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1986 ENVIRONMENTAL MONITORING REPORT

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

June 1987

SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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SAFETY AND ENVIRONMENTAL PROTECTION DIVISION

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BROOKHAVEN NATIONAL LABORATORY
ANNUAL ENVIRONMENTAL REPORT

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1.0 INTRODUCTION

1.1 Background

The primary purpose of Brookhaven National Laboratory's (BNL) environmental 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 Laboratory's environmental monitoring program is designed to accomplish these two primary objectives. While this annual report for calendar year 1986 follows the recommendations given in DOE Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements [1], and DOE/EP-0023, "A Guide for Environmental Radiological Surveillance at U.S. DOE Installations" [2], the scope has been broadened to meet site-specific environmental monitoring needs. This program includes the sampling and analysis for radioactivity, water quality indices, metals, and organic compounds.

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 surrounding communities is shown in Figure 1. About 1.33 million persons reside in Suffolk County [3] and about 0.39 million persons reside in Brookhaven Township, within which the Laboratory is situated. The distribution of the resident population within 80 km of the BNL site is also shown in Figure 1 and Table 1. Although much of the land area within a 16 km radius is either forested or under cultivation, there has been continuing development near the Laboratory during recent years.

The Laboratory site is shown in Figure 2. It consists of some 21.3 square kilometers (2130 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 watershed, with a principal tributary of the river rising in marshy areas in the northern and eastern sections of the site.

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 [4,5]. The average temperature in 1986 was 10°C (50°F) and the range was -17°C (2°F) to 35°C (95°F).

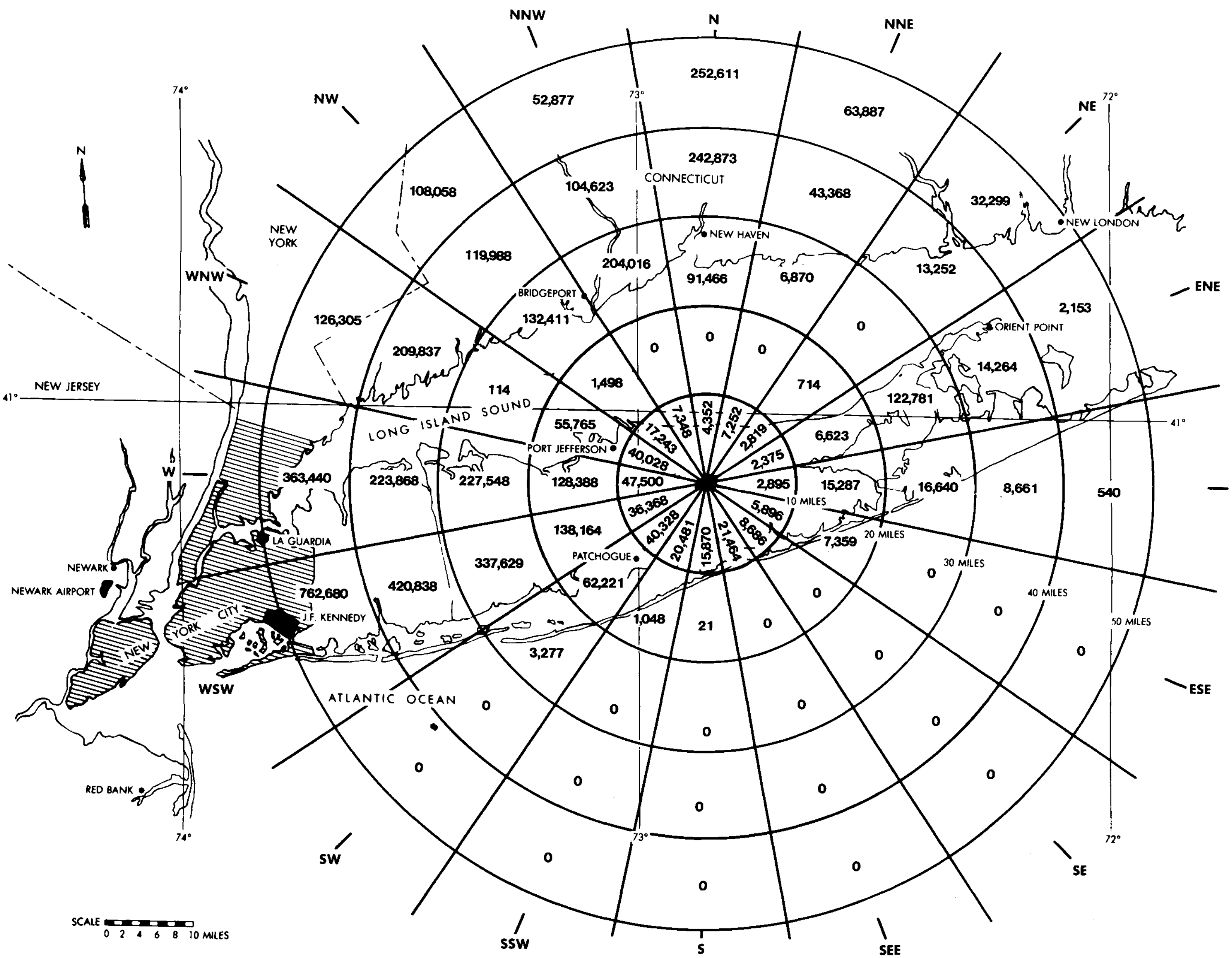


Figure 1. Resident Population Within an 80-km Radius of BNL

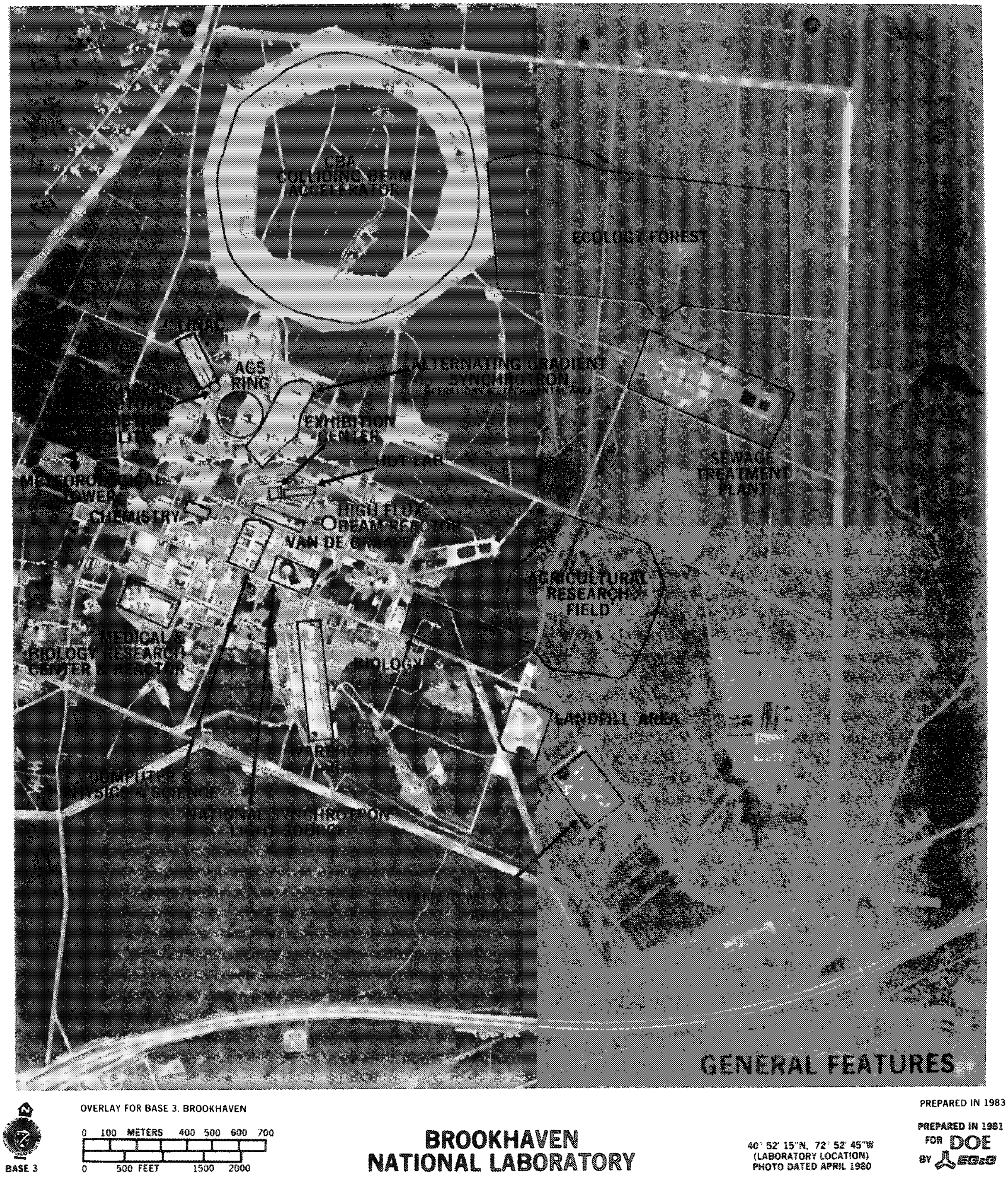


Figure 2. Brookhaven National Laboratory - Major Facilities

Studies of Long Island hydrology and geology [6-9] in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, which are between 31-61 m thick, are generally sandy and highly permeable. Water penetrates them readily and there is little direct run-off into surface steams, except during periods of intense precipitation. The total precipitation for 1986 was 111 cm. On the average, about half of this annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge ground water. The ground water in the vicinity of the Laboratory moves predominantly in a horizontal, southerly direction to the Great South Bay [6-9], taking a more easterly direction in the Peconic River watershed portions of the site. The estimated rate of movement at the ground water surface is about 45 cm/d [9].

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, and of other energy-related environmental pollutants,

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 High Flux Beam Reactor (HFBR) is fueled with enriched uranium, moderated and cooled by heavy water, and operated at a routine power level of 60 MW thermal.

2) The Medical Research Reactor (MRR), 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 (AGS), a proton accelerator, operates at energies up to 33 GeV, and is used for high energy physics research.

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

Production Facility (BLIP) and in the Chemistry Linac Irradiation Facility (CLIF).

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.

6) The National Synchrotron Light Source (NSLS) 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). It 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 200-MeV Radiation Effects Facility (REF) is being used for proton radiation damage studies on communication components and systems, and other materials. The REF utilizes the 200 MeV negative hydrogen ion beam produced at the Linac injector to the AGS.

9) The Relativistic Heavy Ion Collider (RHIC) is a proposed facility which will use the existing Tandem Van de Graaff, Heavy Ion Transfer Tunnel, the AGS Booster Ring (under construction), and the AGS to accelerate ions of deuterium, carbon, sulfur, copper, iodine, and gold at energies from 1.5 GeV/amu to 100 GeV/amu into an appropriate target in an effort to produce nuclear matter at extreme conditions of temperature and baryon density.

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

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, BLIP, MRR, and the research Van de Graaff, with lesser contributions from the Hot Laboratory, the HWM Facility, the Chemistry Building, and the MRC. The HFBR and BLIP contribute principally to the Laboratory's liquid radioactive wastes. Additional smaller contributions originate from the MRC, the Hot Laboratory complex, as well as from decontamination and laundry operations. Liquid radioactive waste is processed at the BNL Waste Concentration Facility.

2.0 SUMMARY

The environmental monitoring program has been designed to determine that BNL facilities operate such that the applicable environmental standards and effluent control requirements have been met. The data were evaluated using the appropriate environmental regulatory criteria. The environmental levels of radioactivity and other pollutants found in the vicinity of BNL during 1986 are summarized in this report. Detailed data are not included in the main body of the report, but are tabulated and presented in Appendix D. The environmental data include external radiation levels; radioactive air particulates and halogens; tritium concentrations; the amounts and concentrations of radioactivity in and the water quality of the stream into which liquid effluents are released; the organics, radioactivity, and water quality of the potable supply wells; the concentrations of radioactivity in biota from the stream; and the concentrations of organics, radioactivity, and the water quality of ground waters underlying the Laboratory. In 1986, the results of the surveillance program demonstrated that the Laboratory has operated within the applicable environmental standards.

2.1 Airborne Effluents

Argon-41, oxygen-15, and tritium were the predominant radionuclides released from BNL facilities. In 1986, 1225 Ci of argon-41 were released from the MRR stack; 150 Ci of oxygen-15 were released from BLIP; and 234 Ci of tritium were released from the Van de Graaff, MRC, and HFBR stacks.

2.2 Liquid Effluents

The effluent from the Laboratory sewage treatment plant is subject to the conditions of the State Pollutant Discharge Elimination System (SPDES) Permit No. NY 000 5835, authorized by the New York State Department of Environmental Conservation (NYSDEC). Operations at the sewage treatment plant resulted in a greater than 99% compliance rate in meeting permit requirements.

At the sewage treatment plant, the concentrations of gross alpha, gross beta, strontium-90, and gamma-emitting radionuclides have remained virtually constant. Tritium releases were 70% below those of 1985.

Approximately 12 million liters per day (MLD) of water were returned to the aquifer through on-site recharge basins. The monitoring data indicates that only trace quantities of radioactivity were discharged to the recharge basins as a result of routine facility operations. These concentrations were all small fractions of the applicable guides or standards. Analysis of non-radiological water quality parameters indicates that, with the exception of iron and pH, the discharge to the recharge basins met NYS drinking water standards.

2.3 External Radiation Monitoring

Thermoluminescent dosimeters (TLDs) were used to monitor the external exposure at on-site and off-site locations. The average annual on-site integrated dose for 1986 was 63.3 ± 5.6 mrem, while the off-site integrated dose was 59.2 ± 5.6 mrem. The difference between the on-site and off-site integrated exposure is within the statistical uncertainty of the measurement. If the measurement is real, it is most likely related to variations in the terrestrial component of the external dose.

2.4 Atmospheric Radioactivity

Tritium was the predominant radioactive effluent detected in environmental air samples. The maximum annual average tritium concentration at the site boundary was 2.8 times the average annual tritium air concentration measured at the control stations. This concentration would result in an annual effective dose equivalent of 0.003 mrem to the maximally exposed individual residing at the site boundary.

2.5 Radioactivity in Precipitation

In rainfall, the following radionuclides were detected: beryllium-7, cesium-137, iodine-131, ruthinium-103, and strontium-90. The measured concentrations were consistent with typical washout values associated with atmospheric scrubbing [10] and activity resulting from the accident at Chernobyl.

2.6 Radioactivity in Soil or Vegetation

No nuclides attributable to Laboratory operations were detected in samples collected in the vicinity of the Laboratory.

2.7 Peconic River

Concentrations of metals and indices of water quality were comparable to the Sewage Treatment Plant effluent; well within drinking water standards and reflecting ambient levels. At the former site boundary, the annual average gross beta concentration was 6.1 pCi/L or 12% of the New York State (NYS) Drinking Water Standards; and the average tritium concentration was 2.5 nCi/L or 13% of the NYS Drinking Water Standards. At the site boundary, the average gross beta concentration was 7.0 pCi/L or 14% of the NYS Drinking Water Standards; and the average tritium concentration was 2.0 nCi/L or 10% of the NYS Drinking Water Standards.

The Peconic River was sampled in Riverhead, approximately 19.5 km downstream of the site boundary. The average gross alpha concentration was 0.13 pCi/L; the average gross beta concentration was 1.7 pCi/L, and the average tritium concentration was below the analytical detection limit of the system. The gross alpha and beta concentrations were 0.1% and 3.4%, respectively, of the NYS Drinking Water Standards. In addition, cesium-137 was detected in the second quarter sample at a concentration of 0.13 pCi/L.

2.8 Aquatic Biological Surveillance

Fish were collected at stations HA, HB, HC, HD, HM (shown in Figure 12), and at control locations not influenced by the Peconic River. Shellfish in the Peconic Bay were also sampled in 1986. Only a small fraction of these samples have been analyzed. The preliminary data are reported here. All analyses are expected to be completed in 1987 and will be reported as the data become available. Based on results from a single Peconic River fish sample and a single control sample, the maximum individual dose from this pathway was 0.19 mrem and the collective dose was 112 mrem.

2.9 Potable Water Supply

With the exception of one well, all tritium concentrations were at or near the minimum detection limit. The average tritium concentration at this well, 2100 pCi/L, corresponded to 11% of the EPA Drinking Water Standard. Other nuclides, including cobalt-60 and sodium-22, were detected in several wells at small fractions (<0.01%) of the applicable Radiation Concentration Guide (RCG) [11]. No heavy metals were detected in the water supply wells. Two of these wells were removed from service in 1986. Well No. 1 was removed from service in September 1986, due to an observed concentration of 1,1,1-trichloroethane. Well No. 3 was removed from service in November 1986, due to the discovery of a potential ground water contamination within the steam plant.

2.10 Ground Water Surveillance

In addition to comparison of ground water concentrations to the applicable RCGs, the monitoring well data were evaluated against the more restrictive Environmental Protection Agency (EPA), New York State Department of Environmental Conservation (NYSDEC), and Department of Health (NYSDOH) Drinking Water Sandards since the aquifer underlying Long Island has been designated a "sole source" aquifer [12]. However, the prescribed limits are not directly applicable to the monitoring well data as these standards apply to community water supplies servicing more than 25 individuals [13].

2.10.1 Radionuclide Analysis

Elevated gross beta and tritium concentrations have been found on site adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to water losses from the tile collection field underlying the sand filter beds and the recharge of the Peconic River in these areas. In 1986, on-site gross beta and tritium concentrations were 20% and 30%, respectively, of the NYS regulations [13,14]. Adjacent to the Peconic River at the site boundary, the annual average gross beta concentration was 3% and the annual average tritium concentration was 33% of the NYS regulations. At a surveillance well located adjacent to the Peconic River and several hundred meters downstream of the site boundary, the annual average tritium concentration was 23% of the NYS standards.

In addition to the BNL off-site surveillance wells, private potable wells were sampled and analyzed for gross alpha, gross beta, strontium-90, and tritium as part of a cooperative program with the Suffolk County Department of Health. Five off-site areas were identified with detectable quantities of tritium in the potable water. The annual average tritium concentrations at these locations were less than 8% of the EPA Drinking Water Standard.

At the current and former sanitary landfill area, the maximum gross beta concentration was 50% of the applicable guide, while the maximum tritium concentration observed was 1.2 times the EPA Drinking Water Standard. One well in this area exceeded the strontium-90 drinking water standard by a factor of 1.4. Given the distance to the site boundary, radioactive decay alone would serve to reduce the tritium concentration to a level well below the Drinking Water Standard.

The data from the ground water program at the Hazardous Waste Management area indicate that the tritium, fission, and activation products the have entered the ground water system are migrating from their source. The concentrations of cesium-137 and cobalt-60 were 0.003% and 0.002%, respectively, of the RCGs.

2.10.2 Analysis of Metals, Organics, and Water Quality

Iron, lead, and manganese were found in excess in the NYS standards in numerous sampling wells on site. However, with the exception of wells which monitor the landfill, this appears to be related to corrosion from the well casings and not to Laboratory effluents. At the landfill, the maximum concentrations of iron, lead, and manganese, were 102, 0.04, and 6.4 mg/L, respectively. Trace levels of 1,1,1-trichloroethane were detected in two monitoring wells near the sand filter beds, in one well near the current landfill, in two control wells, and in two wells which monitor the former landfill.

Elevated levels of chlorocarbons (low ppm range) were measured in wells which monitor the Hazardous Waste Management Facility. During 1986, the Laboratory determined the extent of chlorocarbon contamination, which is currently confined to the Laboratory property [9]; and has adopted an aggressive plan for aquifer restoration. Samples from wells in this area which were analyzed prior to and after the initiation of this project exhibited significant changes in the concentration of the organics.

2.11 Off-Site Dose Estimates

For the year 1986, the collective dose-equivalent attributable to Laboratory sources, for the population up to distance of 80 km, was calculated to be 2.0 rem. This can be compared to a collective dose-equivalent to the same population of approximately 300,000 rem due to natural sources.

3.0 ENVIRONMENTAL PROGRAM INFORMATION: Facility Effluents, Environmental Measurements and Analyses

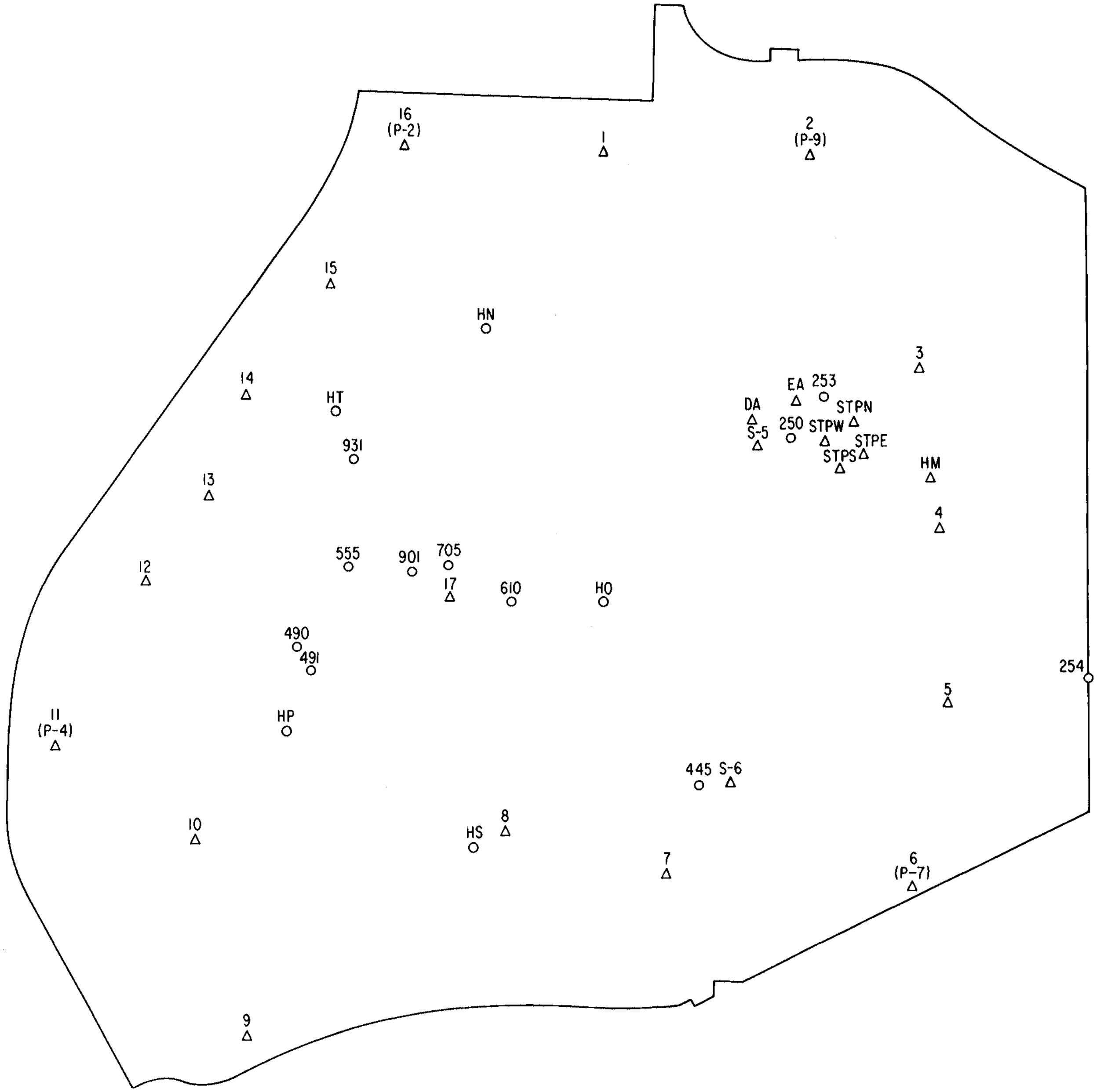
3.1 Airborne Effluents

The locations of principal Laboratory facilities from which radioactive effluents are released to the atmosphere are shown in Figure 3. The installed on-line effluent monitors, sampling devices, and the types and amounts of effluents released during 1986 are indicated in Appendix D, Table 2. Tritium was the major radionuclide detected at the site boundary which was attributable to Laboratory operations.

3.1.1 Airborne Radioactive Effluents

At the BLIP facility, oxygen-15, which has a two minute half-life, is produced by the interaction of protons and water in the beam tubes and generated at an estimated rate per unit beam current of 6 mCi per microampere-hour. The 1986 oxygen-15 production rate was determined by facility management during a reassessment of BLIP airborne effluent releases [15]. Based on 25 milliampere-hours of operation, 150 Ci of oxygen-15 was produced in the beam tubes at the BLIP facility during 1986 and released via the stack. At the Medical Research Reactor, argon-41, which has a 110-minute half-life, is

Figure 3. Brookhaven National Laboratory – Effluent Release Points and On-Site Environmental Monitoring Stations



0 180 360 Meters
SCALE

△ ENVIRONMENTAL MONITORING STATIONS

AIR

- 1 THRU 16 PERIMETER STATIONS
- S-6 WASTE MANAGEMENT AREA
- S-5 SEWAGE TREATMENT PLANT
- 17 CENTER OF SITE
- STPN SEWAGE TREATMENT PLANT NORTH
- STPE SEWAGE TREATMENT PLANT EAST
- STPS SEWAGE TREATMENT PLANT SOUTH
- STPW SEWAGE TREATMENT PLANT WEST

WATER

- DA SEWAGE TREATMENT PLANT INFLUENT
- EA SEWAGE TREATMENT PLANT EFFLUENT
- HM PECONIC RIVER, 0.5 MI. DOWNSTREAM FROM TREATMENT PLANT

○ 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 GRAAFF STACK
931	BLIF STACK
445	WASTE MANAGEMENT
610	STEAM PLANT
HN	RECHARGE BASIN
HO	RECHARGE BASIN
HP	RECHARGE BASIN
HS	RECHARGE BASIN
HT	RECHARGE BASIN

produced by neutron activation of stable atoms of argon-40 in the ventilating air of the reflector. It is released from the stack at an estimated rate of 2 Ci $MW^{-1}h^{-1}$. The release estimate for the MRR stack during 1986 was 1200 Ci of argon-41. Of the 234 Ci of tritium released from the Laboratory research facilities during 1986, 77 Ci were in the gaseous elemental form, and 157 Ci were released as tritiated water vapor.

The Laboratory incinerates certain wastes which contain low-level radioactivity in the Hazardous Waste Management Incinerator (Figure 3). The total quantities of the individual radionuclides that were incinerated during 1986 are shown in Appendix D, Table 3. Tritium was the radionuclide released from the incinerator in the largest quantity, 94.5 mCi. Site meterological 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.

Gamma-emitting nuclides released from the 100-meter stack at Building 705 are shown in Appendix D, Table 4. Bromine-82, iodine-131, and iodine-133 are present as a result of operations and experimental activities at the HFBR. The remaining radionuclides are generated from operational activities at the Hot Laboratory.

3.1.2 Airborne Elemental and Hydrocarbon Effluents

The potential sources of elemental and hydrocarbon air pollutants emitted by BNL facilities and all environmental permits issued to the Department of Energy at BNL are listed in Appendix D, Table 5. Under the air permits issued by the NYSDEC, individual stack monitoring is not required since emissions are reduced at the source through the use of pollution control equipment appropriate for the specific process.

Most of the heating and cooling requirements for the principal buildings at the Laboratory are supplied by the Central Steam Facility (Figure 3). From 1976 to the present, the Laboratory has utilized light feed stock (LFS) materials, such as mineral spirits, alcohol, solvents, jet fuel, and reconstituted fuels in addition to No. 6 oil. These materials are classified as EPA-regulated hazardous waste due to their ignitability and are blended with No. 6 oil to form Alternate Liquid Fuel (ALF). In 1986, the fraction of LFS relative to total fuel consumption, was approximately 55%. These light stock fuels typically have a weighted average sulfur content of 0.5% or less as compared to the NYSDEC regulatory limit of 1% sulfur content in No. 6 oil [16]. NYSDEC also requires that the combustion efficiency of the boilers be 99.0% at a minimum [16]. Stack testing, conducted in accordance with NYSDEC requirements, has demonstrated the mean fuel combustion efficiency over the entire range of boiler loading capacities to be greater than 99.9% for the individual boiler units firing ALF [17,18], thus meeting the state criteria.

Samples of all LFS used in the preparation of ALF are routinely analyzed for polychlorinated biphenyls (PCBs) to ensure that the facility operations are conducted in accordance with EPA and NYSDEC regulations. In October of 1984, it was determined that 300,000 gallons of off-specification military fuels contained low levels of PCBs at a concentration of 80 ppm. The U.S. EPA and NYSDEC were notified and the Laboratory applied for a provisional EPA permit (in accordance with 40 CFR 761) to burn the fuel. A 10% fuel firing rate will ensure that the concentration will be well below the EPA limit of 50 ppm. The demonstrated destruction and combustion efficiencies and the installation of additional monitoring equipment during 1985 indicates that the EPA requirements will be satisfied.

Technical approval to incinerate the PCB-contaminated fuel in BNL's high-efficiency boilers, designated as Boiler No. 4 and Boiler No. 5, was granted by the USEPA Region II on January 21, 1986.

