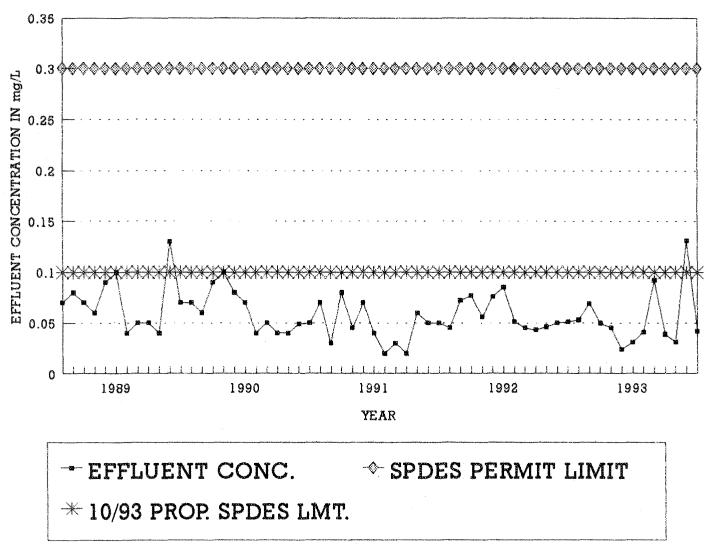


Figure 21: DAILY AVERAGE LOADING OF ZINC AT BNL'S STP, 1989 - 1993

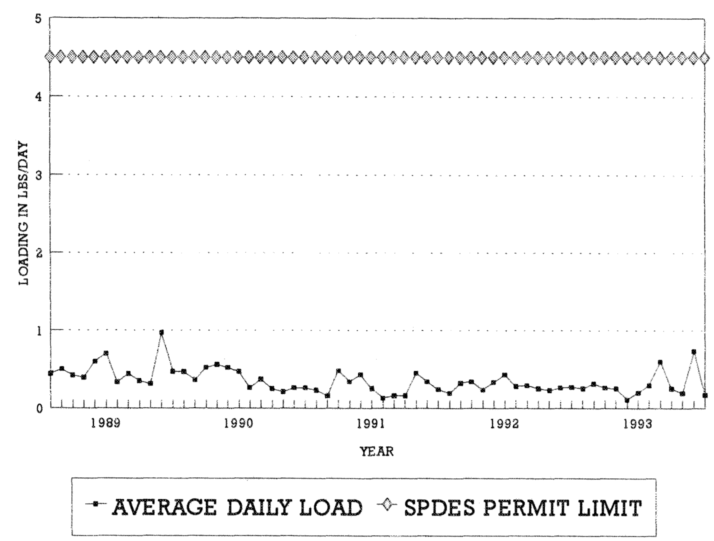
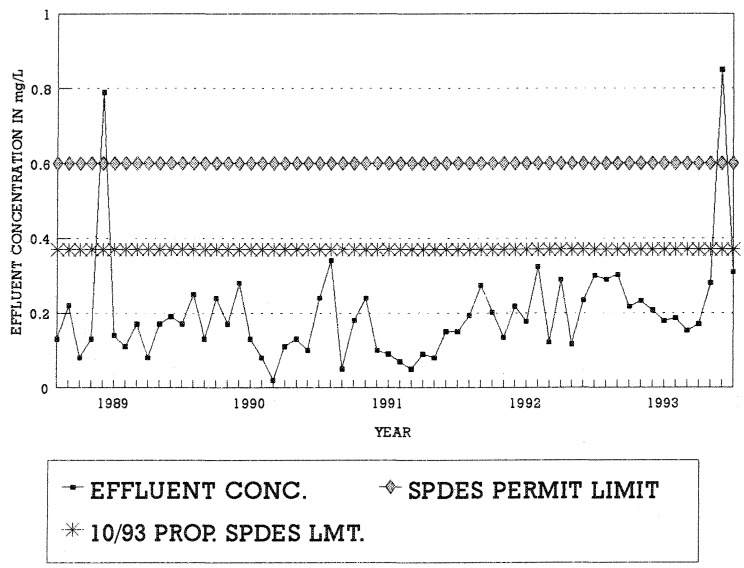


Figure 22: **MAXIMUM EFFLUENT CONCENTRATION OF IRON DISCHARGED BY BNL'S STP, 1989 - 1993**



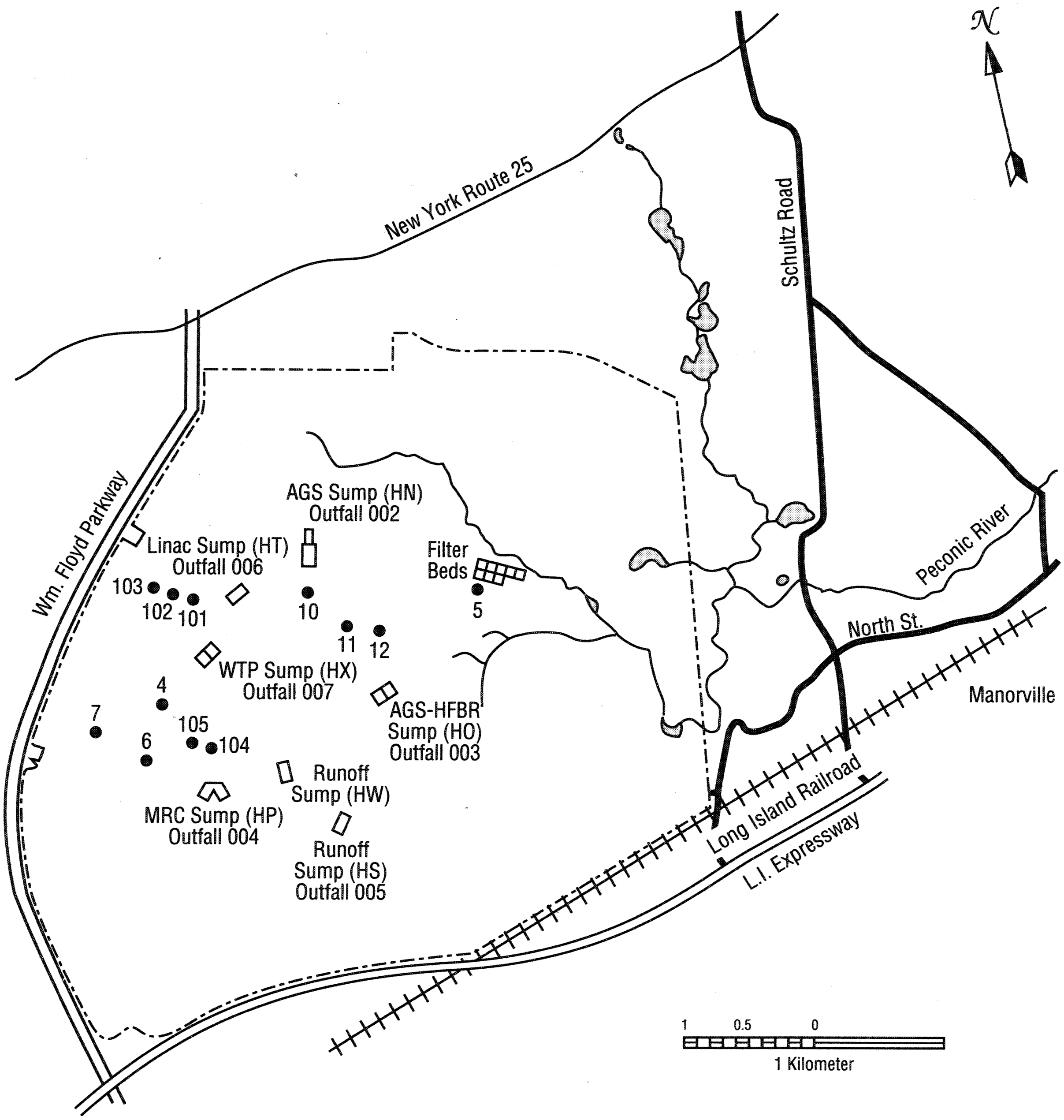
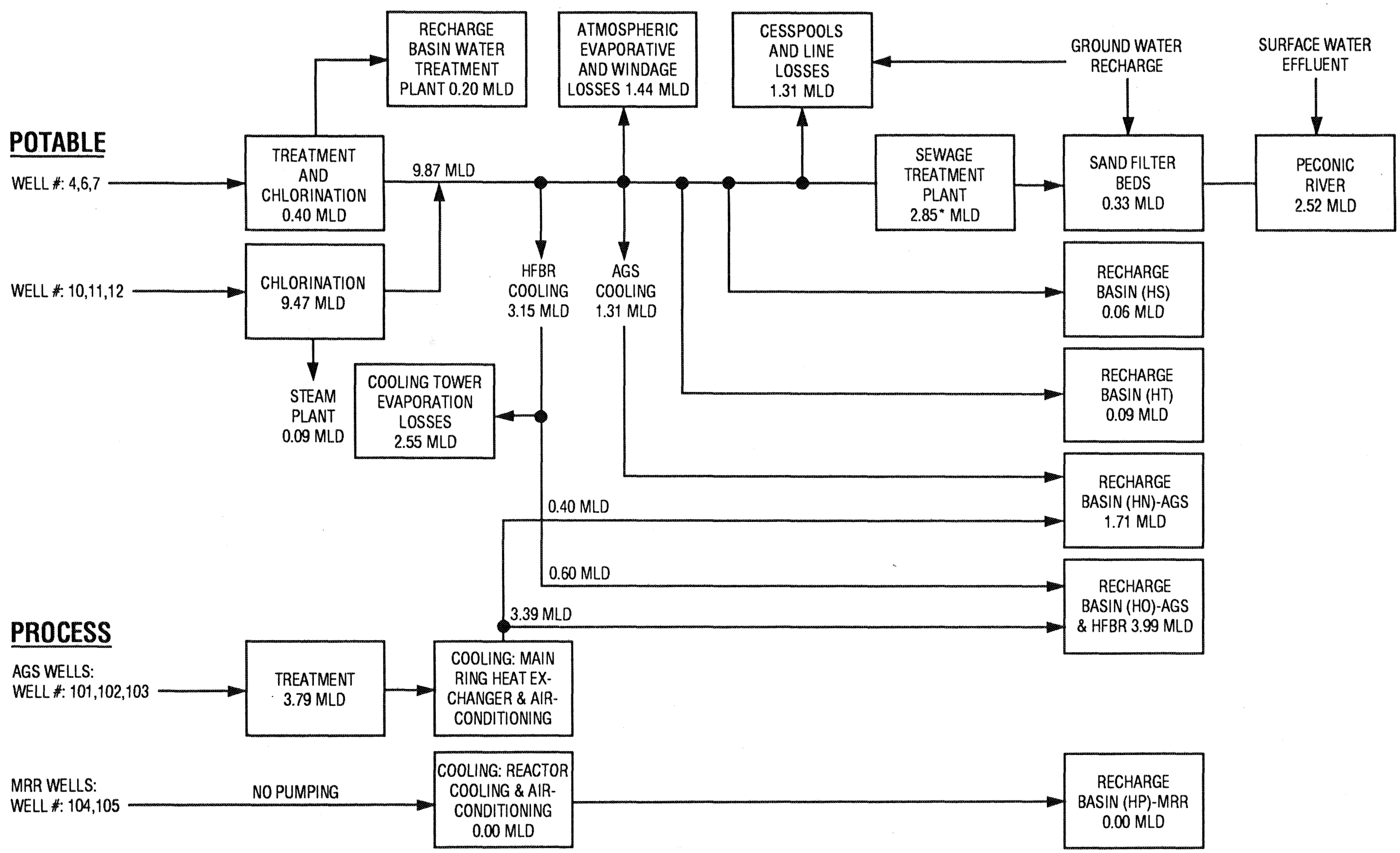


Figure 23: **On-Site: Potable and supply wells and recharge sumps.**



NOTE: WELL #s: 102,104 & 105 WERE NOT OPERATING.
*THIS ALSO INCLUDES STORM RUN-OFF THROUGH THE SANITARY SYSTEM.

Figure 24: **BROOKHAVEN NATIONAL LABORATORY SCHEMATIC OF WATER USE AND FLOW FOR 1993.**

4.1.4.5 Recharge Basins - Radiological Analyses

Radiological results for recharge basin samples are reported in Table 11. The data indicates that trace quantities of activity were discharged to Recharge Basin HN. All concentrations detected were small fractions of effluent release limits. The activity detected at Recharge Basin HN resulted from the discharge of primary magnet rinse water into the recharge basin. The observed concentrations of Be-7 result from high energy particle interactions in the cooling water at both the AGS and LINAC facilities. The presence of the remaining radionuclides is most likely due to activation of facility components and subsequent corrosion. No samples contained strontium-90 above ambient levels and for virtually all samples the tritium concentration was at or less than the system MDL. If a person ingested water from Sump HN as the sole source of drinking water for one year, this would result in a committed effective dose equivalent of less than 0.005 mrem (5E-5 mSv).

4.1.4.6 Recharge Basins - Nonradiological Analysess

To determine the overall impact of these discharges on the environment, the analytical data are compared to NYSDEC ground-water discharge standards promulgated under 6NYCRR Part 703.6. Samples collected from these recharge basins were analyzed for water quality parameters, metals, and volatile organic compounds. The water quality and metals data have been summarized in Tables 12 and 13, respectively. Review of the analytical data for samples collected from the recharge basins showed all parameters, except for iron at Recharge Basin HO and pH at Recharge Basin HS, to comply with the respective ground-water discharge standard. Effluents to Recharge Basin HO contain elevated levels of iron due to the discharge of ground water which is used in once-through cooling water systems. Recharge Basin HS receives predominantly storm water run-off, consequently the cause of the high pH values measured in April 1993 are not readily apparent. The water within this basin is subject to stagnation which may contribute to the high pH. There were no VOCs detected in the samples collected from these locations.

In March 1993, storm water samples were collected from the run-off discharged to Recharge Basins HN and HT and were analyzed for conventional and industrial pollutants. The analytical data for these samples showed all inorganic pollutants with the exception of iron to be within NYSDEC effluent standards. Iron was found present at concentrations which exceed the NYSDEC standards and is most probably present due to the accumulation of sediment within the samples and the high iron content of native soils. The discharge to Basin HT exhibited elevated concentrations of TCA ranging from 41 to 88 $\mu g/L$ which exceeds the NYSDEC ground-water effluent standard of 5 $\mu g/L$. The source of this contaminant was determined to be a chemical storage room which had a leaking roof. Precipitation entering the room was permitted to contact several TCA storage containers prior to draining into an outdoor storm drain. Subsequently, the roof to this facility has been repaired and the storm water discharge resampled. Analysis of these samples have shown all organic compounds to be less than the analytical detection limit of 2.0 $\mu g/L$.

Table 11
BNL Site Environmental Report for Calendar Year 1993
Radiological Analysis of Recharge Basin Water
Annual Radionuclide Concentrations

Location	Collect Date	Be-7 (pCi/L)	Na-22 (pCi/L)	Cs-137 (pCi/L)	V-48 (pCi/L)	Cr-51 (pCi/L)	Tritium (pCi/L)	G. Alpha (pCi/L)	G. Beta (pCi/L)
HN	19-Apr-93	---	---	---	---	---	214.00	-0.21	3.48
HN	08-Jul-93	5.88	0.53	---	1.23	6.50	296.00	1.83	7.75
HN	13-Oct-93	---	---	0.11	---	---	-292.00	0.61	0.08
Avg. pCi/L		1.96	0.18	0.04	0.41	2.17	72.67	0.74	3.77
HO	19-Apr-93	---	---	---	---	---	129.00	0.59	1.67
HO	26-Jul-93	---	---	---	---	---	197.00	0.55	1.59
HO	12-Oct-93	---	---	---	---	---	-90.00	0.70	1.44
Avg. pCi/L		0.00	0.00	0.00	0.00	0.00	78.67	0.61	1.57
HS	19-Apr-93	---	---	---	---	---	90.10	1.26	2.54
HS	08-Jul-93	---	---	---	---	---	726.00	0.59	1.63
Avg. pCi/L		0.00	0.00	0.00	0.00	0.00	408.05	0.93	2.09
HT	20-Apr-93	---	---	---	---	---	17.50	0.45	1.32
HT	08-Jul-93	---	---	---	---	---	280.00	0.84	2.39
HT	12-Oct-93	---	---	---	---	---	-58.40	1.51	3.41
Avg. pCi/L		0.00	0.00	0.00	0.00	0.00	79.70	0.93	2.37
Typical MDL		1.60	0.20	0.20	---	1.60	300.00	0.46	1.20
DOE Order 5400.5 DCG*		1,000,000	10,000	3,000	20,000	1,000,000	2,000,000	---	---
SDWA Concentration**		40,000	400	120	800	40,000	80,000	---	---

*DCG = Derived Concentration Guide. The DCG value represents the concentration of a radionuclide in water that would cause a committed effective dose equivalent (CEDE) of 100 mrem if 2 liters a day were ingested for one year.
**Concentration required to produce the Safe Drinking Water Act (SDWA) annual dose limit of 4 mrem.
Note: Basin HP was dry throughout 1993.

Table 12
BNL Site Environmental Report for Calendar Year 1993
Water Quality Data for On-Site Recharge Basins

Location (a)		pH SU	Temperature C	Conductivity umhos/cm	Chlorides mg/L	Sulfates mg/L	Nitrate as N (b) mg/L
HN (RHIC Recharge)	N	3	3	3	3	3	3
	Minimum	6.7	15	92	7.9	6.6	<1.0
	Maximum	8.7	28	121	17.2	13.4	<1.0
	Average	NA	20	108	13.1	10.6	<1.0
HO (HFBR-AGS)	N	3	3	3	3	3	3
	Minimum	6.5	13	109	17.6	10.1	<1.0
	Maximum	7	20	141	19.3	13.1	<1.0
	Average	NA	17	122	18.7	11.4	<1.0
HS (Storm Water)	N	2	2	2	2	2	2
	Minimum	8.5	20.6	57	<4.0	<4.0	<1.0
	Maximum	9.3	39.5	114	4.7	4.9	<1.0
	Average	NA	30.1	86	<4.0	<4.0	<1.0
HT (LINAC)	N	6	6	6	6	6	6
	Minimum	6.7	13	101	12.3	10.6	<1.0
	Maximum	7.7	21	300	32.8	23.9	<1.0
	Average	NA	18	154	17.4	13.6	<1.0
HW (Weaver Rd.)	N	2	2	2	2	2	2
	Minimum	6.9	20	42	<4.0	<4.0	<1.0
	Maximum	8.4	23	42	<4.0	4.3	<1.0
	Average	NA	22	42	<4.0	<4.0	<1.0
NYSDEC SPDES Effluent or Water Quality Standards		6.5 - 8.5	(c)	(c)	500	500	20
Typical MDL		NA	NA	10	4	4	1

MDL: Minimum Detection Limit
NA: Not Applicable
(a): The location of the recharge basins is provided in Figure 23.
(b): The holding times specified by the USEPA were exceeded for all nitrate analyses.
(c): No effluent standard specified.

Table 13
BNL Site Environmental Report for Calendar Year 1993
Average Metals Data for On-site Recharge Basins

Location (a)	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
HN (RHIC)	3	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.7	<0.002	0.046
		Maximum	<0.025	<0.0005	<0.005	<0.05	0.2	<0.0002	<0.05	21	<0.002	0.057
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	14.7	<0.002	0.052
HO (AGS/HFBR)	5	Minimum	<0.025	<0.0005	<0.005	<0.05	0.49	<0.0002	0.15	15.4	<0.05	<0.02
		Maximum	0.03	<0.0005	<0.005	<0.05	1.65	0.0003	0.34	18.2	<0.05	0.045
		Average	<0.025	<0.0005	<0.005	<0.05	0.91	<0.0002	0.25	16.9	<0.05	0.022
HS (Storm Water)	2	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	4.3	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	<0.05	0.48	<0.0002	0.06	4.8	0.024	0.039
		Average	<0.025	<0.0005	<0.005	<0.05	0.24	<0.0002	<0.05	4.6	<0.002	<0.02
HT (b) (LINAC)	6	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	0.071	0.12	<0.0002	<0.05	41.1	0.004	0.043
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	20.2	<0.002	0.028
HW (Weaver Road)	2	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	<1.0	<0.002	0.036
		Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	3.6	<0.002	0.073
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	1.8	<0.002	0.055
Min. Detection Limit			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02
NYSDEC Effluent Limitation			0.1	0.02	0.1	1	0.6	0.004	0.6	(c)	0.05	5

(a): Locations of recharge basins are shown in Figure 23.
(b): This recharge basin has two effluents which are denoted HT and HT2 in data contained in Volume 2.
(c): Standard not specified.

4.1.5 Environmental Measurements and Analyses

4.1.5.1 External Radiation Monitoring

Dose-equivalent rates from gamma radiation at the site boundary, including natural background, weapons test fallout, and that attributable to Laboratory activities were determined through the use of CaF_2:Dy TLDs.[37,38] The locations of the on-site and off-site TLDs are shown in Figures 25 and 26, respectively. The TLDs were positioned using a standard 16 sector wind-rose with Sector No. 1 centering on true north. The dose-equivalent rates observed are given in Table 14. The annual average dose-equivalent rate as indicated by all TLDs was 64.5 mrem/yr (0.64 mSv/yr). The dose-equivalent rate at the site boundary was 66.2 mrem/yr (0.66 mSv/yr), while the off-site average rate was 63.5 mrem/yr (0.63 mSv/yr). Differences between the on-site and off-site TLD dose-equivalent rate are the result of the terrestrial component of the external dose measurement and not related to BNL operations.[9]

The maximum dose at the site boundary due to argon-41 and oxygen-15 airborne emissions was calculated using CAP88[39] as 0.176 mrem (0.002 mSv). This value is not measurable using today's best available technology.

4.1.5.2 Atmospheric Radioactivity

The Laboratory's environmental air monitoring program is designed to identify and quantify airborne radioactivity attributable to natural sources, to activities unrelated to the Laboratory (e.g., above ground nuclear weapon tests), and to Laboratory activities. The predominant radionuclides measured in air at the site boundary were tritium, fission products related to weapons test, fallout, and Be-7 produced in the atmosphere as a result of cosmic particle interaction in the atmosphere.

4.1.5.3 Tritium Analyses

Sampling for tritium vapor was performed at twenty-two different on-site stations (as shown in Figure 25). Air samples were also routinely collected in the analytical lab (Location 0920). The method of sampling was the collection of water vapor by drawing a stream of air through silica gel cartridges. The data collected from these stations are presented in Table 15. The maximum annual average tritium concentration at the site boundary was observed at Station 0820 (SE Location) and was 5.7 pCi/m^3 (0.21 Bq/m^3). This air concentration would result in whole body dose from the inhalation and submersion pathways of 0.004 mrem (4E-5 mSv). By comparison, the National Council on Radiation Protection (NCRP) publication 91 recommends that 1 mrem (0.01 mSv) is a dose which is below regulatory concern.[40]

The airborne tritium concentrations measured outside Building 535 (Location 0901) reflect ambient air concentrations in the central part of the Laboratory site. The annual average air concentration at this location was 10.5 pCi/m^3 (0.39 Bq/m^3) and would represent a dose of 0.008 mrem (8E-5 mSv) to the typical BNL employee.

Table 14
BNL Site Environmental Report for Calendar Year 1993
External Dose Equivalent Rates for All TLD Locations

Location	No. of Samples	Exposure Period (days)	Annual Dose (mrem/yr)
10T12.0	4	371	65.35
10T1.8	4	367	70.19
10T9.3	4	363	73.93
11T2.1 (P4)	3	275	64.99
11T3.7	4	373	58.71
12T12.5	4	371	73.65
12T1.4	4	379	69.87
12T5.0	4	373	65.74
12T7.2	4	384	63.48
13T1.3	4	371	69.08
13T1.4	4	371	75.17
13T2.6	4	363	64.67
13T8.2	4	378	59.54
14T1.3	4	371	71.19
14T3.1	3	274	65.07
14T5.6	4	372	74.86
15T1.4	4	371	72.77
15T1.7	4	371	67.98
15T3.0	4	353	55.57
16T2.1 (P2)	4	371	61.38
16T3.4	4	363	63.74
1T2.2	4	371	55.96
1T3.0	4	364	59.59
1T8.8	4	379	57.04
2T10.5	4	386	73.43
2T2.6	3	278	54.86
2T3.2	4	389	48.45
3T2.8	4	371	60.08
3T8.8	4	363	60.09
4T2.4	4	371	61.07
4T2.6	4	371	56.27
4T7.5	4	360	59.58
5T17.1	4	376	60.80
5T2.5	4	371	70.36
5T4.2	4	375	54.99
5T6.5	4	380	59.62
6T2.8 (P7)	4	371	62.81
6T5.6	4	373	59.99
7T1.6	4	371	68.97
7T2.5	4	371	63.37
7T9.7	4	374	57.56
8T1.3	4	371	69.54
8T2.3	4	371	58.48
8T8.0	4	365	68.22
9T2.6	4	371	63.78
9T8.3	4	383	75.85
BLDG-197	4	371	81.42
BLDG-907	4	371	62.16
2T2.4 (S13)	4	371	69.86
GUN BARREL	4	417	26.93
GUN BARREL	4	406	25.13

Annual Average, all locations:	64.51	+/-	6.79 mrem
Annual Average, On-Site Locations:	66.17	+/-	7.14 mrem
Annual Average, Off-Site Locations:	63.53	+/-	6.96 mrem
Annual Average, Gun Barrel TLDS:	26.03	+/-	0.90 mrem

Table 15
BNL Site Environmental report for Calendar Year 1993
Ambient Tritium Concentrations at Perimeter and Control Locations

Location	No. of Samples	Min. (pCi/m3)	Max. (pCi/m3)	Avg. (pCi/m3)	Flow Wt'd. Avg. (pCi/m3)
On-Site Samples					
0101	31	-1.44	10.01	3.36	3.36
0302	50	-1.67	11.04	2.74	2.61
0401	50	-1.45	16.64	2.92	2.83
0501	47	-2.08	32.51	4.16	3.64
0602	52	-0.83	40.51	3.01	3.03
0601	51	-0.60	61.73	3.73	3.82
0802	12	-0.59	18.75	5.74	5.74
0801	14	0.19	21.26	6.13	5.47
1001	50	-1.62	13.70	2.79	2.68
1101	49	-1.67	18.30	2.93	2.69
1401	48	-2.84	82.60	7.42	3.65
1501	50	-1.19	15.55	3.09	2.99
1602	51	-2.19	13.66	2.18	2.10
0901	32	-1.86	82.60	9.91	10.53
Process Control					
0920	50	1.99	28.20	8.83	8.13
Background Locations					
1201	52	-0.63	10.72	2.57	2.55
1601	49	-1.38	121.95	4.71	4.98

Note : DOE Order 5400.5 Derived Air Concentration Guide for semi-infinite clouds of H-3 is 1.E+05 pCi/m3.

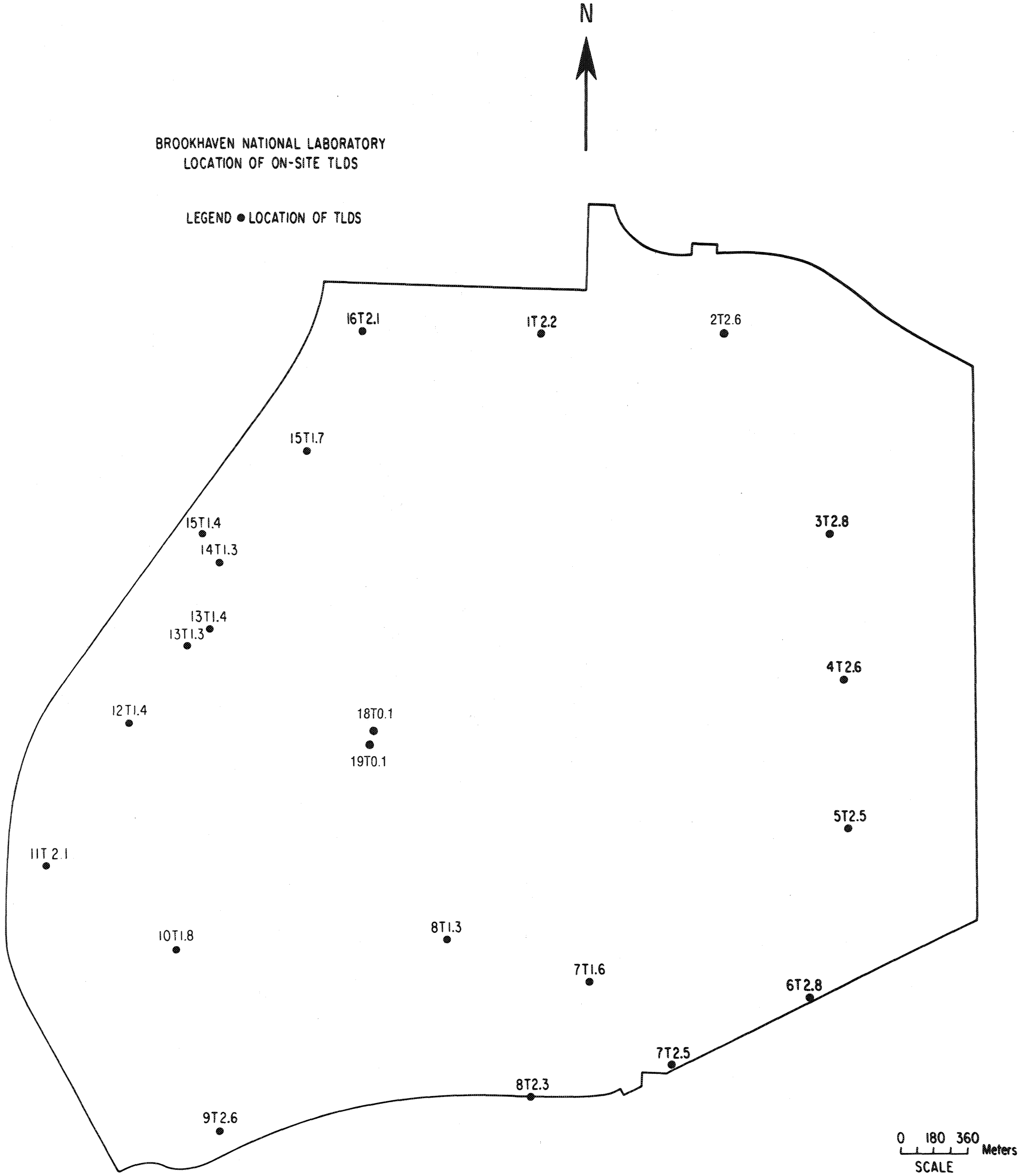


Figure 25: Brookhaven National Laboratory Location of On-site TLDs.

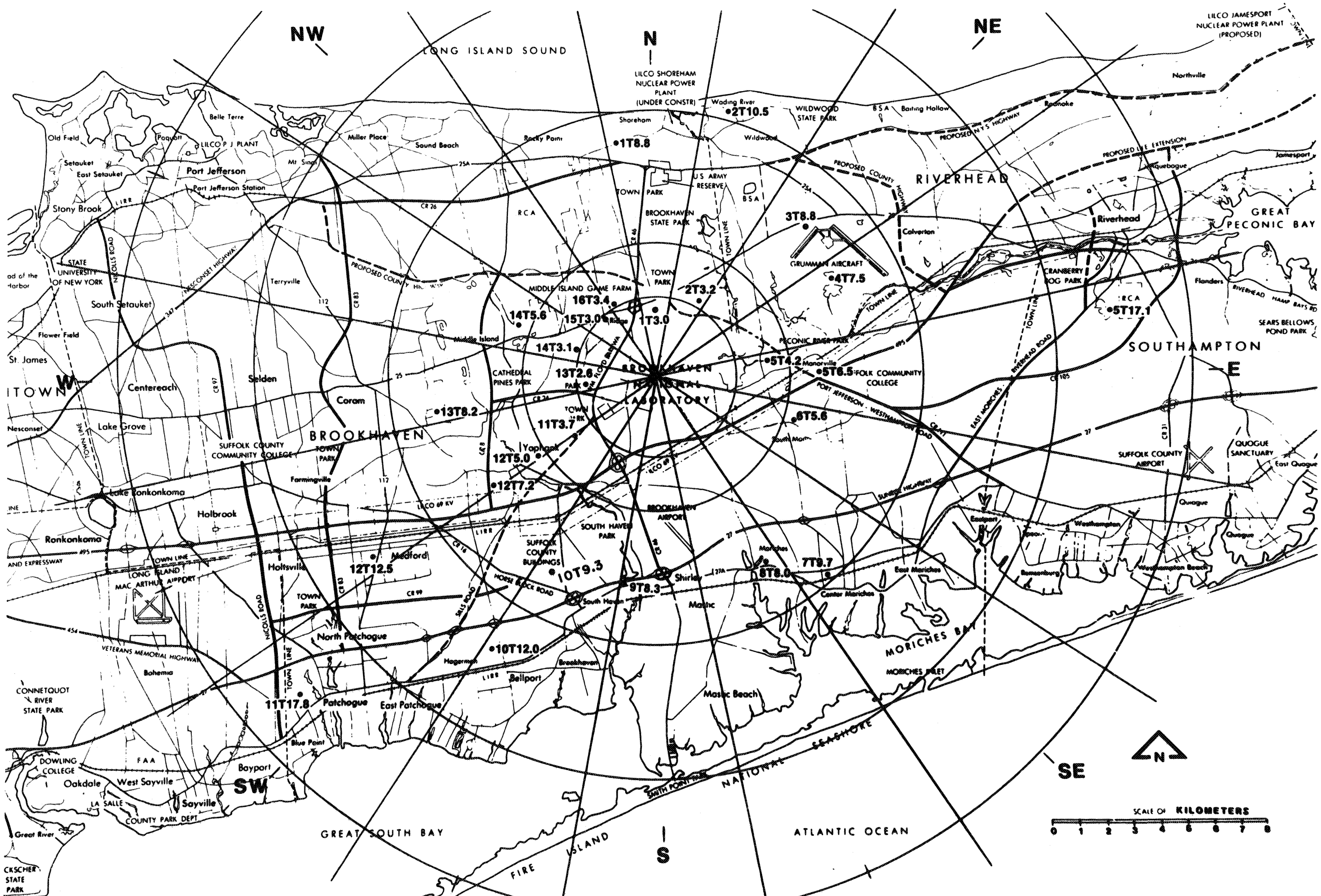


Figure 26: Brookhaven National Laboratory Location of Off-site TLDs.

For the present, site perimeter monitoring will continue to be used as a method to monitor for potential large releases and provide an upper boundary for both model verification and dose estimates. Compliance verification will be performed using CAP88 and measured source terms plus BNL meteorology. However, BNL has purchased a new site perimeter monitoring system that will use on-line neutron and gamma radiation detectors to monitor site boundary radiation levels in real time. These detectors will be placed at the same locations as the current air sampling stations and will relay exposure rate levels back to a central computer station via modem. This system will provide both a comprehensive record of site boundary radiation levels as well as instantaneous notification of any unplanned releases.

4.1.5.4 Radioactive Particulates

During 1993, positive displacement air pumps were operated at five on-site monitoring stations (0420, 0601, 0701, 1201, and 1601). The sampling media consisted of a 5-cm diameter air particulate filter followed by a 51.5 cm^3 canister of triethylene diamine-impregnated charcoal for the collection of radiohalogens. Air particulate samples were collected on a weekly basis (except where the schedule was disrupted by the construction of the new environmental monitoring stations, i.e., at Stations 0601 and 1601) and counted for gross alpha and beta activity using an anticoincidence proportional counter. The gross beta concentrations observed are comparable to EPA values for Yaphank, New York.[5-8]

In addition, analyses for gamma-emitting nuclides were performed on a weekly composite of the filter papers and on charcoal filter bed samples that had a sample period of one month. The analytical results for air particulate filters are shown in Table 16. Gamma-emitting radionuclides detected on charcoal filters are reported in Table 17.

The presence of Chernobyl fallout, weapons test fallout from previous years, and cosmogenically produced radionuclides were detected by gamma spectroscopy at or near the systems minimum detectable activity levels.

Table 16
BNL Site Environmental Report for Calendar Year 1993
Gross Alpha, Gross Beta, and Gamma-Emitting Radionuclide Concentrations for Ambient Air Monitoring Stations

Station	Total Flow (m3)		G. Alpha (pCi/m3)	G. Beta (pCi/m3)	Be-7 (pCi/m3)	Mn-54 (pCi/m3)	Th-228 (pCi/m3)	K-40 (pCi/m3)	Co-57 (pCi/m3)	Co-60 (pCi/m3)	Cs-137 (pCi/m3)
0420	5641	Min.	-0.0031	-0.0173	0.1011	0.0091	0.0084	0.3460	ND	ND	ND
		Max.	0.0033	0.0450	0.3567	0.0091	0.0084	0.5023	ND	ND	ND
		Avg.	0.0006	0.0147	0.2042	0.0091	0.0084	0.4242	ND	ND	ND
		N	51	51	55	55	55	55	55	55	55
0601	1117	Min.	0.0000	0.0000	0.2070	ND	ND	0.0200	ND	ND	ND
		Max.	0.0036	0.0729	2.7300	ND	ND	0.0200	ND	ND	ND
		Avg.	0.0017	0.0285	0.8266	ND	ND	0.0200	ND	ND	ND
		N	11	11	14	14	14	14	14	14	14
0701	5136	Min.	-0.0038	-0.0121	0.3320	ND	ND	0.1962	ND	ND	ND
		Max.	0.0040	0.0374	0.6534	ND	ND	1.2610	ND	ND	ND
		Avg.	0.0006	0.0125	0.4792	ND	ND	0.7286	ND	ND	ND
		N	51	51	52	52	52	52	52	52	52
1201	5269	Min.	-0.0019	-0.0072	0.0897	ND	ND	ND	ND	0.0222	ND
		Max.	0.0049	0.0652	0.3165	ND	ND	ND	ND	0.0222	ND
		Avg.	0.0007	0.0145	0.1761	ND	ND	ND	ND	0.0222	ND
		N	51	51	51	51	51	51	51	51	51
1601	1165	Min.	-0.0006	-0.0019	0.3260	0.0652	ND	0.2200	0.0162	ND	0.0135
		Max.	0.0040	0.0408	0.5060	0.0900	ND	0.6620	0.0162	ND	0.0135
		Avg.	0.0017	0.0194	0.4008	0.0736	ND	0.4023	0.0162	ND	0.0135
		N	11	11	20	20	20	20	20	20	20

N: Number of samples collected.
ND: Not Detected.
Note: Stations 1601 and 0601 not in service for part of 1993 due to the construction of new monitoring stations.

Table 17

BNL Site Environmental Report for Calendar Year 1993
Air Station Charcoal Filter Gamma Analysis Results

Location	Total Flow (m3)		K-40 (pCi/m3)	Cs-137 (pCi/m3)
16T2.1	5427	min	0.1870	---
		max	0.5400	---
		avg	0.3411	---
		n	11	11
11T2.1	5193	min	0.2140	0.0038
		max	0.5420	0.0065
		avg	0.4003	0.0019
		n	12	12
6T2.8	5106	min	0.2380	0.0129
		max	0.7100	0.0136
		avg	0.3329	0.0029
		n	12	12
4T2.4	4408	min	0.0953	---
		max	0.5650	---
		avg	0.1162	---
		n	12	12
S6	3584	min	0.0440	---
		max	0.6200	---
		avg	0.5026	---
		n	12	12
DOE Order 5400.5 DAC			900	400

4.1.5.5 Terrestrial Ecological Studies

In response to a DOE Tiger Team finding (Weakness E/W-2: Lack of a Terrestrial Monitoring Program), the Laboratory in 1992, contracted IT Corporation to develop a site-wide soil and vegetation sampling plan for the BNL Site. In the same year, a fauna sampling plan was developed and implemented, where fauna samples were collected at on-site and off-site (control) locations. In 1993, the information provided by IT Corporation was used to locate 25 stations for collecting soil and vegetation samples. This was implemented in September 1993. In addition, a routine annual sampling by SCDOH of soil, vegetation, and fruits from farms in the vicinity of the Laboratory was also completed in June 1993. In March 1993, a deer population dynamic study was also initiated.

The vegetation and fauna samples were analyzed for radioactivity only, while soils were analyzed for radioactivity and metals, and screened for organics.

4.1.5.5(a) Radioactivity in Soil, Vegetation and Fruits

The results obtained from analysis of soil and vegetation samples for radioactivity are given in Tables 18 and 19, respectively. In general, the radionuclides present and their concentrations were consistent with values typically seen in soil samples collected throughout Suffolk County for radioactivity assay, except in specific areas on site where contamination was known to have occurred from past events. The principal radionuclides observed were tritium, gross beta, and Cs-137. Since the vegetation samples were collected from areas adjacent to the soil sampling locations, the radionuclide content of the vegetation reflected the degree of soil contamination, except for the presence of Be-7. There also seemed to be no preferential tree species that could be treated as an indicator species. These soil and vegetation samples were not analyzed for Sr-90.

The off-site soil and vegetation sampling program is a cooperative effort between BNL and the Suffolk County Department of Health Services (SCDHS). Local farms situated adjacent to BNL were sampled in June 1993. No radionuclides attributable to Laboratory operations were detected in any of these samples (Table 20). The observed concentrations represent the contribution of primordial and cosmogenic sources, and weapons test fallout.

