5 Water Quality

Wastewater generated from Brookhaven National Laboratory (BNL) operations is discharged to surface waters via the Sewage Treatment Plant (STP) and to groundwater via recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and vigilant operation of treatment facilities ensure that these discharges comply with all applicable requirements and that the public, employees, and environment are protected.

Analytical data for 2009 show that the average gross alpha and beta activity levels in the STP discharge were within the typical range of historical levels and were well below drinking water standards. During 2009, tritium was detected in the STP effluent only once at a concentration above the minimum detectable activity (490 pCi/L), which is less than 3 percent of the drinking water standard. Tritium was also detected twice in the influent, but at levels just above the minimum detectable activity. Analysis of the STP effluent continued to show no detection of cesium-137, strontium-90, or other gamma-emitting nuclides attributable to BNL operations. Similarly, there were no radionuclides detected along the Peconic River in 2009 that were attributable to BNL operations.

Nonradiological monitoring of the STP effluent showed that, except for isolated incidents of noncompliance, organic and inorganic parameters were within State Pollutant Discharge Elimination System effluent limitations or other applicable standards.

Examination of analytical data for discharges to recharge basins shows that the average concentrations of gross alpha and beta activity were within typical ranges and no gamma-emitting radionuclides were detected in 2009. Tritium was detected in a single sample collected at Basin HT-W at a very low level (400 ± 220 pCi/L), and with high uncertainty. Review of organic data shows that disinfection byproducts are detected in discharges to recharge basins due to the use of chlorine and bromine for the control of algae and bacteria in potable and cooling water systems. Inorganics (i.e., metals) are also detected in these discharges, primarily from sediment run-off in stormwater discharges. Inorganic data from Peconic River samples collected upstream, downstream, and at control locations demonstrated that elevated amounts of aluminum and iron detected in the river are associated with natural sources.

5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the BNL STP is discharged into the headwaters of the Peconic River. This discharge is permitted under the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) Program. Effluent limits are based on the water quality standards established by NYSDEC, as well as historical operational data. To assess the impact of wastewater discharge on the quality of the river, surface water is monitored at several locations upstream and downstream of the discharge point. Monitoring Station HY (see Figure 5-8), on site but upstream of all Laboratory operations, provides information on the background water quality of the Peconic River. The Carmans River is monitored as a geographic control location for comparative purposes, as it is not affected by operations at BNL or within the Peconic River watershed.

On the Laboratory site, the Peconic River is an intermittent stream. Off-site flow occurs only during periods of sustained precipitation, typically in the spring. Off-site flow in 2009 was only persistent through late July, and then started flowing again in mid-November. When flow ceased, standing water was continuous throughout the year in several of the deeper sections of the river. The following sections describe BNL's surface water monitoring and surveillance program.

5.2 SANITARY SYSTEM EFFLUENTS

The STP effluent (Outfall 001) is a discharge point authorized under a SPDES permit issued by NYSDEC. Figure 5-1 shows a schematic of the STP and its sampling locations. The Laboratory's STP treatment process includes four principal steps: 1) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, 2) secondary clarification, 3) sand filtration for final solids removal, and 4) ultraviolet disinfection for bacterial control prior to discharge to the Peconic River. Tertiary treatment for nitrogen removal is also provided by controlling the oxygen levels in the aeration tanks. During the aeration process (Step 1), the oxygen levels are allowed to drop to the point where microorganisms use nitrate-bound oxygen for respiration; this liberates nitrogen gas and consequently reduces 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. During the night (when photosynthesis does not occur), aquatic plants use oxygen in the water. Too much oxygen uptake by aquatic vegetation deprives a water system of oxygen needed by fish

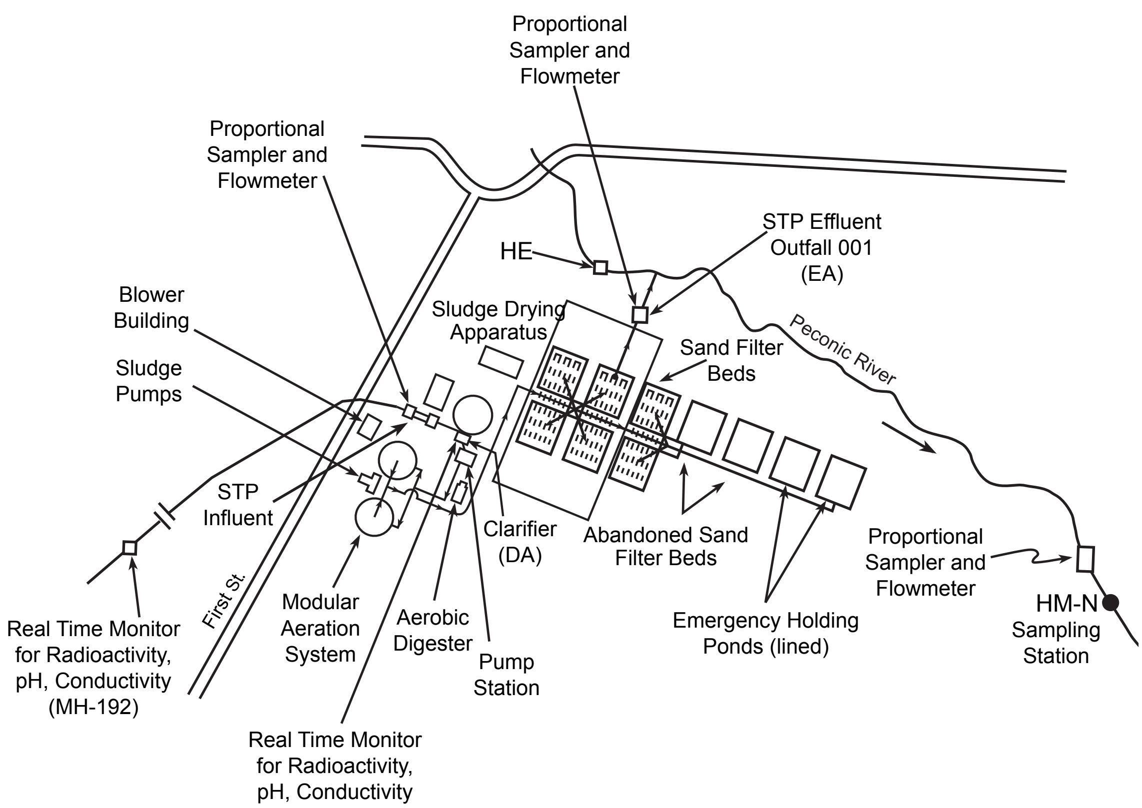

Figure 5-1. Schematic of BNL's Sewage Treatment Plant (STP).

and other aquatic organisms for survival. Limiting the concentration of nitrogen in the STP discharge helps keep plant growth in the Peconic River in balance with the nutrients provided by natural sources.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity takes place at two locations. The first site (MH-192, see Figure 5-1) is approximately 1.1 miles upstream of the STP, providing at least 30 minutes' warning to the STP operators if wastewater is en route that may exceed SPDES limits or BNL effluent release criteria (which are more stringent than DOE-specified levels). The second site is at the point where the STP influent enters the treatment process, as shown in Figure 5-1.

Based on the data collected by the real-time monitoring systems, any influent to the STP that may not meet SPDES limits or BNL effluent release criteria (whichever is more stringent) is diverted to two double-lined holding ponds. The total combined capacity of the two holding ponds exceeds 6 million gallons, or approximately 18 days of flow. Diversion continues until the effluent's water quality meets the permit limits or release criteria. If wastewater is diverted to the holding ponds, it is tested and evaluated against the requirements for release. If necessary, the wastewater is treated and then reintroduced into the STP at a rate that ensures compliance with SPDES permit limits for non-radiological parameters or BNL effluent release criteria for radiological parameters. In 2009, there were no instances that required diversion of the waste water to the hold-up ponds.

Solids separated in the clarifier are pumped to aerobic digesters for continued biological solids reduction and sludge thickening. Until 2007, the thickened sludge was periodically emptied into solar/heat lamp-powered drying beds, where it was dried to a solid cake. The dried sludge historically contained very low levels (less than 0.5 pCi/g) of radioactivity, such as residual levels of cobalt-60 (Co-60: half-life 5.2 years) from sewage releases. Consequently, the dried sludge was dispositioned as low-level radioactive waste. In an effort to reduce a high inventory of sludge stored in the aerobic digesters, in 2007 the Laboratory retained the services of Mineral Processing Services to process the sludge for drying and eventual off-site disposal. The sludge was processed in late 2007 and placed into Geotubes (large filter bags) and left to dry throughout 2008. In the summer of 2009, the dried sludge was mixed with sand from the sand filter beds and disposed off site at a landfill authorized by NYSDEC. New sand was placed in the filter beds and they were placed back into service. With the clean-out of the digesters, newly generated sludge was analyzed and found to be free of radiological contamination. In 2008, authorization was received from the local County authority to transfer waste sludge directly from the aerobic digester to the County-operated sewage treatment facility. In 2009, two shipments (approximately 50,000 gallons of sludge each) were released to the County sewage works at Bergen Point after waste characterization samples of the sludge were found to be acceptable.

5.2.1 Sanitary System Effluent–Radiological Analyses

Wastewater at the STP is sampled at the inlet to the treatment process, Station DA (see Figure 5-1) and at the Peconic River Outfall (Station EA). At each location, samples are collected on a flow-proportional basis; that is, for every 1,000 gallons of water treated, approximately 4 fluid ounces of sample are collected and composited into a 5-gallon collection container. These samples are analyzed for gross alpha and gross beta activity and for tritium concentrations. In 2009, samples were collected three times weekly. Samples collected from these locations are also composited and analyzed monthly for gamma-emitting radionuclides and strontium-90 (Sr-90: half-life 29 years).

Although the Peconic River is not used as a direct source of potable water, the Laboratory applies the stringent Safe Drinking Water Act (SDWA) standards for comparison purposes when monitoring the effluent, in lieu of DOE wastewater criteria. Under the SDWA, water standards are based on a 4 mrem (40 µSv) dose limit. The SDWA specifies that no individual may receive an annual dose greater than

Table 5-1. Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).

