Chapter 10

Monitoring and Assessment of Controls
In accordance with Part IV.J of the MS4 Permit, the City must develop and implement a monitoring and assessment program. This chapter describes the MS4 Monitoring Program, which can rely on existing programs, to satisfy the following MS4 Permit requirements:

- Assess MS4 Permit compliance;
- Measure the effectiveness of the SWMP;
- Characterize and assess the quality of stormwater discharges at representative MS4 outfalls;
- Identify sources of specific pollutants;
- Detect and eliminate illicit discharges, including illegal connections, to the MS4; and
- Evaluate long-term trends in water quality.

The MS4 Monitoring Program includes evaluation of impaired waters as required under Part II.B of the MS4 Permit, and considerations for specific waterbodies, impairments, and pollutant sources. The program combines data collection from existing monitoring programs with multiple phases of outfall flow metering and water quality sampling. This multi-phase strategy is an adaptive management approach for monitoring and assessing water quality in impaired waters. Appendix 10.1 provides additional information about the MS4 Monitoring Program developed by the City to collect and analyze water quality data. Chapter 5 details the City’s efforts to detect and eliminate illicit discharges.

10.1 Existing Programs

The City has collected water quality data in New York Harbor since 1909. Today the data sets are available on the DEP website and in the annual New York Harbor Water Quality Report.1 Regulators, scientists, educators, and citizens use the data to assess impacts, trends, and improvements in the water quality of the harbor. According to the City’s most recent report, the harbor is cleaner now than at any time in the last 100 years.

Approximately 60 percent of New York City is served by the combined sewer system where a single pipe carries both wastewater and stormwater to a wastewater treatment plant (WWTP). During times of heavy precipitation, the combined sewer system may be overwhelmed and discharge into waterbodies. This discharge is known as a combined sewer overflow (CSO). CSOs are among the largest non-MS4 contributors of pollutants of concern. Since the 1980s, over 80 percent of CSOs in NYC have been reduced due to billions of dollars of investment in projects such as sewer separation. CSO tanks that store combined flow until it can be pumped to the wastewater treatment plant for treatment, sewer system upgrades, wastewater treatment plant upgrades, and a $1.5 billion green infrastructure program. DEP is currently developing and implementing 11 Long Term Control Plans (LTCPs) to build on these earlier investments. These LTCPs are comprehensive evaluations of long-term solutions to reduce CSO events and contribute to water quality improvements in New York City’s waterbodies. In addition, the City’s stormwater management efforts under the SWMP will further contribute to this positive water quality trend by taking steps to reduce stormwater pollution as part of a comprehensive integrated planning approach. For more information about the City’s efforts to address combined sewer overflows2 refer to the Introduction of this Plan.

The City’s routine ambient water monitoring programs described below provided useful data for the development of the MS4 Monitoring Program. These monitoring programs will continue, and the City will use the data to complement the MS4 Monitoring Program.

Harbor Survey Program

DEP and predecessor City agencies began monitoring water quality in New York Harbor waters in 1909. Today, the Harbor Survey Program assesses changes in water quality in New York Harbor over long periods to measure the effectiveness of the City’s various water pollution control programs. This program routinely measures dissolved oxygen (DO), fecal coliform, enterococci, secchi depth (transparency), chlorophyll “A,” total suspended solids (TSS), and total nitrogen (TN).

Sentinel Monitoring Program

DEP monitors waterbodies throughout NYC for pathogens in accordance with DEP’s I4 Wastewater Treatment Plants (WWTPs) SPDES Permits. Under this program, initiated in 1998, DEP collects samples at 80 monitoring stations on a quarterly basis. DEP compares sampling results to the NYSDEC-established water quality baseline. If sampling results are above baseline criteria, DEP investigates the adjacent shoreline through a mini-shoreline survey to determine whether there is a contaminated dry weather discharge that would require source trackdown and abatement actions.

Shoreline Survey

DEP identifies and characterizes shoreline outfalls in NYC. Under this program, DEP surveys 100 percent of the shoreline every ten years, with progress made each year. If DEP observes a dry weather discharge, it conducts an investigation, which may include sampling, to track down the source and take steps to abate the problem.