4.1.5.5(b) Nonradioactive Contaminants in Soil

In most areas of the site, the levels of total organic carbon (TOC) were representative of background values as observed at other sites in Suffolk County.[41] However, elevated (TOC) in soil (Table 21) also confirmed a relationship to past spills or specific activities that led to the increase in organic contamination, such as, adjacent to the railroad tracks and sanitary systems. Among the metals, Fe was ubiquitous as expected, whereas, Cu, Cr, Pb, Hg, Mn, and Zn varied in levels over the site. This observation will be used as a benchmark to compare with other soil from on-site and off-site locations in 1994.

Table 18
BNL Site Enviropnmental Report for Calendar Year 1993
Soil Sampling Program - Radionuclide Concentrations

Location	Grid. #	Gross Alpha pCi/Kg	Gross Beta pCi\Kg	Tritium pCi/Kg	K-40 pCi\Kg	Cs-137 pCi/Kg	Pb-212 pCi\Kg	Ra-226 pCi/Kg	Th-228 pCi\Kg	Th-232 pCi/Kg
Soil Adjacent to Wells 07-02/07-04	7	821	6740	231	4490	391	436	ND	ND	ND
Soil Adjacent to Wells 25-01/25-02	25	<376	8470	<4230	5180	576	612	ND	ND	ND
Soil adjacent to Well 26-01	26	692	6160	<4230	4280	397	542	ND	542	616
Soil adjacent to STP: 20' East of Clarifier	38	548	6660	<4230	4170	974	ND	360	ND	ND
Soil adjacent to STP: Emergency Pond	39	<376	4210	<4230	3710	4010	444	ND	ND	444
Soil adjacent to Well 40-01	40	<379	2650	<4020	2730	48	394	ND	394	ND
Soil adjacent to Well 54-66	54	699	6740	<4020	5040	100	508	ND	ND	ND
Soil from Grid 054	54	1120	5320	<4020	4500	207	524	ND	ND	586
Soil from Grid 065	65	<379	6720	<4020	5120	601	ND	ND	ND	502
Soil adjacent to HFBR B707A	75	419	5410	4020	4050	163	568	ND	ND	ND
Soil from 650 Outfall Pipe	66	559	10200	<4020	3850	5780	814	ND	814	ND
Soil from Meadow Marsh Area	79	835	8030	<200	4730	1550	576	ND	ND	455
Soil from Upland Recharge Area	69	1120	5210	<200	4680	439	717	ND	ND	733
Soil adjacent to Well 130-02	130	420	6750	<4020	5300	312	742	ND	ND	838
Soil adjacent to MH 231	120	558	5870	<4020	4610	363	537	366	ND	485
Soil adjacent to Bldg. 304	109	1260	5410	37000	3620	569	413	ND	413	509
Soil adjacent to wooded area near Bldg. 494	94	976	4640	<4020	3180	131	ND	ND	ND	398
Soil adjacent to Well 104-01	104	<379	5410	<4020	4990	1140	577	ND	ND	573
Soil adjacent to NE side of Railroad	108	975	7190	<4020	4930	350	1060	728	ND	1090
Soil adjacent to St. P7	90	837	6730	<4020	4610	176	546	ND	ND	601
Soil fromN side of Bldg. 526B	76	839	4370	<4020	2770	873	426	ND	ND	ND
Soil from Center St. and Pearson Ave.	74	1250	8980	<4020	5120	359	787	624	ND	931
Soil adjacent to Well 75-01	75	698	7770	<4020	5590	194	691	ND	ND	555

Table 19
BNL Site Environmental Report for Calendar Year 1993
Vegetation Sampling Program - Radionuclide Data

LOCATION	GRID #	Be-7 pCi/Kg. wet	K-40 pCi/Kg. wet	Cs-137 pCi/Kg. wet
Oak tree adjacent to Well 07-04	7	911	1651	49
Oak tree adjacent to Wells 25-01/25-02	25	1464	3078	432
Oak tree adjacent to Well 26-01	26	983	1252	539
Grass in the vicinity to STP Filter Bed # 2	39	2104	2479	531
Maple Tree adjacent to Well 40-01	40	1632	1711	86
Locust tree adjacent to Well 54-05	54	3304	1913	86
Oak tree adjacent to Well 54-03	54	564	1799	15
Locust tree adjacent to Well 65-11	65	3260	3076	214
Locust tree adjacent to Bldg. 707A	75	4281	4722	61
Cherry tree adjacent to 650 discharge pipe	66	4671	4956	994
Maple tree within the Meadow-Marsh area	79	1232	1081	50
Oak tree within the Upland Discharg area	69	1527	1872	223
Oak tree adjacent to Well 130-02	130	855	2643	99
Oak tree in the vicinity of sewer line MH #23	120	933	1582	231
Maple tree adjacent to Bldg. 303	109	ND	3425	25
Cherry tree adjacent to Bldg. 494	94	2550	5663	62
Oak tree adjacent to Wel l 104-01	104	1186	2037	53
Oak tree, NE side of railroad	108	1804	1554	148
Oak tree adjacent to station P7	90	1186	950	218
Oak tree adjacent to Bldg. 526B	76	1140	1944	104
Hedge at Center St./Pennsylvania St.	74	697	3483	ND

Table 20
BNL Site Environmental Report for Calendar Year 1993
Radionuclide Concentrations in Vegetation and Soil Around BNL

Location	Matrix	Sample Date	Be-7 pCi/Kg	K-40 pCi/Kg	Cs-137 pCi/Kg	Ra-226 pCi/Kg	Th-228 pCi/Kg
Yaphank Honor Farm	Soil	06/16/93	300	4250	95	431	ND
NYS Game Farm (Ridge)	Soil	06/16/93	ND	2400	409	199	ND
Young's Orchard (Northville)	Soil	06/16/93	334	5240	ND	752	1620
Yaphank Honor Farm	Grass	06/16/93	2410	11800	ND	ND	ND
NYS Game Farm (Ridge)	Grass	06/16/93	418	5720	116	ND	ND
Young's Orchard (Northville)	Grass	06/16/93	1270	6790	ND	ND	ND
Young's Orchard (Northville)	Strawberry's	06/16/93	ND	1340	15	ND	ND
Typical MDL			0.07	0.18	0.01	0.03	0.23

ND: Not Detected. Radionuclide Concentration less than the system MDL.
MDL: Minimum Detection Limit.

Table 21
BNL Site Environmental Report for Calendar Year 1993
Soil Sampling Program - Non-Rad Data

Location	Grid. #	ORGANICS TOC ppm	TOX ppm	METALS Cu ppm	Al ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Fe ppm	Mn ppm	Zn ppm
Soil Adjacent to Well s 07-02/07-04*	7	10000	<20	<2.0	5200	<0.4	4.9	14	0.02	5900	24	8.8
Soil Adjacent to Wells 25-01/25-02*	25	31000	<20	5.4	5800	<0.4	5.4	27	0.04	8100	36	12
Soil adjacent to Well 26-01	26	13000	<20	<2.0	4000	<0.4	2.8	16	0.02	4000	19	6.2
Soil adjacent to STP: 20' East of Clarifier	38 39	19000	<20	8.6	5900	<0.4	6.7	30	0.18	6000	41	35
Soil adjacent to STP: Emergency Pond	40 54	3500	<20	6.1	2200	<0.4	4.7	8.7	0.14	2300	14	15
Soil adjacent to Well 40-01	40	3300	<20	2.6	2700	<0.4	3.1	3.8	0.01	2400	16	3.6
Soil adjacent to Well 54-66	54	18000	35	9.7	4500	<0.4	6.6	16	0.01	5800	73	130
Soil from Grid 054	54	17000	<20	4.3	8800	<0.4	8.1	25	0.02	8100	50	20
Soil from Grid 065	65	19000	<20	6	9300	<0.4	8.3	22	0.03	9100	99	20
Soil adjacent to HFBR B707A	75	31000	<20	6.6	5800	<0.4	8.9	23	0.02	6200	150	28
Soil from #650 Outfall Pipe	66	35000	<20	19	5800	<0.5	8.9	52	0.07	6200	40	55
Soil from Meadow Marsh Area	79	44000	<20	17	8900	<0.5	8.7	37	0.31	3100	30	40
Soil from Upland Recharge Area	69	8600	<20	3.2	9200	<0.5	7.7	15	0.03	6500	39	13
Soil adjacent to Well 130-02	130	13000	<20	<1.0	7600	<0.4	7.4	22	0.01	7700	48	16
Soil adjacent toMH 231	120	30000	<20	<2.0	4500	<0.5	5.3	17	0.03	7200	24	7.3
Soil adjacent to Bldg. 304	109	33000	<20	<1.0	5600	<0.4	6.1	38	0.04	5800	58	18
Soil adjacent to wooded area near Bldg. 494	94	23000	<20	<1.0	5900	<0.4	7.1	19	0.01	5600	54	21
Soil adjacent to Well 104-01	104	20000	<50	5.7	NA	<0.5	5.2	39	0.06	NA	NA	9.3
Soil adjacent to NE side of Railroad	108	33000	<50	5.4	NA	<0.5	6.9	19	0.03	NA	NA	8.6
Soil adjacent to St P7	90	16000	<50	6.3	NA	<0.5	6	13	0.01	NA	NA	9.5
Soil fromN side of Bldg. 526B	76	22000	<50	35	NA	<0.5	5.2	58	0.04	NA	NA	18
Soil from Center St. and Pearson Ave	74	32000	<50	9.6	NA	<0.5	20	69	0.08	NA	NA	45
Soil adjacent to Well 75-01	75	17000	<50	6.6	NA	<0.5	7.6	26	0.11	NA	NA	24

TOC: Total Organic Carbon
TOX: Total Organic Halide.
*Areas Not Affected by Laboratory Activities (i.e., Background, Wooded Areas).

An area adjacent to Building 464, showed the presence of Hg and PCB contamination. This was observed during construction in this area. Remediation of the site consisted of excavating and disposing of all soils containing greater than 1 mg/Kg mercury and all soils with PCB concentrations greater than 10 mg/Kg. Disposal of soils containing less than 260 mg/Kg were sent to a RCRA permitted Model City Landfill, while soils greater than 260 mg/Kg are temporarily stored at the BNL permitted hazardous waste storage facility pending disposal at the Bethlehem Apparatus Co. Inc., proposed retort facility (see Section 2.3.5.1, Compliance Chapter for a detailed report).

4.1.5.5(c) <u>Terrestrial Ecology</u>

Analysis of fauna samples, collected during the special fauna collection program of 1992, was continued in 1993 for radionuclide content. These were the samples that could not be processed in time for inclusion in the 1992 SER. The major difference in the samples that were analyzed in 1993, as opposed to that reported in SER 1992, were those samples (same species) that were predominantly from off-site areas. Data from these samples, therefore, are considered as representing background conditions. In addition, deer samples from upstate New York and from areas surrounding the Laboratory such as Ridge and Calverton, were also sampled. Thus an expanded data set of radioactive contamination in fauna from off-site areas was developed, allowing for estimation of Laboratory contribution to the radionuclide burden in fauna on-site. These data confirmed that the principal radionuclide detected was Cs-137, and had the following distribution:

Fauna	On-site	Off-site
	<-----------------------Cs-137	-------------------->
		pCi/Kg. wet
Deer	278 - 6150	55 - 149 (Upstate, NY) 180 - 252 (Ridge/Calverton)
Raccoon	132 - 1380	10 - 262 (Long Island)

The above data confirms that Cs-137 was present in concentrations above background in those species collected from the Hazardous Waste Management Area (HWMA), recharge basins, and alongside the Peconic River, where there is evidence of past environmental releases from BNL activities. As these fauna were not part of the food chain pathway for man, dose assessments were not performed.

In March 1993, a deer population dynamics study at BNL was conducted by Ms. Wendy Thomlison, University of Maine, Orono, Maine.[42] The preliminary estimate of the deer population on site was about 900. Data collected during this study will be compared to other sites on Long Island, such as the Grumman property, in 1994.

4.1.5.6 Peconic River Aquatic Surveillance - Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at six locations; HM, the location of the former site boundary, approximately 790 meters downstream of the STP discharge point; HQ, located approximately 2.1 km downstream from the discharge point; HA and HB, located approximately 5 km downstream from the discharge point; HC, located approximately 7 km downstream of the discharge point; and HR, located 21 km downstream from the discharge point. A control location (Location HH) located on the Carmans River in North Shirley, which is not influenced by BNL liquid effluent, was also sampled. The Peconic River sampling stations are identified in Figure 27. Routine grab sampling at Location HM and at Location HQ were conducted three times per week. The locations are equipped with V-notched weirs to permit flow proportional sampling and volume measurements. Due to heavy vegetation growth down stream of these weirs, which causes no vertical drop across the weir, volume measurements could not be performed with the existing equipment. Figure 28 provides a twenty-three year review of liquid discharge volumes to the Peconic River and flow estimates for the Peconic River on-site. The data indicate that there was no measurable flow at the site boundary since 1983. Non-quantifiable flow, due to vegetation growth in the river bed downstream of the weir, has existed at Location HM since 1984. Between 1985 and 1993, water levels at Location HQ have been below the conduit which transports water from the BNL site to the weir at Location HQ. As stated earlier, vegetation growth below the weir is too dense to permit flow measurement using the currently installed equipment. Samples from Locations HA, HB, HC, HR, and HH were collected during the second, and fourth quarters of 1993.

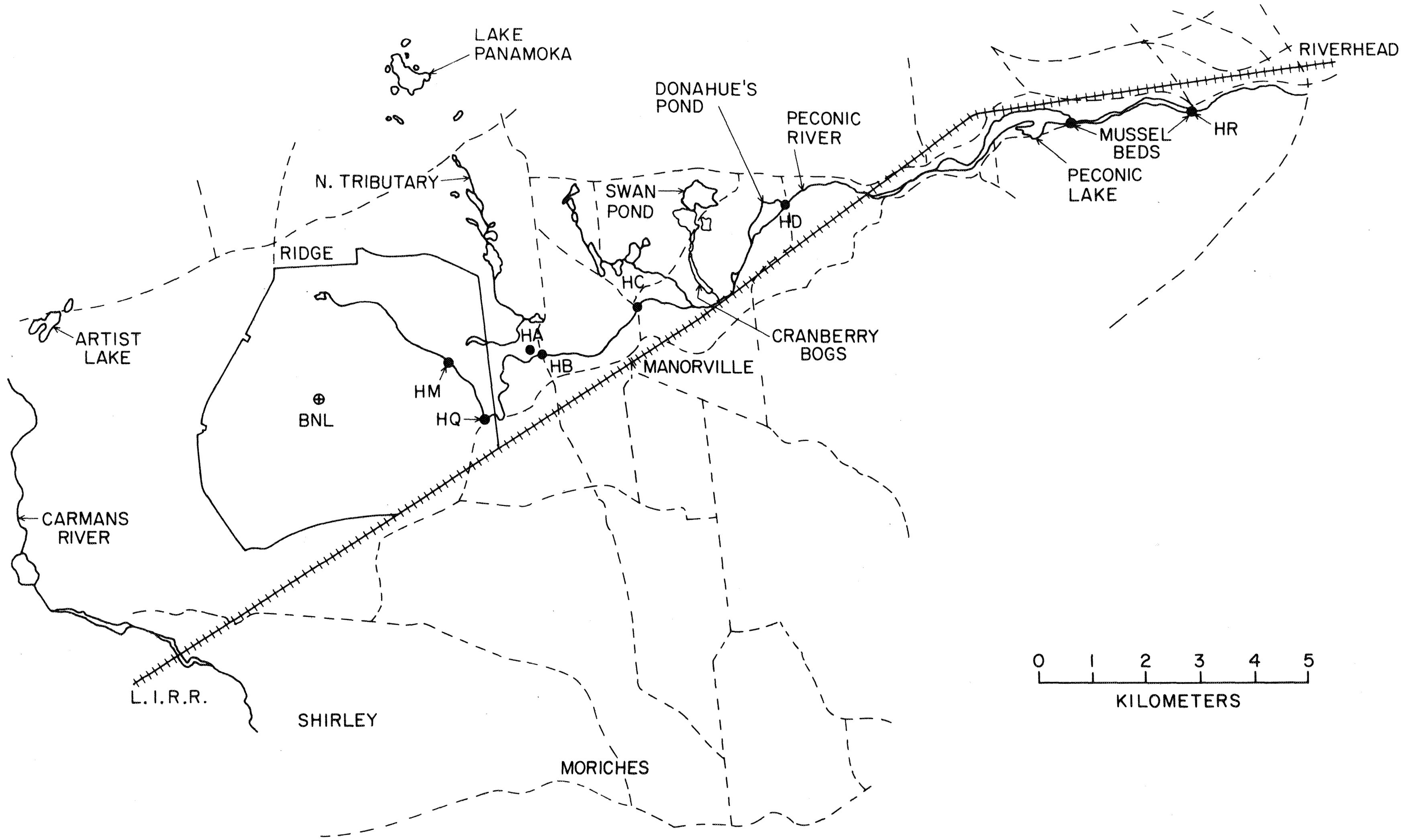


Figure 27: Peconic River Sampling Stations.

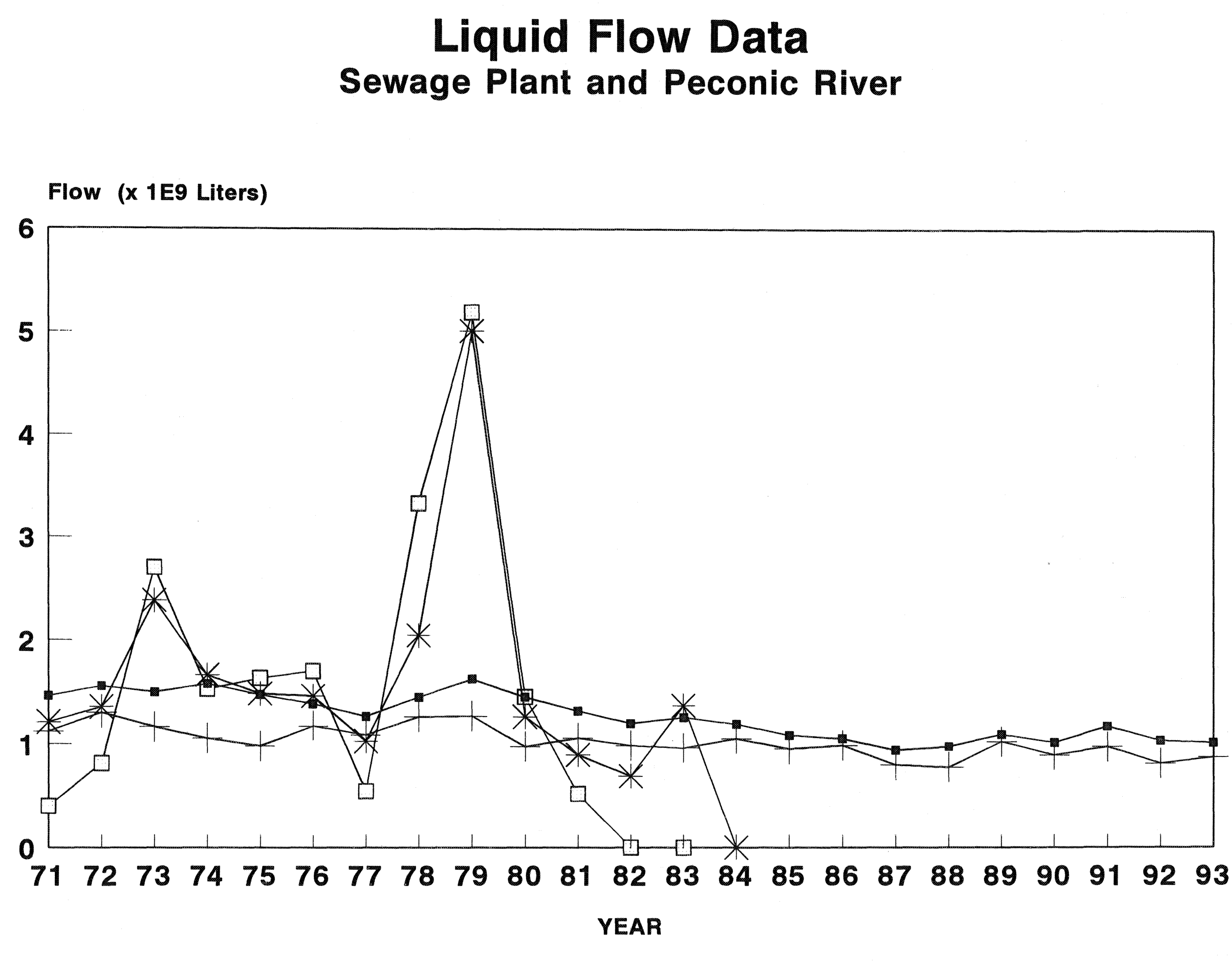


Figure 28: **Liquid Flow Data - Sewage Plant and Peconic River: 1971 to 1993**

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Table 22. The data indicate that gross beta, Cs-137, and Co-60 are present above ambient levels at Locations HM and HQ, with the tritium level exceeding BNL's administrative limit in October at Station HM.

4.1.5.7 Peconic River Aquatic Surveillance - Nonradiological Analyses

The Peconic River was sampled at six locations during 1993; two on-site (Sampling Locations HM and HQ) and four off site (Sampling Locations HA, HB, HC, and HR). In addition, the Carmans River was also sampled (Location HH) as an off-site control location. These locations were sampled and analyzed for water quality parameters (i.e., pH, temperature, conductivity, and dissolved oxygen), anions (i.e., chlorides, sulfates, and nitrates), metals, and VOCs routinely during 1993. Location HQ was not analyzed for metals nor water quality parameters during 1993 due to the intermittent nature of this discharge.

A summary of water quality and metals analytical data for samples collected from the surface waters is contained in Tables 23 and 24, respectively. Review of this data indicates all water quality parameters to be consistent with the off-site control location and/or with historical data. The analytical data for metals showed all parameters to be consistent with historical data and the background Carmans River Station. All metal concentrations, with the exception of iron, are well below the existing SPDES effluent limitations established by the NYSDEC for discharges to the Peconic River. Iron is prevalent above the SPDES limits at several locations most probably due to the high concentration of iron prevalent in ground water and native sediments.

With regard to VOC analyses, during 1993 all surface waters were analyzed for VOC contamination by the SEP analytical laboratory. Table 25 summarizes the VOC data detected in samples collected in 1993. Review of this table reveals that three compounds were found present at detectable concentrations at Sampling Location HQ. With regard to concentrations of TCA and DCA, a single sample collected on March 12, 1993 tested positive for these compounds; all other analyses showed these compounds to be non-detectable at an analytical detection limit of 2.0 μg/L. Toluene was detected in four samples collected at Location HQ during the period beginning July 21 and ending August 13; however, all concentrations were well below the NYSDEC effluent standard of 50 μg/L. There were no other VOCs detected in the surface water samples.

Table 22
BNL Site Environmental Report for Calendar Year 1993
Annual Gross Alpha, Gross Beta, Tritium, Gamma , and Sr-90 Activity
Concentrations in Peconic River and Carmans River

Sampling Site	DS	Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	K-40 pCi/L	C0-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
HM : Peconic River / On-site	N	149	149	149	12	12	12	3
	Max.	4.31	38.51	20160	4.56	ND	3.42	0.87
	Avg.	0.82	7.99	3027	1.73		1.87	0.38
HQ: Peconic River Boundary / On-site	N	119	119	119	0	0	0	1
	Max.	8.34	56.79	14330	NA	NA	NA	NA
	Avg.	0.88	12.26	2546				
HA: Peconic River / Off-site	N	1	1	1	1	1	1	1
	Max.	0.51	1.75	512	ND	ND	ND	0.18
	Avg.	0.51	1.75	512				0.18
HB: Peconic River/ Off-site	N	2	2	2	2	2	2	1
	Max.	0.47	1.44	395	3.19	ND	0.2	0.23
	Avg.	0.46	1.4	150	1.59		0.1	0.23
HC: Peconic River/ Off-site	N	2	2	2	2	2	2	1
	Max.	0.95	2.62	390	ND	ND	0.22	0.22
	Avg.	0.55	2.56	235			0.16	0.22
HR: Peconic River Riverhead/ Off-site	N	2	2	2	2	2	2	1
	Max.	0.44	2.35	87	3.55	ND	0.32	0.27
	Avg.	0.18	1.89	-23	1.78		0.16	0.27
HH: Carmans River Background	N	2	2	2	2	2	2	1
	Max.	0.82	1.48	334	ND	ND	ND	ND
	Avg.	0.47	1.35	50				
Typical MDL		0.46	1.2	300	3.9	0.23	0.2	0.1
Typical MDL for ST. # HM and HQ only		2.3	6	1000				
DOE Order 5400.5 Derived Concentration Guide		(a)	(a)	80000	7000	200	120	40
Concentration Required to Produce SDWA Annual Dose		(a)	(a)	20000	280	(a)	(a)	8

NA: Not Analyzed.
ND: Not Detected.
N: Number of Samples.
MDL: Minimum Detection Limit.

Table 23
BNL Site Environmental Report for Calendar Year 1993
Water Quality Parameters for Surface Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location		pH SU	Conductivity umhos/cm	Temperature C	Dissolved Oxygen mg/L	Chlorides mg/L	Sulfates mg/L	Nitrates mg/L
Peconic	HM	N	149	149	149	131	44	44	44
		Minimum	5.6	119	1.3	4.04	18.2	13	2.5
		Maximum	6.8	393	34.7	20.5	34.1	23.20	10.96
		Average	NA	200	14.3	9	24.97	15.71	4.21
	HA	N	1	1	1	1	1	1	1
		Concentration	6.1	60.9	1.3	10.9	9.5	7.30	<1.0
	HB	N	2	2	2	2	2	2	2
		Minimum	5.7	60.6	1.1	6.4	7.2	6.2	<1.0
		Maximum	6.6	71.7	19	5.9	8.8	8.7	<1.0
		Average	NA	66.2	10.05	6.15	8	7.45	<1.0
	HC	N	2	2	2	2	2	2	2
		Minimum	5.8	66.7	2.7	6.4	9	6.9	<1.0
		Maximum	6.6	68.1	19.6	7.7	9.9	9.5	<1.0
		Average	NA	67.4	11.15	7.05	9.45	8.2	<1.0
	HR	N	2	2	2	2	2	2	2
		Minimum	7	96.5	4.7	10	12.4	9.3	<1.0
		Maximum	7.2	108.1	20.6	10.6	14.2	11.5	<1.0
		Average	NA	102.3	12.65	10.3	13.3	10.4	<1.0
Carmans	HH	N	2	2	2	2	2	2	2
		Minimum	6.3	120	5.3	10	21.8	10.2	<1.0
		Maximum	7	144.7	18.2	12.2	21.9	10.4	1.3
		Average	NA	132.35	11.75	11.1	21.85	10.3	<1.0
NYS SPDES Effluent or Water Quality Standards			5.8 - 9.0	(a)	32 C	(a)	(a)	(a)	(a)

NA: Not Applicable
The Peconic and Carmans Rivers sampling locations are shown in Figure 27.
(a): There are no effluent standards or water quality standards specified for discharges of these compounds to the Peconic River.

Table 24
BNL Site Environmental Report for Calendar Year 1993
Metals Concentration Data for Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Na mg/L	Pb mg/L	Zn mg/L
Peconic	HM	N	12	12	12	12	12	12	12	12	12	12
		Minimum	< 0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	24.03	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	0.076	0.659	<0.0002	0.13	29.59	0.0041	0.046
		Average	<0.025	<0.0005	<0.005	<0.05	0.287	<0.0002	<0.05	27.02	<0.002	0.033
	HA	N	1	1	1	1	1	1	1	1	1	1
		Concentration	<0.025	<0.0005	<0.005	<0.05	0.226	<0.0002	<0.05	6.1	0.0039	0.025
	HB	N	2	2	2	2	2	2	2	2	2	2
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.6	<0.0002	<0.05	5.21	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	<0.05	1.61	<0.0002	0.51	5.69	0.0029	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	1.1	<0.0002	<0.05	5.45	<0.002	<0.02
	HC	N	2	2	2	2	2	2	2	2	2	2
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.36	<0.0002	<0.05	6	0.0021	<0.02
		Maximum	<0.025	<0.0005	<0.005	<0.05	1.59	<0.0002	0.16	6.7	0.0027	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.98	<0.0002	0.08	6.35	0.0024	<0.02
	HR	N	2	2	2	2	2	2	2	2	2	2
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.19	<0.0002	<0.05	8.3	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	<0.05	0.38	<0.0002	0.076	9.5	0.0028	0.036
		Average	<0.025	<0.0005	<0.005	<0.05	0.24	<0.0002	<0.05	8.9	<0.002	<0.02
Carmans	HH	N	2	2	2	2	2	2	2	2	2	2
		Minimum	< 0.025	<0.0005	<0.005	<0.05	0.17	<0.0002	<0.05	14	<0.002	<0.02
		Maximum	<0.025	<0.0005	<0.005	<0.05	0.44	<0.0002	0.093	14.3	0.0021	0.027
		Average	<0.025	<0.0005	<0.005	<0.05	0.31	<0.0002	<0.05	14.2	<0.002	<0.02
NYSDEC SPDES Effluent or Water Quality Standards			0.05	0.001	0.15	0.4	0.6	0.0002	(a)	(a)	0.067	0.3

(a): There are no Effluent or Water Quality Standards specified for these compounds for the Peconic River.

Note: Peconic and Carmans River sample locations shown on Figure 27.

Table 25
BNL Site Environmental Report for Calendar Year 1993
Volatile Organic Compound Data for
Water Samples Collected from the Peconic and Carmans Rivers

River	Location		1,1,1 - Trichloroethane ug/L	1,1 - Dichloroethane ug/L	Toluene ug/L
Peconic	HA	N	1	1	1
		Concentration	<2.0	<2.0	<2.0
	HB	N	2	2	2
		Minimum	<2.0	<2.0	<2.0
		Maximum	<2.0	<2.0	<2.0
		Average	<2.0	<2.0	<2.0
	HC	N	2	2	2
		Minimum	<2.0	<2.0	<2.0
		Maximum	<2.0	<2.0	<2.0
		Average	<2.0	<2.0	<2.0
	HM	N	1	1	1
		Concentration	<2.0	<2.0	<2.0
	HQ	N	39	39	39
		Minimum	<2.0	<2.0	<2.0
		Maximum	10	9	37
		Average	<2.0	<2.0	<2.0
	HR	N	1	1	1
		Concentration	<2.0	<2.0	<2.0
Carmans	HH	N	1	1	1
		Concentration	<2.0	<2.0	<2.0
NYS SPDES Effluent or Water Quality Standards			50	50	50

The Peconic and Carmans River sample collection locations are shown in Figure 27.

4.1.5.8 Aquatic Biological Surveillance

The Laboratory, in collaboration with the NYSDEC Fisheries Division, has an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies (Figure 27). In 1993, fish samples from the Peconic River were collected at Donahue's Pond, and Forge Pond. Control samples were collected from Carmans River and Swan Pond. Specific information regarding the sampling point, distance from the BNL effluent release point, species of fish collected and analytical results are presented in Table 26. In CY 1993, only gamma spectroscopy analysis was performed on these samples. The Peconic River fish contained Cs-137 concentrations which ranged from near background levels at Forge Pond (22 - 121 pCi/kg-wet [0.83 - 12.33 Bq/kg-wet]) to 894 pCi/kg-wet (33 Bq/kg-wet) at Donahue's Pond. In order to obtain an estimate of the Sr-90 concentrations in fish for 1993, a Cs-137 to Sr-90 ratio was developed from the data reported in previous years. This relationship was then used to estimate the Sr-90 concentration for use in dosimetric assessment.

The Forge Pond and Donahue's Pond analytical data for Cs-137 indicates that this radionuclide is present in net concentration levels which range from <1.0 to 22 times control data. The presence of these levels may be indicative of a BNL contribution to the Cs-137 at the Peconic River ecosystem inventory. The maximum individual and collective dose from the aquatic biological pathway were calculated based on the measured 1993 Cs-137 concentrations and the Sr-90 estimated concentrations (arrived at by dividing the 1993 Cs-137 concentrations by the Cs-137 to Sr-90 ratio). Since fishing for human consumption occurs downstream of the Laboratory's boundary, only samples collected off site were used for this assessment. Based on the methods and results just described, the maximum individual committed effective dose-equivalent was estimated to be 0.31 mrem (0.0031 mSv) and the collective committed effective dose-equivalent was estimated to be 0.362 person-rem (0.0036 person-Sv). The exposed population was estimated to be 625[16] and comprised of individuals who frequently fish in the Forge Pond Area and the Donahue's Pond areas.

4.1.5.9 Biomonitoring of the STP Liquid Effluent

Analysis of the STP effluent, which discharges into the Peconic River, for water quality and radioactivity is an integral part the Laboratory's EM program. Biomonitoring, which monitors the impact of BNL effluent on aquatic biota, was added to the base monitoring effort in 1987 and a Chronic Toxicity Test program in 1993.

4.1.5.9(a) Biomonitoring: Fish Species

The species used in the 1993 biomonitoring effort ranged from sensitive species (brown or rainbow trout) to hardy species (bluegills, large mouth bass, golden shiner, etc.). The latter (hardy) species are endemic to Long Island freshwater bodies, and are considered as local game fish. The experimental set up consisted of a once-through flow system of the effluent through an aquarium which contained the fish. Dissolved oxygen and temperature was monitored daily. Integrated water samples were collected in conjunction with fish sampling. Data collected in 1993 paralleled observations made in 1987 - 1992 in that there is a short term rapid intake of the principal radionuclide Cs-137. Data indicates that equilibrium is reached when the Cs-137 concentration in fish flesh is about 40 times the concentration found in the water. No significant differences were found between the trout species and the endemic species except that variations in dissolved oxygen and temperature were found to have a marked impact on uptake characteristics of the trout species (decreased uptake during summer months).

Table 26
BNL Site Environmental Report for Calendar Year 1993
Radionuclide Concentrations in Fish

Sample Location	Distance from BNL Discharge (Km)	Remarks	Sample Date	Species	Cs-137 Total Concentration pCi/Kg/ wet	Cs-137 Net Concentration pCi/Kg/ wet	K-40 pCi/Kg/ wet	Sr-90 Total Concentration pCi/Kg/ wet	Sr-90 Net Concentration pCi/Kg/ wet
Swan Pond	Adjacent to Donahue's Pond	Control	4/28/93	Bluegill	92	NA	2160	66	NA
		Control	4/28/93	Largemouth Bass	149	NA	2260	92	NA
		Control	4/28/93	Pumpkin Seed	178	NA	4290	105	NA
		Control	8/25/93	Black Crappie	135	NA	1926	83	NA
		Control	8/25/93	Bluegill	81	NA	1640	45	NA
Carmans River Lower Lake	Southwest of the Laboratory	Control	4/28/93	Bluegill	ND	NA	3290	ND	NA
		Control	4/28/93	Largemouth Bass	23	NA	1640	28	NA
		Control	4/28/93	Black Crappie	31	NA	1870	38	NA
		Control	8/26/93	Largemouth Bass	36	NA	1920	44	NA
		Control	8/26/93	Bluegill	28	NA	1640	34	NA
		Control	8/26/93	Black Crappie	37	NA	2370	45	NA
		Control	8/26/93	Black Crappie	39	NA	1820	46	NA
Donahue's Pond	10 Km	Peconic	4/28/93	Largemouth Bass	384	343	1880	260	222
		Peconic	4/28/93	Golden Shiner	162	121	1870	145	107
		Peconic	4/28/93	Golder Shiner	127	86	1590	140	102
		Peconic	4/28/93	Brown Bullhead	343	302	2660	175	137
		Peconic	4/28/93	Brown Bullhead	343	302	2660	185	147
		Peconic	4/28/93	Brown Bullhead	178	137	1520	190	152
		Peconic	4/28/93	Brown Bullhead	193	152	1580	179	141
		Peconic	4/28/93	Brown Bullhead	131	90	1410	152	114
		Peconic	4/28/93	Brown Bullhead	935	894	4220	330	292
		Peconic	8/25/93	Brown Bullhead	303	262	1630	195	157
		Peconic	8/25/93	Brown Bullhead	269	228	1430	210	172
		Peconic	8/25/93	Brown Bullhead	229	188	1490	188	150
		Peconic	8/25/93	Golden Shiner	520	479	3170	225	187
Forge Pond	20 Km	Peconic	8/25/93	Chain Pickerel	162	121	2290	125	87
		Peconic	8/25/93	Golden Shiner	63	22	1230	70	32
		Peconic	8/25/93	Black Crappie	153	112	1950	130	92

Effluent characteristics seemed to promote good growth rate, thus testifying to the viability of the effluent stream. In addition, TLDs which were implanted on mussels in 1992 to determine the feasibility of estimating doses to aquatic fauna, were analyzed in 1993. Because of the low levels of radionuclides in the water, it became clear that use of TLDs were impractical. To continue the assessment, it was decided to transplant mussels from non-contaminated areas to the STP outfall, where the highest radionuclide concentrations are to be expected, and study the uptake over a period of one year and use this uptake data and dose estimation computer models to calculate doses to these organisms. This will be reported on in the 1994 SER.

4.1.5.9(b) Biomonitoring: Chronic Toxicity Tests

In accordance with the conditions set forth in the BNL draft SPDES permit, a Toxicity Testing program was initiated in 1993. While the requirements for this program do not become effective until the issuance of the final permit, the program was launched in 1993 in order to ascertain the toxicity of the BNL STP effluent. This program consisted of performing seven day, Tier II, Chronic Toxicity Tests of the BNL STP effluent quarterly. Two fresh water organisms, ceriodaphnia, and fathead minnows, were utilized during testing. Testing consisted of subjecting these organisms, in replicates of ten, to varying concentrations of the STP effluent for a period of seven days. During the testing period, size and or rate of reproduction was measured and compared to control organisms. All toxicity testing was conducted in accordance with the "New York State Manual for Toxicity Testing of Industrial and Municipal Effluents".

Three toxicity tests were performed during 1993. The results of these assays showed that there was no acute nor chronic toxicity exhibited for the fathead minnows caused by the STP effluent. While there was no acute toxicity exhibited in the ceriodaphnia organisms (i.e., all organisms survived), a marked decrease in reproduction was evident in two of the three testings. Investigation into the cause of this effect revealed that the total hardness of the effluent (approximately 30 mg/L) was much less than the hardness of the water used to breed the organisms (approximately 100 mg/L). The shock caused by the transfer of the organisms into the soft water was most likely a contributory cause to the decrease in reproduction. In order to test this hypothesis, a sample of pure, dechlorinated tap water was tested and was found to have a similar effect on the organisms. Consequently a modification to the toxicity testing program has been requested by the Laboratory. This modification consists of using well water, which has hardness characteristics similar to the STP discharge, as the control. This request is currently being evaluated by the NYSDEC.

5.0 GROUND-WATER PROTECTION

D. E. Paquette and J. R. Naidu

The effort to protect ground-water quality at BNL is being implemented through programs designed to minimize future releases of environmental pollutants, and through site remediation activities being carried out under the IAG between the USDOE, USEPA, and NYSDEC. The IAG provides a framework for remediation of contaminated soils and ground water at BNL.

The strategy for protecting ground water at the BNL site is comprised of the following elements:

1. Engineering design reviews and environmental assessments for new and existing facilities to ensure that potential environmental impacts are fully evaluated and reduced to acceptable levels;

2. Upgrading existing facilities to reduce the risk of accidental release of contaminants to the environment (i.e., upgrading underground storage tanks, replacement of deteriorated sewer lines, construction of new waste management facilities utilizing best available technologies, etc.);

3. Prompt response and remediation of spills to prevent migration of contaminants to surface waters and ground water;

4. Conducting a ground water and surface water monitoring program to provide for the early detection of contaminant releases;

5. Development of waste minimization practices to reduce the volume and toxicity of all wastes, and to utilize best management practices for the management and proper disposal of generated wastes;

6. Development of a Pollution Prevention Awareness Program to ensure that employees are cognizant of their responsibilities for the proper storage, use, and disposal of chemicals in the work place; and,

7. Conducting environmental restoration activities in areas where soils and ground water have been contaminated by chemical and radionuclides by past accidental spills, storage, and disposal activities.

5.1 Ground-water Surveillance

Ground-water quality at BNL is routinely monitored through a network of 153 surveillance wells. The surveillance wells generally monitor specific site facilities where degradation of the ground water is known or suspected, to fulfill permit requirements, and at BNL site boundary areas to assess the quality of ground water entering or leaving the site. Specific facilities include: the STP/Peconic River Area, Meadow Marsh-Upland Recharge Area, HWMF area, Current Landfill, Former Landfill, Ash Repository, CSF/MPF, AGS, WCF, and a number of smaller facilities. Wells located in specific areas of concern are shown in Figures 29 through 34.