		Flow (a) (Liters)	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
			max.	avg.	max.	avg.	max.	avg.
January	*influent*	2.50E+7	< 380	-6.2 ± 68.5	< 1.4	0.6 ± 0.2	7.2 ± 1.6	4.6 ± 1.0
	effluent	2.02E+7	< 350	8.1 ± 54.4	< 1.7	0.5 ± 0.3	5.9 ± 1.2	4.1 ± 0.4
February	*influent*	2.21E+7	360 ± 210	80.8 ± 64.3	< 1.3	0.1 ± 0.2	9.2 ± 1.5	5.4 ± 0.8
	effluent	1.74E+7	< 330	100.8 ± 48.5	< 1.4	0.3 ± 0.3	6.1 ± 1.3	4.8 ± 0.5
March	*influent*	2.84E+7	< 250	43.8 ± 45.7	5.5 ± 3.7	0.7 ± 0.8	6.3 ± 1.1	4.4 ± 0.6
	effluent	2.16E+7	< 270	57.7 ± 48.8	< 2.6	0.4 ± 0.3	5.6 ± 1.1	4.4 ± 0.4
April	*influent*	3.66E+7	630 ± 220	92.3 ± 97.4	1.6 ± 1.1	0.7 ± 0.3	6.9 ± 1.2	4.4 ± 0.7
	effluent	3.12E+7	< 310	84.3 ± 56	< 1.3	0.2 ± 0.2	5.6 ± 1.3	3.8 ± 0.4
May	*influent*	2.31E+6	< 330	78.1 ± 66.9	3.5 ± 1.6	0.9 ± 0.5	6.8 ± 1.4	5.6 ± 0.5
	effluent	3.19E+7	< 330	89.9 ± 55.1	< 1.3	0.2 ± 0.3	5.5 ± 1.2	4.1 ± 0.4
June	*influent*	3.57E+7	< 310	14.9 ± 50.6	5.4 ± 2.7	1.4 ± 0.8	10.4 ± 2.2	6.4 ± 1.0
	effluent	2.89E+7	< 310	87.7 ± 30.2	< 1.5	0.0 ± 0.2	6.2 ± 1.2	5.0 ± 0.3
July	*influent*	4.04E+7	< 300	71.6 ± 47.1	3.5 ± 1.8	1.2 ± 0.6	8.0 ± 1.5	5.3 ± 0.8
	effluent	4.14E+7	< 310	103.8 ± 38.5	< 2.6	0.5 ± 0.4	6.5 ± 1.2	4.7 ± 0.7
August	*influent*	3.86E+7	< 420	12.5 ± 49.6	6.4 ± 2.7	2.3 ± 1.0	11.4 ± 1.8	6.4 ± 1.6
	effluent	4.27E+7	< 380	75.5 ± 48.5	< 1.9	0.4 ± 0.3	7.1 ± 1.4	5.3 ± 0.7
September	*influent*	1.91E+7	< 160	23.6 ± 29.4	6.8 ± 3.1	2.3 ± 1.7	12.9 ± 3.4	7.2 ± 2.2
	effluent	1.81E+7	< 170	32.7 ± 30.8	5.0 ± 2.3	1.2 ± 1.3	7.7 ± 1.7	5.4 ± 1.2
October	*influent*	1.22E+7	< 160	23.2 ± 27.7	2.6 ± 1.1	1.0 ± 1.3	5.6 ± 1.1	4.3 ± 1.2
	effluent	1.19E+7	< 190	39.2 ± 44.5	2.1 ± 1.0	0.7 ± 1.0	6.7 ± 1.2	5.3 ± 0.9
November	*influent*	3.44E+7	< 340	39.8 ± 41.9	< 2.2	0.5 ± 0.3	6.1 ± 1.1	4.3 ± 0.8
	effluent	3.37E+7	490 ± 230	83.5 ± 78.6	< 1.5	0.5 ± 0.3	5.2 ± 1.1	4.1 ± 0.3
December	*influent*	3.89E+7	< 120	22.2 ± 31.1	< 1.6	0.4 ± 0.3	6.4 ± 1.2	4.8 ± 0.7
	effluent	3.63E+7	< 120	14 ± 35.2	1.5 ± 1.0	0.5 ± 0.4	6.2 ± 1.3	4.2 ± 0.5
Annual Avg.	*influent*	2.78E+7		43.2 ± 17.6		1.0 ± 0.2		5.3 ± 0.3
	effluent	2.79E+7		67.8 ± 15.3		0.4 ± 0.1		4.5 ± 0.2
Total Release		**3.35E+8**		**22.3 mCi**		**0.1 mCi**		**1.4 mCi**
Average MDL (pCi/L)				**270.7**		**1.6**		**1.2**
SDWA Limit (pCi/L)				**20,000**		**15**		**(b)**

Notes:
All values are reported with a 95% confidence interval.
Negative numbers occur when the measured value is lower than background (see Appendix B for description).
To convert values from pCi to Bq, divide by 27.03.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act
(a) Effluent values greater than influent values occur when water that had been diverted to the holding ponds is tested, treated (if necessary), and released.
(b) The drinking water standards were changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

4 mrem from radionuclides that are beta or photon emitters, which includes up to 168 individual radioisotopes. The Laboratory performs radionuclide-specific gamma analysis to ensure compliance with this standard. The SDWA annual average gross alpha activity limit is 15 pCi/L, including radium-226 (Ra-226: half-life 1,600 years), but excluding radon and uranium.

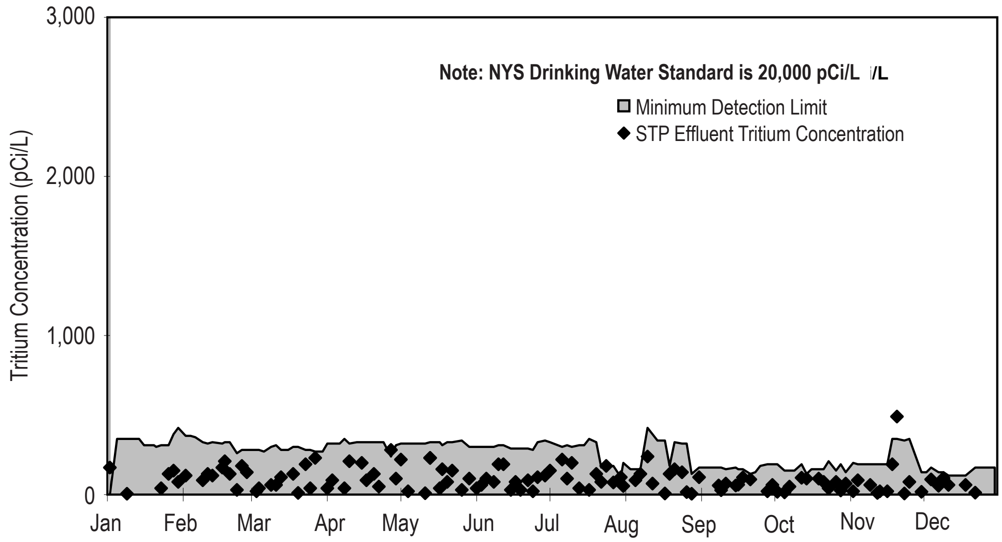

Figure 5-2. Tritium Concentrations in Effluent from the BNL Sewage Treatment Plant (2009).

Other SDWA-specified drinking water limits are 20,000 pCi/L for tritium (H-3: half-life 12.3 years), 8 pCi/L for Sr-90, 5 pCi/L for Ra-226 and radium-228 (Ra-228: half-life 5.75 years), and 30 µg/L for uranium. Gross activity (alpha and beta) measurements are 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 2009. Annual average gross alpha and beta activity levels in the STP effluent were 0.4 ± 0.1 pCi/L and 4.5 ± 0.2 pCi/L, respectively. These concentrations remain essentially unchanged from year to year. Control location data (Carmans River Station HH; see Figure 5-8) show average gross alpha and beta levels of 0.22 ± 0.68 pCi/L and 1.45 ± 1.1 pCi/L, respectively (see Table 5-7). The average concentrations of gross alpha and beta activity in Peconic River water samples collected upstream of BNL were 0.49 ± 0.33 pCi/L and 2.48 ± 1.17 pCi/L, respectively.

Tritium detected at the STP originates from either High Flux Beam Reactor (HFBR) sanitary system releases, or from small, infrequent batch releases that meet BNL discharge criteria from other facilities. Although the HFBR is no longer operating, tritium continues to be released from the facility at very low concentrations due to off-gassing. When the HFBR was operating, air within the reactor building contained higher levels of tritium in the form of water vapor. The water was absorbed by many porous surfaces and materials, which slowly liberated the tritiated moisture as it is replaced by untritiated water. Once tritium is in the air stream, it condenses as a component of water vapor in the air conditioning or air compressor units and is discharged in these wastewater streams. To minimize the quantity of tritium released to the STP, efforts have been made to capture most of the air compressor condensate collected in the equipment areas of the structure. A plot of the 2009 tritium concentrations recorded in STP effluent is presented in Figure 5-2. A 15-year trend plot of annual average tritium concentrations measured in the STP discharge is shown in Figure 5-3. The annual average concentration trend has been declining since 1995.

In 2009, with the exception of a single low-level reported value, tritium was not detected in the discharge of the STP (EA, Outfall 001) for the entire year. The concentration measured in the single sample of the STP discharge in November (see Figure 5-2) was 490 ± 230 pCi/L. Although this was a low level of detection with high uncertainty, this concentration may be attributed to work to further ready the HFBR for decommissioning and decontamination (D&D). Residual moisture within the HFBR piping systems may have been exposed during D&D activities and could result in higher tritium releases to the STP. The annual average

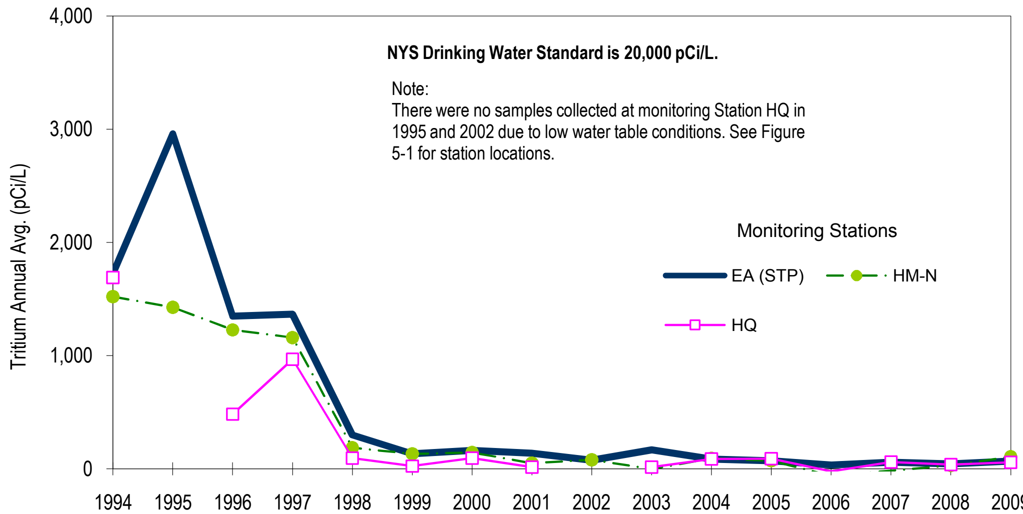

Figure 5-3. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1994–2009).

