Water Quality 5

Wastewater generated from operations at Brookhaven National Laboratory 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 regulatory requirements and that the public, employees, and the environment are protected.

Analytical data for 2013 show that the average gross alpha and beta activity levels in the discharge of the STP (EA, Outfall 001) were within the typical range of historical levels and were well below New York State Drinking Water Standards (NYS DWS). Tritium was not detected above method detection limits in the STP discharge during the entire year and no cesium-137, strontium-90, or other gamma-emitting nuclides attributable to Laboratory operations were detected.

Nonradiological monitoring of the STP effluent showed that organic and inorganic parameters were within State Pollutant Discharge Elimination System (SPDES) effluent limitations or other applicable standards. The average concentrations of gross alpha and beta activity in water discharged to recharge basins were within typical ranges and no gamma-emitting radionuclides were detected. Tritium was not detected above method detection limits in any of the discharges to recharge basins. Disinfection byproducts continue to be detected at very low concentrations, just above the method detection limit, 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) were detected; however, their presence is due primarily to sediment run-off in stormwater discharges.

Radiological data from Peconic River surface water sampling in 2013 show that the average concentrations of gross alpha and gross beta activity from BNL on-site locations were indistinguishable from off-site locations and control locations, and all detected levels were below the applicable NYS DWS. Tritium was detected in a single water sample collected upstream of the STP discharge at Station HY (530 ± 370 pCi/L). However, due to the low level of detection and high uncertainty with the measurement, the data may be a false positive. 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. Concentrations of silver, copper, lead, and zinc detected were consistent with concentrations found in the STP discharge, and were within BNL SPDES permit limits.

5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the Laboratory's STP is discharged into the headwaters of the Peconic River. This discharge is permitted under the New York State Department of Environmental Conservation (NYSDEC) SPDES Program. Effluent limits are based on water quality standards established by

NYSDEC, as well as historic operational data. To assess the impact of wastewater discharge on Peconic River water quality, surface water is monitored at several locations upstream and downstream of the discharge point. Monitoring Station HY on site, but upstream of all Laboratory operations, provides information on the background water quality of the Peconic River (see Figure 5-4). The Carmans River is monitored as a geographic control location for comparative purposes, as it is not affected by operations at BNL and is not within the Peconic River watershed.

On the Laboratory site, the Peconic River is an intermittent, ground water fed stream. Off-site flow occurs only following periods of sustained precipitation and a concurrent rise in the water table, typically in the spring. Off-site flow in 2013 was only persistent between March and April due to a wet spring and then again for a short period of time in June and July. When flow ceased, standing water was present throughout the year in several of the deeper sections of the river.

Five years of analytical data associated with BNL's surface water monitoring program were evaluated in 2012, and a determination was made by DOE and BNL personnel to reduce the sampling frequencies for both on- and off-site Peconic River monitoring stations starting in 2013. This decision was based on the fact that historical monitoring data indicates no significant variations in water quality throughout the Peconic River system, Peconic River Remediation efforts have been completed, and pollution prevention efforts at the Laboratory has significantly reduced the risk of accidental releases to the sanitary system. 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 BNL's SPDES permit. Figure 5-1 shows a schematic of the STP and its sampling locations. The Laboratory's STP treatment process includes four principal steps:

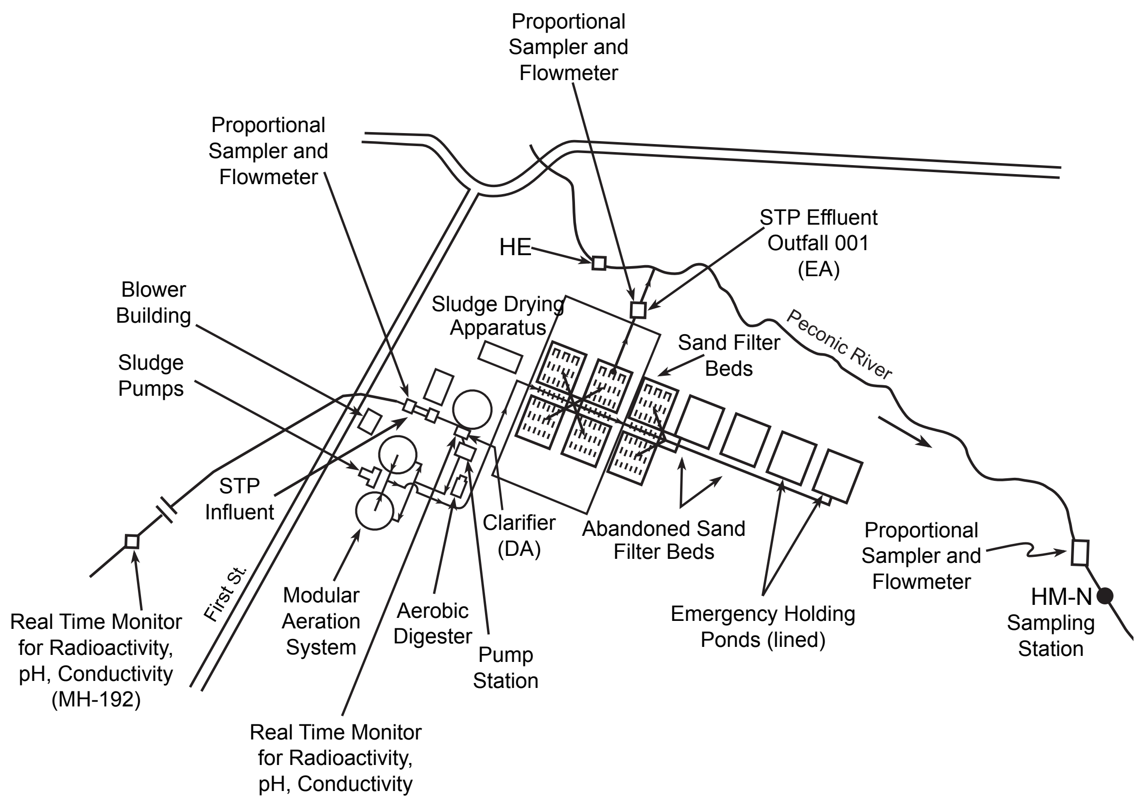

Figure 5-1. Schematic of BNL's Sewage Treatment Plant (STP).