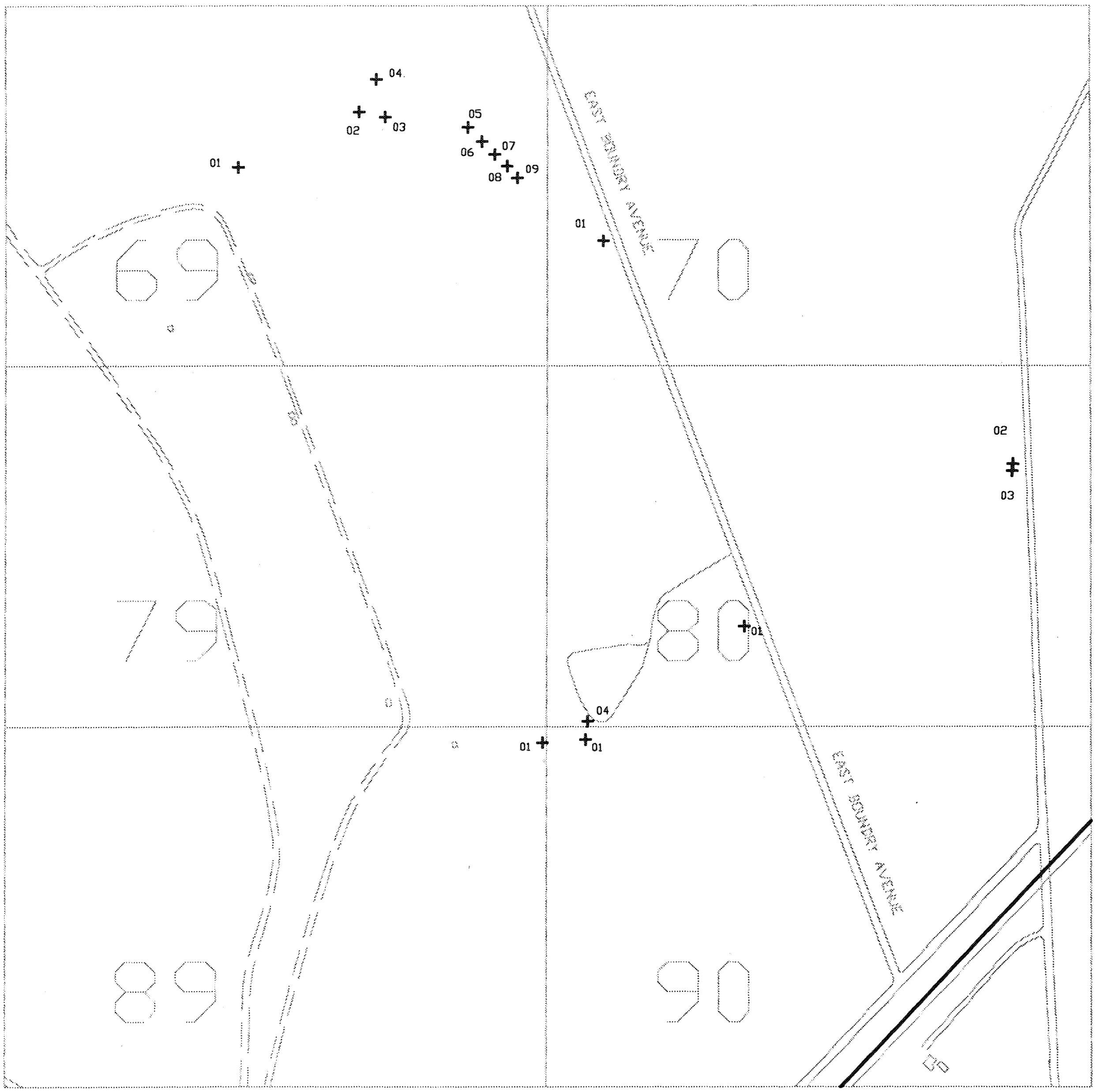


Figure 29: Ground Water Monitoring Wells: Meadow Marsh Area.

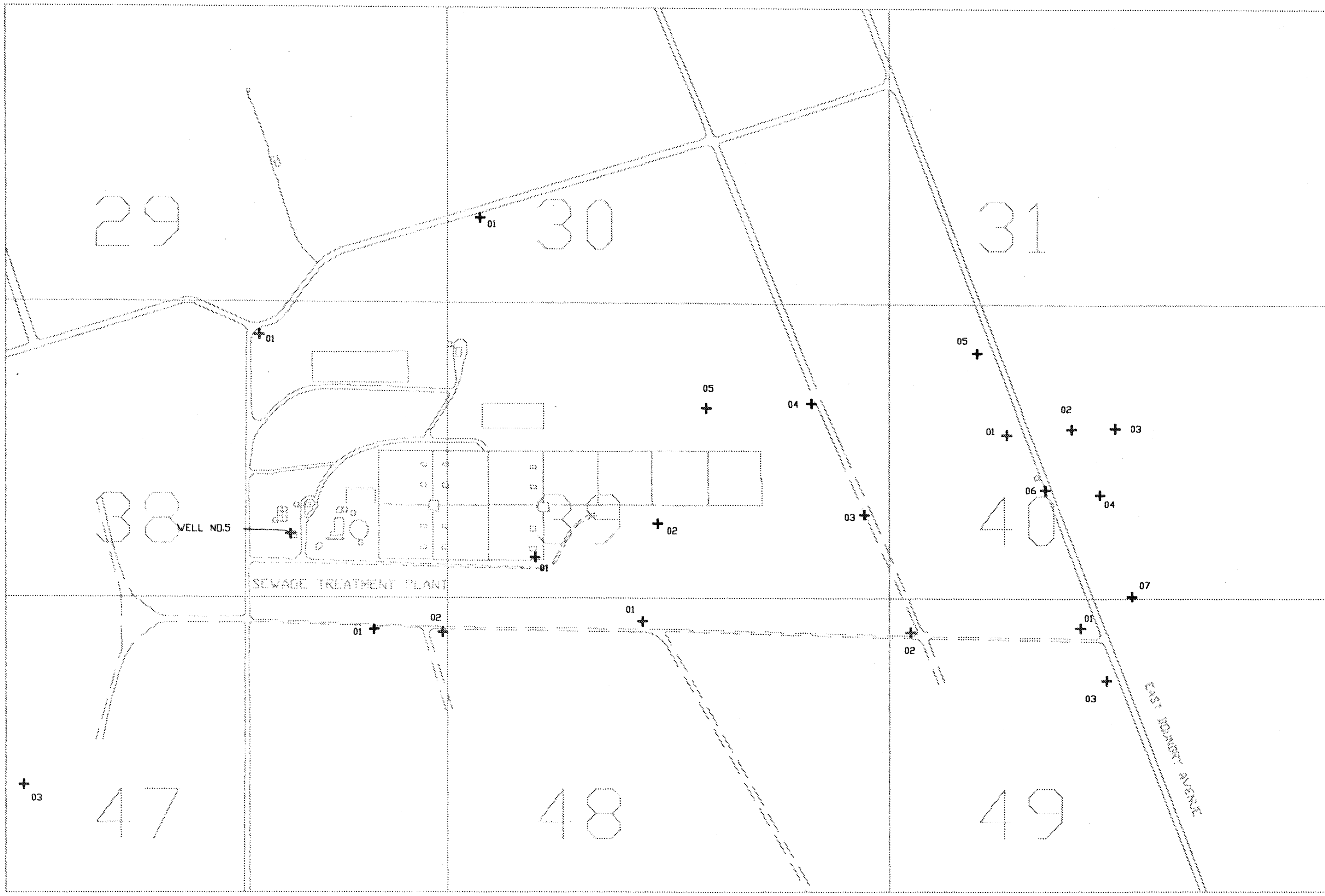


Figure 30: Ground Water Monitoring Wells: Peconic River Area.

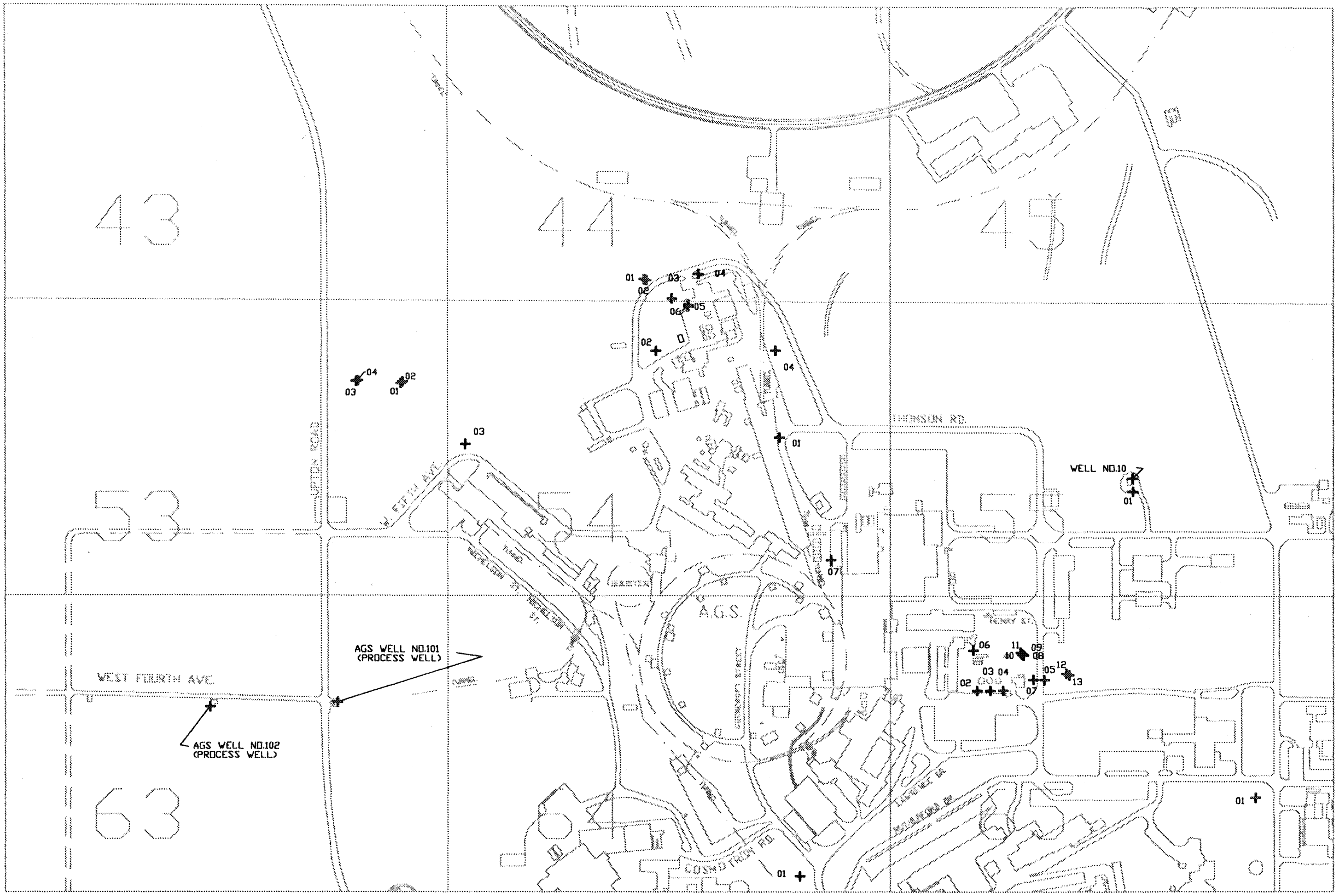


Figure 31: Ground Water Monitoring Wells: AGS and Building 811 Areas.

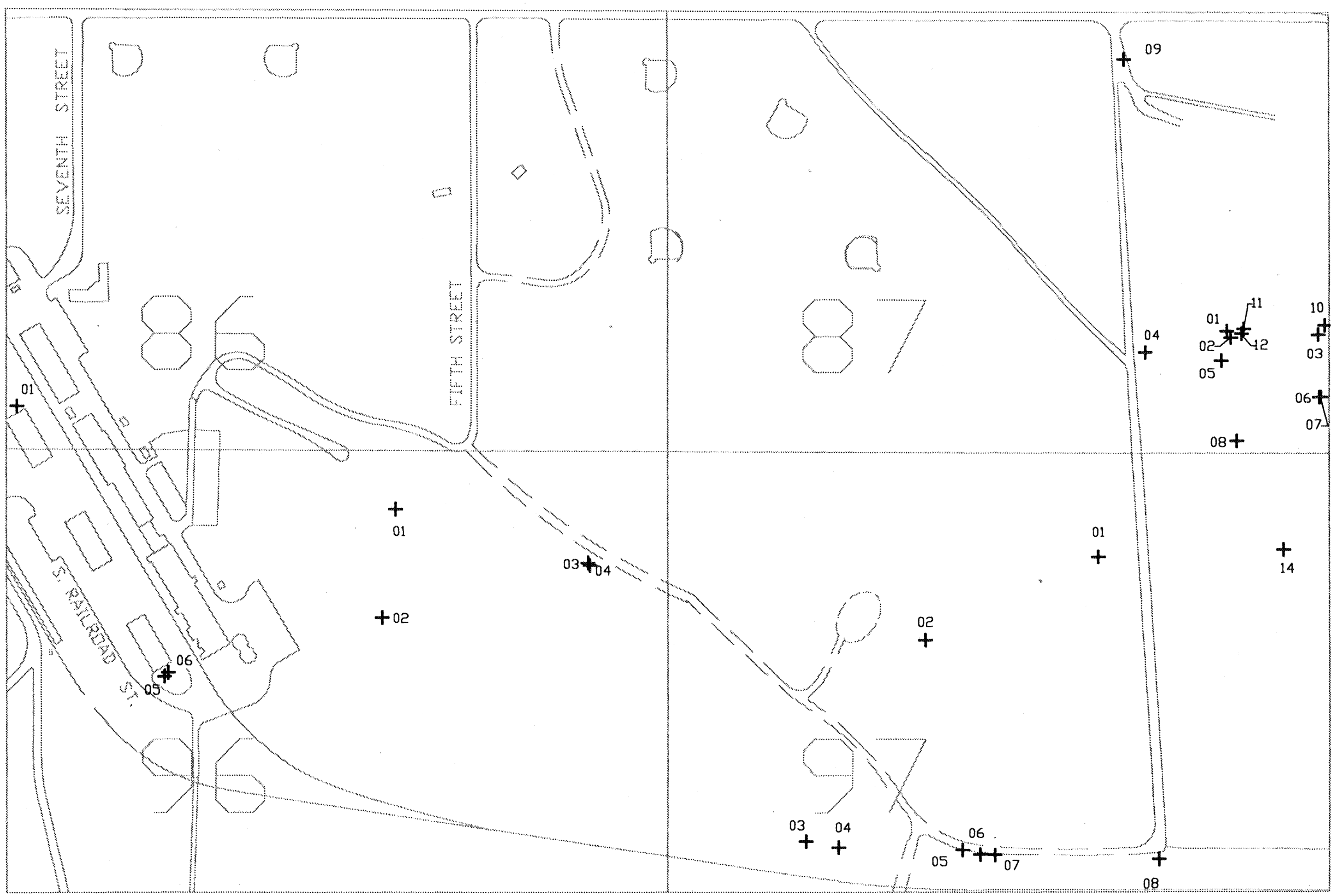


Figure 32: Ground Water Monitoring Wells: Current Landfill, Former Landfill, and Ash Fill Areas.

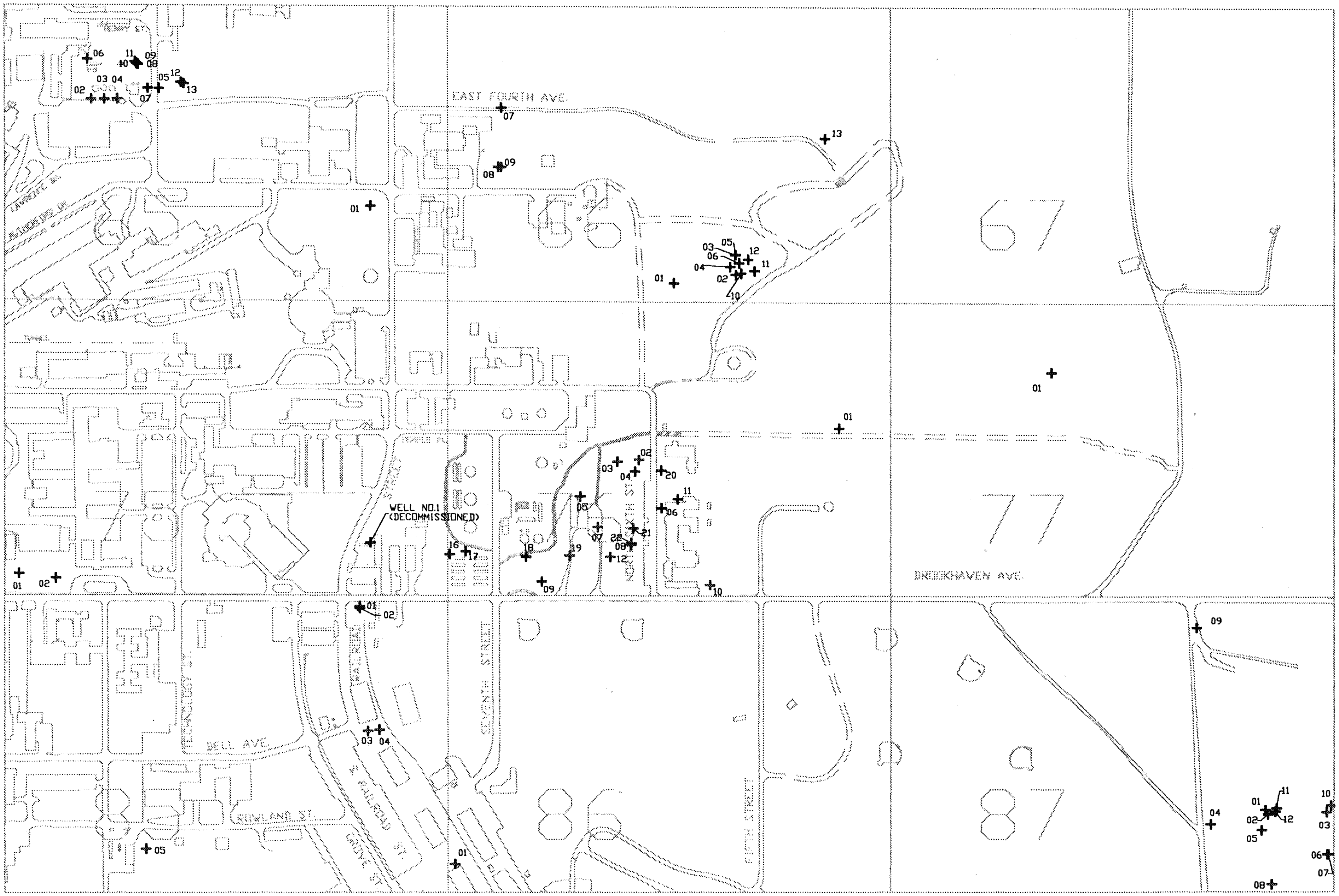


Figure 33: Ground Water Monitoring Wells: Central Steam Facility Area.

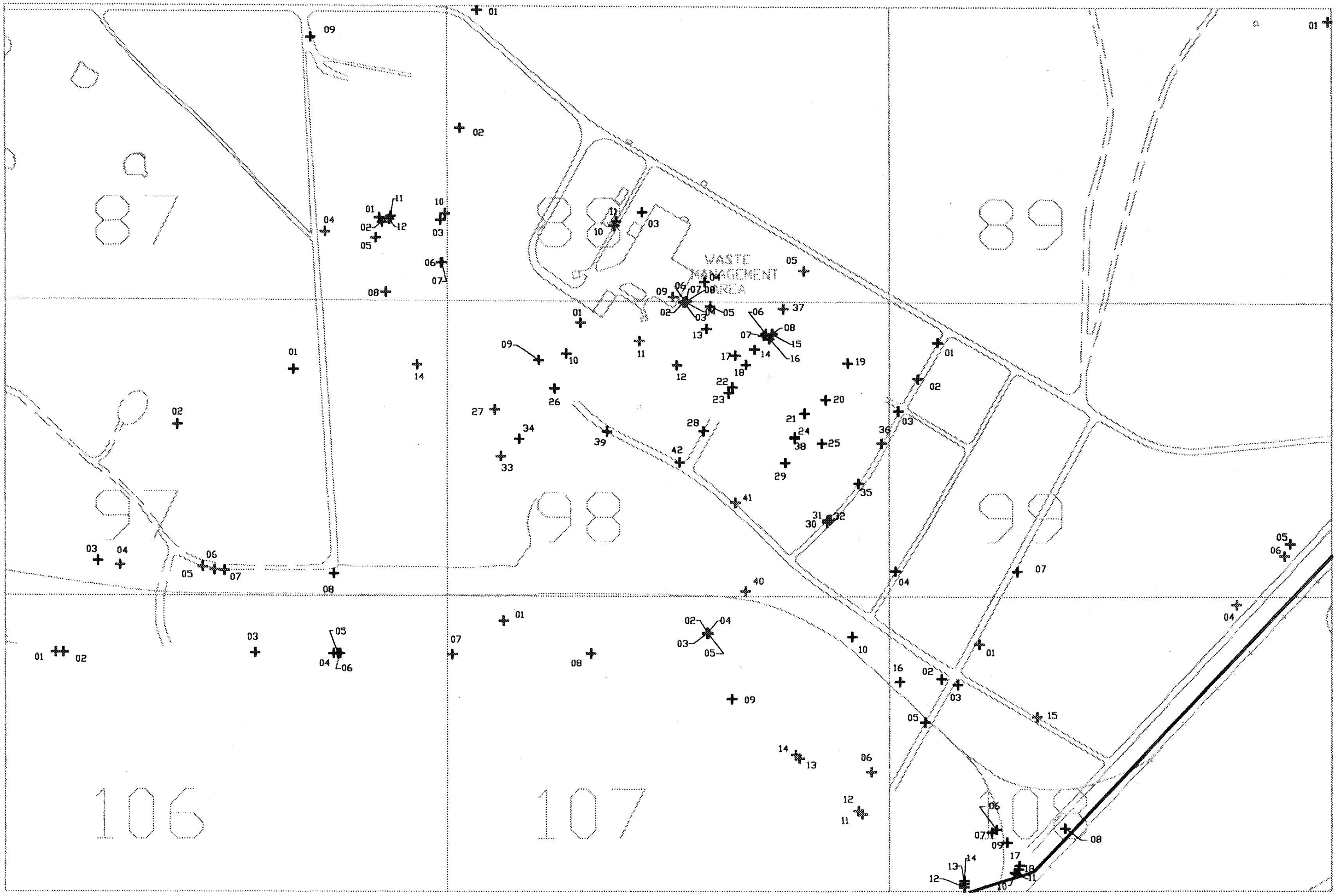


Figure 34: Ground Water Monitoring Wells: Hazardous Waste Management and Current Landfill Areas.

5.1.1 Potable Water and Process Supply Wells

During 1993, approximately 13.8 MLD were pumped from the BNL potable and process water supply network. This network consists of six potable supply wells (Wells 4, 6, 7, 10, 11, and 12) and seven secondary cooling/process water supply wells (Wells 5, 9, 101, 102, 103, 104, and 105). The six potable supply wells and six of the secondary cooling/process supply water wells are screened within the Upper Glacial aquifer. Well No. 104, however, is screened in both the Upper Glacial aquifer and the Magothy aquifer. During 1993, Wells 4, 6, 7, 10, 11, and 12 were used to supply drinking water, Wells 101 and 103 were used to supply secondary cooling water to the AGS; and Wells 5 and 9 were used to supply process water to the STP and Biology fish house, respectively. Well 102 was not used during 1993 and all AGS cooling water was obtained from Wells 101 and 103. Wells 104 and 105, which supply secondary cooling water to the BMRR, were not operational during 1993 due to TCA concentrations above NYS DWS ground-water effluent standards (5 μg/L). Following the shut down of these wells in 1990, water from the Chilled Water Facility has been utilized for secondary cooling requirements of the MRR. In 1992, the pump was permanently removed from Well 104 and it is anticipated that this well will be permanently abandoned. In 1993, Well 105 was equipped with an activated carbon adsorption system for the mitigation of the volatile organic contaminants. This well should be returned to active service sometime during 1994.

The data presented in the subsequent text and tables are compared to DCGs to determine compliance with operational limits, and because the Upper Glacial aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" aquifer, the data are also compared to the NYS DWS.

Grab samples were obtained from Potable Wells 10 and 11 on a quarterly basis and analyzed for radioactivity, water quality indices, metals, chlorocarbon compounds, trihalomethane compounds, and benzene, ethylbenzene, toluene, and xylene (BETX). In 1993, Potable Wells 4, 6, and 7 were out of service until October due to the shut down of the WTP for maintenance purposes. Consequently, during 1993 Wells 4 and 6 were sampled only once and Well 7 was not sampled at all by the EM Group. Regulatory compliance samples required under the SDWA were collected quarterly, the results of these analyses are discussed in Chapter 2.

Process Supply Wells 5, 9, 101, and 103 were used periodically during 1993. With the exception of Well 9, these wells were sampled three times in 1993 for water quality, inorganic and organic contaminants; Well 9 was sampled four times in 1993. Water chemistry analyses (i.e., pH and conductivity) were also performed for Wells 101 and 103 by the AGS facility operators as needed to meet the AGS operational requirements. Well 102 was not in service during 1993. As discussed above, Process Supply Wells 104 and 105, which were used to provide secondary cooling water to the MRR, remained out of service due to the presence of TCA in concentrations above NYS DWS and were not sampled in 1993.

5.1.1.1 Radiological Analyses

The average radionuclide concentrations in potable and process wells are reported in Table 27. The concentrations of radionuclides observed in potable water, were all small fractions of the applicable drinking water standards or guides and therefore do not pose a safety or health risk to individuals who drink or use the water on site. The annual dose resulting from consuming 100% of the daily water intake from the highest concentration water sources would result in a committed effective dose equivalent of 0.01 mrem (0.0001 mSv). Quality Control samples consisting of distilled and tap water from Building 535 are analyzed daily for gross alpha, gross beta, and tritium. These results are also presented in Table 27 and can be used for comparison with other ground-water sample results.

5.1.1.2 Non-radiological Analyses

Six wells were used to supply potable water at BNL during CY 1993. The NYSDOH governs the quality of potable water supplies and requires that the water purveyor routinely monitor the supply for organic, bacteriological, and inorganic constituents. The NYSDOH requirements (under authority of the Safe Drinking Water Act) are implemented by the SCDHS. Monitoring requirements for 1993 included quarterly analysis for POCs and SOCs, monthly bacteriological analyses, annual microextractables analysis, annual asbestos analyses, and semi annual inorganic analyses. Potable water samples were collected by BNL personnel and analyzed by a NYSDOH certified contractor laboratory using standard methods of analysis. All analytical data were submitted to the SCDHS as required by Chapter I, Part 5 of the NYS Sanitary Code. The bacteriological and inorganic analytical data and POC and SOC analytical data collected during CY 1993 has been summarized on Tables 4 and 5, respectively. Review of these data show the BNL potable supply to meet the NYS DWS. There were no SOCs or microextractables detected in the BNL potable water system during 1993.

In addition to the NYSDOH compliance monitoring requirements, the S&EP Division maintains a comprehensive sampling and analysis program for the BNL potable water supply. During 1993, S&EP monitored the potable wells for metals, water quality parameters, and VOCs. Statistical analysis of the data collected during 1993 for the potable wells is contained in Tables 28, 29, and 30. In November 1992, malfunctioning butterfly valves used to isolate the WTP filter beds during backwash operations resulted in the substantial loss of filtration media and the subsequent shutdown of this facility and Potable Wells 4, 6, and 7 until October 1993. Consequently in 1993, Potable Wells 4 and 6 were only sampled once and Potable Well 7 and the WTP influent and effluent were not sampled at all by the EM Group.

Review of the water quality data for the Laboratory potable supply wells shows the indices of water quality such as nitrates, sulfates, and chlorides to be well within the limits established in the NYS DWS. The pH values in these wells ranged from 5.4 - 6.5, and are typical of values for drinking water supplies on Long Island. Well Nos. 10, 11, and 12 are equipped with metering pumps which control the addition of sodium hydroxide in order to maintain the pH of the well pump effluent at approximately 7.3 which reduces the corrosivity of the ground water.

Table 27
BNL Site Environmental Report for Calendar Year 1993
On-site Potable and Process Water
Annual Radionuclide Concentrations (pCi/L)

Well #	No. of Samp.	DS	Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	Be-7 pCi/L	K-40 pCi/L	Mn-54 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
FD - #4	1	Max.	0.08	0.26	-199	ND	ND	ND	ND	ND
		Avg.	0.08	0.26	-199					
FE - #5	3	Max.	0.08	2.11	66	ND	ND	1.51	0.4	0.07
		Avg.	0.04	1.59	5			1.51	0.18	
FF - #6	1	Max.	0.23	0.3	-277	ND	ND	ND	ND	ND
		Avg.	0.23	0.3	-277					
FH - # 101 AGS	3	Max.	0.7	1.97	318	ND	6.24	ND	ND	ND
		Avg.	0.53	1.48	85		2.08			
FJ - # 103	3	Max.	1.1	2.73	224	ND	4.21	ND	ND	0.01
		Avg.	0.57	1.73	13		1.4			
FM - # 9 Biology	4	Max.	0.37	1.74	306	ND	ND	ND	0.5	-0.05
		Avg.	0.23	1.13	110				0.13	
FO - # 10	4	Max.	0.58	1.55	741	ND	8.56	ND	0.32	0.04
		Avg.	0.45	1.23	270		2.14		0.08	
FP - # 11	4	Max.	0.29	3.39	507	ND	ND	ND	ND	0.02
		Avg.	0.15	2.14	210					
FQ - # 12	4	Max.	0.81	2.26	721	7.27	ND	ND	ND	0.07
		Avg.	0.32	1.77	356	1.82				
NYS Drinking Water Standard			15	50	20000	(a)	(a)	(a)	(a)	8
DOE 5400.5 Drinking Water Guide			(a)	(a)	80000	4000	280	2000	120	40
Typical MDL			0.53	1.2	300	1.6	280	0.18	0.2	0.1

ND: No Detected.
MDL: Minimum Detection Limit.
(a): No Standard Specified.

Note: DOE Order 5400.5 Drinking Water Guide concentrations derived by dividing DCGs by 25.

Table 28
BNL Site Environmental Report for Calendar Year 1993
Potable Water and Process Supply Wells
Water Quality Data

Well Id. (a)		pH SU	Conductivity umhos/cm	Chlorides mg/L	Sulfates mg/L	Nitrate as N (b) mg/L
WTP - In	N	0	0	0	0	0
WTP - Eff	N	0	0	0	0	0
4 (FD)	N	1	1	1	1	1
	Concentration	5.9	101.4	14.1	10.2	<1.0
6 (FF)	N	1	1	1	1	1
	Concentration	6	107.2	12.4	9.5	<1.0
7 (FG)	N	0	0	0	0	0
10 (FO)	N	4	4	4	4	4
	Minimum	6.12	106.4	12	11.7	<1.0
	Maximum	7	116.5	13.2	12.3	<1.0
	Average	NA	112.5	12.5	12.08	<1.0
11 (FP)	N	4	4	4	4	4
	Minimum	5.8	105.6	13.8	11.6	<1.0
	Maximum	6.2	123.3	14.9	13	<1.0
	Average	NA	116.7	14.3	12.15	<1.0
12 (FQ)	N	4	4	4	4	4
	Minimum	6.3	91.5	15	11.5	<1.0
	Maximum	6.5	120.1	16.8	12	<1.0
	Average	NA	110.9	15.7	11.72	<1.0
5 (FE)	N	3	3	3	3	3
	Minimum	5.4	56.7	5.4	8.6	<1.0
	Maximum	6	67	6.6	9.2	<1.0
	Average	NA	62.6	6	8.9	<1.0
9 (FM)	N	4	4	4	4	4
	Minimum	5.7	105	16.1	12	<1.0
	Maximum	6.4	139.7	18	15	<1.0
	Average	NA	117	17	13.5	<1.0
101 (FH)	N	3	3	3	3	3
	Minimum	5.6	115.3	15.1	9	<1.0
	Maximum	6.2	122.9	18.3	9.5	<1.0
	Average	NA	118	16.3	9.2	<1.0
103 (FJ)	N	3	3	3	3	3
	Minimum	5.4	116.1	21.3	9.4	<1.0
	Maximum	5.8	132.6	29.3	10.4	<1.0
	Average	NA	124.5	24.7	9.8	<1.0
NYSDWS		(a)	(a)	250	250	10
Typical MDL		NA	10	4	4	1

MDL: Minimum Detection Limit
(a): No standard specified.
(b): All nitrate analyses exceeded the holding times specified by the USEPA.

Due to the shut down of the WTP for maintenace purposes, there were no samples collected from this facility nor from Well 7 during CY1993.

Table 29
BNL Site Environmental Report for Calendar Year 1993
Potable and Process Supply Wells
Annual Metals Concentrations

Well Id.		Ag (mg/L)	Cd (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Hg (mg/L)	Mn (mg/L)	Na (mg/L)	Pb (mg/L)	Zn (mg/L)
WTP-In	N	0	0	0	0	0	0	0	0	0	0
(F1)	Minimum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(a)	Maximum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
WTP-Eff	N	0	0	0	0	0	0	0	0	0	0
(F2)	Minimum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
(a)	Maximum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Average	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 (FD)	N	1	1	1	1	1	1	1	1	1	1
	Concentration	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	0.106	9.76	0.002	<0.02
6 (FF)	N	1	1	1	1	1	1	1	1	1	1
	Concentration	<0.025	<0.0005	<0.005	<0.05	3.88	<0.0002	0.16	8.65	<0.002	0.048
7 (FG)	N	0	0	0	0	0	0	0	0	0	0
	Concentration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10 (FO)	N	4	4	4	4	4	4	4	4	4	4
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.76	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	10.35	<0.002	0.077
	Average	<0.025	<0.0005	<0.005	<0.05	<0 .075	<0.0002	<0.05	10.2	<0.002	0.025
11 (FP)	N	4	4	4	4	4	4	4	4	4	4
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	9.99	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.2	<0.002	0.022
	Average	<0.025	<0.0005	<0.005	<0.05	<0 .075	<0.0002	<0.05	10.61	<0.002	<0.02
12 (FQ)	N	4	4	4	4	4	4	4	4	4	4
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.45	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	13.4	<0.002	0.034
	Average	<0.025	<0.0005	<0.005	<0.05	<0 .075	<0.0002	<0.05	12.47	<0.002	<0.02
5 (FE)	N	3	3	3	3	3	3	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	0.4	<0.0002	<0.05	4.1	<0.002	0.083
	Maximum	<0.025	<0.0005	<0.005	0.15	1.1	<0.0002	<0.05	5.2	0.0025	0.17
	Average	<0.025	<0.0005	<0.005	0.079	0.52	<0.0002	<0.05	4.71	<0.002	0.12
9 (FE)	N	4	4	4	4	4	4	4	4	4	4
	Minimum	<0.025	<0.0005	<0.005	<0.05	0.078	<0.0002	<0.05	12	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	0.132	<0.0002	<0.05	13.3	<0.002	0.089
	Average	<0.025	<0.0005	<0.005	<0.05	0.113	<0.0002	<0.05	12.5	<0.002	0.036
101 (FH)	N	3	3	3	3	3	3	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	<0.05	11.9	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	0.89	<0.0002	0.055	15.8	<0.002	0.15
	Average	<0.025	<0.0005	<0.005	<0.05	0.59	<0.0002	<0.05	13.4	<0.002	0.058
103 (FJ)	N	3	3	3	3	3	3	3	3	3	3
	Minimum	<0.025	<0.0005	<0.005	<0.05	1.43	<0.0002	0.5	14.8	<0.002	<0.02
	Maximum	<0.025	<0.0005	<0.005	<0.05	3.81	<0.0002	0.59	19.3	<0.002	0.043
	Average	<0.025	<0.0005	<0.005	<0.05	3	<0.0002	0.27	16.3	<0.002	0.023
NYSDWS		0.05	0.01	0.05	1.3	0.3	0.002	0.3	(b)	0.015	5
Minimum Detection Limit		0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

(a): No standard specified.
Due to the shut down of the WTP for maintenace purposes, there were no samples collected from this facility nor from Well 7 during CY1993.

The average metal concentration has been calculated by summing all detectable concentrations then dividing the sum by the total number of samples collected. All non-detectable quantities have been evaluated as zero. If the average is less than the typical minimum detection limit, the average is reported as less than this limit.

Table 30
BNL Site Environmental Report for Calendar Year 1993
Potable Water and Process Supply Wells
Volatile Organic Compound Data

Well Id.		Chloroform ug/L	1,1 Dichloroethane	1,1 Dichloroethylene	1,1,1 - Trichloroethane ug/L
WTP-In	N	0	0	0	0
WTP-Eff	N	0	0	0	0
4 (FD)	N	1	1	1	1
	Concentration	9	<2.0	<2.0	3
6 (FF)	N	1	1	1	1
	Concentration	<2.0	<2.0	<2.0	<2.0
7 (FG)	N	0	0	0	0
10 (FO)	N	4	4	4	4
	Minimum	<2.0	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0	3
	Average	<2.0	<2.0	<2.0	<2.0
11 (FP)	N	4	4	4	4
	Minimum	<2.0	<2.0	<2.0	2
	Maximum	<2.0	<2.0	<2.0	4
	Average	<2.0	<2.0	<2.0	2.75
12 (FQ)	N	4	4	4	4
	Minimum	<2.0	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0	2
	Average	<2.0	<2.0	<2.0	<2.0
5 (FE)	N	3	3	3	3
	Minimum	<2.0	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0	<2.0
9 (FM)	N	4	4	4	4
	Minimum	<2.0	<2.0	3	8
	Maximum	<2.0	6	10	31
	Average	<2.0	2.5	5.3	18.8
101 (FH)	N	3	3	3	3
	Minimum	<2.0	<2.0	<2.0	<2.0
	Maximum	3	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0	<2.0
103 (FJ)	N	3	3	3	3
	Minimum	<2.0	<2.0	<2.0	<2.0
	Maximum	<2.0	<2.0	<2.0	<2.0
	Average	<2.0	<2.0	<2.0	<2.0
NYS Drinking Water Standard		100	5	5	5
Typical MDL		2	2	2	2

WTP-In: Water Treatment Plant Influent
WTP-Eff: Water Treatment Plant Effluent
MDL: Minimum Detection Limit

Due to the shut down of the WTP for maintenance purposes, there were no samples collected from this facility nor Potable Well 7 during CY1993.

The majority of metals including silver, cadmium, chromium, copper, and mercury were not detected in the Laboratory supply system. Manganese, lead, and zinc were detected at levels below their respective NYS DWS. Iron was not detected in water samples collected at the well head of Potable Well Nos. 10, 11, and 12 but was detected at ambient levels in Potable Well Nos. 4 and 6. The water from these latter wells is treated at the WTP which has an iron removal efficiency in excess of 90%, and permits distribution of water at concentrations below the 0.3 mg/L NYS DWS. Sodium was detected in all wells at ambient concentrations.

During the second or third month of each quarter, BNL schedules the collection of potable water samples which are analyzed on site by S&EP for ten organic compounds. The ten organic compounds consist of volatile halogenated aliphatic hydrocarbons and aromatic hydrocarbons. These samples serve both as a quality control on the contractor laboratory and as an additional source of organic data used in trend analysis of water quality. Water samples are collected from the well head and before treatment. Review of the organics data shows that only chloroform and TCA were detected in the potable wells. The analytical data for Potable Wells 10 and 11 indicates that these water supplies contain 1,1,1 trichloroethane at concentrations which approach the drinking water standard. These wells are equipped with activated carbon adsorption vessels which effect the removal of volatile organic compounds from the ground-water supply. All water samples collected post treatment were found to meet the NYS DWS. All remaining eight organic compounds were not detected in water samples collected during CY 1993.

Process Supply Wells 5, 9, 101, and 103 were also sampled and analyzed during CY 1993. Wells 101 and 103 are used solely for supplying cooling water to the AGS, Well 9 is used for supplying fresh water to the fish tanks housed in Building 463 and Well 5 is used as a supply of non-potable water to the BNL STP. Review of the analytical data for these wells show the concentration of water quality and inorganic parameters to be within ambient levels (Tables 28 and 29). Iron is present in the water obtained from Wells 103 and 5 but at concentrations which are consistent with native ground water. With the exception of Well 9, all wells proved negative for volatile organic contaminants. Well 9, which is located within a known Area of Concern, was found to contain concentrations of 1,1 dichloroethane, 1,1 dichloroethylene, and 1,1,1 trichloroethane which exceed the NYS DWS. This well is not used for potable water purposes, and the concentration of contaminants present does not interfere with the fish experimentation conducted within Building 463. Samples of waste water discharged from this operation have been analyzed and found to be free of these contaminants which indicate that the fish tank aeration and filtration process is effective for the removal of these contaminants from the water.

5.1.2 <u>Ground-water Monitoring</u>

Ground-water monitoring is being performed at BNL as an integral part of the BNL Environmental Monitoring Program. This program includes monitoring at active waste processing and temporary storage facilities to comply with RCRA, waste treatment facilities, operational monitoring around accelerators, and in areas of known or suspected soil and ground-water contamination.