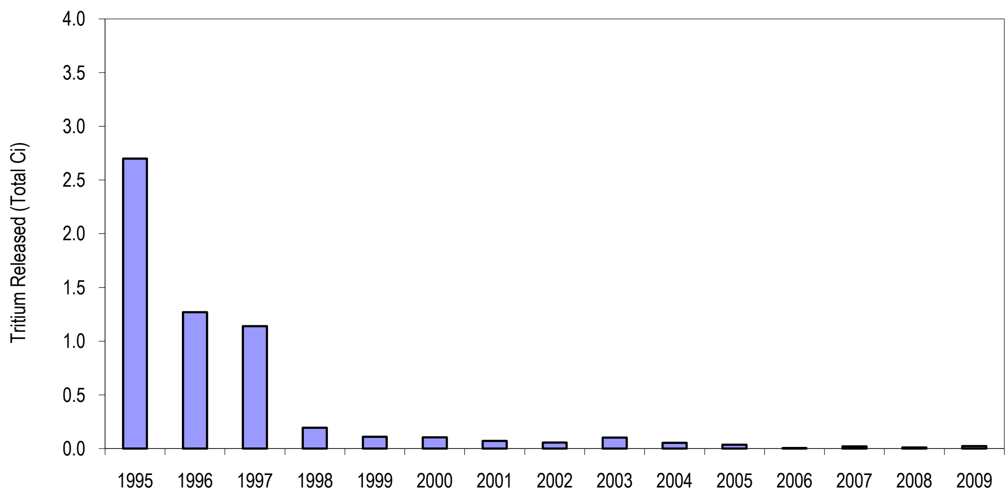

Figure 5-4. Tritum Released to the Peconic River, 15-Year Trend (1995–2009).

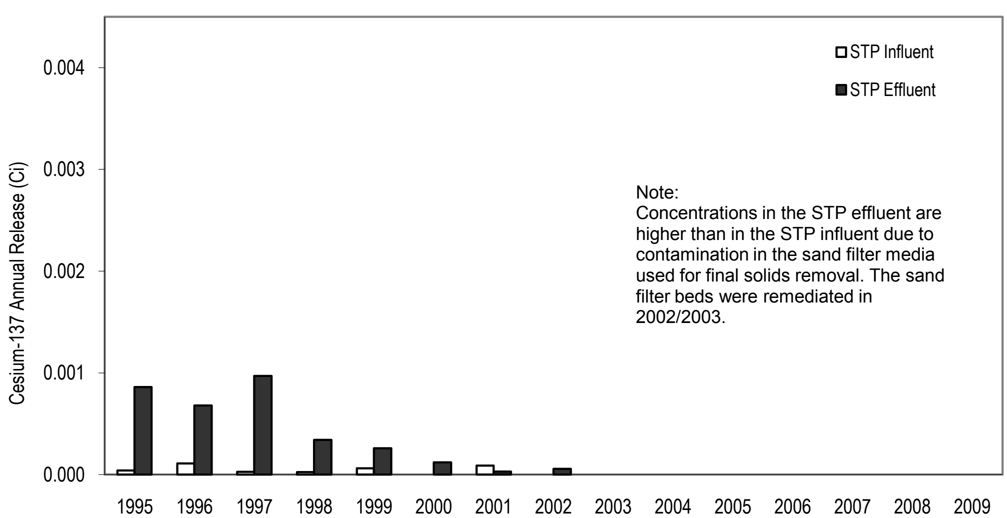

Figure 5-5. Cesium-137 in the BNL Sewage Treatment Plant Influent and Effluent (1995–2009).

tritium concentration, as measured in the STP effluent, was 67.8 ± 15.3 pCi/L, which is only 25 percent of the average MDL, 270 pCi/L, and well below the drinking water standard (DWS) of 20,000 pCi/L. Using the annual average concentration and the flow recorded for the year, a total of 0.022 Ci (22.3 mCi) of tritium was released during the year, which is consistent with total releases of tritium over the last five years (see Figure 5-4). Low levels of tritium were also detected in two influent samples collected in February and April 2009 (360 ± 210 pCi/L and 630 ± 220 pCi/L, respectively) and were also most likely attributed to D&D work at the HFBR.

Table 5-2 presents the gamma spectroscopy data for anthropogenic radionuclides historically detected in the monthly STP wastewater composite samples. In 2009, there were no gamma-emitting nuclides detected in the STP effluent, which is consistent with data reported for 2003–2008 (see Figure 5-5). Sr-90 was detected (0.83 pCi/L) in a single sample of influent collected in July but was not detectable in the effluent.

Table 5-2. Gamma-Emitting Radionuclides and Strontim-90 in Water at the BNL Sewage Treatment Plant.

		Flow (Liters)	Co-60	Cs-137	Be-7 (pCi/L)	Na-22	Sr-90
January	*influent*	2.50E+7	ND	ND	ND	ND	ND
	effluent	2.02E+7	ND	ND	ND	ND	ND
February	*influent*	2.21E+7	ND	ND	ND	ND	ND
	effluent	1.74E+7	ND	ND	ND	ND	ND
March	*influent*	2.84E+7	ND	ND	ND	ND	ND
	effluent	2.16E+7	ND	ND	ND	ND	ND
April	*influent*	3.66E+7	ND	ND	ND	ND	ND
	effluent	3.12E+7	ND	ND	ND	ND	ND
May	*influent*	2.31E+6	ND	ND	ND	ND	ND
	effluent	3.19E+7	ND	ND	ND	ND	ND
June	*influent*	3.57E+7	ND	ND	ND	ND	ND
	effluent	2.89E+7	ND	ND	ND	ND	ND
July	*influent*	4.04E+7	ND	ND	ND	ND	0.83
	effluent	4.14E+7	ND	ND	ND	ND	ND
August	*influent*	3.86E+7	ND	ND	ND	ND	ND
	effluent	4.27E+7	ND	ND	ND	ND	ND
September	*influent*	1.91E+7	ND	ND	ND	ND	ND
	effluent	1.81E+7	ND	ND	ND	ND	ND
October	*influent*	1.22E+7	ND	ND	ND	ND	ND
	effluent	1.19E+7	ND	ND	ND	ND	ND
November	*influent*	3.44E+7	ND	ND	ND	ND	ND
	effluent	3.37E+7	ND	ND	ND	ND	ND
December	*influent*	3.89E+7	ND	ND	ND	ND	ND
	effluent	3.63E+7	ND	ND	ND	ND	ND
Total Release to the Peconic River (mCi)			**0**	**0**	**0**	**0**	**0**
DOE Order 5400.5 DCG (pCi/L)			**5,000**	**3,000**	**50,000**	**10,000**	**1,000**
Dose limit of 4 mrem EDE (pCi/L)			**100**	**200**	**6,000**	**400**	**8**

Notes:
No BNL-derived radionuclides were detected in the effluent to the Peconic River for 2009.
To convert values from pCi to Bq, divide by 27.03.
DCG = Derived Concentration Guide
EDE = Effective Dose Equivalent
ND = Not Detected

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 for nonradiological contaminants 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. Composite samples of the STP effluent are collected using a flow-proportional refrigerated sampling device (ISCO Model 3700RF) and are then analyzed by contract analytical laboratories. Samples are analyzed for 23 inorganic elements and for anions, semivolatile organic compounds (SVOCs), pesticides, and herbicides. 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 water quality and inorganic analytical results for the STP samples. Comparing the effluent data to the SPDES effluent limits (or New York State Ambient Water Quality Standards [NYS AWQS], as appropriate) shows that most of the analytical parameters were within effluent permit limits (see also the compliance data in Chapter 3). Only total aluminum, iron, and zinc were detected in the effluent at concentrations exceeding the SPDES permit limits or ambient water quality standards. Aluminum was detected in a single sample in July at a concentration of 107 µg/L, which is just above the NYS AWQS limit of 100 µg/L. Iron was detected in a single sample in April at a concentration of 0.8 mg/L, approximately two times the SPDES limit of 0.37 mg/L, and zinc was detected in May at a concentration of 134 µg/L, which is just above the SPDES limit of 100 µg/L. Review of the STP monthly reports for each of these months indicate that all of these excursions were likely associated with the decant of water from the aerobic digesters that occurred prior to collecting effluent samples. Samples of decant collected in the past have shown high concentrations of aluminum, iron, and zinc. Aluminum is also regulated in the ionic (i.e., dissolved) form. All data reported in Table 5-3 are for "total recoverable," which includes suspended and dissolved fractions; consequently, the data are conservative (err on the side of caution). The iron concentration is consistent with the compliance data reported in Chapter 3, and since the SPDES permit limit for zinc is represented as 0.1 mg/L, with standard rounding, the measured value would not constitute a violation of the limit.

In 2009, two VOCs were detected in the STP effluent, but at very low concentrations. Methyl chloride was detected on one occasion with a concentration estimated at less than 1 µg/L, and much less than the NYS AWQS of 5 µg/L. Acetone was also detected, at concentrations ranging from 1.5 µg/L to a maximum of 6.8 µg/L. Acetone is a common solvent used in the contract analytical laboratory and is routinely detected due to cross-contamination within the contract analytical laboratory.

5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may contain constituents above SPDES permit limits or ambient water quality discharge standards must be held by the generating facility and be 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, subsequently, the Peconic River.