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, 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 and other aquatic organisms for survival. Limiting the concentration of nitrogen in the STP discharge is important in maintaining a balance of plant growth in the Peconic River with the nutrients provided by natural sources.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity occurs at two locations. The first site, MH-192 (see Figure 5-1), is approximately 1.1 miles upstream of the STP, providing a minimum of 30 minutes' warning to the STP operators that wastewater is en route that may exceed SPDES limits or BNL administrative effluent release criteria. The second monitoring site is at the point where the STP influent enters the treatment process.

Based on the data collected by the real-time monitoring systems, any influent to the STP that may not meet SPDES limits and BNL effluent release criteria 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 would continue until the effluent's water quality meets the permit limits and 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 nonradiological parameters or BNL effluent release criteria for radiological parameters.

In 2013, there was one instance that resulted in diversion of wastewater to the hold-up ponds. On November 14, BNL wastewater was diverted to a holdup pond due to elevated concentrations of ammonia that was initially identified during routine in-house process control sampling. Immediate corrective actions taken by the STP operators to address the issue (e.g., increase aeration time in clarifier to improve nitrification of ammonia) reduced the concentrations and the plant was placed back to normal operations the next day. However, STP effluent SPDES results from samples collected in December 2013 revealed that permit limits exceeded total nitrogen and ammonia. Section 3.6.1 in Chapter 3 provides more information on the immediate and long-term corrective actions that were implemented to address these excursions.

Solids separated in the clarifier are pumped to aerobic digesters for continued biological solids reduction and sludge thickening. Once the sludge in the aerobic digester reaches a solids content of 6 percent, the sludge is sampled to ensure it meets the waste acceptance criteria for disposal at the Suffolk County Department of Public Works Sewage Treatment Facility at Bergen Point, in West Babylon, New York.

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. In 2013, samples were collected weekly. In previous years, samples were collected three times per week. The reduction in sampling frequency was justified after a review of radiological data collected over the previous 5 years showed only an occasional low-level detection of tritium and no detection of any other BNL-generated radionuclides in both the STP influent and effluent. In addition, the sewage collection system is monitored in real-time using beta and gamma detection systems to detect any unplanned releases that could jeopardize the quality of the STP effluent. 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 4 mrem from radionuclides that are beta or photon emitters, which includes up to 168 individual radioisotopes. BNL 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. 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 alpha and beta activity 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 2013. Annual average gross alpha and beta activity levels in the STP effluent were 0.4 ± 0.1 pCi/L and 4.3 ± 0.2 pCi/L, respectively. These concentrations have remained essentially unchanged from year to year. Control location data from the Carmans River Station HH (see Figure 5-4) show average gross alpha and beta levels of 0.52 ± 0.24 pCi/L and 0.84 ± 0.35 pCi/L, respectively (see Table 5-5) and concentrations were less than method detection limits in the one sample collected upstream of the STP outfall. Tritium was not detected above method detection limits in the discharge of the STP (EA, Outfall 001) for the entire year. The annual average tritium concentration, as measured in the STP effluent, was 68.2 ± 38.7 pCi/L, which is only 16 percent of the average minimum detection level (MDL) of 424.9 pCi/L, and well below the NYS DWS of 20,000 pCi/L. Using the annual average concentration and the flow recorded for the year, a total of 0.0312 Ci (31.2 mCi) of tritium was released during 2013, which is consistent with total releases of tritium over the past 5 years. In 2013, there were no gamma-emitting nuclides detected in the STP effluent, which is consistent with data reported since 2003. Sr-90 was detected in one effluent sample collected in September (0.73 ± 0.46 pCi/L); however, this value is consistent with historical levels both upstream and downstream of the STP and most likely attributable to worldwide fallout and not BNL-derived.

5.2.2 Sanitary System Effluent – Nonradiological Analyses

Starting in 2013, surveillance monitoring of the STP for VOCs, inorganics, and anions was discontinued. This decision was based on historical data and that all of these parameters are already monitored as part of the Compliance Program, which is discussed in further detail in Chapter 3.

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 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 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

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*	1.51E+07	< 470	<MDL	< 1.6	1.1 ± 0.2	5.4 ± 1.2	3.6 ± 1.3
	effluent	3.27E+07	< 310	<MDL	< 1.6	0.1 ± 0.6	5.5 ± 1.2	4.6 ± 0.9
February	*influent*	3.01E+07	< 420	<MDL	< 1.9	0.6 ± 1.3	3.4 ± 0.8	2.7 ± 0.6
	effluent	2.95E+07	< 460	<MDL	1.3 ± 1.0	0.6 ± 0.5	4.7 ± 1.0	3.9 ± 0.9
March	*influent*	3.25E+07	< 420	<MDL	1.3 ± 0.9	0.6 ± 0.9	17.7 ± 2.1	6.8 ± 7.1
	effluent	2.94E+07	< 340	<MDL	< 1.5	0.2 ± 0.4	5.6 ± 1.1	4.5 ± 0.8
April	*influent*	4.54E+07	< 440	<MDL	< 1.5	0.4 ± 0.4	5.7 ± 1.1	5.1 ± 0.4
	effluent	5.68E+07	< 460	<MDL	< 1.8	0.6 ± 0.3	5.4 ± 1.1	4.5 ± 0.6
May	*influent*	4.11E+07	< 430	<MDL	< 1.5	0.1 ± 0.2	9.6 ± 1.5	6.9 ± 2.2
	effluent	2.84E+07	< 440	<MDL	< 1.4	0.2 ± 0.3	6.0 ± 1.2	5.1 ± 0.9
June	*influent*	4.73E+07	< 490	<MDL	7.6 ± 3.4	2.2 ± 3.6	12.4 ± 2.8	7.0 ± 3.5
	effluent	3.84E+07	< 390	<MDL	< 1.7	0.3 ± 0.4	4.4 ± 1.0	3.9 ± 0.7
July	*influent*	7.04E+07	< 450	<MDL	5.9 ± 2.3	2.7 ± 1.7	6.7 ± 1.5	6.2 ± 0.7
	effluent	5.28E+07	< 430	<MDL	< 1.2	0.7 ± 0.2	6.5 ± 1.2	4.6 ± 1.0
August	*influent*	3.25E+07	< 440	<MDL	6.3 ± 2.3	2.1 ± 2.9	7.1 ± 1.5	6.4 ± 1.0
	effluent	3.26E+07	< 460	<MDL	< 1.2	0.4 ± 0.4	5.1 ± 0.9	4.8 ± 0.4
September	*influent*	5.05E+07	< 390	<MDL	12.5 ± 6.6	5.8 ± 4.8	21.2 ± 4.9	11.7 ± 5.8
	effluent	3.74E+07	< 397	<MDL	< 1.5	0.2 ± 0.4	6.5 ± 1.2	4.4 ± 1.3
October	*influent*	3.44E+07	< 355	<MDL	4.7 ± 2.1	2.4 ± 1.7	9.0 ± 1.7	6.5 ± 2.3
	effluent	2.72E+07	< 467	<MDL	< 1.9	0.2 ± 0.4	4.3 ± 0.8	3.8 ± 0.7
November	*influent*	3.06E+07	< 410	<MDL	< 7.8	4.4 ± 3.0	17.7 ± 4.5	11.2 ± 6.4
	effluent	2.18E+07	< 496	<MDL	< 1.8	0.1 ± 0.2	5.5 ± 0.9	4.5 ± 0.7
December	*influent*	3.19E+07	< 442	<MDL	6.7 ± 2.8	2.3 ± 2.3	11.4 ± 2.1	6.5 ± 2.8
	effluent	2.58E+07	< 436	<MDL	< 1.9	0.9 ± 0.6	4.5 ± 1.0	3.7 ± 0.8
Annual Avg.	*influent*			<MDL		2.1 ± 0.8		6.8 ± 1.1
	effluent			<MDL		0.4 ± 0.1		4.3 ± 0.2
Total Release		**4.13E+08**		**31.2 mCi**		**0.2 mCi**		**1.8 mCi**
Average MDL (pCi/L)				**424.9**		**1.6**		**0.9**
SDWA Limit (pCi/L)				**20000**		**15**		**(b)**

