BROOKHAVEN
NATIONAL
LABORATORY

SITE ENVIRONMENTAL REPORT 2000

Chapter 5

Water Quality

Some operations at BNL discharge, or have the potential to discharge, wastewater containing very low levels of radiological, organic, and/or inorganic contaminants. Monitoring ensures that these effluents comply with all applicable requirements, and that the public, employees, and environment are protected.

Analytical data for 2000 showed that the average gross alpha and beta activity levels in the Sewage Treatment Plant (STP) discharge were within the range typical of background surface waters. Tritium releases to the Peconic River continued to drop and were the lowest since monitoring began in 1966; 90% of the daily samples had tritium concentrations below the minimum detection limit. Cesium-137 was detected only once in the STP effluent during the year at less than 1% of the drinking water standard.

Non-radiological monitoring of the STP effluent showed that, with the exception of isolated incidents of noncompliance, organic and inorganic parameters were within State Pollutant Discharge Elimination System effluent limitations or other applicable standards. Inorganic data from the upstream, downstream, and control locations not affected by STP discharges demonstrated that elevated amounts of aluminum, silver, lead, iron, and zinc detected within the Peconic River are a result of natural geology. The low pH detected within several sections of the river was due to natural causes.

Based upon the 2000 nonradiological data, the Peconic River water quality is comparable to other local fresh water rivers and is of consistent quality both upstream and downstream of the BNL STP discharge. Radiological data for the year showed no impact from BNL operations downstream of the BNL site. Low concentrations of tritium were detected at the STP outfall, but only sporadic detections were found at the first monitoring station downstream. The maximum concentration downstream of the STP discharge was approximately 7% of the drinking water standard.

5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the BNL Sewage Treatment Plant (STP) is discharged into the headwaters of the Peconic River. This discharge is a New York State Department of Environmental Conservation permitted point source discharge. Effluent limits are based upon the water quality standards derived from the New York State Department of Environmental Conservation and historical operational data. To assess the impact of this discharge on the quality of the river, surface water monitoring is conducted at several locations upstream and downstream of the point of discharge. The Carmans River is monitored as a control location for comparative purposes as it is not affected by BNL operations.

To assess the true quality of Peconic River background water, BNL monitors a location upstream from all Laboratory operations. This sampling station (Station HY) is located onsite and just east of the William Floyd Parkway. During 1999, Station HY was monitored for radiological parameters only. In 2000, non-radiological monitoring was added to the sampling protocol for this station. Detailed information regarding BNL's sampling program is documented in the *BNL Environmental Monitoring Plan* (BNL 2000).

On the BNL site, the Peconic River is an intermittent stream. Offsite flow only occurs during periods of sustained precipitation, typically in the spring. Due to the very wet early summer in 2000 (see Figure 1-11), offsite flow was recorded from April through early September. Figure 5-1 shows one of the many spillways located throughout the Peconic River.

Figure 5-1. Peconic River Spillway between Donohue's Pond and Forge Pond.

The following sections describe BNL's surface water monitoring and surveillance program.

5.2 SANITARY SYSTEM EFFLUENTS

The STP outfall (Outfall 001) is a discharge point operated under a State Pollutant Discharge Elimination System (SPDES) permit. Figure 5-2 shows a schematic of the STP and STP sampling locations. The BNL STP treatment system includes: (1) primary clarification to remove settleable solids and floatable materials, (2) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, (3) secondary clarification, (4) intermittent sand filtration for final effluent polishing, and (5) ultraviolet disinfection for bacterial control prior to discharge to the Peconic River. During the aeration process, an oxygen minimizer causes the microorganisms to use nitrate-bound oxygen for respiration, liberating nitrogen gas and consequently reducing the concentration of nitrogen in the STP discharge. Nitrogen is an essential nutrient in biological systems that in high concentrations can cause excessive aquatic vegetation growth. Since aquatic vegetation utilizes oxygen during nighttime hours, too much plant life can deprive a water system of oxygen needed by fish and other aquatic organisms for survival. By reducing the concentration of nitrogen in the STP discharge, plant growth within the river remains in balance with the nutrients provided by natural sources. During 2000, the STP discharge continuously met the nitrogen limit of 10 mg/L specified in the SPDES permit.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity takes place at two locations: approximately 1.1 miles (1.8 km) upstream of the STP and just prior to the point where the influent enters the primary clarifier. The upstream station provides at least 30 minutes advance warning to the STP operator if wastewater that may exceed SPDES limits or BNL effluent release criteria were to enter the sewer system. In addition, effluent leaving the primary clarifier is monitored a third time for radioactivity. Any influent to the clarifier that does not meet SPDES limits or BNL effluent release criteria would be diverted to lined holding ponds. The total combined capacity of the two holding ponds exceeds 7,000,000 gallons (26.5 million liters) or approximately 12 days of flow. Diversion continues until the effluent's water quality meets the permit limits or release criteria. The requirements for treating the effluent diverted to the holding ponds are evaluated and, if necessary, the waste is treated and reintroduced into the STP at a rate that ensures compliance with SPDES permit limits or BNL effluent release criteria. In 2000, the STP influent was diverted on one occasion due to a false radiation alarm. Inspection of the monitoring system showed that an electrical surge was the most likely cause for a false positive reading at the upstream monitoring location.

Solids separated in the clarifiers are pumped to a digester where they are reduced in volume by anaerobic bacteria. Periodically a fraction of the sludge is emptied into a drying bed. The drying bed uses solar energy to dry the watery sludge to a semisolid cake. Since the dried sludge contains very low levels of radioactivity, it is containerized for offsite disposal at an authorized facility.

In 2000, BNL finalized plans for and began the next phase of STP upgrades. These upgrades include replacement of the anaerobic digester with a digester that uses aerobic organisms to degrade the sludge; upgrades to the pipe distribution system within the sand filters; relining of the holding ponds; and replacement, repair, or relining of approximately 9,000 linear feet (2.7 km) of sewer piping. One important component of the project is the upgrading and cleaning of the sanitary sewer system. Cleaning of the sewer system will remove most of the sludge containing low levels of radioactivity from historical operations, and repair/lining of the sewer lines will provide a liquid tight conduit to the STP, thus reducing leakage to soil or groundwater.

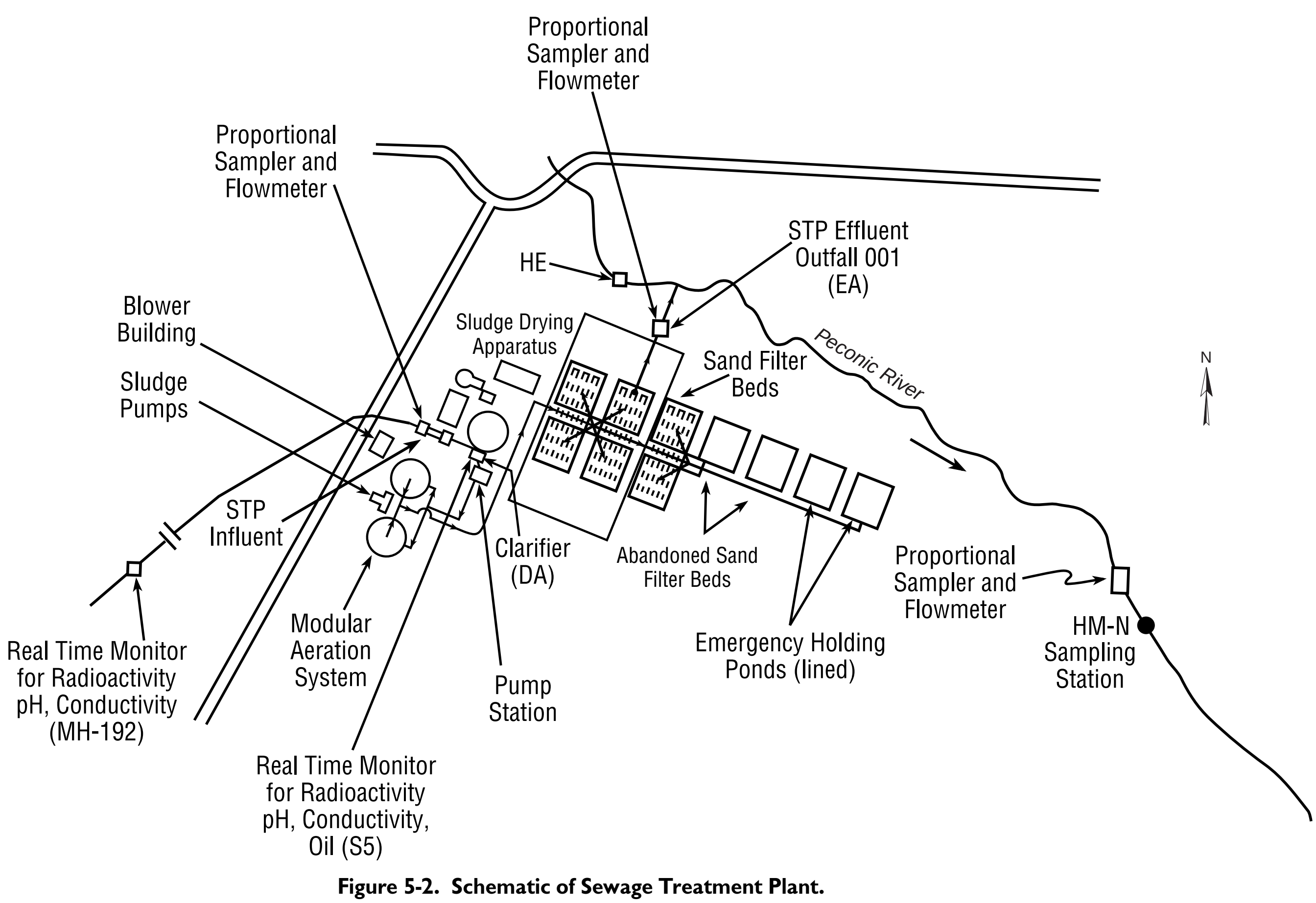

Figure 5-2. Schematic of Sewage Treatment Plant.

5.2.1 SANITARY SYSTEM EFFLUENT–RADIOLOGICAL ANALYSES

The STP effluent is sampled at the output of the primary clarifier (Station DA) and at the Peconic River Outfall (Station EA). At each location, samples are collected daily on a flow-proportional basis; that is, for every 1,000 gallons (3,780 L) of water treated, approximately 4 fluid ounces (125 ml) of sample are collected and composited into a 5-gallon (19-L) collection container. These samples are analyzed for gross alpha and gross beta activity and tritium concentrations. Samples collected from these locations are also analyzed for gamma-emitting radionuclides and strontium-90 on a monthly basis.

The Safe Drinking Water Act (SDWA) specifies that no individual may receive an annual dose greater than 4 mrem (40 μSv) per year from radionuclides present in drinking water. Although the Peconic River is not used as a direct source of potable water, BNL applies the stringent drinking water standards for comparison purposes, in lieu of DOE wastewater criteria. Under the SDWA, the annual average gross alpha activity limit is 15 pCi/L (0.6 Bq/L) (including radium-226, but excluding radon and uranium). The SDWA also stipulates a 50 pCi/L (1.85 Bq/L) gross beta activity screening level, above which radionuclide-specific analysis is required. BNL goes beyond this basic screening requirement by performing radionuclide-specific gamma analysis regardless of the gross beta activity. Other SDWA-specified drinking water limits are 20,000 pCi/L (740 Bq/L) for tritium and 8 pCi/L (0.3 Bq/L) for strontium-90. For all other radionuclides, Derived Concentration Guides (DCGs) found in DOE Order 5400.5 (DOE 1990), *Radiation Protection of the Public and the Environment,* are used to determine the concentration of the nuclide, which, if continuously ingested over a calendar year, would produce an effective dose equivalent (EDE) of 4 mrem (40 μSv).