The Laboratory's SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from printed-circuit-board fabrication operations conducted in Building 535B, metal cleaning operations in Building 498, and cooling tower discharges from Building 902. These operations are monitored for contaminants such as metals, cyanide, VOCs, and SVOCs. In 2009, analyses of these waste streams showed that, although

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

		STP Influent				STP Effluent				SPDES Limit or AWQS (1)	Comment or Qualifier
ANALYTE	*Units*	N	Min.	Max.	Avg.	N	Min.	Max.	Avg.		
pH	SU	CM	6.8	7.9	NA	CM	6.1	8.0	NA	5.8 - 9.0	
Conductivity	µS/cm	CM	NR	NR	NR	172(a)	136	746	361.4	SNS	
Temperature	°C	CM	NR	NR	NR	172(a)	3.5	26.2	14.3	SNS	
Dissolved Oxygen	mg/L	NM	NM	NM	NM	172(a)	6.1	14.3	9.9	SNS	
Chlorides	mg/L	12	48.7	118.0	66.1	12	39.6	136.0	64.1	SNS	
Nitrate (as N)	mg/L	11	0.1	3.1	1.7	11	0.7	6.7	3.7	10	Total N
Sulfates	mg/L	12	1.8	19.8	15.1	12	11.7	19.9	17.3	250	GA
Aluminum	µg/L	12	116.0	5950.0	849.1	12	17.1	107.0	60.9	100	Ionic
Antimony	µg/L	12	0.5	13.9	< 10	12	0.3	< 10	< 10	3	GA
Arsenic	µg/L	12	0.8	23.7	< 10	12	1.2	< 10	< 10	150	Dissolved
Barium	µg/L	12	29.7	915.0	173.9	12	14.4	28.6	19.3	1000	GA
Beryllium	µg/L	12	0.1	< 4	< 4	12	0.1	< 4	< 4	11	Acid Soluble
Cadmium	µg/L	12	0.4	8.2	< 2	12	0.2	0.6	0.4	1.1	Dissolved
Calcium	mg/L	12	10.9	23.8	14.9	12	10.1	18.1	13.1	SNS	
Chromium	µg/L	12	3.5	57.1	< 20	12	3.0	< 20	< 20	34.4	Dissolved
Cobalt	µg/L	12	0.3	21.1	3.2	12	0.3	1.1	0.7	5	Acid Soluble
Copper	µg/L	12	49.7	5720.0	750.9	12	25.8	69.8	45.8	150	SPDES
Iron	mg/L	12	0.6	20.4	3.2	12	0.1	0.8	0.3	0.37	SPDES
Lead	µg/L	12	3.1	550.0	64.2	12	1.0	5.5	3.2	19	SPDES
Magnesium	mg/L	12	2.9	6.7	4.3	12	2.7	5.4	3.8	SNS	
Manganese	µg/L	12	19.1	194.0	62.1	12	2.5	11.9	6.5	300	GA
Mercury	µg/L	12	0.1	5.2	0.9	12	0.1	0.2	< 0.2	0.2	SPDES
Nickle	µg/L	12	2.7	224.0	32.0	12	3.2	13.7	7.3	110	SPDES
Potassium	mg/L	12	3.8	10.5	6.4	12	3.2	7.5	4.7	SNS	
Selenium	µg/L	12	0.4	7.4	< 5	12	0.2	< 10	< 10	4.6	Dissolved
Silver	µg/L	12	0.4	34.2	4.3	12	0.7	3.9	2.0	15	SPDES
Sodium	mg/L	12	30.8	91.6	47.1	12	25.5	78.3	43.0	SNS	
Thallium	µg/L	12	0.1	< 10	< 10	12	0.2	< 10	< 10	8	Acid Soluble
Vanadium	µg/L	12	3.2	115.0	12.7	12	3.3	< 10	< 10	14	Acid Soluble
Zinc	µg/L	12	46.2	4790.0	589.6	12	30.5	134.0	72.7	100	SPDES

Notes:
See Figure 5-1 for locations of the STP influent and effluent monitoring locations.
All analytical results were generated using total recoverable analytical techniques.
For Class C Ambient Water Quality Standards (AWQS), the solubility state for the metal is provided.
(1) Unless otherwise provided, the reference standard is NYSDEC Class C Surface Water Ambient Water Quality Standards (AWQS).
(a) The conductivity, temperature, and dissolved oxygen values reported are based on analyses of daily grab samples.
AWQS = Ambient Water Qualty Standards
NR = Not Recorded
CM = Continuously monitored
NYSDEC = New York State Department of Environmental Conservation
GA = Class GA (groundwater) AWQS
SNS = Standard Not Specified
N = Number of samples
SPDES = State Pollutant Discharge Elimination System
NA = Not Applicable
SU = Standard Units
NM = Not Monitored

several operations contributed contaminants (principally metals) to the STP influent in concentrations exceeding SPDES-permitted levels, these discharges did not affect the quality of the STP effluent.

Process wastewaters that were not expected to be of consistent quality because they were not routinely generated were held for characterization before release to the site sewer system. The process wastewaters typically included purge water from groundwater sampling, wastewater from cleaning of heat exchangers, wastewater generated as a result of restoration activities, 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 were compared to the SPDES effluent limits and BNL's effluent release criteria. If the concentrations were within limits, authorization for sewer system discharge was granted; if not, alternate means of disposal were used. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceeded Laboratory effluent release criteria was sent to the BNL Waste Management Facility for proper management and off-site disposal.

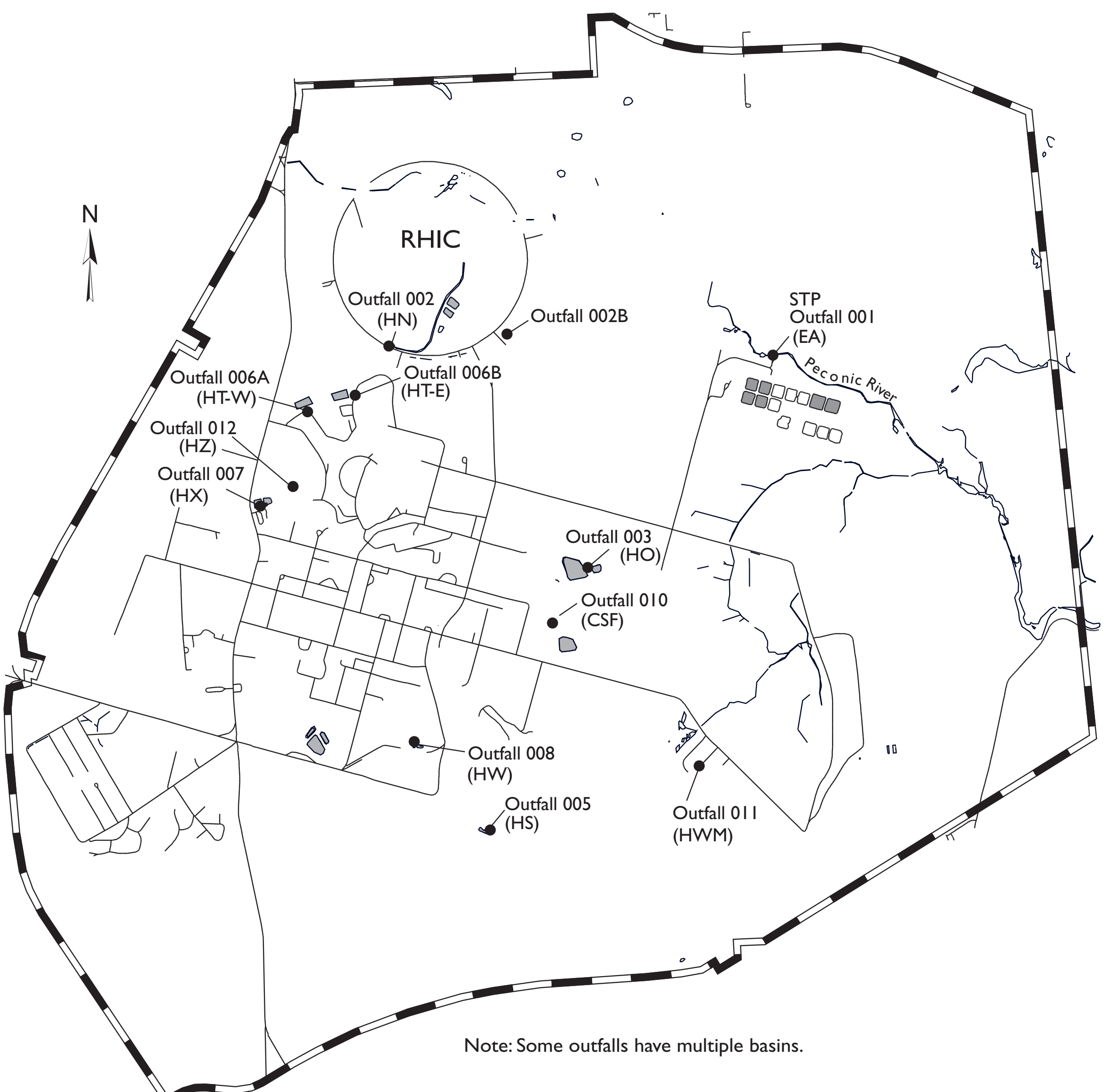

Figure 5-6. BNL Recharge Basin/Outfall Locations.

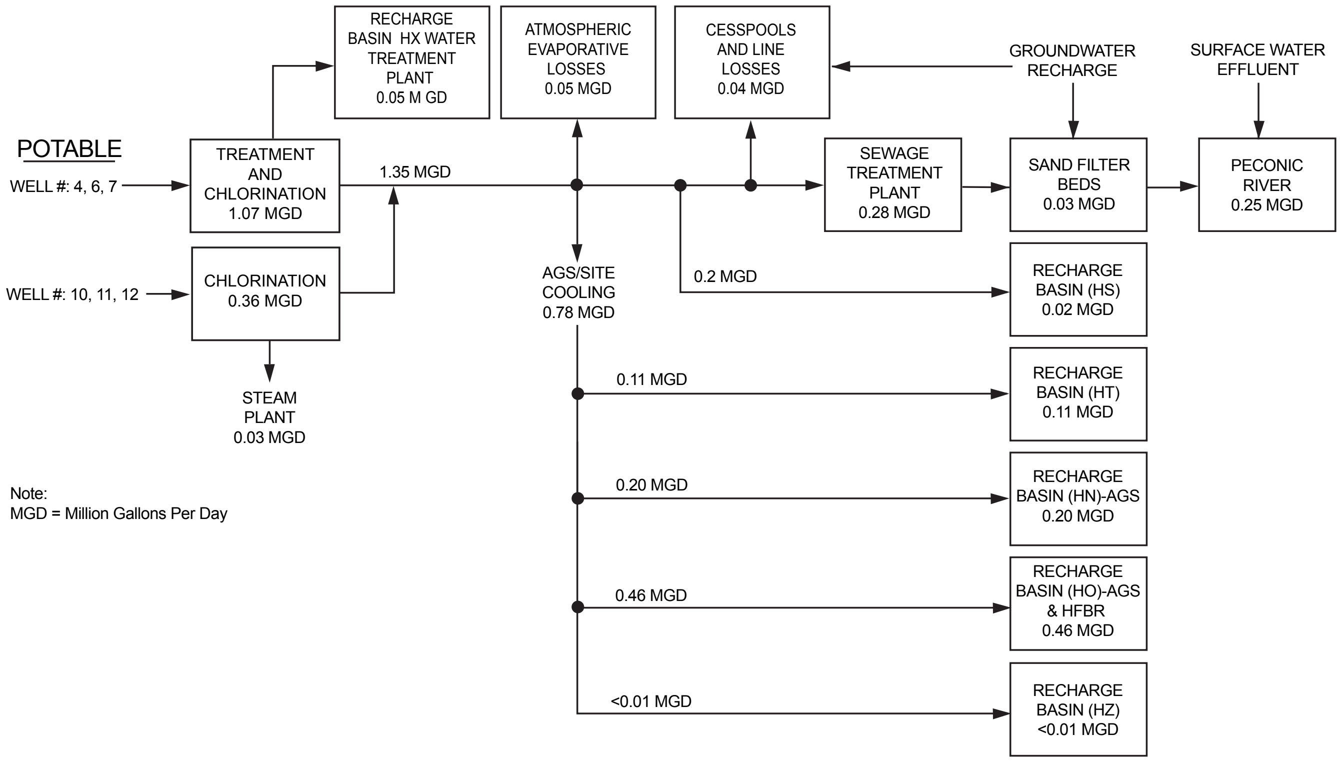

Figure 5-7. Schematic of Potable Water Use and Flow at BNL.