Notes:
All values are reported 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
(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.

discharges from Building 902. These operations are monitored for contaminants such as metals, cyanide, VOCs, and SVOCs. In 2013, analyses of these waste streams showed that, although 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 sanitary 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.

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 5-2 shows the locations of the Laboratory's discharges to recharge basins (also called "outfalls" under BNL's SPDES permit). Figure 5-3 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 High Flux Beam Reactor (HFBR).
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW near the National Synchrotron Light Source II (NSLS-II) site, 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. Recharge basins HP and RAV are used for discharge of treated water from the groundwater remediation systems and are monitored under BNL's CERCLA equivalency permits.

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, samples are also routinely collected and analyzed under BNL's Environmental Surveillance Program for radioactivity, VOCs, metals, and anions. During 2013, water samples were collected from all basins listed above semi-annually 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 semi-annually and analyzed for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. The results are presented in Table 5-2, and show that low levels of alpha and beta activity were detected in most of the samples. Activities ranged from non-detectable to 2.7 ± 1.1 pCi/L for gross alpha activity, and from 1.52 ± 0.57 pCi/L to 4.4 ± 1.0 pCi/L for gross beta activity. These 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).

No gamma-emitting nuclides attributable to BNL operations were detected in any discharges, and tritium was not detected above method detection limits.

5.4.2 Recharge Basins – Nonradiological Analyses

To determine the overall impact on the environment from 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 semi-annually for water quality parameters, metals, and VOCs. Field-measured parameters (pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-3 and 5-4.

Low concentrations of disinfection byproducts were periodically detected above method detection limits 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, lead to the formation of VOCs, including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. All concentrations were less than 5 µg/L. No other VOCs were detected above method detection limits in any of the recharge basins in 2013.

For 2013, all water quality parameters were within effluent standards (Table 5-3), and most metals, except for aluminum and iron, complied with the respective water quality or groundwater discharge standards (Table 5-4). Due to the natural prevalence of these metals in soils, their presence in the water samples is likely due to suspended soil particles introduced at the time of collection. Acidification of the samples results in the dissolution of the element and its detection during analysis. This is supported by the observation that the concentrations in all filtered samples were significantly less, and well below the discharge standard or AWQS. As these metals are in particulate form, they pose no threat to groundwater quality, because the recharge basin acts as a natural filter, trapping the particles before they reach groundwater.

Table 5-2. Radiological Analysis of Samples from BNL On-Site Recharge Basins.

Basin		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
No. of samples		2	2	2
HN	*max.*	< 1.6	1.55 ± 0.69	< 360
	avg.	0.51 ± 1.35	1.25 ± 0.6	<MDL
HO	*max.*	2.7 ± 0.97	3.24 ± 0.76	< 470
	avg.	1.55 ± 2.26	1.94 ± 2.56	<MDL
HS	*max.*	< 1	5.1 ± 1.1	< 370
	avg.	0.93 ± 0.1	3.18 ± 3.75	<MDL
HT-E	*max.*	< 1.4	2.94 ± 0.66	< 370
	avg.	0.52 ± 1.35	2.02 ± 1.79	<MDL
HT-W	*max.*	1.81 ± 0.89	2.01 ± 0.53	< 370
	avg.	1.24 ± 1.12	1.43 ± 1.14	<MDL
HW	*max.*	2.7 ± 1.1	4.4 ± 1	< 310
	avg.	2.13 ± 1.12	3.24 ± 2.26	<MDL
HZ	*max.*	2.45 ± 0.87	1.52 ± 0.57	< 490
	avg.	1.8 ± 1.28	1.11 ± 0.8	<MDL
SDWA Limit		15	(a)	20,000

Notes:
See Figure 5-2 for the locations of recharge basins/outfalls.
All values reported with a 95% confidence interval.
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