3.2 Liquid Effluents

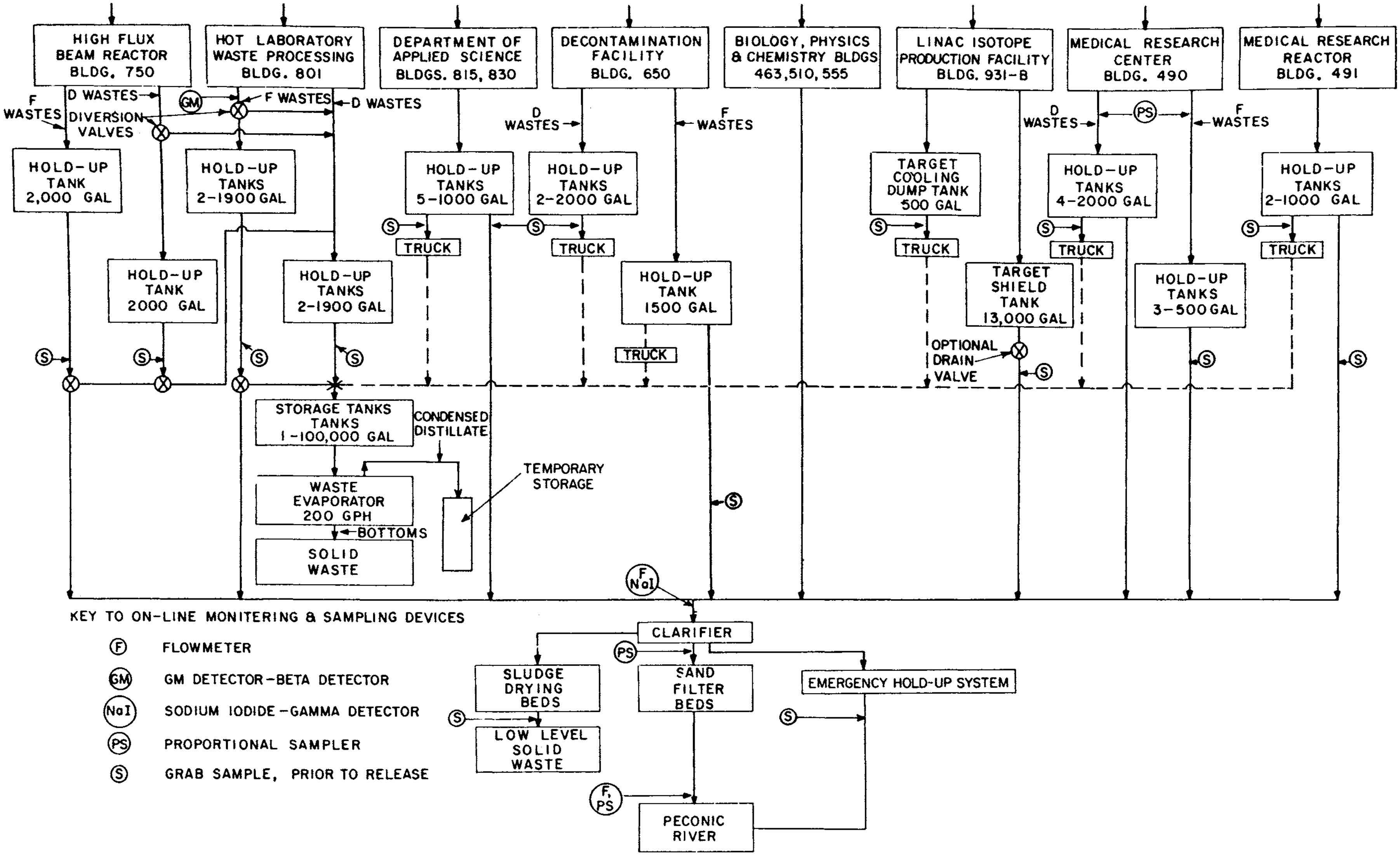
The basic principle of liquid waste management at the Laboratory is to minimize the volumes of liquids requiring decontamination prior to on-site release or processing into solid form for off-site burial at a licensed facility [19]. Accordingly, liquid wastes are segregated by the generator at the point of origin on the basis of their anticipated concentrations of radioactivity or other potentially harmful agents.

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

The Waste Management Group also collects small quantities of liquid radioactive wastes. Depending on the radionuclide and its concentration, these wastes are either solidified at the Hazardous Waste Management Facility or processed at the Waste Concentration Facility. Buildings where large volumes (up to several hundred liters) of liquid radioactive waste are generated have dual waste handling systems. These systems are identified as "active" (D) and "inactive" (F). As shown in Figure 4, wastes placed into the D and F systems are collected in holdup tanks. After sampling and analysis, they are either discharged directly to the sanitary waste system [20] or are transferred to the Waste Concentration Facility (WCF). At this facility, liquid waste is distilled to remove particulates, suspended and dissolved solids. The residues from the evaporator are transferred to the Waste Management Area for off-site disposal. Wastes routed directly to the Laboratory sanitary waste system become mixed with large quantities (approaching 3,000,000 L/d) of cooling and other uncontaminated water routinely produced by diverse Laboratory operations.

3.2.1 Sewage Treatment Plant (STP)

Primary treatment of the liquid stream collected by the sanitary waste system to remove suspended solids was provided by a 950,000 liter clarifier. The liquid effluent flows from it onto sand filter beds (secondary treatment), from which about 93% of the water was recovered by an underlying tile field. This recovered water was then released into a small stream that contributes to the headwaters of the Peconic River. The balance, about 7%, was assumed to have percolated to the ground water under the beds and/or lost through evaporation. A schematic of the sewage treatment plant and its related sampling arrangements is shown in Figure 5. Volume proportional and grab samples were collected each working day at the STP.



Liquid effluent systems Brookhaven National Laboratory.

FIGURE 4

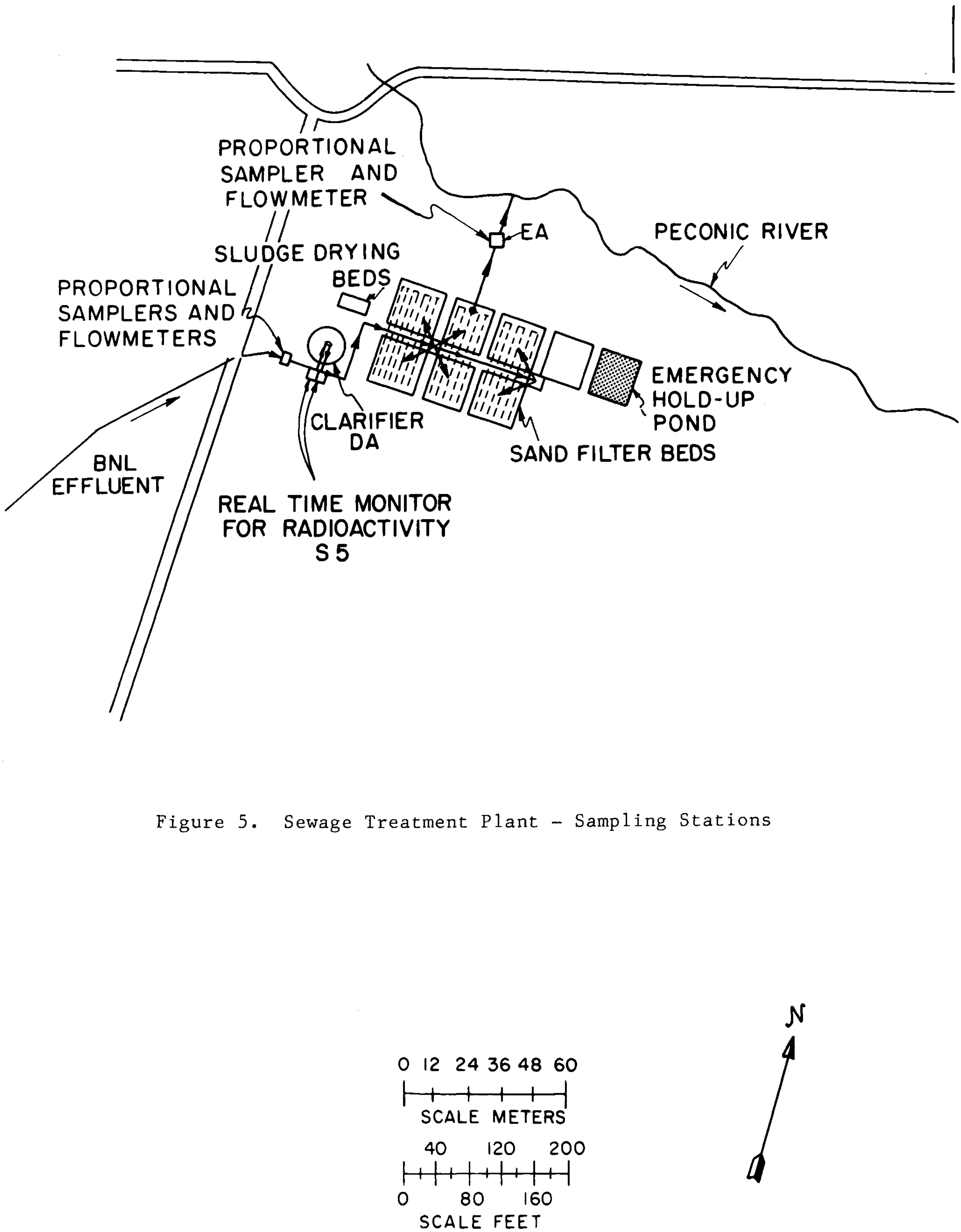


Figure 5. Sewage Treatment Plant - Sampling Stations

3.2.1.1 Radionuclide Analysis

The proportional samples collected at station DA, the influent to the STP clarifier, and station 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 Appendix D, Tables 6 and 7.

The gross alpha, beta, and tritium concentrations at both stations decreased between 1985 and 1986. This reduction represents the Laboratory's continuing efforts to minimize radionuclide releases to the Peconic River. Figures 6 and 7 present trend analyses of gross beta and tritium concentrations over the years 1980 to 1986, which corroborate the above statements. The concentration of strontium-90 at these stations remained within the range observed over the past seven years (0.21 to 1.23 pCi/L). Although slight fluctuations were observed, the released quantities and the radiological profile of gamma emitting radionuclides remained constant (0.3 to 1.5 pCi/L) over the past few years. All radioactive releases were substantially below applicable standards or radiation concentration guides.

3.2.1.2 State Pollutant Discharge Elimination System Permit - Metals and Water Quality Analysis

The effluent from the Laboratory sewage treatment plant (station EA) is subject to the conditions of the State Pollutant Discharge Elimination System (SPDES) Permit No. NY 000 5835, authorized by the New York State Department of Environmental Conservation (NYSDEC). Monitoring reports, which include analytical results, are submitted on a monthly basis to the NYSDEC and the Suffolk County Department of Health Services (SCDHS). A summary of these data for 1986 is shown in Appendix D, Table 8. The summary includes data required under the permit and additional analyses which were performed under the Laboratory's broader surveillance program. Operation at the sewage treatment plant resulted in a greater than 99% compliance rate in meeting permit requirements. One pH and two iron concentration values were not in compliance with the permit conditions.

3.2.2 Recharge Basins

An overall schematic of water use at the Laboratory is shown in Figure 8. After use in "once through" heat exchangers and process cooling, approximately 12 million liters per day (MLD) of water was returned to the aquifer through on-site recharge basins; 0.98 MLD to basin HN located about 610 m northeast of the AGS; 7.0 MLD to basin HO about 670 m east of the HFBR; and 4.0 MLD to basin HP located 305 m south of the MRR. The increase in flow to recharge basin HO and the decrease in flow to basin HN resulted from the rerouting of a major portion of the cooling water from the AGS facility to the HO sump. The locations of the basins on the Laboratory site are shown in Figure 9. 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, 0.54 MLD was discharged to the HN basin, and 4.9 MLD to the HO basin. The HFBR secondary cooling system water recirculates through mechanical cooling towers and was treated with inorganic polyphosphate and

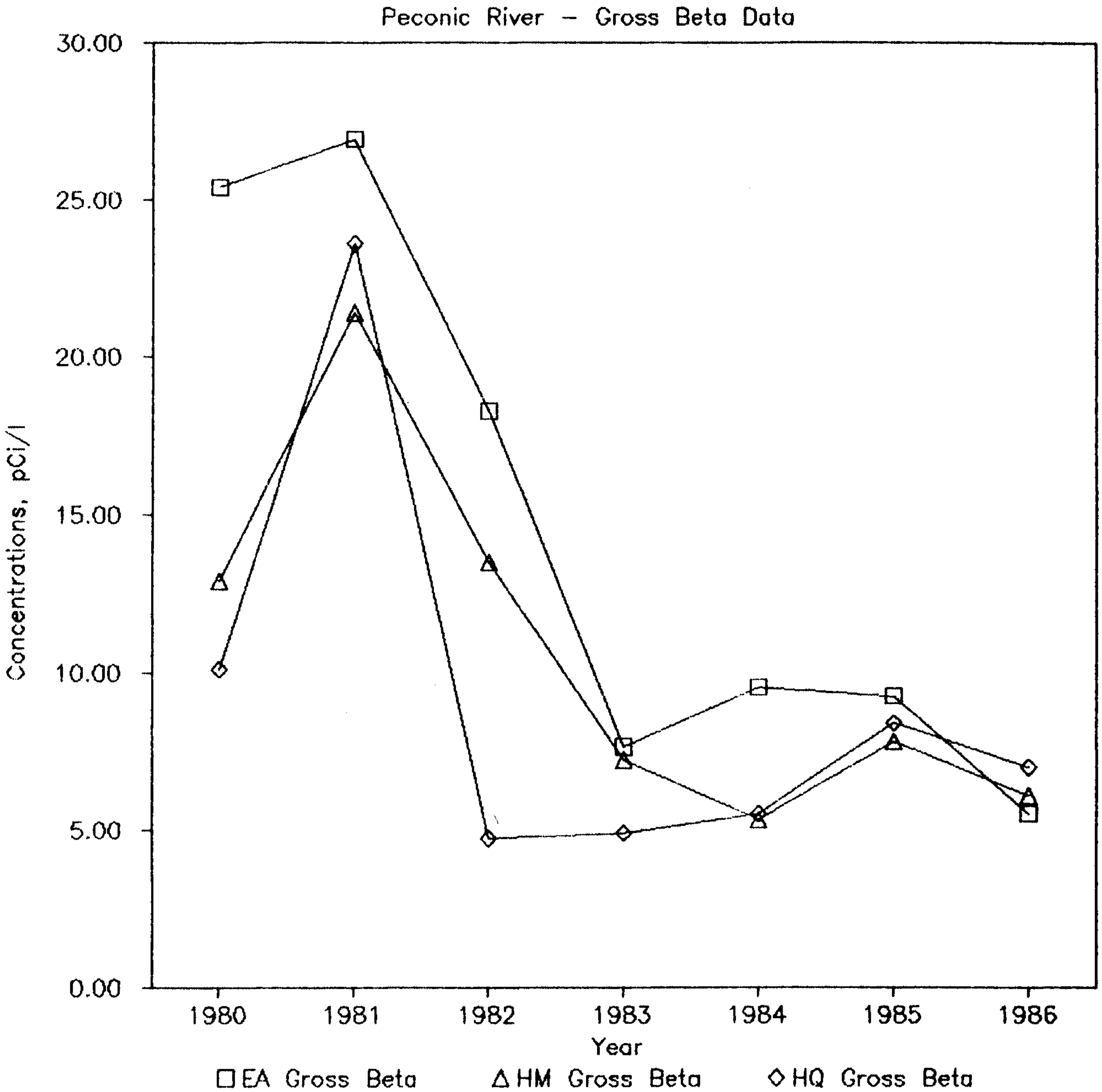


Figure 6. Trend Analysis - Gross Beta Concentration in the Peconic River On-Site 1980 to 1986

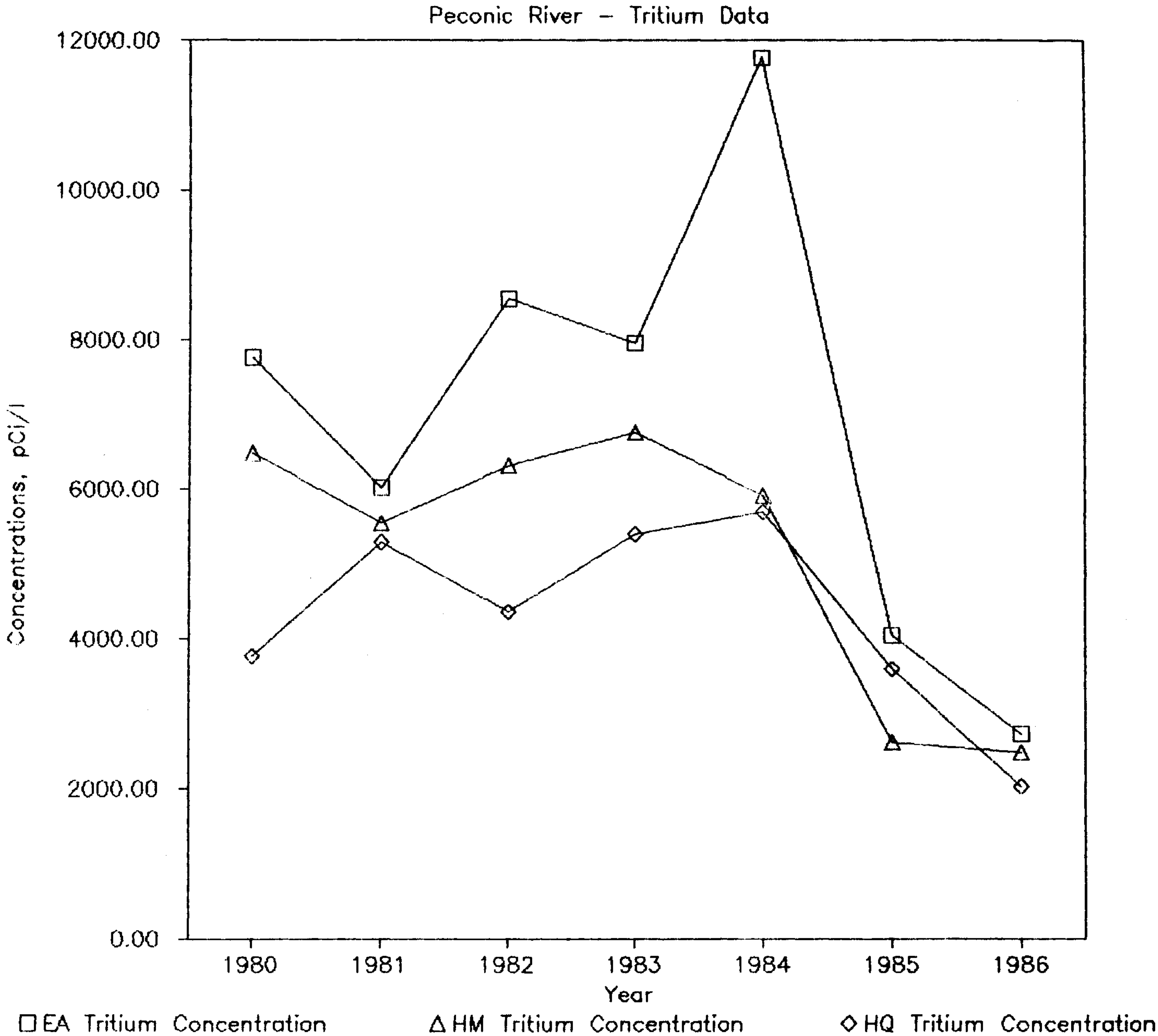


Figure 7. Trend Analysis - Tritium Concentration in the Peconic River On-Site 1980 to 1986

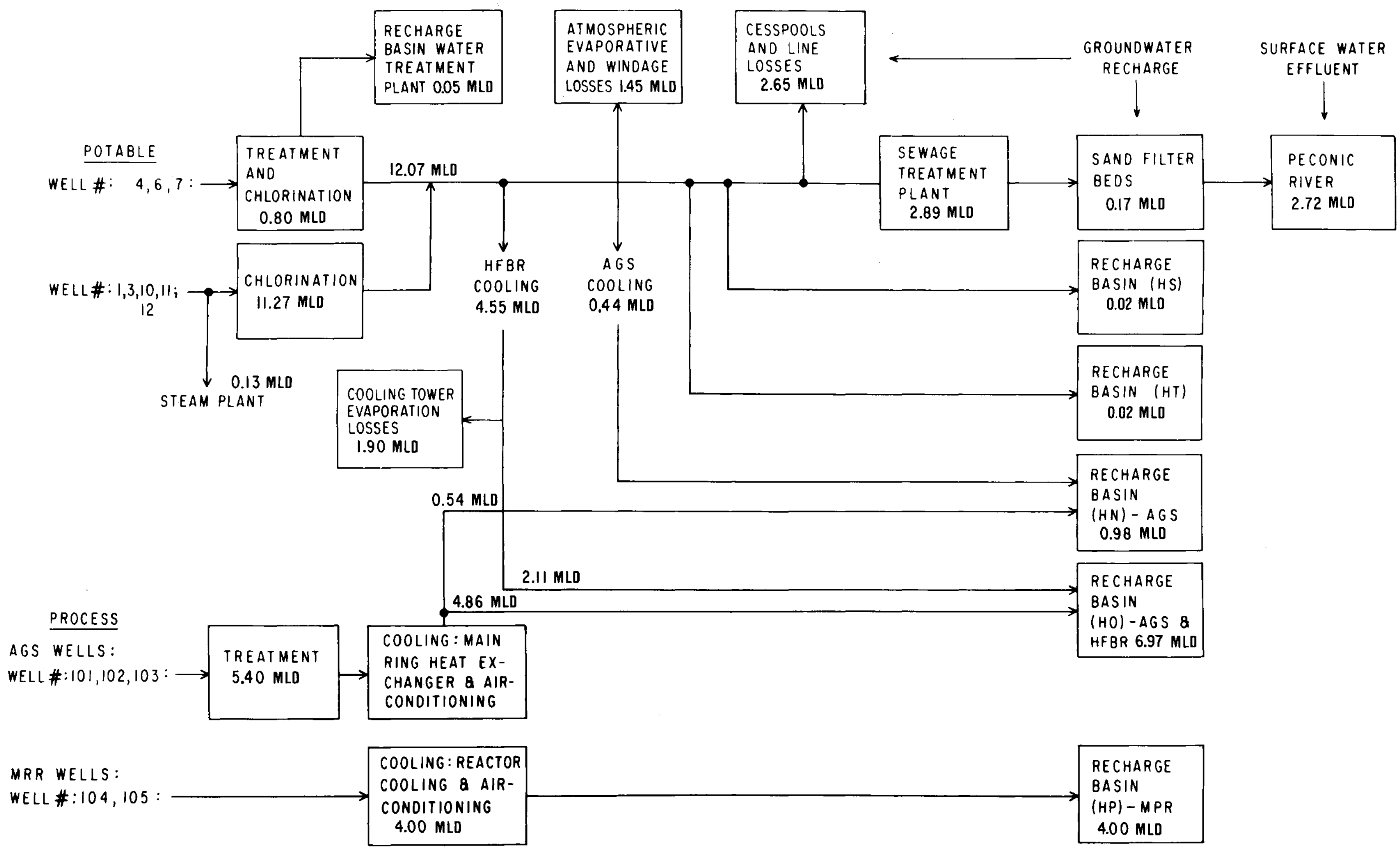


Figure 8. Brookhaven National Laboratory - Schematic of Water Use and Flow

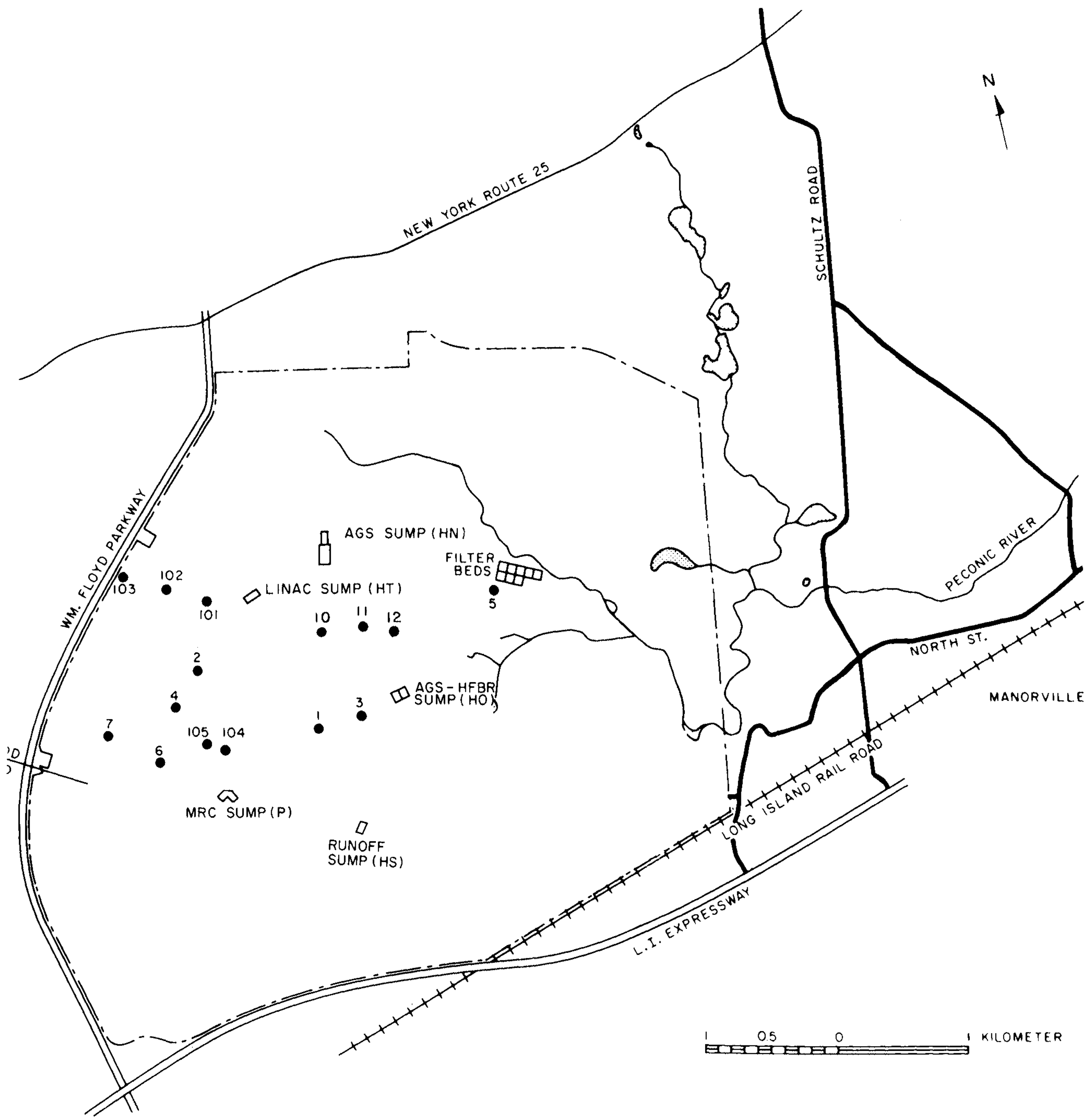


Figure 9. On Site: Potable and Supply Wells and Recharge Sumps

mercaptobenzothiozone to control corrosion and deposition of solids. The blowdown from this system (2.1 MLD) was also discharged to the HO basin. The MRR secondary cooling water (4.6 MLD) was adjusted to a neutral pH prior to use and then discharged to the MRC sump shown in Figure 9. Grab samples were collected at all recharge basins for analysis of water quality.

3.2.2.1 Recharge Basins - Radionuclide Analysis

Radiological results for recharge basin samples are reported in Appendix D, Tables 9A and 9B. The data indicates that trace quantities of activity were discharged to all recharge basins. The activity detected at recharge basin HN results from the discharge of primary magnet rinse water into the recharge basin. The observed concentrations of beryllium-7 and sodium-22 result from high energy particle interactions in the cooling water at both the AGS and Linac facilities. The presence of cobalt-60 is most likely due to activation of facility components and subsequent corrosion.

Tritium is present as a result of its use in research activities conducted in a number of Laboratory facilities. Its concentrations in the recharge basin were small fractions of the applicable guides or standards.

3.2.2.2 Recharge Basins - Metals and Water Quality Analysis

The BNL SPDES permit requires that records be maintained of the pH and quantity of water discharged to the basins. In 1986, the 12 MLD which were recharged had a pH range of 5.0 to 10.1. The results of selected water quality parameters are presented in Appendix D, Table 10. With the exception of iron and pH, the discharge to the basins met both the SPDES permit conditions and NYS drinking water standards for metals and other water quality criteria.

3.3 Environmental Measurements and Analyses

3.3.1 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 thermoluminescent dosimeters (TLDs) [21]. The locations of the on-site and off-site TLDs are shown in Figures 10 and 11, respectively. The standard 16 sectors with sector #1 centering on true North have been used to locate the TLDs. The dose--equivalent rates observed are given in Appendix D, Table 11. The annual average dose-equivalent rate as indicated by all TLDs was 60.7 mrem/a. The dose-equivalent rate at the site boundary was 63.3 mrem/a, while the off-site average rate was 59.2 mrem/a.