Field Sampling Analysis Program (FSAP)

The FSAP is a citywide synoptic sampling program with the objective of evaluating the water quality of CSO-impacted waterbodies. This program is a temporary sampling program for DEP’s CSO LTCP program that targets wet weather events and takes simultaneous water quality samples at multiple locations in a short period. DEP developed a sampling plan for each impacted waterbody to address waterbody-specific considerations. The FSAP focuses on target bacteria (i.e., fecal coliform and enterococci), TSS, biochemical oxygen demand (BOD), temperature, conductivity/salinity, and DO associated with CSO and stormwater discharges.

Beach Sampling

City bathing beaches are regulated, monitored, and permitted by the City and State. Under Article 167 of the City Health Code and Section 6-2.19 of the City Sanitary Code, DOHMH is responsible for beach surveillance and monitoring for all permitted City beaches. This monitoring includes routine enterococci measurements at beaches for compliance with water quality standards. DOHMH compiles the results of routine water quality monitoring and compliance inspections in its Annual Surveillance and Monitoring Beach Report.

Community-Led Monitoring

Many schools, universities, citizens, scientists, recreational water users, and environmental organizations conduct their own water quality testing in NYC waterbodies. The City considers established community-led monitoring data when evaluating long-term trends and comparisons of water quality. For example, during the development of several CSO LTCPs, organizations such as Riverkeeper, Bronx River Alliance, and the New York City Water Trail Association’s Citizens Water Quality Testing Program conducted sampling and submitted data and analyses to the City. The City reviewed this information in relation to its own analyses, noted comparisons and differences, and in some cases used it for modeling calibration processes. DEP compared stakeholder data with City data and provided a summary of the comparison during public meetings, on the DEP website, and in the final CSO LTCP that DEP submitted to NYSDEC. Organizations in addition to those listed above that collect long-term water quality data are encouraged to notify and provide information on their monitoring programs to DEP’s MS4 team by emailing MS4@dep.nyc.gov.

10.2 MS4 Monitoring Program

The MS4 Monitoring Program relies on a phased approach to assess pollutant contributions from stormwater runoff in the MS4 area, and their influence on overall New York Harbor water quality. To support scientific conclusions about pollutant sources and water quality trends in receiving waterbodies over time, DEP commissioned a peer review of the proposed MS4 Monitoring Program to evaluate the effectiveness of the two-phased monitoring and assessment approach. In addition, DEP received feedback from public and environmental organizations such as the Stormwater Infrastructure Matters (SWIM) Coalition. DEP incorporated the following recommendations:

- Implement the monitoring and assessment program in phases;
- Incorporate Phase 1 results for development of Phase 2 sampling plan;
- Increase the sampling frequency of Phase 1; and
- Add an outfall location in Staten Island for low residential land use to represent the variety of low residential land use in the MS4 area.

During Phase 1, DEP will meter and sample at a set of MS4 outfalls during wet weather to assess the influence of land use on stormwater discharge and pollutant concentrations. In NYC, tidal flows influence the majority of outfalls with tidal waters sometimes reaching miles upstream. This influx of harbor water impedes stormwater discharges from outfalls and therefore, presents challenges for measuring stormwater impacts on receiving waterbodies. In order to avoid tidal influence in the sewer, DEP will collect some samples from manholes upstream of the representative MS4 outfalls. Implementation of Phase 1 monitoring will begin by August 2020. DEP will analyze Phase 1 data to aid in developing the Phase 2 sampling plan. During the analysis of Phase 1 data, DEP will identify which of the pollutants of concern (POCs) listed in Table 10.1 are present in significant concentrations. DEP will continue to monitor for those parameters in Phase 2. Phase 2 monitoring will also include pathogen and nutrient parameters, which the MS4 Permit lists as the cause of water quality impairment for specific waterbodies.

In Phase 2, DEP will target a second set of MS4 outfalls as described in Section 10.2.2 to evaluate long-term trends. DEP anticipates that Phase 2 monitoring will apply procedures similar to those in Phase 1, with the addition of water quality sampling in receiving waterbodies conducted at the nearest, existing Harbor Survey or Sentinel Monitoring station or other appropriate location. Phase 2 will start after the Phase 1 analysis is completed and DEP finalizes the Phase 2 sampling plan based on Phase 1 analysis.

The DEP Harbor Survey and Sentinel Monitoring Programs will continue concurrently with and as a complement to Phase 1 and 2 monitoring. DEP will use data from these programs and Phase 2 monitoring to analyze the influence of stormwater loads in receiving waterbodies. Refer to Appendix 10.1 for additional information.

