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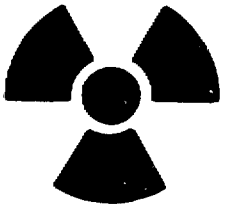

HEALTH PHYSICS AND SAFETY DIVISION

INFORMAL REPORT

1973 ENVIRONMENTAL MONITORING REPORT

Compiled by A. P. Hull and J. A. Ash

Contributors

N. E. Caporaso
V. A. Evans
E. Hartmann
D. M. Henze
R. R. Hyson
O. W. Kulyniak
E. R. Landa
J. A. Nobile
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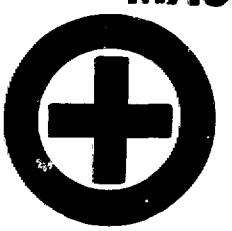
J. R. Steimers
R. D. Williams

March, 1974

BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973



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1973 ENVIRONMENTAL MONITORING REPORT

BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Operated by Associated Universities, Inc.
Under Contract to the U.S. Atomic Energy Commission

March, 1974

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BROOKHAVEN NATIONAL LABORATORY
ENVIRONMENTAL MONITORING REPORT

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INTRODUCTION

Brookhaven National Laboratory is a scientific research center situated in Suffolk County on Long Island, about 70 miles east of New York City. Its location with regard to surrounding communities is shwon in Fig. 1. The largest populations are located in shoreline communities, although the land area within ten miles is mostly either forested or under cultivation. Considerable recent and projected development of suburban housing is located within this area.

The Laboratory site with its principal effluent-producing facilities is shown in Fig. 2. It consists of some 5,265 acres, most of which is wooded, except for a central area of less than 1,000 acres. The site terrain is gently rolling, with elevations varying between 120 and 40 feet above sea level. The land lies on the west rim of the shallow Peconic River watershed, with the river itself rising in marshy areas in the north and east sections of the site.

In terms of its meteorology, Brookhaven can be characterized as a well ventilated site. In common with most of the eastern seaboard, its prevailing winds are from the southwest during the summer of the year, from the northwest during the winter, and about equally from these two directions during the spring and fall. This is reflected in the yearly wind distribution, as observed by the BNL Meteorology Group between 1949 - 1963, shown in Fig. 3.

Studies of the hydrology and geology[1,2] of Long Island in the vicinity of Brookhaven, indicate that the top soil of the Pleistocene deposits, which are locally between 100 - 200 feet thick, are generally sandy and highly permeable. Water penetrates them readily and there is little direct runoff into surface streams except during periods of intense precipitation. The average annual rainfall is about 45 inches per year, which is about equally divided between

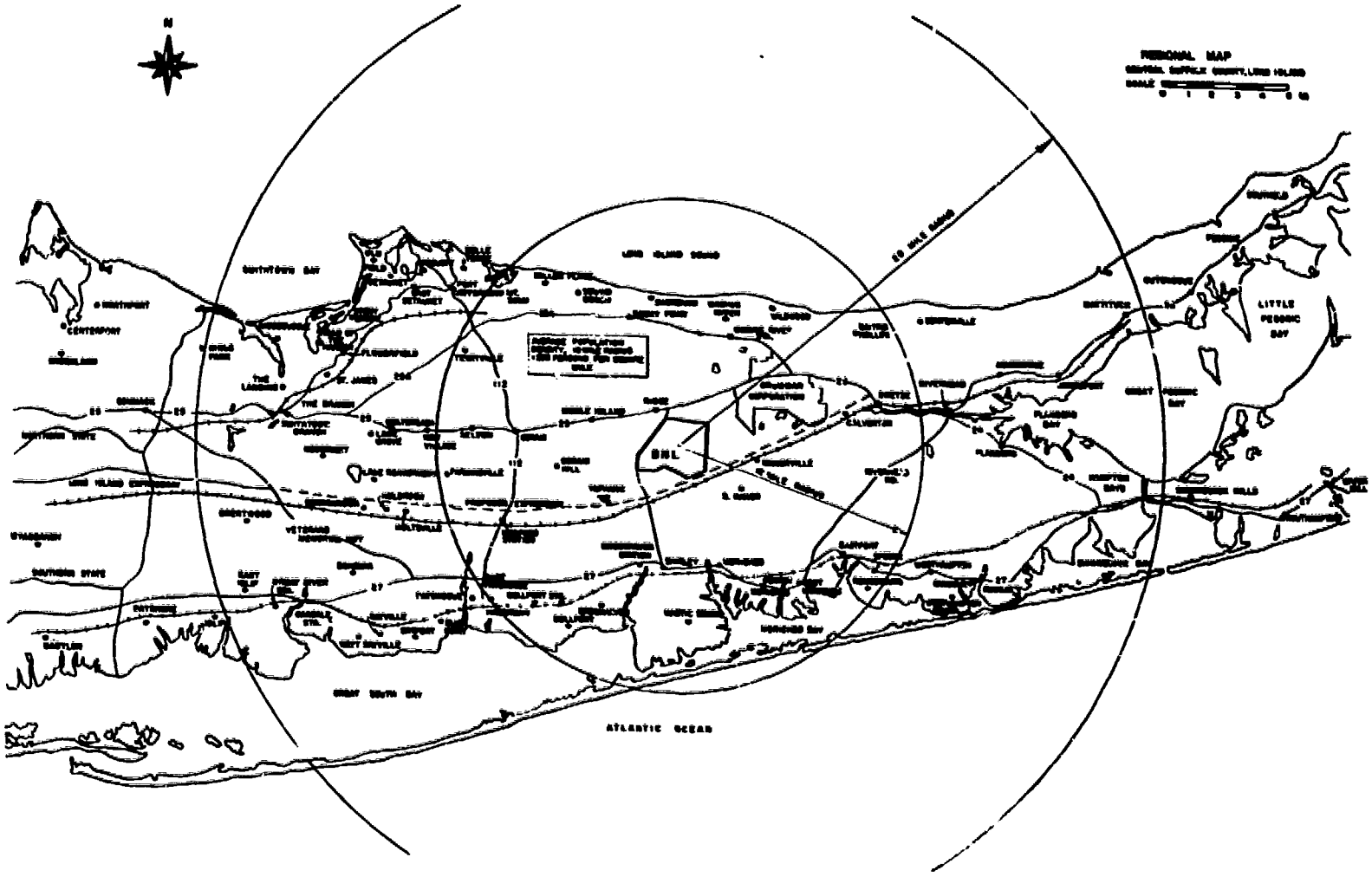


Figure 1 Map of the central area of Suffolk County around Brookhaven National Laboratory.


KEY
SITE BOUNDARY
PERMANENT BUILDINGS
TEMPORARY BUILDINGS
WOODED AREAS
N
1
0
1
MILE

FIGURE 2

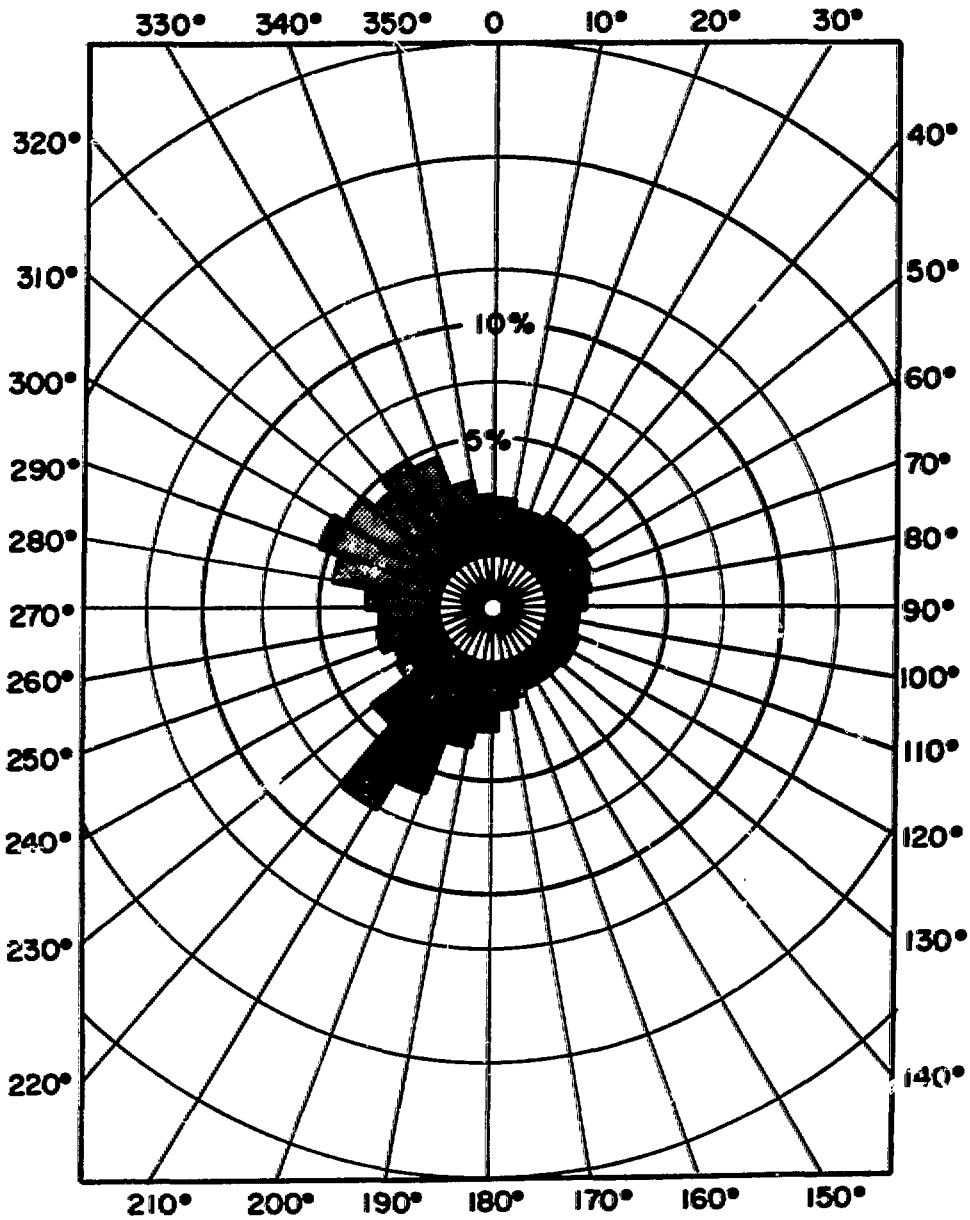


FIGURE 3

Yearly Wind Distribution, 1941 - 1963

evapotranspiration and groundwater recharge. As indicated in Fig. 4, the ground water in the Laboratory region moves predominantly in a horizontal direction to the Great South Bay. This is modified toward a more easterly direction in the Peconic River watershed portion of the site.

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

1) Structure and properties of matter

2) Physical, chemical and biological effects of radiation, and of other energy-related environmental pollutants

3) Radioisotopes and other nuclear applications

4) Nuclear and energy-related technology

5) Energy sources, transmission and utilization, including their environmental effects.

Among the major scientific facilities operated at Brookhaven to carry out the above programs are:

1) The High Flux Beam Reactor (HFBR). It is fueled with enriched uranium, heavy water moderated and cooled, and has a routine power level of 40 MW.

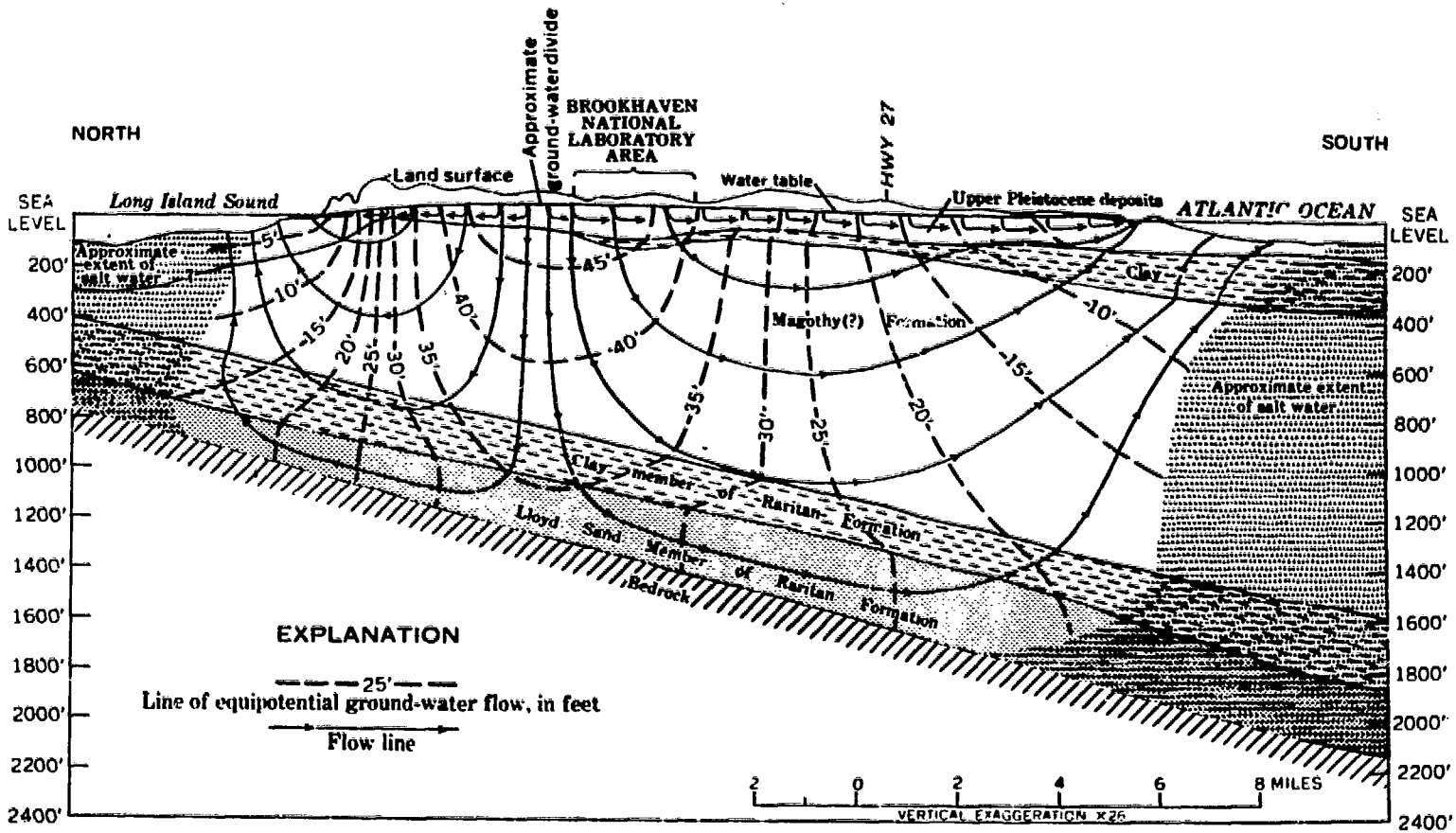
2) The Medical Research Reactor (MRR), which is an integral part of the Medical Research Center. It is enriched uranium fueled, natural water moderated and cooled, and is operated intermittently at power levels up to 3 MW.

3) The Alternating Gradient Synchrotron (AGS) a proton accelerator which operates at energies up to 33 BeV.

4) The 200 MeV Proton Linac, which serves as an injector for the AGS, but also supplies continuous currents of protons for isotope production by spallation reactions, in the Brookhaven Linac Isotopes Facility (BLIF).

5) The Tandem Van de Graaff, 60-inch Cyclotron, Research Van de Graaff, Vertical Accelerator and Chemistry Van de Graaff, which are used in medium energy physics investigations, as well as for special isotope production.

Additional programs involving irradiations and/or the use of radionuclides for scientific investigations are carried on at other Laboratory facilities,



Schematic Ground Water Flow lines,
Brookhaven National Laboratory

FIGURE 4

including the Medical Research Center, the Biology Department (including two multi-curie field irradiation sources), the Chemistry Department, and the Department of Applied Science. The latter includes the Hot Laboratory, where special purpose radioisotopes are developed and processed for on and off-site use.

Most of the airborne radioactive effluents at Brookhaven originate from the HFBR, BLIF and the Research Van de Graaff, with lesser contributions from the Chemistry and Medical Research Centers. The first two also produce significant fractions of the Laboratory's liquid radioactive effluents, but additional significant contributions originate from the Medical Research Center, the Hot Laboratory complex, as well as from decontamination and hot laundry operations.

During 1973, the Department of Applied Science, in cooperation with the Town of Brookhaven, initiated the Upland Recharge Experiment, a study of the use of natural ecosystems to treat sewage and to return clean water to the ground water aquifer. This experiment is conducted in an agricultural and forested area of the Laboratory site. It utilizes a portion of the flow from the sanitary waste treatment plant, and therefore consititutes a potential route for the release of radioactivity to ground water.

SUMMARY

The amount of radioactivity and other environmental pollutants in airborne and liquid effluents, and the natural background and radiation levels in the vicinity of Brookhaven National Laboratory attributable to its operations during 1973 are summarized in this report. Among the data reported are facility releases, external radiation levels; air particulate, tritium and radioiodine concentrations; precipitation and liquid effluent-related concentrations in stream, ground water and surveillance wells, as well as in milk, grass and soil samples.

External radiation levels at the north boundary of the Laboratory, attributable to an ecology forest irradiation source, were 15.5 mrem/yr, or 3.1% of the applicable radiation protection standard[3]. Other than tritium, there was no indication of BNL effluents in environmental air and precipitation samples. In air, the largest average BNL effluent related tritium concentration at the site boundary was 1.3×10^{-11} $\mu Ci/cm^3$ which is <0.01% of the applicable radiation concentration guide (RCG)[3]. In precipitation it was 5.30×10^{-7} $\mu Ci/ml$ which is 0.02% of the RCG for drinking water.

About 78% of the volume of liquid effluent released onto the sand filter beds at the BNL sewage treatment plant was recovered and flowed into the headwaters of the Peconic River. The balance is assumed to have percolated into the ground water underlying the beds. The gross concentration of beta- and gamma-emitters in the recovered effluent was 6.1×10^{-8} $\mu Ci/ml$ which is 4.3% of the applicable RCG. The tritium concentration, 1.6×10^{-5} $\mu Ci/ml$, was 0.53% of its RCG.

Of the combined flow from the sand filter beds and the Peconic River above the outfall, about 7% permeated into the ground water underlying the stream bed between the point of release and the Laboratory perimeter during the latter

months of 1973. On a yearly basis, 113% of the combined flow was at the measuring weir at the boundary apparently due to the inflow of ground water. The gross beta- and gamma-emitter concentration at the site boundary, 2.0×10^{-8} μCi/ml, was 1.5% of the applicable RCG. That of tritium, 6.1×10^{-6} μCi/ml was 0.2% of its RCG.