In 1986, the on-site external exposure measurements made during the first quarter were on a monthly basis. The sampling frequency for the remainder of the year was changed to quarterly in an effort to eliminate the bias identified in the 1985 Environmental Monitoring Report [22]. The convergence of the on-site and off-site TLD measurements indicates that TLD exposure period had an impact on the measurements. A comparison of differences between TLD measurements at the same location and adjacent to each other indicate that the

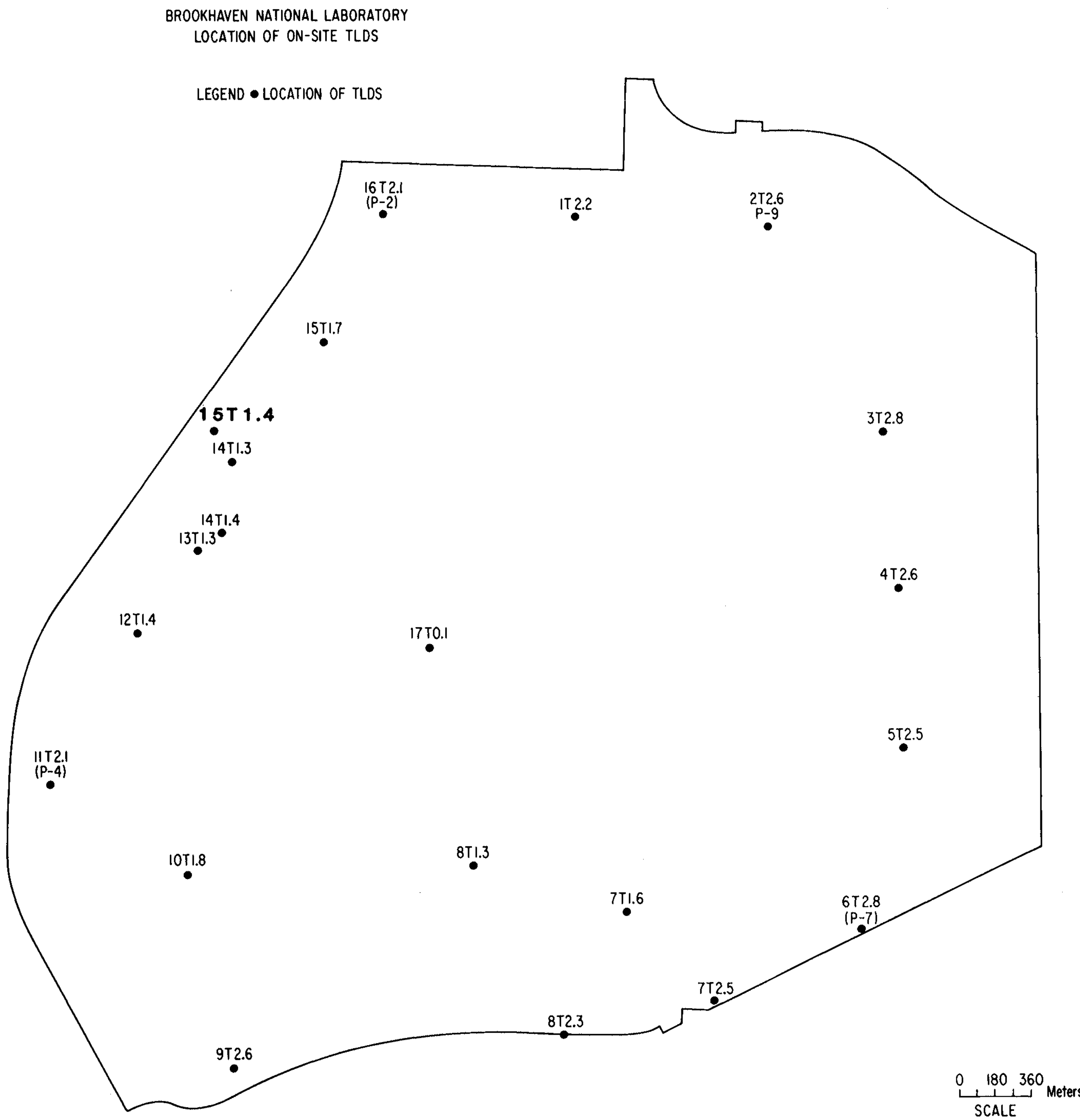


Figure 10. Brookhaven National Laboratory - Location of On-Site TLDs

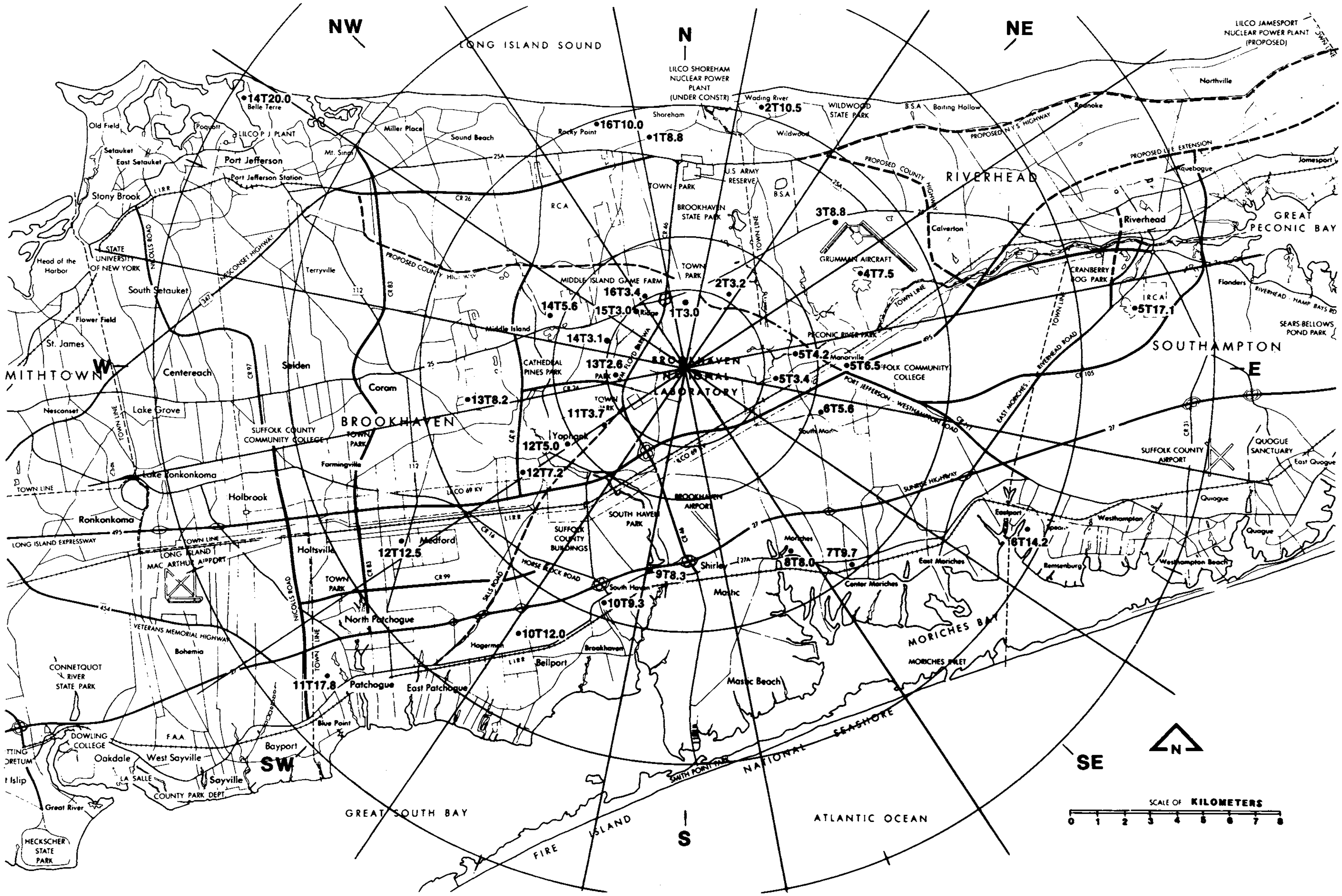


Figure 11. Location of Off-Site TLDs

range of the observed control data is 0.5 to 2 mrem with an average of 1 mrem in 1986.

The maximum site boundary dose due to airborne emissions was calculated using AIRDOS-EPA as being less than 0.07 mrem. This value is not measurable using today's best available technology. Differences between the on-site and off-site TLD measurements data reflects environmental differences between TLD locations.

3.3.2 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 fission products related to the nuclear power accident at Chernobyl, USSR, and tritium.

3.3.2.1 Tritium Analyses

Sampling for tritium vapor was performed at 21 on-site (shown in Figure 3) and one off-site control air sampling location located 17 km southwest of the Laboratory. In addition, results of tritium measurements for a location inside the analytical laboratory are also presented. Water vapor was collected by drawing a stream of air through silica gel cartridges. The data collected from the site perimeter, analytical laboratory, and control monitoring stations are presented in Appendix D, Table 12. Other on-site monitoring stations at the Hazardous Waste Management area and Sewage Treatment Plant are presented in Appendix D, Table 13. The maximum annual average tritium concentration at the site boundary was observed at station 1 and was 5.8 pCi/m^3. This air concentration, if inhaled continuously for one year, would result in whole body dose from the inhalation and submersion pathways of three microrem.

The highest annual average air concentration measured on-site was at the Hazardous Waste Management work area. The air sampler is located in the middle of the facility where radioactive materials are packaged for off-site disposal and where the HWM incinerator is located. The whole body dose resulting from continuous exposure to this concentration would be 21 microrem. The airborne tritium concentrations measured in the S&EP analytical laboratory and outside Builiding 535 reflect ambient air concentrations in the analytical laboratory and in the central part of the Laboratory site.

The monitoring stations at the Sewage Treatment Plant were installed in August 1985 to monitor the air concentrations resulting from the use of the Emergency Holding Pond as a solar evaporator for the disposal of 70,000 gallons of tritiated distillate from the Waste Concentration Facility (WCF). This project was terminated in December 1986, at which time the contents of the pond was pumped back to the sand filter beds and discharged with the normal BNL waste water. The airborne concentrations of tritium measured at the holding pond indicated that this did not contribute to the levels detected at the site boundary nor did they contribute a significant dose to the operators of the Sewage Treatment Plant.

3.3.2.2 Radioactive Particulates

During 1986, positive displacement air pumps were operated at five on-site monitoring stations (P-2, P-4, P-7, S-5, and S-6). The sampling media consisted of a 5-cm diameter air particulate filters followed by a 62.5 cm^3 beds of triethylene diamine-impregnated charcoal for the collection of radiohalogens. The air particulate samples were counted for gross alpha and beta activity using an anti-coincidence proportional counter on a weekly basis. In addition, analyses for gamma-emitting nuclides were performed on the composite filter papers and each charcoal bed on a monthly basis. The gross alpha and beta analytical results are shown in Appendix D, Tables 14A through 14E. Gamma-emitting radionuclides detected on the particulate and charcoal filters are reported in Appendix D, Tables 14F through 14K. The presence of Chernobyl fallout, weapons test fallout from previous years, and cosmogenically produced radionuclides were detected by gamma spectroscopy. No activity attributable to BNL operations was detected.

3.3.3 Radioactivity in Precipitation

A pot-type rain collector is situated adjacent to the sewage treatment plant (see Figure 3). Collections were made whenever precipitation was observed. Portions of each collection were processed for gross alpha, beta, and tritium analysis. A fraction was composited for quarterly strontium-90 and gamma analysis. The data for 1986 are reported in Appendix D, Table 15 and reflect typical wash-out values associated with atmospheric scrubbing [10] and the presence of radioactive particulates resulting from the nuclear accident at Chernobyl, USSR.

3.3.4 Radioactivity in Soil and Grass

The results of soil and grass sampling conducted at four locations in the vicinity of the site are shown in Appendix D, Table 16. The results are consistent with data collected in previous years [22]. No nuclides attributable to Laboratory operations were detected; the observed concentrations represent the contribution of primordial and cosmogenic sources, and weapons test fallout.

3.3.5 Peconic River Aquatic Surveillance

3.3.5.1 Peconic River - Radionuclide Analysis

Radionuclide measurements were performed on surface water samples collected from the Peconic River at several locations; HM, the location of the former site boundary approximately 225 meters downstream of the discharge point; HQ, located at the current site boundary, 700 meters downstream from the discharge point; HA and HB, located approximately 6 km downstream from the discharge point; HC, located approximately 8.5 km downstream from the discharge point; HD, located approximately 12 km downstream from the discharge point; HR, located 21 km downstream from the discharge point, and station HH, a control station located on the Carmens River, which is not influenced by BNL liquid effluent. The Peconic River sampling stations are identified in Figure 12.

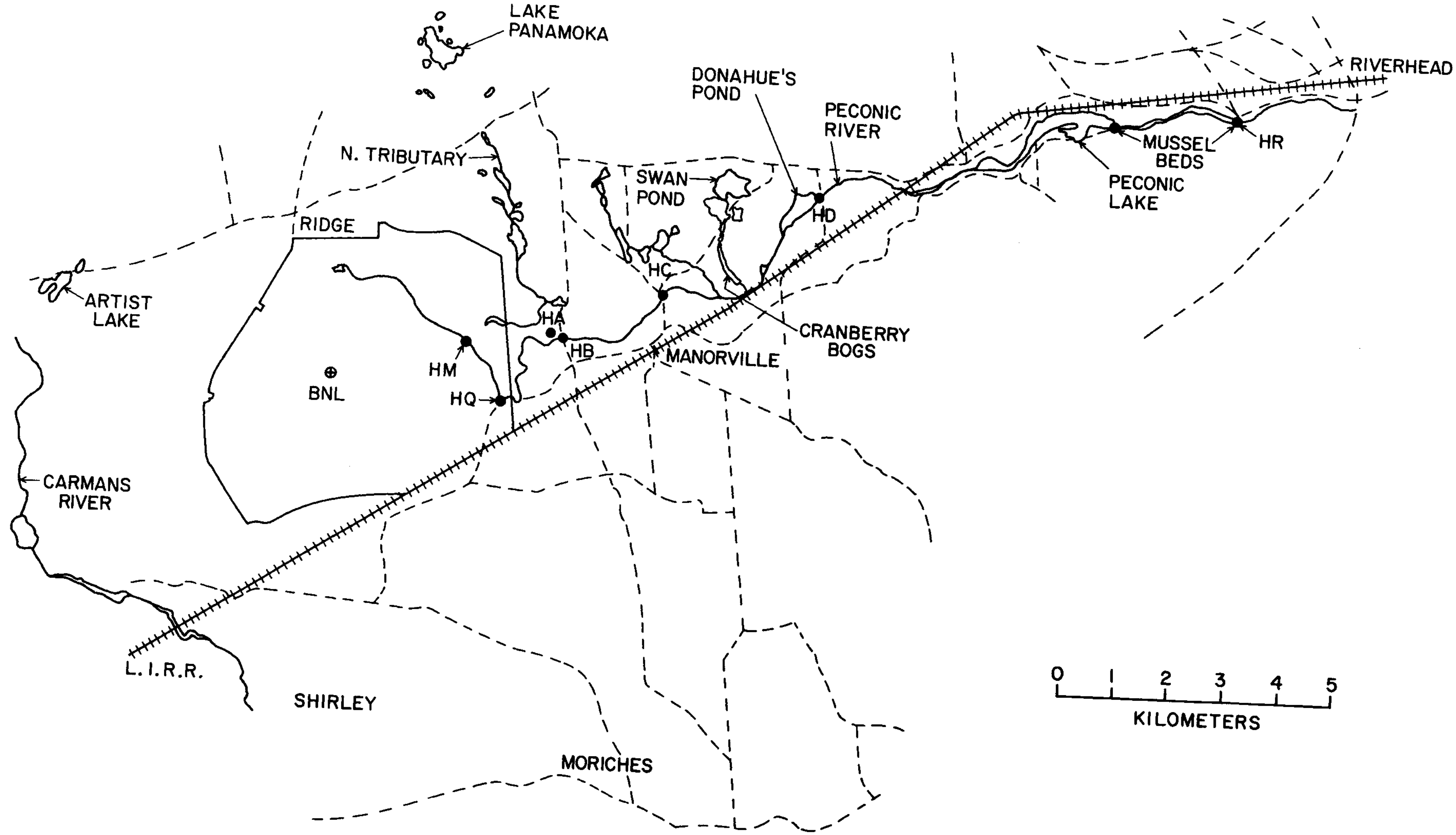


Figure 12. Peconic River Sampling Stations

Samples collected at stations HM and HR were time-proportional samples. No estimate of total flow was made at these stations during the sample period. Sample collections at all other stations along the Peconic River consisted of grab samples that were collected in conjunction with the aquatic biota sampling program. Grab samples were collected at the control station on a monthly basis, weather permitting.

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Appendix D, Tables 17A and 17B. The gross alpha, beta, and tritium data indicate that only gross beta and tritium are present above ambient levels in BNL effluent waters. Elevated gross beta and tritium levels do not extend beyond station HQ. Gamma and strontium-90 analyses were not performed on samples from locations HA, HB, HC, HD or HQ. Gamma spectroscopy results from locations HM and HR indicate that only naturally occurring potassium-40 and cesium-137, due to weapon test fallout, were detectable at station HR. In 1986, almost all of the Sewage Treatment Plant effluent either evaporated or was recharged to the ground water prior to leaving the site. The surface water gamma-spectroscopy, gross beta, and tritium analyses support this observation.

3.3.5.2 Peconic River - Metals and Water Quality Analysis

Measurements of selected non-radiological water quality parameters were performed at the former site boundary location (HM). The pH range was 5.2-7.2. Heavy metals such as chromium, cadmium, silver, and lead were not detected. Manganese and mercury were occasionally detected at the lower limit of detection while concentrations of iron, zinc, sodium, copper, and nitrates were all below the Drinking Water Standards and SPDES effluent limitations.

3.3.6 Aquatic Biological Surveillance

The Laboratory, in collaboration with the New York State Department of Environmental Conservation (NYSDEC) Fisheries Division, has an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies (Figure 12). Fish samples were collected at stations HA, HB, HC, HD, HM, AND EA (Figure 12). Control samples were obtained from off-site fresh water bodies which are not influenced by the Peconic River.

In addition, Peconic Bay shellfish were sampled to determine radionuclide content. Only a small fraction of the samples that were collected have been analyzed. The data from completed analyses are shown in Appendix D, Table 18. All analyses on samples collected in 1986 are expected to be completed in 1987 and will be reported as the data become available.

3.3.7 Potable Water and Process Supply Wells

Well Nos. 1, 4, 6, 7, 10, 11, and 12 supplied water for potable use during 1986. Well No. 3, located at the Central Steam Facility (CSF), was used exclusively for boiler make-up water at the CSF. Well Nos. 101, 102, and 103 provide cooling water to the AGS facility. Well Nos. 104 and 105 provide secondary cooling water to the MRR.

The Laboratory's potable water wells and cooling water supply wells are screened from a depth of about 15 m to about 46 m, in the Upper Glacial aquifer, with one exception. Well No. 104 is screened from a depth of 60 to 90 m in the Magothy aquifer. As was shown in Figure 9, most of these wells are located west or to the northeast of the Laboratory's principal facilities and "upgradient" to them in the local ground water flow pattern. As was indicated in Figure 8, about 22 MLD were pumped from them in 1986. Grab samples were obtained from these wells on a monthly to quarterly basis and analyzed for radioactivity, water quality indices, metals, and volatile organic compounds.

Two of these wells were removed from service in 1986. On September 4, 1986, Well No. 1 was removed from service due to an observed concentration of 1,1,1-trichloroethane. Well No. 3 has also been temporarily removed from service since November 1986 due to the discovery of a potential for ground water contamination (see Section 7.4) within the Steam Plant area.

3.3.7.1 Radionuclide Analysis

The average radionuclide concentrations are reported in Appendix D, Table 19. The presence of tritium, cobalt-60 and sodium-22 in Well Nos. 1, 3, 10, 11, and 101 appear related to Laboratory operations. Radionuclide concentrations in potable water are all fractions of the applicable water standards or guides and do not pose a safety or health risk to individuals who drink or use the water on-site.

3.3.7.2 Metals, Water Quality, and Organic Compound Analyses

The water quality and metals data for the Laboratory potable supply wells are shown in Appendix D, Table 20. With the exception of pH, indices of water quality such as nitrates, sulfates, chlorides, and metals were all well within the limits established in the New York State Drinking Water Standards [13,14]. The lower pH values represent values typical of Long Island. The water supplies were analyzed monthly for residual chlorine and the presence of coliform bacteria and monthly reports were submitted to the SCDHS. The analyses indicated that bacteria were not detected in samples and the BNL potable supply is well within the requirements of the EPA National Primary Drinking Water Standards [23] and the New York State Sanitary Code [13].

The majority of metals including silver, cadmium, chromium, copper, mercury, lead, and zinc were not detected in the Laboratory supply system. Iron, manganese, and sodium were present at ambient levels which were well within the New York State Standards.

Water samples from potable wells were also analyzed for volatile organic compounds. The results are shown in Appendix D, Tables 21A and 21B. The results for 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and chloroform (common contaminants detected in Long Island wells) [24] are shown in Appendix D, Table 21A. Chloroform and 1,1,1-trichloroethane were detected in small concentrations in several of the potable wells on the BNL site. With the exception of Well No. 1, which was removed from service in September, 1986, the observed concentrations were well within the NYS Drinking Water Standards or advisory limit [13,14,23]. The wide distribution of the two compounds apparently represents an extended zone of very low-level contamination in the developed portion of the BNL site. However, since a number of wells are located in areas upstream from the principal facilities, it is not clear whether the low concentrations are due to past Laboratory practices, or to those of the Department of Army during its use as Camp Upton. The concentrations of chloroform and 1,1,1-trichloroethane in Well No. 1 are more clearly related to Laboratory activities. On a less frequent basis (twice per year), the wells were analyzed for the broader range shown in Appendix D, Table 21B. In most cases, these compounds were not detected in BNL potable water.

3.3.8 Ground Water Surveillance

Samples of ground water were obtained from a network of surveillance wells which have been installed in the vicinity of several locations where the potential for ground water contamination exists or has been confirmed. These include areas adjacent to the on-site recharge basins, the sand filter beds, the Peconic River, the Waste Concentration Facility, the Central Steam Plant, the Hazardous Waste Management Facility, the former landfill area, the current landfill, and the decontamination facility sump. The locations of most of these ground water surveillance wells are shown in Figure 13. Wells installed at the landfill and solid waste management area are shown in Figure 14. Because the aquifer underlying Nassau and Suffolk Counties has been designated as a "Sole Source" [12], the data are compared to the EPA [23] and NYS Drinking Water Standards [13,14].

3.3.8.1 Radionuclide Analysis

The yearly average concentrations of radionuclides in samples from the wells adjacent to the sand filter beds at the sewage treatment plant, and downstream on the Peconic River are summarized in Appendix D, Table 22. Elevated gross beta and tritium concentrations have been found in on-site wells adjacent to the sand filter beds and the Peconic River. The observed levels are attributable to losses from the tile collection field underlying the sand filter beds and from the recharge to ground water from the Peconic River in this area. In 1986, on-site ground water concentration ranges were 0-20% for gross beta and 0-33% for tritium of the applicable limits [13,14,23]. Strontium-90 concentrations ranged between 1% and 140% of the EPA Drinking Water Standard. The one well which exceeded the standard was well XL. Gamma-emitting radionuclides, although detectable, were far below applicable standards.

In 1986, a cooperative program with the Suffolk County Department of Health Services was developed for the collection and analysis of samples from wells serving private homes. In this sampling program, 16 samples are collected on a quarterly basis from private drinking water wells in Suffolk County. Twelve of these sampling stations were from homes near the Laboratory, with the remainder from randomly selected control locations. Samples were analyzed for gross alpha, gross beta, and tritium on a quarterly basis, while analyses for strontium-90 and gamma spectroscopy were performed annually. The program, which began in April 1986, is now part of the SCDHS water quality program. Results from the program, presented in Appendix D, Table 23, indicated that tritium was present in private well samples collected from five homes located adjacent to the Laboratory. The private wells, screened at depths ranging from 50 and 200 feet, had annual average tritium concentrations that ranged from 356 to 4627 pCi/L. Although above background, these data were consistent with data collected since 1978, and were less than 21% of the EPA Drinking Water Standard for community water supplies.

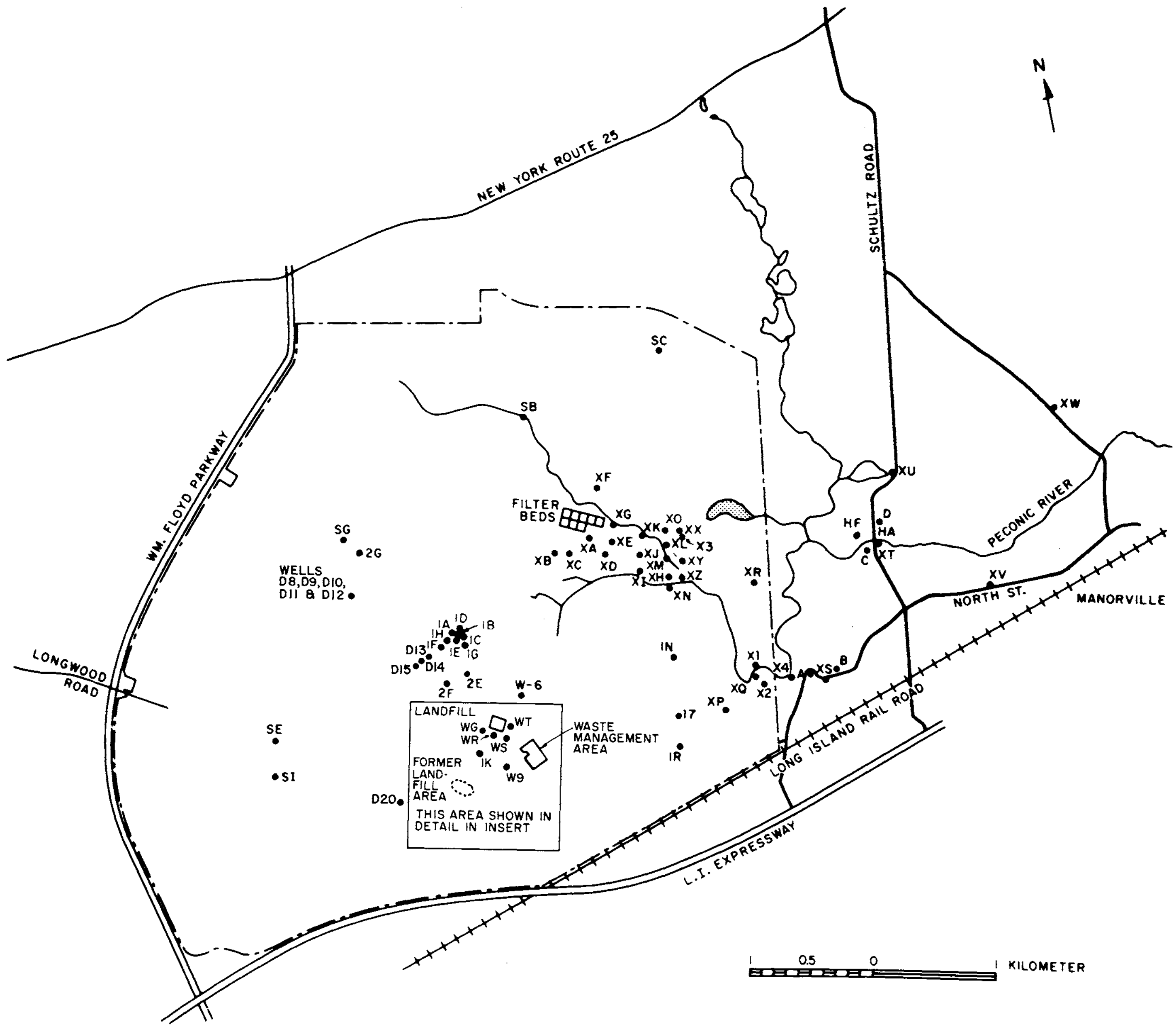


Figure 13. Location of Ground Water Surveillance Wells

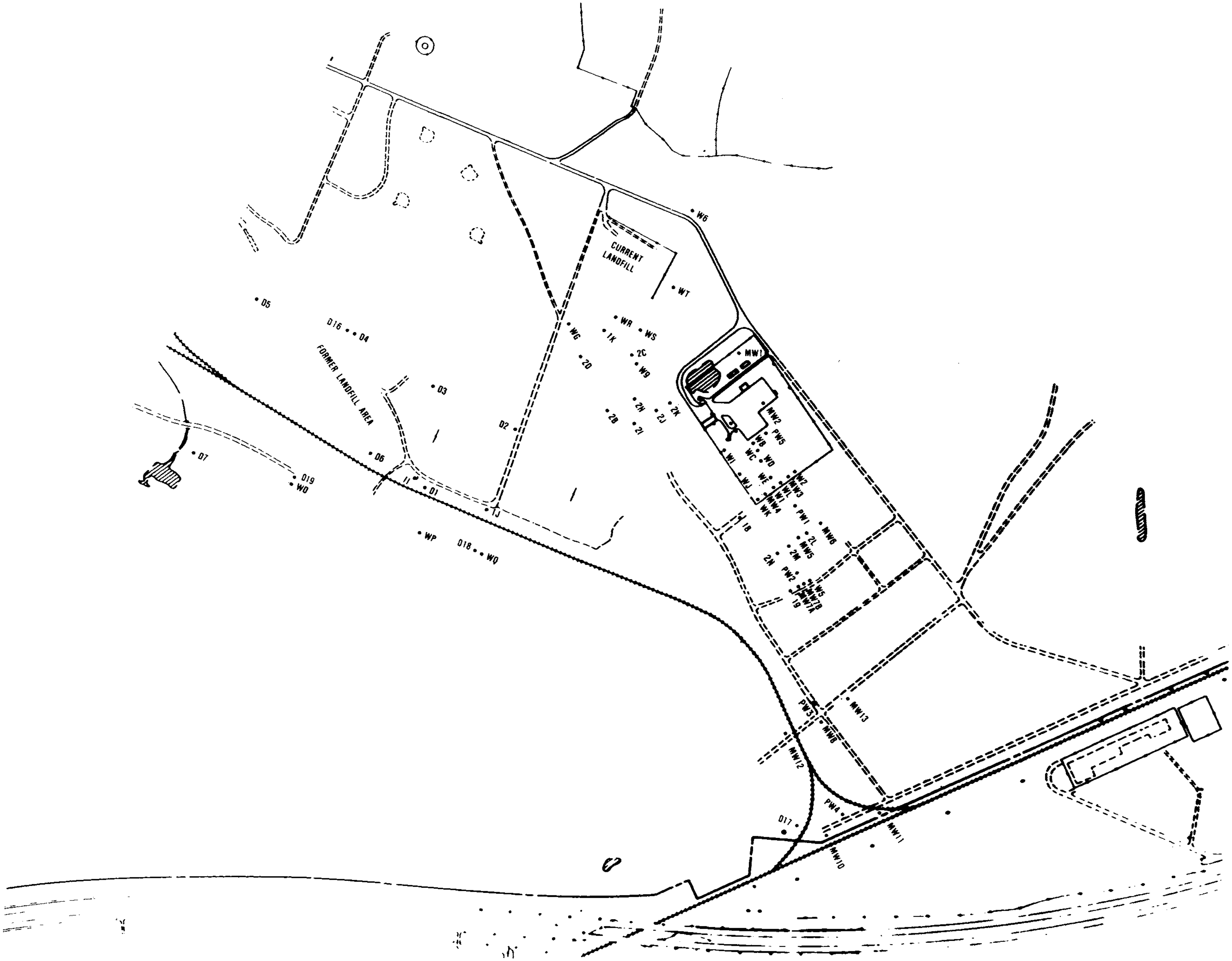


Figure 14. Location of Monitoring Wells in the Landfill Areas and the Hazardous Waste Management Facility

The data for the samples from control wells and wells adjacent to the past and present BNL landfills are shown in Appendix D, Table 24. In general, gross alpha concentrations in wells which monitor the landfill did not differ from results observed in the previous years; remaining at background levels. The concentrations of tritium and activation products in several wells result from the past practices of placing low specific activity material on the landfill. This means of disposal was discontinued in 1978. The average tritium concentration in one well exceeded the EPA Drinking Water Standard for tritium, while in other wells it was between 0% to 85% of the same standard. The range of annual average gross beta concentration was 0-50% of the drinking water limit. Measured concentrations of cesium-137, cobalt-60, manganese-54, and sodium-22 were less than 0.01% of the RCGs [11]. The concentration of strontium-90 exceeded the EPA Drinking Water Standard at one well location (well D6). At all other locations the concentrations ranged between 1% and 70% of the Drinking Water Standard.