Gross activity (alpha and beta) measurements were used as a screening tool for detecting the presence of radioactivity. Table 5-1 shows the monthly gross alpha and beta activity data and tritium concentrations for the STP influent and effluent during 2000. Annual average gross alpha and beta activity in the STP effluent has remained consistent with levels at control locations for many years. This continued to be the case in 2000. Annual average gross alpha and beta activity at the STP Outfall 001 was 2.0 ± 0.2 pCi/L (0.07 ± 0.01 Bq/L) and 9.5 ± 0.8 pCi/L (0.3 ± 0.03 Bq/L), respectively.

Tritium detected at the STP originates with either High Flux Beam Reactor (HFBR) sanitary system releases, or small, infrequent batch releases that meet BNL discharge criteria from other facilities. Tritium continues to be released from the HFBR at very low concentrations due to evaporative losses of primary coolant and condensation within the air conditioning units. A plot of the 2000 tritium concentrations recorded in the STP effluent is presented in Figure 5-3. A 10-year trend plot of annual average tritium concentrations measured in the STP discharge is shown in Figure 5-4. Annual average concentrations have been declining since 1995.

In 2000, the annual average tritium concentration as measured at the STP outfall (EA, Outfall 001) was 163 pCi/L (4.9 Bq/L). This value is below the average minimum detection limit (MDL) of 350 pCi/L (13.0 Bq/L). A total source term of 0.106 Ci (3.9 million Bq) of tritium was released during the year. This level is slightly less than the discharge recorded for 1999 and is the lowest annual release of tritium to the Peconic River observed since routine measurements began in 1966 (see Figure 5-5). Tritium was detected in only 10% of the daily samples collected at the STP discharge to the Peconic River. The maximum concentration of tritium was 1,900 pCi/L (71 Bq/L) that was detected in November. The increased levels of tritium detected in November were investigated and found to be associated with the HFBR. A definitive source could not be determined. Reduced concentrations of tritium are primarily the result of operations readying the HFBR for permanent closure. In 2000 most of the primary coolant, that has very high concentrations of tritium, was drained from the reactor and shipped offsite. The reactor was subsequently refilled with tap water. This significantly reduced the inventory of tritium at the HFBR. These levels will continue to decline as the HFBR moves into permanent decommissioning.

Table 5-2 presents the gamma spectroscopy analysis of the monthly STP composite samples for radionuclides. During

Table 5-1. Tritium and Gross Activity Results of Water at the Sewage Treatment Plant (CY 2000).

	Monthy Flow (Liters)	Tritium Maximum (pCi/L)	Tritium Average (pCi/L)	Gross Alpha Maximum (pCi/L)	Gross Alpha Average (pCi/L)	Gross Beta Maximum (pCi/L)	Gross Beta Average (pCi/L)
STP Clarifier							
January	5.33E + 07	363 ± 213	109 ± 45	6.3 ± 2.8	1.4 ± - 0.8	20.8 ± 6.4	9.6 ± 1.7
February	5.27E + 07	325 ± 218	117 ± 48	4.3 ± 2.2	1.4 ± - 0.6	73.1 ± 9.0	14.2 ± 6.3
March	6.24E + 07	445 ± 189	147 ± 44	3.6 ± 2.0	1.6 ± 0.5	14.5 ± 5.9	8.3 ± 1.2
April	5.65E + 07	305 ± 199	69 ± 51	3.4 ± 2.1	1.9 ± 0.5	15.2 ± 5.9	7.6 ± 1.4
May	6.05E + 07	2540 ± 326	225 ± 215	5.6 ± 2.9	1.1 ± 0.6	28.0 ± 6.8	8.7 ± 2.5
June	8.77E + 07	< 215	92 ± 56	4.0 ± 2.4	1.6 ± 0.6	13.4 ± 6.2	5.6 ± 1.5
July	6.51E + 07	< 293	161 ± 36	4.0 ± 2.4	1.6 ± 0.8	95.3 ±10.1	19.6 ± 10.2
August	8.05E + 07	35 ± 209	92 ± 47	4.0 ± 2.2	1.7 ± 0.6	45.5 ± 7.8	16.8 ± 3.6
September	7.88E + 07	< 261	60 ± 37	5.9 ± 2.6	1.8 ± 0.7	49.8 ± 7.8	13.4 ± 4.9
October	8.04E + 07	284 ± 181	69 ± 53	4.7 ± 2.3	1.8 ± 0.6	16.9 ± 5.7	11.3 ± 1.1
November	6.57E + 07	3350 ± 351	535 ± 360	7.3 ± 3.1	2.7 ± 0.9	26.5 ± 6.6	11.9 ± 2.1
December	4.92E + 07	< 329	99 ± 35	5.0 ± 2.6	1.7 ± 0.8	13.8 ± 5.9	6.2 ± 2.0
Annual Average			145 ± 39		1.7 ± 0.2		11.0 ± 1.2
STP Outfall							
January	4.10E + 07	< 352	116 ± 39	6.6 ± 2.8	1.9 ± 0.8	12.1 ± 5.4	6.3 ± 1.1
February	4.48E + 07	860 ± 238	181 ± 75	4.7 ± 2.7	1.6 ± 0.6	13.6 ± 5.5	8.6 ± 1.2
March	5.25E + 07	410 ± 214	181 ± 41	4.8 ± 2.4	1.8 ± 0.6	14.5 ± 5.9	8.5 ± 1.6
April	5.08E + 07	< 334	152 ± 49	< 4.35	1.5 ± 0.6	14.5 ± 5.8	7.0 ± 1.5
May	5.71E + 07	1880 ± 283	218 ± 154	3.8 ± 2.4	1.8 ± 0.5	14.9 ± 8.3	14.9 ± 5.7
June	8.16E + 07	399 ± 216	144 ± 43	5.2 ± 2.8	1.7 ± 0.7	15.4 ± 6.0	8.3 ± 1.8
July	6.15E + 07	298 ± 190	155 ± 37	4.1 ± 2.0	1.8 ± 0.5	18.8 ± 6.5	10.0 ± 2.0
August	7.30E + 07	450 ± 205	106 ± 53	9.3 ± 3.2	2.2 ± 0.9	23.7 ± 6.4	11.8 ± 1.9
September	6.73E + 07	< 301	86 ± 37	8.0 ± 3.1	1.9 ± 1.1	19.9 ± 6.4	11.9 ± 1.8
October	5.11E + 07	316 ± 175	92 ± 49	8.7 ± 2.9	3.1 ± 0.9	29.4 ± 6.5	10.7 ± 2.5
November	4.26E + 07	1900 ± 280	420 ± 212	5.0 ± 2.7	2.6 ± 0.6	18.8 ± 6.2	10.0 ± 1.7
December	4.41E + 07	466 ± 181	147 ± 52	4.0 ± 2.4	2.0 ± 0.5	14.1 ± 5.9	5.9 ± 1.6
Annual Average			163 ± 27		2.0 ± 0.2		9.5 ± 0.8
Total Release	6.67E + 08		106 (mCi)		2.0 (mCi)		6.6 (mCi)
SDWA Limit			20,000 (pCi/L		15.0 (pCi/L		50.0 (pCi/L)
Average MDL			319 (pCi/L)		3.0 (pCi/L)		8.7 (pCi/L)

Notes:
All values shown with a 95% confidence interval.
To convert values from pCi to Bq, divide by 27.03.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act

2000, the samples showed the presence of cesium-137 only once in the STP effluent. Cesium-137 was not detected at all in the influent. The concentration of cesium-137 detected in the effluent was approximately 1% of the SDWA drinking water standard. The presence of cesium-137 in the STP effluent is due to the continued leaching of very small amounts of cesium-137 from the STP sand filter beds. This radionuclide was deposited during historic releases to the site sanitary system. The cesium-137 concentrations in the STP influent and effluent have been steadily decreasing since 1990, as shown in Figure 5-6. Total releases for 2000 were approximately one-half of 1999 levels. Upgrades to the site sewer system, specifically cleaning and relining/repairing of the piping systems, may be attributing to the decline in cesium-137 releases. Although a few of the individual daily samples showed low-level detections of cobalt-60 and manganese-54 (corrosion products typically found in piping systems exposed to radioactive fields) in the influent, these nuclides were not detected in the STP effluent. Zinc-65 was detected in a single

Figure 5-3. Sewage Treatment Plant Effluent Tritium Concentrations (CY 2000).

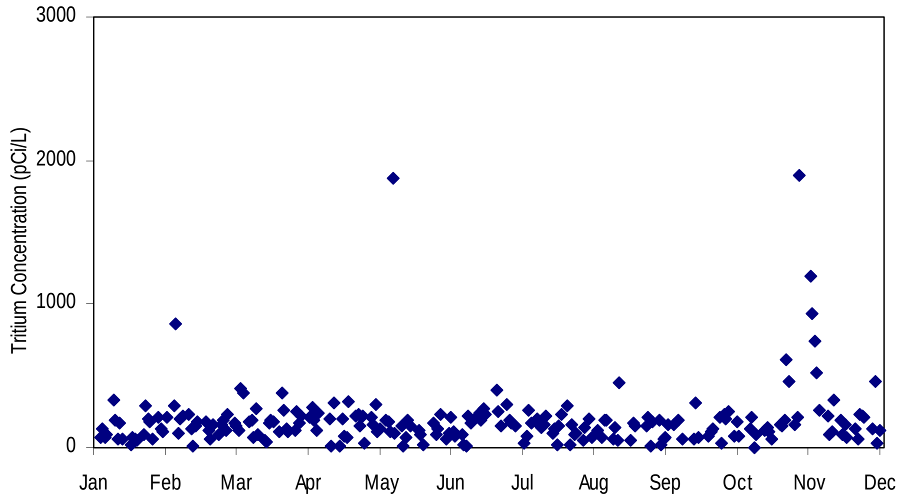

Figure 5-4. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1990-2000).

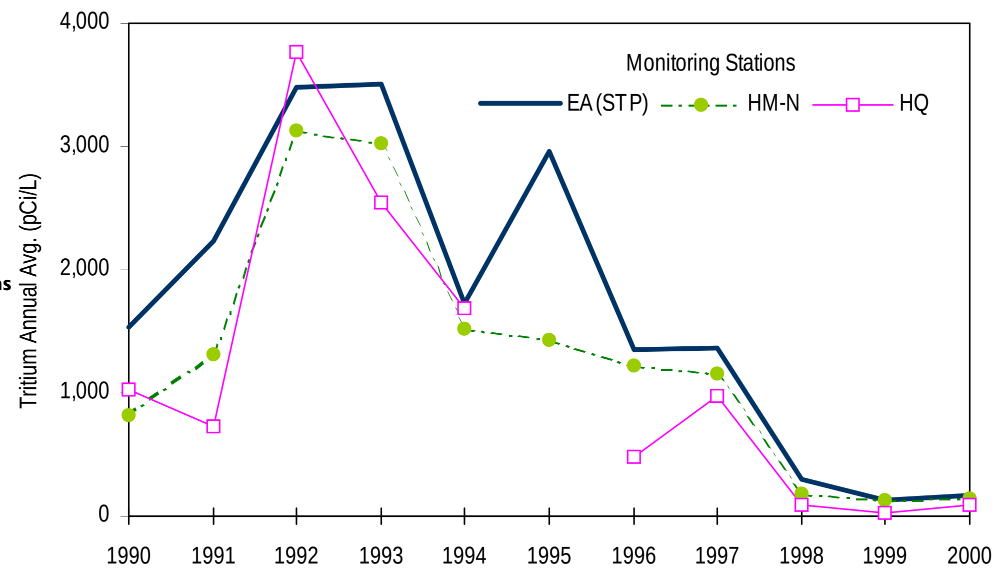

Figure 5-5. Tritium Released to the Peconic River, 15 Year Trend (1986 – 2000).