5.4 RECHARGE BASINS

Recharge basins are used for the discharge of "clean" wastewater streams, including once-through cooling water, stormwater runoff, and 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 5-6 shows the locations of the Laboratory's discharges to recharge basins (also called "outfalls" under BNL's SPDES permit). Figure 5-7 presents an overall schematic of potable water use at the Laboratory. Eleven recharge basins are used for managing once-through cooling water, cooling tower blowdown, and stormwater runoff:

- 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 Building 555 (Chemistry Department), and minimal cooling tower blowdown from the National Synchrotron Light Source (NSLS).
- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the HFBR.
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW in the former warehouse area, Basin CSF at the Central Steam Facility (CSF), Basin HW-M at the former Hazardous Waste Management Facility (HWMF), and Basin HZ near Building 902.

Each of the recharge basins is a permitted point-source discharge under the Laboratory's SPDES permit. Where required by the permit, the discharge to the basin is equipped with a flow monitoring station; weekly recordings of flow are collected, along with measurements of pH. The specifics of the SPDES compliance monitoring program are provided in Chapter 3. To supplement the monitoring program, sam-

Table 5-4. Radiological Analysis of Samples from On-Site Recharge Basins at BNL.

Basin		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
No. of samples		4	4	4
HN	*max.*	< 1.3	< 1.5	< 310
	avg.	-0.03 ± 1.04	0.31 ± 1.17	80.5 ± 62.5
HO	*max.*	< 1.2	5.3 ± 1	< 290
	avg.	-0.03 ± 0.47	2.42 ± 2.01	36 ± 28.07
HS	*max.*	4.2 ± 1.5	7.1 ± 1.2	< 300
	avg.	1.34 ± 1.88	3.95 ± 2.4	91 ± 114.25
HT-E	*max.*	< 3.9	64 ± 62	< 310
	avg.	-11.95 ± 24.86	20.12 ± 28.99	130 ± 104.02
HT-W	*max.*	< 1.6	< 1.2	400 ± 220
	avg.	0.57 ± 0.51	0.62 ± 0.24	186.5 ± 143.26
HW	*max.*	72 ± 19	81 ± 15	< 300
	avg.	35.35 ± 28.62	22.24 ± 23.33	87 ± 65.17
HZ	*max.*	< 1	1.7 ± 1	< 320
	avg.	0.09 ± 0.25	1.12 ± 0.47	-2.5 ± 84.82
SDWA Limit		15	(a)	20,000

Notes:
See Figure 5-6 for the locations of recharge basins/outfalls.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured value is lower than background (see Appendix B for description).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent of this value cannot be calculated.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act
* Samples typically collected 4x per year. HW was sampled 5x in 2009.

ples are also routinely collected and analyzed under BNL's Environmental Surveillance Program for radioactivity, VOCs, metals, and anions. During 2009, water samples were collected from all basins listed above except recharge basin HX at the Water Treatment Plant (exempted by NYSDEC from sampling due to documented non-impact to groundwater) and the recharge basin at the former HWMF, as there are no longer any operations that could lead to the contamination of runoff.

5.4.1 Recharge Basins – Radiological Analyses

Discharges to the recharge basins were sampled throughout the year for subsequent analyses for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. These results are presented in Table 5-4 and show that low levels of alpha and beta activity were detected in most of the basins. Typically, low-level detections of gross alpha and beta activity are attributable to very low levels of naturally occurring radionuclides, such as potassium-40 (K-40: half-life 1.3E+09 years). Surface samples collected from Basin HW in September 2009 exhibited much higher than normal gross alpha/beta results (72 ± 19 pCi/L and 81 ± 15 pCi/L, respectively) with increased uncertainty and minimum detection limit. These elevated results were due to the presence of high residual sediments and dissolved solids in the water sample. Significant clearing and other soil disturbance activities associated with the construction of the NSLS-II Project have contributed to much higher than normal sediment content in the stormwater runoff reaching Basin HW, resulting in false positive results for gross alpha/beta activity. To confirm the elevated results were due to mass loading, a filtered water sample collected during the same time and location was analyzed for gross alpha/beta and the results were within normal ranges.

The contract analytical laboratory reported no gamma-emitting nuclides attributable to BNL operations in any discharges to recharge basins in 2009. Tritium was detected in a single sample collected at Basin HT-W at a very low level (400 ± 220 pCi/L) and with high uncertainty. This basin receives discharges from the Collider-Accelerator complex.

5.4.2 Recharge Basins – Nonradiological Analyses

To determine the overall impact on the environment of discharges to the recharge basins, the nonradiological analytical results were compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations (NYCRR), Part 703.6. Samples were collected quarterly for water quality parameters, metals, and VOCs, and were analyzed by a contract analytical laboratory.

Table 5-5. Water Quality Data for BNL On-Site Recharge Basin Samples.

ANALYTE		HN (RHIC)	HO (AGS)	HS (s)	HT-W (Linac)	HT-E (AGS)	HW (s)	CSF (s)	HZ (s)	NYSDEC Effluent Standard	Typical MDL
	No. of samples	4	4	4	4	4	4	4	4		
pH (SU)	*min.*	7.6	7.5	7.4	7.4	7.9	7.2	7.2	7.4	6.5 - 8.5	NA
	max.	8.1	7.9	8.1	8.7 (a)	8.5	8.4	8.3	8.0		
Conductivity (µS/cm)	*min.*	200	53	177	183	126	79	71	86	SNS	NA
	max.	260	217	355	293	4051	202	153	274		
	avg.	222	163	284	225	1381	153	109	193		
Temperature (ºC)	*min.*	5.0	14.5	4.0	5.8	5.0	9.2	8.4	4.0	SNS	NA
	max.	8.7	27.9	11.0	8.9	11.7	19.0	18.8	19.4		
	avg.	7.2	19.1	7.0	7.5	7.9	14.2	13.9	14.2		
Dissolved oxygen (mg/L)	*min.*	10.7	7.6	10.0	11.8	9.5	8.1	9.2	8.4	SNS	NA
	max.	11.7	10.3	12.6	13.3	12.2	11.6	11.6	11.0		
	avg.	11.2	9.0	11.5	12.4	10.5	10.0	10.3	9.6		
Chlorides (mg/L)	*min.*	33.7	29.2	24.6	27.3	10.2	10.2	6.2	21.6	500	4
	max.	42.9	37.5	82.4	36.2	22500.0	26.6	17.9	38.1		
	avg.	36.7	32.1	54.9	33.3	5681.3	17.7	10.2	33.3		
Sulfates (mg/L)	*min.*	10.4	9.9	3.7	10.1	3.6	4.1	2.2	7.2	500	4
	max.	12.5	10.6	13.3	11.6	161.0	13.7	5.8	11.2		
	avg.	11.1	10.3	9.3	10.8	54.4	10.4	4.6	9.8		
Nitrate as nitrogen (mg/L)	*min.*	0.2	0.3	0.06	0.2	0.02	0.3	0.1	0.2	10	1
	max.	0.5	0.7	0.4	0.7	0.5	4.5	0.4	0.2		
	avg.	0.3	0.4	0.3	0.4	0.3	1.5	0.2	0.2		

Recharge Basin: HN through HZ.

Notes:
See Figure 5-6 for the locations of recharge basins/outfalls.
(a) = The New York State-granted SPDES permit for BNL allows a maximum discharge pH limit of 9.0 SU for this recharge basin.
(s) = stormwater
AGS/HFBR = Alternating Gradient Synchrotron/High Flux Beam Reactor
CSF = Central Steam Facility
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

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.

Low concentrations of disinfection byproducts were periodically detected in discharges to several of the basins throughout the year. Sodium hypochlorite and bromine, used to control bacteria in the drinking water and algae in cooling towers, led to the formation of VOCs, including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. The maximum concentration detected in any of the recharge basins was 11.0 µg/L of bromoform in basin HT-E. Acetone was the only other analyte detected above the MDL for most recharge basins. The concentration of acetone ranged from nondetectable to a maximum of 8.4 µg/L. In most instances, acetone was also found as a contaminant in the contract analytical laboratory, as evidenced by detections in blank samples.

The analytical data in Table 5-5 show that for 2009, the concentrations of all analytes were within effluent standards, except for one high detection of chlorides in Basin HT-E. Chlorides are found to be higher in the discharge samples collected during the winter and are attributed to road salt used to control snow and ice buildup. This particular sample was collected from HT-E after a rain event, which likely washed out a buildup of road salt in the area that had been left over from previous snow events. High concentrations of sodium confirm road salt as the source of chlorides. The data in Table 5-6 show that almost all of the parameters above respective water quality or groundwater discharge standards (aluminum, arsenic, cobalt, chromium, iron, mercury, manganese, lead, and antimony) were associated with recharge basin HW, which, as described in Section 5.4.1, has received higher than normal amounts of residual sediments and suspended solids in the water samples from NSLS-II construction activities. Due to the prevalence of metals in soils, the presence of these elements is likely due to suspended soil in the samples at the time of collection. Acidification of the samples (part of the analytical process) results in the dissolution of the element and its detection during analysis. This is supported by the observation that the concentrations of metals in all filtered samples except for cobalt were significantly less, and well below the discharge standard or NYS AWQS. Cobalt is found in all filtered water samples and is most likely a result of the filtration and not an indicator of water quality. As these metals are in particulate form in the discharge water, they pose no threat to groundwater quality because the recharge basin acts as a natural filter, trapping particles before they reach the groundwater.