Miscellaneous wells identified as S6431, S6434, and S6455 were sampled this year as part of an island-wide USGS study of the Long Island Aquifer System. These wells are located in the central portion of the site, very close to the BNL monitoring wells D-8 through D-12. While wells S6431 and S6455 are screened in the Upper Glacial aquifer, well number S6434 is screened in the Lloyd aquifer.

The ground water monitoring program conducted at the HWMF consists of the shallow well network located near the facility and a newer set of wells that were installed from 1984 to 1986. The radiological results for the samples collected from this program are presented in Appendix D, Table 25.

The average concentration of gross beta and strontium-90 exceed Drinking Water Standards at several wells in this area. Two wells exceed the gross beta value, while the remaining show concentrations that range from 2% to 70% of the standard. The average strontium-90 concentrations at seven wells (28% of the program) exceed the Drinking Water Standard. The remaining show concentrations that range from 1% to 50% of the standard. The average tritium concentration at all wells was below the Drinking Water Standard. All other nuclides detected at these sampling locations that are not specifically quoted in the Drinking Water Standard were compared to Radiation Concentration Guides) and were less than 0.1% of the Radiation Concentration Guides. Ground water concentration at all site boundary stations were well within regulatory guidelines.

In addition to the routine program, gross alpha, gross beta, and tritium analyses were performed on weekly to biweekly samples collected from the Spray Aeration Project wells. These wells, labeled PW1 through PW5 on Figure 14, were operated from April to December 1986. The radiological results of the sampling program are presented in Appendix D, Table 26. The data indicate that the gross beta activity declines as one gets further from the Hazardous Waste Management area. Tritium concentrations tend to increase until they reach their maximum at well PW3. The activity detected at this well, and the increased activity at wells MW8 and MW13, indicates that the tritium plume eminating from the Hazardous Waste Management Facility and landfill has been intercepted by these wells.

3.3.8.2 Metals, Water Quality and Organic Analysis

The data for wells adjacent to the sand filter beds and downstream of the Peconic River on- and off-site, are shown in Appendix D, Tables 27-29. In general, the data for samples obtained from these wells were comparable to those observed during previous years [22]. All analyzed water quality parameters were within New York State Water Quality Standards [14], with some exceptions for pH, Fe, Mn, and Pb. The low pH levels appear to reflect ambient levels of pH in ground water, since pH levels in the potable wells ranged from 5.9 to 6.8 (refer to Appendix D, Table 20). Concentrations of Fe, Pb, and Mn in excess of water quality standards were found in wells along the Peconic. These species were not observed in significant concentrations in either the influent or effluent from the sewage treatment plant. The presence of Fe, Pb, and Mn is believed to reflect a well-casing effect.

These wells were also analyzed for chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. All results for chloroform, trichloroethylene, and tetrachloroethylene were below detection limits. 1,1,1-Trichloroethane was detected in trace quantities, <20 ug/L, in wells XA and XE which are adjacent to the sand filter beds and monitor the loss of treated effluent to the aquifer. This suggests that small quantities of 1,1,1-trichloroethane reach the Laboratory's sewage system.

The surveillance data for the current and former landfills, and control wells are shown in Appendix D, Tables 30 and 31. The BNL landfill is operated in accordance with the permit issued by NYSDEC, Permit No. 52-S-20. The data from the current landfill wells indicate that pH, conductivity, chlorides, sulfates, and most metals are consistent when compared with previous years' observations [22]. Nitrates, Pb, and Zn concentrations decreased in 1986. The data from surveillance wells at the former landfill and control wells are all consistent with prior observations [22]. The ground water monitoring data are consistent with historic use of the area as a landfill. The presence of the above parameters in any monitoring well indicates proximity to a landfill.

The ground water surveillance wells at the landfill areas and control wells were analyzed for the following chlorocarbons: chloroform, 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. These chlorocarbons were not detected in the wells at the current landfill. However, chloroform and 1,1,1-trichloroethane were measured in ground water samples collected from two wells at the former landfill and in the two designated control wells. All chlorocarbon concentrations were within NYSDOH drinking water limits or advisory guidelines. The wells at the landfill areas will continue to be sampled to ensure that no significant aquifer impact occurs as a result of past or current operations.

The average water quality and metals data for the Waste Management area are presented in Appendix D, Table 32. Heavy metals such as silver, cadmium, chromium, and mercury were not detected in any of the wells. Measureable concentrations of iron and zinc were observed in several wells. In general, Fe, Mn, and Na concentrations were lower in 1986 than in 1985 [22].

The wells in the vicinity of the Waste Management Area were also analyzed for volatile organics. The results are presented in Appendix D, Table 33. These wells were sampled on an average of five or six times during the year.

However, volatile organic analyses were performed at the frequency indicated with the reported data. While several wells exhibit average concentration of volatile organics which exceed either the NYS Drinking Water Standards or the NYSDOH advisory guidelines, the impact of the spray aeration project is not reflected by these results. Specifically, the samples from wells MW8, MW10, MW13, MW7B, MW6, MW5, W2, W6, WE, WK, WL, 2M, and 2L were analyzed prior to the initiation of the ground water restoration project. Other wells, such as MW7A, WC, and WD, exhibited dramatic changes as the restoration wells altered the direction of the contaminant plume. Concentrations of volatile organics in this area are expected to be lower in 1987 as a result of this project.

In April 1986, the Laboratory began a ground water restoration project in the vicinity of the Waste Management area. Briefly, the project consists of five high-capacity pumping wells, associated spray aeration equipment installed at each pumping location for removal of the organic compounds and recharge areas for the decontaminated water. Weekly to biweekly samples of well water and residual spray were analyzed for chlorocarbon content. The results are presented in Appendix D, Table 34. The data indicates that the chlorocarbon removal efficiency of the spray aeration technique is 90% to 100%. The average chlorocarbon concentrations in recharged water were at or below the detection limits.

3.3.9 Deer and Small Game

The environmental program was expanded in 1986 to include the analysis of deer and small game. Deer samples were collected from animals that were killed in traffic accidents both on-site and off-site. The racoon sample was obtained from the AGS area. Samples were analyzed for gamma-emitting radionuclides and the results are reported in Appendix D, Table 18. The data indicate that the cesium-137 activity present in the meat is the result of global fallout from the weapons testing program.

4.0 OFF-SITE DOSE ESIMATES

4.1 Collective Dose Equivalents due to Airborne Effluents

The major radionuclides released from BNL airborne effluent discharge points are tritium, oxygen-15, and argon-41. The measured tritium concentrations and dose equivalents at the site boundary are shown in Appendix D, Table 35A. The highest annual average site boundary concentration of tritium vapor was 5.8 pCi/m^3 at station 1 and the committed effective dose equivalent was 0.003 mrem for the hypothetical individual residing at that location [25]. The exposure rates due to argon-41 and oxygen-15 were not measured at the site boundary. The calculated per capita annual average dose-equivalent rates for these radionuclides at the site boundary was 0.07 mrem/a.

The collective (population) dose equivalent was estimated for radionuclides released to the airborne environment using measured effluent release data and recorded BNL meterological parameters. Due to its short half-life, oxygen-15 was not included in the calculation of the collective dose equivalent. Using actual source terms and meterological data at the given release point should yield the best projection of airborn concentrations, and thus dose to the general population. This approach also minimizes the effects of local micrometerological conditions which may exist; resulting in differences between the measured and expected tritium concentrations at the perimeter monitoring stations.

Collective dose equivalents resulting from the 10 meter and 100 meter release heights are shown in Appendix D, Tables 35B and 35C, respectively. Argon-41 effectively contributed the entire collective dose equivalent, 1.77 rem. The dose equivalent contributions from tritium and radioiodines were 0.02 and 0.004 rem, respectively. The computer model AIRDOS-EPA was used to determine the collective and maximum individual dose estimates. The 1986 population collective dose-equivalent resulting from the release of airborne radionuclides by the Laboratory was 1.85 rem. This can be compared to the 1986 population collective dose-equivalent due to natural background of 300,000 rem. The Laboratory airborne releases comprised 0.0006% of the total dose due to natural background.

4.2 Collective Dose Equivalents Due to Liquid Effluents

Since the Peconic River is not used as a drinking water supply [26], nor for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactivity. However, the Peconic River does recharge the aquifer. In 1986, virtually all of the Laboratory's effluent was recharged to ground water. The collective dose equivalent resulting from the discharge of radioactive materials to the Peconic River has been computed by evaluating private, potable water.

For the drinking water pathway, only tritium was detected in off-site potable wells. The highest annual average concentration for a single residence was 4627 pCi/L. The average concentration for the group of five positive tritium concentrations was 1560 pCi/L. This corresponds to a committed effective dose equivalent to the maximum individual of 0.00021 rem and a collective dose equivalent to the population at risk of 0.036 rem.

The radionuclide concentration in the limited fish samples that were analyzed in 1986 were summarized in Appendix D, Table 18. Using these data, the DOE dose conversion factors [27], an estimated population at risk of 600 [28], and a maximum consumption rate of 7 kg/yr [28], the maximum individual committed effective dose equivalent was calculated to be 0.00019 rem and the collective dose equivalent for the population at risk was 0.112 rem.

4.3 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 1986 was the sum of the three component values discussed above, 2.0 rem. The data is summarized in Appendix D, Table 35E.

The collective dose equivalent due to external radiation from natural background to the population within an 80-km radius of the Laboratory, amounts to about 300,000 rem/a, to which about 97,000 rem/a should be added for internal radioactivity from natural sources.

5.0 UNUSUAL OCCURRENCES

During 1986, one significant spill of fuel oil occurred on site at Building 902. Clean-up procedures were instituted and the contaminated soil was disposed of according to the New York State Department of Environmental Conservation recommendations. The soil was analyzed and found to be PCB-free.

A sulfuric acid spill occurred at Building 914. The acid was neutralized with 160 pounds of limestone. The residue was collected and the area flushed with water. The spill was on asphalt and as such notification to NYSDEC was not required.

6.0 PROJECT ENVIRONMENTAL REVIEW

The following major projects were reviewed during various stages of design by members of the Safety and Environmental Protection Division to ensure facility compliance with all applicable environmental regulations and DOE Orders: (1) Radiation Effects Facility, (2) Neutral Particle Beam Facility, (3) AGS Booster, (4) HFBR Vault Complex, (5) National Synchrotron Light Source Phase III, (6) Environmental Assessment for Disposal of WCF Condensate, and (7) Dose Assessment of Ground Water Restoration. On a smaller scale, modifications to existing facilities, e.g., upgrades or preventive maintenance, are reviewed on a frequent basis to ensure construction specifications meet all environmental codes.

7.0 SPECIAL STUDIES

Non-routine surveys were performed in the following areas: (i) evaporation of tritiated distillate at the sewage treatment plant emergency holding pond, (ii) assessment of the potable well water quality, (iii) decomissioning of the old firehouse, (iv) historic oil spill at Building 610, (v) Building 830 "D" waste line leak, (vi) airborne exposure rates due to argon-41, oxygen-15 and cesium-137, (vii) radioactivity in cooling towers water, (viii) monitoring the unsaturated zone, (ix) comparison of predicted air concentrations at the site boundary using collocation and individual effluent release points, and (x) comparison of collective dose using AIRDOS-EPA and the historic BNL methodology.

7.1 Evaporation of Tritiated Distillate at the STP Emergency Holding Pond

The use of the STP holding pond as a solar evaporator for the distillate from the WCF began in August, 1985. By December, 1986, the 11.4 million liter holding pond had accumulated approximately 5 million liters of rain water in addition to the initial tritium inventory. Between December 1-24, 1986, the content of the pond was pumped back to the sand filter beds and released to the Peconic River. Approximately 0.17 Curies was released during this operation. The total evaporative losses from the pond were 95% of the initial, 4 Curie, inventory. The dose to personnel working continually in the area for the two year project was less than 0.01 mrem.

7.2 Assessment of Potable Well Water Quality

In November, 1986, S&EP Division, with the assistance from Plant Engineering Division, embarked on a testing program to evaluate the water quality throughout the BNL distribution system. This study was designed to address complaints of bad taste and color. The Industrial Hygiene Group has the key role in this study with the Environmental Protection Section providing the required analytical services. The study is still in progress and has so far determined that:

a. the quality of water leaving the water treatment plant meets all the regulatory requirements,

b. the quality of water in lines that have high volume and use is satisfactory,

c. the quality of water in lines of low volume and use are questionable.

Further, sampling is planned to confirm finding "c."

7.3 Old Firehouse Soil Remediation Project

In the spring of 1986, a routine radiological survey of the old firehouse prior to its demolition revealed an area of elevated radiation. This area was investigated and it was found that the soil beneath the concrete floor was contaminated. The concrete floor was removed and the soil surveyed for identification of the contaminant. The principle radionuclide detected was cesium-137. The contaminated soil was excavated and was disposed of as low level radioactive waste. Following remediation, residual exposure rates in the area were at background levels of 6-10 micro Roentgen per hour. In achieving this exposure rate, the cesium-137 soil concentration was reduced to less than 5 pCi/g over the area of initial contamination and the strontium-90 concentrations were less than 0.43 pCi/g.

7.4 Historic Oil Spill at Building 610

While installing monitoring wells at the CSF, as part of Major Facility Permit requirements in November 1986, soil contaminated with hydrocarbons was encountered at depths ranging down to ground water (approximately 33 feet). At the present time, a possible source has been suggested. On November 26, 1977, a pipeline ruptured spilling about 25,000 gallons of combined No. 6 fuel oil and waste solvents. It is estimated that 80% of the spill had been recovered. There are three recently installed ground water monitoring wells in the immediate vicinity of the CSF and these are screened at the surface water table. No specific flow data exists on the site ground water, however, the USGS site wide study indicates that a south/southeast direction can be assumed.

The EPA was notified of the spill in 1977, and the cleanup surface restoration procedures were approved and appropriately instituted. The current observation has been reported to the EPA, NYSDEC, and SCDHS.

Brookhaven National Laboratory has begun the process of obtaining a contract with a waste oil recovery vendor to define the extent of the plume and recommend appropriate remediation for the area. A contract is expected by mid-1987.

7.5 Building 830 Leaking Waste Lines

During routine transfer of low level liquid waste to "D" waste hold-up tanks at Building 830, a mass balance inventory check revealed that the status of approximately 3,400 liters of waste could not be determined. The facility operator initiated tests to determine if the waste lines were leaking and whether the mass balance information was correct. Efforts in this area were inconclusive. A review of the waste line engineering drawings indicated that the most probable location for a potential leak was at a location near the underground storage tanks. The waste lines were uncovered and examined in this area. No leaks were found. Due to approaching inclement weather, the area was covered and further action postponed until 1987.

7.6 Airborne Exposure Rates Due to Argon-41, Oxygen-15 and Cesium-137

During the course of this year, the question was raised as to the total dose that a helicopter pilot might receive if he passed through an effluent plume or was exposed to the cesium-137 gamma source that was used at the BNL gamma forest until September of 1979. Helicopters that use radiation detectors to sense rotor pressure failure had apparently yielded false sensor readings in the past while flying over the BNL site. An examination of the instrumentation in one typical helicopter indicated that the sensors would alarm once the pilot was in a radiation field of approximately 2 mR/hr. Helicopters that were flown within 1400 feet of the exposed gamma forest source, or within 200 feet of air effluent stacks at the Medical Research Reactor or Brookhaven Linear Isotope Production Facility could have been placed in radiation fields that would have been sufficient to trigger this false instrument reading. Worst case dose estimates indicate that a total dose of 8.1 to 20 mrem was possible, but a more probable total dose estimate would be a factor of 10 to 100 below the worst case estimate.

7.7 Radioactivity in Cooling Tower Water

Quarterly water samples were collected at BNL cooling towers and analyzed for radioactive content. The project was conducted to determine if liquid discharges from these towers was sufficient to trigger radiation alarms at the STP and to determine if these discharges should be directed to hold-up tanks instead of recharge basins or the sanitary sewage system. The data indicate that most cooling tower water have slightly elevated tritium concentrations. The concentrations are sufficiently below BNL's administrative limit of 20,000 pCi/L so that redirecting or hold-up are not necessary. Other radionuclides were occasionally detected, particularly in the accelerator areas, but at insignificant concentrations.

7.8 Monitoring the Unsaturated Zone

The lysimeters installed in 1985 that are being utilized in a field investigation of the rate of potential continued leaching of contaminants from the unsaturated soil indicated:

a. A differential rate of movement for strontium-90 and cesium-137, with strontium-90 traveling faster than cesium-137.

b. Tritium closely follows rain water as it moves through the unsaturated zone.

In 1987, these movement rates will be quantified and studies to look at movement of organics in the unsaturated zone will be initiated.

7.9 Predicted Air Concentrations at the Site Boundary Using Collocated and Individual Effluent Release Points

Environmental audits conducted in 1985 and 1986 questioned whether the Laboratory's practice of assuming collocated effluent release points at the center of the site for purposes of calculating site boundary dose should be replaced by a method which would use individual effluent release point source to receptor distances. The Laboratory agreed to investigate the difference in the two techniques and report the data in the 1986 Environmental Monitoring Report. Appendix D, Table 36, presents a summary of the predicted air concentrations at the site boundary obtained by collocating the five major sources of tritium releases and by computing the individual contribution from each stack using the correct source to receptor distance. These data were obtained by using the 1986 BNL meteorology tritium effluent release data for each facility and the Brookhaven Atmospheric Dispersion Model.

The data indicate that the average, estimate of site boundary air concentration agrees to within 3%. The worst case deviations occur in the west and north north west locations where the agreement between the model ranges from +20% to -25%. This level of agreement indicates that either model is sufficiently accurate for estimating the site boundary dose for this facility. In the future, as was done in this report, all site boundary dose estimates will be made using collocation of sources.

7.10 Comparison of AIRDOS-EPA to Historical Methods of Calculating Dispersion and Dose

In order to be in compliance with 40 CFR 61, Subpart H, all atmospheric releases must be evaluated using AIRDOS-EPA or other EPA approved predictive models. The use of AIRDOS-EPA and associated software to predict the collective dose equivalent to off-site personnel from 1986 effluent releases marks a departure from the method used over the past few years.

In the past, monthly sector average dispersion factors (X/Q) were calculated from measured meteorological parameters. The dispersion factors were then multiplied by the population resident in each sector, the monthly breathing rate, the monthly effluent release rate, and the ICRP #30 committed effective dose conversion factor for each radionuclide. The total collective dose was then obtained by summing the doses for all radionuclides in each sector over the twelve month interval. The collective dose, calculated in this way, included only the inhalation and submersion pathways.

AIRDOS-EPA and the associated PREPAR software data base compute dispersion, deposition, and dose from the inhalation, submersion, ingestion, and recreational pathways that would result from atmospheric releases of radioactive effluent. The dispersion model uses annual wind-rose data and computes the dispersion to the midpoint of the population sector.

The dose conversion factors were developed from ICRP #2 and thus do not reflect the most recent developments in dose assessment technology.

Because of these differences in the assessment technique, the collective dose was estimated using both methodologies for argon-41 and tritium effluent releases in 1985 and 1986. The collective dose information is presented in Appendix D, Table 37. First, it should be noted that the AIRDOS-EPA software calculates the annual dose to the organ of interest while the former BNL methods calculated committed effective dose. Because the radionuclides that contribute most of the BNL-related collective dose are argon-41 and tritium, the total body annual dose and the committed effective dose will represent the same quantity. The differences observed are due to the differences in the dose conversion factors and the methods used to calculate air concentration and the population weighted air concentration. Although AIRDOS-EPA includes additional pathways, the local land use does not cause these pathways to significantly influence the dose estimate.

In conclusion, the numeric values of collective dose from the BNL site evaluated using AIRDOS-EPA will be lower by a factor of two than those calculated using site-specific dose dispersion models and ICRP #30 dose conversion factors. The largest difference in collective dose is observed in the contribution from argon-41 which contributes dose only via the submersion pathway. Other nuclides, such as tritium, contribute very little to the collective dose relative to the contribution of argon-41 and the collective dose is equivalent using either method. This is fortuitous and occurs only because the differences in the dose conversion factor for tritium is canceled by other factors.

APPENDIX A

A.1 Glossary of Terms

AGS	- Alternating Gradient Synchrotron
ALF	- Alternate Liquid Fuels
BLIP (BLIF)	- Brookhaven Linear Isotope Production Facility
BNL	- Brookhaven National Laboratory
CLIF	- Chemistry Linac Irradiation Facility
CSF	- Central Steam Facility
DOT	- Department of Transporation
EPA	- Environmental Protection Agency
HFBR	- High Flux Beam Reactor
HWMF	- Hazardous Waste Management Facility
LFS	- Light Feed Stocks
LINAC	- Linear Accelerator
MDC	- Minimum Detection Concentration
MDL	- Method Detection Limit
MLD	- Million liters per day
MRC	- Medical Research Center
MRR	- Medical Research Reactor
NA	- Not Analyzed
ND	- Not Detected
NR	- Not Reported
NS	- Not Sampled
NSLS	- National Synchrotron Light Source
NYS	- New York State
NYSDEC	- New York State Department of Environmental Conservation
NYSDOH	- New York State Department of Health
PCB	- Polychlorinated biphenyls
RCG	- Radiation Concentration Guide
REF	- Radiation Effects Facility
RHIC	- Relativistic Heavy Ion Collider
SCDHS	- Suffolk County Department of Health Services
S&EP	- Safety and Environmental Protection
SPDES	- State Pollutant Discharge Elimination System
STP	- Sewage Treatment Plant
TLD	- Thermoluminescent Dosimeters
VUV	- Vacuum Ultraviolet
USGS	- United States Geologic Survey
WCF	- Waste Concentration Facility

A.2 Glossary of Units

a	- Annum
°C	- Degrees Centigrade
cc	- Cubic centimeter
Ci	- Curie
cm	- Centimeter
cm/d	- Centimeters per day
d	- Day
GeV	- Giga electron volt
GeV/amu	- Giga electron volt per atomic mass unit
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
mrem	- Millirem
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
uCi	- Microcuries
uCi/L	- Microcuries per liter
ug/L	- Micrograms per liter

APPENDIX B

METHODOLOGIES

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

Dispersion (X/Q) was calculated for release elevations as listed in Appendix D, Table 1, at each of the 16 directional sectors, and for 5 distance increments (1.6-16 km, 16-32 km, 32-48 km, 48-64 km, and 64-80 km) from the center of the site using AIRDOS-EPA. The 1986 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 Medical Building roof vent, the Van de Graaff roof vent, the BLIP stack, and the Hazardous Waste Management Incinerator stack were used to estimate the air concentrations at a given sector and distance. The air concentration, multiplied by the adult breathing rate (22.8 m^3/d), the number of days per year, the dose conversion factor for a given radionuclide (as provided by the RADRISK data base) [25,27], and the dispersion and population values for that sector and distance resulted in the population nuclide-specific dose equivalent for each sector with distance. This procedure was conducted for each radionuclide. The dose equivalents were then summed to obtain the total population dose equivalent resulting from BNL operations. The total dose, as estimated by the AIRDOS-EPA program, also calculates the contribution from the submersion, ingestion, shoreline, and recreational pathways as a result of an atmospheric release.

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, uCi

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, uCi

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

P = Population at risk

To determine the maximum individual dose, the population parameter was set to unity. For the collective dose calculation, the average concentration was determined from five positive tritium results. The population at risk in this area was assumed to be approximately 500.

3. Methodology for Dose-Equivalent Calculations - Fish Ingestion Pathway

Only one fish sample was analyzed during calendar year 1986. The results of this analysis were used to calculate dose for the the 1986 calendar year. The method used to make this estimate and subsequent estimates, when the data become available, is outlined below. 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 [28].

c. Committed Dose Equivalent Tables [33] were used to get the 50 year Committed Dose Equivalent Factor - rem/uCi intake.

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

^{3}H: 6.3E-05 rem/uCi intake

^{90}Sr: 1.2E-03 rem/uCi intake

^{137}Cs: 5.0E-02 rem/uCi intake

d. Calculation:
Intake (7 kg/yr) x Activity in flesh uCi/kg
x Factor rem/uCi intake = rem

e. Because there are a cesium-137 and strontium-90 background as determined by the control location data, this background was subtracted from all data prior to use for dosimetric purposes.

4. Data Presentation

Analytical results of the environmental and effluent monitoring programs are reported in the tables of Appendix D. Some strontium-90 data are incomplete due to a change in contractor laboratory which suspended analysis during the fourth quarter of 1986. The data presented in these tables were generated in the following way.

First, gross alpha, beta, and tritium results are reported as the 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 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 minimum detectable concentrations for the analyses performed on environmental and effluent samples.

APPENDIX C

The following is a list of typical Minimum Detectable Limits and Concentrations for the various radionuclide analysis performed on environmental and effluent samples.

Nuclide	Matrix	Aliquot (ml)	MDC (uCi/ml)	MDL (uCi)
Gross alpha	water	1	3E-7	3E-7
		100	3E-9	
		500	6E-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	2.0E-7	

Nuclide	300g MDL uCi/g	300ml MDL uCi/ml	12000ml MDL uCi/ml	Charcoal MDC uCi
^{7}Be	1.9E-7	2.2E-7	3.8E-9	2.1E-5
^{22}Na	2.1E-8	2.4E-8	4.2E-10	2.7E-6
^{40}K	2.6E-7	3.0E-7	5.2E-9	3.3E-5
^{48}Sc	2.2E-8	2.6E-8	4.5E-10	2.9E-6
^{51}Cr	2.1E-7	2.1E-7	3.8E-9	2.1E-5
^{54}Mn	2.1E-8	2.5E-8	4.3E-10	2.6E-6
^{56}Mn	5.1E-7	5.7E-7	9.8E-9	5.9E-5
^{57}Co	1.8E-8	2.1E-8	3.5E-10	1.7E-6
^{58}Co	2.3E-8	2.7E-8	4.6E-10	2.8E-6
^{60}Co	2.7E-8	3.2E-8	5.5E-10	3.5E-6
^{65}Zn	4.7E-8	5.3E-8	9.0E-10	5.6E-6
^{134}Cs	2.6E-8	3.0E-8	5.2E-10	3.1E-6
^{137}Cs	2.3E-8	2.8E-8	4.7E-10	2.7E-6
^{226}Ra	5.1E-8	6.0E-8	1.0E-9	5.8E-6
^{228}Th	4.7E-8	5.0E-8	8.3E-10	4.5E-6
^{82}Br	3.4E-8	3.9E-8	6.6E-10	3.8E-6
^{113}Sn	3.0E-8	3.1E-8	6.1E-10	3.2E-6
^{124}I	4.3E-8	5.1E-8	8.6E-10	4.9E-6
^{126}I	5.7E-8	5.8E-8	1.2E-9	5.9E-6
^{131}I	2.4E-8	2.4E-8	4.6E-10	2.4E-6
^{133}I	3.1E-8	3.6E-8	6.1E-10	3.5E-6
^{123}Xe	1.2E-6	1.4E-6	2.4E-8	1.2E-4
^{125}Xe	4.8E-8	5.4E-8	8.9E-10	4.7E-6
^{127}Xe	2.5E-6	2.8E-8	4.6E-10	2.4E-6

Appendix C, continued

Constituent	(All concentration values in Mg/L except where noted)
Ag	0.02
As	0.001
Ba	0.5
Cd	0.005
Cr	0.025
Cu	0.05
Fe	0.05
Hg	0.0002
Mn	0.02
Na	0.025
Pb	0.50
Se	0.008
Zn	0.01
Ammonia-N	0.02
Nitrite-N	0.01
Nitrate-N	0.5
Specific Conductance	25 umhos/cm
Chlorides	5.0
Fluorides	0.02
Sulfates	5.0
1,1,1-trichloroethane	0.007
trichloroethylene	0.008
Chloroform	0.007
Tetrachloroethylene	0.008

Appendix C
Table 1
1986 BNL Environmental Monitoring
Minimum Detectable Concentrations
Gross Alpha, Beta, and Tritium

Nuclide	Water 1 ml	Water 7 ml	Water 100 ml	Water 500 ml	Filter Paper 2.2E7 cc
	<--------------- pCi/L			--------------->	uCi/cc
Gross alpha	300	43	3.2	0.6	1.1E-14
Gross beta	630	90	6.3	1.2	2.8E-14
Tritium	1100	300	NA	NA	NA

NA = Not Applicable.