10.2.1 Phase 1—Land Use-Based Outfall Monitoring

The objective of the land use-based outfall monitoring (Phase 1) is to identify potential sources of specific pollutants, and characterize and assess the quality of stormwater discharges at representative MS4 outfalls, as required by Part IV.I.2 of the MS4 Permit. DEP will use the collected data to determine whether there is any correlation between land use type and pollutant loadings. Understanding this correlation can be useful for identifying and implementing pollutant reduction measures for a particular land use type. DEP may use results from Phase 1 monitoring to refine the current event mean concentrations (EMCs) per land use type. The EMC is the flow weighted mean concentration, which is equivalent to collecting the entire stormwater runoff, completely mixing it and then determining the pollutant concentration. EMCs are used in pollutant load analysis to ensure no net increase of nitrogen contributions to nitrogen-impaired waterbodies. Refer to Chapter 6: Construction and Post-Construction for more information on no net increase requirements.

Pursuant to EPA stormwater monitoring guidance, consideration of land use patterns within a municipality should be a major factor in the selection of outfalls to monitor. Phase 1 will monitor eight outfalls that represent six land use types within NYC, as summarized in Table 10.2 below. DEP identified Phase 1 outfalls and corresponding monitoring locations for metering and sampling through detailed assessments of GIS land use data, sewer system delineations, and previous water quality data collection efforts and reporting. All outfalls were visited to confirm location details and accessibility. Phase 1 outfalls may change as data collection is initiated if DEP determines that data collection is limited by any unforeseen conditions or if more appropriate outfalls are identified. This ongoing ability to modify monitoring procedures is aligned with the adaptive management approach being employed by DEP to collect and evaluate the most meaningful data for the multi-phased MS4 Monitoring Program. Other factors considered in selecting sampling locations include:

- farthest downstream manhole or outfall pipe not influenced by tides;
- no dry weather flows; and
- safely accessible by sampling field crews.

Phase 1 monitoring will occur once per quarter for two years at each location for a total of 64 samples. After Phase 1 is complete, DEP will evaluate the collected data to determine next steps and may extend Phase 1 monitoring if the data suggest some correlation between land use and specific pollutants.

### Summary of MS4 Monitoring Program Phases

#### Table 10.1

<table>
<thead>
<tr>
<th>Phase</th>
<th>Goal</th>
<th>Sampling Sites</th>
<th>Frequency</th>
<th>Monitoring Parameters</th>
<th>Anticipated Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Assess the effect of land use on stormwater discharge and pollutant concentrations</td>
<td>BMS4-outfalls representative of 6 land use types (mixed, high-density residential, low-density residential, 2 industri-al, 1 open space, and highway)</td>
<td>Quarterly for 2 years</td>
<td>Nutrients, Pathogens, Nutrients, Metals, Oil and grease, Field-in-situ Flow</td>
<td>By August 2020</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Evaluate long-term trends</td>
<td>MS4 outfalls to be determined based on Phase 1 results</td>
<td>To be determined based on Phase 1 results</td>
<td>Pathogens(s), Nutrient(s), Other parameters</td>
<td>After analysis of Phase 1 data</td>
</tr>
</tbody>
</table>

### Phase 1 Monitoring Locations

#### Table 10.2

<table>
<thead>
<tr>
<th>Target Outfall ID</th>
<th>Borough</th>
<th>Land Use</th>
<th>Drainage Area to Anticipated Monitoring Location (acres)</th>
<th>Land Uses Per MapPLUTO Overlay</th>
<th>Anticipated Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP-627</td>
<td>Bronx</td>
<td>Open Space</td>
<td>12.4</td>
<td>Open Space and Outdoor Recreation</td>
<td>85%</td>
</tr>
<tr>
<td>HP-640</td>
<td>Bronx</td>
<td>Mixed</td>
<td>4.3</td>
<td>Multi Family Residential, Commercial and Office Buildings, and Public Facilities and Institutions</td>
<td>61%</td>
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<tr>
<td>NOAA-532</td>
<td>Queens</td>
<td>Industrial</td>
<td>87.2</td>
<td>Industrial and Manufacturing</td>
<td>63%</td>
</tr>
<tr>
<td>OA-722</td>
<td>Staten Island</td>
<td>Low-Density Residential</td>
<td>45.3</td>
<td>One and Two Family Buildings</td>
<td>69%</td>
</tr>
<tr>
<td>OH-607</td>
<td>Brooklyn</td>
<td>Industrial</td>
<td>5.1</td>
<td>Industrial and Manufacturing</td>
<td>52%</td>
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<tr>
<td>TI-604</td>
<td>Queens</td>
<td>Highway</td>
<td>15.4</td>
<td>Highway</td>
<td>63%</td>
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<tr>
<td>TI-633</td>
<td>Queens</td>
<td>High-Density Residential</td>
<td>15.1</td>
<td>One and Two Family Buildings</td>
<td>69%</td>
</tr>
<tr>
<td>TI-658</td>
<td>Queens</td>
<td>Low-Density Residential</td>
<td>26.0</td>
<td>One and Two Family Buildings</td>
<td>69%</td>
</tr>
</tbody>
</table>
Water quality sampling for wet weather monitoring programs