About 1% of the total flow at the Clarifier was utilized in the Upland Recharge Experiment. The average gross beta concentration in the effluent applied to the several plots of this experiment, 9.2×10^{-8} μCi/ml, was 3.1% of the applicable RCG, and the average tritium concentration, 6.8×10^{-6} μCi/ml, was 0.2% of this RCG.

Except for pH, the water released into the Peconic from the Liquid Effluent Treatment Facility was within the standards for drinking water quality established by the New York State Department of Health[4]. The average pH, 6.3, was 97% of the minimum, standard; but was within the range of local background levels.

At downstream locations, the largest yearly average gross beta concentration in monthly grab samples, 8.5×10^{-9} μCi/ml, was 0.6% of the applicable RCG. These downstream gross beta concentrations were only slightly above those measured at remote "control" stream locations. The largest tritium concentration, 3.3×10^{-6} μCi/ml, was 0.1% of its RCG.

Seasonal sampling of Peconic River bottom sediments, stream vegetation and of miscellaneous aquatic fauna indicated that small concentrations of ^{60}Co ($<10^{-6}$ μCi/gm), and of ^{137}Cs above prevailing fallout background, were present in some samples obtained in the upper reaches of the Peconic, on-site and a few miles downstream. These concentrations are insignificant ($\sim$ 1%) relative to calculated RCG's.

Routine samples from the Laboratory's potable and cooling water supply wells, most of which are screened at a depth of from 100 to 150 feet or about

50 to 100 feet into the water table, disclosed no significant differences between those upstream in ground water flow and those downstream from the principal Laboratory facilities. The gross beta concentration of the large volume of cooling water released to on-site sumps was only very slightly increased above that of the supply wells. The largest concentration, 1.0×10^{-8} μCi/ml, was 0.3% of the applicable RCG. Tritium concentrations were generally below the lower limit of detection (0.6×10^{-6} μCi/ml or 0.02% of the RCG).

Ground water surveillance was conducted in shallow sampling wells installed adjacent to identified areas from which there is a potential for the percolation and migration of radioactivity. Immediately adjacent to the sand filter beds and the Peconic River on-site, gross alpha, gross beta, strontium and tritium concentrations up to a few percent of the applicable RCG's were found. The largest gross alpha concentration, 3.3×10^{-9} μCi/ml, was 3.3% of the applicable RCG. The largest BNL effluent related gross beta concentration, 4.4×10^{-8} μCi/ml, was 1.4% of the RCG, while that for tritium was 0.5% of its RCG.

Additionally, in a few wells adjacent to the sand filter beds and the Peconic on-site, Zn was present in concentrations up to 1.5 ppm, or two times the New York State ground water quality standard[5]. Adjecent to the site boundary, radioactivity concentrations were at or close to background, and off-site all were at background. Water quality in these wells was within the standards for ground water, with the exception of pH, which appeared to be within the range of local background as determined from wells remote from the BNL site.

On-site, in wells adjacent to a decontamination drain sump, adjacent to the solid waste packaging area, adjacent to the sanitary landfill and to the former open dump, above background concentrations of gross beta activity, ^{90}Sr and tritium were encountered. Most of the gross beta activity appeared to be related

to ^{90}Sr, for which the largest concentration in a well ~500 ft. south of the solid waste packaging area was 6.3×10^{-8} μCi/ml, or 21% of its off-site RCG. The largest tritium concentration, 9.4×10^{-5} μCi/ml, or 3.1% of its RCG, was found in a well immediately south of the sanitary landfill area. Tritium concentrations up to 1.8×10^{-6} μCi/ml, or 0.05% of the off-site RCG, were found in a few wells in the Upland Recharge Area.

However, all the foregoing appeared to be confined to within a few hundred feet of their origin, and would require ground water travel times of decades of years before reaching the site boundary. Concentrations of radioactivity in ground water from wells at the perimeter and off-site were either only a few percent of the applicable RCG's, or for the most part at background levels.

Some contamination of ground water was found in a few wells adjacent to the solid waste packaging area, the sanitary landfill area, and the former open dump. A pH of 3.9, or 60% of the minimum standard, was found in one well at the waste packaging area. Fe up to a concentration of 86 ppm, or 140 times the standard, and Zn up to 4.4 ppm, or seven times the standard, was found in wells adjacent to the landfill and dump areas. Water quality in more distant wells, adjacent to the site boundary, was within standards, except for the slightly low pH levels previously indicated.

Quarterly milk samples were obtained from two Suffolk County dairy farms. The nearest was 10 km S.E. of the site, and the other a "control", 40 km E. No significant differences between ^{137}Cs levels in these and those generally prevailing in the northeast United States were apparent. During the winter and spring quarters of 1972, the levels of ^{90}Sr in milk from these farms were also typical of those in the northeast. As was the case during 1972 third and fourth quarters, levels of ^{90}Sr in the milk from the more nearby farm

were about twice the generally prevailing New York State background and in the upper range of reported nationwide levels during this period. However, there is no plausible connection between these local levels and Laboratory effluents.

Grass and soil samples were also collected from these and three other farms, as well as from perimeter and on-site locations. There was no significant difference between off-site samples generally downwind and those generally upwind of Brookhaven. Small concentrations of ^{137}Cs above those generally prevailing off-site were found in some soil and grass samples obtained at the BNL perimeter and on-site adjacent to the Solid Waste Disposal Area and to the former High Intensity Radiation Development Laboratory.

MONITORING DATA COLLECTION, ANALYSIS AND EVALUATION

External Exposu Monitoring

External radiation levels, including natural background (as influenced by fallout) and increments attributable to BNL activity were measured continuously by the use of a thermo-luminescent dosimeter exposed for monthly periods at each of the four perimeter stations shown on Fig. 2. The measured TLD levels were normalized on the basis of the average monthly level determined by an ion chamber and dynamic condensor electrometer, which was operated at the southeast perimeter for part of the year and at the northeast perimeter for the full year. These units are capable of accurately measuring < 10 μR/hr and of detecting changes of the order of 1 μR/hr, and have been operated at Brookhaven for the past twenty-five years.

The observed monthly average radiation levels are set forth in Table I. There was no addition to the natural background attributable to BNL activities, except at the northeast perimeter. At this location, the Ecology Forest irradiation source, which contained about 6,750 curies of ^{137}Cs, produced a

radiation level of 15.5 mrem/yr, or 3.1% of the radiation protection standard for a hypothetical individual at this location. Since the measuring station was located about 250 meters south of the present BNL north perimeter, the observed readings at that location were adjusted on the basis of spot comparisons, which indicated an average ratio of 0.2 between the station and the actual north perimeter radiation levels.

Airborne Effluents and Ground-Level Air Particulate, Tritium and Radioiodine Monitoring

The principal radioactive effluents released to the atmosphere from BNL facilities during 1973 are summarized in Table II. The nuclide released in the largest amount was Oxygen-15, which has a half-life of only two minutes. During the operation of the BLIF, at a beam current of 180 μamps, calculations indicate that it is evolved from the BLIF stack at the rate of 0.6 Ci/min. Thus at equilibrium, the maximum amount in existence at any one time would have been 1.75 Ci. It was dosimetrically insignificant at the site boundary.

The Brookhaven environmental monitoring air sampling program is conducted so as to distinguish between airborne radioactivity attributable to natural sources, to activities remote from the Laboratory, i.e. above ground nuclear weapons tests, and to Laboratory activities. Almost all of the radioactivity detected during 1973 was attributable to the first two sources.

High volume (500 l/min) positive displacement air pumps (Gast 3040) were operated at a monitoring station immediately east of the Solid Waste Packaging Area, and at the northeast and southwest perimeter stations (Fig. 2, P-9 and P-4). The air sampling media consisted of a 3-inch diameter air particulate filter (Gelman Type G) followed by a 3" x 1" bed of petroleum-based charcoal (Columbia Grade LC 12/28 x mesh) for sampling of radiohalogens. Short term fluctuations in air particulate concentrations may be indicative of the presence

of recent weapons test debris. Accordingly, the Solid Waste Packaging Area air particulate filter was changed and counted on a daily (during work week) basis. The remaining samples were changed and counted on a two-week basis.

After allowing several days for the decay of short-lived natural radioactivity, gross alpha counts of the air particulate samples from the Solid Waste Packaging Area station were made using a 5" diameter Zn-S coated photomultiplier. After a similar delay, gross beta counts were made of all air particulate samples, using a 5" beta scintillator. These data are shown in Table III. No consistent differences between sampling locations were apparent and there was no indication of BNL effluent radionuclides in air particulate samples at any location.

Concentrations of tritium vapor in air at the BNL perimeter in excess of the prevailing background concentration were attributed to Laboratory facility stack effluent releases, which totaled about 1,000 curies during 1973. They were arrived at by subtracting the tritium concentrations found in an off-site precipitation collection from those found in vapor collected at the perimeter. Due to operating problems with the thermo-electric coolers previously utilized for the collection of tritium vapor at the BNL perimeter, a decision was made early in the year to shift to silica gel samplers. Due to a shortage of the necessary components, these were not installed until mid-August. The data obtained using these devices for the balance of the year are shown in Table IV. The average net concentrations, 1.3×10^{-11} $\mu Ci/cm^3$ from mid-August through November at the southwest perimeter, and 1.1×10^{-11} $\mu Ci/cm^3$ at the northeast perimeter, were less than 0.01% of the RCG.

In addition to the gross beta counts indicated above, shortly after the end of each month, analyses for gamma-emitting nuclides were performed on a consolidated monthly composite of all individual air particulate samples.

Additional gamma analyses were also scheduled at six-month and one-year post-collection to facilitate the resolution of short- and long-lived nuclides with photopeaks too close to be resolved by the NaI detection system employed. The charcoal samples were reanalyzed at one month post-collection to determine ^{131}I by decay in its photopeak region during this time. Available data are reported in Table V. In the absence of any detectable recent fission products such as ^{131}I or ^{140}Ba during most of the year, all transactions in its energy region have been attributed to 285-day ^{144}Ce. The slight increases in ^{95}Zr-Nb and ^{144}Ce concentrations during the latter months of the year are attributed to the reported atmospheric nuclear weapons test by the Chinese on June 26, 1973[6]. These data did not disclose any indication of BNL effluent components.

The amounts of conventional pollutants released from the Central Steam Plant are also indicated in Table II. Of these, SO_2 is released in the largest amount. It also has the most restrictive ambient air quality standard[7], 0.03 ppm, on an annual average basis. It has been calculated[8] that for 2.5% sulfur oil, the annual average concentration at the BNL site boundary would be less than 0.01 ppm. Data obtained by Environmental Analyst, Inc.[9] for the Long Island Lighting Co. indicate that between 1968-1971 in Suffolk Cty., the mean SO_2 levels were at the current air quality standard during 1970, and below the standard otherwise. These data also suggest that the Suffolk County levels are more influenced by the importation of SO_2 with westerly winds from the Metropolitan New York area than by local emissions. Under these circumstances, it has not been deemed necessary to establish local surveillance for SO_2, or for other emissions from the Central Steam Plant.

During the evaluation of the Upland Recharge Experiment, the possibility of the generation of microbial aerosols was considered. The literature[10,11],

indicates an initial rapid die-off of such aerosolized bateria. In view of this and of the remoteness of the Upland Recharge Experiment from any nearby population, these aerosols do not seem to present a significant off-site airborne hazard. To date, sampling for them has not been conducted, on or off-site.

About 200 lbs. of various pesticides, chiefly carbaryl and parathion, were applied [12] on-site at Brookhaven during 1973, principally to protect crops which were grown for biological research purposes. All of these pesticides were considered readily bio-degradable, with persistence times in the order of a week, and were furthermore applied with a "sticker" additive to minimize their subsequently becoming airborne.

Precipitation

Two pot-type rain collectors, each with a surface area of 0.33 m^2, were situated adjacent to the BNL filter beds. Two routine collections were made from these, one whenever precipitation was observed during a previous 24-hour (or weekend) period, and the other once a week whether or not precipitation had occurred. Part of each collection was evaporated for gross beta counting, a small fraction composited for monthly tritium analysis, and the balance put through ion exchange column for subsequent monthly ^{89}Sr-^{90}Sr and gamma analyses. The data are reported in Table VI.

With the possible exception of tritium, there is no indication in the on-site precipitation collection of the washout of BNL released airborne radioactivity. As indicated in Table VII, the average tritium concentration of 5.3×10^{-9} µCi/ml in the collector located at the filter beds (in a predominant downwind direction) was almost twice that of the off-site collection. However, it was less than 0.02% of the RCG for drinking water. The total deposition of

tritium on the BNL site during 1973 was between 6.5 and 13.4 curies. The lower estimate is based on the concentration in the off-site collection, and the upper on that in the on-site downwind sample.

Liquid Effluent Monitoring

Within established administrative limits[13], small amounts of low-level radioactive liquid effluents may be routinely disposed of by release into the Laboratory's sanitary waste system. This system affords considerable dilution by a large volume ($\sim 10^6$ gal/day) of predominantly uncontaminated water. Primary treatment to remove suspended solids from the liquid effluents discharged to this system was provided by a 250,000 gallon Clarifier. The liquid effluent then flowed onto sand filter beds, from which most of it was recovered by an underlying tile field. It was then chlorinated and released into a small stream that formed one of the headwaters of the Peconic River.

A schematic illustration of the sewage treatment plant, including the related monitoring arrangements, is shown in Fig. 5. In addition to the in-plant flow measurement and sampling instrumentation, totalizing flowmeters (Leopold & Stevens TF 61-2), which include provision for actuating a sampler with each 2,000 gallons of flow in combination with a positive-action battery-operated sampler (Brailsford DU-1), were located at the Chlorine House, at the former site boundary 0.5 miles downstream on the Peconic, and at the site boundary, 1.6 miles downstream .

The monthly average flow and the monthly totals of gross beta and principal nuclide activities at the Clarifier (input to the filter beds) and at the Chlorine House (output from the beds) are shown in Table VIII. Yearly totals and average concentrations are also indicated. During 1973, 78% of the liquid effluent flow into the sand filter beds appeared in the output from them. The balance was assumed to have percolated to the ground water flow under the beds. Estimates of the amounts of radioactivity released to the ground water in this manner

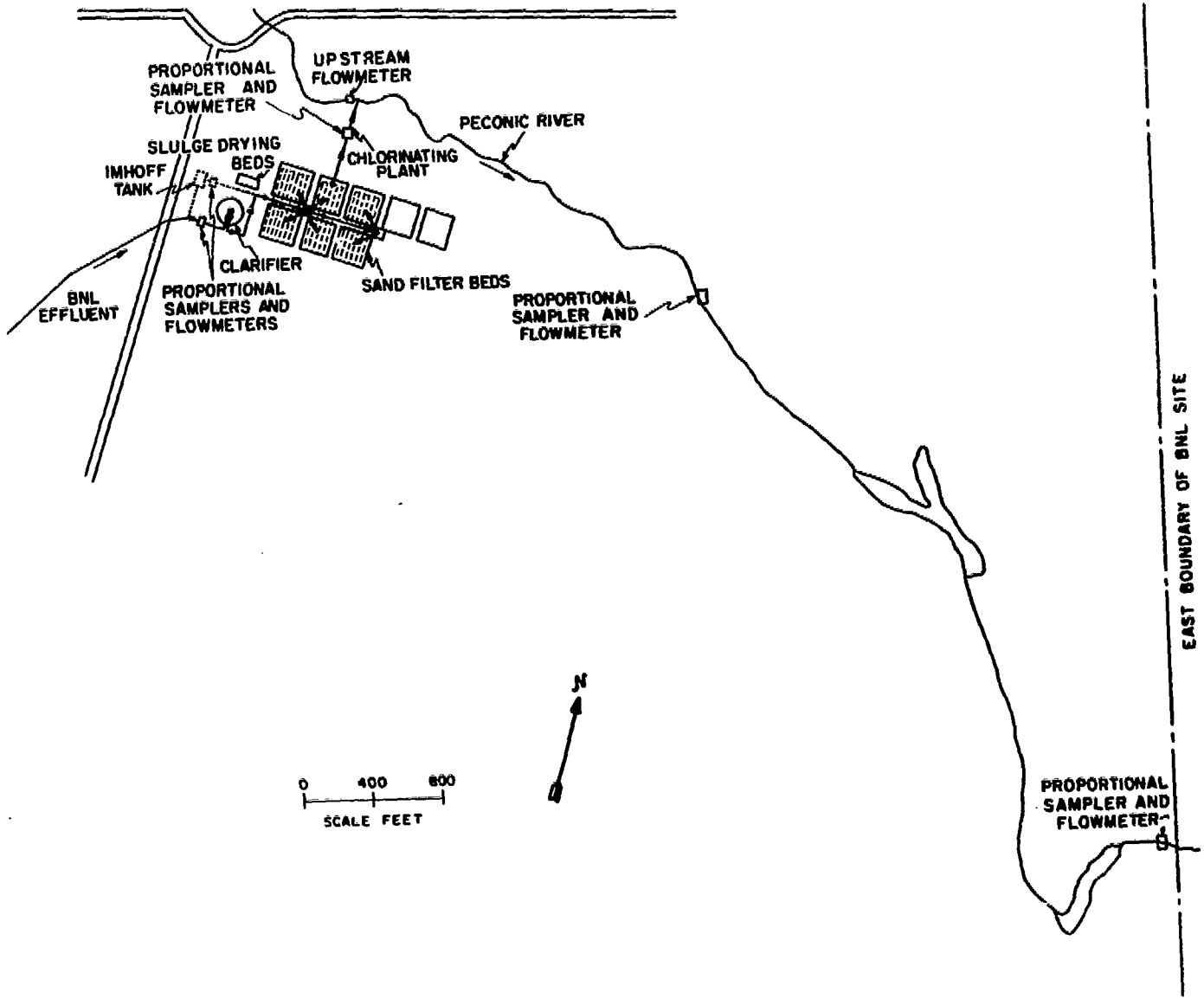

PROPORTIONAL SAMPLER AND FLOWMETER
UPSTREAM FLOWMETER
PECONIC RIVER
SLUDGE DRYING BEDS
IMHOFF TANK
CHLORINATING PLANT
CLARIFIER
SAND FILTER BEDS
BNL EFFLUENT
PROPORTIONAL SAMPLERS AND FLOWMETERS
PROPORTIONAL SAMPLER AND FLOWMETER
EAST BOUNDARY OF BNL SITE
PROPORTIONAL SAMPLER AND FLOWMETER
N
0 400 800
SCALE FEET

FIGURE 5

during 1973 are also shown in Table VIII. These were calculated on the additional assumption that the average concentrations of the contained nuclides corresponded to those in the observed output from the beds.

