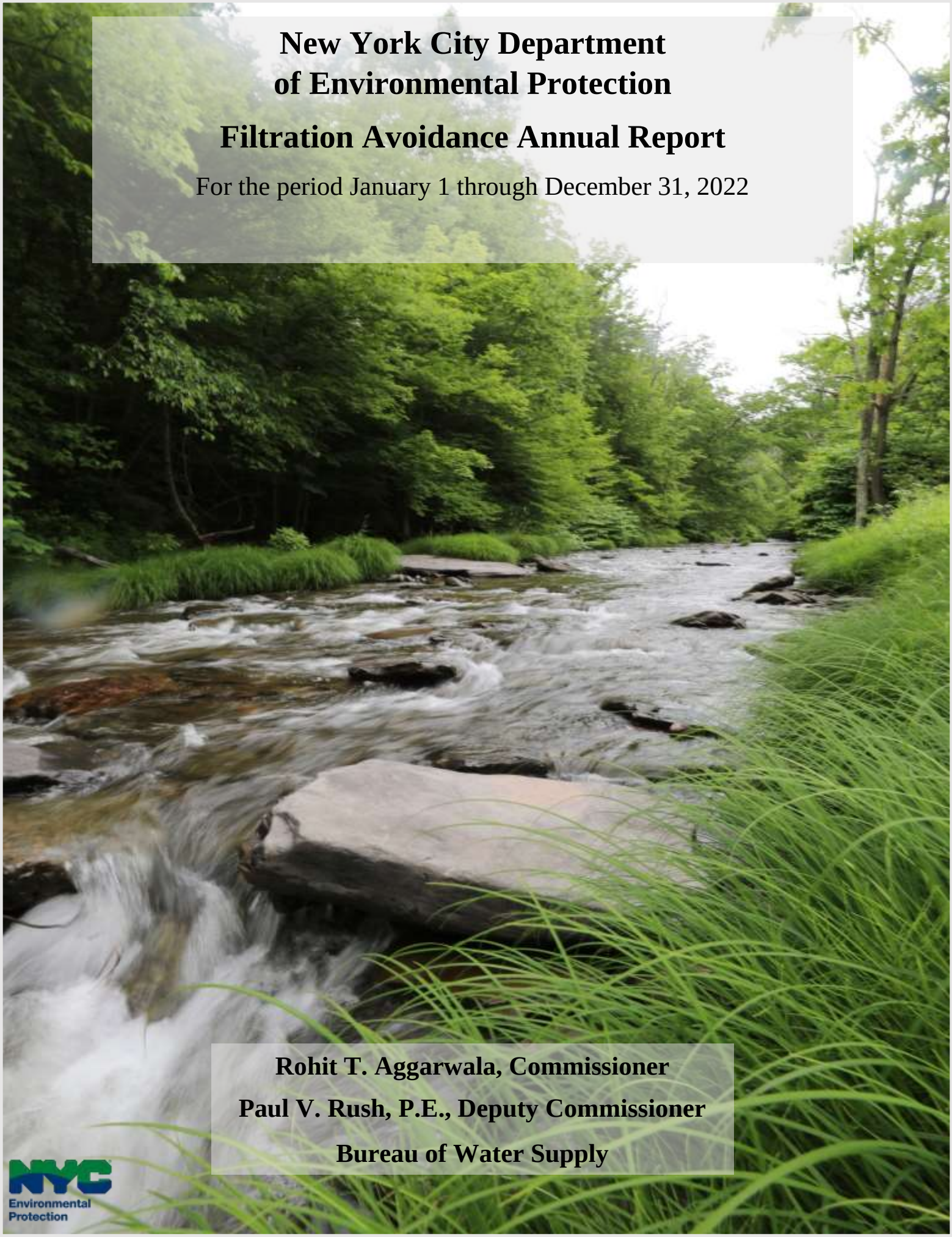

New York City Department of Environmental Protection

Filtration Avoidance Annual Report

For the period January 1 through December 31, 2022

Rohit T. Aggarwala, Commissioner

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Bureau of Water Supply

NYC Environmental Protection

Cover photo: The Batavia Kill as it flows toward Pepacton Reservoir./DEP Photographer Kristen Artz

Table of Contents

List of Figures ..... **v**

List of Tables ..... **vii**

List of Acronyms ..... **viii**

1. Introduction **1**

2. Federal and State Objective Water Quality Compliance **5**

2.1 Surface Water Treatment Rule Monitoring and Reporting 5

2.1.1 Raw Water Fecal Coliform Concentrations (40 CFR Section 141.71 (a)(1)) 5

2.1.2 Raw Water Turbidity (40 CFR Section 141.71(a)(2)) 6

2.1.3 Raw Water Disinfection/CT Values (40 CFR Sections 141.71(b)(1)(i) and141.72(a)(1)) 6

2.1.4 Entry Point Chlorine Residual (40 CFR Sections 141.71(b)(1)(iii) and 141.72(a)(3)) 7

2.1.5 Distribution System Disinfection Residuals (40 CFR Sections 141.71(b)(1)(iv) and 141.72(a)(4)) 7

2.1.6 Trihalomethane Monitoring (40 CFR Section 141.71(b)(6)) and HAA5 Monitoring (40 CFR Section 141.171) 7

2.2 Total Coliform Monitoring 8

2.2.1 Monthly Coliform Monitoring (40 CFR Section 141.71(b)(5)) 8

2.2.2 Chlorine Residual Maintenance in the Distribution System 9

3. Environmental Infrastructure **11**

3.1 Septic Programs 11

3.2 Community Wastewater Management Program 11

3.3 Sewer Extension Program 12

3.4 Stormwater Programs 12

3.4.1 Stormwater Cost-Sharing Programs 12

3.4.2 Stormwater Retrofit Program 13

4. Protection and Remediation Programs **15**

4.1 Waterfowl Management Program 15

4.2 Land Acquisition 15
4.2.1 Solicitation Goals 18
4.2.2 Purchase Contracts 23
4.2.3 Transfer of Conservation Easements to New York State 24
4.2.4 New York City-Funded Flood Buyout Program 25
4.2.5 Streamside Acquisition Program 26
4.2.6 Farm and Forest Easement Programs 27
4.2.7 Water Supply Permit 27
4.2.8 Use of LAP-Acquired Land by Local Communities 27
4.3 Land Management 27
4.3.1 Fee Simple Lands 27
4.3.2 Conservation easements 29
4.3.3 Deer Management 29
4.3.4 Watershed Recreation 30
4.4 Watershed Agricultural Program 32
4.5 Watershed Forestry Program 35
4.6 Stream Management Program 36
4.6.1 Water Quality Stream Projects 37
4.6.2 Flood Hazard Mitigation Program 40
4.6.3 Stream Management Plan Implementation Program 45
4.6.4 Stream Studies 47
4.6.5 Watershed Emergency Stream Response and Recovery Plan 47
4.7 Riparian Buffer Protection Program 47
4.7.1 Activities on City-owned or Controlled Land 47
4.7.2 Catskill Streams Buffer Initiative 48
4.8 Ecosystem Protection Program 51
4.8.1 Wetlands Protection Program 51
4.8.2 Forest Management 57
4.8.3 Invasive Species 60
4.9 East of Hudson Non-Point Source Pollution Control Program 63

4.9.1 Wastewater Programs 64
4.9.2 Stormwater Retrofit and Remediation 64
4.9.3 Stormwater Facility Inspection and Maintenance 65
4.9.4 Stormwater Retrofit Grant Program 65
4.10 Kensico Water Quality Control Program 65
4.10.1 Septic Reimbursement Program 65
4.10.2 West Lake Sewer 65
4.10.3 Video Sanitary Sewer Inspection 66
4.10.4 Stormwater BMPs 66
4.10.5 Wildlife Sanitary Surveys 67
4.10.6 Spill Containment Facilities 69
4.10.7 Shaft 18 Shoreline Stabilization 69
4.10.8 Other Activities 70
4.11 Catskill Turbidity Control 71
5. Watershed Monitoring, Modeling, and GIS 75
5.1 Watershed Monitoring Program 75
5.1.1 Routine Water Quality Monitoring 75
5.1.2 Additional Water Quality Monitoring 76
5.1.3 Wastewater Treatment Plant Protozoan Monitoring 78
5.1.4 Water Quality Reports 78
5.2 Multi-Tiered Water Quality Modeling Program 78
5.2.1 Overview 78
5.2.2 Modeling Program 79
5.2.3 Operations Support Tool (OST) 81
5.3 Geographic Information System 84
5.3.1 GIS Technical Support 84
5.3.2 Completion or Acquisition of New GIS Data Layers and Aerial Products 84
5.3.3 GIS Infrastructure Improvement 86
5.3.4 Data Dissemination to Stakeholders 88
6. Regulatory Programs 89
6.1 Project Review 89

6.1.1 SEQRA Coordination 90
6.1.2 Delegation Agreements 90
6.2 Enforcement Activities 90
6.3 Wastewater Treatment Plant Compliance and Inspection Program 91
6.3.1 Facility Compliance in the Catskill/Delaware Watershed 91
6.3.2 Facility Compliance in the East of Hudson Watershed 92
6.3.3 Sampling of WWTP Effluents 93
6.4 Capital Replacement Program 94
7. In-City Programs 95
7.1 Waterborne Disease Risk Assessment Program 95
8. Education and Outreach 99
9. Miscellaneous Reporting Provisions 103
9.1 Water Conservation/Demand Management 103
9.1.1 Water Demand Management Plan 104
9.2 Updates to Drought Management Plan 107
9.3 Delaware Aqueduct Leak 108
9.4 Catskill/Delaware Filtration Plant 110
9.5 Arkville office 110
References 111
Appendix A: Land Acquisition Tables 113

List of Figures

Figure 1.1 New York City East-of-Hudson watershed protection and partnership programs as of December 2022. 3
Figure 1.2 New York City West-of-Hudson watershed protection and partnership programs as of December 2022. 4
Figure 2.1 Percent fecal coliform samples >20 CFU/100mL over the previous six months, Catskill-Delaware System, 2018-2022. 6
Figure 2.2 Catskill-Delaware source water turbidity, January 1, 2022-December 31, 2022..... 7
Figure 2.3 Positive total coliform samples, NYC distribution system, 2018-2022. 8
Figure 4.1 Percent of land protected in each Catskill/Delaware basin. 18
Figure 4.2 Annual acres secured by purchase contracts in the Catskill/Delaware watershed organized by LAP program, 1995-2022. 24
Figure 4.3 This 1-acre parcel in the Town of Shandaken was signed to contract in 2022 through the NYCFFBO. The residence is in a floodplain near the headwaters of the Esopus Creek and was repeatedly damaged by multiple floods. 25
Figure 4.4 This vacant 2.25-acre property was appraised by the SAP in 2022, after which the owner signed a purchase contract. 26
Figure 4.5 Acres of City-owned watershed land and reservoirs open for recreational access since 2003. 30
Figure 4.6 Location of SMP projects, 2022. 37
Figure 4.7 The Batavia Kill at Red Falls Project 2 before (top) and after (bottom) restoration ..... .39
Figure 4.8 Stony Clove above Jansen Road before construction (top) and after contruction (bottom). 41
Figure 4.9 Location and status of LFA projects, 2021. 42
Figure 4.10 Townsend Elementary School flood hazard mitigation project 44
Figure 4.11 Boiceville firehouse under construction, December 2022. 45
Figure 4.12 Locations of CSBI projects completed, 2009-2021 50
Figure 4.13 Locations of wetland permits reviewed EOH in 2022. 52
Figure 4.14 Locations of wetland permits reviewed WOH in 2022. 53
Figure 4.15 Reference wetland and seasonal pool monitoring sites in the CAT/DEL watersheds. 56
Figure 4.16 Skidder utilizing bridge to cross regulated stream on Neale Hollow FMP. 59
Figure 4.17 Spotted lanternfly in trap at Hillview Reservoir. 62
Figure 4.18 Adult zebra mussels at Amawalk Reservoir. 63
Figure 4.19 BMPs within the Kensico Reservoir basin. 67

Figure 4.20 Aerial photograph showing the stabilization sites at the cove (background) and western shoreline (foreground). 70
Figure 5.1 Recently mapped sewer manholes are hyperlinked to their associated inspection photos. All are viewable within the WaLIS application's map interface. 85
Figure 5.2 Features of the next generation of the WaLIS application now in beta development will include enhanced map quality due to better integration with Portal map services. Improved graphic rendering can be seen in output from the new beta version (top) compared with current WaLIS version (bottom). 87
Figure 7.1 Cases of giardiasis and cryptosporidiosis diagnosed exclusively by syndromic multiplex panels (SMPs) 2015-2022 96
Figure 9.1 New York City water demand and population. 103

List of Tables

Table 3.1 WOH future stormwater controls projects approved for funding in 2022. 13
Table 4.1 Catskill/Delaware stream length, riparian buffer, wetland, forest cover, and floodplain summary, December 31, 2022. 16
Table 4.2 Solicitation outcomes by basin since 1997. 19
Table 4.3 Solicitation outcomes by county since 1997. 21
Table 4.4 Status of WQSPs toward fulfillment of the Revised 2017 FAD requirement. 38
Table 4.5 Number of SMIP awards by category for 2022 and totals to date. 46
Table 4.6 Summary of locally driven SMIP projects completed in 2022 46
Table 4.7 Summary of CSBI projects completed in 2022. 49
Table 4.8 Wetlands and deepwater habitats acquired or protected by the NYC Land Acquisition Program (LAP) in the Catskill/Delaware and Croton systems as of December 31, 2022 54
Table 4.9 FMPs awarded in 2022. 58
Table 4.10 FMPs in planning in 2022 for award in 2023. 58
Table 4.11 Kensico Reservoir 2022 wildlife sanitary surveys. 68

Appendix A Table 1 Status of acquisitions since January 1, 2010, by town. 113
Appendix A Table 2 Contracts signed in the CAT/DEL System by reporting period and R.E. Type 115
Appendix A Table 3 Contracts signed in the CAT/DEL System by reporting period and R.E. Type 116
Appendix A Table 4 Contracts closed in the CAT/DEL System by reporting period and R.E. Type 117
Appendix A Table 5 Contracts closed in the CAT/DEL System by reporting period and R.E. Type 118
Appendix A Table 6 Parcels eased or acquired in fee simple, 2022. newly acquired tax parcels by county and town and closing date; System = CAT/DEL 119
Appendix A Table 7 Summary of LAP signed contracts program-to-date by priority area. ... 120
Appendix A Table 8 New York City-funded Flood Buyout Program - purchase contracts by county. 121

List of Acronyms

APHIS	Animal and Plant Health Inspection Service
BMP	best management practice
BWS	Bureau of Water Supply
CAT/DEL	Catskill/Delaware
CC	compliance conference
CCE	Cornell Cooperative Extension
CCCD	Catskill Center for Conservation and Development
CCEUC	Cornell Cooperative Extension of Ulster County
CDUV	Catskill/Delaware Ultraviolet Disinfection Facility
CE	conservation easement
CFI	continuous forest inventory
CREP	Conservation Reserve Enhancement Program
CRISP	Catskill Regional Invasive Species Partnership
CSBI	Catskill Streams Buffer Initiative
CT	contact time
CUNY	City University of New York
CWC	Catskill Watershed Corporation
CWMP	Community Wastewater Management Program
DCPD	Delaware County Planning Department
DEIS	Draft Environmental Impact Statement
DEM	Digital Elevation Model
DEP	New York City Department of Environmental Protection
DFIRM	digital flood insurance rate map
DMAP	Deer Management Assistance Permit
DOC	dissolved organic carbon
DOE	New York City Department of Education
DOHMH	New York City Department of Health and Mental Hygiene
DPR	New York City Department of Parks and Recreation
DSEIS	Draft Supplemental Environmental Impact Statement
DUA	Day Use Area
EFC	New York State Environmental Facilities Corporation
EIS	environmental impact statement
EPP	Ensemble Forecast Post-Processor
EOH	East of Hudson
EOHWC	East of Hudson Watershed Corporation
FAD	Filtration Avoidance Determination
FDNY	New York City Fire Department
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FITT	Forestry Interdisciplinary Technical Team

FMP	Forest Management Project
GCM	global climate model
GCSWCD	Greene County Soil and Water Conservation District
GI	gastrointestinal illness
GIS	Geographic Information System
GPS	Global Positioning System
HAA5	haloacetic acid five
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HHC	New York City Health and Hospitals Corporation
HPC	Heterotrophic Plate Count
IAR	inactivation ratio
IRSP	individual residential stormwater permit
ISAC	Invasive Species Advisory Committee
ISC	New York State Invasive Species Council
ISWG	Invasive Species Working Group
JV	Joint Venture
LAP	Land Acquisition Program
LFA	Local Flood Analysis
LFHMIP	Local Flood Hazard Mitigation Implementation Program
LiDAR	Light Detection and Ranging
MAP	Management Assistance Program
MARFC	Middle Atlantic River Forecast Center
MFO	Master Forest Owner
MCL	Maximum Contaminant Level
MGD	million gallons per day
MOA	New York City Memorandum of Agreement
NAS	National Academies of Science
NASEM	National Academy of Sciences, Engineering and Medicine
NHD	National Hydrography Dataset
NMP	nutrient management plan
NOV	Notice of Violation
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
NWI	National Wetlands Inventory
NYC	New York City
NYCFFBO	New York City-Funded Flood Buyout Program
NYNJTC	New York-New Jersey Trail Conference
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
O&M	Operation and maintenance

OST	Operations Support Tool
PAA	Public Access Area
PFM	precision feed management
PRISM	Partnership for Regional Invasive Species Management
RBAP	Riparian Buffer Acquisition Program
RCMP	Riparian Corridor Management Plan
REP	Regulatory and Engineering Programs
RFP	Request for Proposals
RIWP	remedial investigation work plan
RNSP	Rondout/Neversink Stream Program
RWBT	Rondout-West Branch Tunnel
SAP	Streamside Acquisition Program
SCSWCD	Sullivan County Soil and Water Conservation District
SDEIS	Supplemental Draft Environmental Impact Statement
SEIS	Supplemental Environmental Impact Statement
SEQRA	State Environmental Quality Review Act
SFI	Stream Feature Inventory
SMIP	Stream Management Implementation Program
SMP	Stream Management Program
SPDES	State Pollutant Discharge Elimination System
SSTS	subsurface sewage treatment system
STRP	sediment turbidity reduction projects
SUNY	State University of New York
SWAC	Schoharie Watershed Advisory Committee
SWAT	Soil Water Assessment Tool
SWCD	Soil and Water Conservation District
SWPPP	stormwater pollution prevention plan
SWTR	Surface Water Treatment Rule
TCR	Total Coliform Rule
THM	trihalomethane
TKN	total kjeldahl nitrogen
TSI	timber stand improvement
TTHM	total trihalomethane
UCSWCD	Ulster County Soil and Water Conservation District
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
UV	ultraviolet light
WAC	Watershed Agricultural Council
WaLIS	Watershed Lands Information System
WAP	Watershed Agricultural Program

WDRAP	Waterborne Disease Risk Assessment Program
WECC	Watershed Enforcement Coordination Committee
WFMP	Watershed Forest Management Plan
WFP	whole farm plan
WOH	West of Hudson
WQSP	Water quality stream projects
WRF	Water Research Foundation
WRRF	Water Resource Recovery Facility
WR&R	New York City Watershed Rules and Regulations
WSP	Water Supply Permit
WWQMP	Watershed Water Quality Monitoring Plan
WWTP	wastewater treatment plant
WWTPCI	Wastewater Treatment Plant Compliance and Inspection

1. Introduction

In the early 1990s, New York City embarked on an ambitious program designed to protect and enhance the quality of the City's drinking water supply. The City's approach was based on a simple premise: it is better to keep water clean at the source than allow it to get contaminated and clean it up later. Over the past 30 years, New York City's programs have been recognized as an international model for source water protection.