Table 31
BNL Site Environmental Report for Calendar Year 1993
Radionuclides and Chemicals Analyzed in Environmental Samples

Radiological Parameters	Chemical Parameters
^{3}H	pH (field and laboratory)
Sr-90	Conductivity (field)
γ-spectrometry: Natural Activation Fission	Ag, Cd, Cr, Cu, Fe, Hg, Na, Pb, and Zn
Gross Alpha	
Gross Beta	Chlorides, Sulfates, Nitrate-Nitrogen Volatile Organic Constituents Semi-volatile Organic Constituents

Table 32

BNL Site Environmental Report for Calendar Year 1993

Radionuclide Concentrations in Off-site Potable Water

Sample Location	Number of Samples	Gross Alpha Avg	Gross Alpha Max	Gross Beta Avg	Gross Beta Max	Tritium Avg	Tritium Max	Co-60 Avg	K-40 Avg	Cs-137 Avg
		<----------				pCi/L			---------->	
1	3	-0.06	0.09	0.75	0.97	-44	95	1.16	<MDL	<MDL
2	3	0.39	0.85	1.19	1.22	-86	-17	0.45	<MDL	<MDL
3	3	0.32	0.79	1.05	1.17	-63	-25	<MDL	3.13	<MDL
4	4	0.41	0.62	1.63	2.11	922	1300	NS	NS	NS
5 (PR)	3	0.35	0.55	4.30	5.04	2665	5030	<MDL	<MDL	<MDL
6	4	0.33	0.48	2.12	2.44	64	302	*	*	*
7	4	0.07	0.38	1.79	2.10	-34	243	<MDL	3.92	<MDL
8	4	0.21	0.23	1.49	2.08	1692	2790	<MDL	<MDL	<MDL
9	3	0.96	1.45	0.52	0.80	9	214	*	*	*
10	2	-0.11	0.00	0.30	0.49	104	319	NS	NS	NS
11 (PR)	4	0.34	0.58	2.03	2.69	77	511	NS	NS	NS
12	4	0.31	0.72	1.17	2.24	7	326	*	*	*
13	4	0.17	0.50	1.25	2.16	106	677	<MDL	<MDL	<MDL
14	3	0.50	0.65	3.50	5.26	52	352	NS	NS	NS
15	3	0.60	0.87	2.68	5.64	98	289	NS	NS	NS
16	3	0.77	1.43	1.44	2.32	136	438	*	*	*
17	2	0.17	0.22	3.26	3.80	-36	-25	*	*	*
18	1	0.23	1.99	1.79	---	-32	---	NS	NS	NS
19	2	0.25	0.50	3.47	3.94	4369	7238	*	*	*
20	2	0.11	0.34	1.72	2.46	926	1045	*	*	*
21	1	0.13	---	1.48	---	-111	---	NS	NS	NS
22	1	0.00	---	0.90	---	-259	---	NS	NS	NS
23	1	-0.10	---	2.61	---	-214	---	NS	NS	NS
NYS Drinking Water Standard		15		50		20,000		(a)	(a)	(a)
Typical MDL		0.53		1.2		300		0.23	3.9	0.2

PR: Peconic River Sampling Point.
* No Activity Detected.
MDL: Minimum Detection Limit.
(a) Standard Not Specified.

Most ground-water monitoring wells on the site are 2" to 4" in diameter and constructed of PVC material and were installed using RCRA and CERCLA protocols. In several areas of the site (e.g., the STP, HWMF, and Current Landfill), a number of old, small diameter (1.25") wells constructed of carbon steel casings and brass screens are currently utilized. These wells will be upgraded to PVC during the planned remedial investigations, and these older wells will either be abandoned or used exclusively for water level measurements.

Ground-water samples were collected following documented sampling procedures based on EPA guidelines.[43] Analytical techniques used are described in this report (see Appendix C), and in the BNL Site Environmental Monitoring Plan.[33] The chemical and radioactive species that are analyzed are listed in Table 31.

Samples were analyzed by the BNL S&EP Analytical Laboratory and state approved contract laboratories. The data presented in subsequent text and tables are compared to DCGs to determine compliance with operational limits, and because the Upper Glacial aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" aquifer,[2] these data are also compared to New York State Drinking Water Standards (NYS DWS) and New York State Ambient Water Quality Standards (NYS AWQS).

5.1.2.1 Radiological Analyses

In 1993, the cooperative program between BNL and the SCDHS continued for the collection and analysis of samples from wells serving private homes. As part of this program, samples were collected quarterly from 21 private drinking water wells in Suffolk County and two from the Peconic River. Twelve of these sampling stations were from homes near the Laboratory, with the remainder from locations randomly selected by SCDHS. A total of 23 different locations were sampled in 1993. Samples were analyzed for gross alpha, gross beta, and tritium on a quarterly basis, while analyses for gamma spectroscopy were performed annually. Results from this program are presented in Table 33 and indicate that tritium was detected in samples collected from eight locations adjacent to the Laboratory. (Two locations were sampling points along the Peconic River and six locations were private potable wells.) The private wells, sampled in the this program, are screened at depths ranging from 50 to 200 feet and had annual average tritium concentrations that ranged from below detection limits to 4369 pCi/L (160 Bq/L). Although above background, these data were consistent with data collected since 1979, and were less than 24% of concentration limits and 6% of the dose limit specified by the NYS DWS for community water supplies. Gamma spectroscopy results from these private wells in 1993 indicated the presence of trace quantities of world-wide fallout radionuclides Cs-137, and of naturally occurring K-40. In most of the samples, the observed concentrations were below the detection limit but above the two sigma counting error. They are reported as trace for trending purposes. The Peconic River sampling location was observed to contain Cs-137. Strontium-90 results are effectively at or below the analytical detection limits.

The data for the samples collected from control wells, wells in the North Boundary and West Sectors, South Boundary, central part of the BNL site, RHIC, the Current and Former Landfills, Former Army Landfill, Ash Repository, MPF, CSF, Peconic River on site/off site, Meadow Marsh-Upland Recharge, and the HWM areas are shown in Tables 33, 34, 35, 36, 37, 38, and 39.

Sewage Treatment Plant/Peconic River Area: The yearly average concentrations of radionuclides in samples from the wells adjacent to the sand filter beds at the STP, downstream of the Peconic River, and adjacent to the Meadow Marsh-Upland Recharge Area are summarized in Table 33. The location of these wells are presented in Figures 29 and 30. Elevated gross beta, tritium, Co-60, and Cs-137 concentrations have been found in on-site wells adjacent to the sand filter beds and the Peconic River. The observed levels are probably attributable to losses from the tile collection field underlying the sand filter beds and periodic recharge to ground water from the Peconic River in this area. In 1993, on-site average gross beta ground-water concentrations in this area ranged from <0.01% to 36.3% of the NYS DWS. Average tritium concentrations ranged from nondetectable to 14.3% of the NYS DWS. Gamma emitting radionuclides, K-40, Co-60, and Cs-137, were the only radionuclides detected in the Peconic River on site/off site and the Meadow Marsh-Upland Recharge Area monitoring wells. The latter wells also indicated the presence of Sr-90.

North Boundary, Former Army Landfill, AGS, WCF, PG&A, NSLS, RHIC, Building 830, South Boundary, and West Sector (Figure 31 and Tables 34 and 35): Most results from wells in these areas were either below the system detection limits or typical of ground water not impacted by laboratory operations. The highest gross beta and Sr-90 levels observed were in the vicinity of WCF area at Locations 65-02 and 65-03. Down gradient of the AGS and at Building 811, Na-22 was routinely detected at concentrations less than 1% of NYS DWS. Strontium-90 was also detected in these and other AGS area wells in concentrations representing less than 23% of the NYS DWS.

Building 650 Area: In the vicinity of Building 830 (Table 35), radiological results for ground-water monitoring samples indicated the presence of Co-60 in two of these wells. The Co-60 concentrations are most likely related to operational activities at Building 830 associated with the "D-waste" line leak. The observed concentrations are less than 1% of the NYS DWS. Ground-water samples analyzed from monitoring wells near the P&GA building indicated no significant concentrations of radionuclides.

Table 33
BNL Site Environmental Report for Calendar Year 1993
Peconic River On-site/Off-site, Meadow Marsh/Upland Recharge Area
Ground Water Surveillance Wells, Radioactivity Data

Area	Sample ID	No. of Samples		Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	K-40 pCi/L	Co-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
Peconic River On-Site	22-01	2	Max.	0.38	2.13	61	ND	ND	ND	NA
			Avg.	0.26	1.69	-146				
	30-01	2	Max.	0.3	1.51	92	17.8	ND	8.21	NA
			Avg.	0.15	0.97	-18	1.91		4.11	
	38-01	3	Max.	0.86	3.34	283	2.2	ND	0.17	NA
			Avg.	0.38	2.48	119	0.71		0.06	
	39-03	2	Max.	0.13	2.27	-94	ND	ND	ND	NA
			Avg.	0.03	1.99	-99				
	39-04	3	Max.	1.29	10.3	3730	ND	0.23	ND	NA
			Avg.	1.08	7.2	2860		0.08		
	39-05	4	Max.	0.74	2.85	1030	3.42	ND	0.25	NA
			Avg.	0.36	2.07	556	0.86		0.06	
	40-01	2	Max.	0.37	18	2940	3.58	ND	ND	NA
			Avg.	0.19	15.05	2860	1.79			
	40-02	2	Max.	1.01	5.07	-137	ND	ND	0.14	NA
			Avg.	0.85	4.83	-189			0.07	
	40-03	2	Max.	0.13	1.4	-36	ND	ND	ND	NA
			Avg.	0.11	1.14	-92				
	40-04	2	Max.	0.37	4.77	6	ND	ND	ND	NA
			Avg.	0.06	4.68	-83				
	40-05	2	Max.	0.29	3.17	-119	ND	ND	ND	NA
			Avg.	0.25	3.11	-125				
	40-07	2	Max.	0	1.32	76	ND	ND	0.94	NA
			Avg.	-0.06	1.27	-126			0.47	
	47-01	2	Max.	0.54	2.82	-110	ND	ND	ND	NA
			Avg.	0.39	2.34	-188				
	47-02	2	Max.	1.86	4.47	305	ND	0.62	ND	NA
			Avg.	1.77	3.95	53		0.31		
	47-03	3	Max.	0.35	0.72	82	ND	0.32	ND	NA
			Avg.	0.18	0.71	-9		0.11		
	48-01	2	Max.	0.21	1.21	1540	ND	1.19	ND	NA
			Avg.	-0.03	0.82	834		0.59		
	49-02	2	Max.	0.33	4.69	378	ND	0.49	0.59	NA
			Avg.	0.32	4.28	254		0.25	0.3	
	58-01	3	Max.	0.56	1.51	-69	3.25	ND	ND	NA
			Avg.	0.39	1.3	-124	1.08			
Peconic River Off-Site	80-02	3	Max.	0.21	1.7	683	ND	ND	ND	NA
			Avg.	0.14	0.4	206				
	80-03	3	Max.	0.36	0.83	11	ND	ND	ND	NA
			Avg.	0.25	0.53	-23				
Meadow Marsh/ Upland Recharge	70-01	3	Max.	1.05	1.82	230	ND	ND	ND	0.51
			Avg.	0.58	1.25	122				0.51
	89-01	3	Max.	0.94	3.52	35	ND	0.13	ND	0.18
			Avg.	0.57	2.26	-16		0.04		0.18
	100-03	3	Max.	0.55	1.66	114	ND	ND	ND	NA
			Avg.	0.38	1.37	38				
	100-04	2	Max.	19.6	25.5	-17	8.15	0.71	ND	NA
			Avg.	15.1	18.15	-427	4.08	0.35		
NYS Drinking Water Standard				15	50	20000	(a)	(a)	(a)	8
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(a)	(a)	80000	120	200	280	40
Typical MDL				0.53	1.2	300	0.2	0.23	3.9	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit
(a): No Standard Specified

NOTE: The following wells showed the presence of:
Well 40-07: Be-7/4.45 pCi/l; Well 40-01: Mn-54/0.14 pCi/L and Th228/0.82 pCi/L;
Well 40-04: Mn54/0.88 pCi/L; Well 100-04: Ra226/0.57 pCi/L:

Table 34
BNL Site Environmental Report for Calendar Year 1993
North Boundary, West Sector, South Boundary, and Supply & Material Areas
Ground Water Surveillance Wells, Radioactivity Data

Area	Sample ID	No. of Samp.		Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	K-40 pCi/L	Co-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
North Boundary	12-01	3	Max.	0.42	2.23	240	ND	ND	ND	0.05
			Avg.	0.07	1.26	-54				0.05
	18-01	3	Max.	0.56	1.7	124	ND	0.95	0.15	0.45
			Avg.	0.35	1.58	-1		0.32	0.05	0.45
	18-02	3	Max.	0.74	0.72	108	16.1	0.38	11.4	ND
			Avg.	0.37	0.52	50	6.37	0.13	3.8	
	18-03	3	Max.	0.94	1.56	224	ND	ND	ND	-0.04
			Avg.	0.49	1.14	53				-0.04
	25-01	3	Max.	0.64	2.34	259	2.5	ND	ND	ND
			Avg.	0.31	1.94	55	0.83			
	25-02	3	Max.	0.84	1.59	254	3.76	ND	ND	0.06
			Avg.	0.53	0.91	115	1.25			0.06
West Sector	72-01	3	Max.	0.21	1.18	119	ND	ND	ND	0.13
			Avg.	-0.08	0.75	31				0.13
	83-01	3	Max.	0.52	2	34	ND	ND	ND	ND
			Avg.	0.35	1.19	-36				
	83-02	3	Max.	0.52	1.44	459	2.42	ND	ND	ND
			Avg.	0.19	1	287	0.81			
	84-01	3	Max.	0.21	5.29	221	11.8	ND	ND	ND
			Avg.	0.15	3.24	61	4.97			
	101-01	3	Max.	0.47	2.98	30	2.78	ND	ND	0.03
			Avg.	-0.08	2.01	-76	0.93			0.03
South Boundary	118-01	4	Max.	0.22	1.7	206	ND	ND	ND	-0.02
			Avg.	-0.08	0.79	70				-0.02
	118-02	4	Max.	0.72	1.13	209	ND	ND	ND	0.04
			Avg.	0.03	0.59	76				0.04
	122-01	4	Max.	0.34	2.23	192	ND	ND	0.48	-0.03
			Avg.	-0.02	0.99	21			0.12	-0.03
	122-02	4	Max.	16.2	19.9	466	5.21	ND	ND	-0.05
			Avg.	4.71	6.24	410	0.82			-0.05
	126-01	4	Max.	0.88	1.7	161	5.56	ND	0.14	-0.01
			Avg.	0.28	0.93	34	1.36		0.04	-0.01
	130-02	3	Max.	0.78	1.74	512	ND	ND	ND	ND
			Avg.	0.23	1.36	245				
Supply & Material	85-03	4	Max.	0.55	3.84	297	4.73	ND	0.5	ND
			Avg.	0.28	2.31	66	1.81		0.13	
	86-01	2	Max.	1.49	3.06	18	ND	ND	ND	ND
			Avg.	1.26	2.94	17				
	96-06	4	Max.	0.46	2.05	117	ND	0.44	0.5	0.17
			Avg.	0.3	1.54	81		0.14	0.13	0.17
NYS Drinking Water Standard				15	50	20000	(a)	(a)	(a)	8
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(a)	(a)	80000	120	200	280	40
Typical MDL				0.53	1.2	300	0.2	0.23	3.9	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit
(a): No Standard Specified

NOTE: The following wells showed the presence of:
Well 72-01/ Mn-54: Max: 0.19 pCi/L; Avg: 0.06 pCi/L.
Well 101-01/ Th-228: Max: 0.62pCi/L; Avg: 0.21 pCi/L.

Table 35
BNL Site Environmental Report for Calendar Year 1993
Miscellaneous Areas of the BNL Site
Ground Water Surveillance Wells, Radioactivity Data

Area	Sample ID	No. of Samp.		Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	Na-22 pCi/L	K-40 pCi/L	Co-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
Army Landfill (X-26)	53-01	1	Max.	0.94	1.73	110	ND	ND	ND	ND	NA
			Avg.	0.94	1.73	110					
	53-02	1	Max.	0	1.51	25	ND	ND	ND	ND	NA
			Avg.	0	1.51	25					
	53-03	1	Max.	0.23	1.09	31	ND	ND	ND	ND	NA
			Avg.	0.23	1.09	31					
	53-04	1	Max.	0	0.34	123	ND	ND	0.6	ND	NA
			Avg.	0	0.34	123			0.6		
AGS	44-01	3	Max.	0.65	3.13	-24	ND	3.46	ND	ND	0.68
			Avg.	0.22	2.95	-103		1.89			0.68
	44-02	3	Max.	0.35	1.89	32	ND	3.46	ND	ND	0.04
			Avg.	0.12	0.98	-69		1.15			0.04
	54-01	1	Max.	0.73	5.84	-119	1.89	ND	ND	ND	NA
			Avg.	0.73	5.84	-119	1.89				
	54-05	3	Max.	0.37	2.34	114	ND	2.32	1.18	0.21	NA
			Avg.	0.05	1.45	37		0.77	0.39	0.07	
	54-06	3	Max.	0.34	4.57	341	ND	2.68	ND	ND	NA
			Avg.	-0.01	3.86	152		0.89			
	64-01	3	Max.	0.49	4.3	392	0.55	7.92	ND	ND	0.32
			Avg.	0.19	3.98	351	0.27	3.62			0.32
WCF	65-01	4	Max.	1.29	3.05	172	ND	3.92	ND	ND	0.09
			Avg.	0.44	1.38	18		1.57			0.09
	65-02	3	Max.	0.97	6.08	1760	0.79	2.62	0.71	ND	1.16
			Avg.	0.51	5.37	746	0.5	0.87	0.24		1.16
	65-03	3	Max.	0.68	5.58	901	1.4	4.03	0.13	ND	1.81
			Avg.	0.50	5.33	410	0.96	1.35	0.08		1.81
	65-04	3	Max.	0.15	6.9	179	1.61	12.1	ND	0.15	1.65
			Avg.	-0.14	6.24	96	0.89	5.37		0.05	1.65
PG&A	75-01	2	Max.	0.79	1.34	339	ND	ND	0.49	ND	0.23
			Avg.	0.25	1.26	289			0.24		0.23
	75-02	2	Max.	0.76	2.61	417	ND	22.3	0.66	ND	0.12
			Avg.	0.14	1.96	345		15.1	0.33		0.12
NSLS	85-01	3	Max.	0.68	2.28	364	ND	3.07	0.19	ND	-0.01
			Avg.	0.36	1.65	218		1.02	0.06		-0.01
	85-02	3	Max.	0.22	1.24	218	ND	ND	ND	ND	-0.02
			Avg.	0.19	1.1	174					-0.02
Bldg. # 830	66-07	3	Max.	0.18	1.86	100	ND	8.59	0.23	ND	-0.03
			Avg.	0.05	1.26	4		2.86	0.08		-0.03
	66-08	3	Max.	0.34	4.06	11	ND	ND	0.42	0.78	0.07
			Avg.	0.17	3.09	-68			0.14	0.31	0.05
	66-09	3	Max.	0.70	3.96	234	ND	ND	ND	ND	-0.02
			Avg.	0.14	1.84	25					-0.02
RHIC	37-01	2	Max.	0.32	2.33	207	ND	5.46	ND	ND	0.45
			Avg.	0.31	2.33	62		4.55			0.45
LINAC	54-03	3	Max.	1.49	2.48	214	ND	6.47	ND	ND	NA
			Avg.	0.63	1.53	-112		3.97			
NYS Drinking Water Standard				15	50	20000	(a)	(a)	(a)	(a)	8
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(a)	(a)	80000	400	280	200	120	40
Typical MDL				0.53	1.2	300	0.2	3.9	0.23	0.2	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit
(a): No Standard Specified

NOTE: The following wells showed the presence of:

Well : 44-02 / Ra-226: Max: 0.43 pCi/L; Min: 0.14 pCi/L.
Well : 85-01/ Th-228: Max: 0.34 pCi/L; Min: 0.12 pCi/L.

Current Landfill: Radionuclide results for samples collected at the Current (Figure 32) are presented in Table 36. At the Current Landfill, twelve downgradient wells consistently show elevated gross beta concentrations; 15 wells exhibit above background concentrations of tritium; eight wells (essentially those with elevated gross beta concentrations) have elevated Sr-90 levels; Na-22 was detected in four wells; and Cs-137 was detected in four wells. The highest annual average gross beta, tritium, and Sr-90 concentrations were 48%, 77%, 57%, and 39%, respectively of the NYS DWS. In general, radionuclide concentrations in the downgradient Current Landfill wells are consistent with inorganic contaminants, specifically iron, observed at the same locations. The presence of radionuclides in ground-water samples, collected from the Current Landfill area, is the result of BNL's past practice of disposing of low specific activity material in that location. This practice was terminated in 1978.

Former Landfill Area: The maximum gross beta concentrations of 49.2 pCi/L was observed in Well 97-03. Tritium and gamma activity concentrations were at or below the MDL of the system and well below the NYS DWS. This has been observed consistently over the past few years. The presence of radionuclides in ground-water samples from the Former Landfill and Chemical Hole Area is the result of BNL's past practice of disposing of low specific activity material in that location.

Central Steam Facility/Major Petroleum Facility Area: Table 37 shows that radionuclide concentrations in the MPF and CSF Areas (Figure 33). Data indicates that the radionuclides were all at or below the MDL of the system, except for the presence of Co-60 in wells at the CSF. Well 66-08 which is used as an upgradient well for the CSF (but down gradient of Building 830) showed Co-60 which is attributable to the spill at Building 830.

Hazardous Waste Management Facility (HWMF) Area: The ground-water monitoring program conducted at the HWMF (Figure 34) consists of a shallow well network located near the facility and a set of deeper wells that extends out from the facility in the direction of ground-water flow. The radiological results for the samples collected from this program are presented in Table 38. Elevated annual average gross beta concentration was observed in Well 88-04. The observed concentration was 458% of the gross beta NYS DWS and supports the observation made in the SER 1993[9] that the gross beta concentrations were decreasing in time. Twenty-three well locations exhibit tritium concentrations in excess of ambient levels. The maximum annual average concentration observed in this area was 20% of the NYS DWS. Sodium-22 and Co-60 were detected periodically in samples from this area at concentrations substantially less than 1% of the NYS DWS. Strontium-90 was detected in excess of the NYS DWS at the three wells identified with elevated gross beta concentration. At Well 88-04, the Sr-90 concentration was 180 pCi/L (6.77 Bq/L); and at Well 98-30, the Sr-90 concentration was 13.6 pCi/L (0.50 Bq/L). The NYS and EPA Sr-90 NYS DWS is 8 pCi/L (0.3 Bq/L). The locations where these concentrations were observed were well within the site boundary. Ground-water concentrations at all site boundary stations were well within regulatory guidelines.

Table 36
BNL Site Environmental Report for Calendar Year 1993
Current Landfill, Old Landfill, and Ash Repository Areas
Ground Water Surveillance Wells, Radioactivity Data

Area	Sample ID	No. of Samp.	DS*	Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	Na-22 pCi/L	K-40 pCi/L	Mn-54 pCi/l	Co-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
Current Landfill	87-05 (a)	4	Max.	3.81	21.5	18500	0.39	12.9	ND	0.63	ND	1.45
			Avg.	3	17.42	8035	0.09	7.91		0.16		1.27
	87-06	4	Max.	3.64	31	14200	ND	17	ND	ND	ND	3.17
			Avg.	1.88	20.62	10500		14.2				2.81
	87-07	4	Max.	2.46	30.4	17400	0.4	14	ND	ND	0.24	3.35
			Avg.	2.22	24.03	15325	0.26	13.4			0.06	3.11
	87-09	4	Max.	0.95	3.7	76	ND	2.85	ND	ND	ND	0.08
			Avg.	0.4	1.92	2		0.71				0.08
	87-10	4	Max.	5.21	19.6	998	0.55	14.1	ND	ND	ND	1.07
			Avg.	2.28	15.6	512	0.51	10.02				0.73
	87-11	4	Max.	1.95	17.4	4990	ND	16.5	ND	ND	0.37	1.42
			Avg.	0.71	15.28	2370		11.32			0.32	1.15
	88-01	3	Max.	0	1.89	253	ND	2.83	ND	ND	ND	0.17
			Avg.	-0.58	1.44	12		0.94				0.12
	88-02	4	Max.	1.73	3.99	463	ND	1.64	ND	ND	ND	-0.03
			Avg.	0.86	2.09	142		0.41				-0.05
	97-14	4	Max.	1.22	2.89	1380	ND	4.18	ND	0.32	ND	1.98
			Avg.	0.58	1.6	546		1.04		0.08		0.66
	98-01	4	Max.	0.46	8.98	478	ND	5.8	ND	ND	ND	ND
			Avg.	-0.11	7.68	286		1.45				
	98-09	5	Max.	0.58	8.18	3210	ND	3.12	ND	ND	0.58	ND
			Avg.	0.37	6.84	2238		0.63			0.14	
	98-10	3	Max.	0.84	14	10200	0.18	2.97	ND	ND	ND	ND
			Avg.	0.31	11.84	6463	0.06	0.99				
	98-33	3	Max.	0.82	3.27	705	ND	ND	ND	ND	ND	0.41
			Avg.	0.76	2.46	643						0.41
	98-34	2	Max.	1.74	10.5	5630	ND	6.1	ND	ND	ND	1.16
			Avg.	1.72	9	4020		3.05				1.16
	107-07	5	Max.	1.99	2.38	777	ND	ND	ND	ND	ND	-0.02
			Avg.	0.79	1.42	374						-0.02
	107-08	5	Max.	1.37	4.39	1060	ND	19.4	ND	ND	ND	-0.03
			Avg.	0.43	2.22	865		4.28				-0.03
	107-09	7	Max.	1.53	2.13	2470	ND	ND	ND	0.31	ND	-0.01
			Avg.	0.42	0.99	1710				0.05		-0.02
	115-01	4	Max.	0.28	2.16	51	ND	ND	ND	ND	ND	-0.02
			Avg.	0.09	1.3	-52						-0.02
	115-02	4	Max.	0.67	1.29	118	ND	ND	1.59	ND	ND	-0.02
			Avg.	0.33	0.93	-25			0.4			-0.02
	115-03	4	Max.	0.51	1.97	322	ND	ND	ND	0.44	ND	-0.01
			Avg.	0.25	1.04	94				0.11		-0.01
	115-04	5	Max.	0.68	3.18	6370	ND	4.77	ND	ND	ND	0.01
			Avg.	0.27	2.21	5174		0.96				0.01
	115-05	4	Max.	0.86	1.92	6400	ND	ND	ND	ND	0.29	0.03
			Avg.	0.34	1.06	3220					0.07	0.03
Old Landfill	96-02	4	Max.	0.3	1.93	140	ND	ND	0.2	ND	0.18	ND
			Avg.	0.09	1	7			0.05		0.05	
	96-03	5	Max.	0.18	4.38	192	ND	14.8	3.6	ND	ND	ND
			Avg.	-0.37	2.18	8		5.63	0.9			
	96-04	3	Max	0.72	3.08	0	ND	ND	ND	0.49	ND	ND
			Avg.	0.27	2.44	-46				0.16		
	97-01	3	Max.	0.27	2.19	222	ND	ND	ND	ND	0.5	ND
			Avg.	0.04	1.71	47					0.17	
	97-02	4	Max.	0.34	3.06	284	ND	1.85	ND	ND	ND	0.02
			Avg.	0.07	1.38	93		0.46				0.02
	97-03	4	Max.	0.56	49.2	328	ND	2.77	ND	ND	ND	ND
			Avg.	-0.06	20.66	104		0.7				
	97-05	4	Max.	0.54	3.67	214	ND	ND	0.91	ND	ND	ND
			Avg.	0.11	2.44	80			0.23			
	97-08	4	Max.	0.36	2.61	79	ND	ND	ND	ND	ND	ND
			Avg.	0.06	1.04	-28						
	105-01	3	Max.	0.51	2.77	330	ND	ND	ND	ND	ND	ND
			Avg.	0.12	1.48	75						
	106-04	4	Max.	0.69	1.96	364	ND	ND	ND	ND	ND	ND
			Avg.	0.15	1.15	105						
Ash Repository	104-01	1	Max.									
			Avg.									
NYS Drinking Water Standard				15	50	20000	(a)	(a)	(a)	(a)	(a)	8
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(a)	(a)	80000	400	120		200	280	40
Typical MDL				0.53	1.2	300	0.2	0.2		0.23	3.9	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit
(a): No Standard Specified

NOTE: The following wells showed the presence of:
Well 87-07/ Th-228: Max: 0.48 pCi/L; Avg: 0.12 pCi/L.
Well 88-01/ Th-228: Max: 0.66 pCi/L; Avg: 0.22 pCi/L.
Well 87-06/ Ra-226: Max: 0.54 pCi/L; Avg: 0.14 pCi/L.
Well 97-08/ Ra-226: Max: 0.89 pCi/L; Avg: 0.22 pCi/L.
Well 88-02/ Be-7: Max: 2.49 pCi/L; Avg: 0.62 pCi/L.
Well 115-02/ Be-7: Max: 2.31 pCi/L; Avg: 0.60 pCi/L.

Table 37
BNL Site Environmental Report for Calendar Year 1993
Major Petroleum Facility and Central Steam Facility
Ground Water Surveillance Wells, Radioactivity Data

Area	Sample ID	No. of Samp.	DS	ross Alph	Gross Beta	Tritium	K-40	Co-60	Cs-137	Sr-90
				pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L	pCi/L
Major Petroleum Facility	66-08 (a)	3	MAX.	0.34	4.06	11	ND	0.42	0.78	0.07
			AVG.	0.17	3.09	-68		0.14	0.14	0.05
	76-16	2	MAX.	0.56	3.28	-20	ND	ND	ND	0.36
			AVG.	0.28	2.74	-21				0.33
	76-17	2	MAX.	0.28	2.54	44	ND	ND	ND	0.09
			AVG.	0.04	2.13	5				0.03
	76-18	2	MAX.	0.27	3.75	10	ND	ND	ND	0.51
			AVG.	0.05	3.55	-60				0.38
	76-19	2	MAX.	0.13	2.5	27	3.71	ND	ND	0.92
			AVG.	0.11	2.28	25	1.86			0.49
	95-04	2	MAX.	0.41	2.66	151	3.11	ND	ND	ND
			AVG.	0.2	2.32	-66	1.56			
Central Steam Facility	76-02	2	MAX.	-0.28	2.09	334	7.61	0.57	ND	0.32
			AVG.	-0.3	2.04	100	3.82	0.29		0.32
	76-04	2	MAX.	0.49	1.85	153	ND	ND	ND	0.65
			AVG.	0.45	1.42	-150				0.65
	76-05	2	MAX.	0.4	3.02	29	3.25	ND	ND	0.75
			AVG.	0.07	1.51	-95	1.63			0.75
	76-06	2	MAX.	0.84	3.03	83	4.23	ND	ND	0.18
			AVG.	0.53	2.97	-56	3.32			0.18
	76-07	2	MAX.	0.36	1.06	-79	ND	ND	ND	0.5
			AVG.	0.13	0.78	-162				0.5
	76-08	2	MAX.	0.12	2	-103	4.13	ND	ND	0.76
			AVG.	-0.14	1.94	-185	2.06			0.76
	76-09	2	MAX.	0	1.02	105	ND	ND	ND	0.5
			AVG.	-0.16	0.82	50				0.5
	76-10	2	MAX.	-0.54	9.34	ND	2.7	ND	0.1	1
			AVG.	-0.55	4.94		1.35		0.05	0.76
	76-20	2	MAX.	0.26	4.65	233	ND	ND	ND	0.92
			AVG.	0.2	3.08	32				0.92
	76-21	2	MAX.	0.55	1.7	-149	2.15	ND	ND	0.74
			AVG.	0.15	1.06	-150	1.08			0.74
	76-22	2	MAX.	-0.27	1.1	-152	3.21	ND	ND	0.97
			AVG.	-0.28	0.97	-232	1.62			0.97
NYS Drinking Water Standard				15	50	20000	(b)	(b)	(b)	8
DOE Order 5400.5 Derived Concentration Guide for Drinking Water				(b)	(b)	80000	120	200	280	40
Typical MDL				0.53	1.2	300	0.2	0.23	3.9	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

NOTE: The following wells showed the presence of:
Well 95-04/Ra-226: Max: 0.54 pCi/L; Avg: 0.27 pCi/L.
Well 76-08/ Be-7: Max: 4.64 pCi/l; Avg: 2.32 pCi/L.

Table 38
BNL Site Environmental Report for Calendar Year 1993
Hazardous Waste Management Area
Ground Water Surveillance Wells, Radioactivity Data

Area	Samp. ID	No. of Samp.	DS	Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	Na-22 pCi/L	K-40 pCi/L	Co-60 pCi/L	Cs-137 pCi/L	Sr-90 pCi/L
Hazardous Waste	88-03	4	MAX.	0.65	8.5	1530	ND	3.79	24.3	6.49	2.34
Management Area			AVG.	0.4	4.57	1260		3.76	6.1	1.62	
	88-04	4	MAX.	1.48	291	2990	10.8	5.35	1.69	ND	180
			AVG.	0.79	229.25	1750	3.64	1.34	0.82		45
	98-04	3	MAX.	0.34	36.5	2230	0.13	4.11	0.16	0.2	ND
			AVG.	0.31	28.4	1410	0.04	2.98	0.05	0.07	
	98-07	4	MAX.	0.32	2.69	2160	ND	2.55	ND	ND	0.04
			AVG.	-0.07	1.71	1145		0.64			
	98-19	4	MAX.	0.24	1.21	1500	ND	3.63	ND	ND	-0.02
			AVG.	-0.17	0.92	760		0.91			
	98-21	4	MAX.	0	6.93	1410	ND	ND	ND	ND	2.94
			AVG.	-0.14	4.47	945					
	98-22	4	MAX.	0.64	7.25	614	0.16	4.49	ND	ND	3.25
			AVG.	0.19	6.45	302	0.04	1.12			
	98-30	4	MAX.	0.46	33.5	1130	ND	5.64	ND	ND	13.6
			AVG.	0.06	27.98	968		1.41			
	98-32	4	MAX.	0.07	3.63	1140	0.19	4.31	ND	ND	0.1
			AVG.	-0.09	2.26	1038	0.05	2.97			
	98-36	3	MAX.	0.35	2.62	18	ND	ND	ND	ND	ND
			AVG.	0.97	2.06	-113					
	99-01	2	MAX.	0.58	0.3	177	ND	ND	ND	ND	-0.01
			AVG.	0.38	0.2	102					
	99-02	3	MAX.	0.48	6.85	62	ND	ND	ND	0.7	ND
			AVG.	0.18	3.91	18				0.24	
	99-04	4	MAX.	0.32	1.78	1370	ND	ND	ND	0.73	0.04
			AVG.	0	0.98	1235				0.18	
	99-05	4	MAX.	0.42	2.38	150	ND	4.87	0.48	0.55	0.07
			AVG.	0.06	1	-22		3.87	0.32	0.14	
	99-06	4	MAX.	0.93	1.51	38	ND	2.44	ND	ND	-0.04
			AVG.	0.38	0.91	20		2.37			
	107-10	4	MAX.	0.57	2.57	1430	ND	ND	ND	0.16	-0.06
			AVG.	0.06	1.33	1378				0.04	
	107-11	4	MAX.	0.59	1.17	1520	ND	ND	1.03	ND	0.06
			AVG.	0.33	0.38	1278			0.26		
	107-12	4	MAX.	0.22	3.36	1470	ND	3.02	ND	ND	0.01
			AVG.	0.08	2.75	1149		2.97			
	107-13	4	MAX.	0.72	1.36	219	ND	ND	ND	ND	-0.06
			AVG.	0.25	0.71	182					
	107-14	4	MAX.	0.16	1.51	1200	ND	ND	ND	ND	0.04
			AVG.	0.06	0.94	1120					
	108-01	4	MAX.	0.44	3.71	1290	ND	4.55	ND	ND	-0.01
			AVG.	0.15	2.39	1195		3.74			
	108-03	4	MAX.	0.53	3.93	1320	ND	3.29	ND	ND	-0.02
			AVG.	0.23	3.46	1250		0.82			
	108-05	4	MAX.	0.67	5.98	2900	ND	4.57	ND	ND	-0.02
			AVG.	0.28	2.36	1760		3.34			
	108-07	4	MAX.	1.15	3.51	1550	ND	3.19	ND	ND	0.03
			AVG.	0.71	1.94	1460		3.06			
	108-08	4	MAX.	0.8	4.65	1220	ND	5.28	ND	ND	-0.04
			AVG.	0.44	2.83	1090		4.66			
	108-12	4	MAX	0.68	3.6	3790	ND	ND	ND	ND	ND
			AVG.	0.22	3.13	2810					
	108-13	4	MAX.	0.68	3.78	2280	ND	5.3	ND	0.25	0.08
			AVG.	0.2	2.72	1670		1.3		0.06	
	108-14	4	MAX.	0.53	1.55	4050	ND	2.44	ND	ND	-0.02
			AVG.	0.41	0.78	2945		2			
	108-17	4	MAX.	0.23	2.15	1980	0.1	10.2	ND	0.19	0.07
			AVG.	-0.01	1.35	1605	0.03	1.8		0.05	
	108-18	4	MAX.	0.24	2.27	199	ND	ND	ND	ND	0.03
			AVG.	-0.05	0.63	135					
NYS Drinking Water Standard				15	50	20000	(a)	(a)	(a)	(a)	8
DOE Order 5400.5 De Concentration Guide for Drinking Water				(a)	(a)	80000	400	120	200	280	40
Typical MDL				0.53	1.2	300	0.2	0.2	0.23	3.9	0.1

NA: Not Analyzed.
ND: Not Detected.
MDL: Minimum Detection Limit
(a) : No Standard Specified.

NOTE: The following wells showed the presence of:
Well 98-19/ Th-228: Max: 0.21 pCi/L; Avg: 0.05 pCi/L.
Well 99-05/Mn-54: Max: 0.18 pCi/L; Avg: 0.05 pCi/L.

5.1.2.2 Nonradiological Analyses

Sewage Treatment Plant/Peconic River Area: The surveillance well network at the STP and Peconic River areas consist of 27 shallow Upper Glacial aquifer wells. Because of known radiological and chemical contamination of the soils and ground water, the BNL STP, and the nearby Peconic River areas (both on site and off site), are to be the subject of the Operable Unit V RI/FS to be conducted under the IAG between DOE, EPA, and NYSDEC. During 1993, ground-water samples from the 27 surveillance wells were analyzed for water quality, VOCs, and metals (Tables 39 - 42). Water quality data from most wells located both upgradient and downgradient of the STP indicate that the pH was typically below the NYS AWQS of 6.5 - 8.5, with a median pH of 5.99. Nitrate was detected above NYS AWQS in Well 39-08 at a maximum concentration of 10.5 mg/L. Other water quality parameters were below the applicable NYS AWQS. Results of metals analyses of ground-water samples indicate that iron concentrations were above NYS DWS in twelve, with maximum observed iron concentrations ranging from 0.32 - 63.44 mg/L. Zinc was also detected in Well 40-04, at a maximum concentration of 8.10 mg/L. Volatile Organic Compounds were not detected in any samples.

Meadow Marsh-Upland Recharge Area: The surveillance well network at the Meadow Marsh-Upland Recharge area consists of nine shallow to middle Upper Glacial aquifer wells and one upper Magothy aquifer well. The Meadow Marsh-Upland Recharge area was used by BNL in the mid 1970s as an experimental sewage treatment area. As a result of this experiment, the soils and ground water in this area are suspected of being contaminated with a variety of radionuclides, metals, and VOCs. Biological agricultural fields are also located in this area, and recent analysis of ground-water samples indicate that pesticides such as ethylene diblomide (EDB) may have been applied to these agricultural fields. Soil contamination in the Meadow Marsh-Upland Recharge area will be examined during the Operable Unit VI RI/FS, whereas the extent of ground-water contamination will be examined during the Operable Unit I RI/FS to take place in 1994. During 1993, ground-water samples from the nine Upper Glacial aquifer surveillance wells were analyzed for water quality, VOCs, and metals (Tables 39 - 42). Additionally, 30 temporary monitoring wells were installed during 1993 as part of a cooperative study between BNL and the SCDHS. The cooperative study was initiated to examine the vertical and horizontal extent of EDB contamination downgradient of the Meadow Marsh-Upland Recharge area, including in off-site areas. Water quality data from wells located both upgradient and downgradient of the Meadow Marsh area indicate that the pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.70. Two wells, 80-04 and 89-01, exhibited elevated but below NYS AWQS nitrate-nitrogen levels. Other water quality parameters were below the applicable NYS AQWS. Results of metals analyses of ground-water samples indicate that iron was detected above NYS DWS in Well 89-01 and in Magothy aquifer well 100-04 at maximum concentrations of 0.35 and 5.50 mg/L, respectively. Both lead and chromium were detected above NYS DWS in Well 100-03, with maximum observed concentrations for lead at 0.025 mg/L, and chromium at 0.052 mg/L. Analysis of ground-water samples from both permanent and temporary wells indicate that EDB was the only VOC detected above NYS DWS (DWS for EDB = 0.050 μg/L). Ethylene dibromide was detected above NYS DWS in permanent Well 99-06 (0.18 μg/L), and in temporary wells SC-2 (1.0 μg/L), SC-3 (3.0 μg/L), SC-4 (0.13 μg/L), SC-5 (0.12 μg/L), SC-12 (0.25 μg/L), SC-13 (0.06 μg/L), SC-23 (1.15 μg/L), SC-24 (0.59 μg/L), and SC-27 (0.07 μg/L).