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

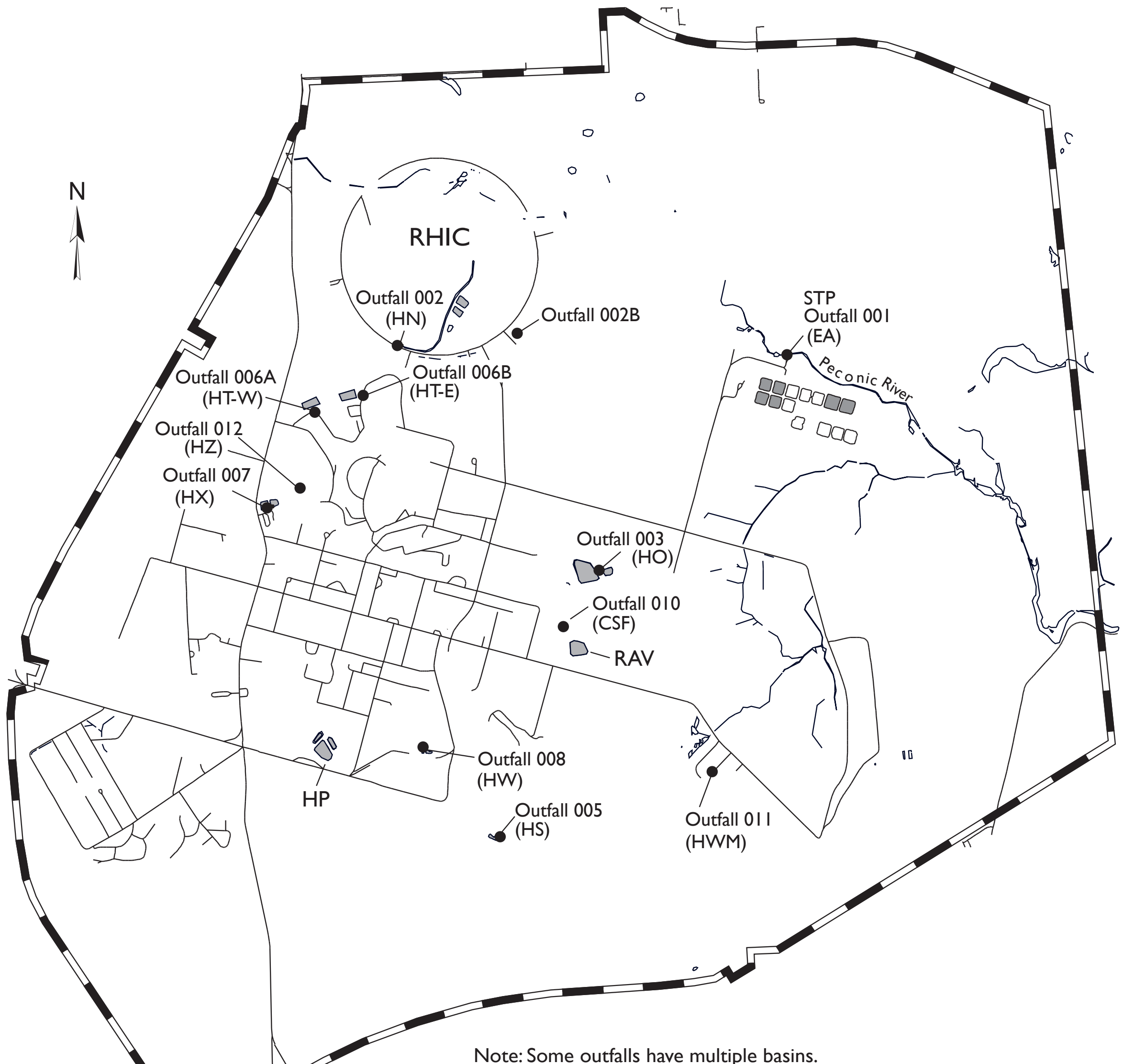

Figure 5-2. BNL Recharge Basin/Outfall Locations.

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 HFBR areas. Basin CSF receives runoff from the CSF area and along Cornell Avenue east of Renaissance Road. Basin HW receives runoff from the NSLS-II site, 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 has 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 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.

Table 5-3. Water Quality Data for BNL On-Site Recharge Basin Samples.

ANALYTE		Recharge Basin 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		2	2	2	2	2	2	2	2		
pH (SU)	*min.*	7.0	8.0	7.5	7.3	7.2	8.0	7.9	7.9	6.5 - 9.0	NA
	max.	7.2	8.7	8.2	8.1	7.7	8.3	8.3	8.7		
Conductivity (µS/cm)	*min.*	202	70	139	190	110	62	109	46	SNS	NA
	max.	238	232	224	272	128	117	208	274		
	avg.	220	151	182	231	119	90	159	160		
Temperature (ºC)	*min.*	8.4	11.1	7.4	18.1	6.4	6.2	7.2	9.7	SNS	NA
	max.	27.2	20.5	21.0	23.1	24.1	23.0	20.9	21.2		
	avg.	17.8	15.8	14.2	20.6	15.3	14.6	14.0	15.5		
Dissolved oxygen (mg/L)	*min.*	7.3	7.1	6.6	7.2	7.3	7.9	8.7	7.1	SNS	NA
	max.	10.8	12.0	11.8	9.1	12.4	12.6	12.5	11.9		
	avg.	9.1	9.5	9.2	8.1	9.9	10.2	10.6	9.5		
Chlorides (mg/L)	*min.*	31.2	11.7	34.0	42.3	28.4	9.6	7.0	8.4	500	4
	max.	45.5	45.5	61.7	51.0	49.9	13.5	17.8	45.3		
	avg.	38.4	28.6	47.9	46.7	39.2	11.6	12.4	26.9		
Sulfates (mg/L)	*min.*	8.5	1.5	5.5	11.1	3.2	1.2	1.5	1.2	500	4
	max.	8.8	9.4	8.5	13.9	14.3	7.2	4.2	9.4		
	avg.	8.7	5.5	7.0	12.5	8.8	4.2	2.9	5.3		
Nitrate as nitrogen (mg/L)	*min.*	0.6	0.1	0.5	0.7	0.7	0.1	0.1	0.1	10	1
	max.	0.9	0.3	1.5	1.4	1.4	1.3	0.8	0.2		
	avg.	0.7	0.2	1.0	1.1	1.0	0.7	0.4	0.1		

Notes:
See Figure 5-2 for the locations of recharge basins/outfalls.
(s) = stormwater
AGS = Alternating Gradient Synchrotron
CSF = Central Steam Facility
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

Basin sediment sampling is conducted on a 5-year testing cycle to ensure these discharges are in compliance with regulatory requirements. The next sampling event will occur in 2017.

5.5 PECONIC RIVER SURVEILLANCE

Several locations are monitored along the Peconic River to assess the overall water quality of the river and to assess any impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-4. In total, 10 stations (three upstream and seven downstream of the STP) were sampled in 2013. 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 monitored for radiological and nonradiological parameters.