Promulgated in 1989, the federal Surface Water Treatment Rule (SWTR) requires all public surface water systems in the United States to filter their water for the protection of public health. Water suppliers could apply for a waiver from the filtration requirements, but only if they could meet stringent water quality, disinfection, and source protection criteria. The New York City Department of Environmental Protection (DEP), which operates and protects the City's water supply, believed that the Catskill/Delaware portion of the City's system qualified for a filtration waiver. Following an initial application, DEP received the first Filtration Avoidance Determination (FAD) in January 1993 and has maintained a filtration waiver continually since that time. DEP has spent or committed more than $2.7 billion to implement an array of programs that target both existing and potential sources of contamination. The result is that New York City consumers continue to enjoy affordable, high-quality water.

Essential to the success of these efforts are the strong relationships developed between DEP and key water supply stakeholders including the watershed communities; locally based organizations; environmental groups; and federal, state, and local government agencies. DEP's investments are designed to meet the twin goals of water quality protection and preservation of the economic vitality of watershed communities. DEP employs the largest workforce in the watershed and scores of additional jobs are created through direct and indirect employment from DEP's contracts. Project funding and tax payments account for more than $250 million annually. Projects completed enhance the quality of life for residents in many ways, for example by providing reliable and inexpensive wastewater treatment or increasing resiliency from floods. In addition, DEP's reservoirs and land holdings are a valuable resource for local tourism economy.

The cornerstone of DEP's source water protection program is extensive research by DEP scientists into existing and potential sources of water contamination, and the detailed characterization of land use and land cover in the watershed. As part of DEP's source water monitoring program, tens of thousands of samples are collected annually throughout the watershed. Each year DEP performs hundreds of thousands of laboratory analyses. Based on the information collected through its monitoring and research efforts, DEP has crafted a watershed protection strategy that focuses on implementing initiatives that address current potential pollution sources and prevents the creation of new sources.

In December 2017, the New York State Department of Health, in consultation with United States Environmental Protection Agency, issued a 10-year FAD. The programs identified

in the 2017 FAD built on the significant program accomplishments to that time and reflected DEP's continued commitment to long-term watershed protection. The 2017 FAD was the first to include a complete set of program and financial commitments for the full 10-year period.

In 2018, the National Academies of Science, Engineering, and Medicine (NASEM) convened an expert panel to evaluate New York City's source water protection program. This study follows a similar evaluation conducted by NASEM in the early 2000s. Over approximately two years, the panel engaged in a comprehensive process, which included eight meetings, dozens of presentations by DEP staff and watershed stakeholders, several site visits in the watershed, countless information requests and hundreds of hours of discussion and drafting. Their final report was released in August 2020. The report includes a strong endorsement of the work DEP and its partners have undertaken over many years, stating the programs "have admirably supported water quality" with "strong indications" they will continue to be effective in the future.

Based on the panel's recommendations, DEP conducted a review of the source water protection programs and engaged with regulators and water supply stakeholders. In December 2021, DEP submitted a revised Long-term Watershed Protection Plan that included proposed adjustments to the requirements of the 2017 FAD. DEP's plan in turn was the basis of mid-term modifications to the FAD, which were issued by NYSDOH in 2022. The Revised 2017 FAD calls for continuation of major program elements, with targeted enhancements and adjustments where needed. DEP protection strategies have continued to evolve over the past 30 years based on program success; changes in watershed conditions; climate change impacts and projections; and improved monitoring and science. The Revised 2017 FAD continues these trends and positions DEP's source water programs for continued success.

This annual report covers the period January 1, 2022, through December 31, 2022, and is compiled to satisfy the requirements of the 2017 FAD. Material in this report is organized to parallel the sections of the FAD. Figure 1.1 and Figure 1.2 depict the impressive level of accomplishment over the past thirty years. The programs, each designed to target specific pollution sources, have touched nearly every corner of the City's vast catchment.

While the report focuses primarily on the efforts of New York City, it is important to recognize that DEP works in partnership with many agencies, organizations, and communities throughout the region to achieve its goals. These partnerships are vital to the continued success of the source water protection program and recognize the need to strike a balance between protecting water quality and the fact that the watershed is home to tens of thousands of people. The contributions of many of these groups are acknowledged throughout this report. The other private, governmental, community, academic, and non-profit entities that share a role in this complex effort are too numerous to list. However, DEP gratefully acknowledges their ongoing help and support.

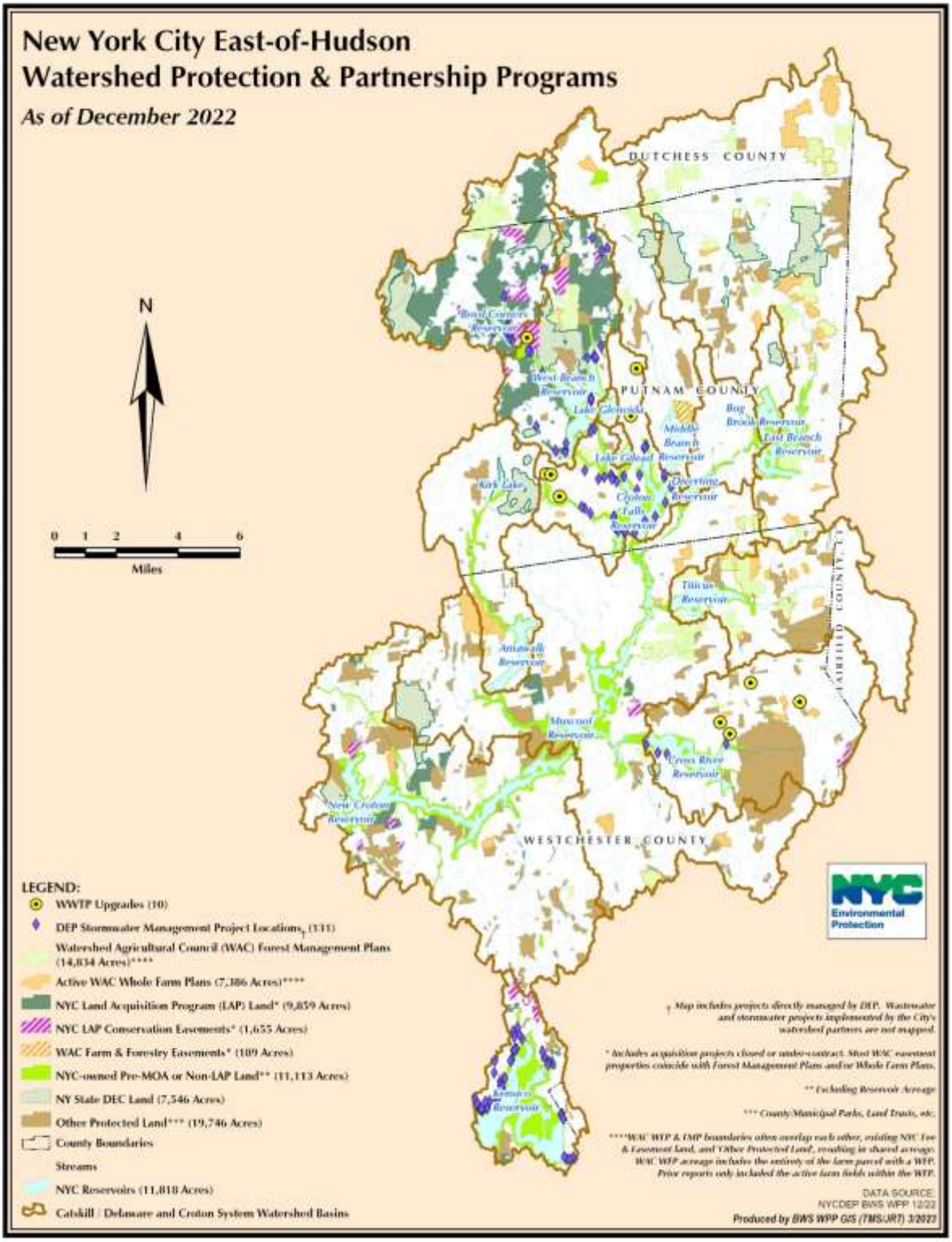

Figure 1.1 New York City East-of-Hudson watershed protection and partnership programs as of December 2022.

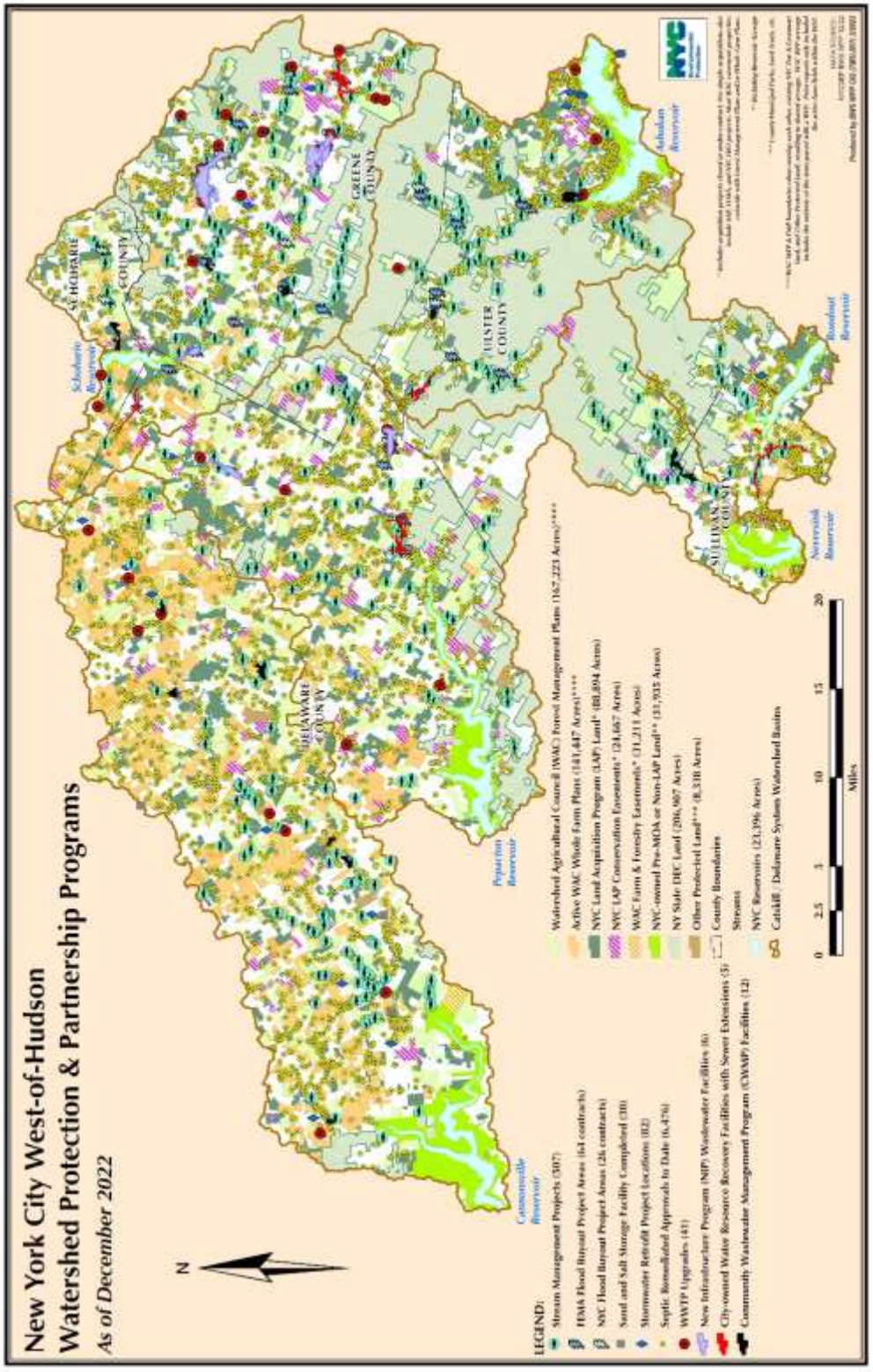

Figure 1.2 New York City West-of-Hudson watershed protection and partnership programs as of December 2022.

2. Federal and State Objective Water Quality Compliance

During 2022, DEP continued its comprehensive water quality monitoring efforts. New York City's sampling program is far more extensive than is required by federal or state law. Each year, the City collects tens of thousands of samples in the watershed and in the distribution system. In 2022, DEP collected approximately 43,900 samples and conducted 577,000 analyses. Of these, 32,300 samples were collected, and 376,700 analyses were completed within the City. Once again, the results were notable: the City complied with the objective criteria of the Surface Water Treatment Rule (SWTR) (USEPA 1989).

By the tenth of every month, DEP provides both the U.S. Environmental Protection Agency (USEPA) and the New York State Department of Health (NYSDOH) with the results of its extensive monitoring program via the monthly Water Quality Report, which is issued in compliance with the requirements of the SWTR and other federal regulations in effect since 1991. The City, as an unfiltered surface drinking water supplier, must meet the SWTR specified objective criteria and demonstrate this in the monthly Water Quality Report. The information provided below summarizes compliance monitoring conducted during 2022.

2.1 Surface Water Treatment Rule Monitoring and Reporting

SWTR monitoring includes raw water monitoring for fecal coliform concentrations, turbidity, and disinfection/contact time (CT) values; entry point monitoring for chlorine residuals; distribution system monitoring for chlorine residuals and coliform bacteria levels; and quarterly monitoring in the distribution system for total trihalomethanes and haloacetic acids (HAA5). In 2022, all monitoring samples complied with thresholds defined by the SWTR, except for a first quarter exceedance of the calculated locational running annual average (LRAA) for HAA5 as detailed below in section 2.1.6.

2.1.1 Raw Water Fecal Coliform Concentrations (40 CFR Section 141.71 (a)(1))

In 2022, the Catskill Aqueduct between Kensico Reservoir and the Catskill/Delaware Ultraviolet Light Disinfection Facility (CDUV) was offline. Therefore, no Catskill Aqueduct effluent fecal coliform samples were collected for the year. The Delaware Aqueduct effluent from Kensico Reservoir exhibited fecal coliform concentrations in water prior to disinfection at levels less than or equal to 20 fecal coliforms/100mL in at least 90% of the samples collected during the year, as calculated by six-month running percentages.

In 2022, as shown in Figure 2.1, the highest six-month running percentage of positive raw water fecal coliform samples at the Delaware Aqueduct effluent from Kensico Reservoir was 3.3%, well below the maximum percentage of positive samples allowed under the SWTR.