Appendix C
Table 2
1986 BNL Environmental Monitoring
Minimum Detectable Concentrations
Gamma Spectroscopy

Nuclide	Particulate Filter 4.2E9 cc uCi/cc	Charcoal Filter 2.5E8 cc uCi/cc	Soil or Vegetation 15 g uCi/g	Soil or Vegetation 50 g uCi/g	Water 12,000 ml uCi/ml
Be-7	3.3E-15	5.0E-14	7.6E-7	3.1E-7	2.0E-9
Na-22	4.6E-16	7.0E-15	1.0E-7	4.1E-8	2.5E-10
Na-24	7.5E-16	1.1E-14	1.7E-7	6.7E-8	4.1E-10
K-40	6.5E-15	9.9E-14	1.5E-6	5.8E-7	3.6E-9
Ar-41	3.8E-14	5.8E-13	8.7E-6	3.4E-6	2.1E-8
Sc-48	4.4E-16	6.7E-15	1.0E-7	4.0E-8	2.4E-10
Mn-54	4.0E-16	6.2E-15	9.1E-8	3.6E-8	2.3E-10
Fe-59	7.7E-16	1.2E-14	1.8E-7	7.0E-8	4.4E-10
Co-58	4.0E-16	6.1E-15	9.0E-8	3.6E-8	2.3E-10
Co-60	4.4E-16	6.7E-15	1.0E-7	4.0E-8	2.4E-10
Zn-65	9.5E-16	1.5E-14	2.2E-7	8.5E-8	5.4E-10
Se-75	5.6E-16	7.5E-15	1.3E-7	5.3E-8	3.5E-10
Br-82	5.8E-16	8.8E-15	1.3E-7	5.4E-8	3.5E-10
Ru-103	3.8E-16	5.8E-15	8.6E-8	3.5E-8	2.3E-10
RuRh-106	3.5E-16	5.4E-14	7.8E-7	3.3E-7	2.1E-9
I-123	5.6E-16	8.4E-15	1.3E-7	5.7E-8	3.6E-10
I-124	6.4E-16	9.7E-15	1.4E-7	5.9E-8	3.8E-10
I-126	9.8E-16	1.5E-14	2.4E-7	9.7E-8	6.4E-10
I-131	4.1E-16	6.1E-15	9.9E-8	4.1E-8	2.7E-10
I-33	5.4E-16	8.2E-15	1.2E-7	5.0E-8	3.2E-10
Cs-134	4.2E-16	6.5E-15	9.5E-8	3.8E-8	2.4E-10
Cs-137	4.2E-16	6.4E-15	9.2E-8	3.9E-8	2.5E-10
Ge-69	2.0E-15	3.1E-14	4.5E-7	1.8E-7	1.1E-9
Xe-125	8.4E-16	1.3E-14	2.1E-7	8.6E-8	5.5E-10

APPENDIX D

Tabulated Analytical Results

Table 1
1986 BNL Environmental Monitoring
Resident Population Distribution[a] Within 80-Km Radius of BNL

Sector	0 - 16 Km	16 - 32 Km	32 - 48 Km	48 - 64 Km	64 - 80 Km	Total	Remarks
SSW	20,481	1,048	0	0	0	21,529	Beyond 32 Km - Atlantic Ocean
SW	40,328	62,221	3,277	0	0	105,826	Beyond 48 Km - Atlantic Ocean
NSW	36,368	138,164	337,629	420,838	762,680	1,695,679	Beyond 80 Km - Part of New York City
W	47,500	128,388	227,548	223,868	363,440	990,744	Beyond 80 Km - New York City
WNN	40,028	55,765	114	209,837	126,305	432,049	Beyond 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut and New York
NW	17,243	1,498	132,411	119,988	108,058	379,198	Same as WNW
NNW	7,348	0	204,016	104,623	52,877	368,864	Between 16 Km and 32 Km - Long Island Sound; Beyond 32 Km - Connecticut
N	4,352	0	91,466	242,873	252,611	591,302	Same as NNW
NNE	7,252	0	6,870	43,368	63,887	121,377	Same as NNW
NE	2,819	714	0	13,252	32,299	49,084	Between 32 Km and 48 Km - Long Island Sound; Beyond 48 Km - Connecticut
ENE	2,375	6,623	122,781	14,264	2,153	148,196	North Fork of Long Island
E	2,895	15,287	16,640	8,661	540	44,023	South Fork of Long Island and Atlantic Ocean
ESE	5,896	7,359	0	0	0	13,255	Long Island; Beyond 32 Km - Atlantic Ocean
SE	8,686	0	0	0	0	8,686	Beyond 16 Km - Atlantic Ocean
SSE	21,464	0	0	0	0	21,464	Same as SE
S	15,870	21	0	0	0	15,891	Beyond 32 Km - Atlantic Ocean
TOTAL	280,905	417,088	1,142,752	1,401,572	1,764,850	5,007,167	

(a) Population estimated from data supplied by the Long Island Regional Planning Board [3].

Table 2
1986 BNL Environmental Monitoring
Atmospheric Effluent Release Locations and Radionuclide Activity

Release Point Building No.[a]	Facility	Release Height[b] (meters)	Principal Radionuclide	On-Line Monitoring	Fixed Sampling Devices	Amount Released During 1986 (Ci)
490	Medical Research Center Roof Stack	9.5	Tritium	None	Dessicant for tritium vapor	13.1
491	Medical Research Reactor Stack[c]	45.7	Argon-41	Moving tape for radioparticulates	Charcoal for radioiodines	1225.4
555	Chemistry Roof Stack	16	Tritium	None	Dessicant for tritium vapor	0.130
705	High Flux Beam Reactor	97.5	Tritium	None	Dessicant for tritium vapor, particulate filter for gross beta analysis, and charcoal filter for radioiodines	137.2
			Br-82			0.0078
705	Hot Laboratory	97.5	Gross Beta Particulates	Beta Scintillator for radioactive gases	Particulate filter for gross beta; charcoal cartridge for radioiodines	2.5E-5
			^{126}I			2.0E-4
			^{131}I			4.5E-4
			^{127}Xe			2.8E-4
			^{68}Ga			5.3E-4
901	Van de Graff Accelerator	21	Tritium	Kanne chamber for tritium	Dessicant for tritium vapor	77 (gas) 6.61 (vapor)
931	Linac Isotope[d] Facility	20	Oxygen-15	G-M Detector for radioactive gases	Dessicant for tritium vapor, particulate filter for gross beta, and charcoal filter for radionuclides	150
			Tritium			0.073
445	Incinerator	8.7	See Table 3	None	None	See Table 3

(a) Locations shown in Figure 2.
(b) Above ground level.
(c) Calculated from reported operating time and "one-time" measured emission rate at 3MW power level.
(d) Calculated from reported operating and estimated production rate at 180 uamp full beam current.

Table 3
1986 BNL Environmental Monitoring
Estimated Radioactivity in Incinerated Material
(Activity in mCi)

Month	^{3}H	^{99}Tc	^{14}C	^{103}Ru	^{32}P	^{59}Fe	^{35}S	^{201}Tl	^{54}Mn	^{113}Sn	^{131}I	^{51}Cr	^{99m}Tc	^{117m}Sn	^{55}Fe	^{57}Co	^{125}I
January	6.06	0.1	0.021	0	0.250	0	0.500	0	0	0.200	0	0.001	0.001	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
April	35.37	0	0.333	0.005	0	0.003	0.071	0.021	0	0	0.002	0.011	0.200	0	5.00	0.021	0.118
May	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July	53.04	0	0.411	0.007	0	0	0	0	0.010	0	0.019	0.100	0	0.042	0.060	0	0.400
August	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
October	0	0	0	0	0	0	0	0	0	0	0	0.001	0	0	0	0	0.003
November	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	94.47	0.1	0.765	0.012	0.250	0.003	0.571	0.021	0.010	0.200	0.021	0.113	0.201	0.042	5.060	0.021	0.521
Annual Average Release Rate (uCi/s)	3.0E-3	3.2E-6	2.4E-5	3.8E-7	7.9E-6	9.5E-8	1.8E-5	6.7E-7	3.2E-7	6.3E-6	6.7E-7	3.6E-6	6.4E-6	1.3E-6	1.60E-4	6.7E-7	1.7E-5

1. A zero value in this table indicates that incinerated material was not identified as having this element as a constituent of the waste.
2. The incinerator operated only in the months of January, April, July, and October.

Table 4
1986 BNL Environmental Monitoring
Airborne Activity Released via Building 705 100-m Stack
(Activity in uCi)

Month	^{3}H	^{82}Br	^{131}I	^{133}I	^{126}I	^{75}Se	^{203}Hg	^{68}Ga	^{127}Xe	^{125}Xe	^{69}Ge
January	8794000	124.00	6.85	42.5	125.6	5.7	0.7	118.0	42.2	-	-
February	15570000	58.00	4.48	-	22.2	2.0	0.1	-	0.8	-	-
March	12450000	80.50	0.63	-	2.5	1.0	0.3	0.03	-	-	-
April	13950000	43.08	8.26	41.10	12.4	2.8	1.0	-	139.3	-	-
May	7879000	2474.10	42.24	-	6.0	3.9	1.6	-	1.14	-	33.7
June	5765000	1367.40	58.31	58.26	3.0	1.1	-	-	19.6	-	-
July	9745000	539.10	152.49	14.51	13.9	1.2	-	353.0	7.6	48.4	429.0
August	11756000	1155.00	193.88	9.02	14.0	-	-	62.2	64.4	-	-
September	6239000	1299.00	3.85	-	-	-	-	-	-	-	-
October	12100000	277.00	2.70	11.57	-	-	-	-	-	-	-
November	18133000	208.00	2.39	1.89	-	-	-	-	1.7	-	-
December	14810000	176.00	15.9	-	-	-	-	-	-	-	-
Total uCi	137191000	7800.90	492.0	178.85	199.6	17.7	3.7	533.2	276.7	48.4	462.7
Avg. Conc. uCi/cc	6.44E-7	5.44E-11	1.07E-12	1.25E-12	6.3E-13	5.6E-14	1.2E-14	1.7E-12	8.7E-13	1.5E-13	1.5E-12
Avg. Release Rate uCi/s	4.35	2.47E-4	1.56E-5	5.67E-6	6.3E-6	5.6E-7	1.2E-7	1.69E-5	8.8E-6	1.5E-6	1.5E-5

Table 5
1986 BNL Environmental Monitoring
BNL Environmental Permits

Bldg/Facility Designation	Process Description	Permitting Agency and Division	Permit Number
134	blueprint machine	NYSDEC-Air Quality	472200 3491 13401
197	blueprint machine	NYSDEC-Air Quality	472200 3491 19701
208	lead melting	NYSDEC-Air Quality	472200 3491 20801
208	vapor degreaser	NYSDEC-Air Quality	472200 3491 20802
208	sandblasting	NYSDEC-Air Quality	472200 3491 20803
208	sandblasting	NYSDEC-Air Quality	472200 3491 20804
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42202
422	cyclone collector	NYSDEC-Air Quality	472200 3491 42203
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42204
422	paint spray booth	NYSDEC-Air Quality	472200 3491 42205
423	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 42304
444	incinerator	NYSDEC-Air Quality	472200 3491 44401
452	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45204
457	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 45704
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46201
462	machining, grinding exhaust	NYSDEC-Air Quality	472200 3491 46202
479	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 47904
493	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 49304
493	incinerator	NYSDEC-Air Quality	472200 3491 493A0
510	blueprint machine	NYSDEC-Air Quality	472200 3491 51001
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
610	combustion unit - ALF	NYSDEC-Air Quality	submitted, status pending
BNL Site	major petroleum facility	NYSDEC-Water Quality	annual renewal
STP[a] & RCB[b]	sewage plant & recharge basins	NYSDEC-Water Quality	NY-0005385
CLF[c]	current landfill	NYSDEC-Solid Waste	10-84-0346
HWMF[d]	waste management	U.S. EPA	submitted, under review
650	scrap lead recycling	NYSDEC-Air Quality	472200 3491 65001
650	shot blasting	NYSDEC-Air Quality	472200 3491 65002
903	blueprint machine	NYSDEC-Air Quality	472200 3491 90301
911	blueprint machine	NYSDEC-Air Quality	472200 3491 91101
T30	combustion unit-No.4 oil	NYSDEC-Air Quality	472200 3491 T3004

(a) Sewage treatment plant.

(b) Recharge basins.

(c) Current landfill.

(d) Hazardous Waste Management Facility.

Table 6
1986 BNL Environmental Monitoring
Sewage Treatment Plant Influent and Effluent Radionuclide Concentrations

Location	Month	Volume $X10^7$ liters	Gross Alpha Concentration Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Concentration Average	Gross Beta Minimum	Gross Beta Maximum	Tritium Concentration Average	Tritium Minimum	Tritium Maximum
			<------	------	------	------	pCi/L	------	------	------	------>
DA	January	7.69	0.288	-1.13	4.02	10.42	2.79	63.90	1,113.3	0	2,670.0
	February	6.94	0.244	-1.13	1.41	10.70	0.52	90.40	968.3	-1,350.0	4,850.0
	March	8.14	0.506	-0.85	1.98	6.12	-5.06	21.10	1,055.4	191.0	4,700.0
	April	8.02	0.133	-1.13	1.41	13.34	2.44	69.10	1,229.4	-745.0	4,120.0
	May	9.84	0.022	-1.98	2.82	8.60	-0.35	36.30	2,816.5	-286.0	6,530.0
	June	10.53	0.213	-1.41	1.41	11.47	4.36	52.00	5,620.8	1,020.0	9,870.0
	July	10.06	0.226	-1.41	1.69	4.84	-1.92	11.70	5,715.1	0	7,910.0
	August	10.41	0.267	-0.85	2.26	7.16	0.18	17.10	4,419.8	822.0	7,490.0
	September	10.67	0.331	-2.26	1.98	7.29	0.35	19.20	2,580.9	199.0	7,150.0
	October	9.12	0.330	-1.69	1.98	5.28	2.44	12.20	1,550.4	-285.0	4,780.0
	November	7.09	0.043	-2.82	2.26	2.77	-1.05	11.00	1,255.5	-274.0	4,870.0
	December	7.15	0.362	-1.13	3.67	7.35	0.70	17.30	1,072.5	-546.0	4,260.0
	Avg. Monthly Value	8.81	0.246	-	-	7.93	-	-	2,671.1	-	-
	Total*	105.66	0.260	-	-	8.37	-	-	2,822.3	-	-
EA	January	7.13	0.261	-1.41	4.52	5.37	2.62	15.70	1,219.3	-180.0	3,600.0
	February	6.80	0.079	-1.41	1.69	4.56	1.57	10.50	725.5	-658.0	2,100.0
	March	7.79	0.246	-1.41	1.13	4.09	-6.28	12.90	1,243.7	-94.8	3,860.0
	April	7.80	-0.089	-1.69	1.13	4.28	1.57	10.30	1,536.4	-277.0	5,090.0
	May	8.39	-0.204	-3.11	1.69	8.87	-3.66	37.00	2,528.1	-573.0	8,020.0
	June	8.70	0.159	-1.41	1.41	7.79	2.44	15.70	5,270.4	1,300.0	9,030.0
	July	7.92	0.084	-1.69	1.98	6.85	1.75	12.60	5,523.1	2,700.0	9,070.0
	August	10.69	0.166	-1.13	2.54	5.29	1.05	11.20	4,432.1	1,100.0	7,580.0
	September	10.60	-0.188	-1.69	1.98	5.51	1.40	8.55	2,755.5	99.5	6,850.0
	October	8.84	0.060	-1.69	1.69	5.60	0.87	14.50	1,866.3	285.0	4,300.0
	November	6.42	-0.023	-1.13	2.82	2.05	-4.54	6.98	1,092.1	-275.0	4,400.0
	December	8.16	0.0002	-1.69	2.26	4.66	1.75	15.90	3,094.1	364.0	8,000.0
	Avg. Monthly Value	8.27	0.020	-	-	5.51	-	-	2,735.2	-	-
	Total*	99.24	0.020	-	-	5.47	-	-	2,714.5	-	-
	New York State Drinking Water Standard		15			50			20,000		

*Total volume is reported in 10^7 liters and total activity is in units of mCi.

Table 7
1986 BNL Environmental Monitoring
Sewage Treatment Plant Influent and Effluent Nuclide Concentrations

Location	Month	Volume x 10^7 l	^{7}Be	^{60}Co	^{137}Cs	^{40}K	$^{106}RuRh$	^{57}Co	^{22}Na	^{141}Ce	^{90}Sr
			<----------				pCi/L				---------->
DA	January	7.69	0.382	0.669	0.375	1.93	-	-	-	-	0.96
	February	6.94	-	0.550	0.178	2.17	-	0.072	0.148	0.163	1.70
	March	8.14	-	0.397	0.296	1.25	-	0.029	0.102	-	0.98
	April	8.02	-	0.665	0.246	1.60	-	-	0.067	-	1.46
	May	9.84	-	0.613	0.157	3.00	-	0.130	0.165	-	0.80
	June	10.53	-	0.627	0.935	1.83	-	0.187	-	-	1.42
	July	10.03	-	0.478	0.413	2.29	0.271	0.126	0.074	-	1.77
	August	10.41	0.624	0.473	0.322	0.99	-	0.019	0.041	0.073	1.50
	September	10.67	-	0.523	0.644	2.77	-	0.038	0.107	-	1.11
	October	9.12	-	0.554	0.278	3.01	-	-	0.195	-	0.65
	November	7.09	-	0.331	0.279	2.02	-	-	0.070	-	0.48
	December	7.15	0.808	0.387	0.216	1.89	-	-	0.240	-	0.19
	Avg. Monthly Concentration	8.81	0.144	0.526	0.381	2.08	0.026	0.056	0.098	0.018	1.12
	Total*	105.66	0.152	0.556	0.403	2.20	0.027	0.059	0.103	0.019	1.18
EA	January	7.13	-	0.390	1.53	2.33	-	-	-	-	1.79
	February	6.80	-	0.239	1.33	3.00	-	-	0.100	0.115	4.41
	March	7.79	-	0.265	1.46	2.95	-	-	0.100	-	0.93
	April	7.80	-	0.237	1.32	2.28	-	-	0.083	-	1.72
	May	8.39	-	0.243	1.12	1.58	-	-	0.238	-	1.61
	June	8.70	-	0.407	1.21	2.20	-	0.056	0.096	-	0.81
	July	7.92	-	0.471	1.65	2.60	-	-	0.122	-	1.27
	August	10.69	-	0.262	0.93	1.38	-	-	0.090	0.074	0.96
	September	10.60	-	0.287	0.68	1.82	-	-	0.962	-	0.82
	October	8.84	-	0.371	1.04	2.94	-	-	0.169	-	1.16
	November	6.42	-	0.766	0.72	1.97	-	-	0.046	-	0.85
	December	8.16	-	0.371	1.13	3.64	-	-	0.396	-	0.53
	Avg. Monthly Concentration	8.27	-	0.350	1.16	2.35	-	0.005	0.222	0.016	1.33
	Total*	99.24	-	0.347	1.15	2.33	-	0.005	0.221	0.016	1.32
	NYS Drinking Water Standards		-	-	-	-	-	-	-	-	8
	Radiation Concentration Guides		2,000,000	30,000	20,000	-	10,000	400,000	30,000	90,000	-

* Total volume is reported in 10^7 liters and total activity is reported in units of mCi.

Table 8
1986 BNL Environmental Monitoring
Sewage Treatment Plant[(a)]
Average Water Quality and Metals Data

	Sewage Treatment Plant Influent (DA)	Sewage Treatment Plant Effluent (EA)	SPDES Effluent Limitation
pH (SU)	6.5-8.3	5.8-6.5	5.8-9.0
Conductivity (umhos/cm)	b	209	c
Temperature maximum (°F)	d	25	32
Total coliform (per 100 ml)	d	663	10,000
Fecal coliform (per 100 ml)	d	283	2,000
<u>Results in mg/L</u>			
Dissolved Oxygen	d	8.9	c
Chlorides	d	30.4	c
Settleable Solids	0.8	0.0	0.1
Suspended Solids - max	66.0	0.0	10.0
- avg	27.3	0.0	5.0
BOD_5 - max	36.6	6.9	20.0
- avg	23.8	2.9	10.0
Ammonia-Nitrogen	d	0.12	2.0
Nitrate-Nitrogen	d	3.0	c
Total Phosphorous	0.44	0.47	c
Ag	<0.02	<0.02	0.05
Ba	d	d	c
Cd	<0.005	<0.005	c
Cr	<0.025	<0.025	c
Cu	0.06	<0.07	0.40
Fe	0.31	0.16	0.60
Hg	<0.0002	<0.0002	c
Mn	0.01	<0.05	c
Na	29.2	29.7	c
Pb	<0.025	<0.025	0.067
Zn	0.06	0.19	0.30

a: Locations shown in Figure 5.
b: Metered.
c: Effluent limitation not specified.
d: No analysis performed.

Table 9A
1986 BNL Environmental Monitoring
Gross Alpha, Beta and Tritium Concentrations in Water at On-Site Recharge Basins

Location	Sample Period	No. of Samples	Gross Alpha Concentration Average	Gross Alpha Concentration Minimum	Gross Alpha Concentration Maximum	Gross Beta Concentration Average	Gross Beta Concentration Minimum	Gross Beta Concentration Maximum	Tritium Concentration Average	Tritium Concentration Minimum	Tritium Concentration Maximum
			pCi/L								
HN	January	1	0.0	-	-	2.48	-	-	-98.2	-	-
	February	1	0.452	-	-	3.07	-	-	101.0	-	-
	April	1	0.282	-	-	2.51	-	-	-39.6	-	-
	May	2	-0.028	-0.226	-0.169	2.85	2.79	2.90	53.0	0.0	106.0
	June	1	0.282	-	-	90.10	-	-	1,950.0	-	-
	July	1	0.282	-	-	3.91	-	-	133.0	-	-
	October	1	0.0	-	-	2.48	-	-	217.0	-	-
	Average		0.155			13.78			296.2		
HO	January	1	0.226	-	-	2.83	-	-	270.0	-	-
	February	1	0.565	-	-	2.90	-	-	452.0	-	-
	April	1	0.057	-	-	3.81	-	-	0.0	-	-
	May	1	0.282	-	-	2.30	-	-	26.7	-	-
	June	1	0.113	-	-	1.50	-	-	263.0	-	-
	July	1	0.452	-	-	1.75	-	-	318.0	-	-
	October	1	0.057	-	-	2.27	-	-	217.0	-	-
	Average		0.250			2.48			221.0		
HP	May	1	-0.113	-	-	0.70	-	-	1.9	-	-
	June	1	0.508	-	-	1.75	-	-	290.0	-	-
	July	1	0.282	-	-	2.30	-	-	53.0	-	-
	October	1	-0.113	-	-	1.33	-	-	246.0	-	-
	Average		0.141			1.52			147.5		
HS	January	21	0.866	-0.847	1.98	4.92	-1.75	14.60	353.4	-1,590.0	1,600.0
	February	16	0.776	-1.130	2.26	4.90	1.40	9.42	271.4	-1,530.0	1,430.0
	March	22	1.078	-0.282	3.67	4.67	-0.18	16.10	724.6	-760.0	2,930.0
	April	22	0.642	-1.690	3.11	5.10	0.0	11.30	539.3	-554.0	1,590.0
	May	20	0.226	-2.540	2.26	5.78	-1.75	18.80	432.0	-846.0	3,550.0
	June	20	0.819	-0.565	6.50	2.92	-3.84	15.00	33.1	-1,490.0	658.0
	July	20	0.466	-1.130	5.65	1.69	-3.84	8.73	331.4	600.0	962.0
	August	20	0.565	-0.847	2.54	1.83	-1.75	7.16	-296.2	-9,350.0	1,320.0
	September	18	0.386	-1.41	3.11	1.48	-3.49	6.48	-272.4	-3,990.0	497.0
	October	23	0.319	-1.98	2.82	2.75	-0.52	6.98	230.6	-836.0	1,410.0
	November	3	0.282	0.0	0.847	1.82	-0.87	1.92	407.0	-377.0	1,130.0
	Average		0.610			3.58			249.7		
HT	January	1	0.113	-	-	2.44	-	-	467.0	-	-
	February	1	0.057	-	-	3.04	-	-	427.0	-	-
	April	1	0.0	-	-	3.39	-	-	105.0	-	-
	May	1	-0.395	-	-	2.55	-	-	214.0	-	-
	June	1	0.113	-	-	1.40	-	-	369.0	-	-
	July	1	0.226	-	-	2.41	-	-	NA	-	-
	October	1	0.113	-	-	3.04	-	-	272.0	-	-
	Average		0.032			2.61			309.0		
	NYS Drinking Water Standard		15.0			50.0			20,000.0		

Table 9B
1986 BNL Environmental Monitoring
Radionuclide Concentration in Water at On-Site Recharge Basins

Location	Sample Period	^{7}Be	^{40}K	^{22}Na	^{48}V	^{54}Mn	^{57}Co	^{58}Co	^{60}Co	^{137}Cs
		pCi/L								
HN	April	2.85	9.0	ND	ND	ND	ND	ND	ND	ND
	June	254.0	2.6	0.92	4.34	0.25	0.31	0.81	0.37	ND
	October	ND	ND	0.56	ND	ND	ND	ND	0.68	0.43
	Average	85.6	3.87	0.49	1.44	0.08	0.10	0.27	0.35	0.14
HO	April	ND	1.00	0.16	ND	ND	ND	ND	0.71	ND
	June	ND	ND	ND	ND	ND	ND	ND	0.76	ND
	October	ND	0.73	0.38	ND	ND	ND	ND	0.78	ND
	Average	-	0.58	0.18	-	-	-	-	0.75	-
HP	June	ND	ND	ND	ND	ND	ND	ND	ND	ND
	October	ND	6.81	ND	ND	ND	ND	ND	ND	ND
	Average	-	3.40	-	-	-	-	-	-	-
HT	February	ND	1.40	0.56	ND	ND	ND	ND	0.47	ND
	June	ND	1.47	1.44	ND	ND	ND	ND	0.33	ND
	October	ND	1.70	1.51	ND	ND	ND	ND	0.43	ND
	Average	-	1.52	1.17	-	-	-	-	0.41	-

ND = Not Detected.

Table 10
1986 BNL Environmental Monitoring
Recharge Basins
Average Water Quality and Metals Data

Parameter	HN	HO	Location[a] HP	HT	HS	NYS Drinking Water Standards
No. of Samples	7	7	4	7	30	
pH (SU)	5.0-10.1	5.0-7.4	5.0-6.0	5.3-7.6	5.9-8.6	6.5-8.5
Specific Conductance (umhos/cm)	126	171	177	140	214	b
Temperature (^{o}C)	16	14	16	17	12	b
Results in mg/L						
Nitrate-N	<2.5	<2.5	<2.5	<2.5	c	10.0
Chlorides	18.8	21.9	23.6	15.4	c	250
Sulfates	12.9	20.8	14.5	14.3	c	250
Ag	<0.02	<0.02	<0.02	<0.02	c	0.05
Ba	c	c	c	c	c	1.0
Cd	<0.005	<0.005	<0.005	<0.005	c	0.01
Cr	<0.025	<0.025	<0.025	<0.025	c	0.05
Cu	0.08	<0.05	<0.05	<0.05	c	1.0
Fe	1.59	1.57	1.33	0.04	c	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	c	0.002
Mn	0.16	0.18	0.10	0.02	c	0.3
Na	16.7	20.7	25.2	24.2	c	b
Pb	<0.025	<0.025	<0.025	<0.025	c	0.025
Zn	0.03	0.03	<0.01	0.01	c	5.0

a: Locations of recharge basins are shown in Figure 9.
b: No standard specified.
c: No analysis performed.