As mentioned in Section 5.1, five years of analytical data associated with BNL's surface water monitoring program were evaluated in 2012, and a determination was made to reduce the sampling frequencies for both on- and off-site Peconic River monitoring stations starting in 2013. This decision was based on the fact that historical data has shown no significant variations in water quality throughout

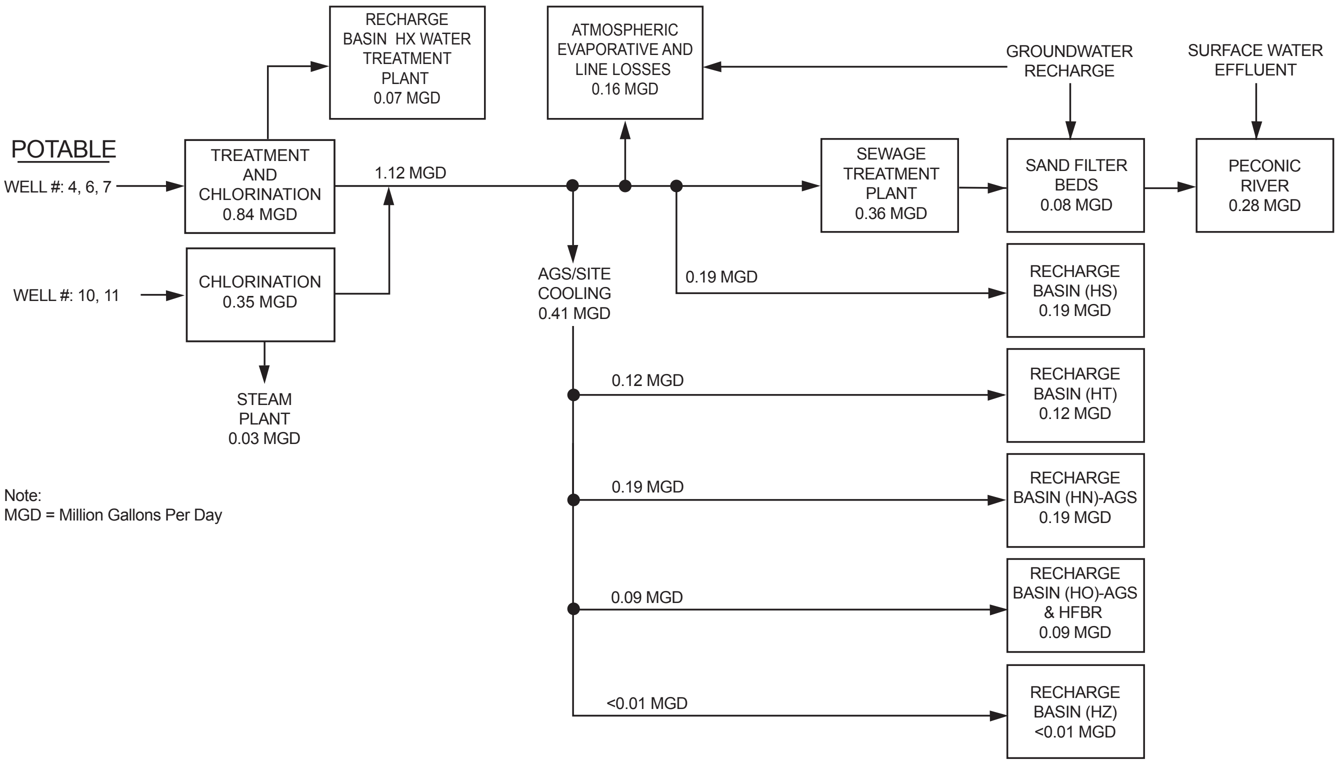

Figure 5-3. Schematic of Potable Water Use and Flow at BNL.

the Peconic River system, Peconic River remediation efforts have been completed, and pollution prevention efforts at the Laboratory has significantly reduced the risk of accidental releases to the sanitary system. 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)

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, plus the control location. Routine samples at stations HM-N and HQ were collected once per quarter, as flow allowed. All other stations were sampled semiannually 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.

Table 5-4. Metals Analysis of Water Samples from BNL On-Site Recharge Basins.

METAL		HO (AGS)		HT-E (AGS)		HT-W (Linac)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
	Total (T) or Filtered (F)	T	F	T	F	T	F	T	F		
	No. of samples	2	2	2	2	2	2	2	2		
Ag Silver (µg/L)	*min.*	< 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		
	avg.	< 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	114.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	2,000	50
	max.	1880.0	< 50.0	306.0	102.0	89.6	< 50.0	2050.0	< 50.0		
	avg.	940.0	< 50.0	210.0	65.7	< 50.0	< 50.0	1032.3	< 50.0		
As Arsenic (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	50	5.0
	max.	< 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		
Ba Barium (µg/L)	*min.*	< 20.0	< 20.0	< 20.0	< 20.0	23.4	23.1	< 20.0	< 20.0	2,000	20
	max.	27.1	27.3	26.0	22.7	39.9	39.7	25.4	24.2		
	avg.	< 20.0	< 20.0	< 20.0	< 20.0	31.7	31.4	< 20.0	< 20.0		
Be Beryllium (µg/L)	*min.*	< 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		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd Cadmium (µg/L)	*min.*	< 2.0	< 2.0	0.2	< 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	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co Cobalt (µg/L)	*min.*	1.0	1.9	0.2	1.5	< 5.0	0.9	1.2	1.1	5	0.1
	max.	< 5.0	< 5.0	0.3	< 5.0	< 5.0	< 5.0	< 5.0	2.0		
	avg.	< 5.0	< 5.0	0.3	< 5.0	< 5.0	< 5.0	< 5.0	1.6		
Cr Chromium (µg/L)	*min.*	< 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	< 10.0	< 10.0	< 10.0		
	avg.	< 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	11.5	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	1,000	10.0
	max.	10.7	< 10.0	22.7	16.3	19.6	15.5	48.4	41.9		
	avg.	< 10.0	< 10.0	17.1	12.8	11.1	< 10.0	28.9	21.6		
Fe Iron (mg/L)	*min.*	0.06	0.05	0.29	0.08	< 0.05	< 0.05	0.07	0.04	0.6	0.05
	max.	2.34	0.05	0.41	0.15	0.14	< 0.05	2.59	0.05		
	avg.	1.20	0.05	0.35	0.12	0.07	< 0.05	1.33	0.05		
Hg Mercury (µg/L)	*min.*	< 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		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	< 5.0	< 5.0	7.4	5.5	< 5.0	< 5.0	< 5.0	5.2	600	5.0
	max.	42.1	7.3	20.1	5.6	21.5	11.7	42.1	7.0		
	avg.	23.3	< 5.0	13.8	5.6	11.2	6.1	23.5	6.1		