Table 39
BNL Site Environmental Report for Calendar Year 1993
Peconic River/Sewage Treatment Plant and Meadow Marsh
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
Peconic River/STP										
47-03 (a)	3	5.5 - 5.8	49.3	45.8	5.4	5.1	8.2	7.9	< 1.0	< 1.0
30-01	2	6.3 - 6.6	62.1	61.9	6.8	6.7	< 4.0	< 4.0	< 1.0	< 1.0
37-01	2	5.1 - 5.3	77.8	77.2	5.5	5.3	12.4	11.7	1.1	< 1.0
38-01	3	4.5 - 4.8	66.8	55.7	5.8	3.3	9.2	8.4	1.6	<1.0
38-02	1	5.7	141.8	141.8	14.1	14.1	11.9	11.9	5.9	5.9
38-03	1	5.3	135.3	135.3	13.9	13.9	16.7	16.7	4.6	4.6
38-05	1	5.7	91.4	91.4	11.2	11.2	9.3	9.3	< 1.0	< 1.0
38-06	1	5.7	57.7	57.7	5.2	5.2	8.6	8.6	< 1.0	< 1.0
39-03	2	5.8 - 6.3	44.5	40.5	5	4.8	7.3	< 4.0	< 1.0	< 1.0
39-04	3	6.3 - 6.4	205.1	190.7	27.4	26.2	13.1	11.8	< 1.0	< 1.0
39-05	3	5.3 - 5.8	73.3	67	10.3	7.2	8.3	7.4	1	< 1.0
39-06	1	6	250.9	250.9	10.3	10.3	16.1	16.1	< 1.0	<1.0
39-07	1	5.6	158	158	23.5	23.5	12	12	4.9	4.9
39-08	1	5.9	245	245	24.6	24.6	15.8	15.8	10.5	10.5
39-09	1	5.3	125.2	125.2	6.6	6.6	31.8	31.8	< 1.0	< 1.0
40-01	2	6.5 - 6.7	240.8	236.5	27.9	26.4	17.8	8.9	< 1.0	< 1.0
40-02	2	6.0 - 6.1	97	94.7	5.7	< 1.0	8.2	6.4	1.1	< 1.0
40-03	2	5.1 - 5.5	237	165.3	10	7.1	80	55.7	< 1.0	< 1.0
40-04	2	6.5 - 6.6	94.4	90.7	10.5	8	12.4	9.5	< 1.0	< 1.0
40-05	2	5.3 - 5.8	69	58.5	10.8	8.3	6.2	6.2	< 1.0	< 1.0
40-07	2	6.3	57.2	56.7	< 4.0	< 4.0	11.8	9.7	< 1.0	< 1.0
47-01	2	5.9 - 6.4	69.7	63.5	5.4	5.2	4.7	4.5	< 1.0	< 1.0
47-02	2	6.2 - 6.4	60.4	59.3	6.8	6.7	7.7	6.7	< 1.0	< 1.0
48-01	2	6.1 - 6.3	67.7	64.5	7	4.6	< 4.0	< 4.0	< 1.0	< 1.0
49-02	2	5.9 - 6.0	48.7	46.4	6.7	6.5	6.4	5.5	< 1.0	< 1.0
60-01	1	5.7	88.2	88.2	8.9	8.9	16.4	16.4	< 1.0	< 1.0
61-03	1	5.8	171.8	171.8	12.5	12.5	46.7	46.7	< 1.0	< 1.0
Upland Recharge/ Meadow Marsh										
58-01 (a)	3	5.2 - 5.3	61.2	57.1	6.9	6.7	9.2	8.9	< 1.0	< 1.0
70-01	3	5.3 - 5.5	48.9	45.8	6.6	5.9	8.1	7.7	< 1.0	< 1.0
80-02	3	5.3 - 5.9	53.1	49.6	7.9	6.4	5.9	5.8	< 1.0	< 1.0
80-03	3	5.5 - 6.0	58	54.2	6.7	6	11.9	11.6	< 1.0	< 1.0
80-04	3	5.2 - 5.6	114.7	103.1	5.5	5.4	18.5	16.9	5.5	3.6
89-01	3	5.5 - 5.9	146.1	134.7	6.3	5.2	22.3	18.5	7.9	6.2
99-05	2	6.0 - 6.2	93.5	89.8	9.9	9.2	8.3	8.2	< 1.0	< 1.0
99-06	3	5.0 - 5.9	160	130.7	9.1	8.9	17.3	16.6	1.2	< 1.0
100-03	3	5.5 - 5.6	48.1	47.3	7.5	7	7.2	6.2	< 1.0	< 1.0
100-04	2	5.9	72	71	7.6	7.4	10.5	10.5	< 1.0	< 1.0
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 40
BNL Site Environmental Report for Calendar Year 1993
Peconic River/Sewage Treatment Plant Area and Meadow Marsh Area
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
Peconic River/STP											
37-01(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	2.66	<0.002	0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	1.33	<0.002	<0.02
47-03(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	4.27	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	3.78	<0.002	<0.02
39-03	2	Maximum	<0.025	<0.0005	<0.005	<0.05	1.00	<0.0002	3.43	<0.002	0.09
		Average	<0.025	<0.0005	<0.005	<0.05	0.63	<0.0002	3.34	<0.002	0.08
39-04	3	Maximum	<0.025	<0.0005	<0.005	<0.05	3.84	<0.0002	27.07	<0.002	0.04
		Average	<0.025	<0.0005	<0.005	<0.05	3.53	<0.0002	25.29	<0.002	0.04
39-05	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.66	<0.0002	6.98	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.46	<0.0002	5.15	<0.002	<0.02
39-06	1	Maximum	<0.025	<0.0005	<0.005	<0.05	1.53	<0.0002	12.89	<0002	<0.02
		Average	---	---	---	---	---	---	---	---	---
40-01	2	Maximum	<0.025	<0.0005	<0.005	<0.05	13.95	<0.0002	28.43	<0.002	0.64
		Average	<0.025	<0.0005	<0.005	<0.05	12.82	<0.0002	25.46	<0.002	0.56
40-02	2	Maximum	<0.025	<0.0005	<0.005	<0.05	5.02	<0.0002	4.34	0.021	0.96
		Average	<0.025	<0.0005	<0.005	<0.05	4.51	<0.0002	3.61	0.010	0.59
40-04	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.904	<0.0002	6.03	0.006	8.10
		Average	<0.025	<0.0005	<0.005	<0.05	0.841	<0.0002	3.57	0.005	7.22
47-01	2	Maximum	<0.025	<0.0005	<0.005	<0.05	3.963	<0.0002	4.39	<0.002	2.42
		Average	<0.025	<0.0005	<0.005	<0.05	2.939	<0.0002	3.98	<0.002	1.38
47-02	2	Maximum	<0.025	<0.0005	<0.005	<0.05	6.30	<0.0002	5.34	<0.002	0.84
		Average	<0.025	<0.0005	<0.005	<0.05	6.10	<0.0002	4.67	<0.002	0.74
48-01	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.322	<0.0002	4.71	<0.002	0.90
		Average	<0.025	<0.0005	<0.005	<0.05	0.266	<0.0002	3.87	<0.002	0.69
60-01	1	Maximum	<0.025	0.0006	0.022	0.12	63.44	<0.0002	17.81	0.018	0.17
		Average	---	---	---	---	---	---	---	---	---
61-03	1	Maximum	<0.025	<0.0005	0.008	0.07	35.16	<0.0002	27.48	0.044	0.10
		Average	---	---	---	---	---	---	---	---	---
All Other Wells (n = 13)	20	Maximum	<0.025	0.0009	<0.005	<0.05	0.228	<0.0002	31.97	0.014	3.20
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	6.26	<0.002	0.29
Recharge/Meadow Marsh											
58-01(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.94	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.40	<0.002	<0.02
89-01	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.349	<0.0002	3.47	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.116	<0.0002	3.28	<0.002	<0.02
100-04	2	Maximum	<0.025	0.0017	0.022	<0.05	5.50	<0.0002	5.46	0.035	1.10
		Average	<0.025	0.0017	0.016	<0.05	5.30	<0.0002	5.36	0.032	1.10
All Other Wells (n = 7)	21	Maximum	<0.025	0.0015	0.05	<0.05	0.17	<0.0002	9.78	0.025	0.036
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.27	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.5	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 41
BNL Site Environmental Report for Calendar Year 1993
Peconic River/Sewage Treatment Plant Area and Upland Recharge\Meadow Marsh Area
Ground Water Surveillance Wells, Chorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
Peconic River/STP								
All Wells (n = 27)	47	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
Upland Recharge/ Meadow Marsh								
All Wells (n = 10)	29	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
ND: Not detected.

Table 42
BNL Site Environmental Report for Calendar Year 1993
Peconic River/Sewage Treatment Plant Area and Upland Recharge/Meadow Marsh Area
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples		Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
Peconic River/STP						
All Wells (n = 27)	47	Maximum	<2	<2	<2	<2
		Average	<2	<2	<2	<2
Upland Recharge/ Meadow Marsh						
All Wells (n = 10)	29	Maximum	<2	<2	<2	<2
		Average	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Current Landfill Area: The surveillance well network at the Current Landfill consists of shallow Upper Glacial aquifer wells near the Landfill and a series of progressively deeper Upper Glacial wells downgradient of the Landfill. The Current Landfill, which ceased operations in 1990 in accordance with the Long Island Landfill Law, has been identified as a source of ground-water contamination. Permanent closure (i.e., capping) of this landfill will follow the completion of the Operable Unit I RI/FS to be conducted under the IAG. In the areas near and downgradient of the Current Landfill, twenty ground-water surveillance wells were sampled for water quality, VOCs, and metals during 1993 (Tables 43 - 46). Water quality data from wells located at the Current Landfill indicate that the pH was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.90. Although water quality parameters were within NYS AWQS, downgradient wells did detect elevated (i.e., above background) conductivity levels. Average conductivity for the upgradient Well 87-09 was 162.4 μmhos/cm, whereas the average conductivities for wells directly downgradient of the Current Landfill ranged from 231 - 1,095 μmhos/cm. Metals analyses indicate that ten surveillance wells in close proximity of the Current Landfill had average iron concentrations that exceeded the NYS DWS of 0.3 mg/L. Upgradient Well 87-09 had an average iron concentration below the typical minimum detection limit, whereas average concentrations in the downgradient wells ranged from 0.80 - 114.4 mg/L. Although there is no NYS DWS specified for sodium, sodium concentrations were elevated in downgradient wells. Upgradient Well 87-09 had an average sodium concentration of 8.6 mg/L, whereas sodium concentrations in the wells located directly downgradient of the Current Landfill ranged from 5.9 - 83.5 mg/L. Ground-water analyses for VOCs indicate that seven downgradient wells had concentrations of organic contaminants above NYS DWS during 1993. Organic contaminants were not detected in upgradient Well 87-09. Of the downgradient wells where NYS DWS were exceeded: TCA was detected at maximum concentrations of 24 μg/L in Well 115-05; DCA was detected at maximum concentrations of 6 μg/L in Well 87-07, 5 μg/L in Well 87-10, 5.5 μg/L in Well 107-08, and 110 μg/L in Well 115-05; DCE was detected in Well 115-05 at a maximum concentration of 6 μg/L; benzene was detected in Wells 87-05, 87-07, and 87-11 at maximum concentrations of 7 μg/L, 6 μg/L, and 6 μg/L, respectively; toluene was detected in Well 87-11 at a maximum concentration of 5 μg/L; and chloroethane was detected in Wells 87-10 and 87-11 at maximum concentrations of 6μg/L each.

Former Landfill: The surveillance well network monitoring the Former Landfill area consist of a total of ten shallow Upper Glacial aquifer wells. The Former Landfill area has been identified as an area contributing to soil and ground-water contamination. Permanent closure (i.e., capping) of the landfill will follow the completion of the planned OU I RI/FS to be conducted under the IAG in 1994. During 1993, ground-water samples were collected from the ten Former Landfill surveillance wells, and were analyzed for water quality, VOCs, and metals (Tables 43 - 46). Water quality data from wells upgradient and downgradient of the Former Landfill indicate that the pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.10. Metals analyses indicate that only Well 97-08 exceeded NYS DWS with a maximum observed iron concentration of 0.318 mg/L. Analyses of ground-water samples for VOCs indicate that only Well 97-02 had concentrations of organic contaminants above NYS DWS, with a maximum PCE concentration of 7.3 μg/L.

Table 43
BNL Site Environmental Report for Calendar Year 1993
Current Landfill, Former Landfill and Ash Repository
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
Current Landfill										
87-09 (a)	3	5.8 - 6.6	251.4	162.4	14.8	12	14.8	13.3	< 1.0	< 1.0
87-05	4	6.1 - 6.4	1121	950.8	81.3	58.9	14.7	11.4	< 1.0	< 1.0
87-06	4	6.3 - 6.4	899.3	781.3	44.3	32.3	10	7.3	< 1.0	< 1.0
87-07	4	6.2 - 6.5	1013.4	910.9	54.7	50.7	6.6	6.1	< 1.0	< 1.0
87-10	4	6.2 - 6.4	1455.9	1095.3	153	93.4	10.9	9.6	< 1.0	< 1.0
87-11	4	6.0 - 6.2	767	675.5	41.4	29.2	7.5	6.2	< 1.0	< 1.0
87-12	3	6.2 - 6.4	316.8	253.6	19.4	17.4	17.7	14.6	< 1.0	< 1.0
88-02	4	5.5 - 6.0	275.2	231.1	38.1	20.3	57.7	50.1	< 1.0	< 1.0
97-14	3	6.1 - 6.3	425	255.3	25.4	21.1	16.3	15	< 1.0	< 1.0
98-09	4	5.6 - 5.7	171	117.1	15.9	14.1	11.7	11.2	< 1.0	< 1.0
98-10	3	5.4 - 5.5	105	93.2	21.1	17.3	< 4.0	< 4.0	< 1.0	< 1.0
98-33	3	6.2 - 6.6	325	263.9	19.2	18.9	10.4	10.1	< 1.0	< 1.0
98-34	2	6.3 - 6.6	324	287.7	27	24.1	12.7	11.7	< 1.0	< 1.0
107-07	4	6.0 - 6.5	364	248.8	21	20	19.6	14	< 1.0	< 1.0
107-08	5	6.1 - 6.7	437	301.2	32.2	28.9	16.1	15.4	< 1.0	< 1.0
115-01	3	5.1 - 6.2	81	64.4	8.2	7.7	7.2	6.7	< 1.0	< 1.0
115-02	3	5.2 - 6.0	82	64.4	7	6.7	7.3	7.2	< 1.0	< 1.0
115-03	3	5.0 - 5.9	80	62.7	6	5.9	8.1	8	< 1.0	< 1.0
115-04	4	5.5 - 6.6	126	90.7	13.6	12.3	11.8	11.3	< 1.0	< 1.0
115-05	3	5.5 - 6.1	188	145.7	16.9	15.8	11.7	11.4	< 1.0	< 1.0
Former Landfill										
96-03 (a)	4	5.4 - 6.1	165	126.6	9.4	8.5	23.5	22.9	< 1.0	< 1.0
96-04 (a)	3	5.3 - 5.7	119.9	106.4	8.5	7.1	11.3	10.4	< 1.0	< 1.0
96-02	3	6.0 - 6.2	132	101.7	7.9	6.5	12.8	12	< 1.0	< 1.0
97-01	3	5.3 - 5.7	59	53.9	7.3	7	9.2	8.7	< 1.0	< 1.0
97-02	2	5.4 - 5.6	72	60.3	6	5.4	8.8	8.3	< 1.0	< 1.0
97-03	3	6.6 - 7.0	506	287.3	9.2	8.9	39.6	29.3	4.4	1.5
97-05	3	5.6 - 5.8	215	154.2	5.9	5.6	12.6	12.4	2.8	2.2
97-08	2	6	54	50.1	4.9	4.8	8.3	8.2	< 1.0	< 1.0
106-02	3	5.8 - 5.9	228	173.1	9	8.5	23.9	23.6	1.7	1.6
106-04	2	5.8 - 6.2	81	75	5.7	5.1	10.1	10	< 1.0	< 1.0
Ash Repository										
104-01	3	5.8 - 6.2	140	131	17.7	16.5	11.1	10.5	<1.0	<1.0
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit
(a): Upgradient Well
(b): Holding time expired for all samples.
(c): No standard specified.

Table 44
BNL Site Environmental Report for Calendar Year 1993
Current Landfill, Former Landfill, and Ash Repository
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
Current Landfill											
87-09(a)	4	Maximum	<0.025	<0.0005	<0.005	<0.05	0.170	<0.0002	10.87	0.004	0.03
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.60	<0.002	<0.02
87-05	4	Maximum	<0.025	<0.0005	<0.005	<0.05	85.25	<0.0002	56.45	0.012	0.39
		Average	<0.025	<0.0005	<0.005	<0.05	59.45	<0.0002	40.39	0.004	0.23
87-06	4	Maximum	<0.025	<0.0005	<0.005	<0.05	57.08	<0.0002	28.49	0.003	0.19
		Average	<0.025	<0.0005	<0.005	<0.05	49.77	<0.0002	22.22	<0.002	0.16
87-07	4	Maximum	<0.025	<0.0005	<0.005	<0.05	53.83	<0.0002	36.53	0.003	0.04
		Average	<0.025	<0.0005	<0.005	<0.05	48.09	<0.0002	34.19	<0.002	0.03
87-10	4	Maximum	<0.025	<0.0005	<0.005	<0.05	132.00	<0.0002	132.20	0.003	0.09
		Average	<0.025	<0.0005	<0.005	<0.05	114.36	<0.0002	83.48	<0.002	0.03
87-11	4	Maximum	<0.025	<0.0005	<0.005	<0.05	62.56	<0.0002	29.38	0.004	0.04
		Average	<0.025	<0.0005	<0.005	<0.05	42.72	<0.0002	20.16	<0.002	0.02
87-12	3	Maximum	<0.025	<0.0005	<0.005	<0.05	23.50	<0.0002	15.87	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	19.71	<0.0002	14.64	<0.002	<0.02
88-02	4	Maximum	<0.025	<0.0005	<0.005	<0.05	7.80	<0.0002	27.59	0.004	0.62
		Average	<0.025	<0.0005	<0.005	<0.05	6.22	<0.0002	10.13	<0.002	0.48
98-10	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.801	<0.0002	10.13	<0.002	0.06
		Average	<0.025	<0.0005	<0.005	<0.05	0.417	<0.0002	9.87	<0.002	0.04
All Other Wells (n = 11)	40	Maximum	<0.025	<0.0005	<0.005	<0.05	0.134	<0.0002	25.13	0.005	0.07
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	12.98	<0.002	<0.02
Former Landfill											
96-03(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.53	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.64	<0.002	<0.02
96-04(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.92	0.002	0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	4.73	<0.002	<0.02
97-08	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.318	<0.0002	4.22	<0.002	0.04
		Average	<0.025	<0.0005	<0.005	<0.05	0.190	<0.0002	3.18	<0.002	0.03
All Other Wells (n = 7)	33	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	18.11	0.006	0.07
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	6.36	<0.002	<0.02
Ash Repository											
104-01	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.83	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.68	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5
Typical MDL			0.025	0.0005	0.005	0.5	0.075	0.0002	1	0.0002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 45
BNL Site Environmental Report for Calendar Year 1993
Current Landfill and Former Landfill Areas
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
Current Landfill								
87-09(a)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
87-07	3	Maximum	<2	<2	<2	6.0	<2	<2
		Average	<2	<2	<2	5.3	<2	<2
87-10	3	Maximum	<2	<2	<2	5.0	<2	<2
		Average	<2	<2	<2	3.3	<2	<2
107-08	4	Maximum	<2	<2	<2	5.5	<2	27.0
		Average	<2	<2	<2	4.9	<2	6.8
115-04	4	Maximum	24.0	3.5	2.2	<2	3.5	3.6
		Average	14.0	<2	<2	<2	<2	2.7
115-05	3	Maximum	<2	<2	<2	110.0	6.0	<2
		Average	<2	<2	<2	96.0	5.2	<2
All Other Wells	39	Maximum	<2	<2	<2	3.0	<2	6.5
(n = 14)		Average	<2	<2	<2	<2	<2	<2
Former Landfill								
96-03(a)	3	Maximum	2.0	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
96-04(a)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
97-02	3	Maximum	3.4	<2	7.3	<2	<2	11.0
		Average	2.2	<2	4.4	<2	<2	6.8
All Other Wells	21	Maximum	<2	<2	<2	<2	<2	3.6
(n = 7)		Average	<2	<2	<2	<2	<2	<2
Ash Repository								
104-01	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient Well.

Table 46
BNL Site Environmental Report for Calendar Year 1993
Current Landfill, Former Landfill, and Ash Repository
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples		Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
Current Landfill						
87-09(a)	3	Maximum	<2	<2	<2	<2
		Average	<2	<2	<2	<2
87-05	3	Maximum	7.0	<2	<2	<2
		Average	5.3	<2	<2	<2
87-07	3	Maximum	6.0	<2	<2	<2
		Average	5.0	<2	<2	<2
87-11	3	Maximum	6.0	<2	5.0	<2
		Average	4.3	<2	<2	<2
All Other Wells	47	Maximum	4.0	<2	<2	<2
(n = 16)		Average	<2	<2	<2	<2
Former Landfill						
All Wells	30	Maximum	<2	<2	<2	<2
(n = 10)		Average	<2	<2	<2	<2
Ash Repository						
104-01	3	Maximum	<2	<2	<2	<2
		Average	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Ash Repository Area: The Ash Repository area is monitored by a single downgradient shallow Upper Glacial aquifer well. The Ash Repository area has been identified as an area potentially contributing to soil and ground-water contamination, and investigated during the OU I RI/FS to be conducted under the 1994. During 1993, ground-water samples were collected from the Ash Repository surveillance well and analyzed for water quality, VOCs, and metals (Tables 43 - 46). Water quality data from Well 104-01 indicate that the pH was typically below the lower limit of the NYS AWQS of 6.5 -8.5, with a median pH of 6.0. The remaining water quality parameters, metals, and VOC concentrations were below the applicable NYS AWQS and DWS.

Hazardous Waste Management Facility Area: At the HWMF, the ground-water surveillance well network consists of shallow Upper Glacial aquifer wells located near the facility and progressively deeper Upper Glacial wells extending out from the facility in the direction of ground-water flow. Soil and ground-water contamination has been found within the HWMF and recent investigations have indicated that ground-water contamination extends from this facility downgradient to an area south of the Long Island Expressway. The full extent of soil and ground-water contamination in this area will be investigated during the OU I RI/FS to be conducted under the IAG during 1994. During 1993, 32 HWMF surveillance wells were monitored for ground-water quality, metals, and VOCs (Tables 47 - 50). Water quality data indicate that the pH was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.10. All other water quality parameters were below the applicable NYS AWQS. Metals analyses of ground water from Wells 98-04, 99-01, and 99-02 indicate that Fe was detected at concentrations above NYS DWS, at 2.28 mg/L, 3.50 mg/L, and 3.29 mg/L, respectively. Also, Pb, Zn, and Ag were detected above NYS DWS in four wells, with Pb detected in Well 99-02 at 0.018; Ag detected in Wells 98-30 and 98-32 at 0.075 mg/L each, and Zn detected in Wells 98-36 and 99-02 at 16.2 mg/L and 24.8 mg/L, respectively. Of the 32 HWMF surveillance wells, 8 wells had VOC concentrations above NYS DWS at least once during 1993. No VOCs were detected in the upgradient Well 88-01 during 1993. Of the surveillance wells within and downgradient of the HWMF in which NYS DWS were exceeded: TCA was detected (maximum values observed) in Well 88-04 (8 μg/L), Well 98-21 (45 μg/L), Well 107-09 (6 μg/L), Well 107-13 (10 μg/L), Well 108-12 (10 μg/L), Well 108-13 (11 μg/L), and Well 108-14 (19 μg/L); PCE was detected in Well 88-04 (39 μg/L), Well 98-21 (8.1 μg/L) and Well 98-22 (5 μg/L); and DCA was detected in Well 98-22 at a maximum observed concentration of 25 μg/L.

Central Steam Facility/Major Petroleum Facility Area: The surveillance well networks at the CSF and MPF consist of a total of 27 shallow, three middle and two deep Upper Glacial aquifer wells. The MPF is the holding area for most fuels used at the CSF. The five shallow wells monitoring the MPF were installed as part of the licensing requirements for this facility, and are screened across the water table to allow for the detection of free product (i.e., oil floating on top of the ground water). The surveillance wells at the CSF were installed primarily to monitor ground-water contamination resulting from a 1977 fuel oil/solvent leak at this facility. The CSF/MPF area is the subject of an on going RI/FS (OU IV) which started in the Fall of 1992 under the IAG. At the CSF and MPF area, 16 of 32 surveillance wells were monitored for water quality, while all 32 were monitored for metals, VOCs (Tables 51 - 54). Additionally, the five MPF wells were sampled for floating petroleum products during 1993. Water

Table 47
BNL Site Environmental Report for Calendar Year 1993
Hazardous Waste Management Facility
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
HWMF										
88-01 (a)	3	6.9 - 7.2	464	334.3	40.7	23.2	20.3	25.5	< 1.0	< 1.0
88-03	3	5.4 - 5.5	102	76.3	6.4	5.3	11.2	9.4	< 1.0	< 1.0
88-04	3	5.9 - 6.1	227	149.5	4.6	< 4.0	31.5	29.1	1.1	< 1.0
88-05	1	5.8	190	190	10.1	10.1	9.6	9.6	< 1.0	< 1.0
98-04	2	5.7 - 6.4	216	163	6.2	6.1	28.2	17	3.3	2.3
98-07	3	5.7 - 6.3	131	99.6	13.7	11.5	13.4	11.5	< 1.0	< 1.0
98-19	2	5.6 - 5.7	97	92	11.1	10.6	14	12	< 1.0	< 1.0
98-21	2	5.4 - 6.1	102	99.6	13	10	17.6	16.2	< 1.0	< 1.0
98-22	3	6.0 - 6.5	215	146.2	10.8	9.9	11.6	11.4	< 1.0	< 1.0
98-30	2	5.5 - 5.9	80.2	80.1	10.7	10.5	12.9	12.6	< 1.0	< 1.0
98-32	2	5.7 - 6.0	80.3	79.7	11.1	11	12.4	12.3	< 1.0	< 1.0
98-36	2	6.1 - 6.4	99	79	8.2	7.6	9.5	9.5	< 1.0	< 1.0
98-42	1	5.4	86	86	10.1	10.1	14.3	14.3	< 1.0	< 1.0
99-01	2	6.4 - 6.5	140	129	7.4	7.3	12.9	12.7	< 1.0	< 1.0
99-02	1	6.5	100	100	7.6	7.6	9.6	9.6	< 1.0	< 1.0
99-04	2	6.1 - 6.7	97	89.5	11.5	11.2	12.6	11.8	< 1.0	< 1.0
107-09	5	6.2 - 6.9	137	101	12.1	11.6	12	11.7	< 1.0	< 1.0
107-10	3	5.3 - 6.8	128	99.7	11.3	11.7	12.6	12.1	< 1.0	< 1.0
107-11	3	6.3 - 6.5	126	102	12.2	10	11.8	11.3	< 1.0	< 1.0
107-12	3	5.7 - 5.9	123	103	11.8	10.5	12.5	12.4	< 1.0	< 1.0
107-13	3	6.1 - 6.8	130	102.5	12.3	11.6	11.8	11.6	< 1.0	< 1.0
107-14	3	5.5 - 6.3	121	97.2	11.9	10.5	11.9	11.7	< 1.0	< 1.0
108-01	2	5.1 - 6.1	84.1	83.1	11.1	11	13	12.9	< 1.0	< 1.0
108-03	2	5.4 - 5.8	89	85.7	10.8	10.7	14.1	13.4	< 1.0	< 1.0
108-05	2	5.1 - 5.8	79.6	79.3	10.4	10.4	13.4	12.9	< 1.0	< 1.0
108-07	3	5.4 - 6.1	120	129.8	11.4	10.9	11.5	11.2	< 1.0	< 1.0
108-08	2	5.8	102	90.4	12	11	10.4	10.3	< 1.0	< 1.0
108-12	3	5.2 - 6.1	139	106.9	10.9	10.8	13.6	12.8	< 1.0	< 1.0
108-13	3	5.2 - 6.1	106	83.4	10.1	9.4	11.7	11.2	< 1.0	< 1.0
108-14	3	5.6 - 6.4	133	103.9	11.8	11.6	13.4	13	< 1.0	< 1.0
108-17	3	4.9 - 6.1	121	94.5	11	10.7	9.6	9.4	< 1.0	< 1.0
108-18	3	5.9 - 6.9	146	118.6	10.8	10.7	7.7	7.1	1.2	< 1.0
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 48
BNL Site Environmental Report for Calendar Year 1993
Hazardous Waste Management Facility Area
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
HWMF								
88-01(a)	2	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
88-04	3	Maximum	8.0	<2	39.0	<2	<2	<2
		Average	7.1	<2	35.0	<2	<2	<2
98-21	3	Maximum	45.0	<2	8.1	<2	2.2	<2
		Average	15.0	<2	2.7	<2	<2	<2
98-22	3	Maximum	<2	<2	8.1	25.0	<2	<2
		Average	<2	<2	2.7	13.3	<2	<2
107-09	5	Maximum	6.0	<2	<2	<2	<2	<2
		Average	2.6	<2	<2	<2	<2	<2
107-13	3	Maximum	10.0	3.0	2.8	<2	<2	<2
		Average	6.3	2.2	<2	<2	<2	<2
108-12	2	Maximum	10.0	2.7	2.9	<2	<2	<2
		Average	5.0	<2	2.4	<2	<2	<2
108-13	3	Maximum	11.0	2.6	2.6	<2	<2	<2
		Average	3.7	<2	<2	<2	<2	<2
108-14	3	Maximum	19.0	3.8	3.9	<2	<2	3.0
		Average	11.0	3.0	2.8	<2	<2	2.5
All Other Wells	63	Maximum	4.4	4.0	4.0	<2	<2	4.0
(n = 23)		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient well.

Table 49
BNL Site Environmental Report for Calendar Year 1993
Hazardous Waste Management Area
Ground Water Surveillance Wells, Metals Data

Location (a)	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
88-01(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.278	<0.0002	20.63	0.005	2.38
		Average	<0.025	<0.0005	<0.005	<0.05	0.241	<0.0002	11.86	<0.002	1.08
98-04	3	Maximum	<0.025	<0.0005	<0.005	<0.05	2.28	<0.0002	5.13	0.007	2.30
		Average	<0.025	<0.0005	<0.005	<0.05	2.169	<0.0002	4.84	0.003	2.07
98-30	4	Maximum	0.075	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.23	0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.02	<0.002	<0.02
98-32	4	Maximum	0.075	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.74	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.32	<0.002	<0.02
98-36	3	Maximum	<0.025	<0.0005	<0.005	<0.05	0.097	<0.0002	4.70	0.002	16.30
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	4.60	<0.002	8.55
99-01	2	Maximum	<0.025	0.0007	<0.005	<0.05	3.50	<0.0002	5.98	<0.002	2.66
		Average	<0.025	0.0006	<0.005	<0.05	2.12	<0.0002	5.75	<0.002	1.68
99-02	3	Maximum	<0.025	0.0013	<0.005	<0.05	3.29	<0.0002	5.75	0.018	24.80
		Average	<0.025	0.0006	<0.005	<0.05	3.13	<0.0002	5.04	0.009	16.29
All Other Wells (n = 25)	83	Maximum	<0.025	0.0005	0.024	<0.05	0.125	<0.0002	11.59	0.004	0.17
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.08	<0.002	<0.02
NYS DWS		Maximum	0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5.0
Typical MDL		Maximum	0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 50
BNL Site Environmental Report for Calendar Year 1993
Hazardous Waste Management Area
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
All Wells	88	4.2	<2	<2	3.4
(n = 31)		<2	<2	<2	<2
NYS DWS		5.0	5.0	5.0	5.0
Typical MDL		2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Table 51
BNL Site Environmental Report for Calendar Year 1993
Major Petroleum Facility/Central Steam Facility
Building 650 and Building 650 Outfall
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
MPF										
66-08 (a)	3	5.8 - 6.1	152.1	118	18.9	10.4	16.8	16.1	1.9	1.7
76-16	2	5.3 - 5.4	151.6	143	8.2	7.4	20.1	19.2	7.8	7.4
76-17	2	5.5 - 5.7	148.8	147.7	8.5	7.6	31.7	27.5	5.5	4.3
76-18	2	5.8 - 6.1	106.3	104.6	4.5	< 4.0	18.4	17.6	2.3	2.2
76-19	1	6.1	149.8	149.8	8.9	8.9	22.9	22.9	< 1.0	< 1.0
CSF										
76-24 (a)	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-02	2	6.7 - 6.8	124.1	116.6	18.8	13.2	12.6	11	< 1.0	< 1.0
76-04	2	6.2 - 6.3	173.5	172.7	20.7	18.4	10.7	10.6	< 1.0	< 1.0
76-05	2	6.1 - 6.2	185.1	182.1	20.6	17.8	25.6	21.6	2.2	2
76-06	2	6.2	287.3	282.2	38	32.6	36.9	29.3	1.9	1.6
76-07	2	6.3	116	111.2	18.7	18	11.6	10.7	< 1.0	< 1.0
76-08	2	6.2 - 6.5	164.6	140.5	12.1	11	15.6	12.9	1.5	< 1.0
76-09	2	5.7 - 6.0	170	159.9	15	14.6	30.9	22.6	1.2	1.1
76-10	2	6.0 - 6.1	150	138.3	7.6	7.5	23.7	22.5	2.3	2.2
76-20	2	6.0	203.9	165	18.1	17.5	25.2	21.6	3.2	2.5
76-21	2	6.2 - 6.3	104.3	98.2	6.8	6.5	11.3	10.5	1.6	< 1.0
76-22	2	6.3 - 6.4	118	114.8	17.7	15.3	14.2	12.5	< 1.0	< 1.0
76-23	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-29	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
77-02	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
77-03	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-02	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-03	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-04	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-05	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-06	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
86-09	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Building 650 and Outfall										
66-20 (a)	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-01	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-15	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-16	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-17	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-18	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
66-19	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-25	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-26	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-27	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
76-28	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 52
BNL Site Environmental Report for Calendar Year 1993
Major Petroleum Facility, Central Steam Facility, and Bldg. 650
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
Major Petroleum Facility											
All Wells	19	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.93	0.011	<0.02
(n = 5)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	10.19	<0.002	<0.02
Central Steam Facility											
76-24(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.40	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.55	<0.002	<0.02
76-04	4	Maximum	<0.025	<0.0005	<0.005	<0.05	10.10	<0.0002	9.89	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	9.24	<0.0002	9.15	<0.002	<0.02
76-06	4	Maximum	<0.025	<0.0005	<0.005	<0.05	2.267	<0.0002	25.92	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.940	<0.0002	21.32	<0.002	<0.02
76-21	4	Maximum	<0.025	<0.0005	<0.005	<0.05	5.48	<0.0002	5.29	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	3.51	<0.0002	4.42	<0.002	<0.02
76-29	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.368	<0.0002	28.50	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.311	<0.0002	18.93	<0.002	<0.02
77-03	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.798	<0.0002	8.57	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.738	<0.0002	8.16	<0.002	<0.02
86-03	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.639	<0.0002	12.00	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.501	<0.0002	11.85	<0.002	<0.02
All Other Wells	50	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	27.70	<0.002	0.03
(n = 17)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.79	<0.002	<0.02
Bldg. 650											
66-20(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.05	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	6.18	<0.002	<0.02
66-01	2	Maximum	<0.025	<0.0005	<0.005	<0.05	90.30	<0.0002	16.00	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	80.75	<0.0002	15.35	<0.002	<0.02
All Other Wells	18	Maximum	<0.025	0.0006	<0.005	<0.05	0.213	<0.0002	17.80	<0.002	<0.02
(n = 9)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	12.98	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 53
BNL Site Environmental Report for Calendar Year 1993
Building 650, Major Petroleum Facility, and Central Steam Facility
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
Bldg. 650								
66-20(a)	2	Maximum	<1	<1	<1	<1	<1	<1
		Average	<1	<1	<1	<1	<1	<1
76-26	2	Maximum	8.5	<1	<1	<1	<1	<1
		Average	6.8	<1	<1	<1	<1	<1
76-28	2	Maximum	5.1	<1	<1	<1	<1	<1
		Average	4.0	<1	<1	<1	<1	<1
All Other Wells (n = 8)	16	Maximum	3.0	<1	<1	<1	<1	<1
		Average	<1	<1	<1	<1	<1	<1
Major Petroleum Facility								
66-08(a)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
76-18	4	Maximum	<2	<2	6.0	<2	<2	<2
		Average	<2	<2	3.0	<2	<2	<2
All Other Wells (n = 3)	12	Maximum	<2	<2	2.0	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
Central Steam Facility								
76-24(a)	2	Maximum	<1	<1	<1	<1	<1	<1
		Average	<1	<1	<1	<1	<1	<1
76-04	4	Maximum	21.0	28.0	47.0	<2	<2	<2
		Average	15.6	19.8	35.5	<2	<2	<2
76-05	4	Maximum	<2	<2	17.0	<2	<2	<2
		Average	<2	<2	11.8	<2	<2	<2
76-08	4	Maximum	7.0	5.0	28.0	<2	<2	<2
		Average	<2	2.2	17.2	<2	<2	<2
76-21	4	Maximum	5.0	6.0	35.0	<2	<2	<2
		Average	<2	<2	19.4	<2	<2	<2
76-23	2	Maximum	<1	<1	10.0	<1	<1	<1
		Average	<1	<1	9.1	<1	<1	<1
All Other Wells (n = 18)	50	Maximum	<2	<2	4.9	<2	<2	3.0
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient Well.

Table 54
BNL Site Environmental Report for Calendar Year 1993
Building 650, Major Petroleum Facility, and Central Steam Facility
Ground Water Surveillance Wells, BETX Data

Location		No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
Bldg. 650						
66-20(a)	Maximum	2	<1	<1	<1	<1
	Average		<1	<1	<1	<1
66-01	Maximum	2	<1	<1	5.0	<1
	Average		<1	<1	2.5	<1
All Other Wells (n = 9)	Maximum	18	<1	<1	<1	<1
	Average		<1	<1	<1	<1
Major Petroleum Facility						
All Wells (n = 5)	Maximum	19	<2	<2	<2	<2
	Average		<2	<2	<2	<2
Central Steam Facility						
76-24(a)	Maximum	2	<1	<1	<1	<1
	Average		<1	<1	<1	<1
76-04	Maximum	4	<2	590.0	2700.0	2200.0
	Average		<2	495.0	1911.0	1940.0
76-08	Maximum	4	<2	12.0	<2	339.0
	Average		<2	3.4	<2	159.0
76-21	Maximum	4	<2	150.0	<2	470.0
	Average		<2	47.6	<2	135.0
All Other Wells (n = 20)	Maximum	56	<2	<2	<2	<2
	Average		<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.

quality data indicate that pH was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.10. Other water quality parameters were below the applicable NYS AWQS. Results from metals analyses ofground-water samples indicate that most metals concentrations were below the applicable NYS DWS, except for elevated iron concentrations detected in samples from Wells 76-04 (10.10 mg/L), 76-06 (2.27 mg/L), 76-21 (5.48 mg/L), 76-29 (0.37 mg/L), 77-03 (0.79 mg/L), and 86-03 (0.63 mg/L). Analyses for VOCs in ground-water samples from the five wells monitoring the MPF indicated that VOCs were present above NYS DWS only in Well 76-18 with PCE observed at a maximum observed concentration of 6 μg/L. No BETX compounds were detected. The five surveillance wells at the MPF were examined for floating petroleum products on a monthly basis. As with previous years, no floating petroleum products were observed during 1993. Of the twenty-four CSF surveillance wells sampled during 1993, five wells had VOCs at concentrations above NYS DWS: TCA was detected in Wells 76-04, 76-08, and 76-21 at maximum concentrations of 21 μg/L, 7 μg/L, and 5 μg/L, respectively; TCE was detected in Wells 76-04, 76-08, and 76-21 at maximum concentrations of 28 μg/L, 5 μg/L, and 6 μg/L, respectively; PCE was detected in Wells 76-04, 76-05, 76-08, 76-21, and 76-23 at maximum concentrations of 47 μg/L, 17 μg/L, 28 μg/L, 35 μg/L, and 10 μg/L, respectively; ethylbenzene was detected in Wells 76-04, 76-08, and 76-21 at maximum concentrations of 590 μg/L and 12 μg/L, and 150 μg/L, respectively; Toluene was detected in Well 76-04 at a maximum concentration of 2,700 μg/L; xylene (total) was detected in Wells 76-04, 76-08, and 76-21 at concentrations of 2,200 μg/L, 399 μg/L, and 470 μg/L, respectively; 1,2-dichlorobenzene in Well 76-04 at 12 μg/L; and Naphthalene in Well 76-04 at 59 μg/L.