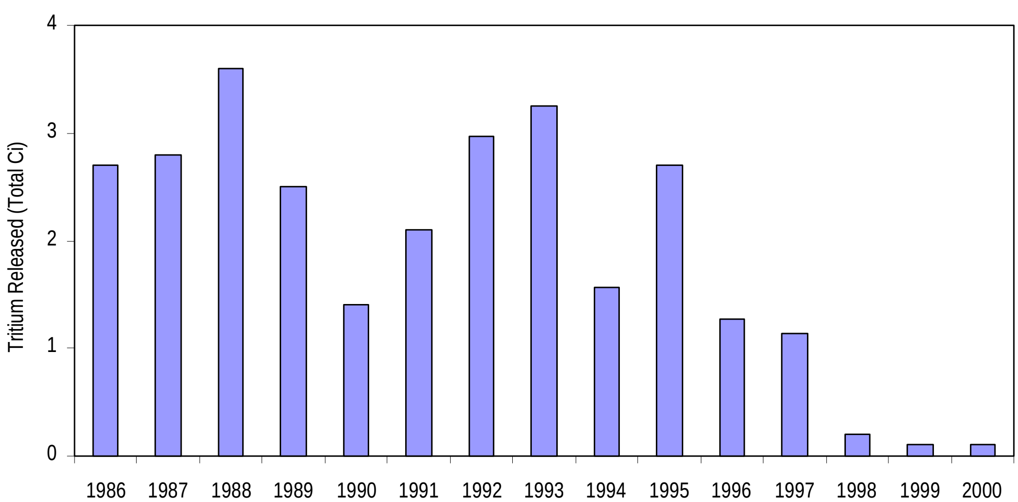

Table 5-2. Gamma-Emitting Radionuclides and Strontium-90 Results of Water at the Sewage Treatment Plant (CY 2000).

	Flow (Liters)	Co-60 (pCi/L)	Cs-137 (pCi/L)	Be-7 (pCi/L)	Na-22 (pCi/L)	Sr-90 (pCi/L)
STP Clarifier						
January	5.33E+07	ND	ND	ND	ND	< 0.16
February	5.27E+07	ND	ND	ND	ND	< 0.17
March	6.24E+07	ND	ND	ND	ND	< 0.16
April	5.65E+07	ND	ND	ND	ND	< 0.16
May	6.05E+07	ND	ND	ND	ND	< 0.16
June	8.77E+07	ND	ND	ND	ND	< 0.17
July	6.51E+07	ND	ND	ND	ND	< 1.05
August	8.05E+07	ND	ND	ND	ND	0.15 ± 0.10
September	7.88E+07	ND	ND	ND	ND	0.14 ± 0.10
October	8.04E+07	ND	ND	ND	ND	< 0.17
November	6.57E+07	ND	ND	ND	ND	< 0.16
December	4.92E+07	ND	ND	ND	ND	< 0.18
STP Outfall						
January	4.10E+07	ND	ND	ND	ND	< 0.16
February	4.48E+07	ND	ND	ND	ND	< 0.16
March	5.25E+07	ND	ND	ND	ND	< 0.16
April	5.08E+07	ND	ND	ND	ND	< 0.16
May	5.71E+07	ND	ND	ND	ND	< 0.16
June	8.16E+07	ND	ND	ND	ND	1.31 ± 0.20
July	6.15E+07	ND	ND	ND	ND	< 0.77
August	7.30E+07	ND	1.64 ± 1.01	ND	ND	< 0.14
September	6.73E+07	ND	ND	ND	ND	< 0.17
October	5.11E+07	ND	ND	ND	ND	< 0.14
November	4.26E+07	ND	ND	ND	ND	0.14 ± 0.09
December	4.41E+07	ND	ND	ND	ND	< 0.22
Total Release	6.67E+08	0 (mCi)	0.12 (mCi)	0 (mCi)	0 (mCi)	0.11 (mCi)
DOE Order 5400.5 DCG		5,000 (pCi/L)	3,000 (pCi/L)	50,000 (pCi/L)	10,000 (pCi/L)	1,000 (pCi/L)
Dose Limit of 4 mrem EDE		100 (pCi/L)	200 (pCi/L)	6,000 (pCi/L)	400 (pCi/L)	8 (pCi/L)

Notes:
All values shown with a 95% confidence interval.
DCG=Derived Concentration Guide
EDE=Effective Dose Equivalent
ND=Not Detected

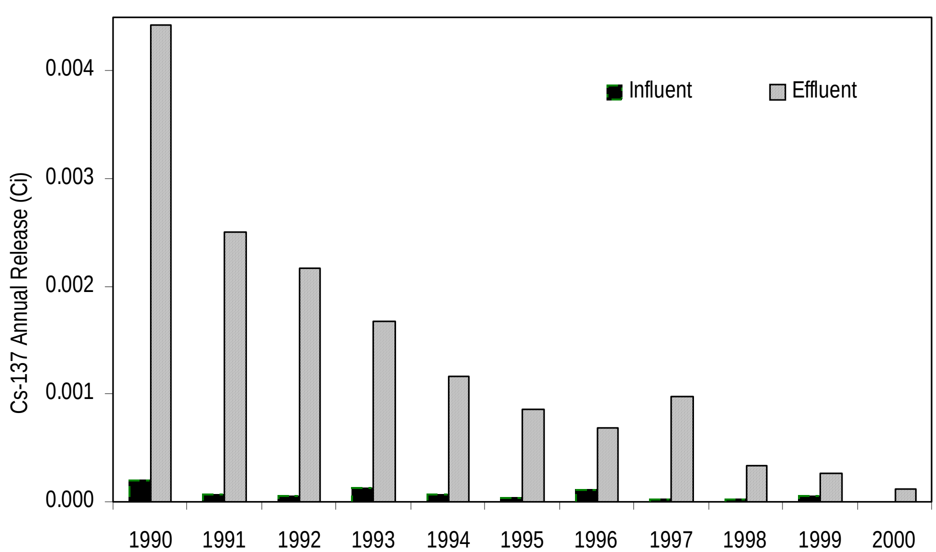

Figure 5-6. Cesium-137 in the Sewage Treatment Plant Influent and Effluent, 11 Year Trend (1990-2000).

sample of STP effluent collected in May. While the concentration (439 ± 371 pCi/L [16.2 ± 13.7 Bq/L]) of zinc-65 exceeded the drinking water standard of 400 pCi/L (14.8 Bq/L), the large uncertainty (85%) and the fact that the nuclide was not detected in the STP influent places this result into question.

Stronitum-90 was detected at very low levels in both the STP influent and effluent monthly composite samples on two occasions in 2000. The largest single value of strontium-90 recorded for the STP influent was 0.15 ± 0.1 pCi/L (0.006 ± 0.004 Bq/L) which is 2% of the drinking water standard of 8 pCi/L (0.3 Bq/L). The largest strontium-90 value for an STP effluent sample was 1.3 ± 0.2 pCi/L (0.05 ± 0.008 Bq/L) or 16% of the drinking water standard. The highest strontium-90 concentration detected in the STP influent was approximately 10% of the highest level recorded in 1999. Effluent concentrations are similar to previous years. Strontium-90 was discharged from BNL facilities in the 1950s and 1960s, and has remained in the sludge within the sanitary piping system. One goal of the sanitary sewer-cleaning project is to remove the residual activity and ultimately reduce the concentrations into and released from the STP.

5.2.2 SANITARY SYSTEM EFFLUENT - NONRADIOLOGICAL ANALYSES

In addition to the compliance monitoring discussed in Chapter 3, effluent from the STP is also monitored under the BNL environmental surveillance program. Data are collected for field-measured parameters, such as temperature, specific conductivity, pH, and dissolved oxygen, as well as inorganic parameters such as chlorides, nitrates, sulfates, and metals. Daily composite samples of the STP effluent are collected using a flow-proportional refrigerated sampling device (ISCO Model 1600™). The BNL Analytical Services Laboratory analyzes these composite samples for 21 inorganic compounds. In addition, grab samples are collected monthly from the STP effluent and analyzed for 38 different volatile organic compounds (VOCs). Daily influent and effluent logs are maintained by the STP operators for flow, pH, temperature, and settleable solids as part of routine monitoring of STP operations.

Table 5-3 summarizes the inorganic analytical results for the STP samples. Comparison of the effluent data to the SPDES effluent limits (or other applicable standard) shows that the majority of the analytical parameters were within SPDES effluent permit limits (see also the compliance data in Chapter 3). Copper, iron, and zinc were detected, each on one occasion, at concentrations exceeding SPDES limits. Both zinc and iron were detected at elevated levels in regulatory compliance samples as discussed in Chapter 3.

Acetone and methylene chloride were detected at trace levels (< 2.0 µg/L) sporadically throughout the year in grab samples collected from the STP effluent. Methylene chloride was also detected at an elevated concentration of 20 µg/L in a single sample collected in May. This compound was not detected at these levels at any other time during the year. No other organic compounds were detected in the STP discharge during 2000.

5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may potentially contain constituents above SPDES permit limits or groundwater discharge standards is held by the generator and characterized to determine the appropriate means of disposal. The analytical results are compared with the appropriate discharge limit, and the wastewater is released to the sanitary system only if the volume and concentration of contaminants in the discharge would not jeopardize the quality of the STP effluent and the Peconic River.

The BNL SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from the photographic developing operations in Building 197B, the printed-circuit-board fabrication operations conducted in Building 535B, the metal cleaning operations in Building 498, cooling tower discharges from Building 902, and boiler blow-down from satellite boilers located at Buildings 244 and 423. These operations were monitored for contaminants such as metals, cyanide, VOCs, and semi-VOCs. Analyses of these waste streams showed that, while several contributed contaminants to the STP in concentrations exceeding SPDES permitted levels, the concentration did not affect the quality of the STP effluent.

Process wastewaters that were not expected to be of consistent quality because

Table 5-3. Sewage Treatment Plant (STP) Average Water Quality and Metals Analytical Results (CY 2000).