(continued on next page)

Table 5-4. Metals Analysis of Water Samples from BNL On-Site Recharge *(concluded).*

METAL		HO (AGS)		HT-E (AGS)		HT-W (Linac)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F		
No. of samples		2	2	2	2	2	2	2	2		
Na Sodium (mg/L)	*min.*	9.1	9.1	24.1	24.2	31.5	31.9	7.3	6.9	SNS	0.25
	max.	26.4	26.2	38.1	37.5	38.2	37.6	27.0	25.9		
	avg.	17.7	17.7	31.1	30.9	34.9	34.8	17.2	16.4		
Ni Nickel (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	200	10.0
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 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	6.9	< 3.0	50	3.0
	max.	7.7	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	24.2	15.4		
	avg.	3.9	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	15.6	7.9		
Sb Antimony (µg/L)	*min.*	< 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	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 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	20	5.0
	max.	< 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		
Tl Thallium (µg/L)	*min.*	< 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	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
V Vanadium (µg/L)	*min.*	< 5.0	< 5.0	3.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5.0
	max.	7.1	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	7.2	< 5.0		
	avg.	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Zn Zinc (µg/L)	*min.*	< 10.0	< 10.0	26.5	22.8	14.0	9.6	38.8	13.5	5000	10.0
	max.	77.3	24.8	38.5	23.8	115.0	97.9	53.8	38.0		
	avg.	38.7	12.4	32.5	23.3	64.5	53.8	46.3	25.8		

Notes:
See Figure 5-2 for the locations of recharge basins/outfalls.
AGS = Alternating Gradient Synchrotron
AWQS = Ambient Water Quality Standards

The radiological data from Peconic River surface water sampling in 2013 are summarized in Table 5-5. 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 at station HV, located upstream of the STP and the maximum beta activity was found at station HM-N, located downstream of the STP Outfall on site. The average concentrations from off-site and control locations were indistinguishable from BNL on-site levels. The beta activity for all locations is therefore attributed to natural sources. All detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP. Tritium was detected in a single water sample collected at HY, an area upstream of the STP discharge, at a concentration of 530 ± 370 pCi/L. Due to the low level of detection and high level of uncertainty in the measurement, the reported result may be a false positive.

Monitoring for Sr-90 was performed at all but one Peconic River station and both control location stations in 2013. A sample from Station HV was not collected due to no water flow conditions. One low-level detection (0.38 ± 0.21 pCi/L) was found at Station HM-N, which is much less than the NYS DWS of 8 pCi/L. This concentration is consistent with historical levels, and can be attributed to worldwide fallout.

5.5.2 Peconic River – Nonradiological Analyses

River water samples collected in 2013 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs. The analytical data for the Peconic River and Carmans River samples are summarized in Table 5-6 (water quality) and Table 5-7 (metals). There were no VOCs detected above the method detection limits from any of the Peconic River sampling stations in 2013.

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 sulfates were highest at Station HM-N, which is immediately downstream of the STP outfall, and were 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, since the Peconic River recharges to groundwater, the

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

Sampling Station		Gross Alpha	Gross Beta	Tritium	Sr-90
		(pCi/L)			
Peconic River					
HY (headwaters) on site, west of the RHIC ring	*N*	2	2	2	2
	max	< 1.1	2.38 ± 0.78	530 ± 370	< 0.77
	avg	0.71 ± 0.69	2.02 ± 0.7	< MDL	0.24 ± 0.64
HV (headwaters) on site, inside the RHIC ring	*N*	2	2	2	NS
	max	0.99 ± 0.6	1.11 ± 0.59	< 490	
	avg	0.92 ± 0.15	1.08 ± 0.06	< MDL	
HE upstream of STP outfall	*N*	1	1	1	1
	max	< 0.84	< 0.87	< 350	< 0.18
	avg	NA	NA	NA	NA
HM-N downstream of STP, on site	*N*	4	4	4	4
	max	< 1.5	6.11 ± 1.14	< 450	0.38 ± 0.21
	avg	0.77 ± 0.34	4.24 ± 1.35	< MDL	0.42 ± 0.23
HM-S tributary, on site	*N*	1	1	1	1
	max	< 0.76	< 0.51	< 370	< 0.62
	avg	NA	NA	NA	NA
HQ downstream of STP, at BNL site boundary	*N*	3	3	3	3
	max	< 1.8	2.92 ± 0.86	< 360	< 0.76
	avg	0.4 ± 1.17	2.21 ± 1.04	< MDL	0.18 ± 0.07
HA off site	*N*	2	2	2	2
	max	< 0.88	1.4 ± 0.66	< 420	< 0.19
	avg	-0.05 ± 0.64	1.11 ± 0.57	< MDL	0.08 ± 0
Donahue's Pond off site	*N*	2	2	2	2
	max	< 1.6	< 0.98	< 470	< 0.18
	avg	0.42 ± 0.04	0.22 ± 0.36	< MDL	0.09 ± 0.14
Forge Pond off site	*N*	2	2	2	2
	max	< 0.9	1.56 ± 0.67	< 410	< 0.21
	avg	0.52 ± 0.32	1.21 ± 0.69	< MDL	0.05 ± 0.1
Carmans River HH control location, off site	*N*	2	2	2	2
	max	< 1.1	1.02 ± 0.66	< 420	< 0.19
	avg	0.52 ± 0.24	0.84 ± 0.35	< MDL	-0.09 ± 0.02
Swan Pond control location, off site	*N*	2	2	2	2
	max	< 0.68	2.13 ± 0.68	< 460	< 0.22
	avg	-0.01 ± 0.14	1.34 ± 1.54	< MDL	0.13 ± 0.12
SDWA Limit (pCi/L)		**15**	**(a)**	**20,000**	**8**

Notes:
See Figure 5-4 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.
MDL = Method Detection Limit
N = Number of samples analyzed
NA = Not Applicable
NS = Not Sampled for this analyte
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
STP = Sewage Treatment Plant