Flow, activity and concentration information at the former site boundary and at the present site boundary are shown in Table IX. A much greater stream flow was observed at the former site boundary than at the Chlorine House, reflecting the upstream addition to the BNL stream effluent, which during 1973 averaged 300,000 gallons per day. Except for radioactive decay of short-lived nuclides, there was only a slight change in the total activity in the stream between these two locations. During the first eight months of 1973, there was a net gain in stream flow between the former perimeter and the present site boundary and a slight loss during the latter four months. Upper limit estimates of the total activity which may in this manner have percolated to the underlying ground water during these months are also shown in Table IX. These are based on the concentrations observed at the former site boundary.

Analysis of September-December monthly composite samples of the Peconic River on-site 0.5 mi. downstream from the Chlorine House showed that on the average, 2.6% of the total activity consisted of ^{90}Sr and that no appreciable amounts of long half-life radioactive Iodine or bone-seeking nuclides such as radium were present. Under these circumstances, the applicable RCG was 3.0×10^{-6} µCi/ml. The apparent gross beta concentration in the river flow which percolated to ground water, 4.2×10^{-8} µCi/ml, was 1.4% of this RCG. At the BNL perimeter (1.6 mi. downstream from the Chlorine House outfall), 14% of the yearly activity was ^{90}Sr. The applicable RCG was 1.3×10^{-6} pCi/ml and the observed concentration of the water released downstream in the Peconic River, 2.0×10^{-8} µCi/ml, was 1.5% of this RCG.

After digestion, the solids removed by the Clarifier are dried on sludge drying beds. After analysis, they are then disposed of to an on-site sanitary landfill. However, no such transfer of dried sludge were made during 1973.

The application of untreated (primary) and treated (secondary) sewage effluents to four Upland Experimental plots was initiated in July. It was initiated to four additional plots in October. A summary of the total flows, the gross beta activity and concentration, and of the tritium activity and concentration of this effluent is set forth in Table X.

The quality and purity of the Clarifier effluent, the sand filter bed effluent, and at two downstream locations on the Peconic River are indicated in Table XI-A. The outflow from the sand filter beds and into the Peconic was within water quality standards for drinking water. The appearance of coliforms in downstream samples was generally atypical, and they do not appear to be directly related to Laboratory effluents.

The sewage used in the Upland Recharge Experiment is prepared at the Brookhaven Sewage Treatment Plant to be equivalent either to the effluent from a primary treatment plant or from a secondary plant. The mixtures are made using cesspool pumpings gathered by scavengers in the Town of Brookhaven. These are blended with the Laboratory sewage, which is normally extremely dilute. The "primary" effluent is a blend of two parts degritted BNL sewage to one part cesspool waste; secondary effluent is a blend of clarified BNL sewage and cesspool waste in a 40 : 1 ratio. Water quality parameters of these two mixtures were evaluated by the BNL Biology Department[14] and cooperating outside agencies. Relevant portions of these data are shown in Table XI-B.

It should be noted that the purpose of the Upland Recharge Experiment is to determine the efficiency of natural ecosystems to retain agents in these effluents sufficiently so that the percolate is within ground water quality standards. Due to the permeable nature of the local soils, there is no surface runoff from the experimental plots, and hence no direct route by which these

effluents might reach a potable water supply.

Monthly "grab" water samples were obtained at on- and off-site locations along the upper tributary of the Peconic River, into which the Laboratory routinely discharges low-level radioactive wastes. Reference "grab" samples were also obtained from other nearby streams and bodies of water outside the Laboratory's drainage area. The sampling locations as shown in Fig. 6 were as follows:

Off-Site (Peconic River, proceeding downstream)

A - Peconic River at Schultz Rd., 15,900 ft. downstream

B - Peconic River at Wading River-Manorville Rd., 23,100 ft. downstream

C - Peconic River at Manorville, 35,000 ft. downstream

D - Peconic River at Calverton, 46,700 ft. downstream

R - Peconic River at Riverhead, 63,500 ft. downstream

Controls (Not in BNL Drainage)

E - Peconic River, upstream from BNL effluent outfall

F - Peconic River, north tributary (independent of BNL drainage)

H - Carman's River - outfall of Yaphank Lake

The individual monthly and yearly average gross beta and tritium concentrations at the downstream and control locations are shown in Table XII. A comparison suggests that the concentrations of BNL effluents in the stream diminish rapidly downstream of the outfall to near background levels at the more remote sampling locations. Since the average flow in the Peconic at Riverhead was about 30 times that at the BNL perimeter, the total amounts of activity at its mouth were manyfold those at the BNL perimeter.

During May, 1973 additional sampling of the stream bottom sediment, of immersed and emergent vegetation, and of small stream fauna was conducted along

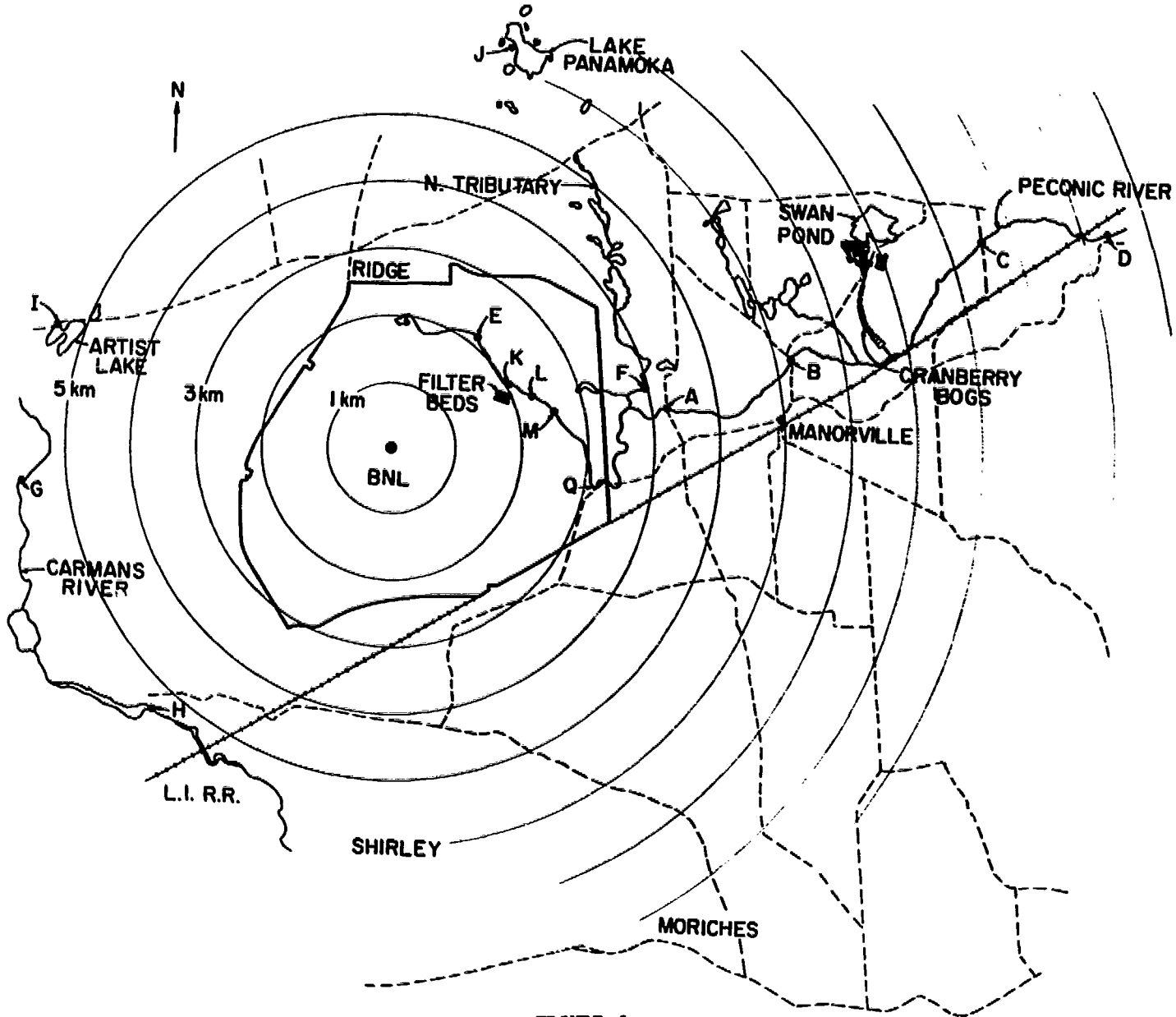

LAKE PANAMOKA
J
N
N. TRIBUTARY
PECONIC RIVER
SWAN POND
C
D
RIDGE
I
ARTIST LAKE
E
K
L
F
B
CRANBERRY BOGS
5 km
3 km
1 km
FILTER BEDS
A
M
MANORVILLE
BNL
Q
G
CARMANS RIVER
H
L.I. R.R.
SHIRLEY
MORICHES

FIGURE 6

the length of the Peconic. Control samples were obtained upstream and from its north tributary. The locations correspond to those used for monthly water samples. In addition, samples were obtained on-site at the following locations:

On-Site (proceeding downstream)

L - Peconic River, 1,300 ft. below effluent outfall

M - Peconic River, 2,600 ft. below effluent outfall (at former BNL boundary)

Q - Peconic River, 6,900 ft. downstream (at BNL boundary)

The sediment data are shown in Table XIII. Concentrations of ^{60}Co and ^{65}Zn, too low to be quantifiable (~100 pCi/kg) were also apparent in a few samples. The concentrations of ^{90}Sr and ^{137}Cs in some samples obtained on-site and in the upper reaches of the Peconic were somewhat greater than those in downstream and control samples. The corrasponding vegetation data are shown in Table XIV. These show considerable scatter. Small concentrations of ^{58}Co, ^{60}Co and ^{131}I, which were unique to BNL effluent releases, were found in samples obtained on-site and at the BNL perimeter.

There was inconclusive indication in these samples of any excess of ^{90}Sr or ^{137}Cs concentrations on-site, at the perimeter, in or nearby the downstream region of the Peconic as compared with remote downstream and control samples, which appear to reflect accumulations of these nuclides from fallout of atmospheric weapons tests.

A few samples of fish, frogs, snakes and turtles were also obtained along the upper reaches of the Peconic. These data, which are shown in Table XV, appear comparable to those found in vegetation. The largest concentration found in these samples was less than 0.8% of RCG's calculated on the basis of an assumed intake of 50 grams/day, and their overall average was less than 0.2% of this calculated RCG.

Potable Water Supply Wells

The Laboratory's potable water wells and cooling water supply wells are screened at a depth of about 100 ft, or about 50 ft below the water table in the Long Island surface layer of glacial outwash, sand and gravel. As apparent from Fig. 7, most of these wells are located generally west to northwest, and therefore upstream in the local ground water flow pattern[1] of the Laboratory's principal facilities. The exceptions are supply well Nos. 1 and 3, and the small well No. 5 adjacent to the sand filter beds. A total of about 5×10^6 gal/day is pumped from them.

Bimonthly grab samples were scheduled for these wells. These were analyzed for gross alpha, gross beta and tritium. All gross alpha concentrations were $< 10^{-9}$ μCi/ml, and almost all tritium concentrations were $< 10^{-6}$ μCi/ml. The gross beta and tritium results are set forth in Table XVI. There were no differences in the gross beta concentrations among these wells which might be attributed to BNL effluents.

Recharge Basins

After use in "once through" heat-exchangers, about 4×10^6 gal/day of the total water pumped from the ground water supply under the BNL site, is returned to this supply in three large open recharge sumps located about 1 km north of the Liquid Waste Evaporator Facility, about 1 km east of the HFBR, and about 1 km south of the MRR. Additional amounts originate from blowdown from air-conditioning systems. No chromates are utilized in any of these "open" systems. The anti-fouling agents utilized in some of the air-conditioning systems were bio-degradable organics, with the exception of Zn in a concentration of 8 ppm. Since the blowdown is small relative to the heat exchanger flow, it was diluted to less than 1/100 of this concentration in the sumps. The applicable standard for Zn in ground water is 0.6 ppm[5]. These are moni-

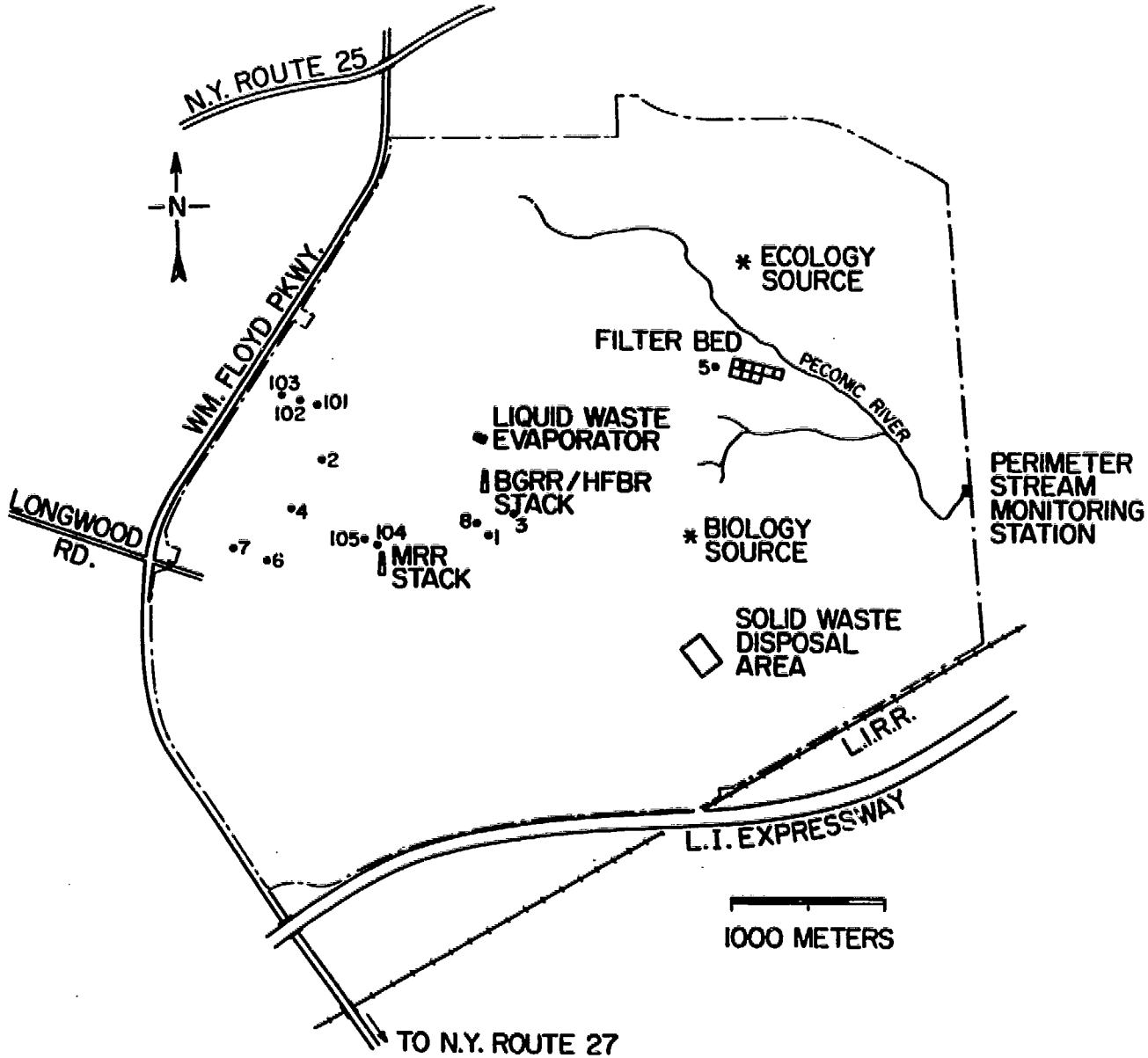

N.Y. ROUTE 25
N
WM. FLOYD PKWY.
LONGWOOD RD.
* ECOLOGY SOURCE
FILTER BED
5
PECONIC RIVER
103
102
101
LIQUID WASTE EVAPORATOR
2
BGRR/HFBR STACK
4
8
3
1
105
104
MRR STACK
7
6
* BIOLOGY SOURCE
PERIMETER STREAM MONITORING STATION
SOLID WASTE DISPOSAL AREA
L.I.R.R.
L.I. EXPRESSWAY
1000 METERS
TO N.Y. ROUTE 27

FIGURE 7

tored by routine monthly grab sampling. Their average gross beta and tritium concentrations are shown in Table XVII. The average gross beta concentration in the sump north of the AGS was slightly above background due to the infrequent release of short-lived nuclides contained in AGS beam stops. It was 0.3% of the applicable RCG. The average gross beta and tritium concentrations in the other sumps were only very slightly increased above those in the BNL supply wells, and were less than 0.1% of the applicable RCG for unidentified gross beta emitters, and less than 0.02% of that for tritium in drinking water.

Ground Water Surveillance

Samples of ground water were obtained from a network of shallow wells previously installed in the vicinity of several areas from which there is a potential for the migration of radioactivity downward from the surface into the saturated zone of ground water. These include areas adjacent to on-site sumps, to the sand filter beds and downstream along the Peconic River, the Solid Waste Handling Area, the former open-pit dump and the sanitary landfill which replaced it in 1967, the Decontamination Facility Sump, and to the Upland Recharge Experiment Area. The locations of most of these ground water surveillance wells are shown in Fig. 8-A. Detailed locations of the several wells installed at the Solid Waste Handling Area are shown in Fig. 8-B, and of those installed in the Upland Recharge Experiment Area in Fig. 8-C.