	STP Influent				STP Effluent				SPDES Limit or Ambient Water Quality Standard[1]
	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	
pH (SU)[2]	242	6.5	8	NA	245	5.7	7.3	NA	5.8 - 9.0
Conductivity (µmhos/cm)[2]					245	21	507	236	SNS
Temperature (°C)[2,3]					245	4.4	27.2	16.9	SNS
Dissolved Oxygen (mg/L)	NA	NA	NA	NA	245	5.1	14.2	9.3	SNS
Chlorides (mg/L)	12	22.2	76.8	39.8	12	17.7	39.6	30.2	SNS
Nitrate (as N) (mg/L)	12	1.3	3.7	2.2	12	2.2	8	5.1	10 (Total N)
Sulfates (mg/L)	12	12.2	35	16	12	10.5	17.5	14	250 (GA)
Aluminum (µg/L)	12	31.6	1920	631.7	12	17.1	86.1	36.9	100 (Ionic)
Antimony (µg/L)	12	< 0.88	8.3	2.4	12	< 0.88	< 0.88	< 0.88	3 (GA)
Arsenic (µg/L)	12	< 3	24	4.5	12	< 3	3.7	< 3	150 (Dissolved)
Barium (µg/L)	12	14.1	201.5	63.5	12	13.1	29.6	19.9	1000 (GA)
Beryllium (µg/L)	12	< 0.66	1.7	< 0.66	12	< 0.66	< 0.66	< 0.66	11 (Acid Soluble)
Cadmium (µg/L)	12	< 1.1	1.2	< 1.1	12	< 1.1	1.1	< 1.1	1.1 (Dissolved)
Chromium (µg/L)	12	1.2	9.9	4.8	12	1	14	2.7	34.4 (Dissolved)
Cobalt (µg/L)	12	0.36	4	1.1	12	< 0.12	0.52	0.36	5 (Acid Soluble)
Copper (µg/L)	12	37.4	607.9	173	12	33.8	189	58.4	150 (SPDES)
Iron (µg/L)	12	526	3411	1303	12	< 75	1717	238	370 (SPDES)
Mercury (µg/L)	12	0.27	4.5	1.5	12	< 0.2	0.4	0.26	0.8 (SPDES)
Manganese (µg/L)	12	8.1	277	58.3	12	3.7	13.2	7.3	300 (GA)
Molybdenum (µg/L)	12	< 5	13.9	< 5	12	< 5	< 5	< 5	SNS
Nickel (µg/L)	12	2.6	26	7.8	12	2.9	7.2	4.3	110 (SPDES)
Lead (µg/L)	12	6.4	98.7	26.3	12	< 1.3	4.1	1.8	19 (SPDES)
Selenium (µg/L)	12	< 5	16.8	5.3	12	< 5	13.9 [4]	< 5	4.6 (Dissolved)
Silver (µg/L)	12	< 1	116.6	25	12	< 1	3.5	1.6	15 (SPDES)
Sodium (µg/L)	12	17.1	40	27.4	12	15.9	42.5	26.2	SNS
Thallium (µg/L)	12	< 0.66	1.8	< 0.66	12	< 0.66	0.66	< 0.66	8 (Acid Soluble)
Vanadium (µg/L)	12	< 5.5	42.4	11.5	12	< 5.5	9.7	< 5.5	14 (Acid Soluble)
Zinc (µg/L)	12	19.4	114	53.8	12	26.9	138	61.7	100 (SPDES)

Notes:
See Figure 5-2 for locations of the STP influent and effluent monitoring locations.
All analytical results were generated using total recoverable analytical techniques.
For Class C standards, the solubility state for the metal is provided.
SPDES=State Pollutant Discharge Elimination System
NA = Not Applicable
SNS = Standard Not Specified
GA = Class GA (groundwater) Ambient Water Quality Standard
[1] Unless otherwise provided, the reference standard is Class C Surface Water.
[2] The pH and temperature values reported are based upon analysis of daily grab samples.
[3] Continuously monitored by STP operators.
[4] The concentration of selenium detected in several samples analyzed in July is estimated due to blank contamination. Analysis of the method blank showed detectable levels of selenium very similar to those found in the samples.

they were not routinely generated were held for characterization before release to the site sewer system. The process wastewaters typically included ion-exchange column regeneration wastes, primary closed-loop cooling water, and other industrial wastewaters. To determine the appropriate disposal method, samples were analyzed for contaminants specific to the process. The analyses were then reviewed, and the concentrations compared to the SPDES effluent limits and BNL effluent criteria. If the concentrations were within limits, authorization for sewer disposal was granted; if not, alternate means of disposal were pursued. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceed BNL effluent criteria were sent to the BNL Waste Management Facility for proper disposal.

In 2000, as part of the Laboratory's commitment to pollution prevention, the Laboratory initiated a revision to its administrative authorization criteria for wastewater containing low levels of radionuclides. This revision is based upon the Environmental As Low As Reasonably Achievable (also known as E-ALARA) concept, whereby the Laboratory will strive to minimize emissions and effluents to the lowest levels technically achievable and economically feasible. The revised criteria will be set at a fraction of the drinking water standards. Effluents that do not meet these stringent criteria will either be managed offsite or must be reviewed by senior management for consideration of institutional risk. The authorization criteria will be finalized and documented in Laboratory-wide standard operating procedures in 2001. This practice is much more stringent than industry standards and supports the Laboratory's commitment to maintaining a clean environment.

5.4 RECHARGE BASINS

Recharge basins are used for the disposal of "clean" wastewater streams including once through cooling water, stormwater runoff, or cooling tower blowdown. With the exception of elevated temperature, and increased natural sediment content, these wastewaters are suitable for direct replenishment of the groundwater aquifer. Figure 5-7 depicts the locations of BNL's discharges to recharge basins. An overall schematic of water use at BNL is presented in Figure 5-8. Nine recharge basins are used for the management of once through

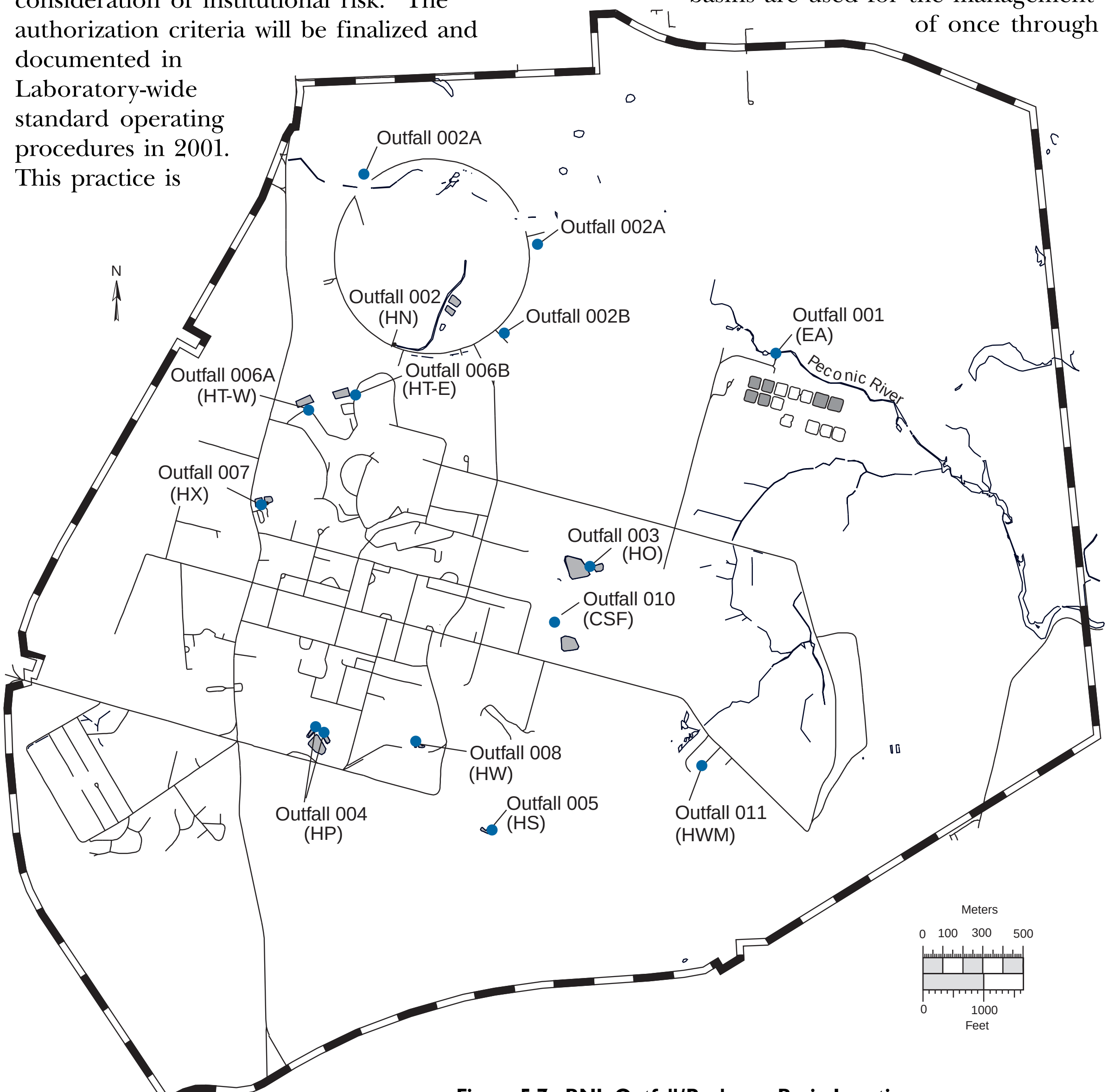

Figure 5-7. BNL Outfall/Recharge Basin Locations.

cooling water, cooling tower blowdown, and stormwater runoff as described below:

- ♦ Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the Alternating Gradient Synchrotron (AGS) and Relativistic Heavy Ion Collider (RHIC) as well as cooling tower blowdown and stormwater runoff.
- ♦ Basin HS receives predominantly stormwater runoff, once-through cooling water from Bldg. 555 (Chemistry Dept.), and minimal cooling tower blowdown from the National Synchrotron Light Source.
- ♦ Basin HX receives Water Treatment Plant filter backwash water.
- ♦ Basin HP receives once-through cooling water from the Brookhaven Medical Research Reactor.
- ♦ Basin HO receives cooling water and cooling tower discharges from the AGS, and stormwater runoff from the area surrounding the HFBR.
- ♦ Several other recharge areas are used exclusively for discharging stormwater runoff including Basin HW in the warehouse area, Basin CSF at the Central Steam Facility, and Basin HWM at the former Hazardous Waste Management Facility.

Each of the recharge basins is a permitted point source discharge under BNL's SPDES permit. Where required by the permit, the outfall to the basin is equipped with a flow monitoring station and weekly recordings of flow are collected, along with records of pH, conductivity, and temperature. The specifics of the SPDES compliance monitoring program are provided in Chapter 3. To supplement the SPDES compliance monitoring program, samples are also routinely collected and analyzed under the environmental monitoring program for VOCs, metals, and anions. During 2000, water samples were collected from Basins HN, HO, HP, HS, HT-E, HT-W, HW, HX, and CSF.