Table 11
1986 BNL Environmental Monitoring
External Dose-Equivalent Rates for All TLD Locations

Location	Alternate Name	1986 1st Quarter	1986 2nd Quarter	1986 3rd Quarter	1986 4th Quarter	Annual Total Dose	Adjusted Annual Total
		mrem					
1T2.2		14.4	DM	11.8	DM	54.5	50.5
1T3.0		13.3	12.9	14.9	13.9	55.0	55.0
1T8.8		13.3	21.4*	16.1	12.6	63.4*	55.6
2T1.4	S-13	16.7	DM	15.2	15.1	64.3	62.5
2T2.6		17.1	DM	DM	DM	69.4	69.4
2T2.6B	P-9	16.7	DM	DM	DM	67.9	67.9
2T3.2		14.7	13.3	16.4	15.0	59.3	59.3
2T10.5		13.8	14.6	20.1	16.0	64.5	64.5
3T2.8		16.1	17.0	14.0	14.1	61.2	59.9
3T8.8		13.6	14.9	16.1	15.9	60.4	60.4
4T2.4		15.2	15.7	13.4	13.1	57.4	56.0
4T2.6		14.7	13.3	14.9	14.9	57.7	57.7
4T7.5		14.6	12.7	16.0	14.1	57.3	57.3
5T2.5		19.3	20.5	17.2	16.2	73.2	71.5
5T4.2		13.1	10.6	13.6	12.2	49.6	49.6
5T6.5		14.0	12.3	16.7	13.1	56.1	56.1
5T17.1		12.7	12.9	16.7	12.6	55.0	55.0
6T2.8	P-7	16.2	16.8	15.1	DM	64.2	63.4
6T5.6		13.3	11.7	14.2	13.0	52.3	52.3
6T14.2							
7T1.6		20.6	DM	18.6	18.5	78.9	76.3
7T2.5		17.7	16.4	20.2	17.7	72.0	72.0
7T9.7		11.9	12.3	14.4	12.7	51.3	51.3
8T1.3		18.5	20.3	17.2	16.5	72.6	71.8
8T2.3		14.0	12.8	15.9	DM	57.0	57.0
8T8.0		14.2	12.7	15.2	13.2	55.4	55.4
9T8.3		15.7	13.9	17.2	14.9	61.7	61.7
10T1.8		17.6	19.3	16.4	15.7	69.0	68.4
10T3.7		18.0	15.5	19.7	DM	71.2	71.2
10T9.3		16.8	29.5*	17.2	14.4	77.9	64.0
10T12.0		15.7	15.2	19.7	15.6	66.2	66.2
11T2.1	P-4	16.3	17.6	14.5	14.1	62.5	61.4
11T3.7		14.3	13.5	17.2	DM	60.3	60.3
11T17.8		12.1	12.2	15.7	12.5	52.5	52.5
12T1.4		17.2	19.4	15.8	16.4	68.8	68.5
12T5.0		14.3	13.0	15.4	14.4	57.1	57.1
12T7.2		13.7	13.4	18.4	16.7	62.2	62.2
12T12.5		14.0	15.6	19.1	14.7	63.4	63.4
13T1.3		17.2	18.1	15.5	15.7	66.5	65.4
14T1.4		14.4	15.0	19.5	15.2	64.1	64.1
13T2.6		14.8	14.4	16.6	15.1	60.9	60.9
13T8.2		12.7	11.1	14.0	12.0	49.8	49.8
14T1.3		17.8	19.6	15.7	15.6	68.7	67.4
15T1.4		16.1	15.3	19.5	15.9	66.7	66.7
14T3.1		DM	15.8	DM	16.0	64.0	64.0
14T5.6		15.8	15.3	20.7	16.4	68.2	68.2
15T1.7		17.5	18.9	15.8	15.5	67.7	66.4
15T3.0		12.8	12.2	14.2	13.4	52.6	52.6
15T14.7		14.9	13.4	19.6	14.2	62.2	62.2
16T2.1	P-2	16.1	17.6	14.7	14.7	63.0	62.4
16T3.4		14.8	13.8	16.7	15.2	60.6	60.6
16T10.0		18.3	12.2	19.2	15.9	65.6	65.6
Control A		4.70	4.20	4.20	4.60	17.8	17.8
Control B		4.90	4.30	5.40	4.40	19.0	19.0
Control C		4.40	4.10	4.70	4.10	17.4	17.4
Control M		5.90	5.20	4.00	5.40	20.5	19.3

Adjusted Annual Average On-Site External Dose (18 observations, stations 7T1.6 and 8T1.6 not included due to proximity to the Hazardous Waste Management Area) = 63.3 mrem ± 5.6 mrem

Adjusted Annual Average Off-Site External Dose (30 observations) = 59.2 mrem ± 5.6 mrem

DM = Data Missing - Monitoring lost during sample period.

* Elevated Exposure due to Ra-226 calibration source. Value not included in Adjusted Annual Total.

Table 12
1986 BNL Environmental Monitoring
Ambient Air Tritium Concentrations at Perimeter and Control Locations

Collection Date	1T	3T	4T	5T	6T1	6T2	7T	8T	10T	11T	12T	13T	14T	15T	16T	Lab 17T	Control 18T	Bldg.535* 20T
	<--									pCi/m^3	--->							
1/15/86	7.6	2.8	5.4	9.1	0	0	13.5	4.9	1.4	0	5.3	2.7	6.6	NS	0	107.0	0.1	NS
1/23/86	13.1	0.8	3.2	11.2	2.0	2.9	2.6	-2.2	1.0	4.9	-0.2	-0.3	0	-0.4	NS	17.8	NS	7.9
1/31/86	17.1	1.5	56.5	43.8	17.7	14.9	133.0	4.4	6.7	72.9	8.6	17.2	17.6	5.5	0.3	17.8	3.3	7.1
2/6/86	NS	-2.9	-1.8	0.1	9.8	4.2	-1.7	0.9	1.6	3.0	-1.1	2.5	0.4	-0.2	7.1	17.8	3.3	10.8
2/13/86	NS	1.4	0.5	2.6	0.9	NS	1.9	0.5	-1.6	0.7	3.2	2.2	1.6	NA	-0.5	8.3	3.3	6.1
2/20/86	7.8	5.2	2.8	6.5	1.2	7.4	-0.8	2.9	0.2	1.2	0.2	4.3	1.9	0	1.2	9.6	2.4	7.6
2/28/86	2.6	0.5	2.0	22.8	1.3	NS	52.6	9.1	-0.4	2.1	0.3	0.9	3.2	0.4	1.5	19.9	0.8	3.3
3/13/86	1.1	-0.3	3.0	NS	1.1	0.8	2.9	1.8	2.6	0.9	0.5	3.9	2.0	NS	0.3	10.5	1.2	8.1
3/19/86	19.4	29.3	4.1	NS	16.2	3.5	15.0	9.3	2.1	6.1	3.7	3.8	2.1	3.7	12.1	41.3	2.4	12.5
3/26/86	5.9	4.2	2.8	1.3	4.1	3.2	2.3	8.1	2.3	4.5	1.6	2.5	2.0	NS	3.7	NS	1.7	6.7
3/31/86	12.3	3.3	9.2	7.4	5.6	9.0	2.6	3.5	NS	17.4	0.9	4.0	6.6	5.8	3.2	NS	1.7	7.9
4/8/86	12.4	11.5	2.3	17.2	2.8	8.0	7.8	5.2	4.2	8.6	1.6	5.6	5.1	2.9	4.2	NS	2.1	1.9
4/15/86	13.8	4.3	9.2	8.7	7.1	7.6	9.8	18.9	11.5	11.2	8.3	5.7	4.1	5.0	9.9	NS	3.7	16.0
4/22/86	22.0	9.8	14.8	16.0	4.1	3.9	NS	14.6	12.4	4.9	7.7	9.6	6.4	12.3	4.9	NS	8.7	12.1
4/30/86	15.9	8.6	7.5	12.3	32.8	3.7	NS	15.8	10.5	3.3	6.7	11.7	13.3	16.2	4.4	NS	8.7	38.5
5/8/86	28.3	6.4	3.6	2.8	5.4	4.3	NS	2.4	5.9	14.3	3.5	5.8	6.5	4.3	10.2	40.6	6.7	9.8
5/14/86	8.4	8.6	8.9	5.4	2.4	4.7	NS	NA	8.4	6.4	12.5	9.0	9.1	7.8	4.6	30.2	3.5	22.3
5/22/86	NS	-7.9	6.9	1.3	4.4	4.2	10.1	2.6	5.1	3.4	0	3.9	9.4	17.4	3.2	29.8	3.4	7.3
5/30/86	NS	1.3	3.3	3.0	2.0	7.8	2.8	5.6	3.4	2.3	4.7	6.0	4.5	0	3.7	40.5	3.4	28.1
6/5/86	NS	3.5	7.7	-0.8	2.3	3.6	NS	29.4	1.6	3.6	5.5	4.4	2.0	0.5	2.4	31.1	3.8	7.8
6/12/86	NS	16.0	14.3	10.5	2.4	2.8	NS	13.6	5.6	3.7	20.9	5.5	6.6	4.0	0.4	30.6	2.0	12.6
6/23/86	NS	3.4	2.6	1.7	75.9	69.1	NS	2.1	8.4	35.3	4.4	73.1	4.6	11.2	24.5	32.4	2.2	21.1
6/30/86	NS	5.5	7.2	10.0	5.6	6.3	NS	9.9	5.4	4.1	6.4	4.6	16.4	12.1	6.4	25.4	6.8	14.8
7/7/86	NS	10.1	2.9	11.0	3.7	4.9	NS	5.4	5.4	4.2	9.9	26.2	3.4	7.2	2.8	34.8	4.4	24.5
7/16/86	NS	4.6	7.3	9.5	6.1	4.9	NS	10.8	9.5	12.5	13.5	0.4	7.4	6.8	7.4	49.0	14.6	44.6
7/23/86	NS	15.3	2.6	5.4	2.6	4.0	NS	4.0	6.3	13.0	6.9	1.7	14.2	16.0	5.9	31.9	5.9	7.8
7/31/86	NS	5.6	6.2	4.8	7.6	1.0	6.3	6.9	4.3	3.4	21.6	-2.9	3.0	9.3	3.1	25.7	12.4	19.7
8/8/86	NS	11.5	13.1	8.8	4.8	6.0	8.1	8.4	5.9	2.7	3.2	4.6	7.5	4.7	5.7	27.9	12.4	6.3
8/15/86	NS	3.1	3.3	0.9	2.9	3.3	7.4	4.5	2.0	-1.0	0.5	2.8	7.6	6.5	4.7	3.1	3.7	7.4
8/21/86	10.0	16.3	3.5	2.8	5.4	0.5	4.2	4.1	6.3	6.2	7.5	9.4	6.2	2.6	9.6	52.2	3.7	4.2
8/27/86	3.5	-3.1	-0.6	0	2.5	0.6	2.3	-2.3	1.7	0.4	2.8	0.7	1.6	-1.3	0.5	34.8	3.7	2.8
9/12/86	4.5	3.6	4.9	4.2	1.1	2.7	3.5	5.3	1.6	3.7	2.6	10.1	1.4	11.1	2.4	36.3	NS	5.9
9/23/86	6.8	4.8	2.1	2.9	1.0	1.7	3.2	2.0	2.0	1.6	3.5	1.4	7.4	3.7	2.6	45.2	7.8	17.7
10/1/86	15.8	14.5	10.9	14.7	-1.2	1.3	6.3	18.7	0.6	14.6	3.9	4.7	2.8	4.6	2.4	45.2	1.1	12.8
10/9/86	4.0	2.1	1.4	8.0	2.9	3.3	6.0	1.5	2.4	3.6	5.2	3.3	3.1	3.2	2.1	25.5	1.1	7.3
10/16/86	3.2	5.4	1.4	3.2	2.3	4.0	0	4.6	2.6	2.4	34.0	29.5	1.3	0.6	2.7	25.5	1.1	5.1
10/23/86	3.4	0.9	3.8	2.1	1.0	0.4	0	1.6	1.1	2.4	1.5	1.8	0	NS	2.0	14.1	1.1	3.9
10/31/86	0.3	0	0.7	0.4	1.5	0.5	4.0	1.1	2.8	4.0	6.5	-0.3	-1.2	NS	2.8	14.1	1.1	1.4
11/6/86	0.3	1.1	5.8	0	1.0	1.4	4.0	1.1	2.8	-0.5	6.5	-0.3	-1.2	29.8	0	14.1	1.1	1.4
11/13/86	1.1	-0.5	-0.3	-0.5	-2.6	1.7	-6.4	0	1.6	0	-1.4	-0.8	0.3	2.6	1.6	19.4	0.4	1.1
11/20/86	4.1	-0.6	0.9	0.6	0.6	1.4	-0.6	0.9	0.2	1.3	-1.3	0	-0.2	-3.6	0.5	19.4	0.4	1.1
11/25/86	-0.3	8.6	4.0	27.2	0.8	0.4	9.1	9.3	0.3	1.9	3.2	8.6	8.8	0.7	NS	15.0	0.4	15.9
12/04/86	-0.1	1.5	0.8	1.0	0.8	0.4	2.9	1.3	2.2	1.9	3.5	2.6	1.7	0.4	NS	15.0	0.4	1.4
12/12/86	NS	0.3	14.9	-0.6	2.1	0.4	0.2	1.6	0	3.3	5.0	-0.6	0	0	NS	15.0	0.4	1.8
12/22/86	NS	0.3	2.2	2.3	1.0	1.2	1.5	1.4	0	1.6	2.3	0.5	0.6	2.4	NS	32.7	0.4	1.8
12/31/86	NS	-1.6	0.4	-2.3	-0.3	-0.2	0	0	-1.7	-0.7	-0.9	0	-0.9	0	NS	32.7	NS	1.8
Annual Average	9.0	4.9	5.5	6.6	6.1	5.3	8.9	5.2	3.6	5.7	4.7	6.9	4.5	3.6	4.0	28.0	3.2	9.4
Net Average Air Concentration	5.8	1.7	2.3	3.4	2.9	2.1	5.7	2.0	0.4	2.5	1.5	3.7	1.3	2.4	0.8	24.8	0	6.2

NS = Not sampled.
NA = Not analyzed.
*Station 20T is located just outside the analytical laboratory. On Figure 3, Stations 17 and 20 are located at the same place with only Station 17 appearing on the figur

Table 13
1986 BNL Environmental Monitoring
Ambient Air Tritium Concentrations
at the Sewage Treatment Plant Hold-up Pond
and the Waste Management Area, pCi/m^3

Collection Date	STPN	STPE	STPS	STPW	STPLAB (250)	S6	WM (445)
1/15/86	9.0	19.2	15.9	8.3	3.1	260.0	20.8
1/23/86	NS	14.2	NS	15.1	3.9	14.7	14.1
1/31/86	22.2	8.8	2.5	3.1	9.4	7.8	10.7
2/6/86	9.1	13.3	8.5	13.3	12.1	6.5	5.8
2/13/86	0.5	10.2	6.8	13.9	4.4	8.3	9.0
2/20/86	9.4	5.9	6.8	6.3	7.2	7.4	5.4
2/28/86	4.0	28.3	20.1	39.7	11.5	5.0	13.0
3/13/86	6.7	49.1	2.9	12.0	7.0	9.7	7.6
3/19/86	NS	29.4	5.9	33.3	2.1	6.3	14.8
3/26/86	22.9	19.3	NS	10.7	6.5	17.5	20.3
3/31/86	58.4	30.4	18.5	11.7	14.5	36.6	10.1
4/8/86	29.8	33.9	8.2	31.7	3.2	10.3	19.0
4/15/86	26.0	23.8	9.7	21.5	7.4	11.6	9.3
4/22/86	23.7	20.1	29.8	39.1	27.0	6.6	14.8
4/30/86	45.6	44.1	38.9	19.4	10.3	10.4	69.7
5/8/86	56.5	87.9	48.3	NS	40.9	32.6	10.4
5/14/86	NS	26.4	34.5	NS	5.8	3.9	23.7
5/22/86	15.2	24.7	17.5	34.8	89.0	21.7	23.5
5/30/86	92.6	38.1	39.6	14.4	9.1	33.0	30.2
6/5/86	64.4	40.2	30.4	51.7	3.8	56.2	30.4
6/12/86	87.6	4.1	53.1	24.7	1.3	63.8	31.3
6/23/86	87.6	4.1	53.1	24.7	1.3	145.0	28.1
6/30/86	45.9	76.8	30.4	NS	6.2	55.2	33.6
7/7/86	28.1	81.3	30.5	54.0	13.5	56.0	20.4
7/14/86	122.0	278.0	NS	105.0	257.0	46.0	45.3
7/23/86	78.0	15.3	49.1	83.2	5.9	31.0	17.1
7/31/86	25.7	66.2	54.1	123.0	37.3	51.9	27.4
8/8/86	79.4	41.3	16.9	50.0	13.9	83.4	36.0
8/15/86	7.3	35.1	23.1	19.0	12.1	71.6	67.6
8/21/86	64.6	20.1	14.0	49.7	4.7	47.8	80.2
8/27/86	23.6	26.6	8.3	13.5	1.8	26.4	144.0
9/12/86	10.3	25.2	11.6	18.6	2.4	1.4	194.0
9/23/86	13.2	18.4	9.2	10.0	4.1	40.6	110.0
10/1/86	13.2	18.4	9.2	10.0	4.1	70.2	127.0
10/9/86	13.2	29.3	7.1	4.3	3.4	54.7	172.0
10/16/86	6.0	49.1	3.4	9.2	0.3	37.7	119.0
10/23/86	4.8	9.0	4.1	6.5	-0.5	38.4	58.0
10/31/86	6.0	15.3	5.8	27.0	-0.2	41.4	43.4
11/6/86	6.0	15.3	5.8	27.0	-0.2	3.3	20.9
11/13/86	5.4	4.4	1.9	6.5	0	24.6	14.6
11/20/86	5.4	8.7	5.0	36.8	1.4	18.5	17.4
11/25/86	8.9	8.7	5.0	36.8	1.4	26.3	8.9
12/4/86	0	4.0	18.0	2.8	0.5	26.3	8.9
12/12/86	0	4.0	18.0	2.8	0.5	17.0	-0.7
12/22/86	0.7	11.7	1.23	3.2	6.4	0	9.4
12/31/86	0.7	11.7	1.23	3.2	6.4	15.8	16.2
Average	26.6	29.8	17.1	39.0	16.6	36.5	42.0
Net Average Air Conc.	23.4	26.6	13.9	35.8	13.4	33.3	38.8

NS = Not Sampled.

Table 14A

1986 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location P-2

Month in 1986	No of Measure-ments	Gross Alpha Ave	Gross Alpha Min	Gross Alpha Max	Gross Beta Ave	Gross Beta Min	Gross Beta Max
		pCi/m^3					
January	3	0.00061	0.00037	0.00097	0.0135	0.0105	0.0165
February	4	0.00134	-0.00039	0.00352	0.0820	0.0075	0.286
March	5	0.00163	-0.00021	0.00337	0.0155	0.0001	0.131
April	4	0.00095	0.00082	0.00099	0.0107	0.0041	0.0168
May	4	0.00053	0.00016	0.00098	0.0920	0.0127	0.1870
June	4	0.00131	-0.00037	0.00327	0.0518	0.0179	0.1620
July	4	0.00100	0.00055	0.00146	0.0120	0.0010	0.0140
August	3	0.00060	-0.00019	0.0013	0.0123	0.0105	0.0133
September	2	0.00069	0.00037	0.00092	0.0089	0.0029	0.0174
October	4	0.00076	-0.00045	0.00187	0.0104	0.0071	0.0123
November	3	0.00145	0.00036	0.00212	0.0096	0.0048	0.0154
December	0	SNC	SNC	SNC	SNC	SNC	SNC
Annual	41	0.00096	-0.00045	0.00352	0.0300	0.0001	0.286

SNC = Sample not collected during the period due to loss of sample station.

Table 14B

1986 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location P-4

Month in 1986	No of Measurement	Gross Alpha Ave	Gross Alpha Min	Gross Alpha Max	Gross Beta Ave	Gross Beta Min	Gross Beta Max
		pCi/m^3					
January	4	0.00047	0.00033	0.00091	0.0075	0.0037	0.0132
February	4	0.00075	0.00035	0.00135	0.0234	0.0066	0.0441
March	5	0.00072	-0.01260	0.00223	0.0140	-0.0082	0.2630
April	4	0.00057	0.00015	0.00087	0.0097	-0.0003	0.0146
May	4	0.00061	-0.00017	0.00179	0.0989	0.0099	0.2430
June	4	0.00105	-0.00021	0.00385	0.0504	0.0125	0.1810
July	4	0.00089	0	0.00147	0.0111	0.0075	0.0136
August	3	0.00054	0.00033	0.00074	0.0135	0.0104	0.0214
September	2	-0.00007	-0.00046	0.00019	0.0068	0.0045	0.0102
October	4	0.00097	0	0.00224	0.0132	0.0059	0.0230
November	3	0.00078	0.00019	0.00130	0.0086	0.0013	0.0164
December	3	0.00048	0	0.00076	0.0080	0.0305	0.0126
Annual	44	0.00062	-0.01260	0.00385	0.0221	-0.0082	0.2630

Table 14C

1986 BNL Enivornmental Monitoring
Gross Alpha and Beta Concentrations
in Air at Particulate Filters from Location P-7

Month in 1986	No of Measure-ments	Gross Alpha				Gross Beta		
		Ave	Min	Max	pCi/m^3	Ave	Min	Max
January	4	0.00097	0	0.00147		0.0125	0.0097	0.0162
February	4	0.00091	0.00034	0.00150		0.0214	0.0126	0.0425
March	5	0.00070	-0.00769	0.00177		0.0151	0.0034	0.1050
April	4	0.00048	-0.00055	0.00131		0.0108	0.0076	0.0143
May	4	0.00082	0.00020	0.00180		0.1110	0.0235	0.2230
June	4	0.00127	0	0.00349		0.0561	0.0106	0.2010
July	4	0.00127	0.00037	0.00291		0.0148	0.0124	0.0170
August	3	0.00046	0.00036	0.00072		0.0142	0.0129	0.0155
September	2	0.00132	0.00115	0.00156		0.0152	0.0084	0.0250
October	4	0.00225	0.00060	0.00419		0.0164	0.0130	0.0203
November	3	0.00087	0.00060	0.00113		0.0119	0.0058	0.0198
December	3	0.00124	0.00045	0.00168		0.0132	0.0121	0.0146
Annual	44	0.00107	-0.00769	0.00349		0.0259	0.0034	0.2230

Table 14D

1986 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location S-5

Month in 1986	No of Measure- ments	Gross Alpha Ave	Gross Alpha Min	Gross Alpha Max	Gross Beta Ave	Gross Beta Min	Gross Beta Max
		(pCi/m^3)					
January	4	0.00135	0.00112	0.00180	0.0157	0.0133	0.0169
February	4	0.00121	0.00065	0.00186	0.0149	0.0139	0.0173
March	5	0.00203	-0.00085	0.00509	0.1390	0.0067	0.7570
April	4	0.00061	0	0.00167	0.0145	0.0094	0.0265
May	4	0.00124	0	0.00215	0.1119	0.0039	0.2740
June	4	0.00117	0.00026	0.00196	0.0640	0.0139	0.2160
July	4	0.00118	0.00075	0.00181	0.0172	0.0139	0.0237
August	3	0.00041	-0.00019	0.00064	0.0199	0.0138	0.0397
September	2	0.00061	0.00058	0.00066	0.0123	0.0065	0.0197
October	4	0.00129	-0.00049	0.00220	0.0150	0.0126	0.0213
November	4	0.00126	0	0.00355	0.0175	0.0144	0.0221
December	3	0.00064	0.00019	0.00130	0.0077	-0.0006	0.0170
Annual	45	0.00107	-0.00085	0.00509	0.0373	-0.0006	0.7570

Table 14E

1986 BNL Environmental Monitoring
Gross Alpha and Beta Concentrations
on Air Particulate Filters from Location S-6

Month in 1986	No of Measure-ments	Gross Alpha			Gross Beta		
		Ave	Min	Max	Ave	Min	Max
		pCi/m^3					
January	20	0.00169	-0.00175	0.01420	0.0205	0.0033	0.0783
February	18	0.00140	-0.00528	0.00815	0.0207	-0.0104	0.0481
March	21	0.00119	-0.00680	0.00652	0.0539	-0.0465	0.7220
April	22	0.00180	-0.00669	0.01050	0.0238	-0.0433	0.2302
May	20	-0.00026	-0.00884	0.00901	0.1133	-0.0287	0.3490
June	21	0.00245	-0.00647	0.00790	0.0660	-0.0040	0.3070
July	21	0.00161	-0.00399	0.00681	0.0149	-0.1130	0.0667
August	21	0.00272	-0.00657	0.04320	0.0183	-0.0095	0.0497
September	20	0.00142	-0.00629	0.00686	0.0177	-0.0027	0.0679
October	23	0.00387	-0.00318	0.01330	0.0214	0.0032	0.0635
November	18	0.00196	-0.00925	0.01780	0.0149	-0.0172	0.0457
December	20	0.00259	-0.01190	0.01360	0.0127	-0.0190	0.0596
Annual	246	0.00189	-0.01190	0.04320	0.0331	-0.1130	0.7220

Table 14F
1986 BNL Environmental Monitoring
Composite Air Particulate Radionuclide Concentrations

Month	Flow (cc)	^{7}Be	^{134}Cs	^{95}Nb	^{103}Ru	^{137}Cs	^{40}K	^{228}Th	$^{106}RuRh$
		<----------	----------	----------	----------	pCi/m^3	----------	----------	---------->
January	NA								
February	NA								
March	4.07E9	0.125	ND	ND	ND	0.00036	0.0058	0.0041	ND
April	4.38E9	0.083	ND	ND	ND	0.00073	0.0055	0.0030	ND
May	4.37E9	0.117	0.011	ND	0.0182	0.0217	0.00037	0.0033	0.0044
June	4.51E9	0.126	0.003	ND	0.0078	0.0059	0.0014	0.0038	0.0030
July	4.74E9	0.056	ND	ND	ND	0.00033	0.0040	0.0019	ND
August	4.29E9	0.033	ND	ND	ND	0.00028	ND	0.0008	ND
September	4.79E9	0.033	ND	0.00032	ND	0.00035	0.0019	0.0008	ND
October	4.25E9	0.053	ND	ND	ND	0.00047	0.0038	0.0024	ND
November	3.04E9	0.109	ND	ND	ND	0.00161	0.0037	ND	ND
December	5.08E9	0.041	ND	ND	ND	ND	ND	ND	ND
Total (pCi)	4.35E10	3260	61.6	1.5	114.7	137.4	125.6	87.9	32.8
Average Concentration	4.35E9	0.075	0.0014	0.00004	0.0026	0.0032	0.0029	0.0020	0.0008

NA = Not Analyzed.
ND = Not Detected.

Table 14G
1986 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location P-2

Month	^{137}Cs	^{40}K	^{131}I
	<---------------	pCi/m^3	--------------->
January	0.002	0.349	ND
February	ND	0.266	ND
March	NA	NA	NA
April	ND	0.350	ND
May	0.010	0.509	0.177
June	NA	NA	NA
July	0.0002	0.240	ND
August	ND	0.300	ND
September	0.002	0.202	ND
October	0.003	0.419	ND
November	ND	0.411	ND
December	NIS	NIS	NIS
Average	0.002	0.338	0.020

NA = Sample not analyzed.

ND = Nuclide not detected and is less than the MDC.

NIS = Station not in service.

Table 14H
1986 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location P-4

Month	^{137}Cs	^{40}K	^{131}I	^{7}Be
	<----------------	pCi/m^3	----------------	---------------->
January	ND	0.280	ND	ND
February	ND	0.304	ND	ND
March	NA	NA	NA	ND
April	ND	0.207	ND	0.046
May	0.001	0.641	0.143	ND
June	0.001	0.234	ND	ND
July	ND	0.203	ND	ND
August	ND	0.251	ND	ND
September	ND	0.152	ND	ND
October	ND	0.385	ND	ND
November	ND	0.192	ND	ND
December	ND	0.492	ND	ND
Average	0.0002	0.304	0.013	0.004

NA = Sample not analyzed.

ND = Nuclide not detected and is less than the MDC.

Table 14I
1986 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location P-7

Month	^{137}Cs	^{40}K	^{131}I	^{7}Be
	<--------------------	pCi/m^3		-------------------->
January	0.001	0.267	ND	ND
February	0.001	0.273	ND	ND
March	NA	NA	NA	NA
April	NA	NA	NA	NA
May	0.003	0.756	0.150	ND
June	0.001	0.237	ND	0.016
July	ND	0.378	ND	0.021
August	0.002	0.231	ND	ND
September	ND	0.249	ND	ND
October	ND	0.330	ND	ND
November	ND	0.162	ND	ND
December	ND	0.436	ND	ND
Average	0.001	0.332	0.015	0.004

NA = Sample not analyzed.

ND = Nuclide not detected and is less than the MDC.

Table 14J
1986 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location S-5

Month	^{137}Cs	^{40}K	^{131}I
	<--------------	pCi/m^3	-------------->
January	ND	0.154	ND
February	ND	0.274	ND
March	NA	NA	NA
April	ND	0.258	ND
May	ND	0.640	0.240
June	ND	0.338	ND
July	0.002	0.257	ND
August	ND	0.264	ND
September	ND	0.264	ND
October	ND	0.257	ND
November	ND	0.410	ND
December	ND	0.437	ND
Average	0.0002	0.323	0.022

NA = Sample not analyzed.

ND = Nuclide not detected and is less than the MDC.

Table 14K
1986 BNL Environmental Monitoring
Radionuclides Detected on Charcoal Filter Samples
from Location S-6

Month	^{137}Cs	^{40}K	^{131}I
	<---------------	pCi/m^3	--------------->
January	ND	0.257	ND
February	ND	ND	ND
March	NA	NA	NA
April	0.002	0.262	ND
May	0.002	0.655	0.138
June	0.002	0.218	ND
July	0.0004	0.240	ND
August	ND	0.285	ND
September	0.003	0.214	ND
October	ND	0.220	ND
November	ND	0.176	ND
December	0.004	0.358	ND
Average	0.001	0.262	0.013

NA = Sample not analyzed.

ND = Nuclide not detected and is less than the MDC.