One of the goals of this wet weather monitoring program is to better understand the correlation between water quality samples and stormwater runoff. DEP grabs samples from inside a storm sewer pipe at a manhole or an outfall, or in a receiving waterbody when it is raining. This information is important for linking specific water quality results directly to the stormwater runoff that may be carrying discharging pollutants. Sampling programs must identify and assess predicted rain events in advance to determine whether an event will produce enough stormwater runoff to measure, and whether there was sufficient time between storms to allow pollutants to build up between rain events.

10.2.2 Phase 2—Targeted Outfall Monitoring

After DEP evaluates the Phase 1 monitoring data, DEP will develop a targeted outfall monitoring program for Phase 2 to evaluate long-term trends. The Phase 2 program will target outfalls that generally meet one or more of the following criteria:

- **Discharge to impaired waterbodies**: Part IV.1.2.b of the MS4 Permit requires the monitoring program to assess the water quality of impaired waterbodies, including Priority MS4 Waterbodies.
- **Discharge from large upstream areas**: Outfalls with a large upstream drainage area convey the greatest stormwater volume and likely the largest pollutant load, and therefore have a greater impact on receiving water quality.
- **Discharge to sensitive areas**: Sensitive areas such as recreational beaches that have potential human health and safety hazards.
- **Discharge from drainage areas where the SWMP was implemented**: Outfalls with a drainage area where source controls such as education and outreach, green infrastructure, stormwater control measures (SCMs), and other SWMP-related programs are expected to be implemented will support evaluations of SWMP effectiveness.

DEP will analyze data from Phase 2 in comparison with data collected by the Harbor Survey, Sentinel Monitoring, and other publicly-led programs to evaluate the role stormwater plays as a potential pollutant source and analyze long-term trends in receiving water quality. To ensure the data are comparable, this analysis will account for the following factors:

- **Proximity**: DEP will identify and use Harbor Survey and Sentinel Monitoring stations closest to each Phase 2 outfall location.
- **Timing**: DEP will collect samples from these Harbor Survey and Sentinel Monitoring stations after a qualifying rain event.
- **Parameters**: DEP will measure the same Phase 2 parameters at the nearby Harbor Survey and/or Sentinel Monitoring stations.

10.3 MS4 Monitoring Program Procedures

The MS4 Monitoring Program procedures will support DEP’s characterization and assessment of the quality of stormwater discharges at representative MS4 outfalls, identification of sources of specific pollutants, and evaluation of long-term trends in receiving water quality. Appendix 10.1 describes in more detail the procedures summarized below.

10.3.1 Outfall Flow

In order to estimate the pollutant loading from each outfall, a measurement of volumetric flow is necessary (i.e., flow × concentration = load). Because stormwater outfalls are only expected to have flow during and after rainfall events, automated flow meters will be used in manholes. DEP may use manual measuring devices when collecting samples to corroborate automated flow meter readings. Flow measurements will be limited to a subset of the monitored outfalls and DEP will compare measurements to other data points or conditions including drainage area size, impervious cover, and precipitation data from the nearest City rain gauge.

10.3.2 Sample Collection and Field Measurements

Field activities will include collecting grab samples of water for laboratory analysis. DEP will deploy crews to collect samples for qualifying rain events. DEP defines a qualifying rain event as:

- 48 hours of relatively dry weather (no storm in excess of 0.1 inch in the outfall catchment area) precedes rain event;
- predicted at least a day in advance by weather forecasts;
- predicted by weather forecasts with 80 percent probability of occurring; and
- predicted to result in greater than 0.2 inches of rain.