5.4.3 Stormwater Assessment

All recharge basins receive stormwater runoff. Stormwater at BNL is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces and directing it to recharge basins via underground piping and above-grade vegetated swales. Recharge basin HS receives most of the stormwater runoff from the central, developed portion of the Laboratory site. Basins HN, HZ, HT-W, and HT-E receive runoff from the Collider–Accelerator complex. Basin HO receives runoff from the Brookhaven Graphite Research Reactor (BGRR) and High Flux Beam Reactor (HFBR) areas. Basin CSF receives runoff from the CSF area and along Cornell Avenue east of Railroad Avenue on site. Basin HW receives runoff from the former warehouse area, and HW-M receives runoff from the fenced area at the former HWMF.

Stormwater runoff at the Laboratory typically has elevated levels of inorganics, and low pH. The inorganics are attributable to high sediment content in stormwater (inorganics occur naturally in native soil). In an effort to further improve the quality of stormwater runoff, BNL has finalized formal procedures for managing and maintaining outdoor work and storage areas. The requirements include covering areas to prevent contact with stormwater, conducting an aggressive maintenance and inspection program, implementing erosion control measures during soil disturbance activities, and restoring these areas when operations cease. Basin sediment sampling is conducted on a 5-year testing cycle to ensure these discharges are not compromising the quality of the basins. Samples were collected in 2007 and results presented in the 2007 Site Environmental Report in Chapter 6. The next sampling event will occur in 2012.

5.5 PECONIC RIVER SURVEILLANCE

Several locations are monitored along the Peconic River to assess the overall water quality of the river and assess any impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-8. In total, 10 stations (three upstream and seven downstream of the STP) were regularly sampled in 2009. A sampling station along the Carmans River (HH) was also monitored as a geographic control location, not affected by Laboratory operations or within the Peconic River watershed. All locations were routinely monitored for radiological and nonradiological parameters. The sampling stations are located as follows:

Upstream sampling stations

- HY, on site immediately east of the William Floyd Parkway
- HV, on site just east of the 10:00 o'clock Experimental Hall in the RHIC Ring
- HE, on site approximately 20 feet upstream of the STP outfall (EA)

Table 5-6. Metals Analysis of Water Samples from BNL On-Site Recharge Basins.

METAL		Recharge Basin																NYSDEC Effluent Limit or AWQS	Typical MDL
		HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)			
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
No. of samples		4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3		
Ag Silver (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	50	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	2.6	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al Aluminum (µg/L)	*min.*	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	564.0	313.0	358.0	< 50.0	< 50.0	< 50.0	2,000	50
	max.	< 50.0	< 50.0	< 50.0	< 50.0	1450.0	< 50.0	127.0	< 50.0	< 50.0	< 50.0	288000	886.0	1030.0	< 50.0	< 50.0	< 50.0		
	avg.	< 50.0	< 50.0	< 50.0	< 50.0	589.9	< 50.0	59.1	< 50.0	< 50.0	< 50.0	122669	608.3	797.6	< 50.0	< 50.0	< 50.0		
As Arsenic (µg/L)	*min.*	< 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	0.6	50	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	23.6	22.8	< 5.0	< 5.0	131.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	7.1	8.2	< 5.0	< 5.0	41.4	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	<20	<20	22.0	24.9	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	2,000	20
	max.	31.5	31.2	33.6	33.9	37.4	32.8	188.0	53.6	33.6	32.7	1360.0	<20	<20	<20	26.5	24.3		
	avg.	24.4	23.7	26.2	30.2	31.0	22.5	70.3	25.9	25.8	23.5	462.1	<20	<20	<20	<20	<20		
Be Beryllium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	SNS	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	6.2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	3.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd Cadmium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	10	2.0
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	14.6	4.2	< 2.0	< 2.0	4.2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	4.9	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co Cobalt (µg/L)	*min.*	< 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	< 5.0	5	0.1
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.2	< 5.0	< 5.0	< 5.0	< 5.0	74.8	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	31.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Cr Chromium (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	100	10.0
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10.1	< 50.0	< 10.0	< 10.0	< 10.0	311.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 50.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu Copper (µg/L)	*min.*	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	12.6	10.1	1,000	10.0
	max.	22.5	<10.0	12.4	11.1	<10.0	<10.0	125.0	52.5	23.8	19.6	155.0	<10.0	14.3	<10.0	36.9	20.1		
	avg.	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	53.2	22.3	15.0	10.3	70.8	<10.0	<10.0	<10.0	24.3	14.4		

(continued on next page)

Table 5-6. Metals Analysis of Water Samples from BNL On-Site Recharge Basins *(continued)*.

METAL		Recharge Basin: HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
No. of samples		4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3		
Fe Iron (mg/L)	*min.*	0.07	<0.05	0.06	<0.05	0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.52	0.22	0.36	<0.05	<0.05	<0.05	0.6	0.05
	max.	0.18	0.07	0.11	<0.05	1.43	0.06	1.03	0.44	0.06	<0.05	228.00	0.66	1.43	<0.05	0.19	0.05		
	avg.	0.12	0.05	0.07	<0.05	0.64	0.05	0.51	0.17	<0.05	<0.05	90.80	0.40	0.96	<0.05	0.12	<0.05		
Hg Mercury (µg/L)	*min.*	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.4	0.2
	max.	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.9	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.8	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	7.7	6.1	<5.0	<5.0	<5.0	6.9	5.0	5.9	<5.0	<5.0	8.5	10.2	8.3	<5.0	<5.0	5.6	600	5.0
	max.	24.5	18.2	10.4	<5.0	17.5	10.0	232.0	67.5	5.9	4.2	1880.0	36.2	40.2	15.5	14.6	6.5		
	avg.	16.3	10.2	6.2	<5.0	12.3	8.5	101.1	28.5	<5.0	<5.0	856.0	24.5	21.3	7.8	7.4	6.1		
Na Sodium (mg/L)	*min.*	18.4	18.9	15.8	15.0	15.9	16.0	8.9	8.6	15.6	17.8	8.4	7.2	5.5	5.4	12.5	11.9	SNS	0.25
	max.	34.7	33.9	22.7	22.2	37.8	35.1	13500.0	191.0	35.6	35.3	22.3	19.2	14.7	5.8	24.8	22.2		
	avg.	23.2	24.7	18.4	18.6	28.9	26.2	3431.6	72.7	22.9	25.0	14.9	11.6	7.9	5.6	19.8	18.1		
Ni Nickel (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	200	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	22.7	< 10.0	< 10.0	< 10.0	141.0	< 10.0	11.7	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	60.6	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Pb Lead (µg/L)	*min.*	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	4.6	< 3.0	3.6	< 3.0	< 3.0	3.9	50	3.0
	max.	< 3.0	< 3.0	< 3.0	< 3.0	6.1	< 3.0	< 15.0	< 3.0	< 3.0	< 3.0	776.0	< 3.0	17.2	< 3.0	34.0	21.3		
	avg.	< 3.0	< 3.0	< 3.0	< 3.0	3.0	< 3.0	< 15.0	< 3.0	< 3.0	< 3.0	248.1	< 3.0	8.6	< 3.0	15.2	9.7		
Sb Antimony (µg/L)	*min.*	< 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	< 5.0	6	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	13.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	6.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se Selenium (µg/L)	*min.*	< 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	< 5.0	20	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	14.7	< 5.0	< 5.0	13.6	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl Thallium (µg/L)	*min.*	< 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	< 5.0	SNS	5.0
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	6.3	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		

(continued on next page)

Table 5-6. Metals Analysis of Water Samples from BNL On-Site Recharge Basins *(concluded).*

METAL		Recharge Basin: HN (RHIC)		HO (AGS)		HS (stormwater)		HT-E (AGS)		HT-W (Linac)		HW (stormwater)		CSF (stormwater)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F	T	F	T	F	T	F	T	F		
No. of samples		4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3		
V Vanadium (µg/L)	*min.*	< 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	< 5.0	SNS	5.0
	max.	< 5.0	< 5.0	8.0	5.3	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	262.0	< 5.0	9.5	5.2	6.4	6.1		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	128.0	< 5.0	6.1	< 5.0	< 5.0	< 5.0		
Zn Zinc (µg/L)	*min.*	11.0	10.8	1.9	<10.0	13.2	<10.0	14.8	23.6	<10.0	<10.0	16.4	<10.0	13.4	<10.0	25.7	28.2	5000	10
	max.	38.1	20.4	14.6	23.0	30.4	<10.0	64.2	36.8	15.4	17.3	540.0	11.4	65.3	21.7	70.4	67.5		
	avg.	20.3	14.5	<10.0	13.5	20.4	<10.0	34.1	30.3	11.0	10.8	229.1	<10.0	36.3	14.8	48.0	42.1		

Notes:
See Figure 5-6 for the locations of recharge basins/outfalls.
AGS = Alternating Gradient Synchrotron
AWQS = Ambient Water Quality Standards
CSF = Central Steam Facility
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

- *Downstream sampling stations*
- HM-N, on site 0.5 mile downstream of the STP outfall
- HM-S, on site on a typically dry tributary of the Peconic River
- HQ, on site 1.2 miles downstream of the STP outfall at the site boundary
- HA, first station downstream of the BNL boundary, 3.1 miles from the STP outfall
- Donahue's Pond, off site, 4.3 miles downstream of the STP outfall.
- Forge Pond, off site
- Swan Pond, off site, not within the influence of BNL discharges

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 10 sampling locations. Routine samples at Stations HM-N and HQ were collected once per month, as flow allowed. All other stations were sampled quarterly unless conditions (such as no water flow) prevented collection. Stations HE, HM-N, and HQ have been equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water sampling in 2009 are summarized in Table 5-7. Radiological analysis of water samples collected both upstream and downstream of the STP discharge and from background locations had very low concentrations of gross alpha and gross beta activity. The maximum concentration of gross alpha activity was found in the sections of the Peconic River upstream of the STP, and the maximum gross beta was found at the off-site location (Donahue's Pond). The average concentrations from off-site and control locations were indistinguishable from BNL on-site levels. The beta activity for all locations is