Building 650: The surveillance well network at Building 650 and the 650 Outfall area consists of 11 shallow Upper Glacial aquifer wells. Ten of these wells were installed in 1993 as part of the OU IV RI/FS. Building 650 was utilized as a decontamination facility for the removal of radioactivity from clothing and heavy equipment. Drainage from an exterior heavy equipment decontamination pad led to a natural depression approximately 800 feet to the northeast of Building 650 (known as the Building 650 Sump Outfall), near AGS Recharge Basin HO. The full extent of soil and ground-water contamination resulting from operations at Building 650 is presently being evaluated as part of the OU IV RI/FS. During 1993, ground-water samples were collected from the eleven surveillance wells, and were analyzed for metals and VOCs. Metals analyses indicate that Fe concentrations exceed NYS DWS in Well 66-01 (a well constructed of carbon steel casings), with a maximum observed concentration of 90.30 mg/L. Ground-water samples from all other wells showed metals concentrations below NYS DWS. Volatile Organic Compounds were detected in ground-water samples from two wells located directly downgradient of Building 650. The TCA was detected at concentrations exceeding NYS DWS in Well 76-26 (8.5 μg/L) and in Well 76-28 (5.1 μg/L). In the Building 650 Sump Outfall area, Toluene was detected in Well 66-01 at the NYS DWS of 5 μg/L. Volatile Organic Compounds were not detected in samples from any other well in the 650 Sump Outfall area.

Alternating Gradient Synchrotron Area: The surveillance well network for the AGS area consists of 11 shallow Upper Glacial aquifer wells which primarily monitor ground water near and downgradient of the AGS Bubble Chamber spill areas and the AGS Booster facility. The Bubble Chamber area, which has been the

Table 55
BNL Site Environmental Report for Calendar Year 1993
AGS, Linac, and RHIC
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
AGS										
44-01 (a)	3	5.2 - 5.7	97	90	9.2	4.7	17.8	16.7	1.6	< 1.0
44-02 (a)	3	5.0 - 5.8	69.4	60.5	< 4.0	< 4.0	11	10.4	< 1.0	< 1.0
54-01	1	6.4	174.1	174.1	20.3	20.3	13.4	13.4	< 1.0	< 1.0
54-02	1	6.5	67.6	67.6	9.1	9.1	7.5	7.5	< 1.0	< 1.0
54-05	2	5.7 - 5.8	134.7	124.5	4.3	< 4.0	28.2	26.2	1.8	< 1.0
54-06	3	6.1 - 6.2	275.9	248.9	16.1	12.4	37.1	30.7	2.2	1.8
54-07	1	6.8	200	200	10.9	10.9	20.7	20.7	2.4	2.4
54-08	2	6.1	194	155.1	30.6	22.1	11.4	10.4	< 1.0	< 1.0
64-01	3	5.9	244.4	177.1	38.9	23.9	21.9	19.6	2.4	1.4
64-02	2	6.1 - 6.3	278	258	24.2	21.8	23.7	23	3.4	3.4
64-03	2	5.9 - 6.2	161	155.1	10.8	10.5	16.2	16	4.5	3.8
LINAC										
53-01 (a)	1	5.6	75.4	75.4	6.7	6.7	6.4	6.4	< 1.0	< 1.0
53-02 (a)	1	5.6	60.3	60.3	7.1	7.1	9	9	< 1.0	< 1.0
54-03	3	6.4 - 6.5	448	256.2	16.2	15.5	155.6	68.8	< 1.0	< 1.0
RHIC										
37-01	2	5.1 - 5.3	77.8	77.2	5.5	5.2	12.4	11.7	1.1	< 1.0
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

NA: Analysis Not Available.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 56
BNL Site Environmental Report for Calendar Year 1993
AGS, Linac, and RHIC
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
AGS											
44-01(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	5.35	<0.002	<0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	3.78	<0.002	<0.02
44-02(a)	3	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	2.75	<0.002	0.03
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	2.39	<0.002	<0.02
54-01	1	Maximum	<0.025	0.0010	<0.005	<0.05	0.976	<0.0002	8.69	<0.002	8.55
		Average	---	----	---	---	---	---	---	---	---
54-02	1	Maximum	<0.025	<0.0005	<0.005	<0.05	0.386	<0.0002	6.22	<0.002	0.05
		Average	---	----	---	---	---	---	---	---	---
All Other Wells	16	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	18.35	<0.002	0.02
(n = 7)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	11.12	<0.002	<0.02
Linac											
All Wells	5	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	26.91	<0.002	0.03
(n = 3)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	15.66	<0.002	0.03
RHIC											
37-01	2	Maximum	<0.025	0.0006	<0.005	<0.05	<0.075	<0.0002	2.66	<0.002	0.02
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	1.33	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 57
BNL Site Environmental Report for Calendar Year 1993
AGS, Linac, and RHIC
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
AGS								
44-01(a)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
44-02(a)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
54-07	1	Maximum	8.0	<2	<2	<2	<2	<2
		Average	---	---	---	---	---	---
64-03	2	Maximum	32.0	<2	<2	9.0	<2	<2
		Average	29.0	<2	<2	7.5	<2	<2
All Other Wells (n = 7)	14	Maximum	3.0	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
Linac								
All Other Wells (n = 3)	3	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
RHIC								
37-01	2	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient Well.

Table 58
BNL Site Environmental Report for Calendar Year 1993
AGS, Linac, and RHIC
Ground Water Surveillance Wells, BETX Data

Location		No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
AGS						
All Wells	Maximum	23	<2	<2	<2	<2
(n = 11)	Average		<2	<2	<2	<2
Linac						
All Wells	Maximum	3	<2	<2	<2	<2
(n = 3)	Average		<2	<2	<2	<2
RHIC						
37-01	Maximum	2	<2	<2	<2	<2
	Average		<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

location of numerous accidental chemical releases to the environment, will be the subject of a RI/FS (OU III) conducted under the IAG. During 1993, three surveillance wells were installed at the AGS Booster in order to monitor potential impacts of this facility on ground water. During 1993, ground-water samples were collected from the 11 AGS area surveillance wells, and were analyzed for water quality, VOCs, and metals (Tables 55 -58). Water quality analyses indicate that the pH of the ground-water samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.90. Other water quality parameters were below the applicable NYS AWQS. Results for metals analyses indicated that except for elevated iron and zinc concentrations in samples collected from Wells 54-01 and 54-02, all metals were at concentrations below the applicable NYS DWS. Metals analyses from Wells 54-01 and 54-02 (both older wells constructed of carbon steel casings) indicate above NYS DWS for iron (0.98 mg/L and 0.39 mg/L, respectively), and zinc in Well 54-01 (8.55 mg/L). Analyses for VOCs in ground-water samples collected from this area indicate that TCA and DCA were detected in concentrations that exceeded NYS DWS. The TCA was detected above NYS DWS in Wells 54-07 and 64-03 at maximum concentrations of 8 μg/L and 32 μg/L, respectively. DCA was also detected in Well 64-03, at a maximum concentration of 9 μg/L. The TCA detected in Well 54-07 is likely to have originated from the Bubble Chamber Spill area, whereas the TCA and DCA detected in Well 64-03 may have originated from cesspools associated with Buildings 914 and 919, which are located directly upgradient of this well. The contents of these cesspools have been investigated under the IAG (Cesspools EE/CA) and have been shown to contain VOCs at levels in exceedance of NYS Soil Cleanup Guidelines. The extent of ground-water contamination will be examined during the OU III RI/FS.

Waste Concentration Facility Area: The surveillance well network monitoring the WCF consists of six shallow Upper Glacial aquifer wells. Soil and ground-water contamination at the WCF area has been confirmed, and the WCF area will be the subject of a RI/FS (OU II) conducted under the IAG. At the WCF (D-Tanks area), three downgradient surveillance wells were sampled during 1993 (Tables 59 - 62). Water quality analyses indicate that the pH of the ground-water samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.15. Other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground water from this area indicated that all metals were below the applicable NYS DWS. Analysis for VOCs in ground-water samples indicate TCA at concentrations exceeding NYS DWS in Wells 65-02 (9 μg/L) and 65-06 (18 μg/L). Based upon ground-water flow directions, the TCA detected in Well 65-06 (the upgradient well from this facility) is likely to have originated from an unidentified source located to the north-northwest of the WCF.

Building 830 Area: The surveillance well network near Building 830 consists of three shallow Upper Glacial aquifer wells which were installed to investigate the effects of a radioactive waste pipe line leak. The full extent of soil and ground-water contamination in this area will be assessed during a RI/FS (OU III) to be conducted under the IAG. During 1993, ground-water samples were collected from the three Building 830 area surveillance wells, and were analyzed for water quality, VOCs, and metals (Tables 59 - 62). Water quality analyses indicate that the pH of the ground-water samples collected was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of

6.20. Other water quality parameters were below the applicable NYS AWQS. Results from metals and VOC analyses of ground-water samples indicate that all metals and VOC concentrations were below the applicable NYS DWS.

Photography and Graphic Arts (T-111) Area: The surveillance well network near the P&GA area consists of two shallow Upper Glacial aquifer wells which were installed to investigate the effects of reported spillage of TCE near former Building T-111. Soil and ground-water contamination will be assessed during the OU III RI/FS to be conducted under the IAG. During 1993, ground-water samples were collected from the P&GA area surveillance wells, and were analyzed for water quality, VOCs, and metals (Tables 59 - 62). Water quality analyses indicate that the pH of the ground-water samples collected was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.25. Other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground-water samples from this area indicate that all metals concentrations were below the applicable NYS DWS. Analyses for VOCs in ground-water samples indicate that only TCA was detected, with maximum TCA concentrations of 5 μg/L and 6 μg/L detected in Wells 75-01 and 75-02, respectively.

Water Treatment Plant Area: During 1993, five ground-water surveillance wells were installed at the Water Treatment Plant in order to assess potential leaching of suspended Fe from the plant's recharge basins into the ground water. Naturally high levels of Fe in ground water are removed at the WTP, and the sequestered Fe is discharged to the recharge basins. During 1993, a single round of ground-water samples were collected from the WTP surveillance wells, and were analyzed for water quality, VOCs, and metals (Tables 59 - 62). Water quality analyses indicate that the pH of the ground-water samples collected from upgradient wells was typically slightly below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.85, whereas the pH was within limits in wells directly downgradient of the basins. Other water quality parameters were below the applicable NYS AWQS. Results from metals and VOC analyses of ground-water samples from this area indicate that all metals and VOC concentrations were below the applicable NYS DWS.

Table 59
BNL Site Environmental Report for Calendar Year 1993
Waste Concentration Facility, Building 830
Photography and Graphic Arts and the Water Treatment Plant
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
WCF										
65-06 (a)	2	6.2 - 6.3	263.7	253.4	15.8	14.8	27.1	25	3.8	3.3
65-01	3	5.9 - 6.2	285	221.3	26	22.5	9.6	5.1	< 1.0	< 1.0
65-02	3	6.3	311.6	275.8	35.6	25.4	6.4	3.9	< 1.0	< 1.0
65-03	3	6.0 - 6.4	281	252.6	31.8	25	3.1	2.6	< 1.0	< 1.0
65-04	3	5.8 - 6.0	267.9	261.3	32	29.6	4.5	3.2	1.8	< 1.0
65-05	3	6.1 - 6.5	251	231	34.1	30.6	4.5	1.5	2.2	1.8
Building 830										
66-07 (a)	2	6.0 - 6.1	125.4	123.6	17.4	16.6	13.4	13.2	< 1.0	< 1.0
66-08	3	5.8 - 6.1	152.1	118	18.9	10.7	16.8	16.1	1.9	1.7
66-09	3	6.3 - 6.6	127.6	121	19	17.2	14.6	14.2	< 1.0	< 1.0
P&GA										
75-01	2	6.1 - 6.3	224	214.5	30.9	24.8	23.7	22.3	2.4	2.3
75-02	2	6.1 - 6.4	364.2	314.6	49.9	36.8	34.8	33.3	3	2.8
WTP										
63-01 (a)	1	5.8	160.8	160.8	42.3	42.3	7.9	7.9	< 1.0	< 1.0
63-02 (a)	1	5.9	130.3	130.3	14.5	14.5	11.5	11.5	< 1.0	< 1.0
63-03	1	6.6	179.4	179.4	13.6	13.6	13	13	< 1.0	< 1.0
73-01	1	6.9	197.3	197.3	21.6	21.6	12	12	< 1.0	< 1.0
73-02	1	6.7	171.6	171.6	15.6	15.6	11.2	11.2	< 1.0	< 1.0
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 60
BNL Site Environmental Report for Calendar Year 1993
Miscellaneous Areas of BNL Site
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
WCF											
All Wells	18	Maximum	<0.025	<0.0005	<0.005	<0.05	0.161	<0.0002	28.87	<0.002	0.06
(n = 6)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	16.92	<0.002	<0.02
Bldg. 830											
All Wells	9	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	16.24	<0.002	0.04
(n = 3)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	12.77	<0.002	<0.02
P&GA (T-111)											
All Wells	5	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	34.71	<0.002	<0.02
(n = 5)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	23.94	<0.002	<0.02
WTP											
All Wells	5	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	21.79	<0.002	0.03
(n = 5)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	14.84	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(a)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): No Standard Specified.

Table 61
BNL Site Environmental Report for Calendar Year 1993
Miscellaneous Areas
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
WCF								
65-06(a)	2	Maximum	18.0	<2	<2	<2	<2	<2
		Average	13.0	<2	<2	<2	<2	<2
65-02	3	Maximum	9.0	<2	<2	<2	<2	<2
		Average	5.0	<2	<2	<2	<2	<2
All Other Wells	13	Maximum	4.0	<2	<2	<2	<2	<2
(n = 4)		Average	<2	<2	<2	<2	<2	<2
Bldg. 830								
All Wells	9	Maximum	<2	<2	<2	<2	<2	<2
(n =3)		Average	<2	<2	<2	<2	<2	<2
P&GA (T-111)								
75-01	2	Maximum	5.0	<2	<2	<2	<2	<2
		Average	2.5	<2	<2	<2	<2	<2
75-02	2	Maximum	6.0	<2	<2	<2	<2	<2
		Average	3.0	<2	<2	<2	<2	<2
WTP								
All Wells	5	Maximum	<2	<2	<2	<2	<2	<2
(n = 5)		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient Well.

Table 62
BNL Site Environmental Report for Calendar Year 1993
Miscellaneous Area
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
WCF					
All Wells	18	<2	<2	<2	<2
(n = 6)		<2	<2	<2	<2
Bldg. 850					
All Wells	9	<2	<2	<2	<2
(n = 3)		<2	<2	<2	<2
P&GA (T-111)					
All Wells	4	<2	<2	<2	<2
(n = 2)		<2	<2	<2	<2
WTP					
All Wells	4	<2	<2	<2	<2
(n = 5)		<2	<2	<2	<2
NYS DWS		5.0	5.0	5.0	5.0
Typical MDL		2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.

Supply and Material Area: The surveillance well network near the Supply and Material area consists of eight shallow and two middle Upper Glacial aquifer wells. There have been several documented spill events within the Supply and Material area: a TCA release to the sanitary system and soils in the vicinity of Building 208, and a leaking underground fuel oil tank near Building 457. In an attempt to understand the extent of TCA contamination in the Building 208 area, ICF Kaiser Engineers conducted a soil gas survey, collected soil samples, and installed three shallow surveillance wells (ICF-1, 2, and 3) during 1993. The results of the ICF Kaiser investigation will be used to support the OU III RI/FS which will examine the full extent of soil and ground-water contamination in the Supply and Material area. During 1993, the wells were sampled for water quality, VOCs, and metals (Tables 63 - 66). Water quality analyses indicate that the pH of the ground-water samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.90. Other water quality parameters were below the applicable NYS AWQS. Results from metals analyses of ground water from this area indicated that Fe concentrations were above NYS DWS in Well 105-02 (an older well constructed of carbon steel casings), with a maximum observed concentration of 1.34 mg/L. Analyses of ground-water samples for VOCs indicated that TCA was detected above NYS DWS in shallow Upper Glacial aquifer Wells 85-03 (30 μg/L), 96-06 (54 μg/L) and in ICF-3 (340 μg/L). In middle Upper Glacial Well 105-02, both TCA and PCE were detected at maximum observed concentrations of 7 μg/L and 34 μg/L, respectively.

Building 479 Area: In 1992, a single shallow Upper Glacial aquifer well (95-04) was installed to investigate a lubricating oil spill in the heavy machine shop located in Building 479. During 1993, Well 95-04 was sampled for water quality, VOCs, metals, and floating product. Water quality analysis indicated that the pH of the ground-water sample collected was 5.75, which is below the lower limit of the NYS AWQS of 6.5 - 8.5. Other water quality parameters were below the applicable NYS AWQS. No floating product was observed, and the results from VOC and metals analyses of the ground-water sample indicated that all VOC and metals concentrations were below the applicable NYS DWS. Additionally, as the result of an extensive PCB/hydrocarbon contaminated soil removal action in the Building 479 area, ground-water quality in the Building 479 area will be assessed in greater detail during the OU III RI/FS to be conducted under the IAG.

North Boundary Area: Along the north boundary of BNL, twelve surveillance wells monitor background (ambient) water conditions. These wells consist of shallow, intermediate, and deep Upper Glacial aquifer wells, and one upper Magothy aquifer well. During 1993, these wells were sampled for water quality, VOCs, and metals (Tables 67 - 70). Water quality analyses indicate that the pH of the ground-water samples collected from the shallow to middle Upper Glacial aquifer was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 6.10, whereas the pH in the deep Glacial and Magothy wells was within the NYS AWQS with a median pH of 7.20. Nitrate concentrations exceeded NYS AWQS in deep Upper Glacial Well 17-03 at 10.8 mg/L. Results for metals analyses indicated that all concentrations were below the NYS DWS. Analysis of ground-water samples for VOCs indicate that TCA and DCA were detected in deep Upper Glacial Well 18-03 at maximum concentrations of 11 μg/L and 11 μg/L, respectively. The VOCs detected in Well 18-03 signify the migration of contaminants from off-site areas onto the BNL site.

West Sector Area: The west sector of BNL is monitored by seven shallow to middle Upper Glacial aquifer surveillance wells. During 1993, all seven wells were sampled for water quality, metals, and VOCs (Tables 67 - 70). Water quality analyses indicate that the pH of the ground-water samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.90. All other water quality parameters were below applicable NYS AWQS. Metals analyses indicate that all metals concentrations were below the applicable NYS DWS. The VOC analyses indicate that three wells exceeded the NYS DWS for TCA, with a maximum observed concentration of 31 μg/L in Well 83-02, 10 μg/L in Well 84-01, and 11 μg/L in Well 103-02. Tetrachloroethylene ??? and TCE were also detected at the NYS DWS in two wells with PCE detected at 5 μg/L in Well 83-02 and TCE detected at 5 μg/L in Well 103-02. Soil and ground-water contamination will be assessed in the west sector area, specifically in the vicinity of the Paint Shop, Potable Well 4, and Process Supply Wells 9, 104, and 105, during the OU III RI/FS to be conducted under the IAG.

South Boundary Area: The surveillance well network along BNL's southern (downgradient) boundary, consists primarily of six well couplets or triplets which monitor shallow, intermediate, and deep portions of the Upper Glacial aquifer. (South Boundary surveillance wells monitoring the Current Landfill and HWMF are not included in this summary.) During 1993, all six wells were sampled for water quality, metals, and VOCs (Tables 67 - 70). Water quality analyses indicate that the pH of the ground-water samples collected was typically below the lower limit of the NYS AWQS of 6.5 - 8.5, with a median pH of 5.90. All other water quality parameters were below applicable NYS AWQS. Metals analyses indicate iron and lead concentrations were above NYS DWS in Well 122-02, with maximum observed concentrations of 24.8 mg/L for iron and 0.024 mg/L for lead. The VOC analyses indicate that TCA detected in Well 130-02 exceeded the NYS DWS, with a maximum observed concentration of 13 μg/L, and DCE and TCE were detected just below the DWS with maximum concentrations of 4 μg/L each. Ground-water contamination detected at Well 130-02, and off-site contamination detected in wells downgradient of Well 130-02, will be investigated during the OU III RI/FS to be conducted under the IAG.

Table 63
BNL Site Environmental Report for Calendar Year 1993
Supply and Materiel
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
S&M										
85-01 (a)	2	5.9 - 6.0	298	260.2	54.4	42.3	23.1	21.7	2	1.9
85-02 (a)	2	6.1 - 6.3	113.3	109	12.5	12.4	6.7	6.7	< 1.0	< 1.0
85-03	4	5.9 - 6.1	194.1	188.9	16.8	15.3	18	16.3	3.4	3.2
86-01	2	5.7 - 6.0	350	303.5	58.2	56.8	32	21.5	4.3	3.7
96-06	3	5.7 - 6.0	208	196.5	48.5	34	21.2	18.4	2	2
105-01	3	5.5 - 6.0	74.7	63.7	5.4	5.1	10.3	8.1	< 1.0	< 1.0
105-02	4	5.5 - 5.7	268.3	197.8	60	27.7	38.4	32.5	2.6	1.8
ICF-1	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
ICF-2	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
ICF-3	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

NA: Analysis Not Available.
MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 64
BNL Site Environmental Report for Calendar Year 1993
Supply and Materiel Area
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
85-01(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	0.177	<0.0002	34.87	<0.002	0.02
		Average	<0.025	<0.0005	<0.005	<0.05	0.088	<0.0002	25.00	<0.002	<0.02
85-02(a)	2	Maximum	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.54	<0.002	0.03
		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	7.13	<0.002	<0.02
105-02	4	Maximum	<0.025	<0.0005	<0.005	<0.05	1.34	<0.0002	18.48	0.004	0.06
		Average	<0.025	<0.0005	<0.005	<0.05	1.16	<0.0002	12.84	<0.002	0.04
All Other Wells	13	Maximum	<0.025	0.0006	<0.005	<0.05	0.119	<0.0002	45.08	0.004	0.03
(n = 4)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	18.45	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(b)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): No Standard Specified.

Table 65
BNL Site Environmental Report For Calendar Year 1993
Supply and Materiel Area
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
85-01(a)	2	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
85-02(a)	2	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
85-03	3	Maximum	30.0	<2	<2	<2	3.0	<2
		Average	18.0	<2	<2	<2	<2	<2
96-06	4	Maximum	54.0	<2	<2	<2	<2	<2
		Average	35.0	<2	<2	<2	<2	<2
105-02	4	Maximum	7.0	<2	34.0	<2	<2	<2
		Average	5	<2	26.0	<2	<2	<2
ICF-3	1	Maximum	340.0	4.0	<10	<10	10.0	<10
		Average	---	---	---	---	---	---
All Other Wells (n = 4)	7	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	100.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): Upgradient Well.

Table 66
BNL Site Environmental Report for Calendar Year 1993
Supply and Materiel Area
Ground Water Surveillance Wells, BETX Data

Location	No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
All Wells (n = 10)	23	<2 <2	<2 <2	<2 <2	<2 <2
NYS DWS		5.0	5.0	5.0	5.0
Typical MDL		2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): Upgradient Well.

Table 67
BNL Site Environmental Report for Calendar Year 1993
North, West and South Sectors
Ground Water Surveillance Wells, Water Quality Data

Well Id. No.	No. of Samples	pH SU	Conductivity umhos/cm		Chlorides mg/L		Sulfates mg/L		Nitrate as N (b) mg/L	
		Range	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
North Sector										
007-04	1	5.7	59.1	59.1	6.6	6.6	5.9	5.9	< 1.0	< 1.0
013-01	3	4.9 - 5.8	41.9	40.4	4.8	< 4.0	6.9	6.4	< 1.0	< 1.0
017-01	1	5.8	97.1	97.1	7.1	7.1	14.5	14.5	< 1.0	< 1.0
017-02	1	5.7	303.7	303.7	62.5	62.5	18	18	4.8	4.8
017-03	1	6	296.3	296.3	33.8	33.8	29.7	29.7	10.8	10.8
017-04	1	7.5	125.5	125.5	6	6	< 4.0	< 4.0	< 1.0	< 1.0
018-01	3	5.3 - 5.7	70.2	60.3	6.2	5.1	10.4	8.1	< 1.0	< 1.0
018-02	3	5.6 - 7.1	58.7	57.2	8.3	7.7	7.9	7	< 1.0	< 1.0
018-03	3	6.9 - 7.6	197	192.3	18.5	17.5	12.4	10.9	2.6	2.2
22-01	2	4.3	46.8	43	5.6	5.6	6	5.9	< 1.0	< 1.0
25-01	3	5.4 - 5.6	64	58.9	8.3	7.5	7.8	7.7	< 1.0	< 1.0
25-02	3	5.1 - 5.7	185.7	144.8	58.5	39.4	11.4	9.8	< 1.0	< 1.0
West Sector										
72-01	3	5.5 - 5.7	61.1	58.5	6.7	6.4	11.2	10.3	< 1.0	< 1.0
83-01	3	6.2 - 6.4	131.3	127.8	21	20.1	10.6	10.4	< 1.0	< 1.0
83-02	3	5.9 - 6.2	125.6	120.8	17.4	16.8	10.7	10.2	< 1.0	< 1.0
84-01	3	5.9 - 6.0	190	158.7	27.4	24	17.7	14.9	4.1	2
94-01	1	5.8	115.3	115.3	11.2	11.2	14.4	14.4	2	2
101-01	3	5.6 - 5.8	195.9	182.9	71.9	54.8	14.9	13.2	1.1	< 1.0
102-01	1	5.4	153.8	153.8	30.8	30.8	18.7	18.7	< 1.0	< 1.0
103-01	1	6.1	121.7	121.7	13.4	13.4	14.3	14.3	<1.0	<1.0
103-02	2	5.7 - 6.5	156.8	131.4	24.7	15.4	20.6	16.7	1.2	<1.0
South Sector										
118-01	4	5.9 - 6.1	93	84.5	13.3	11.2	8	7.9	< 1.0	< 1.0
118-02	4	6	134	124.2	25.6	25.3	9.4	9	< 1.0	< 1.0
122-01	4	5.3 - 5.8	42.6	40	6.6	5.8	6.2	5.7	< 1.0	< 1.0
122-02	4	5.8 - 6.6	136.1	127.1	30	23.5	13.8	12.1	< 1.0	< 1.0
126-01	4	5.6 - 6.2	53.3	49.5	6.5	6.1	10.2	9.1	< 1.0	< 1.0
130-02	3	5.6 - 6.1	164.5	161.2	26.9	26.5	20	19.4	1.3	1.2
NYS Ambient Water Quality Standard		6.5 - 8.5	(c)	--	250	--	250	--	10	--
Typical MDL		--	10		4		4		1	

MDL: Minimum Detection Limit.
(a): Upgradient Well.
(b): Holding time expired for all samples.
(c): No standard specified.

Table 68
BNL Site Environmental Report for Calendar Year 1993
North Boundary, West Sector, Southern Boundary
Ground Water Surveillance Wells, Metals Data

Location	No. of Samples		Ag mg/L	Cd mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Hg mg/L	Na mg/L	Pb mg/L	Zn mg/L
North Boundary(a)											
All Wells	25	Maximum	<0.025	<0.0005	<0.005	<0.05	0.130	<0.0002	31.04	<0.002	0.10
(n=12)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	8.48	<0.002	<0.02
West Sector											
All Wells	20	Maximum	<0.025	<0.0005	<0.005	<0.05	0.280	<0.0002	44.84	<0.002	0.06
(n=9)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	15.19	<0.002	<0.02
Southern Boundary(b)											
122-02	4	Maximum	<0.025	<0.0005	<0.005	<0.05	24.790	<0.0002	18.74	0.024	0.15
		Average	<0.025	<0.0005	<0.005	<0.05	6.450	<0.0002	11.62	0.008	0.05
All Other Wells	17	Maximum	<0.025	0.0007	<0.005	<0.05	0.176	<0.0002	12.39	0.004	0.04
(n=5)		Average	<0.025	<0.0005	<0.005	<0.05	<0.075	<0.0002	9.75	<0.002	<0.02
NYS DWS			0.05	0.01	0.05	1.3	0.3	0.002	(c)	0.015	5.0
Typical MDL			0.025	0.0005	0.005	0.5	0.075	0.0002	1.0	0.002	0.02

MDL: Minimum Detection Limit.
(a): North Boundary Wells monitor background water quality for site.
(b): South Boundary Wells monitoring Hazardous Waste Management Facility and Current Landfill not included.
(c): No Standard Specified.

Table 69
BNL Site Environmental Report for Calendar Year 1993
North Boundary, West Sector, and South Boundary
Ground Water Surveillance Wells, Chlorocarbon Data

Location	No. of Samples		TCA ug/L	TCE ug/L	PCE ug/L	DCA ug/L	DCE ug/L	Chloroform ug/L
North Boundary (a)								
18-03	3	Maximum	11.0	<2	<2	11.0	<2	<2
		Average	9.7	<2	<2	9.3	<2	<2
All Other Wells (n = 11)	22	Maximum	<2	<2	<2	<2	<2	<2
		Average	<2	<2	<2	<2	<2	<2
West Sector								
83-02	3	Maximum	31.0	<2	5.0	2.0	4.0	3.0
		Average	22.0	<2	<2	<2	<2	<2
84-01	3	Maximum	10.0	<2	<2	<2	<2	<2
		Average	5.0	<2	<2	<2	<2	<2
103-02	2	Maximum	11.0	5.0	<2	<2	3.0	2.0
		Average	5.5	2.5	<2	<2	<2	<2
All Other Wells (n = 6)	12	Maximum	<2	<2	<2	<2	<2	20.0
		Average	<2	<2	<2	<2	<2	4.8
South Boundary (a)								
103-02	3	Maximum	13.0	4.0	<2	<2	4.0	<2
		Average	12.0	<2	<2	<2	2.0	<2
All Other Wells (n = 5)	18	Maximum	<2	<2	<2	<2	<2	2.0
		Average	<2	<2	<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
TCA: 1,1,1-trichloroethane.
TCE: Trichloroethylene.
PCE: Tetrachloroethylene.
DCA: Dichloroethane.
DCE: Dichloroethylene.
(a): North Boundary Wells monitor background water quality for site.
(b): South Boundary Wells monitoring Hazardous Waste Management Facility and Current Landfill not included.

Table 70
BNL Site Environmental Report for Calendar Year 1993
North Boundary, West Sector, and South Boundary
Ground Water Surveillance Wells, BETX Data

Location		No. of Samples	Benzene ug/L	Ethylbenzene ug/L	Toluene ug/L	Xylene ug/L
North Boundary (a)						
All Wells	Maximum	25	<2	<2	<2	<2
(n = 12)	Average		<2	<2	<2	<2
West Sector						
All Wells	Maximum	20	<2	<2	<2	<2
(n = 9)	Average		<2	<2	<2	<2
South Boundary (b)						
All Wells	Maximum	21	<2	<2	<2	<2
(n = 6)	Average		<2	<2	<2	<2
NYS DWS			5.0	5.0	5.0	5.0
Typical MDL			2.0	2.0	2.0	2.0

MDL: Minimum Detection Limit.
(a): North Boundary Wells monitor background water quality for site.
(b): South Boundary Wells monitoring Hazardous Waste Management Facility and Current Landfill not included.

5.1.2.3 Trend Studies

Site-wide computer generated plots showing the historical distribution (1983 - 1993) of radionuclides (Na-22, Co-60, Cs-137, and Sr-90), and for metals (iron, zinc, and lead). These radionuclides and metals were chosen because of their consistent presence in ground water during this study period. The radionuclide plot is shown in Figure 35 which shows the principal radionuclides Cs-137 and Sr-90 have been concentrated in the HWMA/Landfill Area, where past spills and/or disposal of radionuclides have occurred, and in wells adjacent to the Sewage Treatment Plant where the Laboratory effluent has discharged radionuclides originating from facility operations, into the STP. Radionuclides, such as Na-22 and Co-60, are present in areas where there is a potential of generating activation products in soil, principally in areas such as the AGS where beam dumps could be a source of activation products, and/or areas where activated materials have been stored and subject to corrosion and dissolution by rain water.

The metals plot (Figure 36) shows the ubiquitous distribution of iron, either as occurring naturally, or as a by product of the construction material of wells (1 1/4" galvanized pipe). Presence of zinc in such wells does confirm this observation. The presence of lead, though concentrated around the HWMA and the STP areas, in wells around site is an anomaly and requires further investigation, although use of brass screens in older wells could be one source of lead contamination.

Figure 35: Radionuclide Distribution in Groundwater On-site: 1983-1993

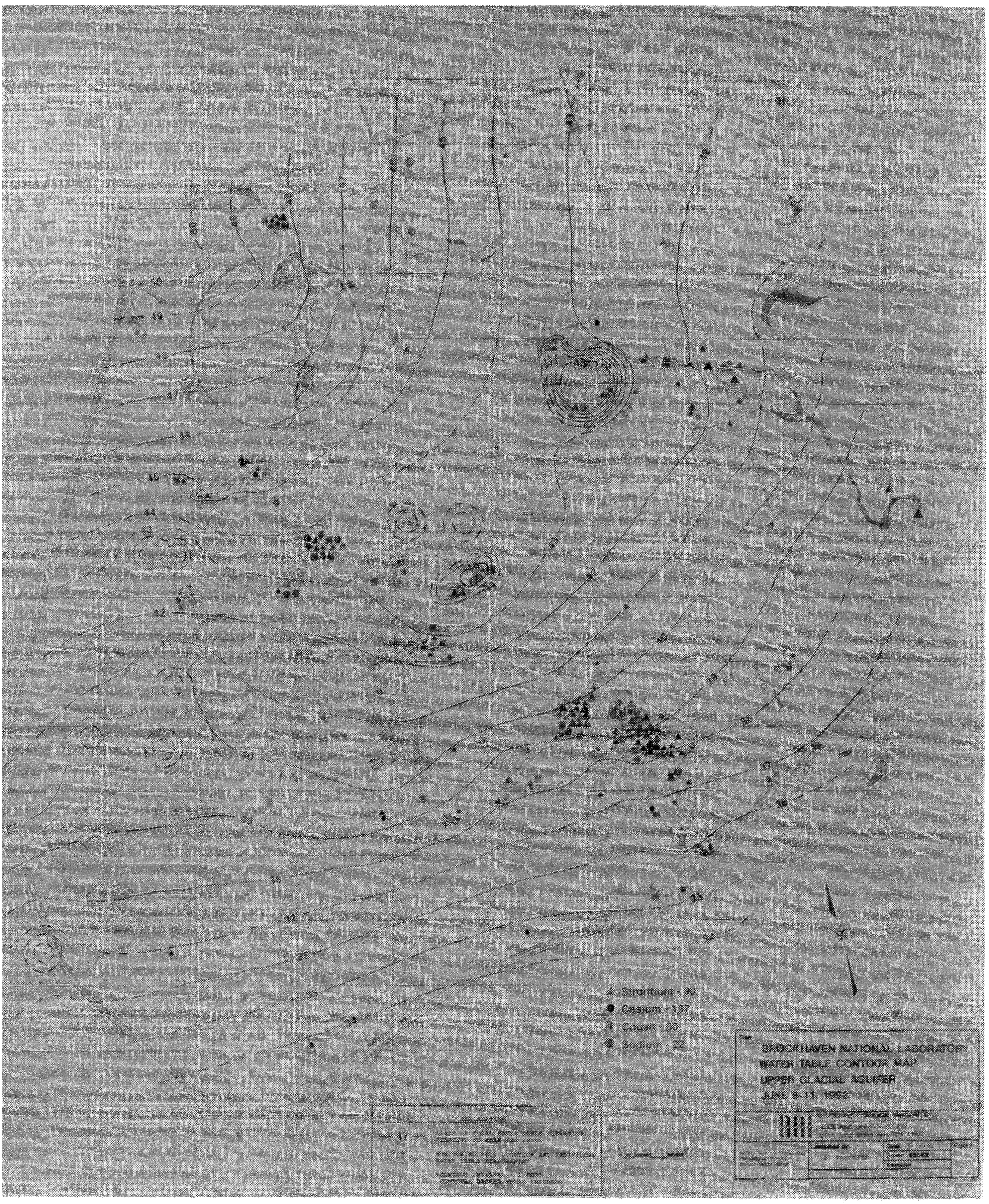
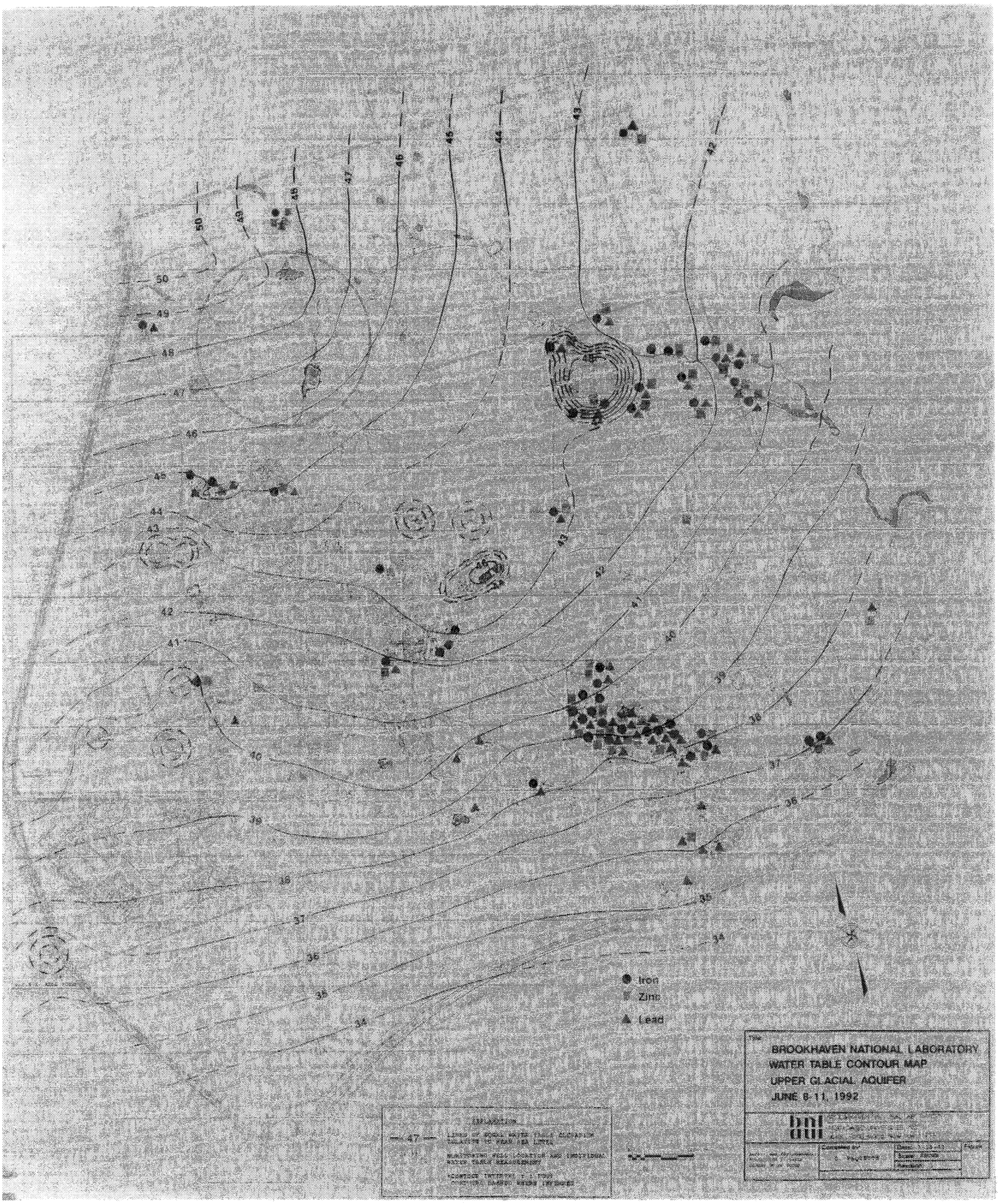


Figure 36: Metal Distribution in Groundwater On-site: 1983-1993



6.0 OFF-SITE DOSE ESTIMATES

G. L. Schroeder and J. R. Naidu

6.1 Dose Equivalents due to Airborne Effluents

The major radionuclides released from BNL airborne effluent discharge points were tritium, oxygen-15, and argon-41. The measured tritium concentrations and dose-equivalents at the site boundary are shown in Table 71. The highest annual average site boundary concentration of tritium vapor was 5.7 pCi/m^3 (0.21 Bq/L) at Monitoring Locations 0802 (SE Sector) and the committed effective dose equivalent (inhalation and skin absorption) was 0.004 mrem (4E-5 mSv) for the hypothetical individual residing at that location. The exposure rates due to argon-41 and oxygen-15 were not measured at the site boundary. The dose-equivalent rates for these radionuclides, calculated using CAP88, are presented in Table 72. The maximum site-boundary dose-equivalent from argon-41 and oxygen-15 was calculated to be 0.178 mrem/yr (0.002 mSv/yr). The maximum site boundary dose from all three radionuclides was 0.182 mrem/yr (0.0018 mSv/yr).