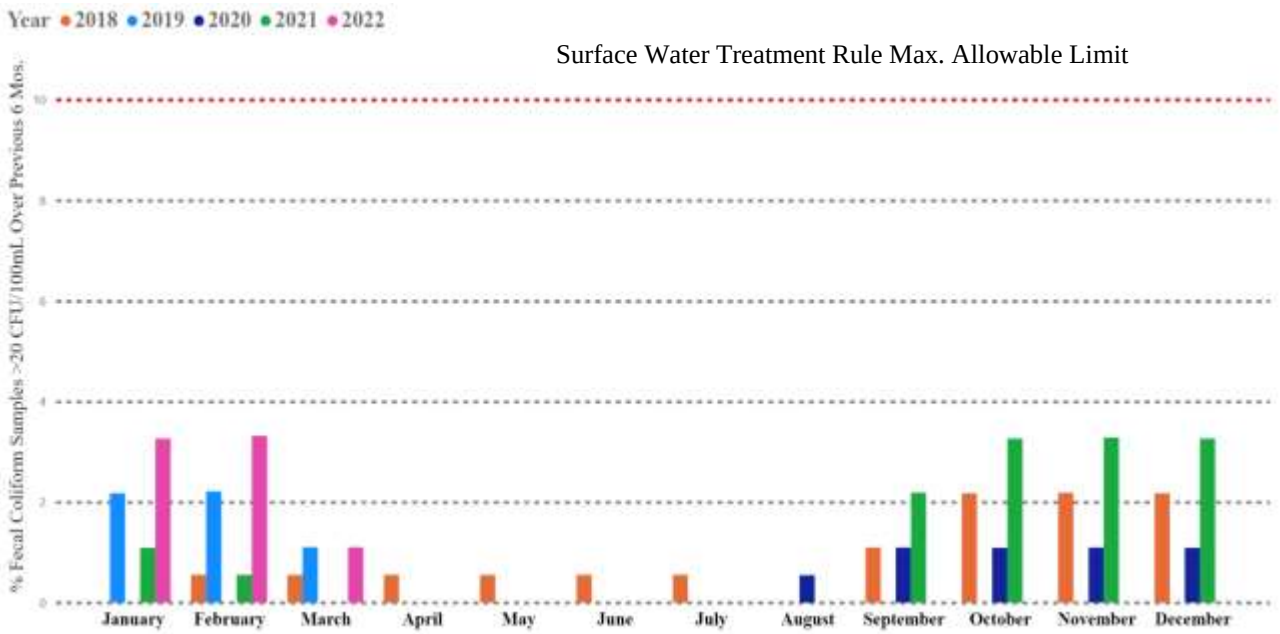

Figure 2.1 Percent fecal coliform samples >20 CFU/100mL over the previous six months, Catskill-Delaware System, 2018-2022.

2.1.2 Raw Water Turbidity (40 CFR Section 141.71(a)(2))

The Delaware Aqueduct effluent from Kensico Reservoir exhibited turbidity levels less than or equal to 5 NTU in water prior to disinfection for the entire 2022 calendar year (Figure 2.2). No samples were collected from the Catskill Aqueduct in 2022 because the Catskill Aqueduct south of Kensico Reservoir was offline.

2.1.3 Raw Water Disinfection/CT Values (40 CFR Sections 141.71(b)(1)(i) and141.72(a)(1))

CT values recorded each day during the year for the Catskill and Delaware systems produced net inactivation ratios (IAR) greater than or equal to 1.0. CT was achieved using both ultraviolet light (UV) and chlorine. For *Cryptosporidium*, 2-log inactivation was achieved with UV with a minimum log inactivation of 2.00. For *Giardia*, the required 3-log inactivation was achieved with 2-log UV plus 1-log chlorine other than from January 5, 2022, to May 16, 2022, and October 28, 2022, to November 18, 2022, when all 3-log was achieved with UV and May 16, 2022, to May 22, 2022, and September 14, 2022, to September 16, 2022, when 2.5 log was achieved with UV. The minimum log inactivation from UV for *Giardia* was 2.09.

The net IAR using chlorine for 1-log *Giardia* inactivation when it was needed was calculated adding the IAR from two segments. The first segment of the Delaware Aqueduct from Kensico to Shaft 19 at the Catskill/Delaware UV Treatment Plant (CDUV) was used for both

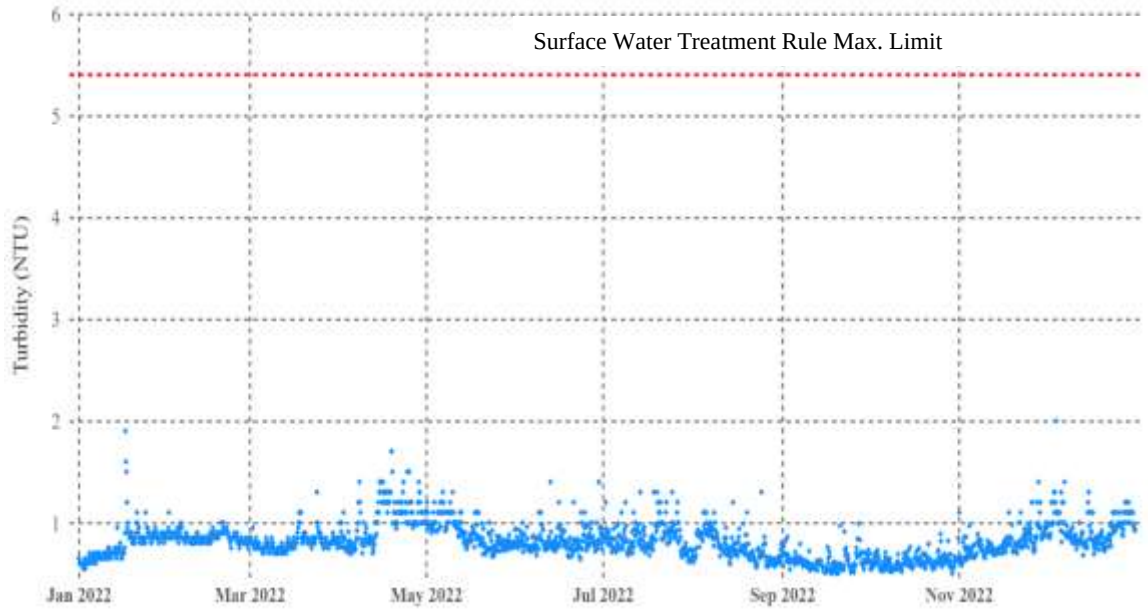

Figure 2.2 Catskill-Delaware source water turbidity, January 1, 2022-December 31, 2022.

aqueducts, because the first segment of the Catskill Aqueduct was offline from Kensico to Eastview and was added to each aqueduct's second segment IARs from the CDUV to Hillview. The actual lowest net IAR for 1-log chlorine in 2022 was 1.8 for the Catskill Aqueduct and 1.4 for the Delaware Aqueduct.

2.1.4 Entry Point Chlorine Residual (40 CFR Sections 141.71(b)(1)(iii) and 141.72(a)(3))

As required, continuous monitoring for free chlorine residual was maintained at the distribution entry points throughout 2022, and at no time did the concentration fall below 0.2 mg/L for more than four hours.

2.1.5 Distribution System Disinfection Residuals (40 CFR Sections 141.71(b)(1)(iv) and 141.72(a)(4))

Of the 15,240 samples measured for residual chlorine within the distribution system during 2022, all were greater than or equal to 0.01 mg/L, except for three samples that equaled 0.00 mg/ L.

2.1.6 Trihalomethane Monitoring (40 CFR Section 141.71(b)(6)) and HAA5 Monitoring (40 CFR Section 141.171)

The analysis for trihalomethanes in 2022, performed on a quarterly basis, resulted in a maximum total trihalomethane (TTHM) value of 72 µg/L. The analysis for haloacetic acids, also

performed on a quarterly basis, resulted in a maximum haloacetic acid five (HAA5) value of 60 µg/L.

The highest TTHM quarterly running annual average during 2022, recorded during the first and second quarters, was 45 µg/ L, a level below the regulated level of 80 µg/L. The highest HAA5 quarterly running annual average, recorded during the first quarter, was 45 µg/L, a level below the regulated level of 60 µg/L.

The calculated LRAA for the first quarter of 2022 exceeded the MCL for HAA5 of 60 µg/L at one of the 20 sites sampled on February 1, 2022, site 50250, Grymes Hill, Staten Island, 10301. The calculated LRAA was 61 µg/L. This was the second consecutive quarter of an HAA5 MCL exceedance at this site. DEP took a multi-step approach to correct this exceedance, including adjustments to the operation of our reservoir system, a reduction in the amount of chlorine used, and adjustments to our in-city distribution system. As a result, all sites were in compliance the remainder of 2022. This was a Tier 2 violation of the SDWA, and public notification was made.

2.2 Total Coliform Monitoring

2.2.1 Monthly Coliform Monitoring (40 CFR Section 141.71(b)(5))

Within the distribution system, coliform monitoring indicated monthly levels of total coliforms below 0.5% for all 12 months of 2022 (Figure 2.3). The number of compliance

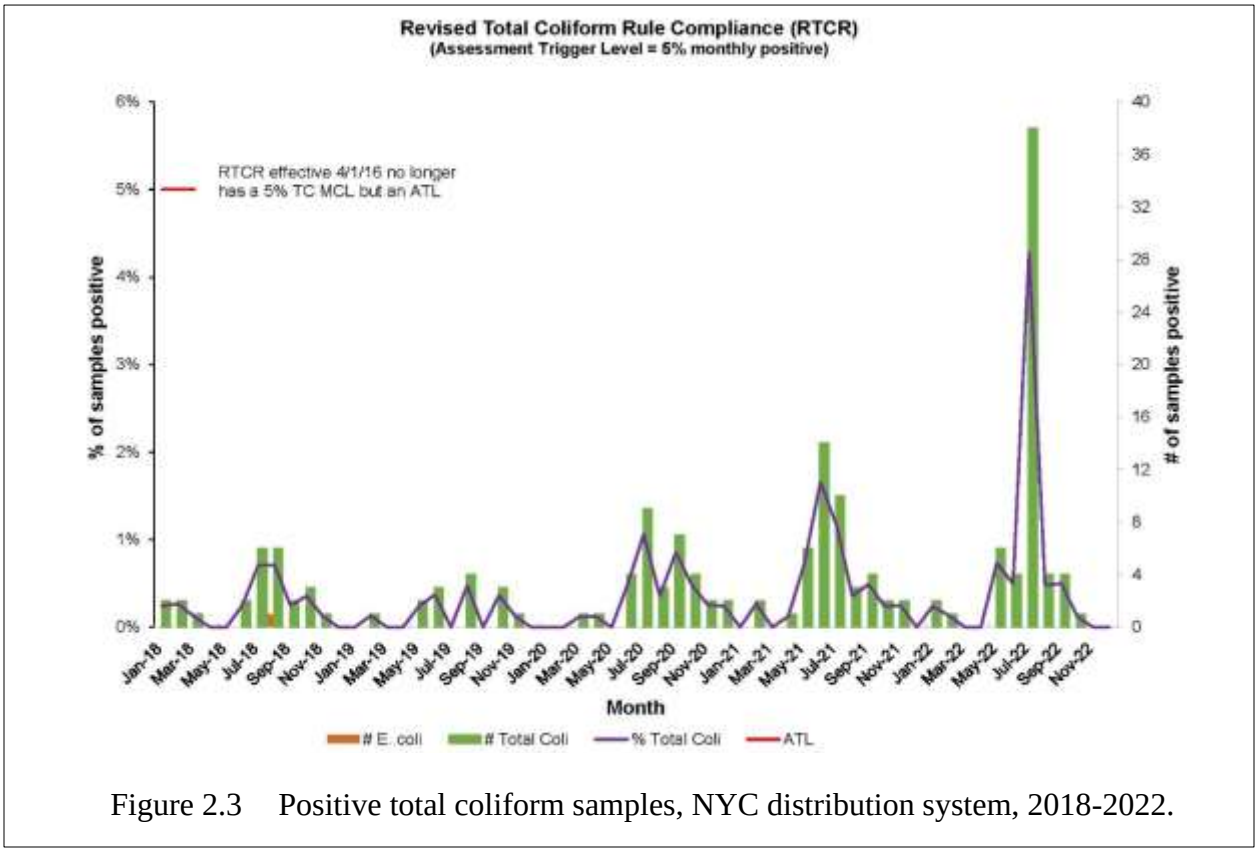

Figure 2.3 Positive total coliform samples, NYC distribution system, 2018-2022.

samples analyzed in 2022 for total coliforms was 9,798, of which 60 were total coliform positive, and none were E. coli positive. The annual percentage of compliance samples that were total coliform positive was 0.6%. Since 1994, DEP has collected 288,168 coliform compliance samples, and only 17 of them have tested positive for E. coli.

Heterotrophic plate counts (HPC) were all ≤500 CFU/mL, equivalent to a measurable free chlorine residual in 2022. Zero percent of the samples had an undetectable free chlorine residual or HPC >500 CFU/mL. This meets the requirements that a free chlorine residual be maintained at representative points in the distribution system, and that no more than 5% of the free chlorine residual samples be undetectable in any two months.

2.2.2 Chlorine Residual Maintenance in the Distribution System

During 2022, DEP continued to ensure adequate levels of chlorine throughout the distribution system by maintaining chlorination levels at the distribution system's entry points, conducting spot flushing when necessary, and operating two permanent chlorination booster stations to improve the chlorine residual levels for the Fort Tilden, Roxbury, and Breezy Point areas (Rockaway Peninsula) in Queens, and for Staten Island. As a result of these steps, detectable chlorine residuals were maintained throughout the distribution system in 2022.

3. Environmental Infrastructure

3.1 Septic Programs

Since 1997, DEP has committed over $190 million to rehabilitate, replace, and maintain septic systems in the West of Hudson (WOH) watershed through the following programs managed by the Catskill Watershed Corporation (CWC): Septic Rehabilitation and Replacement Program, Septic Maintenance Program, Expanded Septic System Rehabilitation and Replacement Program (formerly the Small Business Septic Program), and the Cluster System Program.

The Septic Rehabilitation and Replacement Program funds the repair and replacement of septic systems serving single- or two-family residences. In 2022, CWC reimbursed 263 residential septic repairs, including 11 second time repairs. To date, the program has funded more than 6,400 residential septic systems throughout the WOH watershed.

The Septic Maintenance Program is intended to reduce septic system failures through the subsidizing of regular pump-outs and maintenance. In 2022, CWC subsidized 667 septic tank pump-outs, for a cumulative total of 4,398 pump-outs since program inception.

The Expanded Septic System Rehabilitation and Replacement Program funds the repair or replacement of failed septic systems serving eligible governmental entities, not-for-profit organizations, and small business owners in the WOH watershed. In 2022, CWC funded the remediation of 17 septic systems under the Expanded Septic Program, bringing the cumulative total repairs or replacements to 60 since program inception.

The Cluster Septic System Program funds the planning, design, and construction of cluster systems in 13 WOH watershed communities; operation and maintenance funding are also available. CWC contacts communities about their eligibility for the program when failures are identified. No communities opted to participate in this program during 2022.

3.2 Community Wastewater Management Program

Administered by CWC, DEP funds the Community Wastewater Management Program (CWMP) to support the design and construction of community wastewater management solutions. To date, the CWMP has completed 12 projects in Bovina, DeLancey, Bloomville, Hamden, Boiceville, Ashland, Trout Creek, Lexington, South Kortright, Claryville, Shandaken, and West Conesville. For the remaining three CWMP projects still in progress, highlights for 2022 include:

- Halcottsville – DEP approved a block grant of $8.95 million to connect this community to the City-owned Margaretville Water Resource Recovery Facility (WRRF) in September 2017. The Town of Middletown awarded the project construction contract to Hubbell Companies on February 9, 2022. Based upon the awarded construction bid, DEP issued a revised project block grant letter in June

2022 increasing the approved block grant amount to $11,454,000. Construction commenced in July 2022 and is ongoing.

- New Kingston – DEP approved a block grant of $5.2 million for a community septic system in November 2018. Design approval was issued in February 2022. In April 2022, the Town of Middletown awarded the project construction contract to F.P. Kane Construction, Inc. Based upon the rebidded project, DEP issued a revised project block grant letter in June increasing the block grant amount to $7,700,000. Construction on the project commenced in September 2022 and is ongoing.
- Shokan – DEP approved a block grant of $48.7 million for a wastewater treatment plan serving the hamlets of Boiceville and Shokan in August 2020. The project is in the pre-construction phase. In 2022, the Town of Olive finalized acquisition of the parcel needed for the WWTP. In 2022, DEP received and provided comments on 65% design plans and specifications for the Shokan collection system and for the Boiceville-to-Shokan force main. Project design is ongoing. Due to higher than estimated project costs, DEP amended the Shokan contract with CWC in June 2022 to provide the balance of $24,120,000 in capital funding needed to complete construction. This additional funding was provided to CWC in August 2022.

3.3 Sewer Extension Program

The Sewer Extension Program concluded prior to the 2017 FAD.

3.4 Stormwater Programs

3.4.1 Stormwater Cost-Sharing Programs

DEP pays for incremental costs associated with stormwater measures required solely by the City's Watershed Rules and Regulations (WR&R) to the extent they exceed the costs of complying with state and federal requirements. Pursuant to the 1997 MOA, two separate programs are available to offset eligible WR&R compliance costs related to the design, construction, and maintenance of stormwater pollution prevention plans and individual residential stormwater plans: the WOH Future Stormwater Controls Program (MOA-128) and the Future Stormwater Controls Paid for by the City Program (MOA-145). CWC administers both programs.

The MOA-128 Program reimburses municipalities and large businesses 100% and small businesses 50% for eligible WR&R costs. DEP has provided over $36.4 million to CWC for the MOA-128 Program, of which CWC has reimbursed over $11.9 million to program applicants and transferred approximately $17.6 million to other eligible programs.

The MOA-145 Program reimburses low-income housing projects and single-family homeowners 100% and small businesses 50% for eligible WR&R costs. Through 2022, CWC

has reimbursed over $1,400,000 to MOA-145 Program applicants. Table 3.1 summarizes projects approved for funding under both programs in 2022.

Table 3.1 WOH future stormwater controls projects approved for funding in 2022.