For convenience in assessing the data, the wells have been divided into several groups. Yearly average gross alpha, gross beta and tritium concentrations of the wells generally in the proximity of the on-site sumps, the sand filter beds and downstream on the Peconic River are summarized in Table XVIII. At least one sample from most of these locations was also analyzed for ^{90}Sr and ^{137}Cs

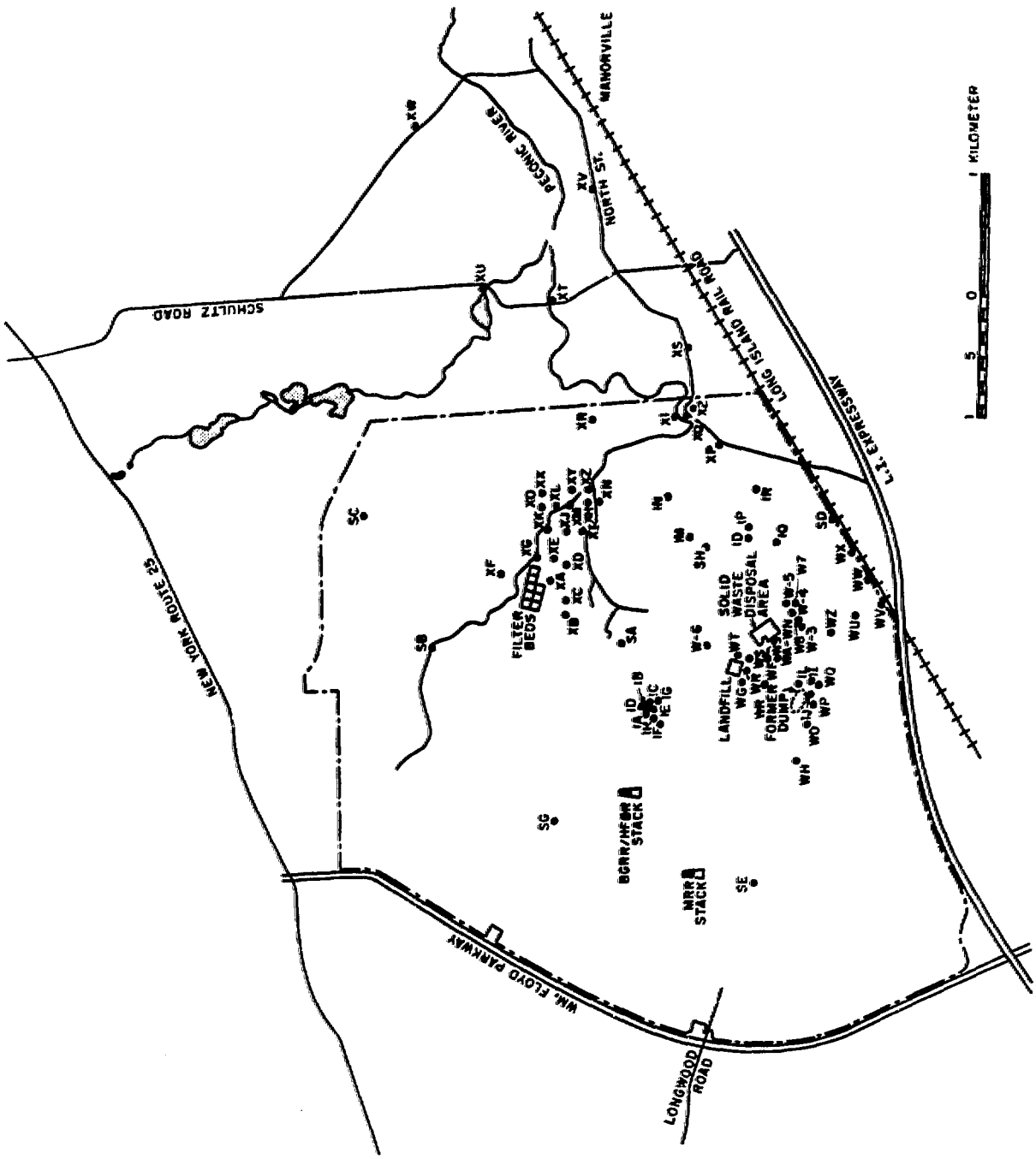

NEW YORK ROUTE 25
SCHULTZ ROAD
PECONIC RIVER
NORTH ST.
MANORVILLE
LONG ISLAND RAIL ROAD
L.I. EXPRESSWAY
WM. FLOYD PARKWAY
LONGWOOD ROAD
FILTER BEDS
SOLID WASTE DISPOSAL AREA
LANDFILL
FORMER WP DUMP
BGRR/INFW STACK
NRR STACK
1 KILOMETER
0
5
1

FIGURE 8A

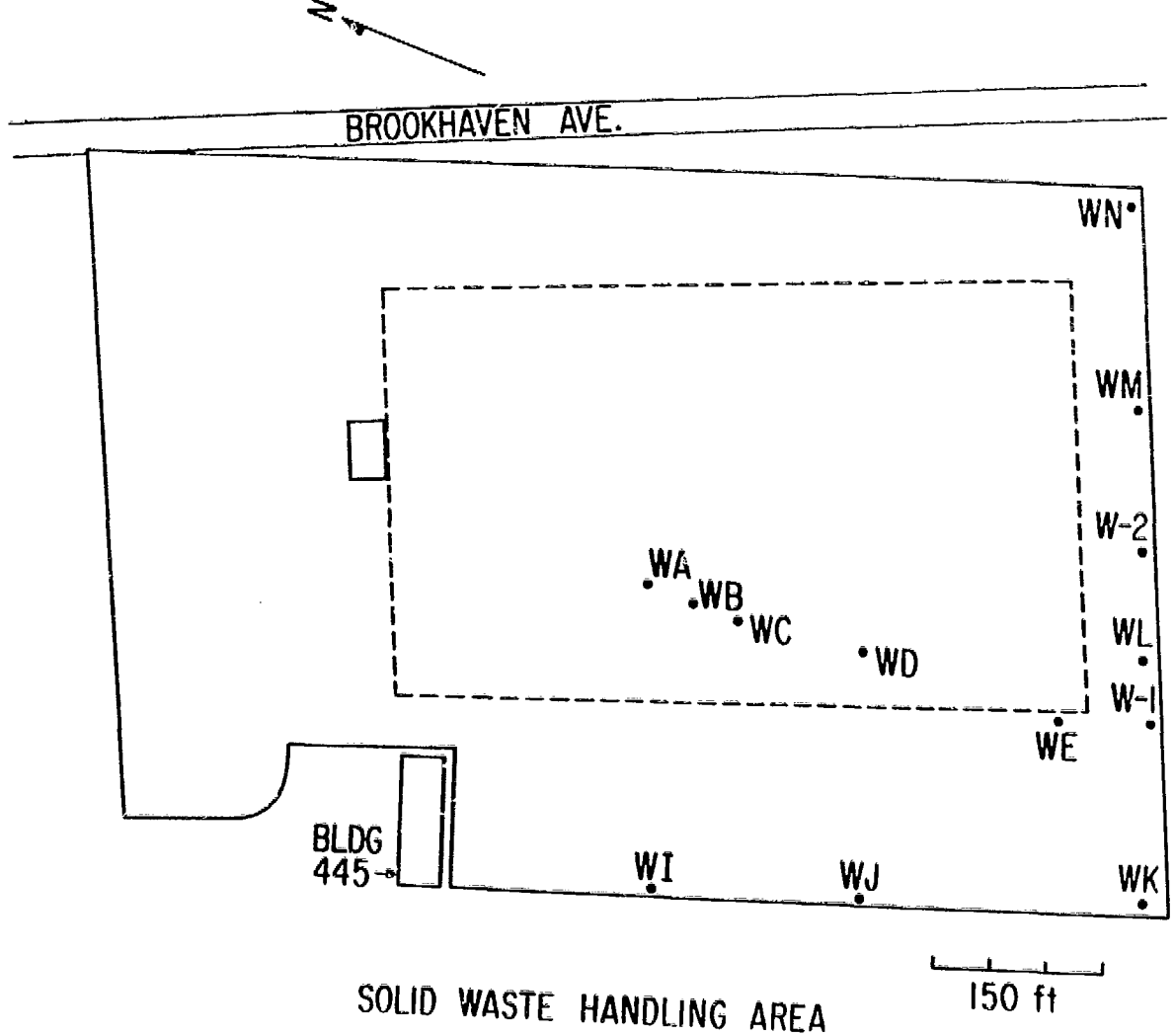
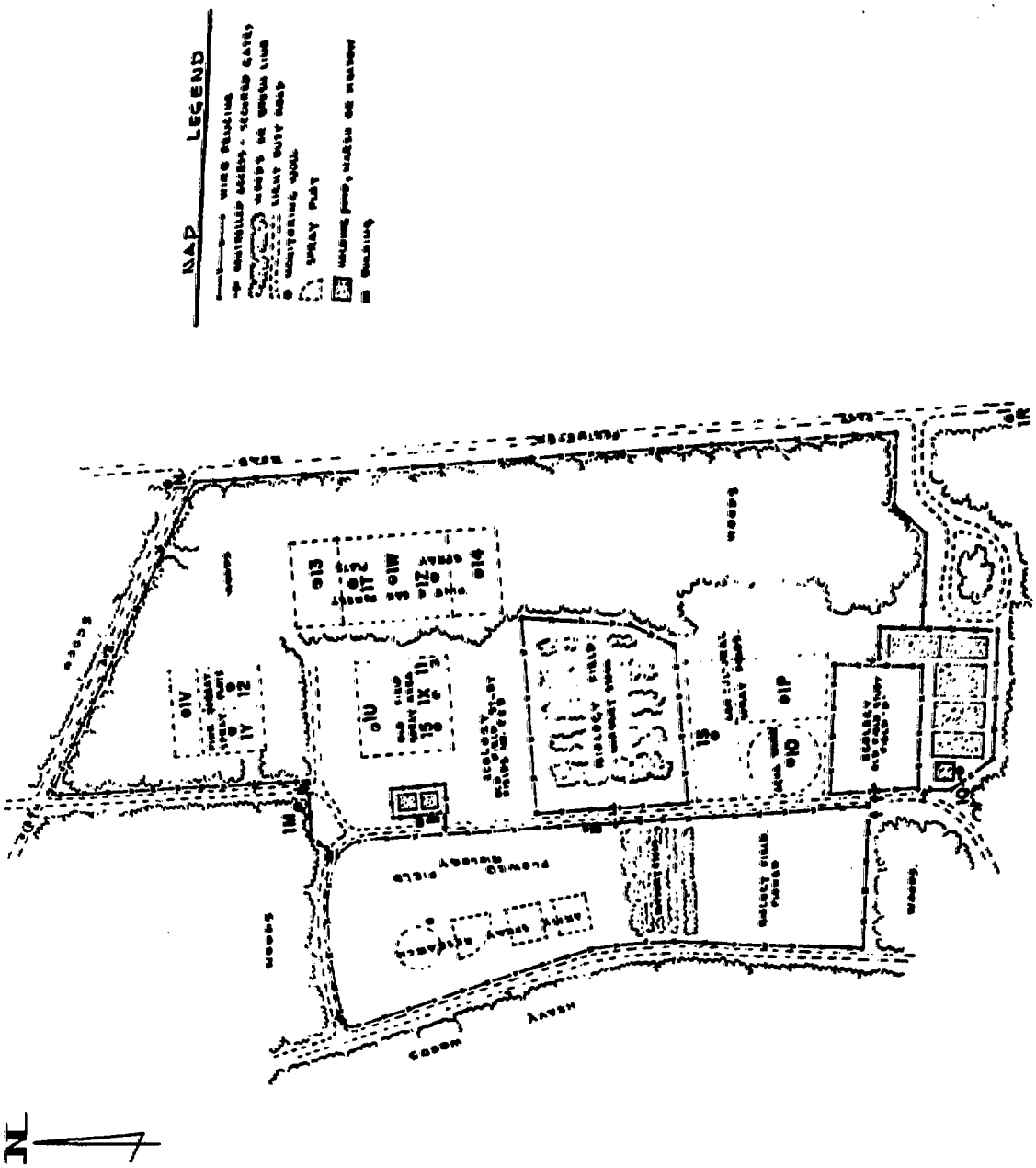

N
BROOKHAVEN AVE.
WN
WM
W-2
WA
WB
WC
WD
WL
W-1
WE
BLDG
445
WI
WJ
WK
SOLID WASTE HANDLING AREA
150 ft

FIGURE 8B



UPLAND RECHARGE WELLS

FIGURE 8C

(by gamma analysis) during the year. As available, these data are also indicated. Corresponding information for the wells generally in the proximity or downstream of the Solid Waste Packaging Area, the landfill and dump zones, and of the Decontamination Facility Sump (about 1 km east of the NFBR) is summarized in Table XIX, and for the wells in the Upland Recharge Experimental Area in Table XX.

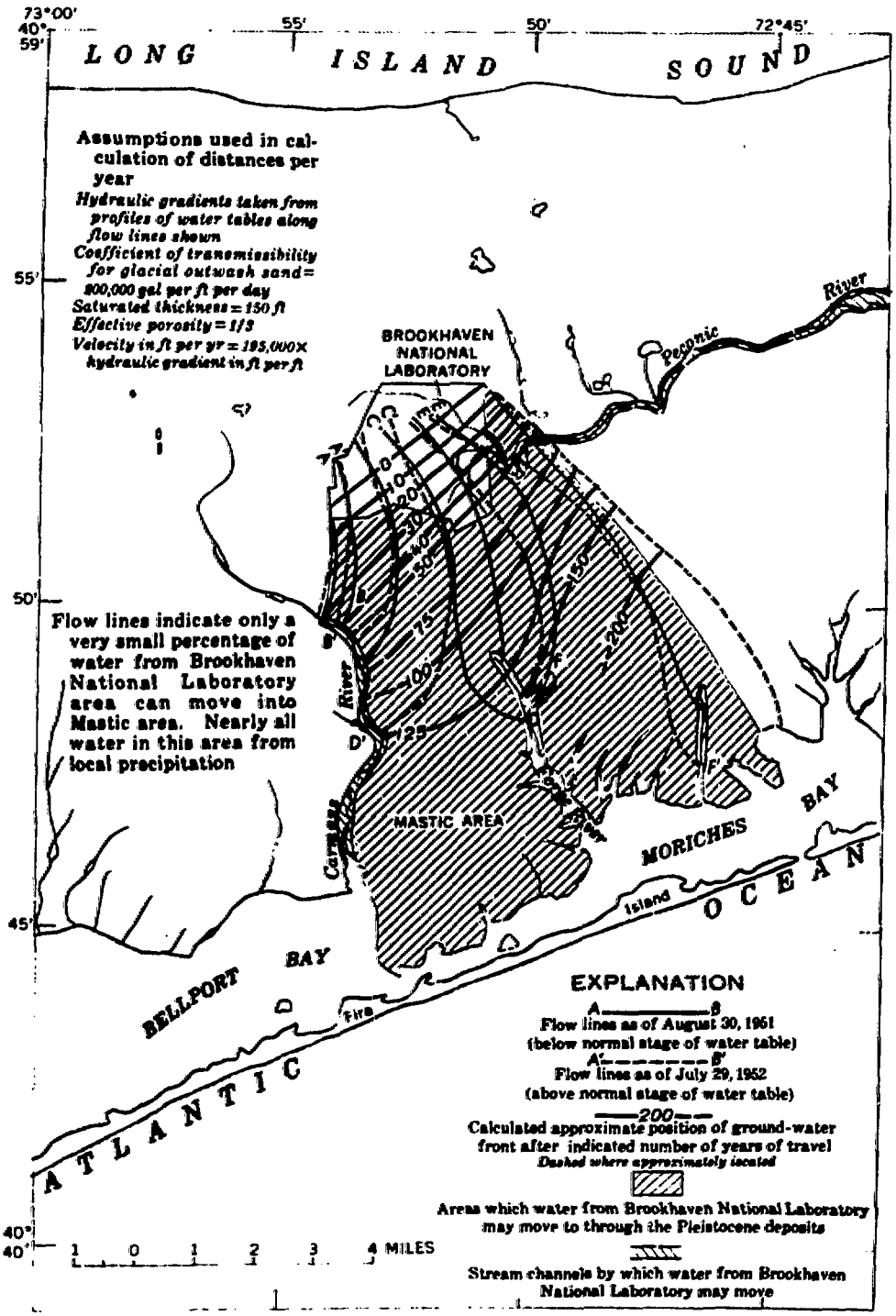
From these data it appears that the spread of contamination in the ground water, if any, is limited to within two hundred meters of the identified foci. Immediately adjacent to the sand filter beds and to the Peconic River, tritium concentrations increased slightly, compared to those found during 1972. Little change was apparent in gross beta and strontium-90 concentrations of on-site surveillance wells adjacent to the filter beds and to the river. Gross beta, ^{90}Sr and tritium concentrations were generally slightly increased in wells adjacent to the Solid Waste Packaging Area and slightly decreased in wells adjacent to the landfill and former dump areas and to the Decontamination Facility Sump. Tritium in slightly above minimum detectable concentrations was found in some wells within the Upland Recharge Experiment Area. Concentrations in wells on or near the site boundary were at or only slightly above background levels.

Several water quality and purity parameters were also evaluated for all ground water surveillance wells. The data for those wells proximate to on-site sumps, the sand filter beds, and downstream on the Peconic River on and off site, are shown in Table XXI-A. Those for wells proximate to the solid waste packaging area, the landfill and dump area, and the Bldg. 650 sump, are shown in Table XXI-B. One set of analyses for heavy metals was conducted for a selected twenty wells immediately adjacent to the sand filter beds, the Peconic River, and the landfill and dump area. These data are shown in Table XXI-C.

With the exception of pH, all generally analyzed parameters were within the New York State Water Quality Standards. The pH of wells at or near the site boundary and off-site appears to be within the range of the prevailing local area background of 5.0 - 6.0, which is somewhat lower than the water quality standard. Concentrations of Fe and Zn above the water quality standard were found in some wells immediately adjacent to the sand filter beds, the Peconic River and the landfill dump areas.

The velocity of ground water movement in the BNL area was investigated in the U. S. Geological Survey hydrology study referred to earlier. A generalized depiction, taken from that report, is shown in Fig. 9. More recently, in a dye test the Upland Recharge investigation determined a ground water velocity of 5.3 in./day (13.4 cm/day) in a fluorescein dye test, which is in good agreement with the estimate by Warren[1] of 0.4 in./day (16.2 cm/day). It thus appears that many years of travel time would be required for on-site ground water containing radioactivity or heavy metals to reach any potential off-site user, during which considerable dilution and/or holdup would be anticipated.

Using the HTO in the applied sewage as a tracer, the Upland Recharge study has found an average percolation rate of about 30 cm/wk for a mean application of about 1 cm/wk. Thus, a time of several months would be required, even if there were no holdup in the natural ecosystems of the experiment, for agents applied at the surface to percolate to the underlying ground water at a depth of some 300 - 450 cm in the Upland Recharge area. Consequently, only a limited amount of preliminary data on the quality of water from these wells is available. From these data the following patterns are apparent: a) total absorption in biota and soil: P and Fe; b) partial absorption: S, Mg; c) decreasing absorption with time and quantity of applied effluent: K, Ca; no absorption: Na, Cl.



Direction and time of travel of ground water laterally in upper Pleistocene deposits from the Brookhaven National Laboratory area to points of discharge.

FIGURE 9

Nitrates in ground water have been variable, and under the oak-pine forest plot increasing toward the total N input concentration, apparently due to the conversion of anomium nitrogen to nitrate. Since the total input N is less than the nitrate standard of 20.0 ppm, it is not anticipated that it can be exceeded in the ground water under any circumstances. No nitrogen has percolated through the pine forest plots to ground water. No data is available from the other plots, since there has been insufficient time since spraying was initiated in them for appreciable percolation to ground water.