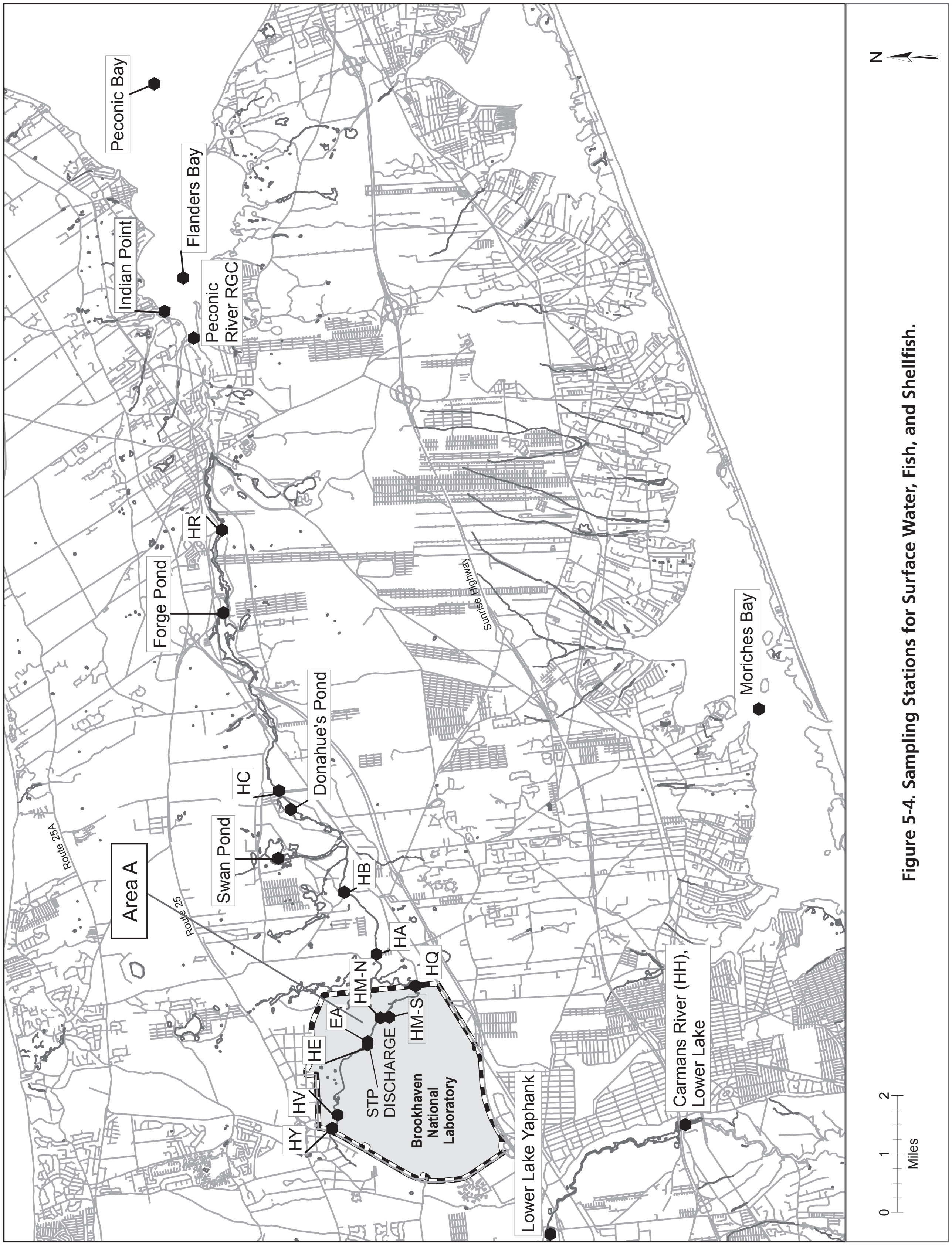

Figure 5-4. Sampling Stations for Surface Water, Fish, and Shellfish.

Table 5-6. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Analyte		Peconic River Station Locations										NYSDEC Effluent Standard	Typical MDL
		HY	HE	HM-N	HM-S	HQ	HA	Donahue's Pond	Forge Pond	Swan Pond	(Control) HH		
	No. of samples	2	1	4	1	3	2	2	2	2	2		
pH (SU)	*min.*	6.5	NA	7.0	NA	6.8	6.3	5.3	6.1	6.1	7.5	6.5-8.5	NA
	max.	7.7	6.5	8.3	3.4	8.1	7.2	6.1	7.5	6.8	7.8		
Conductivity (µS/cm)	*min.*	34	NA	315	NA	9	69	48	70	57	109	SNS	NA
	max.	241	60	431	40	367	71	77	158	75	181		
	avg.	138	NA	379	NA	237	70	63	114	66	145		
Temperature (ºC)	*min.*	12.2	NA	3.9	NA	5	8.9	8.3	8.3	8.6	10.7	SNS	NA
	max.	21.4	4.1	28.2	5.0	28.0	13.0	18.0	20.8	15.6	14.8		
	avg.	16.8	NA	13.4	NA	16	10.9	13.2	14.6	12.1	12.8		
Dissolved oxygen (mg/L)	*min.*	8.2	NA	6.6	NA	5	7.4	8.0	10.2	9.3	10.1	>4.0	NA
	max.	10.4	10.8	15.4	9.8	12.7	10.2	11.4	12.1	10.9	11.2		
	avg.	9.3	NA	12.0	NA	10	8.8	9.7	11.1	10.1	10.7		
Chlorides (mg/L)	*min.*	1.2	NA	56.7	NA	16	8.2	10.2	15.7	9.6	32.7	250(a)	4.0
	max.	66.4	11.5	74.8	4.6	65.8	9.9	11.4	23.2	10.9	33.4		
	avg.	33.8	NA	67.2	NA	46	9.1	10.8	19.5	10.3	33.1		
Sulfates (mg/L)	*min.*	1.2	NA	14.8	NA	5	2.4	4.2	8.5	4.6	12.2	250(a)	4.0
	max.	2.1	6.1	20.0	2.1	14.1	5.5	6.1	13.0	6.4	12.3		
	avg.	1.7	NA	17.3	NA	11	4.0	5.2	10.8	5.5	12.3		
Nitrate as nitrogen (mg/L)	*min.*	0.1	NA	2.5	NA	0	< 0.02	0.0	0.0	< 0.02	1.7	10(a)	1.0
	max.	0.3	0.02	7.0	0.1	1.6	0.1	0.0	0.1	< 0.02	1.7		
	avg.	0.2	NA	4.7	NA	1	0.0	0.0	0.1	< 0.02	1.7		

Notes:
See Figure 5-4 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

AWQS for groundwater (250 mg/L) for these substances is used for comparison purposes.