Table 15
1986 BNL Environmental Monitoring
Radionuclide Activity in Precipitation

Quarter	Precipitation cm	Gross Alpha Concentration Average	Gross Alpha Concentration Minimum	Gross Alpha Concentration Maximum	Gross Beta Concentration Average	Gross Beta Concentration Minimum	Gross Beta Concentration Maximum	Tritium Concentration Average	Tritium Concentration Minimum	Tritium Concentration Maximum	^{7}Be	^{131}I	^{103}Ru	^{137}Cs	^{90}S
		nCi/m^2													
1st	26.90	0.098	0.030	0.182	0.754	0.160	1.278	8.067	-33.087	155.482	17.74	ND	ND	ND	0.0
2nd	12.96	0.043	0.007	0.095	0.808	0.086	2.190	1.698	-27.346	20.736	7.25	2.73*	0.09*	0.10	0.0
3rd	29.38	0.047	-0.066	0.232	0.721	0.031	2.227	-4.830	-69.337	37.606	10.58	ND	ND	0.05	0.0
4th	41.84	0.079	-0.024	0.095	0.300	0.029	0.540	99.872	-43.93	403.337	21.33	ND	ND	0.03	0.0
Total	111.1	0.267	-	-	2.583	-	-	104.81	-	-	56.90	2.73	0.09	0.18	0.0

Collection Area = 0.343 m^2

NA = Not Analyzed during reporting period.

ND = Not Detected.

*Detected only in precipitation samples collected during the month of May. Activity due to fallout from Chernobyl reactor accident.

Table 16
1986 BNL Environmental Monitoring
Radionuclide Concentrations in Vegetation and Soil in the Vicinity of BNL

Location	Sample Matrix	Radionuclides Be-7	K-40	Cs-137	Ra-226	Th-228
		pCi/kg				
JB	Grass	686	4,570	ND	ND	ND
JD	Grass	962	3,760	ND	ND	ND
JE	Grass	640	2,960	166	ND	ND
BA-1	Soil*	ND	4,060	9.0	260	340
BA-2	Soil*	ND	4,100	16.0	130	420

ND = Not Detected. Results less than the MDC.
*Not a surface soil sample.

Table 17A
1986 BNL Environmental Monitoring
Gross Alpha, Gross Beta and Tritium Concentrations
in Peconic and Carmens River Surface Water

Location	Sample Period	No. of Samples	Gross Alpha Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Average	Gross Beta Minimum	Gross Beta Maximum	Tritium Average	Tritium Minimum	Tritium Maximum
			pCi/L								
HM	January	13	0.609	0.282	1.69	6.40	1.22	12.1	1,047.0	-89.0	3,020.0
	February	10	0.847	-1.41	5.93	5.11	-1.05	15.2	665.0	-987.0	1,960.0
	March	13	0.391	-0.282	1.13	4.81	-0.52	9.4	883.4	178.0	2,080.0
	April	13	0.109	-2.54	1.41	5.55	1.40	11.2	1,624.0	-93.5	4,010.0
	May	12	-0.070	-2.54	2.26	14.8	-2.79	132.0	2,831.0	-194.0	5,830.0
	June	13	-0.0004	-1.98	2.82	6.83	1.40	19.2	4,501.0	745.0	9,400.0
	July	12	0.212	-1.41	1.98	5.54	1.57	10.6	5,967.0	4,370.0	7,490.0
	August	13	0.607	-0.57	1.69	5.48	-2.09	15.4	4,059.0	1,550.0	6,250.0
	September	13	0.130	-1.13	1.69	4.30	0.87	8.73	2,445.0	-398.0	7,640.0
	October	14	0.222	-0.847	1.41	6.05	1.40	16.1	1,773.0	376.0	4,180.0
	November	11	0.718	-0.282	2.54	3.44	0.70	7.16	859.0	0	2,350.0
	December	14	0.141	-1.98	1.98	5.01	0.52	13.3	2,798.0	-91.0	6,800.0
	Annual	151	0.312	-2.54	5.93	6.10	-2.79	132.0	2,483.0	-987.0	9,400.0
HR	January	1	-0.056	-	-	2.06	-	-	-49.1	-	-
	February	NS	-	-	-	-	-	-	-	-	-
	March	NS	-	-	-	-	-	-	-	-	-
	April	2	-0.085	-0.169	0	1.69	0.87	2.51	-1,970.0	-2,620.0	-1,320.0
	May	2	0.226	-0.113	0.565	1.44	0.87	2.03	-2,225.0	-2,580.0	-1,870.0
	June	1	0.226	-	-	1.36	-	-	263.0	-	-
	July	3	0.094	-0.113	0.282	1.82	1.26	2.41	0.7	-1,590.0	2,400.0
	August	1	0.169	-	-	3.14	-	-	256.0	-	-
	September	1	0.169	-	-	0.77	-	-	-1,360.0	-	-
	October	2	0.198	0.169	0.226	1.33	1.15	1.50	656.5	509.0	804.0
	November	1	0.282	-	-	1.68	-	-	-1,020.0	-	-
	December	NS	-	-	-	-	-	-	-	-	-
	Annual	14	0.125	-0.056	0.565	1.74	0.77	3.14	-177.7	-2,620.0	2,400.0
HA	July	1	-0.057	-	-	0.94	-	-	-2,960.0	-	-
HB	July	1	0.057	-	-	0.87	-	-	-1,890.0	-	-
HC	July	1	0.113	-	-	0.94	-	-	-2,150.0	-	-
HD	July	1	-0.057	-	-	1.50	-	-	-808.0	-	-
HQ	April	1	0.282	-	-	4.09	-	-	863.0	-	-
	July	1	0	-	-	9.95	-	-	3,200.0	-	-
	Average	2	0.141	0	0.282	7.02	4.09	9.95	2,032.0	863.0	3,200.0
HH	January	NS	-	-	-	-	-	-	-	-	-
	February	1	0.057	-	-	1.82	-	-	251.0	-	-
	March	1	0.169	-	-	1.15	-	-	-523.0	-	-
	April	1	0.057	-	-	0.35	-	-	0	-	-
	May	1	0.282	-	-	0.63	-	-	-2,400.0	-	-
	June	1	-0.226	-	-	1.92	-	-	790.0	-	-
	July	1	0.113	-	-	1.82	-	-	-265.0	-	-
	August	1	0	-	-	0.63	-	-	-513.0	-	-
	September	2	0.396	0.226	0.565	0.30	-0.18	0.77	959.0	-272	2,190.0
	October	1	0.339	-	-	1.50	-	-	1,070.0	-	-
	November	NS	-	-	-	-	-	-	-	-	-
	December	NS	-	-	-	-	-	-	-	-	-
	Annual	10	0.158	-0.226	0.565	1.04	-0.18	1.92	32.8	-2400.0	2,190.0

NS = Not Sampled.

Table 17B
1986 BNL Environmental Monitoring
Nuclide Specific Concentrations in Peconic River Water Samples

Station	Sample Period	Aliquot ml	^{22}Na	^{60}Co	^{65}Zn	^{137}Cs	^{57}Co	^{40}K	^{226}Ra	^{90}Sr
			<-------------------			uCi/ml				------------------->
HM	January	39,640	9.4E-11	2.9E-10	1.5E-10	1.3E-9	ND	1.2E-9	ND	1.25E-9
	February	16,872	2.5E-10	5.0E-10	ND	1.3E-9	ND	3.0E-9	ND	1.25E-9
	March	NR	8.3E-11	2.0E-10	ND	6.2E-10	ND	1.8E-9	2.7E-10	1.25E-9
	April	49,432	7.7E-11	3.4E-10	ND	5.7E-10	ND	1.0E-9	ND	0.59E-9
	May	19,312	1.8E-10	4.0E-10	ND	7.7E-10	ND	8.0E-9	ND	0.59E-9
	June	14,500	9.3E-10	1.8E-9	ND	2.6E-9	2.3E-10	5.5E-9	ND	0.59E-9
	July	15,000	ND	1.3E-9	ND	2.0E-9	ND	ND	ND	1.05E-9
	August	15,000	ND	8.2E-10	ND	8.3E-10	ND	8.3E-9	ND	1.05E-9
	September	14,000	2.8E-10	1.2E-9	ND	1.3E-9	ND	6.0E-9	ND	1.05E-9
	October	22,912	3.4E-10	9.8E-10	ND	1.5E-9	ND	3.0E-9	ND	6.3E-10
	November	32,216	2.4E-10	4.2E-10	3.4E-10	2.1E-9	ND	5.1E-9	2.7E-10	6.3E-10
	December	19,920	4.5E-10	4.9E-10	2.9E-10	1.8E-9	ND	3.8E-9	ND	6.3E-10
	Annual Average	258,804	2.2E-10	6.4E-10	8.8E-11	1.4E-9	1.3E-11	3.5E-9	3.4E-11	8.24E-10
HR	Second Quarter	33,700	ND	ND	ND	1.3E-10	ND	9.9E-10	ND	NA

NA = Not Analyzed.

ND = Not Detected.

NR = Not Recorded.

NOTE: To convert uCi/ml to pCi/l, multiply result by 1.0E+9.

Table 18
1986 BNL Environmental Monitoring
Radionuclide Concentrations in Racoon, Deer Meat, and Peconic River Fish

Common Name	Sample Type	Sample Location	Collection Date	^{137}Cs pCi/kg wet	^{40}K pCi/kg wet	^{3}H uCi/ml wet
Creek Chub	Fluid	BNL	7/8/86	NA	NA	8.1E-6
Creek Chub	Whole Body	BNL	7/8/86	588	1729	NA
Bull Head	Whole Body	Lake Ronkonkoma (off site)	6/8/86	67	3024	NA
Racoon	Flesh	BNL-AGS	11/12/86	133	2231	NA
Deer	Flesh	Ridge (off site)	12/13/86	175	2566	NA
Deer	Flesh	BNL South Gate	12/17/86	178	2523	NA
Deer	Flesh	BNL - West Boundary	12/20/86	202	3097	NA
Deer	Flesh	BNL South Gate	12/22/86	222	2829	NA

NA = Not Analyzed.
ND = Not Detected.

Table 19A
1986 BNL Environmental Monitoring
Potable and Cooling Water Well Radionuclide Data

Well ID	Number of Samples	Annual Pumpage x 10^8 l	Gross Alpha			Gross Beta			Tritium			^{90}Sr	^{60}Co	^{22}Na
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum			
			<----------						pCi/L					---------->
1 (FA)	6	5.00	0.301	-0.057	0.565	1.91	1.05	2.48	2103.2	750.0	6690	NA	2.43	ND
3 (FC)	6	3.803	0.151	-0.057	0.565	4.94	2.97	7.86	210.5	-92.8	711.0	NA	0.60	ND
4 (FD)	1	0.220	0.508	-	-	2.13	-	-	0	-	-	NA	ND	ND
5 (FE)	3	0.05	0.207	-0.057	0.339	1.50	0.98	2.06	-51.3	-233.0	52.7	<0.2	ND	ND
6 (FF)	2	0.556	0.424	0.395	0.452	2.01	1.22	2.79	-171.5	-186.0	-157.0	NA	ND	ND
7 (FG)	2	2.200	0.028	0	0.057	1.09	1.05	1.12	-27.3	-133.0	78.5	NA	ND	ND
10 (FO)	5	10.933	-0.090	-1.130	0.452	1.36	-0.11	2.27	167.4	49.1	318.0	NA	ND	0.5
11 (FP)	6	19.515	-0.273	-2.26	0.282	1.11	-1.26	2.20	179.4	-196.0	369.0	NA	0.89	ND
12	0	2.465	NS	-	-	NS	-	-	NS	-	-	NS	NS	NS
101 (FH)	1	8.332	0	-	-	1.22	-	-	-233.0	0	0	NA	0.21	ND
102 (FI)	0	2.036	NS	-	-	NS	-	-	NS	-	-	NS	NS	NS
103 (FJ)	2	9.172	0.339	0.339	0.339	1.40	-0.18	2.97	-90.4	-207.0	26.3	NA	ND	ND
104 (FK)	3	9.286	0.094	-0.057	0.169	1.58	0.77	2.16	97.4	-25.8	186.0	NA	ND	ND
105 (FL)	1	5.325	-0.057	-	-	1.22	-	-	183.0	-	-	NA	NA	NA
NYS Drinking Water Standard			15.0			50.0			20,000			8.00		
Radiation Concentration Guide													30,000	30,0

NS = Not Sampled.
NA = Not Analyzed.
ND = Not Detected. See List of Minimum Detectable Concentration Tables.

Table 19B
1986 BNL Environmental Monitoring
Potable Water from Building 535B and Distilled Water

Location	Sample Period	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
			<----------	----------	----------	----------	pCi/L	----------	----------	----------	---------->
FN (Bldg 535B)	January	21	0.255	-1.13	1.69	3.32	-1.40	12.50	806.0	-1170.0	7350.0
	February	19	0.490	-1.41	1.69	3.06	-1.22	9.42	358.5	-1440.0	4250.0
	March	21	0.443	-0.85	2.26	1.20	-1.57	8.03	632.7	-286.0	3030.0
	April	22	-0.231	-1.98	1.41	1.52	-1.40	5.24	317.3	-1200.0	3400.0
	May	21	-0.014	-3.67	2.26	0.43	-5.58	5.93	268.2	-668.0	973.0
	June	21	-0.067	-2.26	1.41	2.99	-2.09	10.80	792.7	-470.0	7630.0
	July	21	0.282	-0.847	2.26	0.12	-9.60	3.84	551.8	-864.0	1320.0
	August	21	0.121	-0.847	1.41	0.95	-3.32	4.01	648.8	92.3	1470.0
	September	21	0.161	-1.98	1.41	1.07	-3.32	4.89	188.5	-597.0	598.0
	October	23	0.147	-1.13	1.69	1.95	-2.62	6.11	127.9	-836.0	1130.0
	November	17	0.083	-1.41	2.82	-0.80	-5.93	4.54	302.2	-649.0	2920.0
	December	21	0.591	-1.41	1.69	0.92	-4.54	5.93	479.7	-367.0	1650.0
	Annual		0.186	-3.67	2.82	1.42	-9.60	12.50	456.2	-1440.0	7630.0
ZB (Distilled Water)	January	21	0.229	-1.13	2.26	1.39	-3.32	9.79	179.8	-626.0	1080.0
	February	19	0.223	-2.26	2.26	0.86	-3.49	5.24	-95.9	-1970.0	1080.0
	March	21	-0.067	-1.13	1.41	-0.27	-7.33	4.36	531.0	-950.0	2840.0
	April	22	-0.064	-1.13	1.98	1.68	-5.06	15.20	260.0	-748.0	2590.0
	May	20	-0.085	-3.11	1.69	-0.51	-5.94	7.85	225.3	-480.0	1210.0
	June	21	0.000	-0.85	1.13	-0.40	-6.28	4.89	114.4	-466.0	1890.0
	July	21	-0.107	-1.69	1.13	-1.32	-10.50	6.81	699.3	185.0	1580.0
	August	21	0.242	-1.13	2.54	-0.37	-4.54	4.01	701.3	-366.0	1620.0
	September	21	0.000	-2.26	1.98	-0.57	-3.49	6.46	350.9	-400.0	1590.0
	October	23	0.110	-0.85	2.26	0.44	-2.62	3.66	100.2	-765.0	1040.0
	November	17	0.116	-1.13	1.13	-1.57	-5.76	4.01	269.3	-274.0	2350.0
	December	20	0.424	-1.41	2.26	-0.16	-6.28	4.54	229.3	-649.0	1290.0
	Annual		0.082	-3.11	2.54	-0.04	-10.50	15.20	299.5	-1970.0	2840.0

Table 20
1986 BNL Environmental Monitoring
Potable Supply Wells, Average Water Quality and Metals Data

	Well No. 1 (FA)	Well No. 3 (FC)	Well No. 10 (FO)	Well No. 11 (FP)	NYS Drinking Water Standard
Number of samples	7	7	5	7	
pH (SU)	5.9-6.2	6.1-6.5	6.0-6.8	6.0-6.5	6.5-8.5
Specific conductance (umhos/cm)	132	126	97	93	a
Total coliforms[b]	ND	ND	ND	ND	4/100 ml
Results in mg/L					
Ammonia-N	<0.04	<0.04	<0.04	<0.04	a
Nitrate-N	0.85	0.45	0.50	0.29	10.0
Nitrite-N	<0.01	<0.01	<0.01	<0.01	a
Total solids	110	38	45	60	a
Chlorides	14.6	13.9	11.8	11.8	250
Sulfates	8	6	8	8	250
Ag	<0.02	<0.02	<0.02	<0.02	0.05
Ba	c	c	c	c	1.0
Cd	<0.005	<0.005	<0.005	<0.005	0.01
Cr	<0.025	<0.025	<0.025	<0.025	0.05
Cu	<0.05	<0.05	<0.05	<0.05	1.0
Fe	<0.05	0.07	<0.05	<0.05	0.3
Hg	<0.0002	<0.0002	<0.0002	<0.0002	0.002
Mn	0.02	0.07	<0.01	<0.01	0.3
Na	12.4	13.2	8.9	8.6	a
Pb	<0.025	<0.025	<0.025	<0.025	0.025
Zn	<0.01	<0.01	<0.01	<0.01	5.0

a: No standard specified.
b: Sampled monthly.
c: No analysis performed.
ND: Not Detected.

Table 21A
1986 BNL Environmental Monitoring
Potable Water Supply Wells,
Average Volatile Organic Compound Data

Well ID	No. of Samples		Chloroform	1,1,1-trichloroethane	trichloroethylene	tetrachloroethylene
			mg/L			
1 (FA)	5	Avg:	ND	0.137	ND	ND
		Min:		0.060		
		Max:		0.390		
3 (FC)	5	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
4 (FD)	2	Avg:	0.006	ND	ND	ND
		Min:	0.003			
		Max:	0.008			
6 (FF)	2	Avg:	ND	ND	ND	ND
		Min:				
		Max:				
7 (FG)	2	Avg:	0.002	ND	ND	ND
		Min:	0.001			
		Max:	0.003			
10 (FO)	3	Avg:	ND	0.008	ND	ND
		Min:		ND		
		Max:		0.013		
11 (FP)	5	Avg:	ND	0.008	ND	ND
		Min:		ND		
		Max:		0.015		
NYS Drinking Water Standards			0.100	0.050[a]	0.01	0.050[a]

ND: Not detected. Average Method Detection Limits were: chloroform - 2.85 ug/L; 1,1,1-trichloroethane - 5.48 ug/L; trichloroethylene - 2.21 ug/L; tetrachloroethylene - 2.79 ug/L.

(a) NYSDOH advisory guidelines.

Table 21B
1986 BNL Environmental Monitoring
Potable Water Supply Wells,
Average Volatile Organic Compound Data

Compound	Well No. 1 (FA)	Well No. 3 (FC)	Well No. 4 (FD)	Well No. 6 (FF)	Well No. 7 (FG)	Well No. 10 (FO)	Well No. 11 (FP)	NYS Drinking Water Standards
Benzene	ND	ND	ND	ND	ND	ND	0.001	
Bromodichloromethane	ND	ND	0.004	ND	0.001	ND	ND	
Bromoform	ND	ND	ND	ND	ND	ND	ND	
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	0.005
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	
Chlorodibromomethane	ND	ND	0.002[d]	ND	ND	ND	ND	
Dichlorodifluoromethane	ND	ND	ND	ND	ND	ND	ND	
1,1-dichloroethane	0.001	ND	ND	ND	ND	0.002	0.001	
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	
1,1-dichloroethylene	0.042	ND	ND	ND	ND	0.001	0.001	
Cis-1,2-dichloroethylene	ND	0.002[a]	ND	ND	ND	ND	ND	
Trans-1,2-dichloroethylene	ND	0.002[a]	ND	ND	ND	ND	ND	
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	
2,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	
Cis-1,3-dichloropropene	ND	ND	0.002[d]	ND	ND	ND	ND	
Trans-1,3-dichloropropene	ND	ND	ND	ND	ND	ND	ND	
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	
Methylene Chloride	ND	ND	ND	ND	ND	ND	ND	
1,1,1,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	
1,1,2,2-tetrachloroethane	ND	0.003[b]	ND	ND	ND	ND	ND	
Toluene	ND	ND	ND	ND	ND	ND	ND	
1,1,2-trichloroethane	ND	ND	0.002[d]	ND	ND	ND	ND	
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	
1,1,2-trichlorotrifluoroethane	ND	0.002[c]	0.006[c]	ND	0.002[c]	0.001[c]	0.001[c]	
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	0.005
m-xylene	ND	ND	ND	ND	ND	ND	ND	
o-xylene	ND	ND	ND	ND	ND	ND	ND	
p-xylene	ND	ND	ND	ND	ND	ND	ND	

Note: Anlysis was performed twice during the year.

(a) Reported value represents total including both cis-1,2-dichloroethylene and trans-1,2-dichloroethylene.
(b) Reported value represents total including both tetrachloroethylene and 1,1,2,2-tetrachloroethane.
(c) Reported value represents total including both chloroform and 1,1,2-trichlorotrifluoroethane.
(d) Reported value represents total of all three compounds (chlorodibromomethane, cis-1,3-dichloropropene, and 1,1,2-trichloroethane).

ND = Not detected.

Table 22
1986 BNL Environmental Monitoring
Ground Water Surveillance Wells, Average Radionuclide Data for
Sand Filter Beds and Peconic River

Well ID	No. of Samples	Gross Alpha Concentration			Gross Beta Concentration			Tritium Concentration			^{90}Sr	^{7}Be	^{60}Co	^{22}Na	^{137}Cs
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum					
		<----						pCi/L							---->
XA	2	0.311	0.113	0.508	2.66	2.41	2.90	3,465.0	1,260.0	5,670.0	1.00	ND	1.17	0.11	ND
XB	1	0.00	-	-	0.91	-	-	5,950.0	-	-	0.60	ND	ND	ND	ND
XC	1	0.226	-	-	1.57	-	-	188.0	-	-	0.90	ND	ND	ND	ND
XD	1	0.057	-	-	-1.08	-	-	-370.0	-	-	0.70	NA	NA	NA	NA
XE	1	0.169	-	-	1.82	-	-	4,100.0	-	-	NA	ND	0.36	ND	ND
XJ	1	-0.057	-	-	-0.70	-	-	482.0	-	-	0.90	ND	2.09	ND	1.0
XI	1	0.00	-	-	1.08	-	-	80.4	-	-	NA	ND	ND	ND	ND
XN	2	1.13	0.282	1.980	1.92	1.75	2.09	-927.0	-1,230.0	-624.0	0.507	ND	0.30	ND	ND
XF	1	0.169	-	-	-0.35	-	-	-271.0	-	-	NA	NA	NA	NA	NA
XK	2	0.339	0.113	0.565	2.10	1.08	3.11	1,470.0	1,130.0	1,810.0	0.70	ND	ND	0.11	ND
XO	1	0.395	-	-	2.44	-	-	-212.0	-	-	0.871	NA	NA	NA	NA
XL	1	1.13	-	-	9.95	-	-	522.0	-	-	11.1	ND	ND	ND	ND
X1	4	0.466	0.226	0.960	1.43	0.21	2.03	146.8	-92.3	424.0	0.610	ND	ND	ND	ND
X2	3	0.301	0.113	0.565	0.98	0.80	1.22	6,503.0	6,110.0	6,830.0	0.026	1.0	ND	ND	ND
X3	2	0.423	0.226	0.621	1.80	1.36	2.23	-11.2	-75.4	53.0	0.717	ND	ND	ND	ND
X4	3	0.546	0.452	0.678	3.00	1.43	4.50	4,505.0	874.0	8,950.0	1.355	ND	ND	ND	ND
XS	3	0.452	0.057	0.960	2.67	0.24	4.71	-97.6	-211.0	50.3	NA	ND	ND	ND	ND
XT	4	0.606	0.169	1.070	2.44	0.63	4.09	2.9	-264.0	589.0	<0.05	ND	ND	ND	ND
XX	2	0.480	0.282	0.678	4.21	3.53	4.89	1,117.0	754.0	1,480.0	0.20	ND	ND	ND	ND
XY	2	0.113	-0.169	0.395	2.31	2.13	2.48	963.0	226.0	1,700.0	1.70	ND	ND	ND	ND
X5	1	NA	-	-	NA	-	-	NA	-	-	1.09	NA	NA	NA	NA
NYS Drinking Water Standard		15.0			50.0			20,000.0			8.0				
Radiation Concentration Guide												2,000,000	30,000	30,000	20,000

NA = Not Analyzed.
ND = Not Detected.

Table 23
1986 BNL Environmental Monitoring
Off-Site Potable Water
Radionuclide Concentration, pCi/L

Location	No. of Samples	Gross Alpha			Gross Beta			Tritium			^{90}Sr	Gamma Spectroscopy
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum		
1	3	0.19	0.06	0.28	1.42	0.98	1.78	4627	1950	6880	<0.20	A
2	3	0.30	0.23	0.34	2.06	-0.52	6.60	1597	1270	2060	0.27	A
3	3	0.11	0.0	0.23	0.20	-0.38	0.59	181	77	255	<0.16	A
4	1	-0.11	-	-	-0.63	-	-	-5.3	-	-	<0.07	A
5	3	0.21	0.11	0.34	0.27	-0.14	0.56	356	2.6	703	<0.03	A
6	3	0.08	0.0	0.17	0.40	0.18	0.63	36	2.6	52	<0.06	A
7	3	0.09	0.0	0.17	1.02	0.33	1.80	634	320	911	0.10	A
8	3	0.06	-0.40	0.34	0.27	0.07	0.42	228	7.9	521	<0.07	A
9	3	0.43	0.0	0.85	1.56	1.15	2.03	605	5.3	1340	<0.08	A
10	3	0.15	0.06	0.34	0.73	0.07	1.15	-51	-208	185	<0.10	A
11	3	0.43	0.34	0.51	1.53	0.24	2.30	-8	-156	132	0.38	A
12	3	0.19	-0.11	0.40	0.31	-2.20	2.79	62	-206	391	0.76	A
13	1	0.34	-	-	0.66	-	-	26	-	-	0.46	A
14	3	0.06	-0.11	0.23	1.04	0.56	1.33	-155	-309	-52	0.36	A
15	1	0.06	-	-	-3.3	-	-	185	-	-	0.42	A
16	1	0.06	-	-	-1.9	-	-	5.3	-	-	0.05	A
17	1	0.11	-	-	4.5	-	-	0.0	-	-	0.03	A
18	2	0.54	0.28	0.79	-0.12	-0.35	0.11	52	26	77	NS	NS
19	2	0.03	-0.06	0.11	0.24	-0.11	0.59	170	26	313	NS	NS
20	2	0.31	0.28	0.34	1.01	0.73	1.29	90	-52	232	NS	NS
21	1	0.23	-	-	1.43	-	-	26	-	-	NS	NS
22	1	0.0		-	0.04	-	-	156	-	-	NS	NS
NYS Drinking Water Standards		15.0			50.0			20,000.0			8.0	

A = Samples analyzed for gamma-emitting radionuclides. All results less than MDL.
NS = Not Sampled.

Table 24
1986 BNL Environmental Monitoring
Ground Water Surveillance Wells, Average Radionuclide Concentration Data
for Landfill Areas, 650 Sump, and Miscellaneous On-Site Location

Well ID	No. of Samples	Average	Gross Alpha Concentration Minimum	Maximum	Average	Gross Beta Concentration Minimum	Maximum	Average	Tritium Minimum	Concentration Maximum	^{90}Sr	^{137}Cs	^{22}Na	^{60}Co	^{54}Mn
		pCi/L													
Current Landfill															
W6	4	0.325	0	0.847	3.26	0.84	9.25	33.2	-53.6	162.0	0.117	ND	ND	ND	ND
WT	4	0.592	-0.565	1.860	1.48	0.66	2.37	179.0	126.0	243.0	0.043	ND	ND	ND	ND
WG	2	0.367	0.226	0.508	3.20	3.00	3.39	-146.4	-193.0	-99.7	0.527	NA	NA	ND	ND
WR	4	0.423	0.282	0.847	10.81	8.55	14.10	7573.0	4490.0	15400.0	3.12	0.32	ND	ND	ND
WS	4	1.654	0	4.240	22.78	5.80	33.30	4580.0	578.0	8830.0	2.74	ND	0.70	ND	ND
1K	4	0.283	-0.565	1.130	13.92	9.08	16.80	6138.0	2100.0	10500.0	4.13	ND	0.48	ND	ND
2C	4	-0.028	-0.847	0.565	25.14	5.76	36.00	17000.0	13700.0	21900.0	5.840	ND	0.47	0.16	0.18
W9	4	1.892	0.791	3.390	25.15	6.59	38.70	23075.0	18400.0	29900.0	5.84	ND	0.50	ND	ND
2H	1	0	-	-	2.09	-	-	189.0	-	-	1.640	NA	NA	NA	NA
2J	1	0.282	-	-	9.04	-	-	755.0	-	-	5.730	NA	NA	NA	NA
2K	1	0.169	-	-	4.57	-	-	513.0	-	-	1.580	NA	NA	NA	NA
2D	2	1.554	0.847	2.260	14.15	13.10	15.2	466.0	-668.0	1600	NA	0.18	0.15	ND	ND
2B	1	-0.057	-	-	1.15	-	-	27.0	-	-	0.083	NA	NA	NA	NA
Former Landfill															
D1	4	0.028	-2.260	0.282	0.79	-0.21	1.78	25.5	-145.0	192.0	0.033	ND	ND	ND	ND
D2	3	0.245	-0.057	0.621	0.94	-0.28	2.37	10.5	-51.3	82.7	0.020	ND	ND	ND	ND
D3	3	0.132	-0.113	0.339	0.69	-0.21	1.50	70.5	24.6	110.0	0.040	ND	ND	ND	ND
D4	3	0.188	0.113	0.282	0.51	-0.28	0.91	45.9	-121.0	231.0	0.160	ND	ND	ND	ND
D5	3	0.151	0.057	0.282	0.23	-0.45	0.59	28.6	-138.0	147.0	<0.200	ND	ND	ND	ND
D6	3	0.376	0.339	0.395	12.90	11.30	14.60	32.4	-82.7	180.0	11.350	ND	ND	ND	ND
D7	3	0.339	0.057	0.847	1.18	0.56	1.78	459.7	276.0	565.0	3.604	ND	ND	ND	ND
1I	3	0.244	0.169	0.395	0.44	0.21	0.66	376.6	77.8	744.0	<0.300	ND	ND	ND	ND
1J	3	0.151	0.113	0.226	-0.22	-0.77	0.77	136.9	-104.0	487.0	<0.200	ND	ND	ND	ND
WO	3	0.282	0.169	0.452	0.37	-0.66	1.15	87.7	26.3	154.0	0.001	ND	ND	ND	ND
WP	3	0.151	-0.057	0.282	0.35	-0.35	0.80	228.3	165.0	315.0	0.059	ND	ND	ND	ND
WQ	3	0.151	-0.057	0.282	1.22	0.21	1.85	902.7	-76.9	2840.0	0.024	ND	ND	0.09	ND
Miscellaneous Wells															
SE	1	0.00	-	-	-0.52	-	-	25.8	-	-	NA	ND	ND	ND	ND
SI	1	-0.057	-	-	-0.07	-	-	25.8	-	-	NA	ND	ND	ND	ND
S6431	1	0.00	-	-	0.07	-	-	342.0	-	-	NA	NA	NA	NA	NA
S6434	1	-0.057	-	-	2.90	-	-	-184.0	-	-	NA	ND	ND	ND	ND
S6455	1	0.226	-	-	1.71	-	-	-109.0	-	-	NA	NA	NA	NA	NA
NYS Drinking Water Standards		15.0			50.0			20,000			8.0	-	-	-	-
Radiation Concentration Guide		-			-		-	20,000			30,000	30,000	100,000		

NA = Not analyzed.
ND = Not Detected, activity less than the minimum detectable activity as listed in Appendix C.