Milk Sampling

Quarterly samples of milk were obtained from two dairy farms, one located 10 km south-southeast and a "control" located 40 km east of Brookhaven. These samples were analyzed for gamma-emitters and then processed through an ion exchange column to improve the lower detection capability for ^{131}I. The data are indicated in Table XXII. There was no significant difference between those for the first two quarters and the typical 1973 concentrations reported[15] for milk samples in the northeast region of the United States by the Environmental Protection Agency. As was the case during 1972 for the last two quarters, the average quarterly concentration of ^{90}Sr in the milk from a farm 10 km southeast of the Laboratory, as reported by the New York State Department of Environmental Conservation[16], was among the highest of any of their thirty state-wide sampling locations. This seasonal effect is believed to be related to the feeding practices of this farm which have been under investigation by the Department to ascertain to what extent they may be unique. There was no plausible relationship between these concentrations and Laboratory effluents.

Grass and Soil Sampling

A limited number of soil and vegetation samples were collected during the growing season from selected locations on site, adjacent to the BNL perimeter monitoring station, and from several off-site farms. These were analyzed for

gamma-emitting nuclides. The available data for soil are shown in Table XXIII and those for grass in Table XXIV. Comparison of off-site samples from sites in a prevailing downwind direction (6 km northeast and 10 km southeast) with other samples discloses no consistent differences. Although an insufficient number of samples were analyzed to be conclusive, the concentration of ^{137}Cs in on-site and perimeter samples appear to be somewhat greater than in off-site samples.

DOSE ESTIMATES

The largest potential radiation exposures related to Brookhaven National Laboratory activities and effluents are to hypothetical individuals located at the site boundary. As indicated in the previous sections, these have been small fractions of the applicable radiation protection standards or concentration guides. Most of the areas immediately adjacent to the Laboratory are either very sparsely populated or unpopulated. Due to the rapid dimunition of external radiation with distance and to the dilution of radioactivity in liquid effluents, the estimated exposures to typical individuals have been much smaller, and in all cases less than 1% of the applicable standards.

In addition to a background of 84.6 millirems, the calculated yearly exposure at the north boundary attributed to the Ecology Forest source was 15.5 millirems, or 3.1% of the applicable AEC Radiation Protection Standard[1]. The average individual dose to an estimated population of 100 persons living nearby to the Laboratory in this direction is calculated to be 2.5 millirems, and the calculated population dose 0.25 man-rems, compared to a total background dose of 8.5 man-rems. Measurements made by the Accelerator Survey Group of the Health Physics and Safety Division indicate a yearly "skyshine" exposure of 1.2 millirems at the closest boundary, mostly from the neutron component of the scattered radiation from the AGS. Their experimental measurements indicate that the relaxation length of this scattered radiation in air is about 600 m, so that it falls off quite rapidly with distance. Making the assumption that the population density adjacent to the Laboratory was 100 persons/km^2, the total calculated dose was about 0.42 man-rems, to a population of 3,454 persons within 3.5 km of the Laboratory boundary adjacent to the AGS, compared to a total background dose of some 290 man-rems to this same population.

At the site boundary, the yearly average measured concentration of tritium vapor in air, 1.2×10^{-11} $\mu Ci/cm^2$, would correspond to a yearly dose of less than 0.01 millirems. If this average measured boundary concentration is assumed to diminish with distance by diffusion at the same rate as that previously reported[17] for the ^{41}Ar contained in the air effluent from the Brookhaven Graphite Research Reactor, and a uniform population density of 100 persons/km^2 is also assumed, the calculated total yearly dose to some 31,700 persons (within a radius of 10 km) is 0.10 man-rems. During this same time, the total background to this same number of persons would have been 2,690 man-rems.

The largest potential dose attributable to Brookhaven's liquid effluents would have been 15.0 millirems to the thyroid and 11.2 millirems (over 50 years) to the bone to a hypothetical child drinking water from the Peconic River at the site boundary. In practice, the river is not used for drinking water, nor for irrigation, nor any other similar purpose in which direct ingestion can be adduced. The upper portions of the river, in which a small excess of background concentrations in sediments, vegetation and fish was found, is not utilized for other than occasional sports fishing by a few individuals. Making the assumption that the average ^{137}Cs concentration associated with Brookhaven effluents was 1.5×10^{-9} μCi and that the total catch of fish by 100 fishermen from this narrow confine at the river was 1×10^3 kg, their total ingestion would have been 1.5×10^{-6} Ci. This corresponds to an individual dose of 0.48 millirems and a total exposure of 4.7×10^{-2} man-rems. During this time, the total background of these same 100 fishermen would have been 8.46 man-rems.

There is no evidence that effluent radioactivity or other toxic agents released by BNL were contained in the ground water supply of off-site drinking

water wells, so that the potential dose from this source is taken to be nil.

Thus, during 1973 the Laboratory activities and effluents can be seen to have constituted an inconsequential addition to the normal background exposure of persons living or temporarily in its vicinity.

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TABLE I

1973 BNL ENVIRONMENTAL MONITORING
BACKGROUND AND SOURCE RADIATION LEVELS
(mrem/wk)†

Month	P-2*	P-4*	P-7	Northeast Perimeter (P-9 Bkgd)	Northeast Perimeter (Source)	Northeast Perimeter (Total)	All Stations (Background)
Jan.	1.57	1.54	1.76	1.56	0.23	1.79	1.64
Feb.	1.55	1.64	1.65	1.57	0.25	1.82	1.60
March	1.61	1.63	1.56	1.52	0.24	1.76	1.56
April	1.66	N.A.	1.67	1.60	0.28	1.88	1.64
May	1.60	1.60	1.65	1.60	0.31	1.91	1.61
June	1.65	1.65	1.68	1.59	0.34	1.93	1.64
July	1.68	1.68	1.74	1.53	0.35	1.88	1.66
Aug.	1.64	1.65	1.64	1.62	0.34	1.96	1.64
Sept.	N.A.	1.62	1.64*	1.68	0.33	1.91	1.65
Oct.	1.47	1.54	1.55*	1.75	0.29	2.04	1.58
Nov.	1.59	1.60	1.59	1.70	0.28	1.98	1.62
Dec.	N.A.	N.A.	N.A.	1.68	0.25	1.93	1.68
Average	1.60	1.62	1.64	1.61	0.29	1.89	1.63
Total (mR/yr)	83.2	84.3	85.5	84.0	15.5	98.5	84.6
Radiation Protection Standard for Uncontrolled Areas (3)					500		

Estimated error of individual monthly measurements at 95% confidence level:

DCE - ± 0.10 mrem/wk
TLD - ± 0.25 mrem/wk

† DCE data indicated are measured milliroentgen values, which are assumed to be equivalent to millirems, within the limits of measurement error.

* TLD measurements. Measured levels have been normalized to agree with DCE background measurements for corresponding month.

TABLE II

1973 BNL ENVIRONMENTAL MONITORING

AIRBORNE EFFLUENT DATA

Radioactive Effluents

Bldg.	Facility & Release Point	Elevation*	Nuclide	Amount (Ci)
490-1	Medical Research Reactor Stack	100'	Argon-41	439.0
490-2	Medical Research Center Stack	45'	^{3}H (vapor)	9.0
555-1	Chemistry Bldg. Stack	55'	^{3}H (vapor)	13.5
705-1	High Flux Beam Reactor/Hot Laboratory Stack	300'	^{3}H (vapor)	775.0
			Gross beta (particulate)	1.4×10^{-4}
901-1	Van de Graaff Accelerator Stack	40'	^{3}H (gas)	374.0
			^{3}H (vapor)	198.0
931	Linac Isotope Facility	30'	^{3}H (vapor)	6.8×10^{-2}
			Oxygen 15	7050.0

Steam Plant Effluents

Bldg.	Facility & Release Point	Elevation*	Agent	Amount (kg)
610-1	Central Steam Plant Stack	65'	Particulate	3.26×10^{4}
			SO_2	7.70×10^{5}
			NO_x	5.14×10^{4}

*Above ground level

TABLE III

1973 BNL ENVIRONMENTAL MONITORING MONTHLY AVERAGE GROSS ALPHA AND GROSS BETA CONCENTRATIONS, AIR PARTICULATE FILTERS (pCi/m^3 or 10^{-12} $\mu Ci/cm^3$)

		Gross Alpha				Gross Beta			
Month	Location	No.	Average	Maximum	Minimum	No.	Average	Maximum	Minimum
Jan.	Waste Packaging	22	0.0013	0.0035	0.0006	22	0.0634	0.1650	0.0304
	S.W. Perimeter	-	-	-	-	4	0.0627	0.0823	0.0457
	N.E. Perimeter	-	-	-	-	4	0.0513	0.0622	0.0444
Feb.	Waste Packaging	20	0.0011	0.0024	0.0006	20	0.0654	0.1020	0.0328
	S.W. Perimeter	-	-	-	-	4	0.0550	0.0652	0.0374
	N.E. Perimeter	-	-	-	-	4	0.0471	0.0569	0.0295
March	Waste Packaging	23	0.0008	0.0018	< 0.0001	23	0.0470	0.9838	0.0226
	S.W. Perimeter	-	-	-	-	4	0.0384	0.0622	0.0332
	N.E. Perimeter	-	-	-	-	4	0.0374	0.0477	0.0316
April	Waste Packaging	21	0.0011	0.0029	< 0.0001	21	0.0521	0.1420	0.0151
	S.W. Perimeter	-	-	-	-	5	0.0457	0.0644	0.0220
	N.E. Perimeter	-	-	-	-	5	0.0456	0.0623	0.0226
May	Waste Packaging	21	0.0006	0.0020	< 0.0001	21	0.0428	0.0856	0.0188
	S.W. Perimeter	-	-	-	-	4	0.0312	0.0494	0.0215
	N.E. Perimeter	-	-	-	-	4	0.0326	0.0495	0.0270
June	Waste Packaging	21	0.0006	0.0016	0.0001	21	0.0559	0.1360	0.0214
	S.W. Perimeter	-	-	-	-	5	0.0419	0.0510	0.0251
	N.E. Perimeter	-	-	-	-	5	0.0418	0.0621	0.0269
July	Waste Packaging	24	0.0009	0.0023	0.0003	24	0.0869	0.2320	0.0357
	S.W. Perimeter	-	-	-	-	5	0.0693	0.1120	0.0228
	N.E. Perimeter	-	-	-	-	5	0.0563	0.0782	0.0209
Aug.	Waste Packaging	24	0.0009	0.0023	< 0.0001	24	0.0894	0.2360	0.0302
	S.W. Perimeter	-	-	-	-	5	0.0856	0.1700	0.0520
	N.E. Perimeter	-	-	-	-	3	0.0581	0.0735	0.0357
Sept.	Waste Packaging	20	0.0006	0.0016	0.0001	20	0.0717	0.1680	0.0433
	S.W. Perimeter	-	-	-	-	5	0.0744	0.1320	0.0507
	N.E. Perimeter	-	-	-	-	5	0.0731	0.1050	0.0455
Oct.	Waste Packaging	20	0.0006	0.0013	< 0.0001	20	0.0770	0.1410	0.0286
	S.W. Perimeter	-	-	-	-	4	0.0777	0.1290	0.0246
	N.E. Perimeter	-	-	-	-	4	0.0837	0.1310	0.0721
Nov.	Waste Packaging	20	0.0006	0.0020	0.0002	20	0.0793	0.1650	0.0259
	S.W. Perimeter	-	-	-	-	4	0.0761	0.1170	0.0599
	N.E. Perimeter	-	-	-	-	4	0.0825	0.1310	0.0546
Dec.	Waste Packaging	17	0.0007	0.0014	0.0002	17	0.0702	0.1340	0.0254
	S.W. Perimeter	-	-	-	-	4	0.0479	0.0549	0.0298
	N.E. Perimeter	-	-	-	-	4	0.0479	0.0598	0.0223
Average	Waste Packaging	253	0.0008	0.0035	< 0.0001	253	0.0660	0.2360	0.0151
	S.W. Perimeter	-	-	-	-	55	0.0596	0.1700	0.0215
	N.E. Perimeter	-	-	-	-	51	0.0548	0.1310	0.0209
Est. % Error of Individual Sample		± 25%				± 10%			
Radiation Concentration Guide(3) for Unidentified Mixtures		0.100				100			

TABLE IV

1973 BNL ENVIRONMENTAL MONITORING

AVERAGE TRITIUM VAPOR CONCENTRATIONS IN AIR (pCi/m^3 or $10^{-12}\mu Ci/cm^3$)

Period	No. Samples	Waste Pkg'g. Area	S.W. Perimeter	N.E. Perimeter
8/15-10/1	1	200	20	5
10/1-12/3	1	16	8	15
Average		93	13	11
Radiation Concentration Guide[3]			2×10^5	

Estimated error at 95% confidence level: $\pm$ 10%, or $\pm$ 5 pCi/m^3.

TABLE V

1973 BNL ENVIRONMENTAL MONITORING
MONTHLY AVERAGE CONCENTRATIONS OF GROSS BETA ACTIVITY AND
OF GAMMA EMITTING NUCLIDES IN MONTHLY COMPOSITE,
AIR PARTICULATE FILTERS AND CHARCOAL FILTERS (pCi/m^3 or 10^{-12} $\mu Ci/cm^3$)

Month	Avg.Gβ*	^{7}Be	^{65}Zn	$^{95}ZrNb$	^{131}I**	^{137}Cs	^{144}Ce
Jan.	0.059	0.113	<0.001	0.001	0.001	0.001	0.010
Feb.	0.055	0.116	0.001	0.001	<0.001	0.001	0.015
Mar.	0.041	0.108	<0.001	<0.001	0.001	0.001	0.007
Apr.	0.048	0.120	<0.001	<0.001	<0.001	0.002	0.009
May	0.036	0.089	0.001	<0.001	<0.001	0.002	0.008
June	0.040	0.130	<0.001	<0.001	<0.001	0.002	0.006
July	0.068	0.150	0.001	0.002	<0.001	0.002	0.007
Aug.	0.073	0.110	<0.001	0.002	<0.001	0.001	0.010
Sept.	0.073	0.160	0.001	0.005	<0.001	<0.001	0.008
Oct.	0.083	0.147	<0.001	0.005	<0.001	<0.001	0.008
Nov.	0.079	0.118	<0.001	0.010	<0.001	<0.001	0.004
Dec.	0.053	0.130	0.001	0.009	<0.001	0.001	0.005
Averages	0.059	0.124	<0.001	0.003	<0.001	0.001	0.008
Est. Error of Individual Sample (%)	±10	±25	±100	±50	±100	±50	±50
Radiation Conc. Guide(3)	100	4×10^4	2×10^3	1×10^3	100	500	200

*Average of all stations

**Charcoal filter collections, all other nuclides collected on air particulate filters.

TABLE VI

1973 BNL ENVIRONMENTAL MONITORING
MONTHLY AVERAGE GROSS BETA CONCENTRATION, TOTAL GROSS BETA ACTIVITY
AND INDIVIDUAL NUCLIDE ACTIVITY IN PRECIPITATION

Month	Amount (Inches)	Gβ Conc. (pCi/l or 10^{-9} μCi/ml)	Gβ Activity (nCi/m^2 or 10^{-3} μCi/m^2)	Nuclide Activity (nCi/m^2 or 10^{-3} μCi/m^2)										
				^{7}Be	^{22}Na	^{54}Mn	^{65}Zn	^{90}Sr	^{95}Zr-Nb	^{125}Sb	^{131}I	^{137}Cs	^{140}Ba-La	^{144}Ce
Jan.	3.20	7	0.63											
Feb.	3.25	8	0.66	10.2	<0.7	<0.1	<0.1	0.1	<0.1	0.3	<0.1	0.1	<0.1	1.3
March	3.56	8	0.74											
April	5.35	7	1.00											
May	5.53	11	1.49	13.3	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.2	<0.1	1.5
June	1.76	8	0.32											
July	7.86	24	4.85											
Aug.	1.97	9	0.46	13.9	0.1	<0.1	<0.1	0.1	0.4	< 0.1	<0.1	<0.1	<0.1	0.7
Sept.	3.52	7	0.72											
Oct.	0.11	22	0.06											
Nov.	3.39	12	1.09	16.2	0.1	0.1	<0.1	<0.1	1.1	0.1	<0.1	<0.1	<0.1	0.7
Dec.	7.20	10	2.01											
Total	46.70	11**	14.03	53.6	0.3	<0.4	<0.4	0.3	0.6	0.5	<0.4	0.4	<0.4	4.2
Est. Error	± 0.50	± 1	± 1.40	±10.7	±0.2			±0.1	± 0.6	±0.3		± 0.2		±1.3
Radiation Conc. Guide(3)*		3×10^3		-	-			-	-	-		-		-

* For release to uncontrolled areas of mixture of radionuclides containing <10% ^{90}Sr $^{125\text{-}133}$I and long lived natural alpha emitting nuclides.
** Average Concentration

TABLE VII

1973 BNL ENVIRONMENTAL MONITORING
MONTHLY AVERAGE TRITIUM CONCENTRATION AND ACTIVITY IN PRECIPITATION

Month	BNL Conc. (pCi/l or 10^{-9} μCi/ml)	BNL Activity (nCi/m^2 or 10^{-3} μCi/m^2)	OFF-SITE Conc. (pCi/l or 10^{-9} μCi/ml)
January - March	412	105	183
April - June	472	141	260
July - September	639	218	248
October - December	602	166	347
Total		630	
Yearly Average*	530		255
Estimated Error	± 53	± 63	± 26
Radiation Concentration Guide[3]**	3×10^6		3×10^6

* Quarterly concentrations weighted on basis of amount of precipitation collected on-site in the calculation of yearly average.