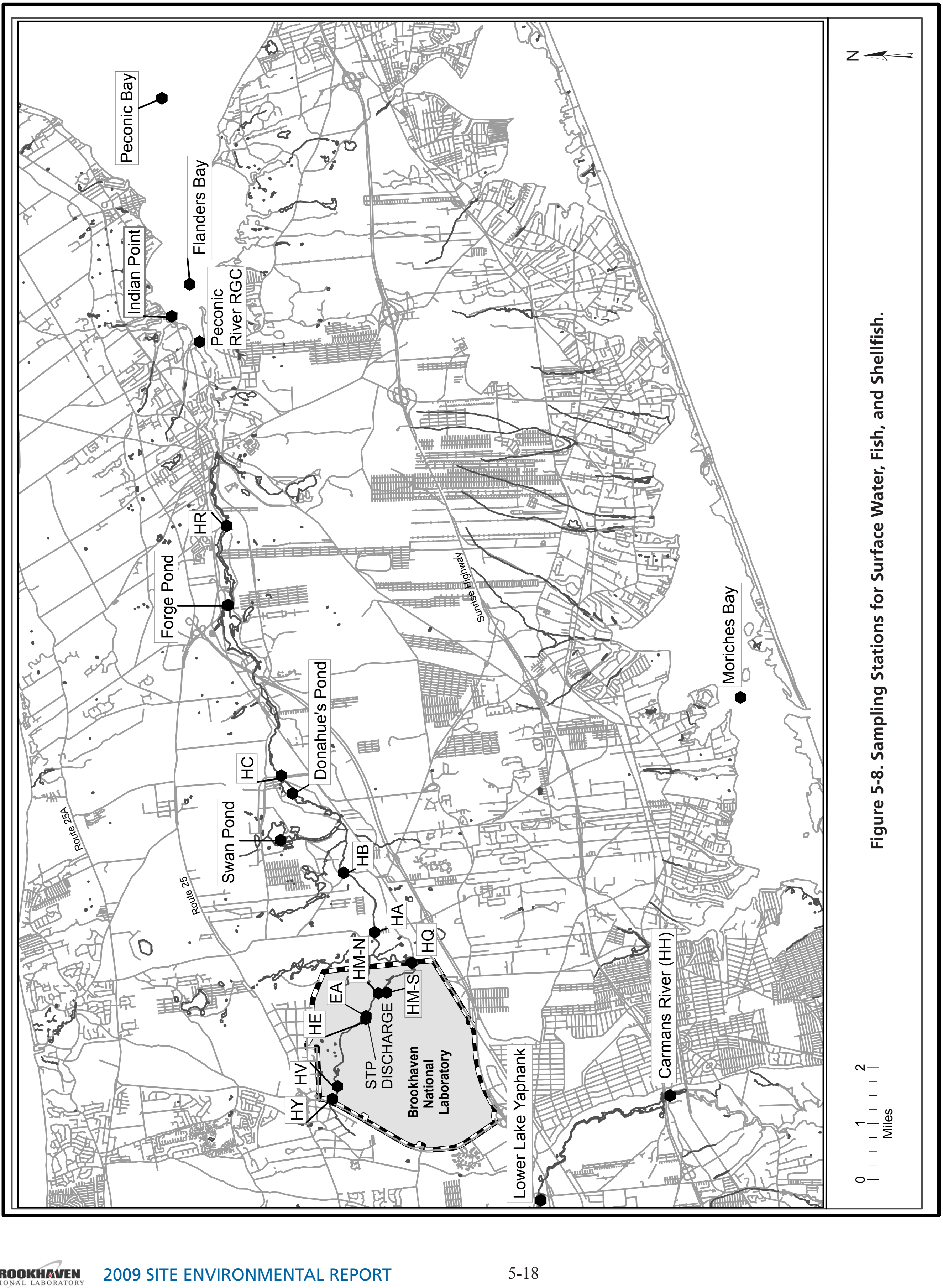

Figure 5-8. Sampling Stations for Surface Water, Fish, and Shellfish.

therefore attributed to natural sources. All detected levels were below the applicable New York State Drinking Water Standards (NYS DWS). No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP. Very low concentrations of tritium were detected at three locations, including Basin HE (390 ± 200 pCi/L) immediately upstream of the STP outfall, Basin HM-N (570 ± 240 pCi/L) downstream of the STP outfall, and HQ (480 ± 230 pCi/L) at the BNL site boundary. All three results were reported by the contract analytical laboratory as "estimated," since the results were greater than the instrument detection limit but less than stated reporting limit. Due to the low level of detection and the high uncertainty, the data may be false-positive. The NYS DWS for tritium is 20,000 pCi/L.

Monitoring for strontium-90 (Sr-90) was performed at all Peconic River and Carmans River stations in 2009. Low-level detections were found at Stations HE, HM-N, HA, Donahue's Pond, and the control location HH (Carmans River) at very consistent levels of 0.38 ± 0.24, 0.75 ± 0.38, 0.32 ± 0.2, 0.35 ± 0.19, and 0.37 ± 0.17 pCi/L, respectively. All concentrations detected were much less than the NYS DWS of 8 pCi/L, are consistent with historical levels, and can be attributed to worldwide fallout.

5.5.2 Peconic River – Nonradiological Analyses

River water samples collected in 2009 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs. Acetone and toluene were the only organic contaminants detected at concentrations above the MDL in 2009. Acetone was detected (14 µg/L) in a single sample collected at location HY (upstream of the STP discharge) but was also found as a contaminant in the contract analytical

Table 5-7. Radiological Results for Surface Water Samples from the Peconic and Carmans Rivers.

Sampling Station		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)	Sr-90 (pCi/L)
Peconic River					
HY (headwaters) on site, west of the RHIC ring	*N*	4	4	4	4
	max	3.4 ± 1.8	4.3 ± 1.1	< 270	< 0.57
	avg	1.4 ± 1.32	2.18 ± 1.67	9.75 ± 61.52	0.01 ± 0.08
HV (headwaters) on site, inside the RHIC ring	*N*	4	4	4	NS
	max	2 ± 0.95	2.45 ± 0.87	< 340	
	avg	1.16 ± 0.55	1.59 ± 0.56	47 ± 54.23	
HE upstream of STP outfall	*N*	4	4	4	4
	max	< 1.4	4 ± 1.2	390 ± 200	0.38 ± 0.24
	avg	0.49 ± 0.33	2.48 ± 1.17	130.75 ± 173.99	0.15 ± 0.29
HM-N downstream of STP, on site	*N*	12	12	12	4
	max	1.9 ± 1	6.4 ± 1.2	570 ± 240	0.75 ± 0.38
	avg	0.63 ± 0.28	4.04 ± 0.61	105.34 ± 96.52	0.21 ± 0.36
HM-S tributary, on site	*N*	1	1	1	1
	max	< 0.93	< 1.2	< 310	< 0.3
	avg	NA	NA	NA	NA
HQ downstream of STP, at BNL site boundary	*N*	10	10	10	3
	max	2.4 ± 1.1	5.1 ± 1.2	480 ± 230	< 0.59
	avg	0.67 ± 0.45	3.56 ± 0.61	55.7 ± 103.31	0.38 ± 0.21
HA off site	*N*	4	4	4	4
	max	< 1.1	1.62 ± 0.75	< 420	0.32 ± 0.2
	avg	0.26 ± 0.4	0.93 ± 0.76	23.5 ± 100.37	0.29 ± 0.1
Donahue's Pond off site	*N*	4	4	4	4
	max	< 1.1	9.8 ± 1.4	< 220	0.35 ± 0.19
	avg	0.4 ± 0.21	2.98 ± 4.48	34.5 ± 77.5	0.24 ± 0.12
Forge Pond off site	*N*	4	4	4	4
	max	1.7 ± 0.99	1.32 ± 0.67	< 140	< 0.36
	avg	0.59 ± 0.74	1.13 ± 0.2	16.25 ± 63.97	0.17 ± 0.08
Carmans River HH control location, off site	*N*	5	5	5	5
	max	< 1.5	2.75 ± 0.94	< 140	0.37 ± 0.17
	avg	0.22 ± 0.68	1.45 ± 1.1	-17.5 ± 35.57	0.16 ± 0.27
Swan Pond control location, off site	*N*	4	4	4	4
	max	< 1.7	2.7 ± 1	< 140	< 0.5
	avg	0.66 ± 0.38	1.97 ± 0.7	69.75 ± 59.02	0.22 ± 0.13
SDWA Limit (pCi/L)		**15**	**(a)**	**20,000**	**8**

Notes:
See Figure 5-8 for the locations of sampling stations.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured values are lower than background (see Appendix B).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.
N = Number of samples analyzed
NS = Not Sampled for this analyte
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
STP = Sewage Treatment Plant

Table 5-8. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Analyte		Peconic River Station Locations HY	HE	HM-N	HM-S	HQ	HA	Donahue's Pond	Forge Pond	Swan Pond	(Control) HH	NYSDEC Effluent Standard	Typical MDL
No. of samples		4	4	12	1	10	4	4	4	4	4		
pH (SU)	*min.*	4.4	5.8	6.1	4.3	6.3	6.1	6.1	6.9	6.3	6.7	6.5-8.5	NA
	max.	8.8	7.4	7.9	4.3	7.9	7.0	7.2	7.2	7.3	7.6		
Conductivity (µS/cm)	*min.*	103	67	140	56	105	45	55	79	77	178	SNS	NA
	max.	285	114	387	56	306	71	71	133	95	199		
	avg.	156	90	262	56	207	57	63	109	85	188		
Temperature (ºC)	*min.*	5.6	2.3	1.3	9.6	3.3	3.3	5.0	4.4	3.9	6.0	SNS	NA
	max.	20.1	11.8	23.3	9.6	24.3	24.2	24.8	28.1	26.0	22.0		
	avg.	13.2	7.8	10.2	9.6	13.0	14.4	15.6	16.8	15.3	14.2		
Dissolved oxygen (mg/L)	*min.*	6.6	5.3	5.2	6.9	1.0	2.8	4.8	8.6	6.8	8.6	>4.0	NA
	max.	10.9	9.5	14	6.9	15.4	13.3	11.7	14.1	9.8	13.4		
	avg.	8.2	7.9	11.1	6.9	8.9	7.9	8.6	10.2	8.7	10.8		
Chlorides (mg/L)	*min.*	14.7	9.0	25.2	4.7	20.6	6.5	8.3	15.1	8.6	28.5	250(a)	4.0
	max.	51.2	15.5	66.2	4.7	61.2	9.7	15.1	20.4	11.1	30.5		
	avg.	27.8	12.7	46.32	4.7	36.2	7.8	10.4	17.7	9.9	29.4		
Sulfates (mg/L)	*min.*	<4.0	<4.0	7.9	<4.0	6.2	<4.0	<4.0	7.0	4.3	11.8	250(a)	4.0
	max.	12.1	7.0	19.8	<4.0	14.2	4.3	5.4	13.2	9.8	12.3		
	avg.	5.1	5.2	14.8	<4.0	10.6	<4.0	<4.0	9.7	7.5	12.0		
Nitrate as nitrogen (mg/L)	*min.*	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.43	10(a)	1.0
	max.	1.16	<1.0	4.76	<1.0	1.69	<1.0	<1.0	<1.0	<1.0	1.80		
	avg.	<1.0	<1.0	2.59	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.57		

Notes:
See Figure 5-6 for the locations of recharge basins/outfalls.
(a) Since there are no NYSDEC Class C surface Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for groundwater is provided, if specified.
Donahue's Pond = Peconic River, off site
Forge Pond = Peconic River, off site
HA = Peconic River, off site
HE = Peconic River, upstream of STP Outfall
HH = Carmans River control location, off site
HM-N = Peconic River on site, downstream of STP
HM-S = Peconic River tributary, on site
HQ = Peconic River, downstream of STP at BNL site boundary
HY = Peconic River headwaters, on site, east of Wm Floyd Pkwy.
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
SNS = Effluent Standard Not Specified

laboratory, as evidenced by a similar detection in the trip blank sample. Toluene was detected (7.3 µg/L) in a single sample collected at location HQ (on site but near the BNL site boundary). Roadway runoff is the most likely source of this contaminant. The inorganic analytical data for the Peconic River and Carmans River samples are summarized in Tables 5-8 (water quality) and 5-9 (metals).