Table 25
1986 BNL Environmental Monitoring
Ground Water Surveillance Well Radionuclide Data for Waste Management Area

Well ID	Number of Samples	Gross Alpha Average	Gross Alpha Minimum	Gross Alpha Maximum	Gross Beta Average	Gross Beta Minimum	Gross Beta Maximum	Tritium Average	Tritium Minimum	Tritium Maximum	^{90}Sr	^{22}Na	^{60}Co	^{137}Cs
		<------						pCi/L						------>
MW1	5	0.565	0.282	0.904	5.94	4.09	9.43	573.4	282.0	720.0	1.09	0.61	ND	ND
WI	1	0.226	-	-	4.78	-	-	512.0	-	-	NA	ND	ND	ND
WJ	1	0.339	-	-	3.35	-	-	458.0	-	-	0.08	0.93	ND	ND
MW2	5	0.702	0.0	1.19	76.92	45.80	136.00	13270.0	2370.0	38000.0	50.10	6.56	0.92	0.77
WC	4	0.042	-0.565	0.452	12.68	10.30	18.00	1777.5	10.0	4300.0	8.44	2.61	ND	0.10
WD	3	0.585	0.226	1.19	35.17	20.7	47.20	5516.7	2830.0	7530.0	10.79	2.55	0.06	0.17
WE	1	0.510	-	-	6.42	-	-	0.0	-	-	NA	NA	NA	NA
MW3	5	0.305	0.057	0.621	14.86	0.489	69.6	221.4	79.8	400.0	1.04	28.00	0.15	ND
W1	2	0.311	0.169	0.452	14.85	11.60	18.10	657.0	398.0	916.0	9.45	1.18	ND	ND
WL	2	0.141	-0.057	0.339	34.65	19.60	49.70	1024.5	919.0	1130.0	16.3	0.48	1.92	ND
W2	3	0.188	0.0	0.339	14.53	13.20	16.20	1436.7	340.0	2830.0	3.97	5.84	ND	ND
MW4	4	1.073	0.395	1.750	6.52	4.50	8.59	1317.50	1070.0	1740.0	2.29	0.98	ND	ND
MW6	5	0.158	-0.282	0.565	0.85	0.49	1.43	264.0	0.0	641.0	0.03	ND	ND	ND
2L	4	0.113	-0.113	0.340	1.69	1.21	2.79	2238.1	74.5	5680.0	0.06	0.15	ND	ND
MW5	5	0.509	-0.452	1.36	5.33	4.36	6.25	2310.0	0.0	5090.0	1.19	0.51	0.11	ND
2M	4	0.085	0.0	0.282	2.05	1.50	3.18	1520.0	1140.0	2130.0	0.03	0.21	0.08	ND
2N	4	0.339	0.057	0.621	1.71	0.035	2.83	652.8	105.0	1730.0	0.08	0.41	ND	ND
WK	1	0.113	-	-	19.90	-	-	547.0	-	-	16.8	0.42	ND	ND
MW7A	5	0.622	-0.169	1.36	71.94	54.0	108.0	2370.0	1310.0	3450.0	53.7	1.22	ND	ND
MW7B	5	0.520	0.057	1.36	2.38	1.01	4.36	649.2	301.0	1270.0	0.19	ND	ND	ND
MW13	5	0.597	0.0	1.520	3.58	2.76	4.22	2859.4	597.0	8870.0	0.06	ND	ND	ND
MW8	5	0.599	0.282	0.904	4.10	3.25	5.45	2952.6	240.0	10400.0	0.01	ND	ND	ND
MW12	5	0.802	0.282	1.45	3.62	2.79	4.61	1622.6	246.0	4490.0	0.06	ND	ND	ND
MW11	5	0.689	0.452	0.960	5.15	4.09	6.25	47.3	-52.5	135.0	<0.20	ND	ND	0.07
MW10	5	0.440	0.0	0.847	3.44	2.51	4.02	548.8	320.0	872.0	0.02	ND	ND	ND
NYS Drinking Water Standards					50.0			20,000.0			8.0			
Radiation Concentration Guides												30,000.0	30,000.0	20,000.0

NA = Not Analyzed.
ND = Not Detected.

Table 26
1986 BNL Environmental Monitoring
Radionuclide Concentrations in Recovery Well Water

Sample Location	Number of Samples	Gross Alpha			Gross Beta			Tritium		
		Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
		pCi/L								
PW1-B	18	0.075	-0.169	0.395	8.71	6.28	12.30	1138.9	653.0	2090.0
PW2-B	17	0.259	-0.169	0.621	6.20	4.09	8.10	2878.2	1460.0	4850.0
PW3-B	18	0.147	-0.057	0.452	1.53	0.66	3.07	12961.1	11000.0	18900.0
PW4-B	18	0.113	-0.113	0.508	1.64	0.14	3.04	235.5	-891.0	1460.0
PW5-B	17	0.093	-0.226	0.339	16.28	6.04	24.70	516.8	-495.0	853.0

Table 27
1986 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	pH (su)	Conductivity (umhos/cm)	Chlorides	Sulfates mg/L	Nitrate-Nitrogen
XF	1	6.2	95	5.8	<5.0	a
XB	1	6.3	74	<10.0	<10.0	<2.5
XC	1	5.6	55	<10.0	<10.0	<2.5
XA	2	6.2 - 6.4	215	26.0	19.8	5.6
XE	1	5.7	163	14.8	15.1	a
XD	2	5.8 - 6.2	67	2.6	3.5	<2.5
XK	2	6.3 - 6.4	197	24.2	17.2	<2.5
XI	1	5.2	51	<10.0	<10.0	<2.5
XJ	1	5.1	47	<10.0	<10.0	<2.5
XY	2	5.7 - 6.1	98	8.5	14.1	<2.5
XX	2	5.7 - 5.9	128	12.0	4.4	<2.5
XO	1	5.2	48	<10.0	<10.0	<2.5
XN	2	6.1 - 6.4	112	14.5	11.3	<2.5
X3	2	5.1 - 5.6	91	2.2	21.0	<2.5
XL	1	6.2	234	25.8	<10.0	<2.5
X1	3	4.7 - 5.5	51	2.9	7.4	<2.5
X2	3	5.5 - 5.7	130	22.5	17.1	<2.5
X4	3	5.8 - 6.1	164	19.8	27.3	<2.5
XS	3	5.0 - 6.1	116	10.7	18.0	<2.5
XT	3	5.0 - 6.2	103	3.0	<10.0	<2.5
NYS Drinking Water Standards		6.5 - 8.5	b	250.0	250.0	10.0

a: No analysis performed.
b: No standard specified.

Table 28
1986 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Metals Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
		mg/L										
XF	1	<0.02	a	<0.005	<0.025	a	a	<0.0002	a	a	<0.025	a
XB	1	<0.02	a	<0.005	a	<0.02	0.57	<0.0002	a	4.2	0.06	3.26
XC	1	<0.02	a	<0.005	a	<0.02	0.66	<0.0002	a	4.7	0.05	0.21
XA	2	<0.02	a	<0.005	<0.025	<0.02	0.07	<0.0002	a	31.3	<0.025	0.38
XE	1	<0.02	a	<0.005	<0.025	a	a	<0.0002	a	a	<0.025	a
XD	2	<0.02	a	<0.005	<0.025	<0.02	<0.05	<0.0002	a	3.7	0.03	0.29
XK	2	<0.02	a	<0.005	<0.025	<0.02	2.21	<0.0002	a	28.9	<0.025	0.05
XJ	1	<0.02	a	<0.005	a	<0.02	0.40	<0.0002	a	3.8	0.04	0.27
XI	1	<0.02	a	<0.005	a	<0.02	0.14	<0.0002	a	3.7	0.03	0.11
XY	2	<0.02	a	<0.005	<0.025	<0.02	0.41	<0.0002	a	10.4	<0.025	1.08
XX	2	<0.02	a	<0.005	<0.025	<0.02	8.58	<0.0002	a	10.2	<0.025	0.19
XN	2	<0.02	a	<0.005	<0.025	<0.02	12.4	<0.0002	a	6.2	<0.025	0.50
X3	2	<0.02	a	<0.005	<0.025	<0.02	<0.05	<0.0002	a	3.0	<0.025	0.01
XL	1	<0.02	a	<0.005	a	<0.02	1.98	<0.0002	a	35.4	<0.025	0.10
X1	2	<0.02	a	<0.005	<0.025	<0.05	0.82	<0.0002	0.10	2.9	<0.025	0.39
X2	2	<0.02	a	<0.005	<0.025	<0.05	<0.05	<0.0002	0.45	16.3	<0.025	0.51
X4	2	<0.02	a	<0.005	<0.025	<0.05	0.56	<0.0002	<0.05	25.6	<0.025	0.07
XS	2	<0.02	a	<0.005	<0.025	0.02	3.77	<0.0002	0.13	4.5	<0.025	0.17
XT	2	<0.02	a	<0.005	<0.025	<0.05	1.76	<0.0002	0.39	4.7	<0.025	0.18
NYS Drinking Water Standards		0.025	1.0	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0

a: No analysis performed.
b: No standard specified.

Table 29
1986 BNL Environmental Monitoring
Sand Filter Beds and Peconic River
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/L			
XF	1	ND	ND	ND	ND
XB	1	ND	ND	ND	ND
XC	1	ND	ND	ND	ND
XA	2	ND	0.002	ND	ND
XE	1	ND	0.018	ND	ND
XD	2	ND	ND	ND	ND
XK	2	ND	ND	ND	ND
XJ	1	ND	ND	ND	ND
XI	1	ND	ND	ND	ND
XY	2	ND	ND	ND	ND
XX	2	ND	ND	ND	ND
XO	1	ND	ND	ND	ND
XN	2	ND	ND	ND	ND
X3	2	ND	ND	ND	ND
XL	1	ND	ND	ND	ND
X1	3	ND	ND	ND	ND
X2	3	ND	ND	ND	ND
X4	3	ND	ND	ND	ND
XS	1	ND	ND	ND	ND
XT	2	ND	ND	ND	ND
NYS Drinking Water Standards		0.100	0.050[a]	0.01	0.050[a]

(a) = NYS DOH advisory guidelines.

ND: Not detected. Average Method Detection Limits were: chloroform - 2.8 ug/L; 1,1,1-trichloroethane - 2.9 ug/L; trichloroethylene - 3.2 ug/L; tetrachloroethylene - 3.8 ug/L

Table 30
1986 BNL Environmental Monitoring
Landfill Areas and On-Site Control Wells
Ground Water Surveillance Wells, Average Water Quality Data

Well ID	No. of Samples	pH (SU)	Conductivity (umhos/cm)	Chlorides	Sulfates	Nitrate-Nitrogen	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
				mg/L												
Current Landfill																
WG	2	5.3-5.8	82	5.9	11.1	a	<0.02	<0.005	<0.025	<0.02	7.09	<0.0002	6.4	4.0	0.03	1.38
WR	4	6.5-6.6	672	34.8	1.7	<2.5	<0.02	<0.005	<0.025	<0.05	88.6	<0.0002	4.18	29.4	<0.025	0.33
WS	4	6.0-6.5	1084	43.2	3.3	<2.5	<0.02	<0.005	<0.025	<0.05	101.8	<0.0002	2.2	48.4	<0.025	0.13
WT	4	4.5-6.1	161	32.4	19.6	<2.5	<0.02	<0.005	<0.025	<0.05	0.67	<0.0002	0.33	13.77	<0.025	1.01
1K	4	6.4-7.0	507	18.9	2.3	<2.5	<0.02	<0.005	<0.025	<0.05	72.6	<0.0002	3.92	16.13	<0.025	0.18
2C	4	6.0-6.5	829	23.8	8.9	<2.5	<0.02	<0.005	<0.025	<0.05	66.6	<0.0002	1.96	31.5	0.04	0.15
W9	4	5.7-6.2	853	31.8	4.6	<2.5	<0.02	<0.005	<0.025	<0.05	54.0	<0.0002	2.29	37.3	<0.025	0.14
2H	1	5.4	66	57.3	11.0	<2.5	<0.02	<0.005	<0.025	<0.02	<0.05	<0.0002	0.01	5.8	<0.025	0.01
2K	1	5.7	80	10.9	<10.0	<2.5	<0.02	<0.005	<0.025	<0.02	0.57	<0.0002	0.03	6.2	<0.025	0.09
2J	1	5.2	77	19.5	<10.0	<2.5	<0.02	<0.005	<0.025	<0.02	0.07	<0.0002	0.07	6.7	<0.025	0.01
2B	1	5.7	60	a	11.3	<2.5	<0.02	<0.005	<0.025	<0.02	<0.05	<0.0002	0.03	4.0	<0.025	0.02
W6	4	6.6-7.0	335	24.1	18.4	<2.5	<0.02	<0.005	<0.025	<0.05	0.18	<0.0002	<0.05	14.6	<0.025	0.18
Former Landfill Area																
D1	3	5.8-5.9	87	2.2	10.6	<2.5	<0.02	<0.005	<0.025	<0.05	2.52	<0.0002	0.5	4.82	<0.025	0.06
D2	3	5.5-5.7	44	2.3	6.3	<2.5	<0.02	<0.005	<0.025	<0.05	1.19	<0.0002	0.17	3.91	<0.025	0.02
D3	3	5.5-6.0	48	1.6	3.2	<2.5	<0.02	<0.005	<0.025	<0.05	2.03	<0.0002	0.23	3.33	<0.025	0.02
D4	3	5.3-5.9	60	1.8	14.3	<2.5	<0.02	<0.005	<0.025	<0.05	3.19	<0.0002	0.35	4.42	<0.025	0.03
D5	3	5.3-6.0	59	2.5	13.1	<2.5	<0.02	<0.005	<0.025	<0.05	2.21	<0.0002	0.29	6.91	0.02	0.03
D6	3	6.4-6.7	402.5	8.0	58.8	3.0	<0.02	<0.005	<0.025	<0.05	0.96	<0.0002	0.16	11.83	0.01	0.03
On-Site Control Wells																
SE	1	6.7	158	20.6	15.8	a	<0.02	<0.005	<0.025	<0.05	0.29	0.0002	<0.05	24.7	<0.025	0.01
SI	1	6.5	100	17.9	13.5	a	<0.02	<0.005	<0.025	<0.05	0.94	0.0002	<0.05	13.3	<0.025	<0.01
NYS Drinking Water Standards		6.5-8.5	b	250.0	250.0	10.0	0.025	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0

a: No analysis performed.
b: No standard specified.

Table 31
1986 BNL Environmental Monitoring
Landfill Areas
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/L			
Current Landfill					
W6	1	ND	ND	ND	ND
WR	1	ND	ND	ND	ND
WS	1	ND	ND	ND	ND
WT	2	ND	ND	ND	ND
1K	1	ND	ND	ND	ND
2C	2	ND	ND	ND	ND
2H	1	ND	ND	ND	ND
W9	2	ND	ND	ND	ND
Former Landfill					
D1	2	ND	0.007	ND	ND
D2	1	0.008	ND	ND	ND
D3	1	0.010	0.009	ND	0.007
D4	1	ND	ND	ND	ND
D5	1	ND	ND	ND	ND
D6	1	ND	ND	ND	ND
On-Site Control Wells					
SE	1	0.011	0.040	0.006	ND
SI	1	0.006	0.013	ND	ND
NYS Drinking Water Standards		0.100	0.050[a]	0.01	0.050[a]

(a) NYSDOH advisory guidelines.
ND: Not detected.

Table 32
1986 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Water Quality and Metals Data

Well ID	No. of Samples	Ag	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn	Chlorides	Sulfates	pH (SU)	Conductivity (umhos/cm)
		mg/L														
MW1	3	<0.02	a	<0.005	<0.025	<0.05	0.16	<0.0002	0.16	5.0	<0.025	<0.01	5.9	4.3	5.3-6.0	90
MW2	3	<0.02	a	<0.005	<0.025	<0.05	0.04	<0.0002	0.04	6.2	<0.025	<0.01	2.2	37.1	5.7-6.2	119
WD	1	a	a	<0.005	<0.02	a	0.43	<0.0002	a	a	<0.025	1.61	5.2	42.3	5.7-6.4	141
WE	1	a	a	<0.005	<0.02	a	a	<0.0002	a	a	<0.025	1.97	4.2	10.2	6.3	109
W2	2	<0.02	a	<0.005	<0.025	<0.05	0.19	<0.0002	0.01	7.8	<0.025	1.63	4.7	33.7	6.0-6.3	136
MW3	3	<0.02	a	<0.005	<0.025	<0.05	0.10	<0.0002	0.02	8.4	<0.025	<0.01	9.8	12.6	5.5-6.1	61
WL	2	<0.02	a	<0.005	<0.025	<0.05	0.12	<0.0002	<0.01	7.0	<0.025	0.27	7.4	11.8	5.9-6.3	78
W1	1	<0.02	a	<0.005	<0.025	<0.05	0.05	<0.0002	<0.01	8.6	<0.025	0.28	7.0	12.2	5.7-6.2	81
MW4	3	<0.02	a	<0.005	<0.025	<0.05	2.08	<0.0002	0.12	8.6	<0.025	0.01	8.1	15.0	5.6-6.0	78
WK	1	a	a	<0.005	<0.02	a	0.75	<0.0002	a	a	<0.025	0.95	4.7	14.2	6.5	84
MW6	3	<0.02	a	<0.005	<0.025	0.06	0.36	<0.0002	0.02	7.3	0.03	0.02	3.0	11.5	5.0-6.0	71
2L	2	<0.02	a	<0.005	<0.025	<0.05	0.14	<0.0002	0.08	7.0	<0.025	0.02	11.1	15.6	5.3-6.3	85
MW5	3	<0.02	a	<0.005	<0.025	<0.05	0.58	<0.0002	0.03	5.1	<0.025	<0.01	1.2	11.6	5.0-6.1	59
2M	2	<0.02	a	<0.005	<0.025	<0.05	0.22	<0.0002	0.10	6.0	<0.025	0.03	13.6	11.7	5.3-5.9	91
2N	1	<0.02	a	<0.005	<0.025	<0.05	0.05	<0.0002	0.03	7.6	<0.025	0.02	15.3	10.1	5.5-5.7	74
MW7A	3	<0.02	a	<0.005	<0.025	<0.05	0.03	<0.0002	0.04	3.9	<0.025	<0.01	1.4	19.8	5.5-6.2	85
MW7B	3	<0.02	a	<0.005	<0.025	<0.05	0.86	<0.0002	0.08	6.9	<0.025	0.01	12.9	12.6	5.0-6.4	82
MW13	3	<0.02	a	<0.005	<0.025	<0.05	0.17	<0.0002	0.05	4.8	<0.025	<0.01	2.6	10.9	5.6-5.9	77
MW8	3	<0.02	a	<0.005	<0.025	<0.05	0.10	<0.0002	0.06	4.2	<0.025	0.01	1.4	11.3	5.5-6.1	75
MW12	3	<0.02	a	<0.005	<0.025	<0.05	0.13	<0.0002	0.04	3.8	<0.025	0.01	1.9	12.8	5.8-6.3	58
MW11	3	<0.02	a	<0.005	<0.025	<0.05	0.15	<0.0002	0.04	3.6	<0.025	<0.01	5.8	14.0	5.6-6.6	65
MW10	2	<0.02	a	<0.005	<0.025	<0.05	0.17	<0.0002	0.05	4.5	<0.025	<0.01	1.9	12.4	5.7-6.5	58
NYS Drinking Water Standards		0.025	1.0	0.01	0.05	1.0	0.30	0.002	0.3	b	0.025	5.0	250.0	250.0	6.5-8.5	b

a: No analysis performed.
b: No standard specified.

Table 33
1986 BNL Environmental Monitoring
Waste Management Area
Ground Water Surveillance Wells, Average Chlorocarbon Data

Well ID	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/L			
MW1	3	ND	ND	ND	ND
MW2	2	ND	0.014	ND	0.084
WC	3	0.002	0.106	ND	ND
WD	3	0.005	0.078	ND	0.016
WE	1	ND	ND	ND	ND
W2	2	0.018	0.125	0.054	0.093
MW3	4	ND	ND	ND	0.002
WL	1	ND	0.017	ND	Na
W1	1	ND	ND	ND	0.013
MW4	1	ND	ND	ND	ND
WK	1	ND	ND	ND	ND
MW6	1	ND	ND	ND	ND
2L	2	ND	ND	ND	ND
MW5	1	0.007	0.048	0.009	0.022
2M	2	0.012	0.216	ND	0.067
2N	2	ND	ND	ND	ND
MW7A	3	0.019	0.112	ND	0.129
MW7B	1	ND	0.019	ND	0.013
MW13	1	0.021	0.073	0.008	0.037
MW8	1	0.576	0.378	0.007	0.009
MW12	2	ND	0.056	ND	ND
MW11	1	0.019	0.007	ND	ND
MW10	1	ND	0.203	ND	ND
NYS Drinking Water Standards		0.100	0.050[a]	0.010	0.050[a]

(a): NYSDOH advisory guidelines.
ND: Not detected.
Na: No analysis performed.

Table 34
1986 BNL Environmental Monitoring
Ground Water Restoration Project at Waste Management Area
Average Chlorocarbon Data

Sample ID[a]	No. of Samples	Chloroform	1,1,1-trichloro-ethane	trichloro-ethylene	tetrachloro-ethylene
		mg/L			
PW1A	9	0.002	0.012	ND	0.008
PW1B	8	ND	ND	ND	ND
PW2A	8	0.001	0.010	ND	0.007
PW2B	7	ND	ND	ND	ND
PW3A	7	0.005	0.040	ND	ND
PW3B	7	ND	ND	ND	ND
PW4A	10	0.008	0.033	ND	ND
PW4B	6	ND	ND	ND	ND
PW5A	7	0.002	0.019	ND	0.003
PW5B	6	ND	0.002	ND	ND
NYS Drinking Water Standards		0.100	0.050[b]	0.010	0.050[b]

ND: Not detected. Average Method Detection Limits were: chloroform - 3.6 ug/L; 1,1,1-trichloroethane - 3.5 ug/L; trichloroethylene - 4.0 ug/L; tetrachloroethane - 4.0 ug/L.

(a) A represents sample collected at the well head and B represents sample collected from the residual spray.

(b) NYSDOH advisory guidelines.

Table 35A
1986 BNL Environmental Monitoring
Tritium Dose Equivalent at the Site Boundary Monitoring Stations

Location ID	Sector ID	Net Average Air Concentration pCi/m^3	Committed Effective Dose Equivalent* mrem
1T	N	5.8	0.0031
3T	NE	1.7	0.0009
4T	ENE	2.3	0.0012
5T	E	3.4	0.0018
6T1 (P-7)	ESE	2.9	0.0015
6T2 (P-7-2)	ESE	2.1	0.0011
7T	SE	5.7	0.0030
8T	SSE	2.0	0.0011
10T	SSW	0.4	0.0002
11T (P-4)	SW	2.5	0.0013
12T	WSW	1.5	0.0008
13T	W	3.7	0.0020
14T	WNW	1.3	0.0007
15T	NW	2.4	0.0013
16T (P-2)	NNW	0.8	0.0004
20T	Central Site	6.2	0.0033

* Committed Effective Dose Equivalent includes the contribution from the air inhalation and submersion pathways. ICRP Publication 30 Dose conversion factors used.

Table 35B
1986 BNL Environmental Monitoring
Collective Dose Equivalent
from the 10-Meter Stack Effluent Releases

Nuclide	Whole Body* Collective Dose (mrem)	Thyroid Collective Dose* (mrem)
^{41}Ar	1770	-
^{15}O	0.0596	-
^{3}H	20.08	-
^{14}C	0.0071	-
^{32}P	0.0095	-
^{35}Sr	0.0018	-
^{51}Cr	0.0004	-
^{57}Co	0.0018	-
^{125}I	0.3575	3.55
^{131}I	0.0112	0.11
^{55}Fe	56.04	-
^{59}Fe	0.0017	-
^{54}Mn	0.0260	-
^{103}Ru	0.0011	-
^{113}Sn	0.0241	-
^{99}Tc	0.0453	-
^{99m}Tc	0.00013	-
Total	1847	3.66

* Dose values obtained from AIRDOS-EPA.

Table 35C
1986 BNL Environmental Monitoring
Collective Dose Equivalent from the 100-Meter Stack Effluent Releases

Nuclide	Total Collective Dose* mrem	Thyroid Collective Dose* mrem
^{3}H	22.18	
^{82}Br	0.210	
^{126}I	0.029	0.487
^{131}I	0.087	0.777
^{133}I	0.004	0.030
^{125}Xe	0.0000066	
^{127}Xe	0.0000002	
^{203}Hg	0.00033	
^{133}Ba	0.023	
^{213}Bi	0.0000001	
^{57}Co	0.00044	
Total	22.53	1.29

* Dose values obtained from AIRDOS-EPA.

Table 35D
1986 BNL Environmental Monitoring
Collective and Maximum Individual Dose from the Water Pathway

Pathway	Nuclide	Maximum Individual mrem	Collective Dose mrem
Water	H-3	0.21	35.9*
Fish	Cs-137	0.19	111.6**

* Based on the average concentration in the 5 potable off-site wells that exceed the analytical minimum detection limit and the assumption that 500 individuals have access to this water.

** The maximum individual and collective dose were calculated using a single Peconic River fish sample and a single control sample.

Table 35E
1986 BNL Environmental Monitoring
Collective Dose from all Pathways

Pathway	Collective Dose Total Body mrem	Collective Dose Thyroid mrem
Atmospheric	1870	4.95
Ingestion	147.5	-
Total	2,017.5	4.95

Table 36
1986 BNL Environmental Monitoring
Predicted Tritium Air Concentrations

Direction	Collocated Air Concentration pCi/m^3	Individual Air Concentration pCi/m^3	(Column 2 - Column 3)
N	0.36	0.39	-0.03
NNE	0.63	0.55	0.08
NE	0.27	0.23	0.04
ENE	0.25	0.21	0.04
E	0.32	0.29	0.03
ESE	0.38	0.33	0.05
SE	0.32	0.33	-0.01
SSE	0.42	0.44	-0.02
S	0.26	0.31	-0.05
SSW	0.23	0.27	-0.04
SW	0.25	0.31	-0.06
WSW	0.32	0.37	-0.05
W	0.30	0.38	-0.08
WNW	0.31	0.32	-0.01
NW	0.30	0.36	-0.06
NNW	0.35	0.29	+0.06
Average	0.33	0.34	-0.01

Table 37
1986 BNL Environmental Monitoring
Comparison of Collective Dose Projections

Year	Collective Dose					
	AIRDOS-EPA Ar-41 45 m[a] mrem	BNL Ar-41 100 m mrem	BNL Ar-41 45 m mrem	BNL Ar-41 10 m mrem	AIRDOS-EPA H-3 all sources mrem	BNL H-3 all sources mrem
1985	1575	1537	NC	4774[b]	56	49
1986	1770	2133	3396	4740	41	41

(a) The MRR effluent release height is approximately 45 meters. BNL has used 100-meter and composite 10-meter release heights in previous years.

(b) This value was reported in the 1985 BNL Environmental Monitoring Report as a conservative estimate of the argon-41 collective dose.

NC In 1985, the argon-41 collective dose was not calculated for the 45-meter release height.

APPENDIX E

Quality Control and Quality Assurance

Quality control and quality assurance activities were dependent on the nature and frequency of measurement. Checks on instrument performance and on overall quality of the data were made with measurement control charts and with certified control organization. Up to 20% of all samples processed were connected with quality control, and these included blanks, replicates and spikes. Where possible, analysts participated in blind round robin tests organized by DOE, EPA, or NYSDEC.

Quality assurance activities are coordinated by an individual whose function is to audit laboratory records, document any deviations from protocols, and verify that laboratory functions were in accordance with established norms.

APPENDIX F

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