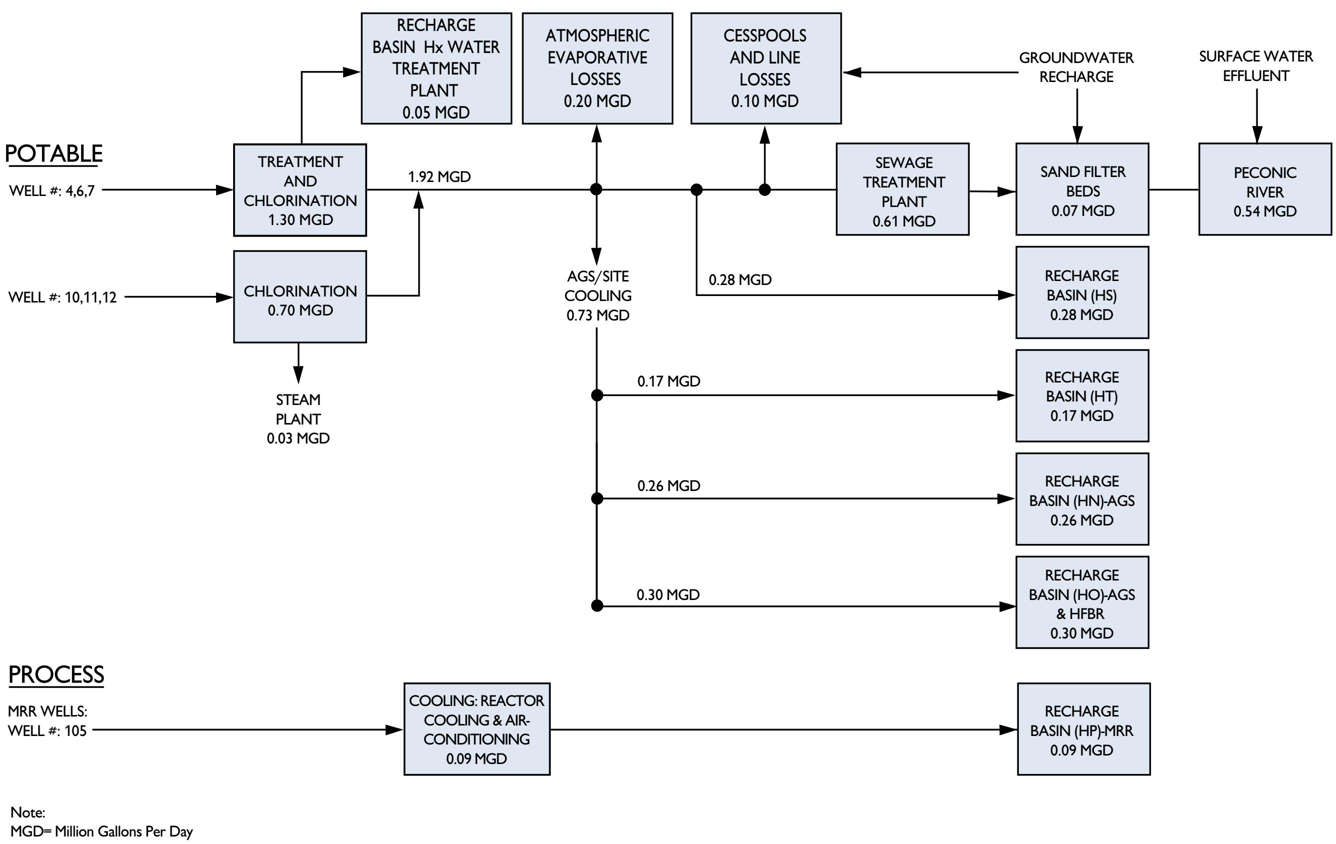

Figure 5-8. Schematic of Water Use and Flow at BNL for 2000.

5.4.1 RECHARGE BASINS - RADIOLOGICAL ANALYSES

Discharges to the recharge basins were sampled throughout the year to measure concentrations of gross alpha and beta activity, gamma-emitting radionuclides, and tritium. Radiological results for water samples collected at the recharge basins are presented in Table 5-4. Review of the data showed there were detectable levels of beta activity in Basins HN and HT-W. The accompanying gamma analysis of water samples collected from these basins showed that only potassium-40 was detectable in these water samples. Potassium-40 is a naturally occurring radionuclide. No gamma-emitting radionuclides attributable to BNL operations were detected in any of the recharge basins. Recharge Basin HN also exhibited slightly elevated levels of tritium. This recharge basin receives cooling water discharges from the AGS. At the AGS, tritium is produced by the interaction of high-energy protons and secondary radiation (due to beam/target interactions) with cooling water. The maximum concentration of tritium 2,280 pCi/L [84.4 Bq/L]) in this discharge was approximately 10% of the drinking water standard.

Table 5-4. Radiological Analysis Results of Outfall/ Recharge Basin Water (CY 2000).

Basin		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)
HN	N	4	4	4
	Max.	0.9 ± 0.6	53.9 ± 2.6	2,280 ± 299
	Avg.	0.5 ± 0.22	2.3 ±18.5	648 ± 935
HO	N	4	4	5
	Max.	6.9 ± 1.0	8.2 ± 1.5	< 319
	Avg.	2.0 ± 2.8	4.3 ± 3.1	30 ± 121
HP	N	4	4	4
	Max.	3.4 ± 0.7	31.7 ± 2.2	< 289
	Avg.	0.9 ± 1.4	11.6 ± 11.5	27 ± 124
HS	N	4	4	4
	Max.	11.7 ± 1.1	15.4 ± 1.7	293 ± 188
	Avg.	3.7 ± 4.5	7.8 ± 4.6	102 ± 122
HT-E	N	4	4	4
	Max.	< 0.8	6.7 ± 1.5	< 361
	Avg.	0.2 ± 0.2	3.8 ± 1.9	123 ± 210
HT-W	N	4	4	4
	Max.	6.1 ± 1.0	51.3 ± 2.6	< 361
	Avg.	1.8 ± 2.4	18.1± 19.5	13 ± 132
SDWA Limit		15	50	20,000

Notes:
Figure 5-7 provides the locations of outfall/recharge basins.
All values reported with a 95% confidence interval.
Recharge basins HW, HX, and CSF were not sampled for radiological parameters in 2000.
N = Number of samples collected for analysis.
SWDA = Safe Drinking Water Act.

5.4.2 RECHARGE BASINS - NONRADIOLOGICAL ANALYSES

To determine the overall impact of the recharge basin discharges on the environment, the analytical results were compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations Part 703.6. Samples were collected quarterly for water quality parameters, metals, and VOCs, and analyzed by the BNL Analytical Services Laboratory. Field measured parameters (pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-5 and 5-6, respectively. For VOCs, low concentrations of disinfection by-products were, as expected, routinely detected in several discharges including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. Concentrations ranged from nondetectable to a maximum of 2.6 µg/L. Sodium hypochlorite and bromine, used to control algae in cooling towers, were responsible for the formation of these compounds. Acetone was also detected sporadically in several samples across BNL at concentrations up to 20 µg/L . Acetone is commonly found as a contaminant in analytical laboratories and may be present due to its ability to evaporate in one area and then redissolve in water in another area of the laboratory.

The analytical data in Tables 5-5 and 5-6 show that most parameters, except for aluminum, iron, and lead, complied with the respective groundwater discharge or water quality standards. Aluminum and iron are natural components of soil and readily dissolve when water is acidified for sample preservation. Iron is present naturally in Long Island groundwater at concentrations that exceed the New York State groundwater effluent limit. The pH measured at several of the recharge basins was outside the groundwater effluent standard of 6.5 – 8.5 Standard Units. The pH of local groundwater and precipitation is lower than the standard, and thus contributed to the low pH observations. The high pH observations are attributed to sodium hydroxide or calcium hydroxide additions to the domestic water system. Periodically the pH of the domestic water is greater than 8.5 due to chemical over addition.

Lead was measured in water samples collected from the discharge to Basin CSF at concentrations up to 105 µg/L. Additionally, vanadium and nickel were also detected at concentrations significantly higher than at other basins. Soil samples collected at this discharge location have historically exhibited high levels of lead and the other inorganics. See Chapter 6 for a discussion of soil sampling results. Due to the high levels in soils,

Table 5-5. Water Quality Data for Onsite Recharge Basins (CY 2000).

Recharge Basin		pH (SU)	Conductivity (µS/cm)	Temperature (°C)	Chlorides (mg/L)	Sulfates (mg/L)	Nitrate as N* (mg/L)
HN	N	16	6	16	4	4	4
(RHIC)	Min.	6.6	80	6.3	21.9	5.6	< 1
	Max.	7.8	158	23.0	33	17	< 1
	Avg.	NA	128	14.0	26.1	12.0	< 1
HO	N	16	4	16	4	4	4
(AGS/HFBR)	Min.	6.5	141	5.0	16.4	9.2	< 1
	Max.	8.1	151	24.7	22.1	11.2	< 1
	Avg.	NA	144	11.5	20.0	10.5	< 1
HP	N	7	4	7	4	4	4
(BMRR)	Min.	6.0	145	11.1	19.1	10.4	< 1
	Max.	7.5	194	26.6	34.3	14.3	< 1
	Avg.	NA	176	18.2	28.6	13.1	< 1
HS	N	15	4	15	4	4	4
(Stormwater)	Min.	6.6	181	4.1	24.5	12.4	< 1
	Max.	8.8	255	49.7	45.7	18.2	1.5
	Avg.	NA	217	14.2	36.6	15.5	< 1
HT-E	N	14	4	14	4	4	4
(AGS)	Min.	6.9	138	5.7	17.6	11.2	< 1
	Max.	8.3	200	22.7	23.7	12.5	< 1
	Avg.	NA	158	17.3	20.6	11.9	< 1
HT-W	N	17	3	17	4	4	4
(LINAC)	Min.	7.0	88	6.8	17.8	11.7	< 1
	Max.	8.4	172	25.9	27.1	13.5	< 1
	Avg.	NA	151	16.4	22.2	12.6	< 1
HW	N	10	1	9	3	3	3
(Weaver Road)	Min.	6.4	79	5.6	< 4	< 4	< 1
	Max.	7.9	79	22.4	33.7	8.6	< 1
	Avg.	NA	79	13.4	13.9	4.8	< 1
CSF	N	8	2	8	3	3	3
(Stormwater)	Min.	6.3	58	5.0	< 4	< 4	< 1
	Max.	7.5	131	24.7	25.8	4.6	< 1
	Avg.	NA	94.5	11.5	10.5	< 4	< 1
NYSDEC Effluent Standard		6.5 - 8.5	SNS	SNS	500	500	10
Typical MDL		NA	10	NA	4	4	1

Notes:
See Figure 5-7 for the locations of recharge basins.
Recharge Basin HX was not sampled for water quality parameters in 2000.
*Holding times for nitrate analyses are routinely exceeded
AGS/HFBR = Alternating Gradient Synchrotron/High Flux Beam Reactor
BMRR = Brookhaven Medical Research Reactor
CSF = Central Steam Facility
MDL = Minimum Detection Limit
N = No. of samples
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

Table 5-6. Metals Data for Onsite Recharge Basins (CY 2000).