The collective (population) dose-equivalent was estimated for radionuclides released to the airborne environment using measured effluent release data and recorded BNL meteorological parameters. Using actual source terms and meteorological data at the given release point should yield the best projection of airborne concentrations, and thus dose to the general population. This approach also minimizes the effects of local micrometeorological conditions which may exist, resulting in differences between the measured and expected tritium concentrations at the perimeter monitoring stations.

Collective whole body doses resulting from the radionuclides released from each facility are presented in Table 73. Argon-41 contributed a collective dose equivalent of 4.55 person-rem (0.0455 person-Sv) which is essentially the entire collective dose equivalent for the site. The dose equivalent contributions from tritium and carbon-11 were 0.028 and 4.56E-3 person-rem (2.8E-4 and 4.56E-5 person-Sv), respectively. This is depicted graphically in Figure 37. The fraction of collective dose as a function of facility is presented graphically in Figure 38. The 1993 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 4.59 person-rem (0.0459 person-Sv). This can be compared to the population collective dose-equivalent due to cosmic and terrestrial natural background of 291,000 person-rem (2,910 person-Sv). The Laboratory airborne releases comprised 0.00091% of the total dose due to natural background.

6.2 Dose Equivalents due to Liquid Effluents

Since the Peconic River is not used as a drinking water supply,[2] nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. However, the Peconic River does recharge the aquifer and acts as a limited source for sport fishing. In 1993, the collective dose equivalent resulting from the ingestion of drinking water was computed by evaluating the radioactive content by private potable water.

Table 71
BNL Site Environmental Report for Calendar Year 1993
Committed Effective Dose Equivalent at Site Boundary
Due to Airborne Tritium

Location	Sector ID	Flow Wt'd. Average (pCi/m3)	CEDE* (mrem)
0101	N	3.36	0.0026
0302	NNE	2.61	0.0020
0401	NE	2.83	0.0022
0501	ENE	3.64	0.0028
0602	E	3.03	0.0024
0601	ESE	3.82	0.0030
0802	SE	5.74	0.0045
0801	SSE	5.47	0.0043
1001	S	2.68	0.0021
1101	SSW	2.69	0.0021
1201	SW	2.55	0.0020
1301	WSW	2.14	0.0017
1401	W	3.65	0.0029
1501	WNW	2.99	0.0023
1602	NW	2.10	0.0016
1601	NNW	4.98	0.0039
0901	Central Site	10.53	0.0082
	Maximum Site Perimeter Dose =		0.0082

*CEDE: Committed Effective Dose Equivalent, the total dose equivalent received over a 50 year period following the intake of a radionuclide.

Note: CEDE included the inhalation and submersion pathways. ICRP Publication No. 30 dose conversion factors used.

Table 72
BNL Site Environmental Report for Calendar Year 1993
Ar-41 and O-15 Site Boundary Dose Equivalents

Sector	Ar-41 (mrem/yr)	O-15 (mrem/yr)	Total (mrem/yr)
N	0.110	0.004	0.114
NNE	0.170	0.005	0.175
NE	0.100	0.002	0.102
ENE	0.090	0.003	0.093
E	0.097	0.004	0.101
ESE	0.160	0.008	0.168
SE	0.150	0.008	0.158
SSE	0.130	0.004	0.134
S	0.100	0.002	0.102
SSW	0.075	0.002	0.077
SW	0.075	0.002	0.077
WSW	0.095	0.005	0.100
W	0.071	0.002	0.073
WNW	0.069	0.002	0.071
NW	0.071	0.003	0.074
NNW	0.062	0.003	0.065

Note: All values are individual dose equivalent rates at a distance of 1,550 m from the center of the site.

Table 73
BNL Site Environmental Report for Calendar Year 1993
Collective Dose - Radioactive Airborne Emissions

Nuclide	Total Ci Released	Total p-rem/yr	HFBR p-rem/yr	B.801A p-rem/yr	B.801 NA p-rem/yr	BMRR p-rem/yr	BLIP p-rem/yr	ncinerator p-rem/yr	Booster p-rem/yr
Ar-41	2.08E+03	4.55E+00				4.55E+00			1.65E-03
As-72	5.45E-05	4.71E-06					4.71E-06		
As-74	4.51E-04	9.51E-08			4.75E-08		4.75E-08		
Au-199	6.62E-05	3.10E-07		1.41E-08	2.96E-07				
Be-7	7.97E-02	4.62E-04	6.68E-08	3.63E-07	9.50E-07		5.31E-05		4.08E-04
Bi-213	2.81E-04	2.73E-07			2.73E-07				
Br-77	1.18E-02	8.69E-05		5.06E-08	8.69E-05				
Br-82	3.62E-04	1.52E-05	6.69E-06		8.55E-06				
C-11	1.58E+02	4.56E-03							4.56E-03
C-14	2.20E-04	4.65E-04						4.65E-04	
Co-57	3.14E-05	2.31E-05		1.05E-06	5.49E-06		1.66E-05		
Co-58	6.40E-05	1.27E-04		8.28E-07	2.77E-06		1.23E-04		
Co-60	1.29E-05	8.68E-04		2.59E-05	2.18E-04		6.24E-04		
Cr-51	2.78E-06	2.85E-08		2.85E-08					
Cs-137	4.33E-05	1.05E-06	2.03E-09	8.17E-08	5.83E-08		9.06E-07		
Ga-68	2.47E-03	3.14E-06		4.00E-09	3.13E-06				
H-3	6.79E+01	2.77E-02	2.75E-02				2.01E-04	6.60E-07	1.00E-06
Mn-54	1.07E-04	5.94E-04			9.84E-05		4.96E-04		
Na-22	1.50E-05	3.64E-04		1.29E-06	2.24E-04		1.39E-04		
N-13	2.17E+02	5.95E-04							5.95E-04
O-15	6.68E+02	1.26E-04					1.04E-04		2.24E-05
Sc-46	2.48E-06	7.95E-06		2.15E-06			5.80E-06		
Se-75	6.50E-04	6.90E-02			6.90E-02				
Totals	3.19E+03	4.66E+00	2.75E-02	3.18E-05	6.96E-02	4.55E+00	1.77E-03	4.66E-04	7.24E-03

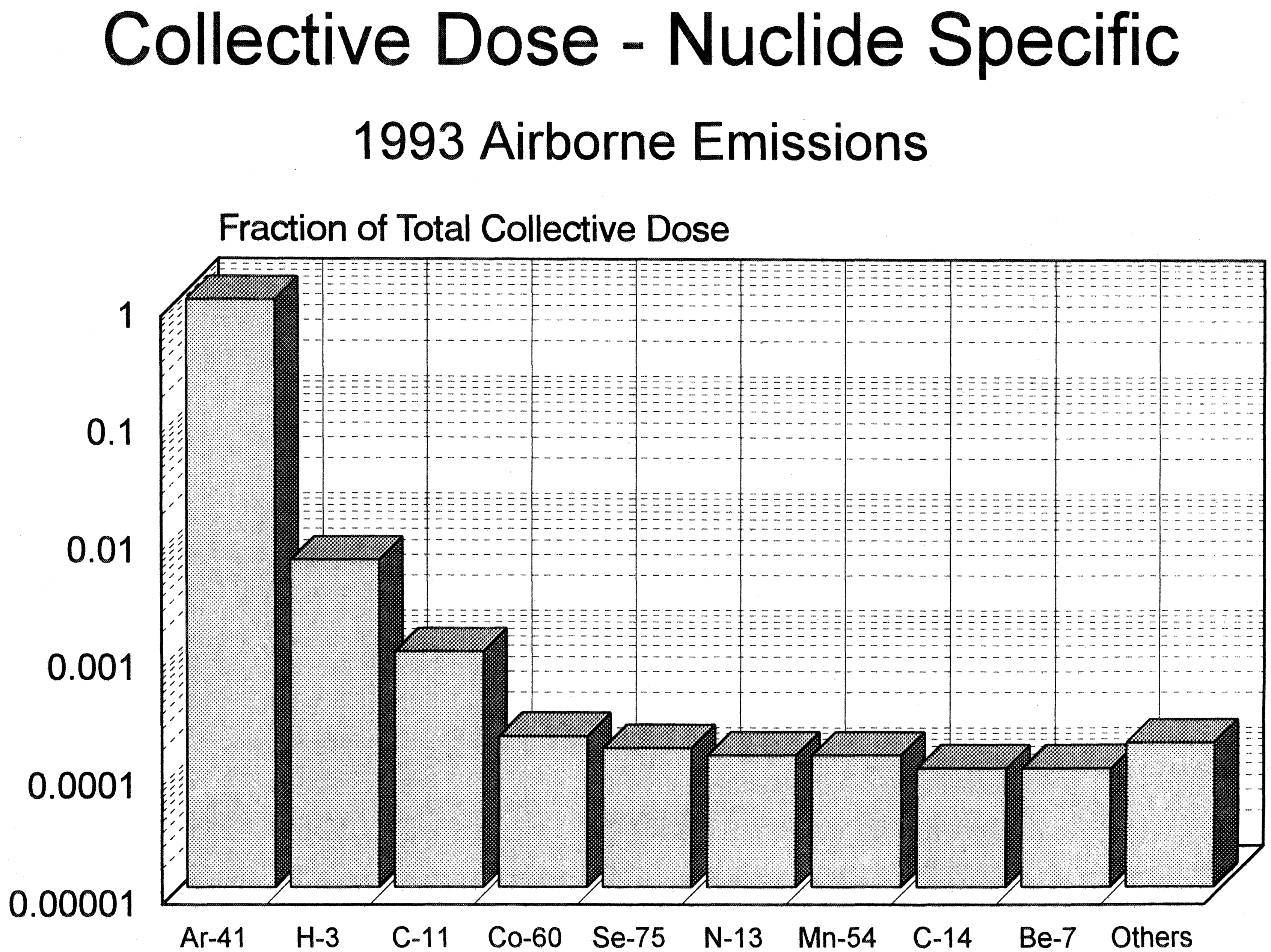


Figure 37: Fraction of Collective Dose by Facility - 1993.

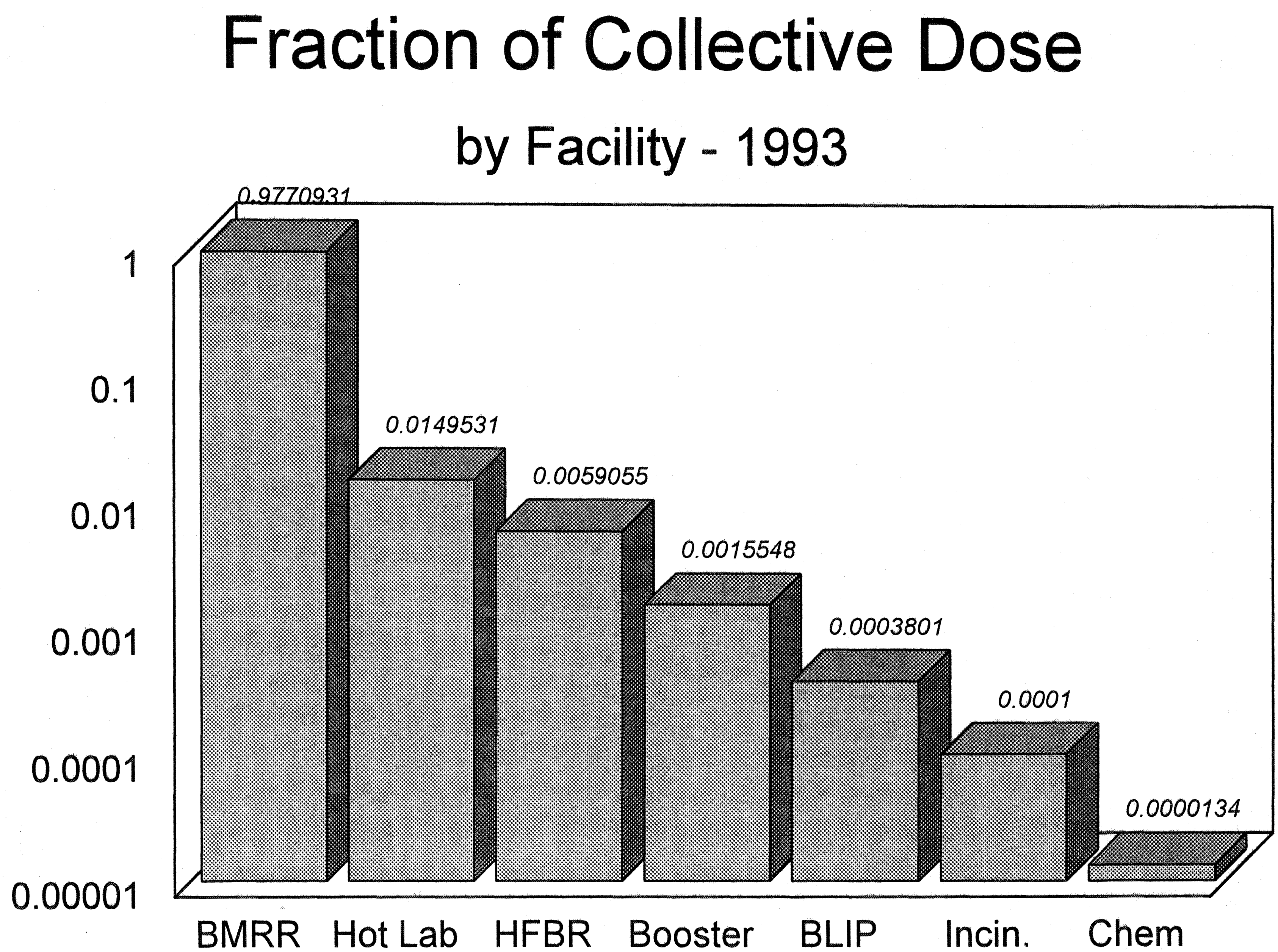


Figure 38: Collective Dose-nuclide Specific 1993 Airborne Emissions.

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 4,369 pCi/L (161 Bq/L). The average concentration for the group of positive tritium concentrations at private potable wells was 707.1 pCi/L (25.9 Bq/L). (The NYS DWS for tritium is 20,000 pCi/L.) This corresponds to a committed effective dose equivalent to the maximum individual of 0.203 mrem (0.002 mSv) and a collective dose equivalent to the population at risk (assumed to be not more than 500 persons) of 0.101 person-rem (0.001 person-Sv). This data is summarized in Table 74.

The cesium-137 concentrations in fish samples collected from Donahue's Pond are reported in Table 26. Using the method described in Appendix B, the maximum individual committed dose equivalent was calculated to be 0.31 mrem (0.0031 mSv). The population collective dose equivalent due to Cs-137 and Sr-90 combined was calculated to be 0.362 person-rem (0.0036 person-Sv). The water and fish pathway dosimetric results are summarized in Table 74.

6.3 Maximum Individual Effective Dose Equivalent

The maximum committed effective dose equivalent to a hypothetical individual residing at the site boundary during 1993 was 0.97 mrem (see Table 75). This dose is a total value which includes the dose resulting from air inhalation, water ingestion, and fish consumption. This value is conservative due to the exclusively from Donahue's Pond. (The committed effective dose-equivalent due to fish ingestion accounts for 59% of the maximally exposed individual's calculated dose.) The 0.97 mrem individual dose value can be compared to the expected dose equivalent received from local natural background sources, approximately 60 mrem. The calculated maximum individual dose is equal to 1.6% of the dose that a local resident could expect to receive even if no Laboratory operations were conducted.

6.4 Collective (Population) Dose Equivalent

The collective (population) dose equivalent (total population dose) beyond the site boundary, within a radius of 80 km, attributed to Laboratory operations during 1993, was 5.05 person-rem (0.051 person-Sv) and was obtained by the summation of the doses from the pathways discussed previously in this report. This data is summarized in Table 75.

The collective dose equivalent to the population within an 80-km radius of the Laboratory, due to external radiation from natural background, amounts to about 291,000 person-rem/yr (2,910 person-Sv/yr), to which about 97,000 person-rem/yr (970 person-Sv/yr) should be added for internal radioactivity from natural sources.

Table 74
BNL Site Environmental Report for Calendar Year 1993
Collective and Individual Committed Effective Dose Equivalent from the Water Pathway

Pathway	Nuclide	Maximum Individual CEDE (mrem)	Collective CEDE (person-mrem)
Drinking Water	H-3	0.203	101
Fish	Cs-137	0.31	195
	Sr-90	0.27	166
All Ingestion Pathways		0.783	462

Note: Sr90 CEDE estimated from 1992 Cs data and a ratio based on Cs:Sr values estimated over previous years.

Table 75
BNL Site Environmental Report for Calendar Year 1993
Collective Dose from All Pathways

Pathway	Maximum Individual CEDE (mrem)	Annual Background Dose Equiv. (mrem)	Maximum Individual Annual Dose Limit (mrem)	Collective CEDE (person-mrem)	Collective Background Dose Equiv. (person-mrem)
Air (a)	0.192	58	10	4,590	2.9E+08
Water	0.203	ND	4	101	ND
Fish	0.58	0.206	NA	391	1.0E+02
All Pathways	0.975	58	100	5,052	2.9E+08

(a) Direct exposure from plume passage included in air component.
ND: Not Detected.
NA: Not Applicable.

7.0 LABORATORY QUALITY ASSURANCE

S. L. K. Briggs

The EM program, which includes surveillance monitoring as well as compliance monitoring, utilizes on-site radiological and analytical chemistry laboratories as well as off-site contractor laboratories. Standard Operating Procedure's are established for the calibration of instrumentation, analysis of samples, and performance of quality control checks. Depending on the analytical method, quality control checks include analysis of blanks or background concentrations, use of Amersham or National Institute for Standards and Technology (NIST) traceable standards, and analysis of reference check standards, spiked samples, and duplicate samples. The respective laboratory managers review all analytical and quality control results before the data is reported and incorporated into the database. In addition, both laboratories underwent an independent assessment during 1993 of their preparation, analysis, and quality assurance methodologies (See Section 3.3, Tier III Assessment).

7.1 Radiological Laboratory

The SEPD Radiological Laboratory performs analysis of both environmental and facility samples for gross alpha, gross beta, gamma, and tritium. The laboratory participates in the DOE Environmental Measurements Laboratory (EML) QA Program and the EPA Nuclear Radiation Assessment Division, Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV) Intercomparison Study. The results of these studies are presented in Tables 76 and 77, respectively.

Twenty of thirty-five EML analyses were within ±10% and showed excellent agreement with the known value; thirteen of thirty-five were within ±23% demonstrating good agreement; and two analyses fell outside the acceptance limits of ±50%, both for tritium. Further investigation of these EML analyses revealed a high energy component (i.e., Co^{60}, Cs^{137}) which interfered with the tritium calculation. Distillation of the sample would have precluded this problem, however, the analysis protocol for environmental samples in the SEPD analytical laboratory does not call for sample distillation. Results of the EMSL-LV intercomparisons exhibited excellent agreement for thirteen analyses, within 1σ of the known value; good agreement for fourteen analyses, within 2σ of the known; two analyses between 2 and 3σ; and five sample analyses which were $> 3\sigma$. Investigation of the unacceptable analyses showed four of the five analyses were within 2 and 3σ of the grand average, implying an error in the known value. An investigation of the QC data for the batch containing the remaining unacceptable analyses showed no problem associated with the sample preparation, analytical process, or data calculations.

Figures 39 and 40 summarize the internal quality control program performance for the radiological laboratory instrumentation. Figure 39 shows the annual mean and 99% confidence interval for the alpha, beta, and tritium instrument efficiencies as determined by a daily calibration standard. It is noted that the tritium analysis process included changes in the scintillation cocktail which contributed to the variability shown. Figure 40 compares the mean and 99% confidence intervals of the Cs^{137} energy for each gamma detector as measured by a daily calibration standard. The plot indicates the theoretical energy of 661.65 KeV with a solid line, and shows the excellent performance of each detector, within ±0.53 KeV.

Table 76
BNL Quality Assessment Program Results
Environmental Measurements Laboratory

Matrix	Units	Isotope	Date	EML	BNL	BNL/EML Ratio
Water	$Bq \cdot L^{-1}$	H^3	3/93	97	250	2.58
			9/93	270	577	2.13
		Mn^{54}	3/93	105	108	1.03
			9/93	109	114	1.05
		Co^{60}	3/93	45.3	48.0	1.06
			9/93	99.6	106.0	1.06
		Cs^{134}	3/93	42.4	46.0	1.08
			9/93	56.1	59.9	1.07
		Cs^{137}	3/93	50.8	54.0	1.06
			9/93	75.5	78.4	1.04
		Ce^{144}	3/93	83.6	88.0	1.05
			9/93	173.0	180.0	1.04
Air Filter	Bq/Filter	Mn^{54}	3/93	11.7	10.8	.92
			9/93	15.4	14.2	.92
		Co^{57}	3/93	2.71	2.10	.77
			9/93	17.3	13.7	.79
		Co^{60}	3/93	1.70	1.50	.88
			9/93	20.5	18.5	.90
		Cs^{134}	3/93	1.96	1.60	.82
			9/93	12.2	9.8	.80
		Cs^{137}	3/93	3.07	2.80	.91
			9/93	18.8	16.9	.90
		Ce^{144}	3/93	19.3	15.0	.78
			9/93	40.3	34.8	.86
		Be^7	3/93	27.4	24.0	.88
		Sb^{125}	9/93	17.4	15.3	.88
Vegetation	$Bq \cdot g^{-1}$	Cs^{137}	3/93	24.6	20.0	.81
			9/93	89.2	80.3	.90
		K^{40}	3/93	383	352	.92
			9/93	842	850	1.01
		Co^{60}	9/93	6.45	6.50	1.01
Soil	$Bq \cdot g^{-1}$	Cs^{137}	3/93	923	746	.81
			9/93	11.4	13.9	1.22
		K^{40}	3/93	321	251	.78
			9/93	28.6	29.9	1.05

Table 77
BNL Intercomparison Study Results
Environmental Monitoring Systems Laboratory

Matrix	Units	Isotope	Date	EMSL	BNL	BNL/EMSL Ratio
Water	$pCi \bullet L^{-1}$	Gross Alpha	1/93	34.0	14.7	.43[a]
			4/93[d]	95.0	69.7	.73
			7/93	15.0	9.3	.62
			10/93[d]	40.0	32.1	.80
			10/93	20.0	10	.50[a]
		Gross Beta	1/93	44.0	33.0	.75[a]
			4/93[d]	177.0	158.0	.89
			7/93	43.0	36.3	.84
			10/93[d]	58.0	54.6	.94
			10/93	15.0	17.7	1.18
		H^3	6/93[d]	9844	10400	1.06
			11/93	7398	8243	1.11
		Co^{60}	4/93[d]	39.0	43.7	1.12
			6/93	15.0	12.3	.82
			10/93[d]	10.0	13.7	1.37
			11/93	30.0	32.7	1.09
		Cs^{134}	4/93[d]	27.0	28.3	1.05
			6/93	5.0	ND	-
			10/93[d]	12.0	11.2	.93
			11/93	59.0	50.3	.85
		Cs^{137}	4/93[d]	32.0	34.3	1.07
			6/93	5.0	6.67	1.33
			10/93[d]	10.0	13.13	1.31
			11/93	40.0	42.3	1.06
		Zn^{65}	6/93[c]	103.0	109.1	1.06
			11/93	150.0	168.0	1.12
		Ba^{133}	6/93	99.0	88.3	.89
			11/93	79.0	77.3	.98
		Ru^{106}	6/93	119.	108	.91
			11/93	201.	160.7	.80[a]
		Sr^{90}	4/93	29.0	NA	-
			10/93	10.0	NA	-
Air	pCi/Filter	Alpha	8/93	19.0	20.3	1.05
		Beta	8/93	47.0	49.0	1.04
		Cs^{137}	8/93	9.0	13.3	1.48
		Sr^{90}	8/93	19.0	NA	-
Milk	$pCi \bullet L^{-1}$	I^{131}	9/93	120.0	183.7	1.53[b]
		Cs^{137}	9/93	49.0	44.3	.90
		Sr^{90}	9/93	25.	NA	
	mg.L	K	9/93	1679	NA	

NA: Not analyzed.
ND: Not detected.
[a]: Outside $\pm 3\sigma$ control limit.
[b]: Determined to be an outlier.
[c]: BNL result shown was corrected due to calculation error.
[d]: Not reported to EMSL-LV

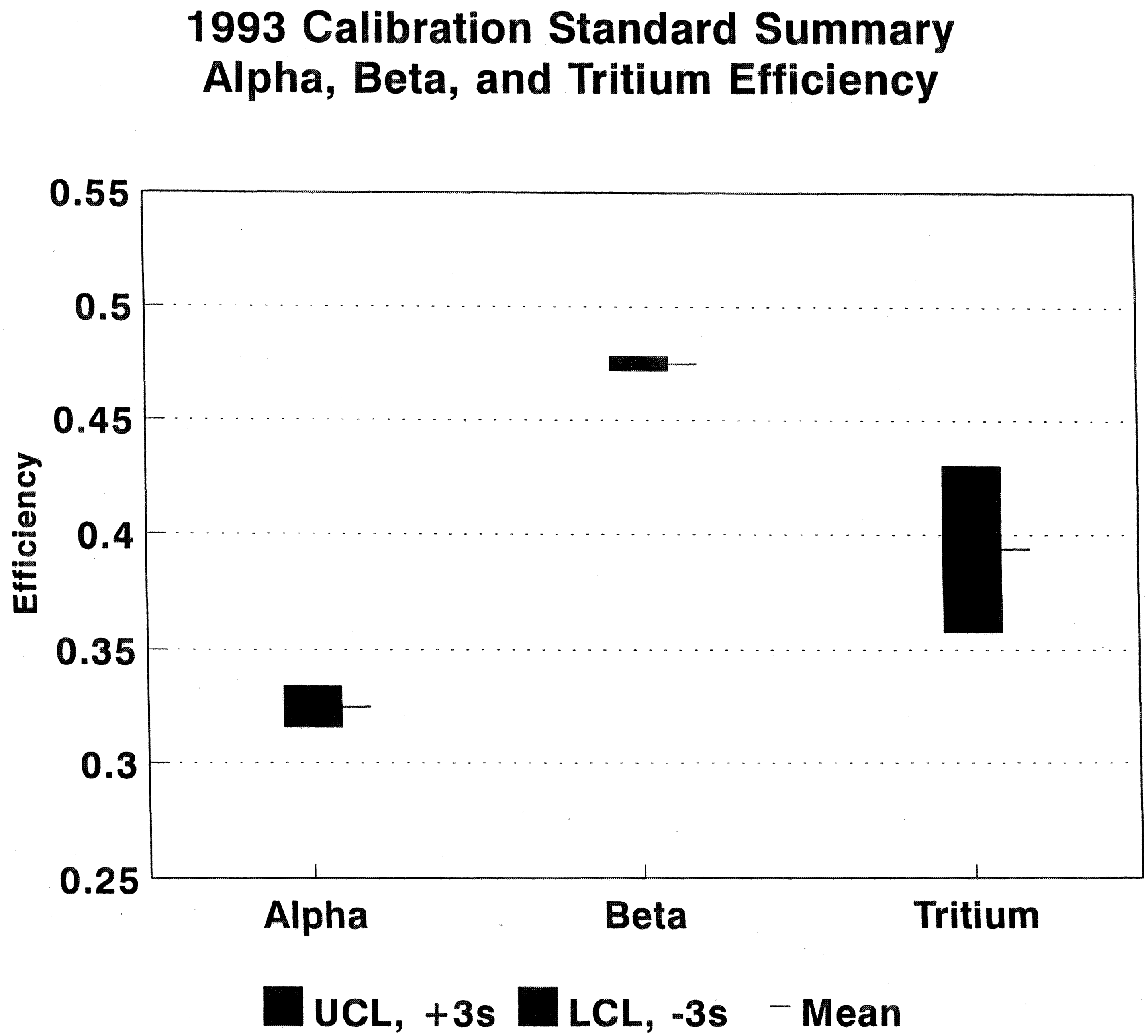


Figure 39: 1993 Calibration Standard Summary.

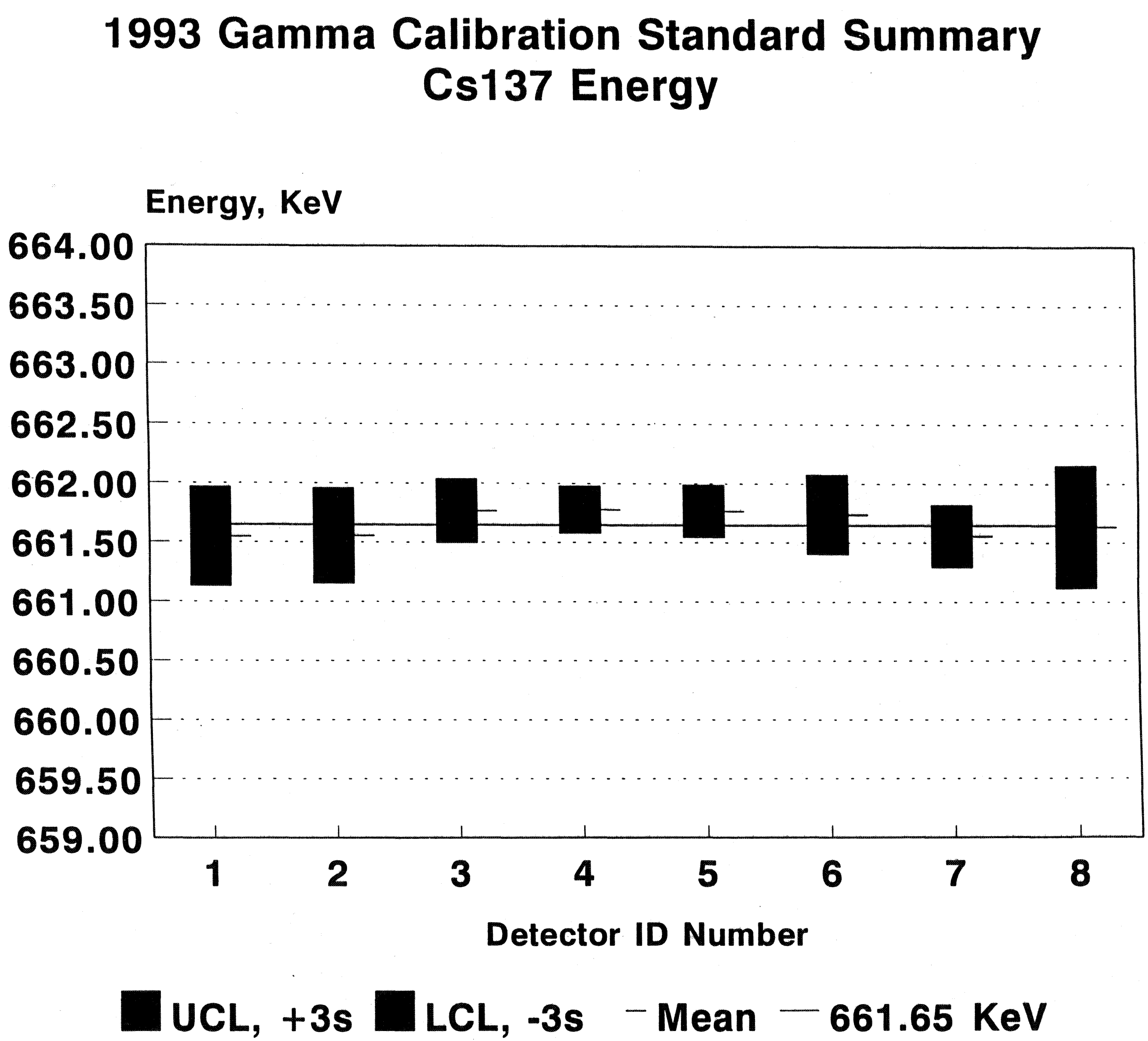


Figure 40: 1993 Gamma Calibration Standard Summary.

7.2 Non-Radiological Laboratory

The S&EP Analytical Chemistry Laboratory is certified by NYSDOH for metals and anions under potable water analyses and specific purgeable organic compounds under non-potable water analyses. These compounds are BTX, ethylbenzene, chloroform, DCA, DCE, TCA, TCE, and PCE. The Laboratory participates in the NYSDOH Environmental Laboratory Approval Program. The results for organic and inorganic analyses are presented in Tables 78 and 79, respectively.

Excellent agreement, within ±5%, was noted in twelve of sixteen organic analysis tests while the remaining four tests fell within ±8% of the known value. Results from the inorganic proficiency samples showed excellent agreement, within ±5, in forty-four of the fifty-two analyses; good agreement, within ±15% in five analyses; and two analyses within ±28%. It is noted that one of these samples was analyzed for mercury which has an acceptance limit of ±30%; the other was chromium which was at a low concentration level close to the MDL.

Figure 41 presents the annual summary of the recoveries measured by the reference check sample analyzed in each metals or anions batch. The results show the anions to be ±10% and the metals at ±13% of the target value, with the exception of cadmium and mercury which were measured at ±17% and ±23%, respectively. Figure 42 summarizes the recoveries of the organic analysis reference check data by presenting the mean and 99% confidence interval for each of the primary volatile organic compounds and two PCB controls. The figure shows a slight negative bias, within -5%, for all volatile organics, and variability of ±14% about that mean. The PCB controls showed a positive bias of 2 - 6% and up to 27% variability about the mean.

Samples collected for regulatory compliance purposes such as SPDES discharge monitoring reports, water treatment plant monthly reports, and the CSF semiannual reports are analyzed by off-site contractor laboratories certified in the respective analytes of interest. Contractors are also used to augment the capabilities of the on-site laboratories, for example Sr^{90} and Toxic Characteristic Leachate Procedure (TCLP). When necessary, they are used to offset workload demands placed on the S&EP Analytical Chemistry Laboratory. The laboratory manager specifies the contract requirements for each analytical method and ensures the incoming data package complies with those specifications before the data is reported. Audits are performed periodically by the respective laboratory supervisor and EP QA Officer on these commercial laboratories to ensure competence in analytical methodology and implementation of a comprehensive QA program. In 1993, one such audit was performed.

Lastly, the contract laboratory responsible for analyzing the SPDES samples is required to participate in the NPDES Performance Evaluation Study. The results of this audit are presented in Table 80. All analyses except total suspended solids were acceptable. Investigation into the total suspended solids analysis revealed a data calculation error.

Table 78
BNL Non-potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP ($\mu g \cdot L^{-1}$)	BNL ($\mu g \cdot L^{-1}$)	BNL/ELAP Ratio
Benzene	2/93	31.3	30.5	.97
		50.1	48.4	.97
	7/93	29.5	28.8	.98
		45.6	45.2	.99
Total Xylenes	2/93	13.9	13.6	.99
		24.8	26.2	1.06
	7/93	35.9	33.1	.92
		50.1	46.3	.92
Toluene	2/93	14.4	14.4	1.00
		38.1	37.7	.99
	7/93	22.4	22.7	1.01
		32.6	33.7	1.03
Trichloroethene	2/93	50.3	47.3	.94
		21.7	21.6	1.00
	7/93	37.0	36.6	.99
		47.4	48.2	1.02
Trichloroethene	1/92	38.8	35.7	.92
		92.6	83.9	.91
	7/92	61.7	61.4	1.00
		46.0	57.0	1.24

Table 79
BNL Potable Water Chemistry Proficiency Test Results
Environmental Laboratory Approval Program

Analyte	Date	ELAP ($\mu g \bullet L^{-1}$)	BNL ($\mu g \bullet L^{-1}$)	BNL/ELAP Ratio
Cloride	4/93	9.78	9.4	.96
		133.0	129.0	.97
	10/93	30.2	30.3	1.00
		99.9	97.7	.98
Nitrate (as N)	4/93	0.609	0.615	1.01
		1.99	2.01	1.01
	10/93	0.50	0.49	.98
		6.01	6.04	1.01
Sulfate	4/93	40.3	40.0	.99
		149.0	147.0	.99
	10/93	69.1	70.1	1.01
		199.0	197.0	.99
Cadmium	4/93	8.00	8.50	1.06
		2.35	2.29	.97
	10/93	4.00	4.14	1.04
		8.00	8.85	1.11
Copper	4/93	60.	59.6	.99
		800.	790.	.99
	10/93	120.	121.	1.01
		900.	904.	1.00
Lead	4/93	13.1	13.2	1.01
		40.0	40.8	1.02
	10/93	20.0	20.8	1.04
		50.0	52.6	1.05
Manganese	4/93	41.0	42.1	1.03
		13.8	13.6	.99
	10/93	80.0	83.0	1.04
		160.0	162.0	1.01
Silver	4/93	23.9	23.4	.98
		37.4	36.2	.97
	10/93	13.4	13.2	.99
		43.6	45.0	1.03
Zinc	4/93	501.	494.	.99
		302.	286.	.95
	10/93	202.	202.	1.00
		1000.	1001.	1.00
Chromium	4/93	37.8	38.7	1.02
		24.9	25.8	1.04
	10/93	10.0	12.8	1.28[a]
		80.0	77.1	.96
Iron	4/93	141.	137.	.97
		81.1	77.6	.96
	10/93	101.	98.	.97
		299.	286.	.96
Mercury	4/93	2.00	1.88	.94
		0.80	0.78	.98
	10/93	0.69	0.50	.72
		6.00	4.95	.83
Sodium	4/93	628.	617.	.98
		431.	406.	.94
	10/93	353.	329.	.93
		1230.	1180.	.96

[a]Outside acceptance limit of ±15%

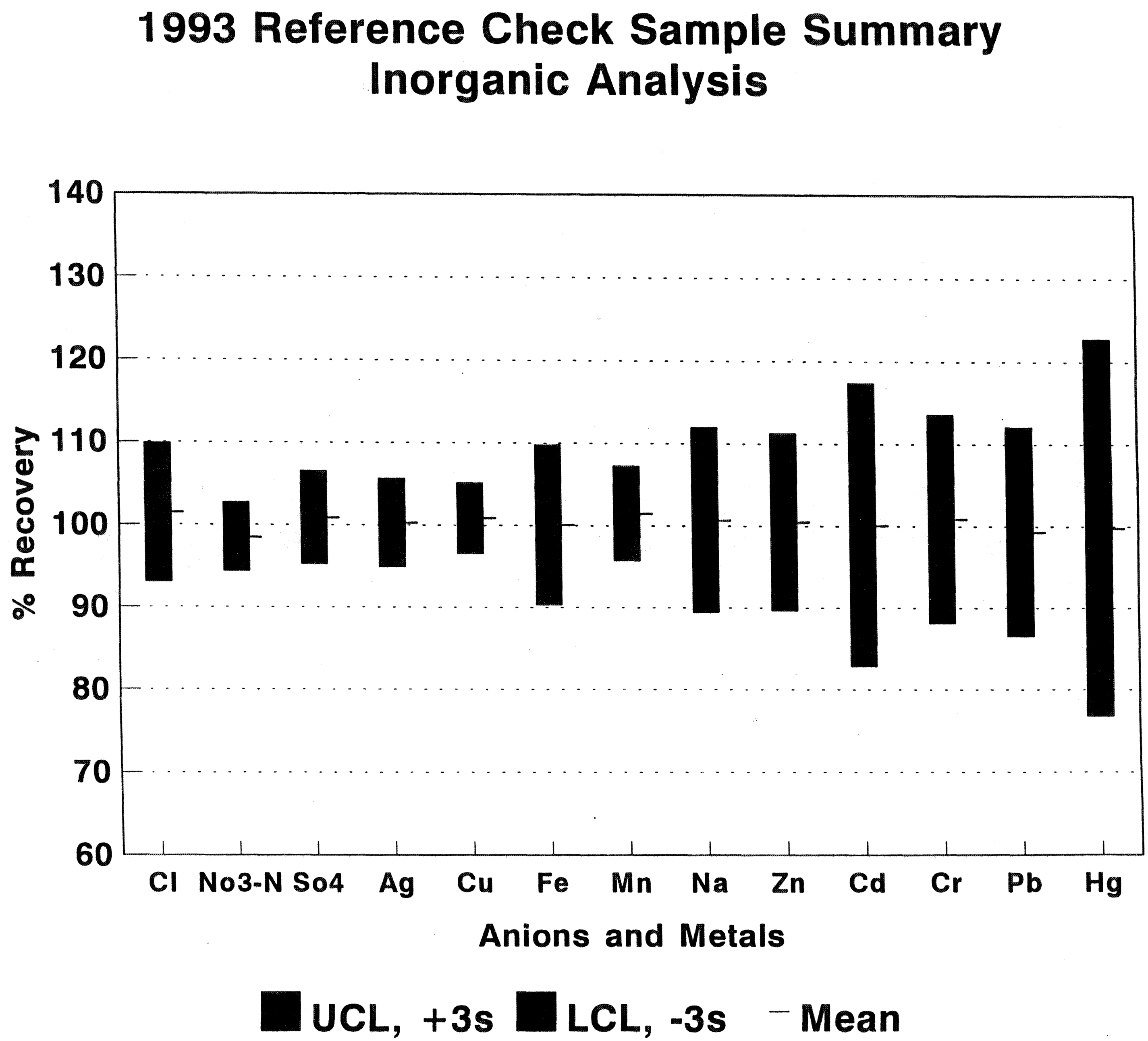


Figure 41: 1993 Reference Check Sample Summary.