Applicant	Project	CWC Funding
Getaway Roscoe, LLC	Campsites, cabins	$176,804.36
KDR Self Storage Inc.	Storage facilities	98,581.21
Michael & Dorian Clara	Residential	$12,000.00
Onteora Club	Subdivision	$206,498.50
Scribner's Catskill Lodge, LLC	New cabins	$534,624.90
Nigel Koulajian	Residential	$637,321.76
Walton Central School District	Parking area	$647,025.00
Macollo, LLC	Parking lot	$220,000.00
DMK Development-Stamford, LLC	Retail store/parking	$6,554.43
Jeannine Antus Koncar	Residential O&M	$11,510.00
Full Nelson, LLC	Gas Station	$90,000.00
Windham Manor	O&M	$15,000.00
Windham Car Wash	O&M	$17,500.00

3.4.2 Stormwater Retrofit Program

Jointly administered by DEP and CWC, the Stormwater Retrofit Program provides funding for the design, permitting, construction, and maintenance of best management practices to address existing stormwater retrofit runoff in concentrated areas of impervious surfaces.

Through 2022, the program has completed 80 stormwater retrofit projects, and 19 planning and assessment projects. In 2022, construction was completed for the Delhi Central School – Delaware Academy stormwater retrofit project with an estimated cost of over $1.5 million. Also in 2022, CWC and DEP approved a project to initiate an assessment and conceptual design at the Town of Jewett Town Hall and highway garage. In addition to the project at the Town of Jewett site, the other open retrofit project is the stormwater collection,

conveyance, and treatment system for Lake Street in the Village of Fleischmanns. This project is substantially complete, with final vegetative stabilization to occur in the first half of 2023.

In addition to the active projects, DEP participated in initial site visits of potential stormwater retrofit applicants at Main Street in Pine Hill (Town of Shandaken) and the Olive Town Library (Town of Olive). Each site had impervious surfaces that could serve as the basis for a potential stormwater retrofit. To date, towns have not submitted applications for these sites.

4. Protection and Remediation Programs

4.1 Waterfowl Management Program

Implementation of the Waterfowl Management Program continued without interruption during 2022. The Waterfowl Management Program Annual Report, submitted on October 31, 2022, summarizes the program's activity from August 1, 2021, through July 31, 2022. The period from August 1 through December 31, 2022, will be summarized in the program's annual report to be submitted on October 31, 2023. Reports are also available on the DEP website (https://www1.nyc.gov/site/dep/about/filtration-avoidance-determination.page).

4.2 Land Acquisition

DEP's Land Acquisition Program (LAP) permanently protects high priority sensitive lands in the Catskill/Delaware watershed through acquisition of conservation easements (CEs) and land in fee simple, both directly by the City and in partnership with the Watershed Agricultural Council (WAC Farm and Forest CE Programs), Catskill Center for Conservation and Development (Streamside Acquisition Program, or SAP), and local municipalities through the New York City-Funded Flood Buyout Program (NYCFFBO).

In 1997, the City owned 3.4% of the land area in the Catskill/Delaware watershed, while an additional 21.3% was owned by New York State and other public entities for a total protected status of 24.7%. As of December 31, 2022, 39.7% of the Catskill/Delaware watershed land area has been permanently protected by the City, state, and others. Table 4.1 describes natural resources and features on City-protected lands and CEs acquired pursuant to the FAD.

DEP now owns or controls more miles of stream, and roughly the same acreage of buffer land within 300 feet of watercourses and 1,000 feet of reservoirs, than are protected in the entire Catskill/Delaware watershed by all other entities combined including New York State. In total, 36% of stream length and stream buffers are under some type of permanent protected status, along with 73% of wetlands and deepwater habitats, 65% of floodplains and 44% of forest cover. Overall, the proportion of protected water features in the watershed roughly equals or exceeds the proportion of acres protected.

Table 4.1 Catskill/Delaware stream length, riparian buffer, wetland, forest cover, and floodplain summary, December 31, 2022.

Land Protection Category	Total in CAT/DEL Watershed incl. reservoirs (acres)[1]	% Total CAT/DEL Watershed Area	CAT/DEL Stream Length (miles)[2]	% total CAT/DEL Stream Miles	CAT/DEL 300 ft. Riparian Buffer (acres)[3]	% Total CAT/DEL Riparian Buffers	CAT/DEL Wetlands (acres)[4]	% Total CAT/DEL Wetlands	CAT/DEL Forest Cover (acres)[5]	% Total CAT/DEL Forest Cover	CAT/DEL Floodplain (acres)[6]	% Total CAT/DEL Floodplain
Publicly owned or Controlled lands[7]												
NYC-owned Non-LAP Property (Pre-1997 or facility-related)	61,365	5.9%	105	2.7%	6,886	2.8%	27,014	62.1%	31,788	3.8%	29,932	55.3%
NYC-owned LAP Property (Post-1997, Fee Simple)	95,179	9.1%	379	9.9%	24,353	9.7%	2,369	5.4%	82,076	9.8%	2,054	3.8%
Land Protected by SAP Fee Simple	269	0.0%	4	0.1%	189	0.1%	31	0.1%	228	0.0%	42	0.1%
Land Protected by LAP NYC Conservation Easement	25,700	2.5%	103	2.7%	6,451	2.6%	444	1.0%	22,206	2.7%	490	0.9%
Land Protected by WAC Conservation Easement	28,037	2.7%	119	3.1%	7,370	2.9%	381	0.9%	14,938	1.8%	1,365	2.5%
Land Protected by WAC Forest Easement	2,969	0.3%	6	0.1%	413	0.2%	17	0.0%	2,782	0.3%	41	0.1%
NYCFFBO - NYC-owned	57	0.0%	2	0.0%	50	0.0%	4	0.0%	43	0.0%	44	0.1%
FEMA FBO – NYC-owned	53	0.0%	1	0.0%	41	0.0%	7	0.0%	32	0.0%	42	0.1%
Subtotal NYC Lands and Easements	**213,631**	**20.4%**	**718**	**18.7%**	**45,752**	**18.3%**	**30,267**	**69.5%**	**154,093**	**18.5%**	**34,010**	**62.9%**
NY State-owned Land	209,530	20.0%	623	16.2%	42,415	17.0%	1,268	2.9%	207,279	24.9%	975	1.8%
Other in Protected Status	9,289	0.9%	46	1.2%	2,796	1.1%	358	0.8%	7,922	0.9%	483	0.9%
NYCFFBO - Municipally-owned	7	0.0%	0.2	0.0%	6	0.0%	1	0.0%	2	0.0%	6	0.0%
FEMA FBO – Municipally-owned	40	0.0%	1	0.0%	30	0.0%	2	0.0%	15	0.0%	36	0.1%
Total CAT/DEL Public Land:	**432,495**	**41.2%**	**1,387**	**36.2%**	**90,998**	**36.4%**	**31,896**	**73.3%**	**369,311**	**44.3%**	**35,510**	**65.7%**
Private Watershed Lands												
Private Land	616,164	58.8%	2,444	63.8%	159,186	63.6%	11,630	26.7%	464,796	55.7%	18,570	34.3%
Total CAT/DEL Privately-owned Land:	**616,164**	**58.8%**	**2,444**	**63.8%**	**159,186**	**63.6%**	**11,630**	**26.7%**	**464,796**	**55.7%**	**18,570**	**34.3%**
Grand Total Land in CAT/DEL:	**1,048,660**	**100.0%**	**3,831**	**100.0%**	**250,184**	**100.0%**	**43,526**	**100.0%**	**834,108**	**100.0%**	**54,080**	**100.0%**

1. *GIS Data Source: NYCDEP BWS, 12/2022. Land ownership acreage categories are calculated directly from areas of GIS polygons and therefore may not match exactly other survey-based acreage totals submitted by DEP. GIS data are clipped to the NYC watershed boundary. CAT/DEL includes all WOH basins plus West Branch, Boyd Corners, and Kensico. Reservoir basin boundaries derived from 1m LiDAR in 2014. Water features are from local-resolution National Hydrography Dataset (NHD) originally derived from 1m LiDAR in 2013 and last updated by DEP GIS staff in 2020.*
2. *Includes streams and river centerlines only as a linear measurement, wherever they intersect with the specified land category.*

3. *Riparian buffers are calculated as a 300-foot area on both sides of watercourses (streams and rivers only, excludes ponds, lakes, and reservoirs). Any water features within these buffers were excluded from buffer acreages.*
4. *Includes wetlands plus deepwater habitats. Acres of both are calculated from a combined GIS layer of NWI and DEC-mapped polygons and summarized by categories specified by DEP Wetlands Scientists, already used for FAD annual reporting purposes. Categories considered "deepwater habitats" include reservoirs or large lakes (L1), unconsolidated bottom (L2UB), riverbeds (RUB & RRB) or streambeds (RSB). Categories considered "wetlands" include palustrine systems and exclude the deepwater habitats classes as well as all upland (U), and unconsolidated shore (L2US). These definitions are distinct from the definition of an NFC-qualified wetland under the WSP.*
5. *Forest features are from landcover classes derived from LiDAR, leaf-off and leaf-on imagery that was acquired by DEP in 2009. Specific classes included are deciduous and coniferous trees from the landcover dataset, using the query "Landcover IN(1 , 4)"*
6. *"Floodplains" are defined as 100-year floodplain, areas with a 1% annual chance of flooding. The query used "FLD_ZONE IN ('AO', 'AH', 'AE', 'A', 'VE')", is extracted from published FEMA DFIRM data. Some wetlands, floodplains, and riparian buffers overlap with each other, so these acreages cannot be added together for a "total water feature" figure.*
7. *All LAP properties are "Under Contract" or "Closed". "Other in Protected Status" means the land is believed to be under some form of permanent ownership by a land trust or municipal government.*

Figure 4.1 depicts protected lands by basin, illustrating that in many high priority reservoir basins the City's land holdings have increased dramatically compared with pre-MOA ownership. In the Rondout, West Branch, and Schoharie basins, for example, the City has raised the number of protected acres by almost 800%, 1,500%, and 3,000% respectively. Through 2022, the City owned or controlled a total of 187,575 acres of land in the Catskill/Delaware watershed, or 18.4% of the land area (excluding reservoirs).

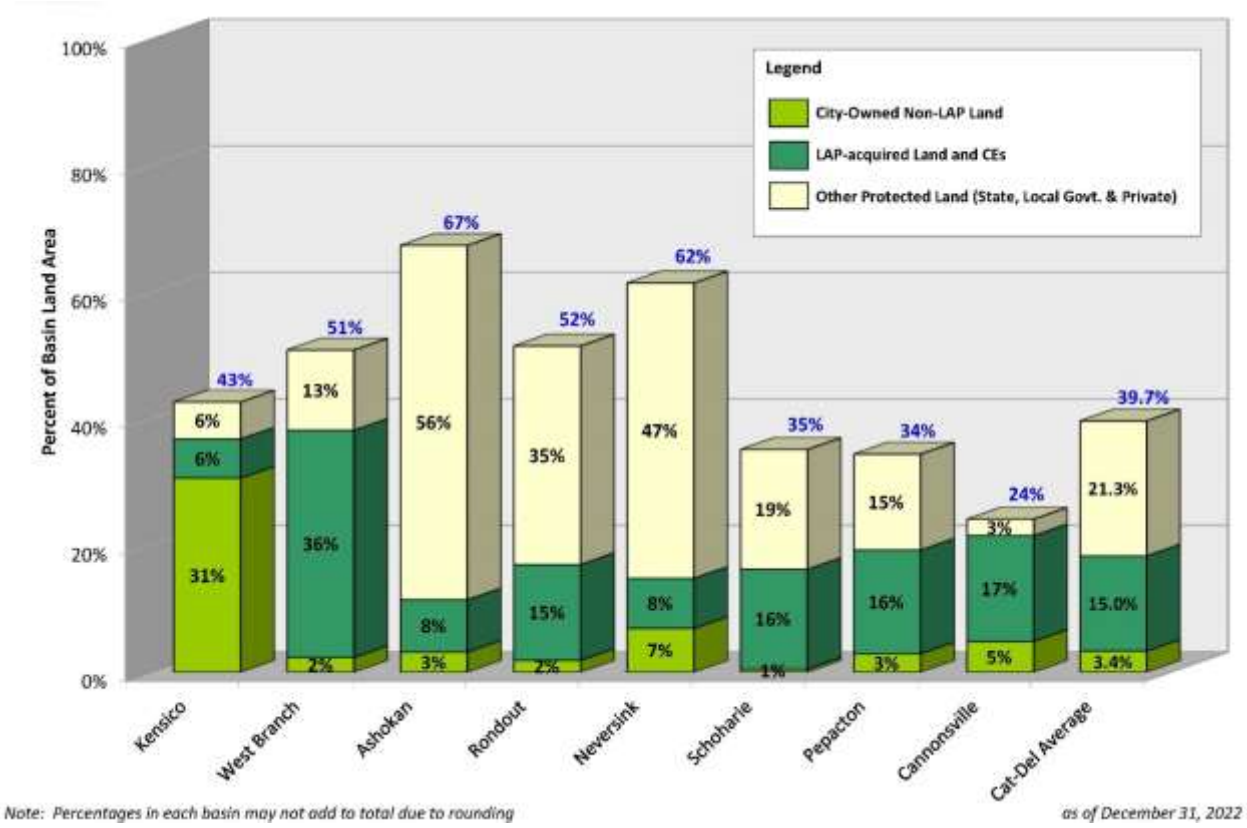

Figure 4.1 Percent of land protected in each Catskill/Delaware basin.

4.2.1 Solicitation Goals

The Revised 2017 FAD requires the LAP to solicit 200,000 acres over the seven-year period 2018-2024. This metric was reduced from 350,000 acres in the original 2017 FAD based on the success of the program to date, recommendations from the National Academies of Sciences, Engineering, and Medicine, and discussions with watershed stakeholders.

In 2022, DEP and its LAP partners solicited 13,711 acres, with DEP responsible for 8,286 acres and the remainder representing the credit available per the FAD resulting from 1,085 acres solicited through the SAP. Zero acres were by the NYCFFBO and the WAC Farm and

Forest CE Programs in 2022. Acreage solicited through the SAP are multiplied by five to yield a total solicitation credit of 5,425.

Combined with acres solicited since 2018, the LAP has thus far solicited 150,390 acres (75%) toward the 200,000-acre FAD goal. Since 1997, the LAP has solicited over 480,000 total acres, with the vast majority now re-solicitations of previously solicited properties.

Overall outcomes of LAP solicitations by basin and county since 1997 are listed in Table 4.2 and Table 4.3, respectively. Relatively high levels of positive responses (measured by contracts executed or under negotiation) are seen among solicited landowners in EOH basins: 41% in Kensico and 68% in West Branch/Boyd Corners; positive landowner responses in two WOH basins (Ashokan and Schoharie) are also at or above 30%. Similar findings exist at the county level, with solicitations in Dutchess, Greene, Putnam and Westchester counties resulting in positive landowner responses above 30%.

Table 4.2 Solicitation outcomes by basin since 1997.

Basin	Current LAP Status	Number of Projects	Acres Solicited in the Basin	% of Basin Acres Solicited
Kensico	Signed/Closed	20	405	40%
	Active, Under Negotiation	1	8	1%
	Offer refused	8	78	8%
	No Response	2	112	11%
	Not Interested	7	360	36%
	Other*	5	39	4%
	Kensico Basin Sub-Totals	**43**	**1,002**	
W. Branch/Boyd Cors.	Signed/Closed	209	9,451	68%
	Active, Under Negotiation	3	148	1%
	Offer refused	40	325	2%
	No Response	42	694	5%
	Not Interested	48	3,004	22%
	Other*	30	307	2%
	W. Branch/Boyd Basin Sub-Totals	**372**	**13,929**	
Ashokan	Signed/Closed	243	12,926	30%
	Active, Under Negotiation	11	431	1%
	Offer refused	76	4,762	11%
	No Response	162	9,639	22%
	Not Interested	169	10,780	25%
	Other*	63	4,390	10%

Basin	Current LAP Status	Number of Projects	Acres Solicited in the Basin	% of Basin Acres Solicited
	Ashokan Basin Sub-Totals	**724**	**42,928**	
Cannonsville	Signed/Closed	275	27,444	20%
	Active, Under Negotiation	4	164	0%
	Offer refused	74	6,751	5%
	No Response	519	45,154	33%
	Not Interested	450	47,809	35%
	Other*	99	7,727	6%
	Cannonsville Basin Sub-Totals	**1,421**	**135,049**	
Neversink	Signed/Closed	30	4,803	22%
	Active, Under Negotiation	1	199	1%
	Offer refused	11	1,365	6%
	No Response	41	4,353	20%
	Not Interested	50	9,289	42%
	Other*	8	1,849	8%
	Neversink Basin Sub-Totals	**141**	**21,858**	
Pepacton	Signed/Closed	332	31,826	28%
	Active, Under Negotiation	5	285	0%
	Offer refused	57	6,534	6%
	No Response	273	24,007	21%
	Not Interested	342	47,395	42%
	Other*	73	3,730	3%
	Pepacton Basin Sub-Totals	**1,082**	**113,777**	
Rondout	Signed/Closed	152	8,328	28%
	Active, Under Negotiation	3	165	1%
	Offer refused	24	883	3%
	No Response	88	4,969	17%
	Not Interested	156	13,908	47%
	Other*	15	1,075	4%
	Rondout Basin Sub-Totals	**438**	**29,328**	
Schoharie	Signed/Closed	386	29,251	32%
	Active, Under Negotiation	16	1,186	1%
	Offer refused	95	5,875	6%

Basin	Current LAP Status	Number of Projects	Acres Solicited in the Basin	% of Basin Acres Solicited
	No Response	418	17,681	19%
	Not Interested	329	25,268	28%
	Other*	176	12,379	14%
	Schoharie Basin Sub-Totals	**1,420**	**91,640**	
Total		**5,641**	**449,551**	

**Other includes properties solicited and now developed, resolicitation under way (awaiting response) and contract rescinded.*

Table 4.3 Solicitation outcomes by county since 1997.