** For tritium in water released to the off-site environment.

TABLE VIII

1973 BNL ENVIRONMENTAL MONITORING

TOTAL ACTIVITIES AND AVERAGE CONCENTRATIONS OF IDENTIFIABLE NUCLIDES IN LIQUID EFFLUENTS

CLARIFIER - (mCi)

Month	Flow x 10^{10} cm^3	^{3}H	^{7}Be	^{22}Na	^{24}Na*	^{51}Cr	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	GS**
January	8.22	1,121	.76	<0.05	0.35	<0.05†	0.02	0.06	<0.02	0.20	1.16	<0.02	0.30	0.30	3.00
February	8.53	3,092	4.45	<0.05	2.12	<0.05†	0.02	0.08	<0.02	0.12	13.53	<0.02	0.05	0.34	22.24
March	9.47	5,123	7.35	<0.05	2.51	0.50†	0.03	0.04	<0.02	0.06	1.47	<0.02	0.25	0.67	14.93
April	15.51	3,025	22.00	0.09	7.60	0.75†	0.40	0.12	<0.02	0.09	1.95	<0.02	0.15	0.22	38.24
May	14.84	2,351	35.20	0.21	3.00	1.00†	1.16	<0.01	<0.02	0.11	1.15	0.02	0.27	<0.05	47.52
June	13.24	805	4.42	0.08	<0.05	0.05	0.05	0.03	0.09	0.09	.38	0.05	0.46	0.17	10.68
July	18.31	942	4.78	0.27	<0.05	0.29	0.11	<0.01	0.05	0.15	1.32	0.07	0.07	0.35	12.23
August	13.37	1,400	3.48	0.20	4.00	1.04	0.10	<0.01	0.29	0.05	7.20	0.05	0.39	1.91	9.70
September	15.89	1,990	10.60	0.10	10.00	0.06	0.10	<0.01	0.06	0.07	1.63	0.08	0.11	0.24	24.45
October	11.20	852	24.40	<0.01	6.00	0.74	<0.20	0.10	<0.02	0.11	<0.06	<0.02	0.22	<0.11	32.73
November	9.87	214	11.39	0.07	8.00	0.64	0.14	0.05	<0.02	0.05	0.90	0.03	0.08	<0.13	21.90
December	11.29	2,060	41.80	0.39	40.00	0.71	0.82	0.05	0.22	0.16	1.12	<0.02	0.19	<0.50	97.91
Total	149.74	22,975	170.63	1.42	83.58	5.83	2.05	0.57	0.78	1.26	31.84	0.35	2.54	4.61	335.53
Avg. Conc. (pCi/l or 10^{-9} µCi/ml)	-	15,350	114	1.0	56.5	3.9	1.4	0.4	0.5	0.8	21.3	0.2	1.7	3.1	224
% of Total**	-	-	50.9	0.4	24.8	1.7	0.6	0.2	0.2	0.4	6.6	0.1	0.8	1.4	100

CHLORINE HOUSE - (mCi)

January	7.46	857	0.09	<0.02	0.35*	<0.02†	<0.02	0.02	<0.02	0.16	0.81	<0.02	0.43	0.25	3.13
February	7.98	2,677	1.02	<0.02	1.17	<0.02†	<0.02	0.07	<0.02	0.63	1.77	<0.02	0.52	0.24	6.11
March	8.17	4,679	0.59	<0.02	1.39	<0.02†	<0.02	0.03	<0.02	0.37	0.41	<0.02	0.61	0.12	3.97
April	12.33	2,280	9.11	0.10	4.18	0.50†	0.11	<0.02	<0.02	0.41	0.22	<0.02	0.21	0.29	6.98
May	11.66	1,957	7.34	0.27	1.20	0.50†	0.56	<0.02	<0.02	0.21	0.39	<0.02	0.70	0.40	11.96
June	10.22	839	1.06	0.10	<0.05	<0.02	0.04	0.04	0.14	0.17	0.15	0.08	0.48	0.08	1.96
July	13.60	689	0.27	0.07	<0.05	0.34	<0.02	<0.02	0.02	0.22	0.09	<0.02	0.61	0.13	2.79
August	10.73	1,184	0.71	0.17	1.00	<0.02	<0.02	<0.02	0.03	0.08	<0.10	0.03	0.65	<0.12	3.67
September	12.19	1,510	2.34	0.01	2.50	0.67	<0.02	<0.02	<0.02	0.12	0.06	0.08	0.68	0.06	7.41
October	6.83	730	0.97	0.03	1.50	0.24	<0.02	<0.02	0.02	0.06	<0.02	0.03	0.54	<0.09	3.65
November	6.86	155	0.76	0.05	4.00	0.19	<0.02	<0.02	<0.02	0.06	0.07	0.03	0.53	<0.06	5.90
December	8.54	1,382	1.40	0.07	10.00	0.13	0.02	<0.02	0.02	0.20	0.02	0.02	0.33	<0.04	13.66
Total	116.57	18,939	25.66	0.90	27.29	2.62	0.81	0.24	0.29	2.69	4.16	0.33	6.29	1.79	71.19
Avg. Conc. (pCi/l or 10^{-9} µCi/ml)	-	16,250	22.0	0.8	23.5	2.2	0.7	0.2	0.3	2.3	3.6	0.3	5.4	1.6	61.1
% of Total**	-	-	36.0	1.3	38.4	3.7	1.1	0.3	0.4	3.8	5.8	0.5	8.8	2.3	100

*Estimated from otherwise unaccounted for activity and occasional daily sample analysis.

**Includes γ-only emitters, does not include ^{3}H.

† Estimated on basis of BLIF operating time.

TABLE VIII - Con't.

GROUND WATER

(mCi)

	Flow $\times 10^{11}$ cm^3	^{3}H	^{7}Be	^{22}Na	^{24}Na	^{51}Cr	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	GB*
Total	3.32	5,400	7.30	0.27	7.81	0.73	0.23	0.07	0.10	0.76	1.20	0.10	1.79	0.53	20.38
Average Conc. (pCi/l)		16,250	22.0	0.8	23.5	2.2	0.7	0.2	0.3	2.3	3.6	0.3	5.4	1.6	61.1
% of Total		-	36.0	1.3	38.4	3.7	1.1	0.3	0.4	3.8	5.8	0.5	8.8	2.3	100
Radiation Conc. Guide (3) pCi/l or 10^{-9} uCi/ml		$3x10^6$	$2x10^6$	$4x10^4$	$2x10^5$	$2x10^6$	$1x10^5$	$5x10^4$	$1x10^5$	300	300	$9x10^3$	$2x10^4$	$1x10^4$	$3x10^{3**}$

* Includes γ-only emitters; does not include ^{3}H.
** See text, page 19.

TABLE IX

1973 BNL ENVIRONMENTAL MONITORING

TOTAL ACTIVITIES AND AVERAGE CONCENTRATIONS OF IDENTIFIABLE NUCLIDES IN LIQUID EFFLUENTS

FORMER PERIMETER - (mCi)

Month	Flow x 10^{10} cm^3	^{3}H	^{7}Be	^{22}Na	^{24}Na*	^{51}Cr	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	GB*
January	11.35	1,016													
February	15.30	2,361	0.47	<0.10	1.32	<0.10	0.02	0.04	<0.05	3.90	0.61	<0.02	1.60	0.30	10.75
March	16.05	4,015													
April	25.00	2,280	2.32	0.22	1.38	<0.05	0.13	<0.02	<0.02		0.08	<0.02	0.53	0.68	6.69
May	35.30	1,850	9.11	0.43	0.60	<0.05	0.71	<0.02	<0.02	1.66	0.42	<0.02	0.81	1.30	14.46
June	33.30	650	0.95	0.09	<0.02	<0.05	0.03	0.04	0.14		0.15	0.08	0.74	0.08	4.43
July	34.80	789	0.41	0.06	<0.02	0.35	<0.02	<0.02	0.09		0.19	<0.02	0.73	0.28	4.33
August	19.32	1,299	0.30	0.20	0.50	<0.05	0.08	<0.02	0.06	0.59	<0.16	<0.02	0.65	0.13	3.25
September	18.12	1,485	0.43	0.09	1.25	0.26	<0.02	<0.02	0.04		0.07	0.03	0.75	0.50	5.03
October	8.50	720	0.47	0.03	1.75	0.09	<0.02	0.02	<0.02		<0.04	0.02	0.58	<0.08	2.72
November	8.45	171	0.50	0.05	2.00	0.15	<0.02	0.07	0.02	0.34	0.11	<0.02	0.48	0.03	3.44
December	13.10	1,416	1.10	0.12	5.00	0.09	0.02	<0.02	0.03		0.04	0.03	0.36	0.12	9.07
Total	238.59	18,052	16.06	1.44	12.86	1.09	1.02	0.22	0.44	7.08	1.77	0.22	7.23	2.46	64.17
Avg. Conc. (pCi/l or 10^{-9} µCi/ml)	-	7,550	6.8	0.6	5.4	0.5	0.4	0.1	0.2		0.8	0.1	3.0	1.5	26.9
% of Total*	-	-	25.0	2.2	20.1	1.8	1.6	0.3	.60	11.0	2.9	0.3	11.3	5.5	100

SITE BOUNDARY

Month	Flow x 10^{10} cm^3	^{3}H	^{7}Be	^{22}Na	^{24}Na*	^{51}Cr	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	GB*
January	11.60	550													
February	19.03	1,953	0.78	<0.05	0.35	<0.10	0.02	0.04	<0.05	3.94	0.63	<0.02	0.87	0.24	10.72
March	24.75	4,889													
April	40.50	2,280	2.92	0.39	0.46	<0.05	0.13	<0.02	<0.02		0.16	<0.02	1.45	0.71	9.30
May	43.92	1,747	9.11	0.43	0.30	0.10	0.71	<0.02	<0.02	2.56	0.43	<0.02	0.81	1.30	15.32
June	35.47	619	0.19	0.06	<0.02	<0.05	0.03	0.05	0.14		0.15	0.08	0.31	0.08	3.96
July	41.42	886	0.27	0.11	<0.02	0.24	0.02	0.04	<0.02		0.13	<0.02	0.48	0.44	5.07
August	21.06	990	0.09	0.06	0.25	<0.05	<0.02	0.02	<0.02	0.72	<0.02	<0.02	0.19	0.04	2.46
September	14.84	1,278	0.30	0.02	0.75	0.05	<0.02	<0.02	<0.02		<0.02	<0.02	0.22	0.08	2.72
October	3.81	344	0.08	<0.02	0.25	<0.05	<0.02	0.03	<0.02		<0.02	<0.02	0.05	0.02	0.98
November	3.99	63	0.37	<0.02	0.50	0.05	<0.02	0.02	<0.02	0.24	<0.02	<0.02	0.04	<0.04	1.12
December	9.99	768	0.60	0.08	1.25	0.09	0.02	0.01	0.02		0.02	<0.02	0.28	0.10	2.34
Total	270.38	16,367	14.71	1.20	4.11	0.68	0.97	0.23	0.26	7.46	1.56	0.17	4.70	3.03	53.99
Avg. Conc. (pCi/l or 10^{-9} µCi/ml)	-	6,050	5.4	0.4	1.5	0.3	0.4	0.1	0.1	2.8	0.6	0.1	1.7	1.1	20.0
% of Total*			27.2	2.2	7.6	1.3	1.8	0.4	0.4	13.9	2.9	0.4	8.7	5.7	100

*Includes γ-only emitters, does not include ^{3}H.

TABLE IX - Con't.

GROUND WATER - mCi

	Flow $\times 10^{11}$ cm^3	^{3}H	^{7}Be	^{22}Na	^{24}Na	^{51}Cr	^{58}Co	^{60}Co	^{65}Zn	^{90}Sr	^{131}I	^{134}Cs	^{137}Cs	^{144}Ce	Gβ*
Total	1.55	1,220	0.81	0.09	2.90	0.19	0.02	0.04	0.03	0.17	0.07	0.03	0.70	0.22	6.52
Average Conc. (10^{-9} µCi/ml)		7,850	5.2	0.6	18.7	1.2	0.1	0.2	0.2	1.1	0.5	0.2	4.5	1.4	41.9
% of Total		-	12.5	1.4	44.7	2.9	0.3	0.6	0.5	2.6	1.1	0.5	10.8	3.4	10.0
Radiation Concentration Guide (10^{-9} µCi/ml)		3×10^6	2×10^6	4×10^4	2×10^5	2×10^6	1×10^5	5×10^4	1×10^5	300	300	9×10^3	2×10^4	1×10^4	3,000**

*Includes gamma-only emitters; does not include tritium.

** For mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$, or long-lived alpha emitters.

TABLE X

1973 BNL ENVIRONMENTAL MONITORING
GROSS BETA, ^{3}H AND ^{90}Sr IN EFFLUENT APPLIED
TO UPLAND RECHARGE EXPERIMENT AREA

	Period	Flow ($\times 10^{9}$ ml)	Gross Beta* Concentration (pCi/l or 10^{-9} $\mu Ci/ml$)	Gross Beta* Amount (μCi)	^{3}H Concentration (nCi/l or 10^{-6} pCi/ml)	^{3}H Amount (mCi)	^{90}Sr** Concentration (pCi/l or 10^{-9} $\mu Ci/ml$)	^{90}Sr** Amount μCi
Pine Forest - Primary	July - Dec.	2.86	59	170	7.4	21.24	0.7	2.0
" " - Secondary	"	2.88	84	240	7.3	21.02	0.7	2.0
Pine-Oak Forest - Primary	"	4.60	69	317	7.3	33.62	0.7	3.2
" " " - Secondary	"	4.63	83	382	7.5	34.48	0.7	3.2
Old Field - Primary	Oct. - Dec.	2.09	116	241	5.4	11.25	1.0	2.1
" " - Secondary	"	1.84	115	212	5.9	10.80	1.0	1.8
Agricultural Spring - Primary	"	1.44	146	211	4.8	6.96	1.0	1.4
- Secondary	"	2.42	126	304	5.6	13.44	1.0	2.4
Total		22.76		2,077		152.81		18.1
Average			92		6.8		0.8	
Radiation Concentration Guide (3)***			3,000		3,000		300	

*Less ^{3}H.

**Estimated from average concentration without dilution of ^{90}Sr at Clarifier since spraying initiated.

***For mixtures of radionuclides containing <10% ^{90}Sr, $^{125-133}I$, or long-lived alpha emitters.

TABLE XI - A

1973 BNL ENVIRONMENTAL MONITORING
LIQUID EFFLUENT QUALITY AND PURITY

	Sample	BOD (ppm)	Chlorides (ppm)	Chromium-Hexavalent (ppm)	Chlorine (residual) (ppm)	Coliform (#/100ml)	Conductivity (μmho/cm)	Dissolved Oxygen (ppm)	Dissolved Solids (ppm)	Nitrate-Nitrogen	Total Phosphorus	pH
	No.	29	-	41	-	-	38	-	-	-	38	219
CLARIFIER	Average	28.7	-	<0.01	-	-	186	-	-	-	1.07	6.7
EFFLUENT	Maximum	54.0	-	<0.01	-	-	196	-	-	-	2.00	6.2
	Minimum	20.5	-	<0.01	-	-	179	-	-	-	0.80	7.1
	No.	219	83	29	219	101	219	188	24	104	136	241
SAND FILTER	Average	2.1	35	<0.01	0.93	45	173	8.6	111	2.6	0.7	6.1
BED EFFLUENT	Maximum	3.3	46	<0.01	1.06	280	199	10.3	134	3.7	1.1	6.3
	Minimum	0.3	26	<0.01	.88	0	153	7.4	88	0.7	0.4	5.8
	No.	-	38	-	-	-	98	98	16	10	10	98
UPSTREAM	Average	-	11	-	-	-	52	7.6	49	0.2	0.1	5.4
OF OUTFALL	Maximum	-	24	-	-	-	58	9.4	84	0.4	0.6	5.9
	Minimum	-	7	-	-	-	46	5.0	37	0.1	< 0.1	4.5
FORMER	No.	-	53	-	-	42	121	121	21	68	67	121
PERIMETER	Average	-	23	-	-	2,200	114	8.8	79	1.4	0.4	6.0
(0.5 mi	Maximum	-	29	-	-	6,375	161	12.9	116	1.5	0.5	6.9
downstream)	Minimum	-	18	-	-	71	79	6.3	52	1.2	0.1	5.5
BNL	No.	-	54	-	-	36	128	128	10	54	77	128
PERIMETER	Average	-	24	-	-	1,475	114	7.3	80	0.8	0.3	6.2
(1.6 mi.	Maximum	-	29	-	-	3,250	157	10.8	118	1.0	0.5	6.8
downstream)	Minimum	-	18	-	-	620	85	3.2	58	0.5	0.1	5.5
WATER QUALITY STANDARD(4)		2.0 (minimum)	250	0.05	-	50	-	< 40	500	10**	-	6.56 8.5

Note: Monthly average maximum and minimum values indicated.
* Sample obtained in Peconic River, 150' below Chlorine House.
** Nitrates and nitrites.

TABLE XI-B

1973 BNL UPLAND RECHARGE EXPERIMENT
PRIMARY AND SECONDARY QUALITY AND PURITY

	Primary			Secondary				
	No. Samples	Average (ppm)	C.V.*	No. Samples	Average (ppm)	C.V.*		Water Quality Standard (2)
BOD	7	372	-	6	131	-		
S. Solids	7	506	0.55	6	168	0.74		
D. Solids	7	210	0.26	6	172	0.40		500
NH_3-N	12	10.9	0.46	9	5.3	0.38		< 2.0
NO_2-N	12	0	0	9	0	0	)	10
NO_3-N	12	0.52	0.76	9	0.93	0.79	)	
CI	12	38.1	0.11	9	33.9	0.12		250
CU	12	0.47	0.35	9	0.24	0.55		< 0.20
Fe	12	1.97	0.19	9	1.08	0.38		-
Mn	11	0.08	0.37	8	0.03	0.45		-
PO_4	12	4.23	0.19	9	1.93	0.25		-
SO_4	12	14.1	0.17	9	10.6	0.14		250
Na	12	33.9	0.06	9	28.5	0.09		< 2.0
Zn	12	1.33	0.22	9	0.70	9.49		< 0.30

* C.V. = $S/\overline{X}$

TABLE XII

1973 BNL ENVIRONMENTAL MONITORING
MONTHLY DOWNSTREAM AND CONTROL WATER SAMPLES

GROSS BETA (pCi/l or 10^{-9} μCi/ml)

	Downstream Locations					Control Locations		
Month	A	B	C	D	R* †	E	F	H
Jan.	9.1	8.5	4.4	6.2	-	4.7	2.8	1.4
March	6.7	6.5	5.1	4.1	-	20.0	5.5	2.5
April	-	-	-	-	8.5	-	-	-
May	7.0	7.4	5.8	4.6	8.3	5.3	4.4	3.3
June	-	-	-	-	9.3	-	-	-
July	7.3	8.1	9.1	6.9	10.1	3.8	6.9	1.9
Aug.	-	-	-	-	10.4	-	-	-
Sept.	8.1	7.7	5.9	5.1	7.1	2.3	5.6	2.2
Oct.	-	-	-	-	7.8	-	-	-
Nov.	5.9	3.9	4.1	5.6	6.1	3.0	2.9	1.8
Dec.	-	-	-	-	8.1	-		-
Average	7.3±0.9	7.0±0.9	5.7±0.9	5.4±0.9	8.5±1.2	6.5±0.9	4.7±0.9	2.2±0.8

TRITIUM (nCi/l or 10^{-6} μCi/ml)

Jan.	2.7	2.1	1.4	0.9	-	< 0.5	< 0.5	< 0.5
March	12.9	6.0	1.8	1.4	-	< 0.5	< 0.5	< 0.5
April	-	-	-	-		< 0.5	< 0.5	< 0.5
May	1.4	1.2	0.7	< 0.5	0.7	< 0.5	< 0.5	< 0.5
June	-	-	-	-		< 0.5	< 0.5	< 0.5
July	0.7	0.8	0.6	< 0.5		< 0.5	< 0.5	< 0.5
Aug.	-	-	-	-		< 0.5	< 0.5	< 0.5
Sept.	1.6	0.9	< 0.5	< 0.5	0.8	< 0.5	< 0.5	< 0.5
Oct.	-	-	-	-		< 0.5	< 0.5	< 0.5
Nov.	0.8	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
Dec.	-	-	-	-	-	-	-	-
Average	3.3±0.5	1.9±0.4	0.8±0.4	0.7±0.4	0.8	< 0.5	< 0.5	< 0.5

Radiation Concentration Guide[3] : Gross Beta: 3,000 pCi/l** , HTO 3,000 nCi/l, ^{90}Sr 300 pCi/l.