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 2013, 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 total (i.e., particulate form) metals data showed that silver, aluminum, copper, iron, mercury, lead, and zinc were present in concentrations at some locations that exceeded NYS AWQS. 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, mercury, lead, and zinc were found in samples collected immediately downstream

Table 5-7. 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		2	2	1	1	5	3	1	1	4	2	2	2	2	2	2	2	2	2	2	2		
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.	< 2.0	< 2.0	< 2.0	< 2.0	9.5	< 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.	< 2.0	< 2.0	< 2.0	< 2.0	3.5	< 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.*	217.0	< 50.0	239.0	205.0	< 50.0	< 50.0	449.0	379.0	< 50.0	217.0	58.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	100	50
	max.	628.0	304.0	239.0	205.0	1200.0	87.0	449.0	379.0	547.0	264.0	115.0	104.0	83.0	65.7	88.1	< 50.0	66.0	< 50.0	< 50.0	< 50.0		
	avg.	422.5	172.5	239.0	205.0	372.4	< 50.0	449.0	379.0	279.7	240.5	86.5	69.4	66.1	52.7	57.3	< 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	< 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		
Ba Barium (µg/L)	*min.*	7.2	5.2	18.6	18.7	16.1	11.0	7.1	5.8	7.4	6.4	7.7	6.9	9.0	8.2	4.8	3.9	9.5	8.4	33.0	31.9	SNS	1.8
	max.	24.3	13.8	18.6	18.7	44.0	26.0	7.1	5.8	10.9	6.7	12.9	12.2	12.2	11.5	5.7	5.3	12.0	11.6	38.8	37.1		
	avg.	15.8	9.5	18.6	18.7	25.7	17.6	7.1	5.8	9.3	6.6	10.3	9.6	10.6	9.9	5.3	4.6	10.8	10.0	35.9	34.5		
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	< 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		
	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	< 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.	< 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		
	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	< 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.	< 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		
	avg.	< 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		
Cu (D) Copper (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	19.1	< 10.0	< 10.0	< 10.0	11.2	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	4	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	76.0	41.2	< 10.0	< 10.0	15.2	13.2	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 10.0	< 10.0	35.3	33.8	< 10.0	< 10.0	< 10.0	12.2	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		

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Table 5-7. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers. *(continued).*

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	2	2	1	1	5	3	1	1	4	2	2	2	2	2	2	2	2	2	2	2		
Fe (AS) Iron (mg/L)	*min.*	0.2	0.1	0.3	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.3	0.2	0.0	0.0	0.3	0.2	0.2	0.1	0.3	0.075
	max.	0.7	0.2	0.3	0.2	0.9	0.1	0.2	0.2	0.2	0.1	3.8	2.2	1.2	1.0	0.1	0.0	0.3	0.2	0.3	0.2		
	avg.	0.5	0.1	0.3	0.2	0.4	0.1	0.2	0.2	0.2	0.1	2.0	1.2	0.8	0.6	0.1	0.0	0.3	0.2	0.3	0.1		
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	0.5	< 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		
	avg.	< 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		
Mn Manganese (µg/L)	*min.*	6.2	4.0	54.3	55.6	7.3	4.9	30.0	31.4	6.3	4.7	19.8	20.1	36.7	35.9	11.4	10.4	14.4	12.8	31.1	30.1	SNS	2
	max.	33.4	30.7	54.3	55.6	16.5	9.1	30.0	31.4	18.2	17.9	173.0	169.0	85.8	82.0	14.8	11.6	66.5	62.6	66.5	66.5		
	avg.	19.8	17.4	54.3	55.6	12.8	6.8	30.0	31.4	11.9	11.3	96.4	94.6	61.3	59.0	13.1	11.0	40.5	37.7	48.8	48.3		
Na Sodium (mg/L)	*min.*	2.2	2.2	7.9	8.0	43.4	48.2	3.1	3.0	15.1	15.2	5.8	5.4	7.4	7.3	6.3	6.6	11.4	10.7	20.1	20.1	SNS	1
	max.	44.7	45.7	7.9	8.0	58.0	56.0	3.1	3.0	49.7	50.1	7.6	7.7	7.4	7.4	6.4	6.6	13.7	14.1	22.5	22.4		
	avg.	23.4	24.0	7.9	8.0	49.5	51.2	3.1	3.0	37.1	32.7	6.7	6.6	7.4	7.4	6.3	6.6	12.6	12.4	21.3	21.3		
Ni (D) Nickel (µg/L)	*min.*	< 1.1	< 1.1	< 1.1	1.1	2.4	2.7	< 1.1	1.2	1.2	1.2	< 1.1	< 1.1	< 1.1	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	23	1.1
	max.	1.4	1.1	< 1.1	1.1	6.5	4.1	< 1.1	1.2	3.8	3.8	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 10.0	< 10.0	< 1.1		
	avg.	< 1.1	< 1.1	< 1.1	1.1	3.7	3.4	< 1.1	1.2	2.6	2.5	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 1.1	< 10.0	< 10.0	< 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.	3.9	< 3.0	< 3.0	< 3.0	5.9	< 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		
	avg.	< 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		
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	< 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		
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	< 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		

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Table 5-7. 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		2	2	1	1	5	3	1	1	4	2	2	2	2	2	2	2	2	2	2	2		
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.	< 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		
Zn (D) Zinc (µg/L)	*min.*	19.2	15.6	18.6	16.6	18.0	28.0	10.2	20.4	< 10.0	25.8	10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	30.2	22.0	18.6	16.6	66.0	69.9	10.2	20.4	34.5	30.2	10.0	12.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	24.7	18.8	18.6	16.6	43.1	44.6	10.2	20.4	19.1	28.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		

Notes:
See Figure 5-4 for the locations of sampling stations.
AWQS = Ambient Water Quality Standards
AS = Acid Soluble
D = Dissolved
DP = Donahue's Pond
NA = Not Applicable
SNS = Effluent Standard Not Specified for these elements in Class C Surface Waters
T = Total

of the STP discharge (Station HM-N) at concentrations greater than the NYS AWQS. The concentrations detected were consistent with those found in the STP discharge and, in most instances, were within the BNL SPDES permit limits. Mercury was detected once in an unfiltered sample collected at Station HM-N, most likely due to historical operations, but none was detectable in filtered samples. The NYS AWQS limits for copper, lead, and zinc are very restrictive; consequently, BNL's 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.

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