County	Current LAP Status	Number of Projects	Acres Solicited in the County	% of County Acres Solicited
Dutchess	Signed/Closed	26	1,058	47%
	Offer refused	7	54	2%
	No Response	7	102	5%
	Not Interested	12	1,028	45%
	Other*	3	18	1%
	Dutchess Sub-Totals	**55**	**2,261**	
Putnam	Signed/Closed	183	8,393	72%
	Active, Under Negotiation	3	148	1%
	Offer refused	33	270	2%
	No Response	35	592	5%
	Not Interested	36	2,016	17%
	Other*	27	290	2%
	Putnam Sub-Totals	**317**	**11,709**	
Westchester	Signed/Closed	20	405	40%
	Active, Under Negotiation	1	8	1%
	Offer refused	8	78	8%
	No Response	2	112	11%
	Not Interested	7	360	36%
	Other*	5	39	4%
	Westchester Sub-Totals	**43**	**1,002**	
Delaware	Signed/Closed	616	58,140	25%
	Active, Under Negotiation	7	338	0%
	Offer refused	135	12,984	6%

County	Current LAP Status	Number of Projects	Acres Solicited in the County	% of County Acres Solicited
	No Response	795	69,480	30%
	Not Interested	778	82,413	35%
	Other*	173	11,939	5%
	Delaware Sub-Totals	**2,504**	**235,294**	
Greene	Signed/Closed	310	25,564	32%
	Active, Under Negotiation	17	539	1%
	Offer refused	67	4,358	6%
	No Response	334	15,770	20%
	Not Interested	266	22,430	28%
	Other*	147	10,218	13%
	Greene Sub-Totals	**1,141**	**78,879**	
Schoharie	Signed/Closed	70	4,630	26%
	Active, Under Negotiation	1	758	4%
	Offer refused	24	1,650	9%
	No Response	103	3,540	20%
	Not Interested	79	4,854	28%
	Other*	29	2,042	12%
	Schoharie Sub-Totals	**306**	**17,473**	
Sullivan	Signed/Closed	71	5,738	23%
	Active, Under Negotiation	3	363	1%
	Offer refused	18	1,194	5%
	No Response	65	5,859	23%
	Not Interested	118	9,605	38%
	Other*	14	2,562	10%
	Sullivan Sub-Totals	**289**	**25,321**	
Ulster	Signed/Closed	351	20,506	26%
	Active, Under Negotiation	12	431	1%
	Offer refused	93	5,984	8%
	No Response	204	11,153	14%
	Not Interested	255	35,148	45%
	Other*	71	4,390	6%
	Ulster Sub-Totals	**986**	**77,613**	
Total		**5,641**	**449,551**	

** "Other" includes properties solicited and now developed, resolicitation under way (awaiting response) and contract rescinded.*

Since 2019, all core LAP solicitations have adhered to NYSDOH-approved modifications that increased Surface Water Criteria (SWC) requirements in relation to other property characteristics and prohibited outgoing solicitations in certain towns upon reaching specified acquisition thresholds. As depicted in Appendix A Table 1, the LAP cannot undertake outgoing solicitations in the towns of Andes, Walton, and Delhi, while Shandaken remains unavailable for solicitation under Special Condition 10(c) of the 2010 Water Supply Permit.

4.2.2 Purchase Contracts

During 2022, the LAP appraised 15 properties totaling 557 acres, including 12 initial appraisals and three updates for time. As depicted in Appendix A Table 2 and Appendix A Table 3 the core LAP and SAP executed 20 purchase contracts in 2022 comprising 770 acres at a fair market value of $16.8 million. The average SWC is 50% for these properties, considerably higher than the cumulative average of 28% across all programs since inception. To date, DEP and its LAP partners have signed 1,841 purchase contracts comprising 155,160 acres at a fair market value of $509.7 million (excluding partner operating costs to administer the WAC and SAP programs). DEP spent an additional $43.6 million on LAP soft costs, such as appraisals and surveys.

Figure 4.2 depicts acreage signed to contract annually under core LAP and partner programs since 1995. The low numbers of appraisals, purchase contracts and acres acquired during the past few years are attributable mainly to a pandemic-induced program hiatus that DEP lifted in 2021.

As depicted in Appendix A Table 4, DEP and its LAP partners closed on three purchase contracts in 2022 comprising 49 acres and representing the small number of purchase contracts that had been executed near the start of the pandemic. The average SWC is 67% for these properties, considerably higher than the average of 28% across all programs since inception. Appendix A Table 5 shows that projects closed in 2022 were valued at $200,000 while Appendix A Table 6 provides details of these acquisitions. To date, DEP and its LAP partners have closed on 1,809 total contracts comprising 153,678 newly acquired acres at a cost of $489.9 million. Appendix A Table 7 summarizes these newly acquired watershed lands by LAP Priority Area.

With the LAP's increasing selectivity toward portions of properties that contain SWC, a higher percentage of projects now require subdivisions. Many subdivisions are purposefully planned and designed at the start of a project to secure desired acreage, but in other cases a subdivision may be needed during the contract phase to solve unexpected encroachments discovered by surveys. Based on research to date, DEP estimates that 26% of core LAP's executed or closed fee simple purchase contracts and 42% of SAP's executed or closed purchase contracts have required subdivisions.

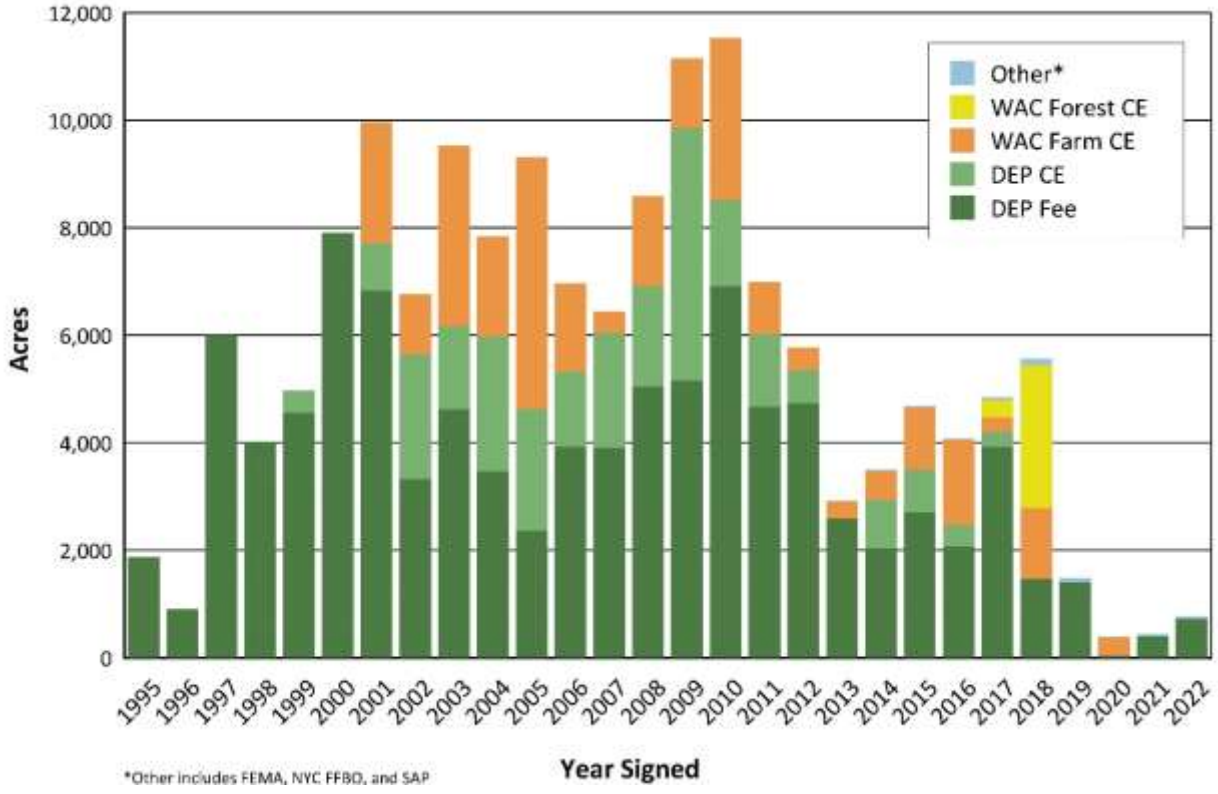

Figure 4.2 Annual acres secured by purchase contracts in the Catskill/Delaware watershed organized by LAP program, 1995-2022.

The exact acreage retained by sellers in the aftermath of subdivisions is difficult to assess because these acres are not the focus of DEP surveys and have not been a metric that DEP tracked historically. However, DEP can report that for the two fee simple properties acquired in 2022, one required subdivision so that 6.8 acres (57% of total original acreage) could be retained by sellers. The one SAP contract closed in 2022 involved a subdivision which allowed 92.2 of the original 121.7 acres to be retained by the seller. As part of the fee simple acquisitions that required subdivisions, LAP acquired approximately 38,569 acres and sellers retained approximately 8,721 acres, or 18%, of their original lands.

4.2.3 Transfer of Conservation Easements to New York State

DEP is required to convey CEs to New York State on all watershed lands acquired in fee simple. DEP did not convey any new CEs to the state during 2022. As of December 31, 2022, watershed wide, DEP had submitted 85 CEs covering 1,112 properties (74,716 acres), of which NYSDEC has recorded 83 CEs on 1,093 properties (72,835 acres).

4.2.4 New York City-Funded Flood Buyout Program

In 2019, DEP and its partners finalized the model CE to be applied to municipally owned properties located wholly within 100-year floodplains. CWC will monitor these properties under an agreement with NYSDEC. DEP continues to work with the Coalition of Watershed Towns and NYSDEC to finalize other model CEs, including one for municipally owned properties with upland areas outside the 100-year floodplain.

During 2022, DEP ordered eight appraisals under the NYCFFBO, including three initial appraisals and five updates for time, which brings to 44 the total number of properties appraised

Figure 4.3 This 1-acre parcel in the Town of Shandaken was signed to contract in 2022 through the NYCFFBO. The residence is in a floodplain near the headwaters of the Esopus Creek and was repeatedly damaged by multiple floods.

to date. As of the end of 2022, appraised values for contracts executed and closed total $4.4 million, with projects in the categories of local flood analysis, stream projects, erosion, and inundation. A total of 52 municipal resolutions have been passed (including one in 2022) and 26 purchase contracts have been executed, of which 22 have closed (none during 2022). A summary

of all NYCFFBO contracts executed and closed to date is provided in Appendix A Table 8. Figure 4.3 depicts a NYCFFBO property signed to contract in 2022.

4.2.5 Streamside Acquisition Program

DEP administers the pilot SAP through an $8 million contract with the Catskill Center for Conservation and Development (CCCD). In 2022, CCCD ordered five appraisals totaling 22 acres, executed four purchase contracts on 33 acres, and closed on one 30-acre project. To date, the SAP has ordered 74 appraisals (including updates for time) on 69 properties which has resulted in 33 signed contracts on 273 acres. As shown in Appendix A Table 2, 77% of this acreage is SWC. To date, the SAP has closed on 26 contracts protecting 227 acres. Figure 4.4 depicts a pending project in the Town of Windham.

As of 2022, CCCD had expended $16,000 worth of incentive payments that were developed in collaboration with watershed stakeholders to increase landowner participation in

Figure 4.4 This vacant 2.25-acre property was appraised by the SAP in 2022, after which the owner signed a purchase contract.

the SAP. This includes $6,000 total for three landowners whose properties contain 85% or greater SWC and a total of $9,000 for three landowners whose properties appraised at or below $40,000; one of the latter landowners also received an additional incentive payment of $1,000 toward subdivision costs. Since late 2019, when all SAP incentives (financial and non-financial) were put in place, 75% (12 of 16) of SAP transactions have involved incentive payments.

4.2.6 Farm and Forest Easement Programs

DEP funds the Farm and Forest CE Programs through a contract with WAC that was extended through December 2024. During 2022, virtually all WAC CE acquisition activities remained on pause as WAC did not solicit any landowners or order any real estate appraisals. As summarized in Appendix A Table 4, Appendix A Table 5, and Appendix A Table 6, WAC has closed on a total of 157 farm CEs protecting 28,229 acres and nine forest CEs protecting 2,982 acres. The average WAC Farm CE includes 29% SWC and the average WAC Forest CE includes 16% SWC. DEP anticipates WAC will resume program activities in 2023.

4.2.7 Water Supply Permit

The 2010 Water Supply Permit authorizes the LAP to acquire up to 106,712 acres of land in the Catskill/Delaware watershed through 2025, beyond the 102,287 acres that had been acquired as of January 1, 2010. Between January 1, 2010, and December 31, 2022, DEP and its LAP partners signed contracts on 53,498 acres, leaving a balance of 53,214 acres for potential acquisition. In June 2022, DEP submitted an initial application for a successor Water Supply Permit that will allow the City to continue acquiring watershed lands beyond 2025.

4.2.8 Use of LAP-Acquired Land by Local Communities

The 2017 FAD requires DEP to participate in a workgroup convened to assess opportunities to use LAP-acquired lands to relocate development out of floodplains. Although watershed stakeholders have not convened any formal meetings with DEP to address this topic in recent years, DEP held conversations with one watershed community in 2022 regarding a potential land swap.

4.3 Land Management

As the City continues to make significant investments acquiring fee simple water supply lands and conservation easements (CEs), DEP continues to focus on the management and stewardship of City-owned water supply lands while supporting and promoting beneficial uses such as watershed recreation.

4.3.1 Fee Simple Lands

As of December 31, 2022, DEP owns and manages 173,674 acres of City-owned fee simple watershed lands and reservoirs; this includes pre-MOA lands and waters as well as properties acquired through the Land Acquisition Program (LAP) under the 1997 MOA. The average sized parcel acquired under the MOA is 43 acres. The largest assemblage of City-owned lands acquired under the MOA totals 2,921acres. As the City acquires new, smaller properties

under the Flood Buyout Program and Streamside Acquisition Program, these properties are often isolated from other City-owned parcels and typically involve active neighbors. Both factors can present an array of property management challenges.

Property Inspections

DEP inspects all City-owned water supply lands pursuant to its monitoring policy, which outlines procedures and frequencies for property inspections and boundary maintenance. All City lands are posted with signage as appropriate, and all properties receive a boundary inspection at least once every five years. These inspections are the most comprehensive and include traversing all property boundary lines as well as the interior of the property. This ensures proper survey monumentation and maintenance of boundary lines over the long term. DEP records all inspections and site visits, along with journal notes, photos, encroachments, and observations, in its Watershed Lands Information System (WaLIS).

Annually, DEP prioritizes ground inspections of properties into two categories based on location, number of adjacent properties, uses conducted on the property, and history of trespass or encroachments. High-priority properties generally have active recreational use, a history of encroachments or trespass, multiple adjacent landowners, or an active DEP permit/project. Standard-priority properties are those where minimal or no trespass or encroachments have been observed, or road frontage and/or public use are limited. DEP performs focused inspections on all high-priority properties, while site visits are conducted on standard-priority properties. Focused inspections are significantly more involved than site visits. DEP can change a property's inspection priority at any time depending on the circumstances, such as the discovery of encroachments.

Encroachments

DEP strives to cure encroachments when they are discovered on City-owned lands, often during routine property inspections or other land management activities. Once an encroachment is identified and categorized either as administrative (minor or major) or criminal under NYS Environmental Conservation Law, DEP coordinates the appropriate actions to pursue resolution with the DEP Police, Bureau of Legal Affairs, or the City Law Department if certain encroachments cannot be resolved through administrative actions.

In 2022, DEP identified 83 new encroachments on City-owned watershed lands, the majority of which were categorized as minor. In 2022, DEP successfully cured 35 encroachments, while resolutions for other encroachments remain ongoing.

Land Use Permits

DEP issues land use permits (LUPs) to qualified entities seeking opportunities for limited use of City-owned lands where no appropriate alternatives exist. LUPs have a term of five years and may be renewed with DEP approval. LUPs include conditions that are intended to protect water quality, City-owned property, and assets and infrastructure. During 2022, DEP issued 30

LUPs and renewed 81 LUPs; these include six amendments to existing LUPs. DEP currently manages 1,185 active LUPs on City-owned water supply lands.

Agricultural Uses

DEP allows for agricultural uses of certain City-owned properties by entering into agricultural license agreements with watershed farmers, which include terms and conditions to protect water quality. The most common agricultural use on City land is the harvesting of hay. Other common uses include the planting and harvesting of row crops, and the pasturing of livestock. Most farmers using City lands are enrolled in the Watershed Agricultural Program (WAP) and follow Whole Farm Plans that prescribe best management practices (BMPs) to protect water quality. These plans can be adapted for use on City lands and over the years DEP has allowed for the implementation of certain low-impact BMPs on City lands, including nutrient management plans, planting of cover crops, and the installation of fencing and watering systems to support rotational grazing of livestock.

In 2022, DEP renewed 19 agricultural licenses and approved four new licenses covering 79 acres. DEP currently manages 132 agricultural licenses covering 2,948 acres.