† Riverhead - ^{90}Sr: 4/73-6/73 0.8 pCi/l, 7.73 - 9/73 0.9 pCi/l, 10/73-12/73 0.6 pCi/l.

* Average of weekly composite samples (April - November).

** For mixture of radionuclides containing <10% ^{90}Sr, $^{125-133}$I, and long-lived alpha emitters.

TABLE XIII

1973 BNL ENVIRONMENTAL MONITORING

CONCENTRATIONS OF ^{90}Sr AND SELECTED GAMMA-EMITTING NUCLIDES IN PECONIC RIVER SEDIMENTS*

Peconic River	^{90}Sr**	^{137}Cs	$^{137}Cs/^{90}Sr$	K	^{238}U†	^{232}Th††	U/Th
	pCi/kg			gm/kg	pCi/kg		
L	166	1,907	11.5	7.5	720	434	1.6
M	55	267	4.9	4.4	546	247	2.1
Q	58	1,247	21.7	3.5	426	277	1.5
A	29	510	17.8	4.6	477	247	1.9
B	24	1,703	70.1	5.9	812	446	1.8
C	46	609	13.2	3.3	661	418	1.6
D	97	909	9.4	3.0	440	262	1.7
R	83	216	2.6	1.6	242	172	1.6
Reference							
E Upstream Peconic	24	201	8.4	3.2	280	156	1.8
F N. Trib. Peconic	26	657	25.0	2.7	245	123	2.0
Estimated error at 95% Confidence Level							
	±20% or 10	± 10% or 100		±0.5	±25%	±25%	

*Dry weight.

**^{90}Sr-^{90}Y equilibrium.

†Calculated from ^{204}Bi (1.76 MeV)

††Calculated from ^{208}Tl (2.62 MeV)

TABLE XIV

1973 BNL ENVIRONMENTAL MONITORING

CONCENTRATIONS OF ^{90}Sr AND SELECTED GAMMA-EMITTING NUCLIDES IN PECONIC RIVER VEGETATION*

Station Peconic	^{7}Be	^{58}Co	^{60}Co	^{90}Sr**	^{106}Ru	^{131}I	^{137}Cs	K	$^{137}Cs/^{90}Sr$
	(pCi/kg or 10^{-9} µCi/gm)							(gm/kg)	
L	773	58	<50	150	<100	<50	1,109	2.49	7.4
M	717	<50	252	183	735	54	381	2.80	2.1
Q	879	"	274	40	<100	57	528	2.50	13.2
A	660	"	<50	341	355	<50	494	2.02	1.4
B	559	"	"	703	174	"	453	1.49	6.4
C	364	"	"	127	<100	"	437	3.35	3.4
D	847	"	"	591	"	"	249	3.57	0.4
R	661	"	"	N.A.	"	"	102	4.90	-
Reference									
E Upstream	402	"	"	112	"	"	402	1.60	3.6
F N. Tributary	405	"	"	405	"	"	405	1.54	1.0
Estimated error at 95% Confidence Level									
	±10%	±50	±50	±50	±100	±50	±10% or ±50	±0.25	-

*Wet weight. Analyses were made on dried samples and these data adjusted on the basis of an assumed 90% moisture content.

**^{90}Sr-^{90}Y equilibrium.

TABLE XV

1973 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES
IN ANIMALS OBTAINED FROM THE PECONIC RIVER

Number	Station	^{60}Co (pCi/kg or 10^{-9} μCi/gm)	^{106}Ru (pCi/kg or 10^{-9} μCi/gm)	^{137}Cs (pCi/kg or 10^{-9} μCi/gm)	K (gm/kg)
Perch					
1	Q	< 50	1110	772	N.A.
Catfish					
1	Q	< 50	703	1355	N.A.
Frogs					
2	L	< 50	261	434	1.9
2	M	< 50	< 100	446	N.A.
1	Q	< 50	< 100	319	1.9
Garter Snake					
1	L	< 50	< 100	1569	N.A.
Water Snake					
1	M	< 50	938	1064	N.A.
Box Turtles					
2	M	< 50	< 100	7258	N.A.
Eastern Painted Turtles					
1	L	< 50	< 100	1332	1.1
1	M	< 50	< 100	3345	1.5
1	A	< 50	748	854	N.A.
Estimated Error at 95% Confidence Level		±50	±25	±10	±0.25
Radiation Concentration Guide (3)		$2x10^6$	$4x10^5$	$9x10^5$	

† Assumed intake of 50 gms/day, see text p. 23
* Live weight.
** Tentative identification.

TABLE XVI

1973 BNL ENVIRONMENTAL MONITORING
GROSS BETA AND TRITIUM CONCENTRATIONS
IN POTABLE WATER SUPPLY WELLS

GROSS BETA (pCi/l or $10^{-9}\mu Ci/ml$)

Well #	1	2	3	4	5	6	7	101	102	103	104	105	W&R
Jan.	2.0	2.3	2.0	2.0	2.1	1.7	1.4	1.2	< 1.0	< 1.0	-	-	0.7
March	2.7	1.4	0.3	2.6	4.7	0.7	1.3	2.8	2.2	1.5	3.2	2.5	1.5
June	1.2	1.3	3.0	1.9	1.1	2.5	1.2	1.4	2.0	1.4	2.9	2.8	1.6
July	1.2	2.2	3.6	1.5	1.2	2.3	3.3	1.8	1.6	2.0	1.9	4.7	1.5
Aug.	-	-	-	-	-	-	-	-	-	-	-	-	-
Sept.	3.2	2.8	5.2	1.1	3.1	3.8	1.9	2.8	2.7	2.9	4.4	6.1	3.0
Oct.	-	-	-	-	-	-	-	-	-	-	0	-	-
Nov.	-	-	-	-	-	-	-	-	-	-	0	-	-
Dec.	0.8	2.7	3.5	2.7	< 1.0	1.8	< 1.0	1.3	1.5	0	0	3.5	1.2
Average	1.9±0.8	2.1±0.8	3.3±0.8	2.3±0.8	2.1±0.7	1.8±0.8	2.0±0.5	1.9±0.8	1.7±0.6	1.3±0.5	3.1±0.9	3.9±1.0	1.6±0.7

Radiation Concentration Guide: 3,000 pCi/l or $3.0 \times 10^{-6}\mu Ci/ml$ (for unidentified nuclides in the absence of ^{90}Sr, ^{226}Ra, ^{228}Ra or ^{129}I).

^{3}H (nCi/l or $10^{-6}\mu Ci/ml$)

Jan.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	-	< 0.5
March	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.7±0.5	< 0.5	< 0.5
May	-	-	-	-	-	-	-	-	-	-	-	-	-
June	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5±0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5±0.5	0.5±0.5
July	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Aug.	-	-	-	-	-	-	-	-	-	-	-	-	-
Sept.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Oct.	-	-	-	-	-	-	-	-	-	-	< 0.5	-	-
Nov.	-	-	-	-	-	-	-	-	-	-	< 0.5	-	-
Dec.	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.2±1.0	< 0.5	< 0.5	< 0.5

Radiation Concentration Guide: 3,000 nCi/l or $3.0 \times 10^{-3}\mu Ci/ml$.

^{90}Sr (pCi/l or 10^{-9} $\mu Ci/ml$)

Yearly Composite	0.2 ±0.1	0.3 ±0.1	0.5 ±0.1	0.3 ±0.1	0.4 ±0.1	0.1 ±0.1	0.3 ±0.1	0.3 ±0.1	0.3 ±0.1	0.3 ±0.1	0.6 ±0.2	0.7 ±0.2	0.8 ±0.2

Radiation Concentration Guide: 300 pCi/l or 3.0×10^{-7} $\mu Ci/ml$.

TABLE XVII

1973 BNL ENVIRONMENTAL MONITORING
MONTHLY SUMP SAMPLES
GROSS BETA AND ^{3}H CONCENTRATIONS

GROSS BETA (pCi/l or 10^{-9} μCi/ml)

	N North of AGS		O East of HIRDL		P Medical	
Month	No. of Samples	Conc.	No. of Samples	Conc.	No. of Samples	Conc.
Jan.	4	35.4	3	2.8	2	3.1
Feb.	3	5.3	3	2.8	3	2.5
March	3	4.8	4	2.6	4	2.8
April	3	8.2	4	2.9	3	3.1
May	3	12.2	3	2.3	3	2.4
June	3	2.7	3	2.9	3	2.6
July	5	2.4	5	2.5	5	2.6
Aug.	5	7.2	5	1.7	5	2.9
Sept.	3	2.7	3	6.5	3	2.9
Oct.	2	5.3	2	2.1	2	3.2
Nov.	3	5.3	4	2.6	4	3.9
Dec.	2	2.7	2	3.0	2	2.1
Total	39		41		39	
Weighted Average		10.3±1.0		2.8±0.8		2.8±0.8

Radiation Concentration Guide[3]: 3,000 pCi/l or 3×10^{-6} μCi/ml, if $^{125\text{-}133}I$, ^{90}Sr and alpha emitters absent.

TRITIUM (nCi/l or 10^{-6} μCi/ml)

Jan.	4	< 0.5	3	< 0.5	2	0.5
Feb.	3	< 0.5	3	< 0.5	3	< 0.5
March	3	< 0.5	4	< 0.5	4	< 0.5
April	3	< 0.5	4	< 0.5	3	0.6
May	3	0.7	3	< 0.5	3	< 0.5
June	3	0.6	3	< 0.5	3	< 0.5
July	5	< 0.6	5	< 0.6	5	< 0.6
Aug.	5	< 0.7	5	< 0.7	5	< 0.7
Sept.	3	< 0.6	3	0.7	3	< 0.6
Oct.	2	< 0.7	2	< 0.7	2	< 0.7
Nov.	3	< 0.5	4	< 0.5	4	0.5
Dec.	2	< 0.5	2	< 0.5	2	< 0.5
Total	39		41		39	
Weighted Average		< 0.6		< 0.6		< 0.6

Radiation Concentration Guide[3]: 3,000 nCi/l or 3×10^{-3} μCi/ml

TABLE XVIII

1973 BNL ENVIRONMENTAL MONITORING
SAND FILTER BEDS AND PECONIC RIVER AREA GROUND WATER SURVEILLANCE WELLS
GROSS ALPHA, GROSS BETA, TRITIUM, ^{90}Sr AND ^{137}Cs AVERAGE CONCENTRATIONS

Well	Sample No.	Gross α (pCi/l or $10^{-9}\mu$Ci/ml)	Gross β (pCi/l or $10^{-9}\mu$Ci/ml)	^{3}H* (nCi/l or $10^{-6}\mu$Ci/ml)	^{90}Sr** (pCi/l or $10^{-9}\mu$Ci/ml)	^{137}Cs** (pCi/l or $10^{-9}\mu$Ci/ml)
SA	2	0.22 ± 0.14	2.9 ± 0.3	0.25 ± 0.10	-	<0.5
SB	1	<0.20	0.7 ± 0.6	<0.50	-	<0.5
SC	2	<0.20	<0.7	<0.50	<0.2	<0.5
SD	3	<0.20	0.8 ± 0.70	<0.60	-	-
SE	2	<0.20	4.1 ± 1.0	<0.50	-	<0.5
SG	2	<0.20	1.3 ± 0.6	<0.50	-	-
XA	5	0.20 ± 0.10	11.8 ± 1.2	15.20 ± 0.80	3.8	<0.5
X-1	3	<0.20	2.0 ± 0.7	0.27 ± 0.11	<0.2	<0.5
XB	6	0.41 ± 0.23	3.6 ± 0.8	0.38 ± 0.12	<0.2	<0.5
X-2	3	<0.20	1.0 ± 0.6	2.70 ± 0.62	<0.1	<0.5
XC	5	0.43 ± 0.22	7.1 ± 1.0	0.31 ± 0.11	2.9	<0.5
XD	5	<0.20	0.4 ± 0.3	0.21 ± 0.10	<0.2	<0.5
XE	5	2.13 ± 1.45	1.6 ± 0.7	0.41 ± 0.13	0.3	0.8
XG	6	0.48 ± 0.24	6.0 ± 1.0	0.96 ± 0.37	0.7	<0.5
XH	4	<0.20	1.2 ± 0.6	0.64 ± 0.25	<0.2	<0.5
XI	3	<0.20	3.0 ± 0.8	0.22 ± 0.10	0.5	<0.5
XJ	4	0.31 ± 0.17	6.3 ± 0.9	0.18 ± 0.10	1.4	0.7
XK	6	0.66 ± 0.40	16.4 ± 1.5	8.84 ± 0.83	3.4	<0.5
XL	3	2.46 ± 0.76	34.3 ± 2.0	2.61 ± 0.62	7.5	0.6
XM	5	0.43 ± 0.27	43.9 ± 2.2	9.01 ± 0.85	8.5	3.3
XN	6	3.26 ± 0.72	8.4 ± 1.1	0.48 ± 0.15	0.8	<0.5
XO	6	0.48 ± 0.27	9.9 ± 1.1	0.73 ± 0.25	3.1	<0.5
XP	1	<0.20	0.8 ± 0.7	0.22 ± 0.10	<0.2	<0.5
XQ	4	<0.20	4.6 ± 0.9	1.45 ± 0.39	<0.2	<0.5
XR	3	0.53 ± 0.27	3.2 ± 0.8	0.25 ± 0.10	0.5	<0.5
XS	3	1.21 ± 0.46	13.0 ± 1.3	0.49 ± 0.15	1.6	-
XT	4	<0.20	2.5 ± 0.9	0.21 ± 0.10	<0.2	<0.5
XU	2	0.24 ± 0.14	7.3 ± 1.0	0.42 ± 0.13	0.7	<0.5
XV	2	<0.20	44.7 ± 2.2	0.59 ± 0.18	<0.2	<0.5
XW	3	<0.20	3.2 ± 0.8	0.39 ± 0.12	<0.2	<0.5
XX	5	<0.20	12.7 ± 1.3	8.46 ± 3.08	3.8	<0.5
XY	4	<0.20	11.8 ± 1.2	7.20 ± 0.65	0.7	<0.5
XZ	4	<0.20	1.4 ± 0.6	0.56 ± 0.18	<0.2	<0.5
Radiation Concentration Guide(3)		100†	3,000††	3,000	300	2×10^4

*^{3}H concentrations less than 1.00 nCi/l established after electrolytic enrichment of one sample during 1973.

**^{90}Sr and ^{137}Cs concentrations established from assay of one sample during year if number of gross beta samples ≤ 3, of two samples, if number of gross beta samples ≥ 4.

†If ^{129}I, ^{226}Ra and ^{220}Ra absent.

††If $^{125\text{-}133}I$, ^{90}Sr and alpha emitters absent.

TABLE XIX

1973 BNL ENVIRONMENTAL MONITORING
SOLID WASTE DISPOSAL AREA, LANDFILL AND DUMP AREA, AND 650 SUMP
GROSS ALPHA, GROSS BETA, TRITIUM, ^{90}Sr AND ^{137}Cs AVERAGE CONCENTRATIONS

Well	Sample No.	Gross α (pCi/1 or 10^{-9}μCi/ml)	Gross β (pCi/1 or 10^{-9}μCi/ml)	^{3}H* (nCi/1 or 10^{-6}μCi/ml)	^{90}Sr** (pCi/1 or 10^{-9}μCi/ml)	^{137}Cs** (pCi/1 or 10^{-9}μCi/ml)
WB	4	0.56 ± 0.33	60.1 ± 2.3	3.07 ± 0.30	6.4	1.0
WC	4	0.51 ± 0.34	31.3 ± 1.9	2.63 ± 0.60	3.8	<0.5
WD	4	0.42 ± 0.26	36.6 ± 2.0	4.95 ± 0.64	7.9	0.6
WE	4	<0.20	11.3 ± 1.2	0.68 ± 0.37	3.0	<0.5
WF	2	<0.20	1.9 ± 0.7	0.30 ± 0.15	0.2	<0.5
WG	2	0.20 ± 0.15	0.8 ± 0.4	0.28 ± 0.15	<0.2	<0.5
WH	4	0.18 ± 0.13	3.7 ± 0.7	<0.5	2.1	0.5
WI	4	1.38 ± 1.06	28.2 ± 1.4	0.35 ± 0.13	<0.2	<0.5
WJ	2	<0.20	5.3 ± 0.4	1.06 ± 0.35	0.8	<0.5
WK	4	0.28 ± 0.19	56.3 ± 2.4	0.71 ± 0.38	15.7	<0.5
WL	4	<0.20	112.1 ± 3.2	1.60 ± 0.45	62.9	<0.5
WM	3	<0.20	8.3 ± 1.0	2.25 ± 0.55	0.9	<0.5
WN	3	<0.20	2.0 ± 0.7	0.45 ± 0.25	<0.2	<0.5
WO	3	<0.20	1.9 ± 0.8	0.15 ± 0.10	<0.2	<0.5
WP	3	<0.20	3.6 ± 0.6	1.60 ± 0.44	0.4	<0.5
WQ	4	<0.20	3.4 ± 0.7	1.42 ± 0.39	0.8	<0.5
WR	3	2.56 ± 1.48	44.8 ± 2.5	93.5 ± 1.4	0.9	-
WS	3	0.55 ± 0.51	8.0 ± 1.4	28.9 ± 1.0	<0.2	<0.5
WT	4	4.11 ± 2.65	1.7 ± 0.7	0.81 ± 0.30	<0.2	<0.5
WU	4	<0.20	1.4 ± 0.7	0.30 ± 0.13	<0.2	-
WV	4	<0.20	1.5 ± 0.8	0.15 ± 0.15	<0.20	<0.5
WW	4	<0.20	2.7 ± 0.9	0.36 ± 0.13	<0.2	<0.5
WX	4	<0.20	2.4 ± 0.8	0.23 ± 0.12	<0.2	<0.5
WZ	4	0.24 ± 0.16	3.1 ± 0.9	0.37 ± 0.13	<0.2	<0.5
W1	2	<0.20	110.2 ± 3.2	0.61 ± 0.35	43.3	<0.5
W2	2	<0.20	10.7 ± 1.2	0.56 ± 0.28	1.8	<0.5
W3	2	<0.20	1.1 ± 0.4	0.28 ± 0.15	<0.2	0.6
W4	2	<0.20	4.2 ± 0.9	0.44 ± 0.26	<0.2	<0.5
W5	2	<0.20	5.0 ± 0.9	0.54 ± 0.28	<0.2	<0.5
W6	2	1.64 ± 1.45	7.1 ± 1.5	0.47 ± 0.25	0.2	<0.5
W7	3	<0.20	2.8 ± 0.9	0.67 ± 0.37	0.2	<0.5
W8	3	<0.20	5.8 ± 1.1	0.32 ± 0.17	<0.2	<0.5
W9	3	1.23 ± 0.69	9.4 ± 1.3	87.10 ± 1.62	0.3	1.6
1A	2	<0.20	50.2 ± 2.3	<0.50	32.2	<0.5
1B	2	<0.20	3.1 ± 0.9	<0.50	1.1	<0.5
1C	2	<0.20	1.9 ± 0.8	<0.50	-	<0.5
1D	2	<0.20	1.7 ± 0.8	<0.50	0.2	<0.5
1E	2	0.19 ± 0.14	105.0 ± 3.0	<0.50	-	-
1F	3	<0.20	32.1 ± 1.5	0.43 ± 0.26	<0.2	-
1G	2	<0.20	1.8 ± 0.7	0.57 ± 0.28	0.4	<0.5
1H	2	<0.20	91.0 ± 3.0	0.42 ± 0.25	30.8	<0.5
1I	3	<0.20	1.3 ± 0.7	0.30 ± 0.13	-	<0.5
1J	3	0.41 ± 0.25	11.8 ± 1.2	4.00 ± 0.60	4.2	<0.5
1K	3	5.37 ± 0.90	14.5 ± 1.5	30.00 ± 1.1	0.5	0.5
Radiation Concentration Guide[3]		100†	3,000††	3,000	300	2×10^4

* ^{3}H concentrations less than 1.00 nCi/l established after electrolytic enrichment of one sample during 1973.