Peconic River water quality data collected upstream and downstream showed that water quality was consistent throughout the river system. The data were also consistent with water samples collected from the Carmans River control location (HH). 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. Chlorides and sodium were highest at Station HM-N, which is immediately downstream of the STP outfall and likely a result of road salting operations at the Laboratory. There are no NYS AWQS imposed for chloride or sulfates in discharges to surface water; however, NYSDEC imposes a limit of 500 mg/L for discharges to groundwater.

The pH measured at some locations was very low, due to the low pH of precipitation, ground-

Table 5-9. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers.

METAL		Peconic River Locations: HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
Total or Dissolved		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
No. of samples		4	3	4	3	12	5	1	1	10	5	4	3	4	3	4	3	4	3	4	3		
Ag (I) Silver (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	0.1	2
	max.	< 4.0	< 2.0	< 2.0	< 2.0	3.9	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 4.0	< 2.0	< 2.0	< 2.0	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al (I) Aluminum (µg/L)	*min.*	457.0	167.0	182.0	112.0	<50.0	<50.0	815.0	705.0	80.9	60.2	83.1	64.1	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	100	50
	max.	1390.0	606.0	535.0	325.0	585.0	116.0	815.0	705.0	443.0	227.0	135.0	108.0	78.1	61.4	150.0	<50.0	61.1	<50.0	<50.0	<50.0		
	avg.	741.5	410.7	362.5	208.7	283.4	73.3	815.0	705.0	286.6	138.2	109.0	80.1	61.0	<50.0	60.3	<50.0	<50.0	<50.0	<50.0	<50.0		
As (D) Arsenic (µg/L)	*min.*	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	150	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	10.1	8.4	16.9	16.5	13.5	10.4	10.9	9.2	8.5	6.0	7.4	6.7	8.0	7.9	4.8	4.4	15.1	14.1	26.4	5.7	SNS	1.8
	max.	52.1	14.8	21.2	18.4	23.8	19.4	10.9	9.2	15.5	11.9	15.4	8.4	21.1	10.3	11.5	20.7	22.2	32.8	36.6	34.7		
	avg.	22.7	11.9	18.9	17.5	19.7	15.3	10.9	9.2	11.4	9.7	10.2	7.7	12.4	8.9	7.1	10.8	19.7	21.7	32.0	22.7		
Be (AS) Beryllium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	11	2
	max.	< 2.0	< 2.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd (D) Cadmium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	1.1	2
	max.	< 4.0	< 2.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 4.0	< 2.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 4.0	< 4.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co (AS) Cobalt (µg/L)	*min.*	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5	5
	max.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Cr (I) Chromium (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	< 20.0	< 10.0	< 10.0	< 10.0	< 20.0	< 20.0	< 10.0	< 10.0	< 20.0	< 20.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 20.0	< 10.0	< 10.0	< 10.0	< 20.0	< 20.0	< 10.0	< 10.0	< 20.0	< 20.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu (D) Copper (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	16.4	24.5	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	4	10
	max.	47.4	< 10.0	< 10.0	< 10.0	70.9	56.2	< 10.0	< 10.0	27.1	24.9	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	14.2	< 10.0	< 10.0	< 10.0	38.8	38.3	< 10.0	< 10.0	12.9	14.8	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Fe (AS) Iron (mg/L)	*min.*	0.3	0.2	1.0	0.4	0.2	0.11	0.4	0.3	0.2	0.1	0.5	0.3	0.4	0.3	0.1	<0.075	0.6	0.2	0.3	<0.075	0.3	0.075
	max.	1.3	0.5	4.4	1.2	1.3	0.4	0.4	0.3	0.8	0.5	4.0	0.8	3.9	0.9	0.2	0.3	2.5	1.0	0.5	0.3		
	avg.	0.6	0.3	2.6	0.9	0.6	0.2	0.4	0.3	0.4	0.3	1.6	0.5	1.7	0.6	0.1	0.1	1.2	0.5	0.3	0.2		

(continued on next page)

Table 5-9. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers *(concluded).*

METAL		Peconic River Locations: HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
Total or Dissolved		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
No. of samples		4	3	4	3	12	5	1	1	10	5	4	3	4	3	4	3	4	3	4	3		
Hg (D) Mercury (µg/L)	*min.*	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.2
	max.	< 0.2	< 0.2	< 0.2	0.2	0.3	0.3	0.3	< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	0.3	< 0.2	0.2		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	min.	10.4	7.4	109.0	80.6	4.9	12.7	20.1	22.1	8.0	4.5	14.2	18.3	25.6	29.7	43.3	42.8	56.0	47.6	44.6	28.2	SNS	2
	max.	106.0	56.1	156.0	218.0	197.0	33.9	20.1	22.1	42.1	44.2	189.0	33.9	270.0	56.2	103.0	67.6	102.0	95.4	68.6	76.8		
	avg.	53.8	37.4	128.8	131.8	48.6	21.5	20.1	22.1	24.6	22.3	63.6	24.6	96.8	39.1	68.7	54.5	79.6	66.0	58.6	56.7		
Na Sodium (mg/L)	min.	10.2	10.7	5.9	6.4	16.5	21.6	3.3	3.0	12.4	20.7	3.9	4.1	4.8	4.8	5.1	6.0	9.5	8.8	15.5	7.4	SNS	1
	max.	65.0	18.6	9.3	9.2	42.5	41.9	3.3	3.0	38.7	39.3	5.7	5.5	6.2	6.4	7.2	12.2	11.9	19.0	18.0	17.3		
	avg.	26.5	14.2	7.7	7.4	32.4	34.0	3.3	3.0	25.7	28.4	5.1	4.9	5.7	5.7	6.2	8.1	10.6	12.8	16.7	13.6		
Ni (D) Nickel (µg/L)	min.	1.2	1.4	< 1.1	1.3	3.1	5.3	1.3	1.2	2.3	4.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	23	1.1
	max.	10.2	2.4	2.9	2.2	8.8	8.3	1.3	1.2	8.4	6.5	< 10.0	1.4	< 10.0	< 10.0	< 10.0	1.3	< 10.0	1.4	< 10.0	1.4		
	avg.	3.7	1.8	1.8	1.7	6.0	6.4	1.3	1.2	4.8	5.3	< 10.0	1.1	< 10.0	< 10.0	< 10.0	0.9	< 10.0	1.1	< 10.0	1.1		
Pb (D) Lead (µg/L)	min.	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	1.4	3
	max.	5.4	3.2	< 3.0	< 3.0	5.4	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	3.1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0		
	avg.	3.3	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0		
Sb Antimony (µg/L)	min.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se (D) Selenium (µg/L)	min.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	4.6	5
	max.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl (AS) Thallium (µg/L)	min.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8	5
	max.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
V (AS) Vanadium (µg/L)	min.	< 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	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	14	5
	max.	65.1	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	17.2	< 5.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 10.0	< 10.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Zn (D) Zinc (µg/L)	min.	15.9	11.2	< 10.0	10.2	21.8	42.7	14.5	13.6	< 10.0	< 10.0	< 10.0	10.1	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	280.0	18.4	19.7	17.1	106.0	92.1	14.5	13.6	47.1	45.7	< 10.0	11.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10.9	< 10.0	15.4		
	avg.	83.2	15.6	14.8	13.5	63.2	65.7	14.5	13.6	26.4	32.2	< 10.0	10.6	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	11.2		

Notes:
See Figure 5-8 for the locations of sampling stations.
AWQS = Ambient Water Quality Standards
AS = Acid Soluble
AS = Acid Soluble
D = Dissolved
DP = Donahue's Pond
SNS = Effluent Standard Not Specified for these elements in Class C Surface Waters
T = Total

water, and the formation of humic acids from decaying organic matter. As spring rains mix with decaying matter, these acids decrease the already low pH of precipitation, resulting in a pH as low as 4.3 Standard Units. A discussion of precipitation monitoring is provided in Chapter 6 (see Section 6.7 for more detail).

Ambient water quality standards for metallic elements are based on their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, whereas other metals are toxic in any form (i.e., dissolved and particulate combined). In 2009, the BNL monitoring program continued to assess water samples for both the dissolved and particulate form. Dissolved concentrations were determined by filtering the samples prior to acid preservation and analysis. Examination of the metals data showed that silver, aluminum, copper, iron, mercury, lead, vanadium, and zinc were present in concentrations at some locations that exceeded NYS AWQS. With the exception of silver, copper, and mercury, the highest concentrations were found at upstream locations, indicating a natural source of contamination. Aluminum and iron are detected throughout the Peconic and Carmans Rivers at concentrations that exceed the NYS AWQS in both the filtered and unfiltered fractions. Iron and aluminum are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater. The highest levels for silver, copper, and mercury were found in samples collected immediately downstream of the STP discharge (Station HM-N) at concentrations greater than the NYS AWQS. The concentrations detected were consistent with the concentrations found in the STP discharge and, in most instances, were within the BNL SPDES permit limits. The NYS AWQS limits for silver, copper, and mercury are very restrictive; consequently, the NYS-granted SPDES permit allows higher limits, provided toxicity testing shows no impact to aquatic organisms. Filtration of the samples reduced concentrations of most metals to below the NYS AWQS, indicating that most detections were due to sediment carryover. Mercury was detected in some samples collected downstream of the STP at concentrations greater than the MDL. Since the concentrations in the Peconic River were typically higher than the levels detected in the STP discharge (see Table 5-3), the river is a contributor of mercury. Further discussion of mercury in the Peconic River sediment, water, and fish samples is found in Chapter 6.

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