4.3.2 Conservation easements

DEP holds 177 conservation easements (CEs) on properties totaling over 26,000 acres in the Catskill, Delaware, and Croton watersheds. DEP conducts two annual inspections of all CE properties pursuant to MOA requirements, including one ground inspection focused on the margins of building envelopes where violations often occur, and one aerial inspection by helicopter. The latter is highly efficient for larger properties and allows DEP to inspect over 10,000 acres in one day. Violations that could pose serious water quality impacts are clearly visible from the air. If problems are observed, ground inspections can be scheduled to further document a situation.

During DEP's 2022 aerial inspections, no new CE violations were identified. DEP resolved three outstanding CE violations in 2022, including clean-up of a log dump that was identified in 2021. Additionally, DEP approved eight new landowner requests to engage in CE-conditioned activities, including four stream projects, three timber harvests, and one installation of improvements.

The Watershed Agricultural Council (WAC) performed all MOA-required farm and forest CE monitoring inspections in 2022, which included two ground monitoring inspections for each property. WAC reported eight easement violations, four of which were resolved.

4.3.3 Deer Management

Healthy forests are a cornerstone of DEP's watershed protection efforts, including strategies to promote forest regeneration by reducing impacts from deer herbivory on City-owned watershed lands. DEP continues to coordinate with NYSDEC, regional sporting groups, and members of the hunting community to improve deer harvesting opportunities on City-owned

watershed lands. In 2022, DEP again participated in NYSDEC's Deer Management Assistance Program (DMAP) by issuing 425 DMAP permits to local hunters that resulted in 64 harvested deer (15% success rate). Since 2012, DEP has issued 3,499 DMAP permits that resulted in 626 harvested deer over the past 11 years (18% cumulative success rate).

4.3.4 Watershed Recreation

One of DEP's land management priorities is to allow and enhance low-impact recreational uses and opportunities at 19 reservoirs, two controlled lakes, and thousands of acres of City-owned lands throughout the Catskill, Delaware, and Croton watersheds. DEP continues to expand public access to City-owned recreational lands while supporting local economies through ecotourism.

In 2022, DEP posted an additional 245 acres of watershed land for recreational use, bringing the total lands and reservoirs available for public use to 154,770 acres This includes

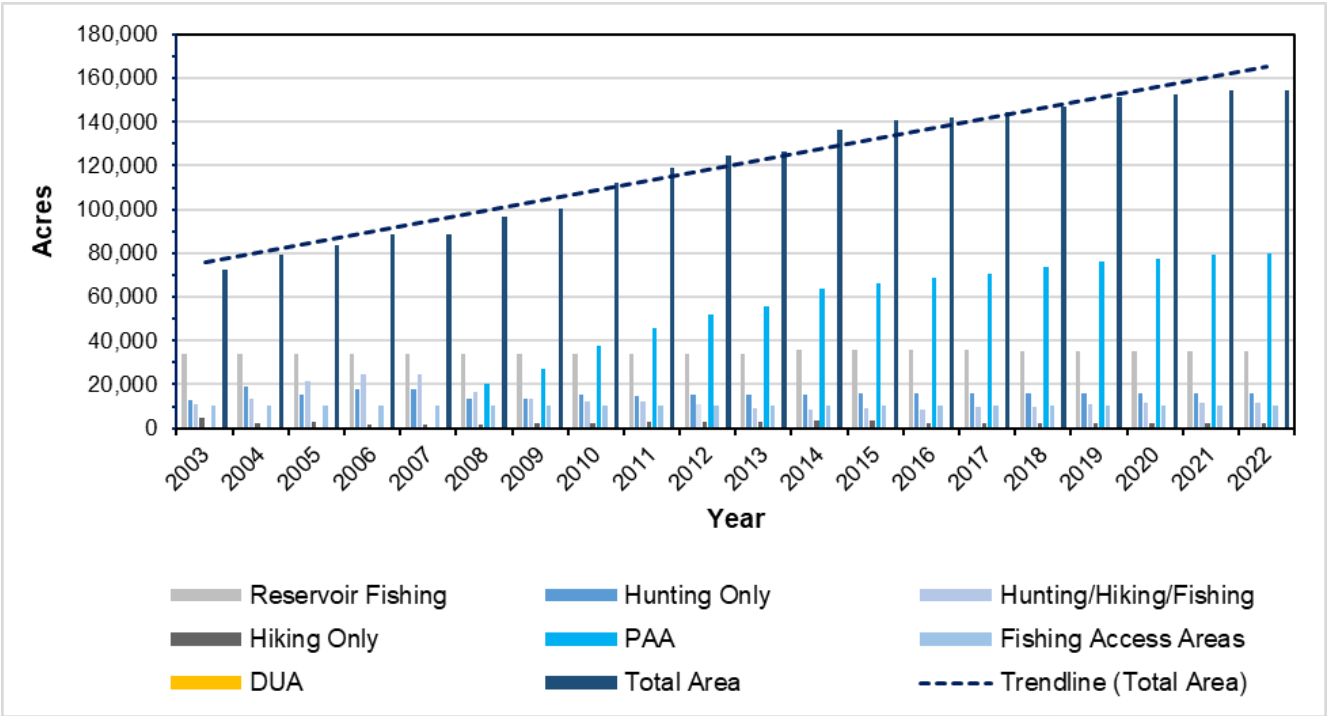

Figure 4.5 Acres of City-owned watershed land and reservoirs open for recreational access since 2003.

79,676 of Public Access Areas (PAAs), 29,664 acres of Access Permit Areas (APAs), 135 acres of Day Use Areas (DUAs), 35,086 acres of reservoirs, and 10,209 acres of reservoir shoreline (pre-MOA lands that were inadvertently excluded from prior reporting). PAAs allow for hunting, hiking, fishing, or trapping without a DEP access permit. APAs allow for fishing and hunting with a valid DEP access permit. DUAs allow for certain day uses including walking and

picnicking without a DEP access permit. Most shoreline areas require an APA permit for fishing, while reservoir use requires a DEP boat permit. Figure 4.5 provides a breakdown of City-owned land and reservoir acres opened for recreation since 2003, by recreational use categories.

In 2022, DEP continued to coordinate with Ulster County to manage the 11.5-mile-long Ashokan Rail Trail, which opened to the public in 2019. DEP tracks recreational use with trail counters installed at each of the three trailheads. Over 150,000 pedestrians and bikers utilized the trail in 2022. Through a partnership with the Woodstock Land Conservancy and NY/NJ Trail Conference, volunteer trail stewards monitor the Ashokan Rail Trail during peak times, assist with enforcing trail rules, and educate recreational users about source water protection.

In partnership with the Hunter Area Trail Coalition, DEP made significant progress on expanding the 11-mile Hunter Branch Rail Trail in 2022, including installation of a pedestrian bridge over a small tributary to the Schoharie Creek. This section of trail officially opens in April 2023.

DEP also continued to work with the Catskill Mountain Club, NY/NJ Trail Conference, Finger Lakes Trail Conference, and watershed communities to support the ongoing use of 16 hiking trails spanning approximately 66 miles of City-owned watershed lands. In 2022, DEP issued five state-licensed guide permits, allowing guides to bring clients onto City-owned lands and reservoirs for recreational activities. DEP currently maintains 52 active guide permits.

DEP allows the use of fishing boats on water supply reservoirs for individuals who register their boats and obtain a DEP boat tag. All boats must be steam-cleaned before storage, and they must remain on their assigned reservoir and within a specific boat storage area. Boat owners must renew their registration every four years, with DEP limiting the number of allowable boats per reservoir. In 2022, DEP issued 526 new fishing boat tags and renewed 2,821 expiring boat tags. DEP currently permits more than 13,400 fishing boats that are stored at Catskill, Delaware, and Croton reservoirs.

DEP's recreational boating program on the Cannonsville, Pepacton, Neversink, and Schoharie reservoirs opened for the expanded season on May 1, 2022, and ran through October 31, 2022. In cooperation with the Catskill Watershed Corporation, DEP allows certified vendors to rent canoes and kayaks for recreational use on City-owned reservoirs. In 2022, a total of 1,232 canoes and kayaks were registered with DEP or rented from qualified local businesses. Rentals were notably lower this year due to low-water drought conditions, which affected several vendors late in the season.

In 2022, DEP implemented a new recreation program allowing for low-impact recreational uses on City-owned lands by organizations, schools, and other stakeholder groups through a letter of permission authorized under DEP's recreational rules. In 2022, DEP approved nine letters of permission for recreational uses of City-owned lands, including group educational activities, group hunting programs, and archeological or natural resource investigatory activities.

These letters of permission improve DEP's responsiveness to increasing numbers of requests for compatible recreational activities.

4.4 Watershed Agricultural Program

The Watershed Agricultural Council (WAC) administers the Watershed Agricultural Program (WAP) using DEP contract funds and technical assistance provided by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Delaware County Soil and Water Conservation District and Cornell Cooperative Extension (CCE). The USDA Farm Service Agency provides technical and financial assistance for the federal Conservation Reserve Enhancement Program (CREP). The WAP reduces the risk of agricultural pollution through the development of Whole Farm Plans (WFPs) and the implementation of best management practices (BMPs), along with the establishment of riparian buffers through CREP.

To date, the WAP has developed 458 WFPs on 375 West of Hudson (WOH) farms and 83 East of Hudson (EOH) farms. At the end of 2022, WAC reports that 307 WFPs (67%) remained active, including 239 WOH farms and 68 EOH farms. Of the 239 active WOH farms, 25 are classified as "active, ineligible" because they do not meet the WAP's current eligibility requirements of at least five animal units.

During 2022, the WAP did not approve any new WFPs on WOH farms; two new WFPs were approved on EOH farms. Five WOH farms went from a status of "active" or "active-ineligible" to "inactive", one WOH "active" farm became "active-ineligible", and seven WOH "inactive" farms were "retired" from the program. The WAP anticipates developing up to one new WFP within the next 12 months. For the 313 active WFPs reported by WAC at the end of 2021, the WAP conducted 312 annual status reviews (239 WOH, 73 EOH) during 2022, exceeding the 90% FAD metric. The WAP also completed 77 WFP revisions on 61 WOH farms and 16 EOH farms.

In 2022, the WAP implemented 182 BMPs on all participating farms at a total cost of $1.3 million. These figures include 110 structural BMPs (of which 33 were repair or replacement BMPs on WOH farms totaling $738,624), 56 nutrient management plans and 16 no-cost management BMPs on EOH farms. To date, the WAP has implemented approximately 8,920 BMPs on all watershed farms at a cost exceeding $76 million; these figures include 8,072 BMPs on WOH farms ($68.3 million) and 848 BMPs on EOH farms ($7.5 million). In 2023, the WAP anticipates implementing approximately 200 BMPs on WOH farms at an estimated cost of $3.5 million and approximately 50 BMPs on EOH farms at an estimated cost of $1,000,000. These projections are subject to change as they are contingent upon WAC's progress in resolving internal financial accounting issues related to its core DEP funding contracts, of which WAC has made significant progress.

The Revised 2017 FAD requires the WAP to achieve several new BMP design and implementation metrics intended to reduce by 50% an existing backlog of BMPs identified in WOH WFPs prior to January 1, 2017, while limiting the creation of a new backlog of BMPs

identified after January 1, 2017. The 50% backlog reduction metric applies to "new" BMPs identified but not yet implemented in WFP pollutant categories I-VI, as well as previously implemented BMPs regardless of pollutant category, in need of repair or replacement.

To serve as a baseline for the FAD metric, DEP and WAC adopted an official BMP backlog list dated January 1, 2017, that is comprised of 1,754 BMPs estimated to cost $35.8 million, including 1,410 priority "new" BMPs not yet implemented in WFP pollutant categories I-VI ($28.1 million) and 344 repair or replacement BMPs ($7.7 million). To achieve the 50% FAD reduction metric, the WAP must design and schedule for implementation at least 705 "new" backlog BMPs by June 30, 2023. WAC successfully completed implementation of at least 50% of backlog BMPs needing repair and replacement before December 31, 2022. The Revised 2017 FAD requires WAC to repair or replace all viable BMPs that were designed and scheduled through calendar year 2022 by December 31, 2024.

Between January 1, 2017, and December 31, 2022, the WAP implemented 547 backlog BMPs at a total cost of $9.7 million, including 312 "new" BMPs in pollutant categories I-VI ($5.27 million) and 235 repair or replacement BMPs ($4.4 million). As such, the WAP has reduced the backlog of "new" BMPs by 22% (44% achievement toward the FAD implementation metric), while reducing the backlog of repair or replacement BMPs by 68% (thus exceeding the FAD metric for this category). During this same period, the WAP completed designs on 482 "new" backlog BMPs (312 implemented and 170 not yet implemented), thus achieving 68% toward the FAD design metric. The WAP also completed designs for 271 repair or replacement backlog BMPs (235 implemented and 36 not yet implemented), thus achieving 158% toward the FAD design metric.

Of the total 110 structural BMPs implemented in 2022, 17 were backlog BMPs (12 "new" and five repair or replacement) costing $701,101 ($68,686 for "new" BMPs and $632,415 for repair or replacement BMPs). To achieve current FAD metric deadlines, the WAP must design an additional 223 "new" backlog BMPs by June 30, 2023, and implement 393 "new" backlog BMPs before December 31, 2024. During 2023, the WAP anticipates designing approximately 275 "new" backlog BMPs for implementation.

Between January 1, 2017, and December 31, 2022, the WAP deleted 391 BMPs (40%) from the backlog list (249 "new" BMPs and 30 repair or replacement BMPs) due to farms becoming inactive, changes in farm operations or practices, or internal data reporting discrepancies. As of December 31, 2022, the WAP's official BMP backlog list included 928 total remaining BMPs, comprised of 849 "new" BMPs and 79 repair or replacement BMPs.

Since January 1, 2017, the WAP has planned or identified an additional 1,798 non-backlog BMPs (including new repair or replacement BMPs) on active WFPs estimated at $23.2 million. Out of these 1,798 newly identified BMPs, the WAP has implemented 458 new (non-backlog) BMPs and 162 non-backlog repair or replacement BMPs totaling $4.1 million. The non-backlog BMP portfolio, more accurately described as a new backlog of BMPs, is being

generated primarily through extensive ongoing revisions to existing WFPs and the planning of new agronomic BMPs such as liming and cover crops. This growing new backlog of BMPs is contrary to the dual goals of the 2017 FAD metric. Since many of these BMPs will not be implemented for years, it is likely that a high percentage will be deleted in the future due to changes in farming operations or farms becoming inactive. DEP, in consultation with WAC, will look to assess these metrics and make recommendations for improvements via the Revised 2017 FAD required report due June 30, 2024.

During 2022, the WAP completed 56 new or updated nutrient management plans (NMPs) on 54 active WOH farms and two active EOH farms. In the WOH watershed, 213 participating farms are following NMPs, of which 193 (91%) are current (developed within the last three years). Additionally, 131 WOH farms participated in the Nutrient Management Credit Program in 2022 (a decrease of one participant from the prior year); three farms left the program because they no longer met the eligibility requirement while three new farms were added to the program.

The WAP also implemented its seventh year of the Precision Feed Management (PFM) Program, completing six new or revised feed management plans in 2022. The PFM Program now has 55 active participants, including 37 dairy farms (24 in the Cannonsville basin, eight in the Pepacton and five in the Schoharie basin) and 18 beef farms (13 in the Cannonsville basin, four in the Pepacton basin and one in the Rondout basin).

In 2022, the WAP enrolled three new contracts totaling 11.14 acres in the Delaware County CREP/Catskill Stream Buffer Initiative (CSBI) pilot program, while five CREP contracts were re-enrolled covering 59.53 acres of riparian forest buffers. Two contacts were either terminated or canceled. CREP implements riparian buffers on agricultural lands; CREP/CSBI implements riparian forest buffers on historical agricultural lands that are no longer actively farmed. As of December 31, 2022, there were 126 CREP contracts containing 1,242 acres of riparian forest buffers in the WOH watershed.

The WAP conducted 40 farmer education programs in 2022 attended by 1,114 total participants, of which 397 were watershed farmers. At least 69 individual WAP participants attended at least one farmer education program during 2022, with highlights including the Catskill Regional Agricultural Conference, Delaware County Dairy Tour, the annual WAC Farm Tour, as well as a series of grazing webinars.

Finally, the WAC Economic Viability Program reaches thousands of people through its Pure Catskills print guide, e-newsletters, marketing website (Pure Catskills), and support of regional events that promote the sale and marketing of locally sourced watershed products. There are currently 325 Pure Catskill members. The Economic Viability Program awarded nine micro grants in 2022 totaling $34,298 and launched the Farms & Forests in Transition Reimbursement Program. The latter is a new initiative to support farms seeking professional services in

transition, estate planning or succession planning, of which one farm was approved for a grant of $5,000.

4.5 Watershed Forestry Program

The Watershed Agricultural Council (WAC) Forestry Program is a partnership between DEP, WAC, and the United States Forest Service (USFS) that promotes well managed, working forests as a beneficial land use for watershed protection. The WAC Forestry Program combines core DEP contract funds with USFS grant funding to support the development of forest management plans, the implementation of forest stewardship activities through the Management Assistance Program (MAP), the implementation of BMPs on active timber harvest projects, professional training for loggers and foresters, and educational programs for landowners and school-based audiences.