Recharge Basin	N		Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Mo µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L
HN	4	Min.	< 1.0	47.4	< 3.0	21.9	< 0.66	< 1.1	0.2	< 1.0	34.0	0.2	< 0.2	7.8	< 5.0	16.2	1.2	2.0	< 0.88	< 5	< 0.66	< 5.5	48.5
(RHIC)		Max.	< 1.0	3690.0	4.2	38.4	< 0.66	< 1.1	0.7	2.4	58.1	3.4	0.4	33.1	< 5.0	29.2	2.9	8.3	< 0.88	14.2	< 0.66	8.3	278.7
		Avg.	< 1.0	1000.0	< 3.0	28.0	< 0.66	< 1.1	0.4	1.4	46.6	1.0	< 0.2	23.7	< 5.0	23.5	1.8	4.5	< 0.88	7.0	< 0.66	< 5.5	130.8
HO	4	Min.	< 1.0	7.6	< 3.0	7.1	< 0.66	< 1.1	0.1	< 1.0	5.6	0.2	< 0.2	7.7	< 5.0	15.3	< 1.1	< 1.3	< 0.88	< 5	< 0.66	< 5.5	8.0
(AGS/HFBR)		Max.	2.7	235.7	< 3.0	25.2	< 0.66	< 1.1	0.7	< 1.0	33.8	0.4	< 0.2	102.5	< 5.0	22.5	1.8	2.8	< 0.88	12.7	< 0.66	< 5.5	61.6
		Avg.	< 1.0	85.7	< 3.0	21.5	< 0.66	< 1.1	0.3	< 1.0	20.0	0.3	< 0.2	47.5	< 5.0	18.6	1.2	< 1.3	< 0.88	< 5	< 0.66	< 5.5	30.1
HP	3	Min.	< 1.0	3.4	< 3.0	37.7	< 0.66	< 1.1	0.2	< 1.0	3.5	< 0.075	< 0.2	53.5	< 5.0	18.1	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	< 4.0
(BMRR)		Max.	< 1.0	328.7	< 3.0	61.0	< 0.66	< 1.1	0.5	< 1.0	7.5	1.0	< 0.2	102.1	< 5.0	19.8	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	36.4
		Avg.	< 1.0	112.8	< 3.0	48.1	< 0.66	< 1.1	0.3	< 1.0	4.9	0.4	< 0.2	70.1	< 5.0	18.9	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	15.0
HS	4	Min.	< 1.0	11.2	< 3.0	25.3	< 0.66	< 1.1	< 0.12	< 1.0	4.5	< 0.075	< 0.2	4.1	< 5.0	22.8	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	5.0
(Stormwater)		Max.	< 1.0	599.4	5.0	44.5	< 0.66	< 1.1	0.2	< 1.0	52.2	0.6	< 0.2	10.0	< 5.0	29.0	2.1	3.3	2.0	12.8	< 0.66	< 5.5	61.9
		Avg.	< 1.0	181.4	< 3.0	34.1	< 0.66	< 1.1	< 0.12	< 1.0	22.1	0.2	< 0.2	6.0	< 5.0	25.5	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	29.4
HT-E	4	Min.	< 1.0	7.6	< 3.0	20.3	< 0.66	< 1.1	< 0.12	< 1.0	11.2	< 0.075	< 0.2	< 2.0	< 5.0	15.6	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	12.2
(AGS)		Max.	< 1.0	45.0	3.1	47.0	< 0.66	< 1.1	0.2	1.2	15.9	0.1	0.3	30.5	< 5.0	28.6	1.9	2.9	< 0.88	13.8	< 0.66	< 5.5	58.0
		Avg.	< 1.0	21.8	< 3.0	28.0	< 0.66	< 1.1	< 0.12	< 1.0	14.4	< 0.075	< 0.2	12.6	< 5.0	21.6	< 1.1	< 1.3	< 0.88	6.8	< 0.66	< 5.5	26.0
HT-W	4	Min.	< 1.0	7.2	< 3.0	17.0	< 0.66	< 1.1	< 0.12	< 1.0	24.9	< 0.075	< 0.2	< 2.0	< 5.0	18.0	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	5.5
(LINAC)		Max.	< 1.0	18.8	4.2	22.9	< 0.66	< 1.1	0.3	2.0	35.0	< 0.075	< 0.2	19.7	< 5.0	27.5	< 1.1	< 1.3	< 0.88	13.4	< 0.66	< 5.5	25.0
		Avg.	< 1.0	13.3	< 3.0	20.9	< 0.66	< 1.1	< 0.12	1.0	31.7	< 0.075	< 0.2	9.5	< 5.0	22.7	< 1.1	< 1.3	< 0.88	< 5.0	< 0.66	< 5.5	11.7
HW	3	Min.	< 1.0	1049.4	< 3.0	15.4	< 0.66	< 1.1	0.4	2.1	38.0	0.8	< 0.2	12.9	< 5.0	3.0	1.7	15.6	< 0.88	< 5.0	< 0.66	7.2	34.3
(Weaver Rd.)		Max.	< 2.0	2312.0	< 6	30.7	< 1.32	< 2.2	0.9	5.9	73.6	2.3	< 0.2	28.5	< 10.0	24.6	6.3	23.2	< 1.76	< 10.0	< 1.32	13.2	67.1
(Stormwater)		Avg.	< 1.0	1660.1	< 3.0	21.2	< 0.66	< 1.1	0.7	4.1	57.4	1.5	< 0.2	20.6	< 5.0	10.7	3.6	19.5	< 0.88	< 5.0	< 0.66	9.4	46.5
CSF	3	Min.	< 1.0	1848.8	< 3.0	17.9	< 0.66	< 1.1	0.5	1.2	27.3	0.7	< 0.2	15.1	< 5.0	2.8	3.7	5.2	< 0.88	< 5.0	< 0.66	13.6	14.8
(Stormwater)		Max.	2.1	4720.0	< 6.0	21.3	< 0.66	< 2.2	1.8	3.7	70.7	3.5	0.3	34.8	< 10.0	15.0	21.1	105.9	< 1.76	< 10.0	< 1.32	50.8	55.7
		Avg.	< 1.0	2808.0	< 3.0	22.3	< 0.66	< 1.1	1.0	2.4	48.6	2.0	< 0.2	24.6	< 5.0	7.8	10.9	42.3	< 0.88	< 5.0	< 0.66	30.8	30.1
NYSDEC Effluent Limitation or AWQS			50.0	2,000.0	50.0	2,000.0	SNS	10.0	5.0	100.0	1,000.0	0.6	1.4	600.0	SNS	SNS	200.0	50.0	6.0	20.0	SNS	SNS	5,000.0
Typical MDL			1.0	2.2	3.0	1.8	0.7	1.1	0.1	1.0	2.0	0.015	0.2	2.0	5.0	1.0	1.1	1.3	0.9	5.0	0.7	5.5	4.0

Notes:
See Figure 5-7 for locations of Recharge Basins.
Recharge Basin HX was not sampled for metals during CY 2000.
AGS/HFBR=Alternating Gradient Synchrotron/High Flux Beam Reactor
AWQS=Ambient Water Quality Standard
BMRR=Brookhaven Medical Research Reactor
CSF=Central Steam Facility
MDL=Minimum Detection Limit.
NYSDEC=New State Department of Environmental Conservation
RHIC=Relativistic Heavy Ion Collider
SNS=Effluent Standard Not Specified

suspended particulates were the most likely cause of the elevated concentrations observed in the water collected from the CSF discharge.

5.4.3 STORMWATER ASSESSMENT

With the exception of Recharge Basins HP and HX, all recharge basins receive stormwater runoff. At BNL, stormwater is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces, and directing it to the recharge basins via underground piping and abovegrade vegetated swales. Recharge Basin HS receives the majority of the stormwater runoff from the central developed portion of the BNL site (all properties south of Cornell Avenue and east of Railroad Avenue). Basins HN and HT-E receive runoff from the AGS and portions of the RHIC complex; Basin HO receives runoff from the BGRR and HFBR areas. As previously indicated, Basins HW, CSF, and HWM receive only stormwater runoff.

Stormwater runoff from the BNL site typically has elevated levels of inorganics and low pH. The inorganics are attributable to high sediment content and the natural occurrence of these elements in native soils.

5.5 PECONIC RIVER SURVEILLANCE

Several locations were monitored along the Peconic River to assess the overall water quality of the river and to assess the impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-9. In total, ten stations are monitored: three upstream and seven downstream of the STP outfall. In addition, a sampling station along the Carmans River (HH) is also monitored as a control location. All locations are monitored for radiological and nonradiological parameters on a routine basis.

The sampling stations are located as follows.

- Downstream sampling stations:
  - HM-N, onsite and 0.5 miles (0.8 km) downstream of the STP outfall
  - HM-S, onsite (a typically dry tributary of the Peconic River)
  - HQ, onsite and 1.2 miles (1.9 km) downstream of the STP outfall
  - HA and HB, offsite and 3.1 miles (5.0 km) downstream of the STP outfall
  - HC, offsite and 4.3 miles (6.9 km) downstream of the STP outfall
  - HR, offsite and 13 miles (20.9 km) downstream of the STP outfall (in Riverhead)
- Upstream locations:
  - HE, onsite, located immediately upstream of the STP
  - HV, onsite, located just east of the 10'oclock Experimental Hall in the RHIC ring
  - HY, onsite, located just east of the William Floyd Parkway
- Control location
  - HH, Carmans River

5.5.1 PECONIC RIVER - RADIOLOGICAL ANALYSES

Radionuclide measurements were performed on surface water samples collected from the Peconic River at all ten locations. Routine samples at Stations HM-N and HQ were collected three times per week, as flow permitted. Station HE was collected quarterly in 2000. Since February 1995, these three locations have been equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled quarterly by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water sampling in 2000 are summarized in Table 5-7. Radiological analysis of upstream water samples showed that gross alpha and beta activities were occasionally detected at low levels at all three locations. Location HY exhibited the highest concentrations of all three upstream locations. Since this is the location closest to the BNL site border, it is used as the representative background location for the Peconic River. The concentrations of gross alpha activity detected in samples collected at HY ranged from 0.4 ± 0.6 to 12.2 ± 1.4 pCi/L (0.015 ± 0.02 to 0.5 ± 0.05 Bq/L). The concentration of gross beta activity ranged from 2.7 ± 1.4 pCi/L to 31.7 ± 7.1 pCi/L (0.1 ± 0.05 to 1.2 ± 0.3 Bq/L). Samples collected downstream of the BNL STP discharge showed very similar concentrations of gross alpha and beta activity to the upstream locations, with the exception of a single sample collected at station HM-N in November. This one sample exhibited a gross alpha concentration of 92.8 ± 9.6 pCi/L (3.4 ± 0.4 Bq/L). Re-analysis of an equal sample aliquot confirmed the original result. Gamma

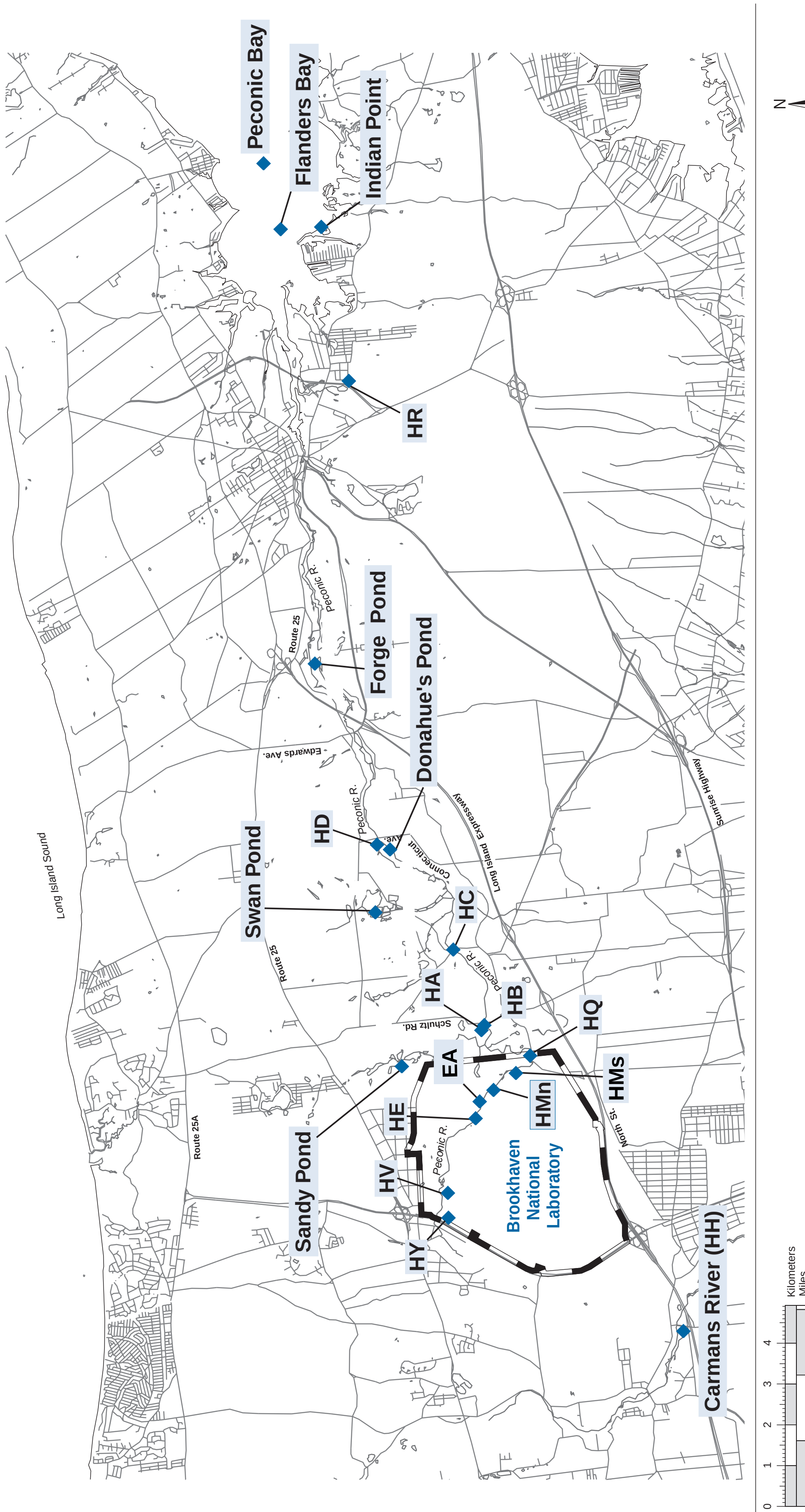

Figure 5-9. Surface Water and Fish/Shellfish Sampling Stations.