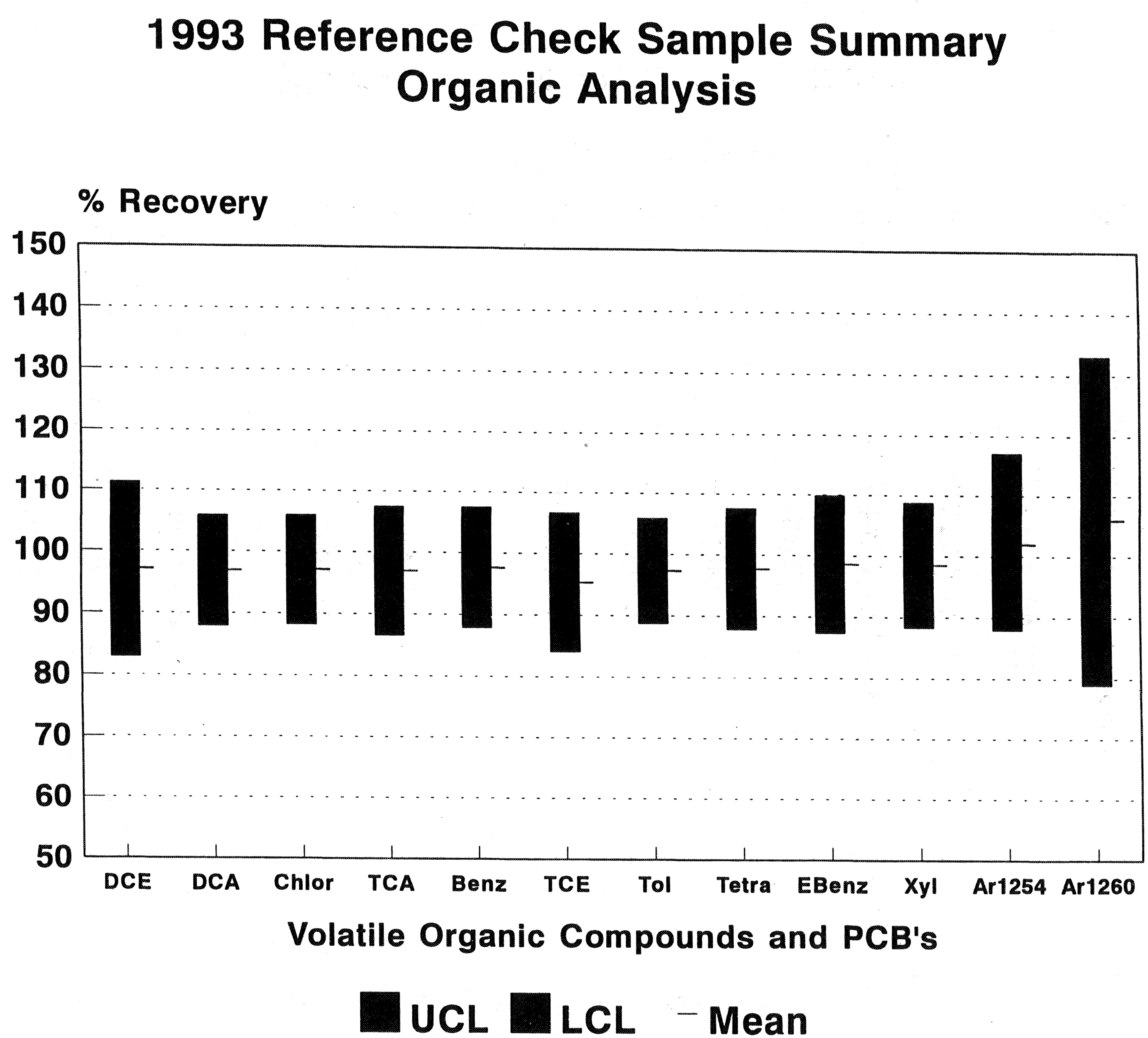


Figure 42: 1993 Reference Check Sample Summary.

Table 80
BNL National Pollutant Discharge Elimination System (NPDES)
Performance Evaluation Report

Analyte	Units	Date	NPDES	BNL	BNL/NPDES Ratio
Cu	$\mu g \cdot L^{-1}$	4/93	62	64	1.03
Fe	$\mu g \cdot L^{-1}$	4/93	3800	3900	1.03
Pb	$\mu g \cdot L^{-1}$	4/93	79.2	80.2	1.01
Zn	$\mu g \cdot L^{-1}$	4/93	1100	1110	1.01
pH	pH units	4/93	8.70	8.70	1.00
TSS	$mg \cdot L^{-1}$	4/93	43.2	45.9	1.06[a]
Ammonia-N	$mg \cdot L^{-1}$	4/93	5.5	5.6	1.02
NO_3-N	$mg \cdot L^{-1}$	4/93	34.0	34.5	1.01
Kjeldahl-N	$mg \cdot L^{-1}$	4/93	9.3	8.1	.87
5-Day BOD	$mg \cdot L^{-1}$	4/93	14.0	12.5	.89
Total Residual Cl	$mg \cdot L^{-1}$	4/93	.729	.68	.93

[a]Outside acceptance limit of ± 15%

APPENDIX A

A.1 Glossary of Terms

AGS - Alternating Gradient Synchrotron
ALF - Alternate Liquid Fuels
AOC - Area of Concern
ATF - Accelerator Test Facility
AUI - Associated Universities Inc.
BHO - Brookhaven Area Office
BLIP - Brookhaven LINAC Isotope Production Facility
BNL - Brookhaven National Laboratory
BETX - Benzene Ethylbenzene Toluene Xylene
BOD - Biochemical Oxygen Demand
CAA - Clean Air Act
CBS - Chemical Bulk Storage
CERCLA - Comprehensive Environmental Response, Compensation & Liability Act
CLP - Contract Laboratory Program
CFC - Chlorofluorocarbon
CH - Chicago
CO - Certificates to Operate
CSF - Central Steam Facility
CY - Calendar Year
CWA - Clean Water Act
DAS - Department of Applied Science
DAT - Department of Applied Technology
DCA - Dichloroethane
DCE - Dichloroethylene
DCG - Derived Concentration Guide
DMR - Discharge Monitoring Report
DOE - Department of Energy
DOT - Department of Transportation
ECL - Environmental Conservation Law
EM - Environmental Monitoring
EMG - Environmental Monitoring Group
EML - Environment Measurements Laboratory
EMSL-LV - Environmental Measurements Systems Laboratory - Las Vegas
EP - Environmental Protection
EPA - Environmental Protection Agency
EPIP - Environmental Protection Implementation Plan (EPIP)
EPS - Environmental Protection Section
ES&H - Environmental, Safety, and Health
GC/MS - Gas Chromatography Mass Spectrometer
HFBR - High Flux Beam Reactor
HWMA - Hazardous Waste Management Area
HWMF - Hazardous Waste Management Facility
HWMG - Hazardous Waste Management Group
HWMS - Hazardous Waste Management Section

IAG	- Interagency Agreement
LEPC	- Local Emergency Planning Committee
LINAC	- Linear Accelerator
LSC	- Liquid Scintillation Counting
MDC	- Minimum Detection Concentration
MDL	- Minimum Detection Limit
MLD	- Million Liters per Day
MOU	- Memorandum of Understanding
MPF	- Major Petroleum Facility
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NA	- Not Analyzed
NPDES	- National Pollutant Discharge Elimination System
ND	- Not Detected
NEPA	- National Environmental Policy Act
NESHAPs	- National Emission Standards for Hazardous Air Pollutants
NIST	- National Institute for Standards and Technology
NOV	- Notice of Violation
NPL	- National Priority List
NR	- Not Reported
NS	- Not Sampled
NSLS	- National Synchrotron Light Source
NYCRR	- New York Code of Rules and Regulations
NYS	- New York State
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
NYSDOT	- New York State Department of Transportation
NYS DWS	- New York State Drinking Water Standard
OER	- Office of Environmental Restoration
OU	- Operational Unit
PCB	- Polychlorinated biphenyls
PCE	- Tetrachloroethylene
PC	- Permit to Construct
P&GA	- Photography and Graphic Arts
PE	- Plant Engineering
PNA	- Polynuclear Aromatics
POC	- Principal Organic Compound
PVC	- Polyvinyl Chloride
QA	- Quality Assurance
RAC	- Remedial Action Committee
RCG	- Radiation Concentration Guide
RCRA	- Resource Conservation Recovery Act
RI/FS	- Remedial Investigation/Feasibility Study
RHIC	- Relativistic Heavy Ion Collider
RSD	- Response Strategy Document
SARA	- Superfund Amendments and Reauthorization Act

SCDHS - Suffolk County Department of Health Services
SDWA - Safe Drinking Water Act
SEAPPM - Safety and Environmental Administrative Policy and Procedures Manual
SEPD - Safety and Environmental Protection Division
SER - Site Environmental Report
SERC - (New York) State Emergency Response Committee
S&M - Supply and Materiel
SOC - Synthetic Organic Compound
SOP - Standard Operating Procedures
SPCC - Spill Prevention Control and Counter Measures
SPDES - State Pollutant Discharge Elimination System
STP - Sewage Treatment Plant
TCA - 1,1,1-Trichloroethane
TCE - Trichloroethylene
TCLP - Toxic Characteristic Leachate Procedure
TLD - Thermoluminescent Dosimeters
TPH - Total Petroleum Hydrocarbons
TSCA - Toxic Substance Control Act
TTA - Tiger Team Assessment
USFWS - United States Fish and Wildlife Service
UST - Underground Storage Tank
VOC - Volatile Organic Compound
WCF - Waste Concentration Facility
WSRRSA - Wild, Scenic, and Recreational River Systems Act
WTP - Water Treatment Plant

A.2 Glossary of Units

Bq	- Becquerel
Bq/L	- Becquerel per liter
Bq/M^3	- Becquerel per cubic meter
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
$CiMW^{-1}h^{-1}$	- Curie per megawatt hour
cm	- Centimeter
cm^3	- Cubicmeter
cm/d	- Centimeters per day
m^3/min	- cubic meters per minute
d	- Day
gal	- Gallon
GBq	- Giga Becquerel
GeV	- Giga electron volt
GeV/amu	- Giga electron volt per atomic mass unit
gph	- Gallon per hour
ha	- Hectare
kg/yr	- Kilogram per year
km	- Kilometer
L/d	- Liters per day
m	- Meter
mCi	- Millicurie
MeV	- Mega electron volt
mg/L	- Milligram per liter
ml	- Milliliter
MLD	- Million liters per day
mrem	- Millirem
mrem/yr	- Millirem per year
mSv	- milli seivert
mSv/yr	- milli seivert/year
MW	- Megawatts
nCi/L	- Nanocuries per liter
pCi/kg	- Picocuries per kilogram
pCi/L	- Picocuries per liter
pCi/m^3	- Picocuries per cubic meter
pH	- Hydrogen ion concentration
rem	- Unit of radiation dose equivalent
Sv	- Seivert
TBq	- Tera Becquerel
μCi	- Microcuries
μCi/L	- Microcuries per liter
μg/L	- Micrograms per liter

APPENDIX B

S. S. Chalasani, R. F. Pietrzak, and G. L. Schroeder

METHODOLOGIES

1. Methodology for Dose-Equivalent Calculations - Atmospheric Release Pathway

Dispersion was calculated for release elevations as listed in Table 6, at each of the 16 directional sectors, and for 6 distance increments (site boundary, 1.6-16 km, 16-32 km, 32-48 km, 48-64 km, and 64-80 km) from the center of the site using CAP88. The 1990 site meteorology as measured at 10 and 100 meter elevations was used to calculate the annual average dispersion for the midpoint of a given sector and distance. The radionuclide specific release rates (Ci/yr) from the HFBR stack, the Chemistry Building roof vent, the Van de Graaff roof vent, the BLIP stack, and the Hazardous Waste Management Incinerator stack were used to determine the annual emission rate for each radionuclide. The site boundary and collective data were obtained from the CAP88 computer code printout. The CAP88 calculates the total dose due to contributions from the submersion, ingestion, shoreline, and recreational pathways as a result of an atmospheric release. In 1990, two percent of the tritium atmospheric release from the 100 m stack was added to the 10 meter tritium source term in an effort to account for down-draft at the 100 meter stack.

2. Method for Tritium Dose-Equivalent Calculations - Potable Water Ingestion Pathway

The method used to calculate the maximum individual committed effective dose equivalent and the collective dose equivalent are present along with the basic assumptions used in the calculation. For the maximum individual, the highest annual average tritium concentration, as measured from a single potable well was used to calculate the total quantity of tritium ingested via the drinking water pathway. For the collective dose equivalent calculation, the annual average tritium concentration was obtained by averaging all positive results from potable wells which were in the demographic region adjacent to the Laboratory. The annual intake of tritium via the drinking water pathway was calculated from the following equation:

$$AI = 1 \times 10^{-6}\ C \cdot IR \cdot T$$

where: AI = Activity Intake, μCi

C = annual average water concentration, pCi/L

IR = Ingestion Rate (2) L/d

T = Time, 365 d

The committed effective-dose equivalent was calculated from the following equation:

$$H = AI \cdot DCF \cdot P$$

where: H = committed effective dose-equivalent, rem

AI = Activity Intake, μCi

DCF = Dose Conversion Factor, Rem/μCi (6.3E-5 rem/μCi)

P = Population at risk

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the population at risk in this area was assumed to be approximately 500.

3. <u>Methodology for Dose-Equivalent Calculations - Fish Ingestion Pathway</u>

In order to estimate the collective-dose equivalent from the fish consumption pathway, the following procedure was utilized:

a. Radionuclide data for fish samples were all converted to pCi/kg wet weight, as this is the form in which the fish is used.

b. The average fish consumption for an individual who does recreational fishing in the Peconic River was based on a study done by the NYSDEC which suggests that the consumption rate is 7 kg/yr.[50]

c. Committed Dose Equivalent Tables[51] were used to get the 50 year Committed Dose Equivalent Factor - rem/μCi intake.

The factors for the ingestion pathway for the radionuclides identified were:

^{3}H: 6.3E-05 rem/μCi intake

^{90}Sr: 1.3E-01 rem/μCi intake

^{137}Cs: 5.0E-02 rem/μCi intake

d. Calculation:

Intake (7 kg/yr) x Activity in flesh μCi/kg
x Factor rem/μCi intake = rem

e. Because there is a cesium-137 background as determined by the control location data, this background was subtracted from all data prior to use for dosimetric purposes.

f. As the Sr-90 analyses of fish samples were delayed, an estimate of Sr-90 concentrations in fish for 1992 were obtained by determining a Cs-137:Sr-90 ratio from Cs-137 and Sr-90 data of previous years. This factor was then used to estimate the Sr-90 concentration for use in dosimetric assessment.

4. Data Processing

Analytical results of the environmental and effluent monitoring programs are reported in tables that accompany the text. The data presented in these tables were generated as described below.

First, gross alpha, beta, and tritium results are reported as the net measured quantity. When only one sample was analyzed, results could be positive, zero, or negative. When the average concentration is reported, the average was computed by averaging the volume-weighted measured quantity. Because measured quantities were used throughout the report for these parameters, the reader should examine Appendix C to determine the typical analytical sensitivity for a particular parameter prior to deciding the importance of a result. Data which are less than the Minimum Detection Concentration (MDC) of the analytical technique should not be considered as positive results. Only data which exceed the MDC were used as positive results.

Second, gamma spectroscopy, strontium-90, and chemical analytical results were not converted to the new data presentation format; measured concentrations that were less than or equal to the MDC, while reported, were not used to compute average concentration levels. All MDC values were evaluated as if the results were zero. This explains occasional instances where the MDC is several times larger than the calculated annual average concentration.

Finally, if an analysis was performed and the result was less than the MDC of the system, the concentration was generally reported as not detected (ND). Appendix C presents typical MDCs for the analyses performed on environmental and effluent samples.

The following is a list of typical Minimum Detectable Limits (MDL) and Concentrations for the various analyses performed on environmental and effluent samples.

Nuclide	Matrix	Aliquot (ml)	MDC (μCi/ml)	MDL (μCi)
Gross alpha	water	1	2E-7	3E-7
		100	2E-9	
		500	5E-10	
Gross beta	water	1	6E-7	6E-7
		100	6E-9	
		500	1E-9	
Tritium	water	1	1.3E-6	1.3E-6
		7	3.0E-7	

Nuclide	300g MDL μCi/g	300ml MDL μCi/ml	12000ml MDL μCi/ml	Charcoal MDC μCi
^{7}Be	7.4E-8	9.8E-8	1.6E-9	9.3E-6
^{22}Na	9.4E-9	1.2E-8	2.0E-10	1.4E-6
^{40}K	1.8E-7	2.3E-7	3.9E-9	2.7E-5
^{48}Sc	1.1E-8	1.4E-8	2.3E-10	1.6E-6
^{51}Cr	7.6E-8	1.0E-7	1.6E-9	9.0E-6
^{54}Mn	8.4E-9	1.1E-8	1.8E-10	1.1E-6
^{56}Mn	2.2E-7	2.8E-7	4.7E-9	3.1E-5
^{57}Co	7.2E-9	9.2E-9	1.4E-10	7.5E-7
^{58}Co	8.3E-9	1.1E-8	1.8E-10	1.1E-6
^{60}Co	1.1E-8	1.4E-8	2.3E-10	1.5E-6
^{65}Zn	2.1E-8	2.2E-8	4.5E-10	3.0E-6
^{134}Cs	1.1E-8	1.4E-8	2.2E-10	1.4E-6
^{137}Cs	9.5E-9	1.2E-8	2.0E-10	1.3E-6
^{226}Ra	2.6E-8	3.0E-8	5.0E-10	2.9E-6
^{228}Th	2.1E-8	2.7E-8	4.3E-10	2.4E-6
^{82}Br	1.2E-8	1.6E-8	2.6E-10	1.6E-6
^{113}Sn	1.2E-8	1.6E-8	2.6E-10	1.4E-6
^{124}I	1.3E-8	1.7E-8	2.7E-10	1.7E-6
^{126}I	2.3E-8	3.3E-8	5.2E-10	2.8E-6
^{131}I	9.4E-9	1.3E-8	2.1E-10	1.1E-6
^{133}I	1.2E-8	1.6E-8	2.6E-10	1.6E-6
^{123}Xe	6.6E-7	8.6E-7	1.3E-8	7.3E-5
^{127}Xe	1.0E-8	1.3E-8	1.0E-10	1.2E-6

Constituent	(All concentration values in mg/L except where noted)
Ag	0.025
Cd	0.0005
Cr	0.005
Cu	0.05
Fe	0.075
Hg	0.0002
Mn	0.05
Na	1.0
Pb	0.005
Zn	0.02
Ammonia-N	0.02
Nitrite-N	0.01
Nitrate-N	1.5
Specific Conductance	10 umhos/cm
Chlorides	6.0
Sulfates	6.0
1,1,1-trichloroethane	0.002
trichloroethylene	0.002
tetrachloroethylene	0.002
chloroform	0.003
chlorodibromomethane	0.002
bromodichloromethane	0.002
bromoform	0.002
benzene	0.002
toluene	0.002
xylene	0.002

APPENDIX C
INSTRUMENTATION AND ANALYTICAL METHODS

S. S. Chalasani and R. F. Pietrzak

The analytical laboratory of S&EP Division is divided into 1) radiological, and 2) non-radiological sections to facilitate analysis of specific parameters in each category. The following analytes are analyzed in each category.

1) Radiological: Gross alpha, gross beta, gamma, tritium, and Sr^{90}.

2) Non-radiological: Purgeable aromatics, Purgeable halocarbons, PCBs, anions, and metals.

A brief description of methods and instrumentation for each category is given below. Only validated and regulatory referenced methods are used during the analysis. All samples are collected and preserved by trained technicians according to appropriate referenced methods. Well qualified and trained analysts are involved in performing different analysis. The analytical laboratory is certified by NYSDOH for all radiological and non-radiological parameters, except for PCBs. The radiological laboratory participates in:

1a) Gross Alpha and Gross Beta Analysis - Water Matrix

Water samples are collected in one liter polyethylene containers. No preservatives are added prior to sample collection. If the samples are effluent or surface stream samples from Locations DA, EA, HM, or HQ or Building 535B daily process samples then 100 ml are extracted for analysis. Ground water samples are typically analyzed using a 500 ml aliquot. Due to high iron content, 100 ml aliquots of ground water samples from the landfill areas may be used in this analysis. The aliquot is evaporated to near dryness in a glass beaker. The beaker is rinsed to remove the solids and the combined solids and rinsate are transferred to a 5 cm diameter planchet. The planchettes are evaporated to dryness, allowed to cool and then are counted in a gas flow proportional counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. System performance is checked daily with an americium-241 and chlorine-36 source.

1b) Gross Alpha and Gross Beta Analysis - Air Particulate Matrix

Air particulate samples are collected on 50 mm filters at a nominal flow rate of 15 liters per minute. At the end of the collection period, particulate filters are returned to the analytical laboratory for assay. Filter papers are counted twice in a gas flow proportional counter for 50 minutes. The first count occurs immediately upon receipt in the analytical laboratory. This count is used to screen the samples for unusual levels of air particulate activity. The filters are then recounted approximately one week later. The week delay permits decay of the short-lived radon/thoron daughters. The second analysis is used for environmental assessments. The first sample of each batch is a blank filter paper that is subtracted from the raw data prior to computation of net concentration. System performance is checked daily with an americium-241 and chlorine-36 source.

1c) Tritium Analysis - Water Matrix

Water samples are collected in one liter polyethylene containers. No preservatives are added prior to sample collection. If the samples are effluent or surface stream samples from Locations DA, EA, HM, or HQ or Building 535B daily process samples then 1 ml is extracted for analysis. Ground water and potable water samples are typically analyzed using a 7 ml aliquot. Liquid scintillation cocktail is then added to the sample aliquot so that the final volume in the liquid scintillation counting vial is 1 or 7 ml of sample plus 10 ml of cocktail. Samples are then counted in a low background liquid scintillation counter for 50 to 100 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. The second sample in each batch is a standard that is used to compute system performance and efficiency. Each sample is also checked for quenching. Corrections for background, quenching, and current system efficiency for the sample matrix and size are factored into the final net concentrations for each sample.

1d) Tritium Analysis - Air Matrix

Ambient and facility tritium air concentrations are measured by drawing the air at a rate of approximately 200 cc/m through a desiccant. At the end of each collection period, typically one week, the desiccant is brought to the analytical laboratory for processing. The desiccant is dried in a glass manifold system. Effluent samples have dedicated glassware as do environmental samples. The off gas containing moisture from the sampled air is collected by means of a liquid nitrogen trap. This water is then assayed for tritium content. A 7 ml aliquot is used for analysis. Liquid scintillation cocktail is then added to the sample aliquot so that the final volume in the liquid scintillation counting vial is 17 ml. Samples are then counted in a low background liquid scintillation counter for 100 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background that is subtracted from the raw data prior to computation of net concentration. The second sample in each batch is a standard that is used to compute system performance and efficiency. Each sample is also checked for quenching. Corrections for background, water recovery, air sample volume, quenching, and current system efficiency for the sample matrix and size are factored into the final net concentrations for each sample.

1e) Strontium-90 Analysis

Strontium-90 analyses are currently performed on water, soil, and aquatic biota samples. Water samples are processed in house using an EPA procedure adjusted in sample volume and counting time to meet MSL requirements. The procedure uses a ion-exchange column separation and isolation of the Sr-90 in a strontium carrier. Samples are prepared in batches. Chemical recovery is determined for each sample by the recovery of strontium carbonate. The use of batch blanks and counting system factors are used to verify the performance of the analytical system. The samples are counted twice to determine the strontium-90 and yttrium-90 ingrowth.

Samples of solids are shipped to a contractor laboratory for analysis of Sr-90. The analysis proceeds by using the HASL-300 procedure which utilizes wet chemistry techniques to isolate strontium-90 from the sample. Samples are counted twice to verify strontium-90 and yttrium-90 ingrowth. Chemical recoveries are determined by a combination of gravimetric and strontium-85 standard addition techniques. Samples are typically process in a batch. Backgrounds and system performance are verified with each batch. Chemical recoveries for both strontium-90 and yttrium-90 are determined for each sample.

1f) Gamma Spectroscopy Analysis

Surface, potable, and ground water surveillance samples are typically 12 liter samples that are placed in polyethylene bottles without preservatives. Samples are then passed through a mixed bed ion exchange column at a rate of 20 cc/m until all 12 liters have passed through the column. The column is then removed, placed in a teflon coated aluminum can, and counted for 50,000 seconds. Where effluent sampling is performed in a flow proportional manner, 10 cc aliquots are passed through the mixed bed column on an as needed basis. Typically samples sizes for this type of sample tend to approach the 50 to 100 liter size. Air particulate filter papers are counted directly on the detector for 10,000 seconds. Charcoal filter canisters are also counted directly on the detector with a count time of 10,000 seconds. Soil, vegetation, and aquatic biota are all processed following collection. Typically, 50g, 100g, or 300g aliquots are taken, placed in a teflon lined canister, and directly counted. For gamma spectroscopy analyses, backgrounds are collected once per week and system performance is verified daily. Analytical results reflect net activity that has been corrected for background and system response of the detection medium.

2a) Purgeable Aromatics and Purgeable Halocarbons

Water samples are collected in 40 ml glass vials with removable teflon-lined caps without any headspace and stored at 4° C and analyzed within 14 days.

Ten (10) purgeable compounds (benzene, toluene, ethyl benzene, total xylenes, chloroform, 1,1-dichloroethane, 1,1-dichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene) are analyzed under this category following EPA Method 624 protocols using GC/MS. These ten compounds were chosen as the target compounds since they are known or suspected to be present in the monitoring wells based on the DOE survey of the site in 1988[52] and a comprehensive analysis of 51 new monitoring wells using EPA's Contract Laboratory Program (CLP)[48,53] procedures in 1989. There are currently two Hewlett-Packard GCMS instruments. One instrument is exclusively used for the analysis of purgeable compounds and the other for screening extractables and other extraneous compounds in non-routine samples. Since ground water under BNL is classified as a sole source aquifer, the detection limits reported for the compounds are close to drinking water standards.

The method involves purging a 25 ml aliquot of the sample with ultra pure helium in a specially designed sparger using Purge and Trap technique. Each sample is spiked with known concentration of internal standards and surrogates before purging to facilitate identification, quantitation, and determination of the extraction efficiency of analytes from the matrix. The purged analytes are trapped on to a specially designed trap and thermally desorbed on to the DB-624 megabore capillary chromatographic column by back flushing the trap with helium. The compounds are separated into individual compounds with a temperature program of the GC and enter the mass spectrometer where they undergo fragmentation to give characteristic mass spectra. The unknown compounds are identified by comparing their mass spectra and retention times with reference compounds, and quantitated by internal standard method. The quantitation data is supported by extensive amount of QA/QC such as tuning mass spectrometer to meet bromofluorobenzene criteria, initial and continuing calibrations verifying daily response factors, method blanks, surrogate recoveries, duplicate analysis, matrix spike and matrix spike duplicate analysis and performing reference standard analysis to verify the daily working standard.

2b) PCB Analysis

Samples are collected in 50-100 ml glass containers with teflon-lined lid and stored at 4° C and analyzed within 14 days.

Transformer oil, mineral oil, hydraulic fluid, waste oil, and spill wipe samples are analyzed for PCBs using gas chromatography-electron capture detector (GC-ECD) method. This method is similar to EPA method 608 and is targeted to identify and quantitate seven different mixtures of PCB congeners in the samples.

The method consists of diluting a known weight of the sample with isooctane and removing the interfering compounds with one or more aliquots of concentrated sulfuric acid till the acid layer is almost colorless. All the oil matrix along with other interfering polar compounds are selectively removed from the sample, leaving PCBs in isooctane solvent.

There are two GC-ECD instruments for the analysis of PCBs. Each GC-ECD instrument is calibrated with different concentrations of each PCB mixture to establish linearity. The PCBs found in the samples are identified and quantitated by comparing the retention times and chromatographic patterns with the standards. Methods blanks, duplicates, spikes, and reference standards are run as part of QA/QC.

2c) Anions

Chloride, nitrate-N, and sulfate are analyzed using Dionex Ion-chromatography (IC) with ion suppression and conductivity detection technique.

Monitoring well samples are collected in 500 - 1000 ml polypropylene bottles, cooled to 4° C, and analyzed within 28 days. For nitrate analysis in drinking water analysis, samples are supposed to be analyzed within 48 hrs. However, even though holding times were exceeded for nitrate analysis of monitoring well samples, it is expected that the depletion of nitrate will be negligible.

The anions are passed through a anion-exchange polymer column and eluted with carbonate/bicarbonate solution. Then the eluent passes through a ion-suppressing column where the background contribution from the eluent is suppressed, leaving the target anions to be detected by conductivity meter.

Initially, the IC system is calibrated with standards to define the working range of the system. The target anions in the samples are identified and quantitated by comparing the retention times and areas with the standards. Method blanks, duplicates, replicates, spikes, and reference standards are routinely analyzed as a part of QA/QC.

2d) Metals

Samples are collected in 1000 ml polypropylene bottles and stabilized with ultra-pure nitric acid to a pH of <2. The samples are analyzed within 6 months, except for mercury, in which case the samples are analyzed within 28 days.

Cadmium, chromium, lead (furnace), copper, iron, manganese, silver, sodium, zinc (flame), and mercury (manual cold vapor) are analyzed with Perkin-Elmer atomic absorption spectrometer. Using the flame technique, the sample containing the target element is nebulized and atomized in an oxy-acetylene flame. At the same time, a beam of light from a element-specific hollow cathode lamp corresponding to the absorption frequency of target element is passed through the flame. The atomized element absorbs the energy specific to that element from the cathode lamp and the intensity of absorption is proportional to the concentration of the element in the sample. Calibration curves are run to establish the linearity of the system and samples are quantitated by comparing with standards.

Using the furnace technique, chemical interference is eliminated in two stages: first by heating the sample at 105 - 110° C to remove moisture and then at 600 - 900° C to burn out any organic matrix. Final atomization is achieved by heating the furnace to 2400 - 2700° C. The rest of the technique is similar to the flame method mentioned above. Using this furnace technique, sub-ppb detection limits are possible for water samples.

Using cold vapor technique for mercury, a 100 ml aliquot of the sample is digested with potassium permanganate/persulfate oxidizing solution at 95° C for 2 hours to oxidize any organically-bound and/or monovalent mercury to mercury (II) ion state. Excess oxidizing agent is destroyed with hydroxylamine hydrochloride. The mercuric ion later is reduced to elemental mercury with excess stannous chloride which is purged with helium into the absorption cell. The absorption is directly proportional to the concentration of mercury in the sample.

All the above mentioned atomic absorption techniques involve initial calibrations to define the calibration range, continuing calibrations, method blanks, duplicates, replicates, matrix spikes, and reference standard analysis as a part of QA/QC.

APPENDIX D

REFERENCES

1. United States Department of Energy, "Radiation Protection of the Public and the Environment", DOE Order 5400.5, February 1990.

2. "Safe Drinking Water Act", New York State-Section 1414 (e): Aquifer Underlying Nassau and Suffolk Counties (NYS) designated as a sole source [U.S. EPA 42 USCA Section 3004-3 (e)].

3. "Safe Drinking Water Act:, Title XIV: Safety of Public Water Systems; Part C: Protection of Underground Sources of Drinking Water".

4. New York State of Environmental Conservation. Water Quality Regulations: NYCRR, Title 6, Chapter X, Part 703.6, Effluent Standards and/or Limitations for Discharges to Class GA Waters.

5. United States Environmental Protection Agency, Environmental Radiation Data Report 59, July - September, 1990, EPA 520/5-91-025, March 1991.

6. United States Environmental Protection Agency, Environmental Radiation Data Report 60, October - December, 1990, EPA 520/5-91-026, June 1991.

7. United States Environmental Protection Agency, Environmental Radiation Data Report 61, January - March, 1990 EPA 520/5-90-031, September 1990.

8. United States Environmental Protection Agency, Environmental Radiation Data Report 62, April - June, 1990, EPA 520/5-91-044, December 1990.

9. Brookhaven National Laboratory Environmental Monitoring Reports - 1971-1987, Safety and Environmental Protection Division, BNL Report Nos. 17874, 18625, 19977, 21320, 22627, 50813, 51031, 51252, 51417, 51697, 51827, 51884, 51993, 52088, 52152, 52207, 52264.

10. Chapter 1 State Sanitary Code NYSDOH Part 5, Drinking Water Supplies Subpart 5-1 (Revised and adopted January 9, 1989).

11. New York State Department of Environmental Conservation, Classification and Standards Governing the Quality and Purity of Waters of New York State, Parts 700-703, 1978.

12. United States Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 1975, Amended February 19, 1988.

13. United States Department of Energy, "Quality Assurance," Order No. 5700.6C, September 1986.

14. Brookhaven National Laboratory, "Quality Assurance Manual," Revised March 1989.

15. Brookhaven National Laboratory, "Safety and Environmental Protection Quality Assurance Program Document", Revised May 1989.

16. Long Island Lighting Company Population Estimates, 1992.

17. Nagle, C. M., Climatology of Brookhaven National Laboratory: 1949-1973, BNL Report No. 50466, November 1975.

18. Nagle, C. M., "Climatology of Brookhaven National Laboratory: 1974 through 1977." BNL-50857, May, 1978.

19. Warren, M. A., W. de Laguna, and N. J. Lusczynski, "Hydrology of Brookhaven National Laboratory and Vicinity," Geological Survey Bulletin 1156-C, 1968.

20. Cohen, P. H. et al., Atlas of Long Island Water Resources, New York State Resources Bulletin No. 62, 1969.

21. Clearlock, D. B. and A. F. Reisenauer, "Site-wide Ground Water Flow Studies for Brookhaven National Laboratory," BNL Informal Report, December 1971.

22. H2M, Holzmacher, McLendon, and P. C. Murrel, in Association with Roux Associates, Aquifer Evaluation and Program Design for Restoration. Submitted to BNL, June 1985.

23. Koppelman, L. Long Island Waste Treatment Management Plan, Vol. I and II, July 1978.

24. Scheibel, Michael S. 1990. "Review of New York State Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory", Letter to Gerald C. Kinne, September 24, 1990.

25. Corin, Leonard P. 1990. "Review of Federally Threatened or Endangered Species Potentially Impacted by Construction of the RHIC at Brookhaven National Laboratory", Letter to Gerald C. Kinne, September 25, 1990.

26. New York Oil Spill, Control and Compensation Act, New York Navigation Law Article 12.

27. New York State Environmental Conservation Law, Article 70 Part 621, Uniform Procedures Act.

28. Letter from C. J. Daggett (U. S. Environmental Protection Agency Region II) to D. Schweller (U. S. Department of Energy Brookhaven Area Office), Reference: PCB-Contaminated Fuel; Subject: U. S. Environmental Protection Agency Final Approval, January 21, 1986.

29. 6 NYCRR Part 596: Registration of Hazardous Substance Bulk Storage Tanks, July 1988.

30. "Tiger Team Assessment of the Brookhaven National Laboratory", U. S. Department of Energy. DOE/EH-0140, June 1990.

31. Action Plan for the Tiger Team Assessment Report, Brookhaven National Laboratory, BNL 52258, Revision 3, October 15, 1990.

32. United States Department of Energy, "General Environmental Protection Program", Order 5400.1, November 1988.

33. Schroeder, G. L., and R. P. Miltenberger, "Brookhaven National Laboratory Environmental Monitoring Plan", 1991.

34. Personal Communications, L. Mausner, Medical Department, BNL, 1986.

35. Energy Research and Development Administration, Brookhaven National Laboratory, Final Environmental Impact Statement, July 1977.

36. Brookhaven National Laboratory, "Safety Manual", OSHA Guide 6.1.0, 1984.

37. Denham, D. M., et al., "A CaF2:Dy Thermoluminescent Dosimeter for Environmental Monitoring", BNWL-SA-4191, 1972.

38. Budnitz, R. J., A. V Nero, D. J. Murphy, and R. Graven, "Instrumentation for Environmental Monitoring," Volume 1, Radiation, Second Edition, Lawrence Berkeley Laboratory, 1983.

39. United States Environmental Protection Agency Regulations on National Emission Standards for Hazardous Air Pollutants, 40 CFR 61 - Revised - Federal Register Vol. 54, No. 240, December 1989.

40. National Council on Radiation Protection and Measurements, Recommendations on Limits for Exposure to Ionizing Radiation, NCRP Report No. 91, 1987.

41. Dvirka and Bartilucci, "Suffolk County Comprehensive Water Resources Management Plan", Volume 1, January 1987.

42. Thomlinson, W., Deer Population Estimate for BNL Site. Summer Project Report, March 1993.

43. "Compendium of Superfund Field Operations Methods", December 1987, U. S. Environmental Protection Agency, Washington, D.C.

44. New York State Department of Environmental Conservation, Personal Communication, Dr. F. Panek, 1985.

45. United States Department of Energy, "Internal Dose Conversion Factors for Calculation of Dose to the Public", July 1988.

DISTRIBUTION

Internal Distribution:

Department	Person	Department	Person
ADD	S. Musolino S. Ozaki	NSLS	K. Batchelor T. Dickinson D. McWhan
AGS	E. Lessard D. I. Lowenstein J. Spinner	OER	R. Howe
BIO	F. Wm Studier N. Temple	OMC	B. Breitenstein M. Sacker
BOOSTER	W. Weng	PE	W. Chaloupka J. Medaris E. Murphy
CHEM	C. Creutz N. Sutin	P&GA	K. Boehm J. Laurie M. Rosen
CS	A. Jens N. Satterly R. Spellman	PHY	P. Bond C. Carlson J. Collins K. Einfeldt J. Throwe
DAS	P. Carr C. Krishna P. Michael L. Petrakis	PUBLIC AFFAIRS	A. Baittenger
DAT	W. Becker R. Duffey	RD	M. Brooks N. Houvener
DIRECTOR'S OFFICE	S. Baron M. Bebon M. Blume M. Davis H. Grahn E. Rohrer N. Samios M. Schwartz R. Setlow	S&EP	W. Casey J. Deitz L. Emma C. Flood H. Kahnhauser A. Kuehner F. Marotta R. Miltenberger M. O'Brien O. White Safety Representatives
INST	V. Radeka R. Richardson	S&M	M. Guacci
MED	D. Joel G. Meinken H. Susskind	AUI	J. Hudis L. Willis

External Distribution:

DOE Distribution:

Office of Environmental Guidance and Compliance (EH-23) - 5 copies
Office of Environmental Audit (EH-24) - 2 copies
Office of NEPA Project Assistance (EH-25) - 2 copies
Chicago Operations Office - 10 copies
Brookhaven Area Office - 10 copies
H. McCammon, Office of Health and Environmental Research - 1 copy

EPA Distribution: (2 copies each)

P. Giardina, Radiation Safety Program, U.S. EPA Region II
W. Gunther, U. S. EPA, Office of Radiological Programs, Washington, DC
J. Logsdon, U. S. EPA, Office of Radiological Safety Program

New York State:

R. Aldrich, NYS Department of Health (DOH)
R. Becherer, NYSDEC
R. Schneck, NYSDEC
R. Cowen, NYSDEC
C. Hamilton, NYSDEC

Suffolk County:

J. Baier, Suffolk County Department of Health Services (SCDHS)
G. Proios, SCDHS
M. Hibberd, SCDHS
D. Moran, SCDHS
J. Pim, SCDHS
P. Ponturo, SCDHS
G. Tarulli, SCDHS
M. Trent, SCDHS
G. Proios, Suffolk County Executive Office
M. LoGrande, Suffolk County Water Authority

U.S. Congressman:

G. Hochbrueckner

General Distribution:

B. Balke, Lawrence Livermore Laboratory
P. E. Bramson, Batelle Pantex
D. Brekke, Sandia National Laboratory
D. A. Cirrincione, Rocky Flats Plant
J. Cossairt, Fermilab
I. M. Fisenne, Environmental Measurements Laboratory
N. W. Golchert, Argonne National Laboratory
D. W. Grobe, Fermilab
W. R. Hansen, Los Alamos Scientific Laboratory
J. D. Heffner, Savannah River Laboratory
D. L. Hoff, Idaho National Engineering Laboratory
J. Hunter, Rutgers University

General Distribution: (continued)

R. E. Jaquish, Pacific Northwest Laboratory
L. Koppelman, Nassau-Suffolk Regional Planning Board
B. Nemickas, United States Geological Survey
E. O'Connell, State University of New York, Stony Brook
P. Rohwer, Oak Ridge National Laboratory
J. D. Sage, Bettis Atomic Power Laboratory
A. R. Seepo, Schnectady Naval Reactors Office
L. Soholt, Los Alamos Scientific Laboratory
J. Soldat, Pacific Northwest Laboratory
R. K. Woodruff, Pacific Northwest Laboratory

NOTE: Additional reports are distributed to interested parties responding to the BNL press release that announces the issuance of the report.