Field activities include collecting grab samples for laboratory analyses (as listed below) and measuring in-field parameters such as pH, DO, temperature, and salinity. DEP will obtain storm volume and duration data from the nearest or most appropriate rain gauge. Because of shorter holding times, DEP will send samples collected for pathogen analysis via messenger to a nearby laboratory. DEP will obtain oil and grease measurements from a single grab sample (as opposed to a composited sample). For all other parameters, DEP will use time-weighted composites. All sampling is subject to DEP’s established quality assurance and quality control (QA/QC) procedures. DEP will use the appropriate standard methods to collect QA/QC samples based on the parameters measured.

DEP staff samples water quality.

DEP sampling in Coney Island Creek.
10.3.3 Laboratory Analyses

DEP selected the parameters and types of laboratory analyses for the MS4 Monitoring Program based on one or more of following criteria:

- Listed as a POC in Appendix 2 of the MS4 Permit
- Listed as a cause for impairment in receiving waterbodies in the Clean Water Act Section 303(d) list
- Identified as being present at representative MS4 outfalls/manholes in the DEP Supplemental Discharge Characterization Report that was prepared for the WWTP SPDES Permits
- Commonly associated with land uses within an outfall’s drainage area
- Historically associated with the City’s MS4 discharges based on existing monitoring programs

Since the data collected under this program will be used for MS4 Permit compliance, samples will be analyzed by a laboratory certified by the New York State Environmental Laboratory Approval Program.

The MS4 Monitoring Program includes sampling for the following parameters identified by existing data sources, reports, and the MS4 Permit:

- **Residue:** Total Dissolved Solids (TDS); Total Suspended Solids (TSS)
- **Pathogens:** Fecal Coliform; Enterococci
- **Nutrients:** Total Phosphorus; Dissolved Phosphorus; Total Ammonia (as N); Total Kjeldahl Nitrogen (TKN as N, the sum of ammonia, and organic nitrogen); Total Nitrogen (TN, the sum of TKN, and nitrate-nitrite)

### Metals: Total Cadmium; Total Chromium; Total Copper; Total Lead; Total Nickel; Total Arsenic; Total Mercury; Total Zinc

### Miscellaneous: Oil and Grease

The parameters above include the POCs listed as the causes of impairment in the MS4 Permit with the exception of floatables, which this Plan addresses in Chapter 9: Control of Floatable and Settleable Trash and Debris. Phase 1 will include sampling for all above parameters. Parameters to be sampled as part of Phase 2 will be identified based on Phase 1 results.

10.4 Assessment of MS4 Monitoring Program

DEP will begin assessing the MS4 Monitoring Program approximately two years (i.e., eight quarterly sampling cycles) after Phase 1 monitoring begins. Assessments of, and recommended adjustments to, the MS4 Monitoring Program will be provided in the Annual Report, as appropriate. Assessments may include comparisons to historical City and national data, and State water quality standards.

Data collection will likely reveal opportunities for MS4 Monitoring Program improvements. This adaptability is essential to the City’s meeting the goals of the SWMP. Accordingly, as DEP develops and implements the MS4 Monitoring Program, it will consider changing sampling frequency or locations to yield more meaningful results.

10.5 Measurable Goals and Program Assessment

As described in Chapter 12: Recordkeeping and Reporting, the City is developing a Consolidated Information Tracking System to track information required by the MS4 Permit for the Annual Report. Table 10.3 lists measurable goals and measures for identified Monitoring and Assessment of Controls best management practices (BMPs). Annual Reports will use these measures to detail the status of each measurable goal and BMP. Part IV.M.4.j.1 of the MS4 Permit requires an Annual Effectiveness Assessment in each Annual Report, as described in Chapter 12: Recordkeeping and Reporting. The City will base the Annual Effectiveness Assessment on its achievement of the stated measurable goals for each chapter of this Plan, including this program. The City will also refine these measurable goals with information gained from program planning and implementation, interagency working groups, and public input. Continuing to refine and update the measurable goals will allow the City to better quantify and accurately represent the effectiveness of each one.

### Summary of BMPs, Measureable Goals, and Measures for the MS4 Monitoring Program

<table>
<thead>
<tr>
<th>BMP</th>
<th>Measurable Goals</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring and Assessment Program</td>
<td>Conduct wet weather sampling from outfalls/manholes</td>
<td>Results of monitoring data collected and analyzed</td>
</tr>
</tbody>
</table>