Table 5-7. Radiological Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).

Sample Station	Geographic Location		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)	Sr-90 (pCi/L)
HY	Peconic River (headwaters)	N	5.0	5.0	2	NS
	onsite, east of the Wm. Floyd Pkwy.	Max.	12.2 ± 1.4	31.7 ± 7.1	< 298	
		Avg.	4.2 ± 3.7	14.3 ± 9.0	86 ± 68	
HV	Peconic River (Headwaters)	N	3.0	3.0	2	NS
	onsite, inside the RHIC ring	Max.	3.6 ± 0.7	5.8 ± 1.4	< 315	
		Avg.	2.0 ± 1.4	4.4 ± 2.2	1 ± 97	
HE	Peconic River,	N	4	4	4	4
	upstream of STP Outfall	Max.	2.8 ± 0.7	7.9 ± 1.6	< 289	0.34 ± 0.01
		Avg.	1.3 ± 1.8	5.3 ± 2.4	16 ± 130	0.30 ± 0.05
HM-N	Peconic River,	N	150	150	150	3
	0.4 mi from STP, onsite	Max.	92.8 ± 9.6	37.7 ± 7.0	1350 ± 262	< 0.17
		Avg.	2.6 ± 1.2	8.6 ± 0.8	143 ± 25	0.03 ± 0.03
HM-S	Peconic River	N	3	3	3	3
	tributary, onsite	Max.	2.5 ± 0.7	4.9 ± 1.4	< 315	< 0.18
		Avg.	1.3 ± 1.1	2.7 ± 2.1	-25 ± 69	0.13 ± 0.01
HQ(1)	Peconic River,	N	46	46	46	2
	BNL site boundary	Max.	5.8 ± 2.7	42.5 ± 7.2	363 ± 207	< 0.17
		Avg.	2.1 ± 0.5	10.1 ± 2.2	93 ± 25	0.13 ± 0.04
HA	Peconic River,	N	5	5	5	NS
	offsite	Max.	2.4 ± 0.7	28.2 ± 2.1	< 338	
		Avg.	0.8 ± 0.7	9.6 ± 3.3	-95 ± 1	
HB	Peconic River,	N	5	5	5	NS
	offsite	Max.	1.6 ± 0.8	4.9 ± 1.4	< 338	
		Avg.	0.8 ± 0.6	2.8 ± 1.2	-62 ± 103	
HC	Peconic River,	N	4	4	4	NS
	offsite	Max.	13.6 ± 1.4	6.8 ± 1.6	< 338	
		Avg.	4.4 ± 5.4	4.6 ± 1.7	-93 ± 111	
HR	Peconic River,	N	4	4	4	NS
	offsite, Riverhead	Max.	2.6 ± 0.7	8.6 ± 1.6	< 338	
		Avg.	1.0 ± 1.0	4.0 ± 2.7	-64 ± 99	
HH	Carmans River	N	4	4	4	NS
	(Control Location)	Max.	2.7 ± 1.4	9.3 ± 2.0	< 338	
		Avg.	0.8 ± 0.7	4.1 ± 2.9	-94 ± 103	
SDWA Limit			15.0	50.0	20,000	8

Notes:
See Figure 5-9 for sample station locations.
No gamma-emitting anthropogenic radionuclides were detected in Peconic River water samples in 2000.
All values shown with 95% confidence interval.
Negative numbers occur when the measured value is lower than background.
For Stations HM-N and HQ, Sr-90 analysis results based on composite samples, all others collected as grab samples.
N = Number of samples analyzed
NS = Not Sampled for this analyte
SDWA = Safe Drinking Water Act
(1)Station HQ was dry for 8 months during 2000.

analysis did not identify a radionuclide capable of producing such a result. Since there was no detection of gross alpha activity at this level in the STP influent or effluent, and there were no detections at stations farther downstream or in subsequent samples collected from this station, the result appears to be an analytical anomaly. No gamma emitting radionuclides attributable to BNL operations were detected either upstream or downstream of the STP.

Tritium analysis of water samples collected upstream and downstream from the STP discharge showed only detectable levels at

Station HM-N. The maximum concentration (1,350 ± 262 pCi/L [50.0 ± 9.7 Bq/L]) was consistent with the levels discharged from the BNL STP.

Monitoring for strontium-90 was performed at stations HE, HM-N and HQ. Trace levels were found at all locations, the highest at Station HE. Strontium-90 was detected at Station HE at a maximum concentration of 0.34 ± 0.01 pCi/L (0.01 ± 0.0004 Bq/L), which is approximately 4% of the drinking water standard and one-third the levels detected in 1999.

5.5.2 PECONIC RIVER - NONRADIOLOGICAL ANALYSES

The inorganic analytical data for the Peconic River and Carmans River samples are summarized in Tables 5-8 and 5-9. Samples collected in 2000 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs.

No VOCs were routinely detected in river water samples above the MDLs, although low concentrations were reported for acetone (5 µg/L or less) and 2-butanone (2 µg/L or less) at several locations. Due to the level of detection, the ubiquitous nature of these compounds in the analytical laboratory, and similar levels of detection in samples collected on the same day, the presence of these compounds is questionable. Trace concentrations of 1,1,1-trichloroethane and 1,1-dichloroethylene were detected in water samples collected at Station HR. Due to the location of this station (Riverhead) and the absence of these compounds at locations closer to BNL, these compounds are not expected to be the result of BNL operations, but may be the result of roadway runoff or other offsite sources. Methylene chloride was detected at 3.3 µg/L in a single sample collected at Station HM-N. This is below the groundwater standard of 5 µg/L and much lower than the Peconic surface water standard of 50 µg/L. No other organic compounds were detected upstream or downstream of the STP discharge.

Comparison of Peconic River water quality data collected upstream and downstream showed that water quality parameters were consistent throughout the river system. These data were also consistent with the Carmans River control location (HH). Chlorides, sulfates, and nitrates tend to be slightly higher in samples collected immediately downstream of the STP discharge (Stations HM-N and HQ) and were consistent with the concentrations in the STP discharge.

The pH measured at several locations was very low due to the low pH of precipitation, groundwater, and the formation of humic acids from decaying organic matter. As the spring rains mix with the decaying matter, these acids decrease the already low pH of precipitation, resulting in a pH of as low as 3.0 Standard Units. A discussion of precipitation monitoring is provided in Chapter 6 of this report.

Ambient water quality standards for metallic elements are based upon their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, while others are toxic in any form (i.e., dissolved and particulate combined). In 2000, the BNL monitoring program assessed water samples for both the dissolved and particulate form. Dissolved concentrations were determined by first filtering the samples prior to acidic preservation and analysis. Examination of the metals data showed that aluminum, copper, lead, mercury, iron, silver, and zinc were present in concentrations which exceeded ambient water quality standards at upstream, downstream and, in some instances, the Carmans River stations. Aluminum, silver, and iron were at the highest concentrations in water samples collected upstream from the STP. Copper, zinc, lead, and mercury were highest in water samples collected immediately downstream at Station HM-N. These elements were routinely detected in the STP discharge and, with the exception of mercury, were detected in the STP discharge in similar concentrations. All levels were less than SPDES permitted effluent limits. Selenium was detected in all samples collected in July 2000. However, the laboratory method blank also tested positive for selenium at similar concentrations. The presence of selenium is most likely due to method blank contamination and not representative of river water quality. Filtration of samples did not influence the concentration of metals in the samples; however, a direct comparison cannot be made since the filtered and unfiltered samples were collected at different times

Table 5-8. Water Quality Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).

Sample Station	Geographic Location		pH (SU)	Conductivity (μS/cm)	Temp. (deg. C)	Dissolved Oxygen (mg/L)	Chlorides (mg/L)	Sulfates (mg/L)	Nitrates as N (mg/L)
HY	Peconic River (headwaters)	N	5.0	5	5.0	5.0	2.0	2.0	2.0
	onsite, east of Wm. Floyd Pkwy.	Min.	4.3	30	5.7	6.9	< 4.0	< 4.0	< 1.0
		Max.	7.4	810	17.5	15.6	< 4.0	< 4.0	< 1.0
		Avg.	NA	202	11.7	10.7	< 4.0	< 4.0	< 1.0
HV	Peconic River (headwaters)	N	3.0	3	3.0	3.0	NS	NS	NS
	onsite, inside the RHIC ring	Min.	4.2	7	3.7	8.6			
		Max.	6.1	200	11.3	12.2			
		Avg.	NA	91	8.7	10.3			
HE	Peconic River	N	4.0	4	4.0	4.0	4.0	4.0	4.0
	upstream of STP Outfall	Min.	5.6	61	0.7	3.6	7.3	4.8	< 1.0
		Max.	6.0	72	20.2	8.3	9.4	7.7	< 1.0
		Avg.	NA	66	11.0	6.1	8.1	6.5	< 1.0
HM-N	Peconic River	N	157.0	157	157.0	156.0	11.0	11.0	11.0
	0.4 mi from STP, onsite	Min.	5.3	19	0.1	4.8	11.8	7.7	1.6
		Max.	6.9	463	23.9	14.0	70.8	17.0	6.6
		Avg.	NA	206	12.4	8.1	29.4	12.7	4.1
HM-S	Peconic River	N	3.0	3	3.0	3.0	3.0	3.0	3.0
	tributary, onsite	Min.	3.6	61	5.8	7.6	5.0	< 4.0	< 1.0
		Max.	5.8	89	10.7	8.0	5.9	5.0	< 1.0
		Avg.	NA	77	8.9	7.7	5.6	1.7	< 1.0
HQ	Peconic River	N	48.0	48	48.0	48.0	5.0	5.0	5.0
	BNL site boundary	Min.	5.8	48	9.1	0.5	8.5	5.3	< 1.0
		Max.	7.9	191	25.4	20.5	81.0	37.7	< 1.0
		Avg.	NA	153	18.1	4.4	29.4	14.3	< 1.0
HA	Peconic River	N	5.0	5	5.0	5.0	5.0	5.0	5.0
	offsite	Min.	6.0	42	1.2	5.0	6.8	< 4.0	< 1.0
		Max.	6.4	52	26.1	13.3	7.6	5.0	< 1.0
		Avg.	NA	47	10.7	9.9	7.3	2.8	< 1.0
HB	Peconic River	N	5.0	5	5.0	5.0	5.0	5.0	5.0
	offsite	Min.	6.3	51	0.8	3.9	8.2	< 4.0	< 1.0
		Max.	6.5	67	23.2	13.8	9.7	4.9	< 1.0
		Avg.	NA	56	12.1	8.3	8.5	2.9	< 1.0
HC	Peconic River	N	4.0	4	4.0	4.0	4.0	4.0	4.0
	offsite	Min.	6.6	55	3.6	7.6	9.1	4.1	< 1.0
		Max.	6.8	88	27.5	11.4	12.1	7.8	< 1.0
		Avg.	NA	68	14.4	10.3	10.2	6.0	< 1.0
HR	Peconic River	N	4.0	4	4.0	4.0	4.0	4.0	4.0
	offsite, Riverhead	Min.	6.3	104	3.7	9.7	14.5	9.3	< 1.0
		Max.	7.7	155	27.9	12.4	18.0	10.5	< 1.0
		Avg.	NA	134	15.3	11.4	16.0	10.2	< 1.0
HH	Carmans River	N	4.0	4	4.0	4.0	4.0	4.0	4.0
	(Control Location)	Min.	6.4	148	4.0	9.5	23.7	9.4	1.1
		Max.	6.9	170	23.7	13.0	26.7	12.1	1.7
		Avg.	NA	158	14.1	11.6	24.8	11.3	1.5
NYS AWQS[a]			6.5 - 8.5	SNS	SNS	SNS	250.0	250.0	10.0
Typical MDL			NA	10	NA	NA	4.0	4.0	1.0