In 2022, WAC funded the development of 33 forest management plans covering 3,719 acres. One of these plans resulted in the new enrollment of 108 acres in the NYS Forest Tax Law (480-a tax abatement program), while the remaining 32 plans (3,611 acres) represented re-enrolled properties. A total of 59,700 watershed acres are enrolled in 480-a forest management plans funded by WAC. Landowners who enroll in this tax abatement program agree to restrict development, limit subdivision, and commit to a rolling 10-year schedule of forest stewardship activities that help prevent conversion of forestland to other less protective uses.

WAC also funded the completion of 73 MAP projects: 22 timber stand improvement projects, 20 wildlife improvement projects, 12 invasive plant control projects, three tree planting projects, one riparian improvement project, and 15 landowner site visits. To date, the program has funded 884 MAP projects on 6,986 acres of forestland, with timber stand improvement and wildlife improvement representing 75% of all completed projects.

In 2022, WAC funded the completion of 46 road BMP projects, which included 14 stream crossing projects on active timber harvest sites. WAC also loaned out two portable bridges and distributed 24 free BMP samples. Additionally, WAC completed 12 Croton Trees for Tribs projects that planted 235 trees and shrubs along 1,566 linear feet of streams.

WAC continues to maintain the interactive MyWoodlot.com website that educates forest landowners through online modules and helps them develop customized goals and management activities for their properties. The website contains 56 goals, 236 activities, 780 pieces of "how-to" information, and 323 blogs and feature stories. In 2022, 42 landowners created MyWoodlot profiles, for 433 profiles to date; 26 of these profiles (6%) belong to WAC staff, WAC committee members and partners. WAC reports that 29,109 unique users visited MyWoodlot.com during 2022.

In collaboration with the NYS Trained Logger Certification Program and Cornell Cooperative Extension, WAC sponsored eight professional logger-training workshops during

2022 attended by 85 participants. Approximately 57 loggers working in the Catskill/Lower Hudson region were "Trained Logger Certified" during 2022.

WAC and its partners sponsored numerous forest landowner education programs in 2022, including 23 workshops attended by 488 participants. The Cornell Master Forest Owners (MFO) Program conducted 54 landowner visits while 45 MFOs were available to assist forest landowners in the watershed, primarily the Catskill region.

The Watershed Forestry Program implemented the following virtual and in-person school-based education programs in 2022: Green Connections School Partnership Program, Watershed Forestry Institute for Teachers, and the Watershed Forestry Bus Tour Grants Program. Green Connections engaged 133 students during the 2021-2022 school year, while 23 teachers attended the Watershed Forestry Institute. WAC sponsored 27 in-person bus tours and 12 virtual bus tours attended by 1,510 participants, primarily New York City students.

Additionally, the four watershed model forests hosted 82 educational programs and outreach events for 3,747 participants including youth, forest landowners, loggers, and water consumers. The Frost Valley Model Forest attracted 0 visitors. The Siuslaw Model Forest hosted 1,479 youth and adult through their programs, while the Clearpool Model Forest reached 2,268 visitors from East of Hudson and New York City.

Finally, the Revised 2017 FAD requires DEP, in consultation with WAC, to assess and report on by December 31, 2025, the effectiveness of the MAP in supporting the implementation of forest management plans. This will include a summary of any modifications made to the MAP or additional improvements that may be needed to promote good forest stewardship.

4.6 Stream Management Program

The Stream Management Program (SMP) contracts with local partners to restore and protect stream system stability and ecological integrity by promoting the long-term stewardship of streams and floodplains. While SMP projects serve multiple objectives, each project has a principal goal that is associated with a core SMP funding category. The core SMP project categories include Water Quality Stream Projects (WQSPs), Flood Hazard Mitigation/Local Flood Analysis (LFA), Stream Management Implementation Program (SMIP), and the Catskill Streams Buffer Initiative (CSBI) which is described in Section 4.7.

In 2022, the SMP completed 12 additional stream projects (Figure 4.6), which taken together with 21 CSBI projects, resulted in 507 completed projects treating more than 55 miles of stream since program inception. Three stream projects and 23 CSBI projects received annual repairs and maintenance. The SMP conducted 20 miles of stream feature inventories (SFIs), bringing the total under the Revised 2017 FAD to more than 144 miles and meeting the FAD requirement that six SFIs be conducted in the prioritized tributaries/main stems of the Schoharie,

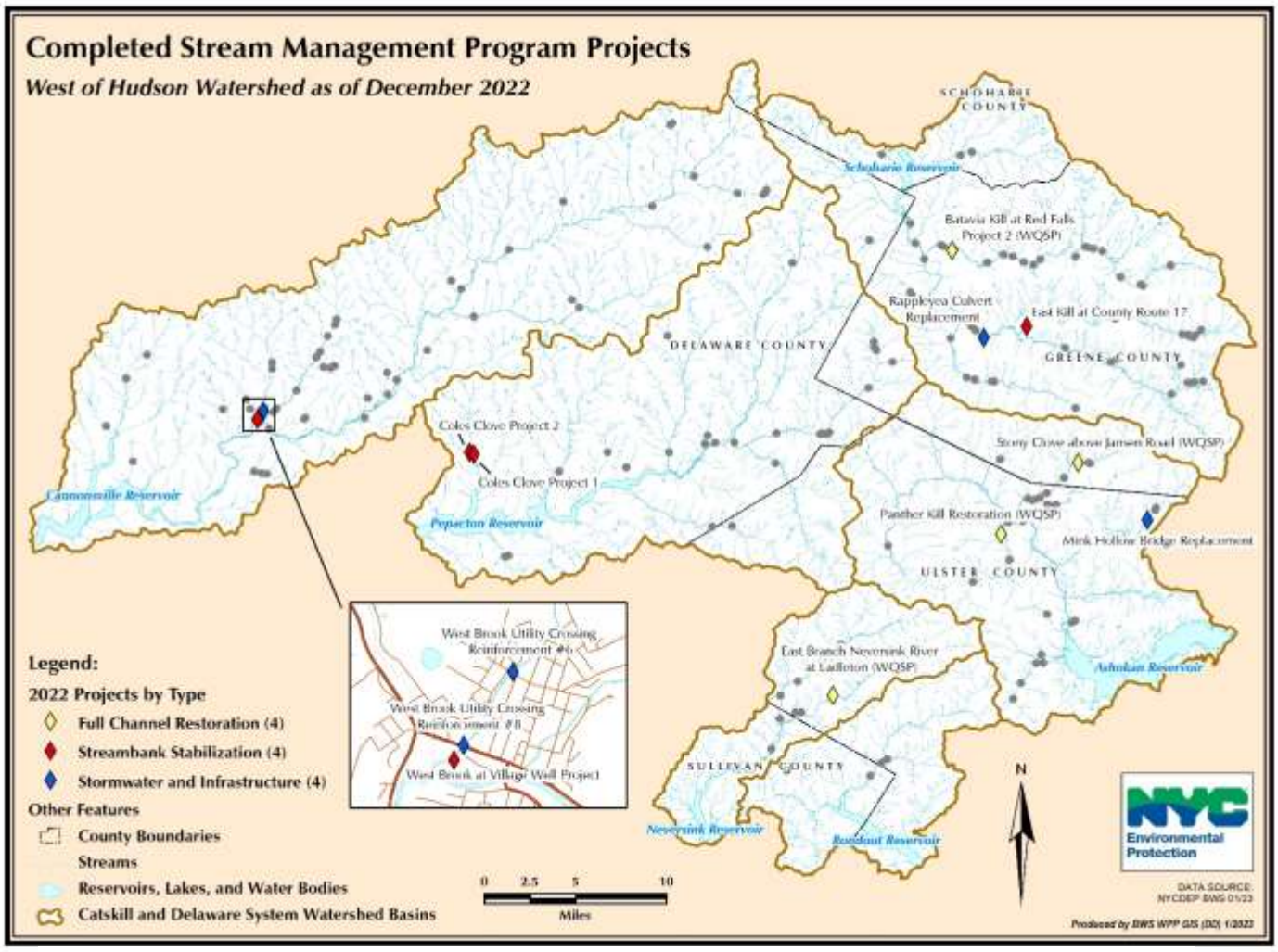

Figure 4.6 Location of SMP projects, 2022.

Ashokan, Neversink, Rondout, Cannonsville and Pepacton basins. Throughout 2022, the SMP continued to deliver a broad base of educational programming, professional engineering services, and technical assistance. DEP also initiated negotiations with the five SMP contract partners for successor contracts, targeting registrations in 2024 and 2025.

4.6.1 Water Quality Stream Projects

The 2017 FAD requires the completion of 24 WQSPs, at least eight of which shall be in the Ashokan watershed and three shall be in the Stony Clove basin to support the Upper Esopus Creek Watershed Turbidity/Suspended Sediment Monitoring Study. Each November, DEP nominates WQSPs for NYSDOH approval under the FAD. In 2022, NYSDOH approved the Batavia Kill at Red Falls Project 3 in Prattsville, the East Branch Neversink River at Riley Brook Confluence Project in Denning, and the Elk Bushkill Project in Shandaken. The SMP

constructed four previously approved projects: Batavia Kill at Red Falls Project 2, Stony Clove above Jansen Road, Panther Kill, and East Branch Neversink River at Ladleton.

In the Ashokan watershed, DEP has now completed five of the required eight WQSPs while meeting the FAD requirement to complete three WQSPs in the Stony Clove basin. In total, 18 WQSPs have been approved by NYSDOH and 11 have been completed toward the FAD goal of 24 projects. Table 4.4 summarizes the status of WQSPs at the close of 2022.

Table 4.4 Status of WQSPs toward fulfillment of the Revised 2017 FAD requirement.

Project Name	Status	Length (feet)	Basin
Batavia Kill at Kastanis	Completed	3,800	Schoharie
Bush Kill at Watson Hollow	Completed	250	Ashokan
Batavia Kill at Red Falls Project 1	Completed	1,606	Schoharie
Batavia Kill at Red Falls Project 2	Completed	830	Schoharie
West Branch Neversink River at Clothes Pool	Completed	850	Neversink
Hillslope Stabilization at Bull Run	Approved	300	Pepacton
East Kill at Colgate Lake Road	Completed	700	Schoharie
Warner Creek Site 1	Completed	540	Ashokan
Warner Creek Site 2	Completed	560	Ashokan
Stony Clove Above Jansen Road	Completed	1,600	Ashokan
West Kill Above Wolff Road	Approved	1,000	Schoharie
East Branch Neversink River at Ladleton	Completed	1,360	Neversink
West Branch Delaware River at Riverhaven Farm	Approved	2,350	Cannonsville
West Branch Delaware River at Birdsong Farm	Approved	2,000	Cannonsville
Panther Kill Restoration	Completed	450	Ashokan
Batavia Kill at Red Falls Project 3	Approved	1,800	Schoharie
East Branch Neversink River at Riley Brook	Approved	2,200	Neversink
Elk Bushkill Restoration	Approved	700	Ashokan

Batavia Kill at Red Falls

The Batavia Kill at Red Falls contains the largest and most complex stream segments to be addressed by the SMP to date. It is approximately 6,000 feet in length and includes multiple large hillslope failures where mass wasting and excessive erosion into glacial lacustrine clay and till deposits were causing significant water quality impacts. The SMP completed Project 1 in two phases during 2020-2021 at a cost of $2.1 million. In 2022, the SMP completed Project 2 at a cost of $1.1 million. Project 2 included 830 linear feet of stream and floodplain restoration and hillslope stabilization. Restoration channel included boulder riffles, log keyways, live stone revetment, as well as extensive floodplain restoration, hillslope stabilization, partial reclamation of the area's access road, and restoration of the dewatering channel and site revegetation. Figure 4.7 illustrates the Batavia Kill at Red Falls Project 2 before and after restoration.

Figure 4.7 The Batavia Kill at Red Falls Project 2 before (top) and after (bottom) restoration.

Stony Clove Above Jansen Road

Located in the Town of Hunter, this WQSP included two primary areas of erosion including a large rotational failure of glacio-lacustrine sediment in a high terrace located above one of the eroding streambanks. The SMP used high resolution topographic mapping and two rounds of SFI mapping to document that this reach had sustained erosional connectivity with glacial sediment that measurably contributed to turbidity production in Stony Clove Creek. A high-risk flood hazard home located at the top of the actively mass-wasting terrace was purchased and removed through the New York City-Funded Flood Buyout Program (NYCFFBO) in 2021, after which the site continued to degrade with a new large rotational failure.

The SMP constructed this WQSP in 2022 at a cost of $2 million. Project objectives were to disconnect the channel from the glacial sediment sources and restore channel stability through realignment and re-dimensioning, increasing erosion resistance through in-stream and floodplain grade control structures and streambank protection with rock revetment, bioengineering, and natural vegetative restoration measures. Installed practices included hillslope/bank and floodplain grading and reconnection, constructed riffle grade controls, root wads, fascine and live stone revetment bank treatments, and revegetation with native trees, shrubs, and seeds. Figure 4.8 shows the Stony Clove Above Jansen Road WQSP before and after restoration.

4.6.2 Flood Hazard Mitigation Program

The SMP supports the development of LFAs, which identify flood hazards in WOH population centers through hydraulic models and engineering analyses. Pursuant to the FAD, City funding is then available to implement LFA-recommended projects through the SMP, the Catskill Watershed Corporation (CWC) Local Flood Hazard Mitigation Implementation Program (LFHMIP), or the NYCFFBO. Several projects have relied upon a combination of these and other state/federal funding sources.

The Revised 2017 FAD requires the City to make $15 million available through SMP partner contracts to fund the implementation of 50 LFA-recommended projects, of which DEP committed an initial $7.1 million in five currently active SMP partner contracts. The Revised 2017 FAD also requires the City to assess the use of $10.1 million in flood hazard mitigation funding that was previously committed to older SMP partner contracts. Of the original $10.1 million that DEP committed to prior SMP contracts, nearly $6.9 million was committed to projects and $6.2 million of that amount was expended prior to those contracts being closed out

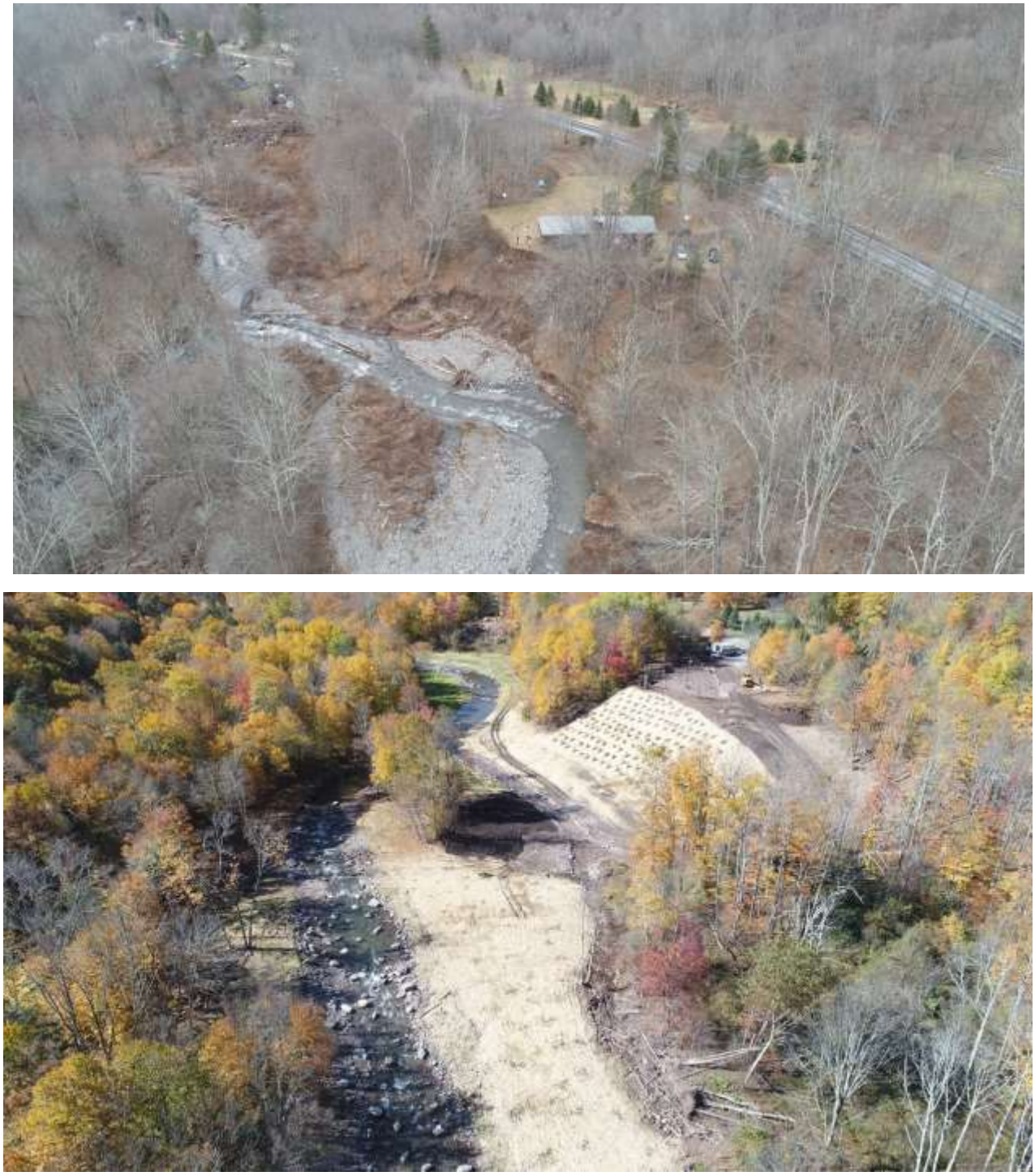

Figure 4.8 Stony Clove above Jansen Road before construction (top) and after contruction (bottom).

during 2019-2020. Of the $7.1 million that DEP committed to current SMP contracts, over $4.8 million has been committed to projects and more than $2.1 million has been expended.