** ^{90}Sr and ^{137}Cs concentrations established from assay of one sample during year if number of gross beta samples ≤ 3, of two samples, if number of gross beta samples ≥ 4.

† If ^{129}I, ^{226}Ra and ^{220}Ra absent.

†† If $^{125\text{-}133}I$, ^{90}Sr and alpha emitters absent.

TABLE XX

1973 BNL ENVIRONMENTAL MONITORING
UPLAND RECHARGE EXPERIMENT SURVEILLANCE WELLS
GROSS ALPHA, GROSS BETA AND TRITIUM CONCENTRATIONS

Well	No. Samples	Gross α (pCi/l or 10^{-9} μCi/ml)	Gross β (pCi/l or 10^{-9} μCi/ml)	^{3}H (nCi/l or 10^{-6} μCi/ml)
1M	6	0.57±0.35	4.0±1.3	< 0.50
1N	6	< 0.20	3.3±1.2	< 0.50
1O	8	< 0.20	5.1±2.4	< 0.50
1P	8	< 0.20	3.7±1.9	< 0.50
1Q	6	< 0.20	3.2±2.3	< 0.50
1R	6	< 0.20	8.6±1.9	< 0.50
1S	7	< 0.20	3.7±1.6	< 0.50
1T	8	< 0.20	3.7±1.7	1.81±0.50
1U	8	5.15±1.75	14.4±1.4	< 0.50
1V	8	0.91±0.45	5.2±2.4	< 0.50
1W	8	< 0.20	3.4±2.3	0.45±0.20
1X	8	< 0.20	3.4±2.3	< 0.50
1Y	8	< 0.20	< 3.3	0.79±0.38
1Z	8	< 0.20	< 3.1	< 0.50
11	8	< 0.20	< 3.7	< 0.50
12	8	< 0.20	< 3.4	1.56±0.45
13	4	< 0.20	< 4.2	< 0.50
14	4	< 0.20	4.1	6.63±0.66
15	4	< 0.20	7.4	0.73±0.30
Radiation Concentration Guide[3]:		100*	3,000**	3,000

*If long-lived alpha emitters not present.

**If ^{90}Sr, $^{125-133}I$ not present.

TABLE XXI-A

1973 BNL ENVIRONMENTAL MONITORING

SAND FILTER BEDS AND PECONIC RIVER GROUND WATER WELLS , WATER QUALITY AND PURITY

	pH		Chlorides		Coliforms		Conductivity		Dissolved Oxygen		Dissolved Solids		Nitrate-Nitrogen		Total Phosphorus	
Well	No. Samples	Average	No. Samples	Average (ppm)	No. Samples	Average (#/100)	No. Samples	Average (µmho/cm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)
SA	1	5.6	1	44.8	0	-	1	192	1	6.2	1	111	1	0.50	1	0.07
SB	1	5.8	1	6.2	0	-	1	38	1	6.2	1	33	1	0.10	10	-
SC	1	5.6	1	5.4	0	-	1	50	1	7.8	1	34	1	0.10	1	0.10
SD	6	6.0	1	5.8	0	-	6	46	6	9.4	5	29	3	0.10	0	-
SE	2	6.4	1	28.1	0	-	1	191	2	8.1	1	110	1	1.60	1	0.08
SG	2	6.2	1	10.9	0	-	1	97	2	6.5	1	57	1	0.57	0	-
XA	11	6.1	2	24.2	0	-	11	171	11	7.6	5	114	3	3.70	1	0.10
XB	3	6.2	2	6.3	0	-	3	69	3	4.0	3	59	3	0.10	0	-
XC	9	5.7	2	5.8	0	-	9	56	9	6.5	5	38	2	0.10	0	-
XD	3	5.8	2	4.3	0	-	3	39	3	6.0	3	28	3	0.10	0	-
XE	7	5.4	2	8.6	0	-	7	59	7	8.9	5	45	2	0.15	0	-
XG	10	5.7	3	10.6	0	-	10	94	10	4.2	7	67	5	0.41	3	0.07
XH	7	6.3	2	5.7	0	-	6	44	7	12.2	3	27	2	0.10	0	-
XI	1	5.5	0	-	0	-	1	47	1	6.4	1	36	1	0.10	0	-
XJ	7	5.5	1	5.3	0	-	7	43	7	7.7	4	31	1	0.20	0	-
XK	10	6.1	3	18.0	0	-	10	154	10	2.7	7	98	5	0.21	4	0.16
XL	4	6.4	1	13.7	0	-	4	127	4	4.3	2	72	2	0.21	1	0.07
XM	10	5.6	3	24.4	1	12	10	133	10	7.9	7	89	5	0.77	4	0.16
XN	7	4.7	2	7.3	0	-	7	52	7	5.4	4	73	2	1.52	1	0.11
XP	0	-	1	6.4	0	-	0	-	0	-	0	-	0	-	0	-
XQ	8	6.2	2	21.3	0	-	7	134	7	3.4	5	86	3	0.10	1	0.06
XR	5	5.6	1	4.1	0	-	4	48	5	6.8	2	27	1	0.10	0	-
XS	6	5.7	1	14.6	0	-	5	100	6	4.1	1	61	2	0.10	0	-
XT	5	6.9	2	7.4	0	-	3	141	5	4.3	3	99	2	0.10	2	0.17
XW	2	5.0	1	48.1	0	-	2	128	2	1.4	2	91	2	0.65	0	-
XX	8	5.5	2	11.9	1	10	7	95	7	3.3	5	67	3	0.20	0	-
XY	5	5.4	2	15.4	0	-	5	88	5	3.2	4	56	4	0.17	0	-
X2	4	5.8	2	7.0	0	-	4	89	4	6.2	4	36	3	0.10	0	-
X1	3	5.1	2	6.4	0	-	3	44	3	7.9	3	32	2	0.10	0	-
X2	3	5.6	2	28.9	0	-	2	135	3	3.3	3	81	2	0.30	0	-
Est. error:		±0.3		± 5%		± 25%		± 10%		±0.5		± 10%		±0.10		±0.10
Water Quality Standard[5]		6.5 to 8.5		500	-	-	-	-	-	-	-	1,000	-	20.0	-	-

TABLE XXI-B

1973 BNL ENVIRONMENTAL MONITORING

SOLID WASTE PACKAGING AREA, LANDFILL AND DUMP AREA, 650 SUMP GROUND WATER WELLS, WATER QUALITY AND PURITY

Well	pH		Chlorides		Coliforms		Conductivity		Dissolved Oxygen		Dissolved Solids		Nitrate-Nitrogen		Total Phosphorus	
	No. Samples	Average	No. Samples	Average (ppm)	No. Samples	Average (#/100)	No. Samples	Average (μmho/cm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)	No. Samples	Average (ppm)
WA	1	6.5	0	-	0	-	1	82	1	12.9	0	-	0	-	0	-
WB	2	5.2	1	20.7	0	-	2	131	2	6.9	2	78	1	1.08	1	2.00
WC	1	3.9	1	23.7	0	-	1	130	1	4.4	1	78	1	1.22	0	-
WD	1	3.6	1	19.5	0	-	1	138	1	6.6	1	91	1	0.89	0	-
WE	2	5.5	1	4.1	0	-	1	49	1	8.6	1	54	1	0.13	0	-
WF	4	6.1	1	6.6	0	-	4	56	4	10.7	3	39	1	0.10	1	0.12
WG	2	5.7	1	6.1	0	-	2	70	2	8.5	1	43	1	0.75	1	0.10
WH	6	5.2	1	5.9	0	-	6	99	6	8.2	4	69	3	1.01	0	-
WI	1	5.6	1	3.3	0	-	1	64	1	7.2	1	54	1	0.25	0	-
WK	2	5.4	2	14.8	1	3	2	102	2	6.9	2	70	1	0.52	0	-
WL	2	5.7	2	4.0	1	3	2	70	2	9.2	2	48	2	0.55	0	-
WM	1	6.1	1	6.5	0	-	1	153	1	7.2	1	102	1	1.95	0	-
WN	1	5.8	1	6.2	0	-	1	105	1	7.8	1	67	1	1.10	0	-
WO	6	5.9	1	7.2	0	-	6	55	6	9.8	3	33	2	0.20	0	-
WP	7	5.5	1	9.1	0	-	7	109	7	1.5	3	70	3	4.33	0	-
WQ	7	5.9	1	6.7	0	-	7	114	7	1.5	3	63	3	2.55	0	-
WR	5	7.1	2	10.4	0	-	5	832	4	3.2	3	578	2	0.60	0	-
WS	4	6.6	2	22.0	0	-	4	645	3	5.8	3	412	2	0.10	0	-
WT	4	N.A.	3	8.0	0	-	4	66	4		3	40	3	0.10	1	0.06
WU	2	5.9	1	7.7	0	-	2	54	2	11.2	2	46	2	0.10	1	0.05
WV	2	5.7	1	5.9	0	-	2	48	2	10.5	2	39	2	0.10	0	-
WW	2	5.6	1	9.8	0	-	2	88	2	9.5	2	53	2	0.43	0	-
WX	2	5.9	1	11.1	0	-	2	82	2	8.3	2	64	2	0.51	0	-
WZ	6	6.1	1	73.0	0	-	6	83	6	8.1	4	56	3	0.10	1	0.07
W1	1	5.7	1	4.1	0	-	1	68	1	9.2	1	30	1	0.38	0	-
W6	1	7.0	1	14.7	1	8	1	400	1	0.8	1	236	1	0.10	0	-
W7	3	6.0	2	7.7	0	-	2	93	3	9.1	2	51	2	0.82	0	-
W8	3	5.7	2	6.1	0	-	3	77	3	10.8	2	39	2	0.10	0	-
W9	3	6.4	3	47.1	0	-	3	502	2	2.0	3	167	3	0.25	0	-
1A	2	6.3	1	18.4	0	-	2	64	2	6.1	1	70	1	0.65	1	0.07
1B	1	6.4	1	15.5	0	-	1	107	1	7.8	1	69	1	0.48	0	-
1C	1	6.4	1	19.9	0	-	1	71	1	9.0	0	-	1	0.60	0	-
1D	1	6.4	1	16.7	0	-	1	108	1	7.0	1	67	1	0.36	0	-
1E	2	6.0	1	18.5	0	-	2	103	2	7.7	1	71	1	0.65	0	-
1F	2	6.3	1	17.0	0	-	2	107	2	8.5	1	71	1	0.40	0	-
1G	2	6.5	1	21.0	0	-	2	115	2	8.6	1	72	1	0.40	0	-
1H	1	5.9	0	-	0	-	1	80	1	8.8	0	-	0	-	0	-
1I	3	6.0	2	5.9	0	-	3	47	3	11.7	2	36	1	0.10	0	-
1J	3	5.0	2	9.4	0	-	3	159	3	6.6	2	65	2	4.20	0	-
1K	3	6.6	3	42.6	0	-	3	375	3	4.2	3	206	2	0.15	0	-
Est. error:		±0.3		± 5%		± 25%		± 10%		±0.5		± 10%		±0.10		±0.10
Water Quality Standard(5)		6.5 to 8.5		500	-	-	-	-	-	-	-	1,000	-	20.0	-	-

TABLE XXI - C

1973 BNL ENVIRONMENTAL MONITORING

GROUND WATER SURVEILLANCE WELLS, WATER QUALITY - HEAVY METALS

Area	Well	Sample Date	Ag (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Pb (ppm)	Zn (ppm)
Sand Filter Beds									
	XA	10/30	<0.02	<0.02	<0.02	<0.02	0.04	<0.2	0.2
	XE	10/30	"	"	"	"	0.08	"	0.5
	XG	10/31	"	"	"	"	11.0	"	0.6
	XK	10/31	"	"	"	"	2.0	"	0.9
Peconic Downstream On-site and Perimeter	XM	11/2	<0.02	<0.02	<0.02	<0.02	0.18	<0.2	0.9
	XN	11/2	"	"	"	"	8.0	"	1.5
	XO	11/2	"	"	"	"	0.02	"	0.5
	XQ	11/1	"	"	"	"	8.0	"	0.3
	XX	11/1	"	"	"	"	0.80	"	0.2
Landfill and Dump Area	WF	9/13	<0.02	<0.02	<0.02	<0.02	0.04	<0.2	0.3
	WG	9/13	"	"	"	"	4.0	"	0.4
	WO	9/14	"	"	"	"	1.2	"	4.4
	WP	9/14	"	"	"	"	5.0	"	0.6
	WQ	9/14	"	"	"	"	5.0	"	1.7
	WR	9/13	"	"	"	"	32.0	"	0.1
	WS	9/13	"	"	"	"	86.0	"	0.3
	WT	9/13	"	"	"	"	0.02	"	2.5
	W9	9/13	"	"	"	"	11.0	"	1.6
	1F	9/12	"	"	"	"	1.6	"	0.4
	1K	9/13	"	"	"	0.02	50.0	"	1.9
Limit of Detection			0.02	0.02	0.02	0.02	0.02	0.2	0.004
Water Quality Standard[5]			0.10	0.02	0.10	0.40	0.60	0.10	0.60

TABLE XXII

1973 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF ^{90}Sr, ^{131}I, ^{137}Cs and K IN MILK

Month	FARM C - 10 km SE				FARM H - 40 km E			
	^{90}Sr**	^{131}I	^{137}Cs	K	^{90}Sr**	^{131}I	^{137}Cs	K
	(pCi/l or 10^{-9}µCi/ml)			gm/l	(pCi/l or 10^{-9}µCi/ml)			gm/l
January	12	< 5	9	1.2	7	-	-	-
April	10	< 5	7	1.4	7	< 5	9	1.4
July	18	N.A.	N.A.	N.A.	8	N.A.	N.A.	N.A.
October †	(19)	< 5	N.A.	N.A.	(8)	< 5	< 5	N.A.
Average	15	< 5	8	1.3	8	< 5	< 7	1.4
Estimated Error at 90% Confidence	± 1	± 5	± 5	± 0.2	± 1	± 5	± 5	± 0.2
Concentration Guide (3)	200*	100*	$4x10^4$	-	200*	100*	$4x10^4$	-

* Based on FRC Radiation Protection Guide[18] Range II upper limit, and on assumed intake of one liter per day.

** Quarterly data of New York State Department of Environmental Conservation[16].

† ( ) Tentative values, data for entire sampling period not available.

TABLE XXIII

1973 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES IN SOIL

Off-Site Location	Month	No. Samples	^{60}Co	^{65}Zn	^{137}Cs	^{144}Ce	U	Th	K
			----------pCi/kg or 10^{-9}			pCi/gm----------			gm/kg
Farm A	June	1	< 100	277	1,479	< 500	1,297	1,600	7.3
3 km NW	Sept.	1	"	< 100	872	< 500	2,240	1,180	11.6
Farm B	June	1	"	148	504	< 500	558	554	3.2
6 km SW	Sept.	1	"	262	542	1,180	1,320	1,260	8.1
Farm C	June	1	"	< 100	918	< 500	802	1,180	2.6
10 km SE	Sept.			N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Farm D	June			N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
15 km NW	Sept.	1	"	451	1,410	1,280	2,500	2,810	10.6
Farm H	June	1	"	< 100	611	< 500	726	724	4.7
6 km NE	Sept.			N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
On-Site Location									
Northwest Perimeter	June	1	"	< 100	699	< 500	1,280	1,280	6.8
Southwest Perimeter	June	1	"	N.A.	3,430	"	1,126	1,830	6.1
Southeast Perimeter	June	1	"	343	1,015	"	1,020	1,220	8.5
Northeast Perimeter	June	1	"	< 100	529	"	1,080	930	5.6
0.5 km NE HFBR	June	1	"	< 100	1,410	"	1,370	1,050	8.0
0.5 km SE HFBR	June	1	"	< 100	1,060	"	3,140	2,040	20.2
Waste Packaging Area	June	1	"	997	2,020	"	699	1,280	8.4
High Intensity Radiation Lab	June	10	819	< 100	1,290	"	1,290	1,401	8.8
Est. Error at 95% Confidence Level			±100	±100	±25	±500	±25	±25	±25

TABLE XXIV

1973 BNL ENVIRONMENTAL MONITORING
CONCENTRATIONS OF γ-EMITTING NUCLIDES IN GRASS

Off-Site Location	Month	No. Samples	^{7}Be	^{65}Zn	^{137}Cs	^{144}Ce	K
			pCi/kg				gm/kg
Farm A 3 km NW	June	1	-	-	-	-	-
Farm B 6 km SW	June	1	788	< 100	76	< 500	5.1
Farm C 10 km SE	June	1	-	-	-	-	-
Farm D 15 km NW	June	1	-	-	-	-	-
Farm H 6 km NE	June	1	1,780	< 100	53	422	3.9
On-Site							
Northwest Perimeter	June	1	-	-	-	-	-
Southwest Perimeter	June	1	443	-	70	-	2.5
Southeast Perimeter	June	1	-	-	-	-	-
Northeast Perimeter	June	1	528	-	56	-	2.7
Est. Error at 95% Confidence Level			±25%	±100	±50	±25%	±25%