Notes:
See Figure 5-9 for sample station locations.
N = No. of samples
NA = Not Applicable
NS = Not Sampled
MDL = Minimum Detection Limit
RHIC = Relativistic Heavy Ion Collider
SNS = Standard Not Specified
STP = Sewage Treatment Plant
[a]Since there are no Class C Surface Water Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for groundwater is provided, if specified.
Su = Standard Unit

Table 5-9. Metals Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).

River	Sample Station	N		Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Na	Pb	Sb	Se*	Tl	V	Zn
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Peconic	HY (Total)	1	Value	< 2.0	965.2	< 3.0	24.1	< 0.7	< 2.2	0.7	2	38.1	0.5	< 0.2	53.1	< 10	3.3	1.6	8.9	1.8	< 10	< 1.3	< 11	27.3
	HY (Filtered)	1	Value	< 1.0	100	< 3.0	4	< 0.7	< 2.2	0.1	< 1	2.8	NR	NR	5.7	< 5	< 1.1	NR	< 1.3	< 0.9	< 5	< 0.7	< 5.5	9.3
	HE (Total)	2	Min.	< 1.0	194.1	3.1	14.2	< 0.7	< 1.1	0.5	< 1.0	< 2.0	0.4	< 0.2	59.7	< 5.0	< 1.1	5.1	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	10.1
			Max.	< 1.0	257	3.4	43.5	< 0.7	< 1.1	0.9	< 1.0	2.8	0.5	NR	122	< 5.0	1.1	5.3	< 1.3	< 0.9	13.7	< 0.7	< 5.5	20.9
	HE (Filtered)	2	Min.	< 1	13	5.6	32.4	< 0.7	< 1.1	0.6	1.5	6.9	0.9	0.2	144	< 5	< 1.1	5.9	< 1.3	< 0.9	< 10.0	< 0.7	< 1.1	23.9
			Max.	79	580.8	6	67.7	< 1.3	< 2.2	1.3	< 2.0	30.9	3.2	0.3	226	< 10	3.1	6.3	6.3	< 1.8	25.8	< 1.3	< 5.5	56.2
	HM-N	10	Min.	< 1.0	17.5	< 3.0	3.9	< 0.7	< 1.1	< 0.1	< 1.0	< 2	< 0.08	< 0.2	< 2	< 5.0	< 1.1	10.4	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	< 4.0
			Max.	< 10.0	338.7	5.4	31.6	< 0.7	< 11	< 1.2	14	93.3	0.7	1.4	98	< 50	< 11	40.1	13.2	< 8.8	25.9	< 6.6	8.8	87.5
			Avg.	1.7	113.8	< 3.0	18.1	< 0.7	< 1.1	0.6	2.3	43.9	0.3	0.2	17.8	< 5.0	4.1	22	2.2	< 0.9	11.6	< 0.7	< 5.5	47.9
	HM-N (Filtered)	1		< 1.0	15.5	< 3.0	18.9	< 0.7	< 1.1	0.3	< 1.0	31.6	0.08	NR	2.3	< 5.0	5.3	24.1	< 1.3	< 0.9	< 5	< 0.7	< 5.5	51.5
	HM-S	2	Min.	< 1.0	630.2	< 3	11.1	< 0.7	< 1.1	0.1	1	45.6	0.27	< 0.2	26.5	< 5.0	< 1.1	1.6	1.8	< 0.9	< 5.0	< 0.7	< 5.5	< 4
			Max.	< 1.0	734.4	7.2	14.9	< 0.7	< 1.1	0.2	1	59.4	0.32	0.4	35.6	< 5.0	5.7	3.5	3.8	< 0.9	17.1	< 0.7	< 5.5	40
	HQ	4	Min.	< 1.0	22.2	< 3.0	12.3	< 0.7	< 1.1	0.2	< 1.0	6.5	0.1	< 0.2	3.7	< 5.0	2.1	7.1	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	7
			Max.	1.4	485.6	7.9	15.9	< 0.7	< 1.1	0.4	1.8	23.6	0.4	0.3	20.7	< 5.0	4.1	24	2.7	< 0.9	17.9	< 0.7	6	10.3
			Avg.	< 1.0	153.2	< 3.0	13.4	< 0.7	< 1.1	0.3	< 1.0	13	0.2	< 0.2	12.2	< 5.0	3	15.8	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	8.7
	HA (Total)	2	Min.	< 1.0	83.2	< 3.0	10.4	< 0.7	< 1.1	0.13	1	2	0.5	< 0.2	21.1	< 5.0	< 1.1	3.8	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	< 4.0
			Max.	30	92.4	< 3.0	13.2	< 0.7	< 1.1	0.17	1	42.9	0.8	< 0.2	47.4	< 5.0	< 1.1	4.9	1.7	< 0.9	< 5.0	< 0.7	< 5.5	16.2
	HA (Filtered)	2	Min.	< 1.0	46.1	< 3.0	10.1	< 0.7	< 1.1	0.2	< 1.0	< 2.0	0.6	0.2	30.1	< 5.0	< 1.1	4.7	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	4.5
			Max.	< 1.0	52.7	3.4	12.6	< 0.7	< 1.1	0.5	< 1.0	4.2	1	< 0.2	75.5	< 5.0	< 1.1	5.2	< 1.3	< 0.9	12.4	< 0.7	< 5.5	5
	HB (Total)	2	Min.	< 1.0	52.1	< 3.0	12.6	< 0.7	< 1.1	0.13	1	< 2.0	0.8	< 0.2	25.5	< 5.0	< 1.1	5.2	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	9.8
			Max.	< 1.0	68.5	< 3.0	14.6	< 0.7	< 1.1	0.3	1	46.6	1.4	< 0.2	76.9	< 5.0	< 1.1	5.4	1.5	< 0.9	< 5.0	< 0.7	< 5.5	16.8
	HB (Filtered)	2	Min.	< 1.0	28.9	< 3.0	9.8	< 0.7	< 1.1	< 0.1	< 1.0	< 2.0	0.9	< 0.2	28	< 5.0	< 1.1	5.2	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	<4.0
			Max.	< 1.0	33.8	4.7	12.2	< 0.7	< 1.1	0.5	< 1.0	< 2.0	1.7	0.4	25.5	< 5.0	< 1.1	5.7	< 1.3	< 0.9	13.9	< 0.7	< 5.5	15.8
	HC (Total)	2	Min.	< 1.0	44.1	< 3.0	15	< 0.7	< 1.1	< 0.1	1	< 2.0	0.8	< 0.2	33.5	< 5.0	< 1.1	6.2	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	9.6
			Max.	< 1.0	90.4	< 3.0	18.5	< 0.7	< 1.1	0.2	1	110	0.8	0.2	122	< 5.0	< 1.1	7.4	2.2	< 0.9	< 5.0	< 0.7	< 5.5	11
	HC (Filtered)	2	Min.	< 1.0	38	< 3.0	11.8	< 0.7	< 1.1	0.1	< 1.0	< 2.0	0.8	< 0.2	21.6	< 5.0	< 1.1	6	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	13.5
			Max.	22	46.3	4	15.2	< 0.7	< 1.1	0.3	< 1.0	< 2.0	1.9	0.5	41.8	< 5.0	< 1.1	6.8	< 1.3	< 0.9	13	< 0.7	< 5.5	13.9
	HR (Total)	2	Min.	< 1.0	40.6	< 3.0	11.3	< 0.7	< 1.1	0.2	1	2	0.7	< 0.2	29.8	< 5.0	< 1.1	9.9	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	< 4.0
			Max.	15.9	736.2	< 3.0	24.3	< 0.7	< 1.1	0.2	1	7.7	0.8	< 0.2	142	< 5.0	< 1.1	11.4	1.5	< 0.9	< 5.0	< 0.7	< 5.5	< 4.0
	HR (Filtered)	2	Min.	< 1.0	15.8	< 3.0	17.4	< 0.7	< 1.1	0.1	< 1.0	< 2.0	0.3	0.2	35	< 5.0	< 1.1	10.7	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	5.8
			Max.	< 1.0	28.6	3.7	18.8	< 0.7	< 1.1	0.2	< 1.0	2	0.9	0.3	50.6	< 5.0	< 1.1	11.3	< 1.3	< 0.9	13.7	< 0.7	< 5.5	48.2
Carmans (Control Location)	HH (Total)	1	Value	< 1.0	9.3	< 3.0	27.3	< 0.7	< 1.1	0.1	< 1.0	2.4	0.1	< 0.2	25.2	< 5.0	< 1.1	17.1	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	<4.0
	HH (Filtered)	2	Min.	< 1.0	10.9	< 3.0	32.6	< 0.7	< 1.1	0.2	< 1.0	2.3	0.3	< 0.2	78.8	< 5.0	< 1.1	16.8	< 1.3	< 0.9	< 5.0	< 0.7	< 5.5	< 4.0
			Max.	< 1.0	78.2	3.5	34.7	< 0.7	< 1.1	0.4	1	2.4	0.5	< 0.2	96.2	< 5.0	< 1.1	17.1	< 1.3	< 0.9	12.8	< 0.7	< 5.5	< 4.0
NYSDEC AWQS				0.1	100	150	SNS	11	1.1	5	34	4	0.3	0.2	SNS	SNS	23	SNS	0.1	SNS	4.6	8	14	37
Solubility State				I	I	D		AS	D	AS	D	D	AS	D		D		D	D	AS	AS	D		
Typical MDL				1	2.2	3	1.8	0.66	1.1	0.12	1	2	0.075	0.2	2	5	1.1	1	1.3	0.88	5	0.66	5.5	4

Notes:
See Figure 5-9 for sample station locations.
Surface water location HV was not sampled for metals in 2000
*The concentration of selenium detected in several samples analyzed in July are estimated due to blank contamination. Analysis of the method blank showed detectable levels of selenium very similar to those found in the samples.
AS = Acid Soluble
D = Dissolved
I = Ionic
MDL = Minimum Detection Limit
N = No. of Samples
NYSDEC AWQS=New York State Department of Environmental Conservation Ambient Water Quality Standard for Class C Surface Water
SNS = Standard Not Specified for these elements for Class C waters

within the year. Filtration of samples will be done again in 2001, and samples will be split at the time of collection with one-half filtered prior to acidic preservation and analysis to allow better comparison of dissolved and particulate levels of metals.

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