SMP Local Flood Analyses (LFAs) and Recommended Projects

In 2022, the SMP supported the communities of Jewett (three population centers), Grahamsville (three population centers), and Pine Hill (one population center) with the completion of their LFAs. To date, DEP has committed just over $2 million to the development of LFAs, with 25 LFAs completed for 43 WOH population centers. Figure 4.9 depicts the locations and status of LFAs. A full list of completed LFAs can be found here.

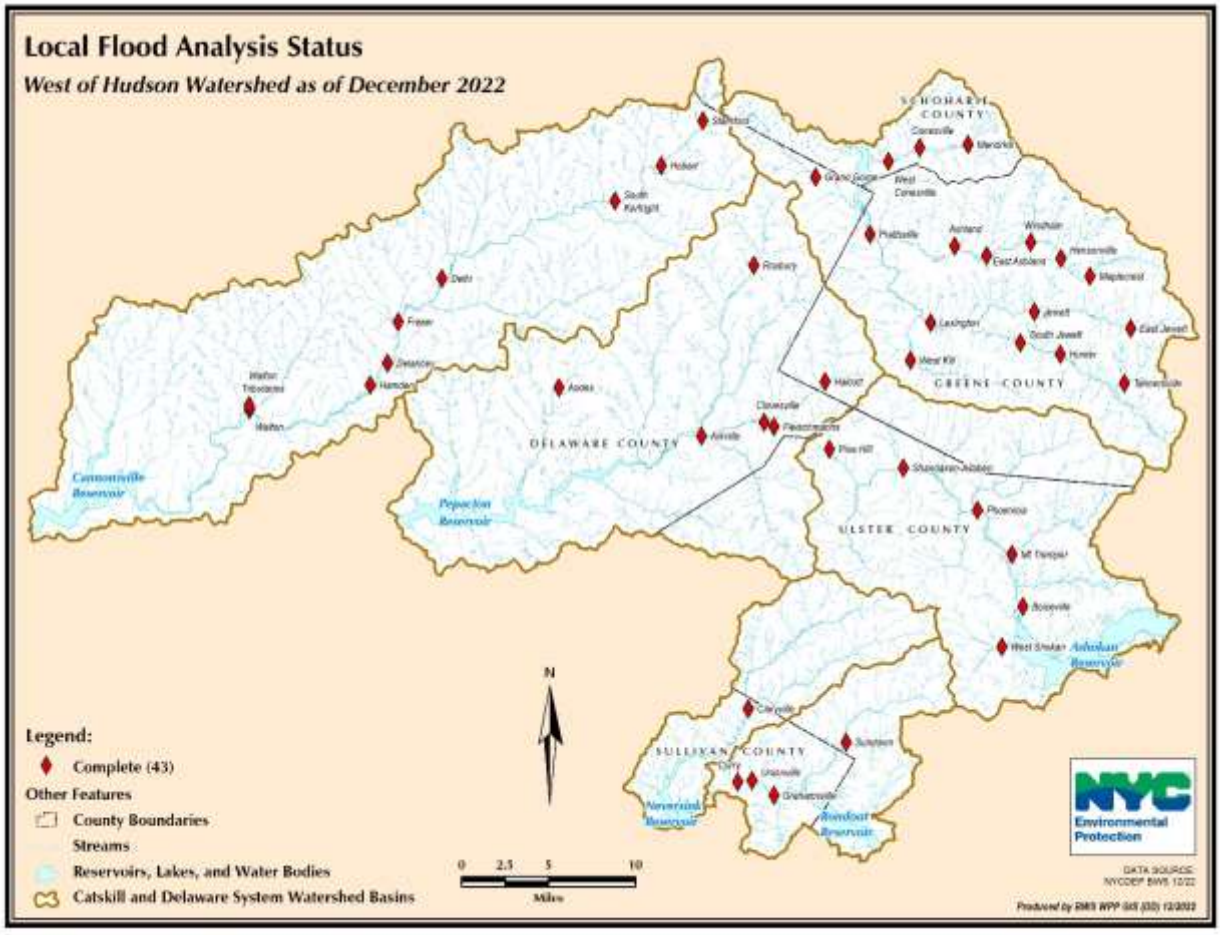

Figure 4.9 Location and status of LFA projects, 2021.

In 2022, SMP partners awarded three grants totaling $1 million to support the implementation of LFA-recommended projects. These grants include design and construction of an expanded bridge over Maple Avenue in Hobart, stabilization of Elk Creek Road in Halcott,

and a culvert expansion/replacement on Vega Mountain Road in Roxbury. To date, the SMP has awarded 31 LFA grants supporting 20 distinct LFA projects.

Several LFA projects were substantially advanced in 2022. For example, the Greene County Soil and Water Conservation District (GCSWCD) completed the design of the Railroad Avenue Streambank Stabilization Project on the Sawmill Creek in Tannersville at a cost of $180,000. The project will address a failing hillslope contributing to channel blockage and instability while stabilizing the road. CWC will oversee project bidding and fund construction, estimated at $1.2 million, with a $545,775 federal contribution through the Water Resources Development Act. This project demonstrates an effective partnership between the SMP and CWC's LFHMIP to implement larger and more expensive flood hazard mitigation stream and floodplain projects, with SWCDs undertaking design and CWC funding construction.

CWC Local Flood Hazard Mitigation Implementation Program

CWC advanced several LFHMIP projects in 2022, including feasibility studies, project designs, and project implementation. CWC also awarded a new two-year contract to LaBella Associates to provide engineering services for the LFHMIP, including the preparation of feasibility studies, designs for property protection measures, and the management of demolitions on properties acquired through the NYCFFBO.

CWC funded five property protection feasibility studies for potential elevation or floodproofing of flood-prone structures, bringing the total number of feasibility studies approved to date to 58. Of these, CWC received four completed studies in 2022, bringing the total number completed to 56.

CWC also funded the design of three property protection projects including a residential elevation in Ashland and two commercial buildings (Hunter and Windham), bringing the total property protection design approvals to 17. Additionally, CWC approved two applications for construction funding intended to mitigate against future flood events (Prattsville Town Hall and a commercial building in Walton). To date, 10 property protection-related construction applications have been approved, and four completed.

CWC funded two public infrastructure projects in 2022. Funding was awarded to the Greene County Highway Department for designing an upsized culvert crossing of Brownell Creek as recommended in the Halcott LFA. Funding was also awarded to construct a wastewater system for the Boiceville fire station currently being rebuilt outside of the floodplain.

Under the pollution prevention category, CWC approved three fuel tank anchoring projects in 2022. To date, CWC has approved 56 applications, and funded the anchoring of 49 propane tanks (16,100 gallons) and 20 fuel oil tanks (5,275 gallons).

After awarding project design funding in 2019, CWC funded the construction of a dry-floodproofing project at Townsend Elementary School in the Village of Walton in 2022. Floodproofing measures included retrofitting 10 exterior doorways with flood panels, removing

dozens of smaller, ground-level openings (ventilation, utilities), and relocating these openings above the design flood elevation (Figure 4.10).

In 2022, CWC and other watershed partners made a significant stride in leveraging City dollars with state, federal, or local funding sources to implement larger-scale flood mitigation projects such as the relocation of critical facilities outside of floodplains. In the hamlet of Boiceville, a new fire station is under construction using more than 25% of total project funding (approximately $2 million) from non-City sources (Figure 4.11). After construction, the existing

Figure 4.10 Townsend Elementary School flood hazard mitigation project

fire station will be acquired through the NYCFFBO and demolished, and the floodplain site will be restored to open space. The Village of Hunter received $1.97 million in funding through NYSDEC's Climate Smart Community Grant Program for construction of a new fire station once a suitable upland location has been secured; CWC is funding a feasibility study to determine such a location.

Figure 4.11 Boiceville firehouse under construction, December 2022.

In 2022, CWC applied to the NYS Division of Homeland Security and Emergency Services for Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program funds. This was to cover 75% of the projected $1.67 million needed to elevate 10 flood-prone properties (eight in Greene County, two in Ulster County) above the base flood elevation.

New York City-funded Flood Buyout Program

DEP works with CWC to fund the removal of structures on floodplain properties acquired through the NYCFFBO. In 2022, five demolitions were completed: two in Tannersville and one each in Fleischmanns, Windham, and Shandaken. One additional bid was awarded in late 2022 for two properties in Mount Tremper, with demolition expected in early 2023. Pre-demolition surveys have been prepared for another three properties scheduled for demolition in 2023 (one each in Hunter, Olive, and Tannersville).

4.6.3 Stream Management Plan Implementation Program

DEP and its SMP partners continue to deliver comprehensive basin-scale programming including stream assessments; project selection, design, and construction; LFA support; and education and technical training of stakeholders. SMP partners met throughout the year with their advisory councils and working groups to implement recommendations made in stream management plans, track status and progress via annual action plans, and administer the Stream Management Implementation Program (SMIP) to support locally driven projects.

Table 4.5 summarizes the total number of SMIP grants awarded in 2022 and to date. Since program inception in 2009, 324 SMIP grants have been awarded. Of this number, 261

grants are complete (81%), 40 are in process (12%), one is in the design phase (0.3%), and 22 are withdrawn (7%). In 2022, SMP partners committed nearly $160,000 to eight new projects and completed eight construction-related projects as summarized in Table 4.6. SMP partners also completed three education and outreach projects and two planning and research projects. Since 2018, the SMP tracks flood hazard mitigation projects separately as LFA-recommended projects to be consistent with the Revised 2017 FAD. Additional information on all SMIP projects can be found here.

Table 4.5 Number of SMIP awards by category for 2022 and totals to date.

SMIP Category	2022	Total[1]
Education and Outreach	4	87
Recreation and Habitat Improvements	0	28
Stormwater and Critical Area Seeding	1	76
Landowner Assistance/Streambank Restoration	1	50
Planning and Research	2	54
Flood Hazard Mitigation[2]	0	29
Total	**8**	**324**

[1] Includes 22 projects awarded but later withdrawn.
[2] Since 2018, flood hazard mitigation projects are tracked separately as LFA-recommended projects to be consistent with the Revised 2017 FAD.

Table 4.6 Summary of locally driven SMIP projects completed in 2022

Basin	Type of Project	Name of Project	Length (feet)
Schoharie	Stormwater/Infrastructure	Rappleyea Culvert Replacement	45
Schoharie	Streambank Stabilization	County Route 17 Emergency Restoration	700
Ashokan	Stormwater/Infrastructure	Mink Hollow Bridge Replacement/Enhancement	210
Cannonsville	Stormwater/Infrastructure	West Brook Utility Crossing Reinforcement #8	15
Cannonsville	Stormwater/Infrastructure	West Brook Utility Crossing Reinforcement #6	15
Cannonsville	Streambank Stabilization	Coles Clove Project 1	195
Cannonsville	Streambank Stabilization	Coles Clove Project 2	50
Cannonsville	Streambank Stabilization	Village Well Project	370

4.6.4 Stream Studies

The SMP conducts scientific investigations to support stream management strategies and implementation. Priorities include (1) advancing and documenting the status of the 10-year collaborative research effort led by USGS and DEP investigating turbidity dynamics and reduction efforts in the upper Esopus Creek watershed, (2) revising the Catskill bankfull discharge and channel geometry regional regression relationships currently used by DEP and SMP partners, and (3) working with SMP partners on research and assessment initiatives.

In 2022, the Upper Esopus Creek Watershed Turbidity/Suspended Sediment Monitoring Study advanced through the sixth water year of the 10-year monitoring period. USGS conducted ongoing measurements at 29 monitoring stations and completed statistical analyses for report and journal manuscript content. DEP completed an initial analysis of the turbidity source conditions in the Stony Clove watershed and summarized the results and findings of the first five years of research in a comprehensive mid-term FAD report submitted in November 2022.

DEP's mid-term FAD report included an update on the evaluation of WQSPs (also referred to as sediment turbidity reduction projects, or STRPs) on measurably reducing turbidity in the Stony Clove watershed following the impacts of the December 25, 2020, flood event. The analyses showed that projects were successful in maintaining a turbidity reduction role, even though new turbidity sources opened and returned the Stony Clove watershed to its former status as a high-ranking turbidity producer. The report also highlighted the significance of connectivity with glacial legacy sediment as a primary control on turbidity production. In 2022, the SMP constructed the third STRP in the Stony Clove watershed that will be used for evaluating upstream and downstream before/after reach-scale turbidity reduction.

4.6.5 Watershed Emergency Stream Response and Recovery Plan

Per the Revised 2017 FAD, the SMP is required to coordinate with NYSDEC regarding the State Programmatic General Permit for emergency response post-storm recovery activities. Upon issuance, DEP and the SMP partners will initiate outreach and training around the permit with a goal of preventing stream destabilization and associated water quality degradation.

4.7 Riparian Buffer Protection Program

DEP protects and manages riparian buffers as an essential component of its overall watershed protection program. DEP's Land Acquisition Program (LAP) acquires publicly owned buffers, while privately owned buffers are managed and protected through the Catskill Streams Buffer Initiative (CSBI), Conservation Reserve Enhancement Program (CREP), and other watershed programs.

4.7.1 Activities on City-owned or Controlled Land

DEP's LAP includes 300-foot buffers on either side of a watercourse as a principal eligibility requirement under the "natural features criteria" set forth in the MOA. Within the Catskill/Delaware watershed, 36.4% (90,998 acres) of all stream buffers are protected by fee

simple public ownership or conservation easements held by the City, state, Watershed Agricultural Council (WAC), local municipalities, or land trusts. This includes lands protected by the Streamside Acquisition Program (SAP), described in Section 4.2. DEP now owns or controls more stream length (718 miles) and roughly the same amount of land within stream buffers (45,752 acres) as are protected in the Catskill/Delaware watershed by all other entities combined.

DEP carefully considers the presence or absence of riparian buffers when reviewing requests for projects on City-owned lands. For example, when issuing agricultural use licenses, DEP requires a minimum 35-foot buffer between farming activities and the stream. Proposals maintaining a larger buffer receive extra points in their rating. DEP reviews all land use permits and proposed projects for potential impacts to riparian buffers, imposing permit conditions as needed to avoid or mitigate these impacts. DEP secures stream crossing permits as required by NYSDEC and takes extra measures during forestry operations to select BMPs, such as temporary bridges or arch culverts, to minimize impacts on streams and buffers.

4.7.2 Catskill Streams Buffer Initiative

The CSBI is a component of DEP's Stream Management Program (SMP) that strives to enhance the extent and functionality of WOH riparian buffers through vegetation mapping, riparian corridor planning, buffer restoration, maintenance and monitoring, invasive plant removal, and extensive education and outreach. DEP works with CSBI coordinators in four county soil and water conservation districts who develop riparian corridor management plans (RCMPs) for participating landowners and guide project design. Since 2009, county CSBI coordinators have completed 182 RCMPs, including 22 new RCMPs in 2022.

One unique aspect of the CSBI is the propagation of local genotypes of Catskill native species. Since 2009, the SMP has contracted with nurseries, including the Greenbelt Native Plant Center and One Nature, LLC, to grow over 73,646 gallon-sized trees and shrubs from locally collected seed. In 2022, DEP and its partners received 3,407 gallon-sized trees and shrubs through these contracts.

Table 4.7 lists the 21 CSBI planting projects completed in 2022; no new plantings were completed through the CREP/CSBI pilot project. The SMP completed CSBI buffer restoration on 12.24 acres of streamside property that span nearly 1.6 miles of stream length. These projects installed 5,001 native Catskill trees and shrubs.

Table 4.7 Summary of CSBI projects completed in 2022.

Basin	Name of Project	Stream Length (feet)	Area (acres)
Ashokan	Pierce MHB	230	0.05
Ashokan	Tinney	105	0.08
Ashokan	Murat Bushkill	350	0.65
Ashokan	Emerson 2022	110	0.03
Schoharie	Bilash	180	0.06
Schoharie	Levy	528	0.65
Schoharie	Stargill	396	0.15
Schoharie	HBRT	60	0.11
Schoharie	Ortega	790	0.56
Schoharie	Hayfield Wedding Venue	1,000	0.87
Schoharie	CR17	665	1.52
Schoharie	DOT Pollinator	450	0.53
Neversink	Leudemann	300	0.09
Rondout	Siragusa	700	0.60
Neversink	Wellington	350	0.14
Rondout	Hutchins	60	0.02
Pepacton	Vly Creek	860	1.30
Pepacton	Ingalls Road	120	0.08
Cannonsville	SUNY Delhi #6	140	0.25
Cannonsville	Cal Terry	600	1.50
Cannonsville	D'Orazio	300	3.00
Total		**8,294**	**12.24**

Since 2009, the CSBI has completed 289 total projects spanning more than 195 riparian acres and nearly 26 miles of stream length. These projects installed nearly 107,000 gallon-sized trees and shrubs, in addition to plugs, tubelings, and cuttings from willow and dogwood species (all native Catskill species). Figure 4.12 depicts the locations of completed CSBI projects. The Revised 2017 FAD requires the CSBI to revegetate a minimum of 10 streambank miles during 2018-2027. Through 2022, the CSBI has achieved 8.5 miles toward this FAD metric.

To understand the factors affecting project success and design follow-up maintenance interventions, CSBI coordinators monitor projects for five years following installation to document browse pressure, plant survival and growth rates, and to assess the effectiveness of installation techniques. Fifty-one sites were monitored, and 23 sites were maintained.

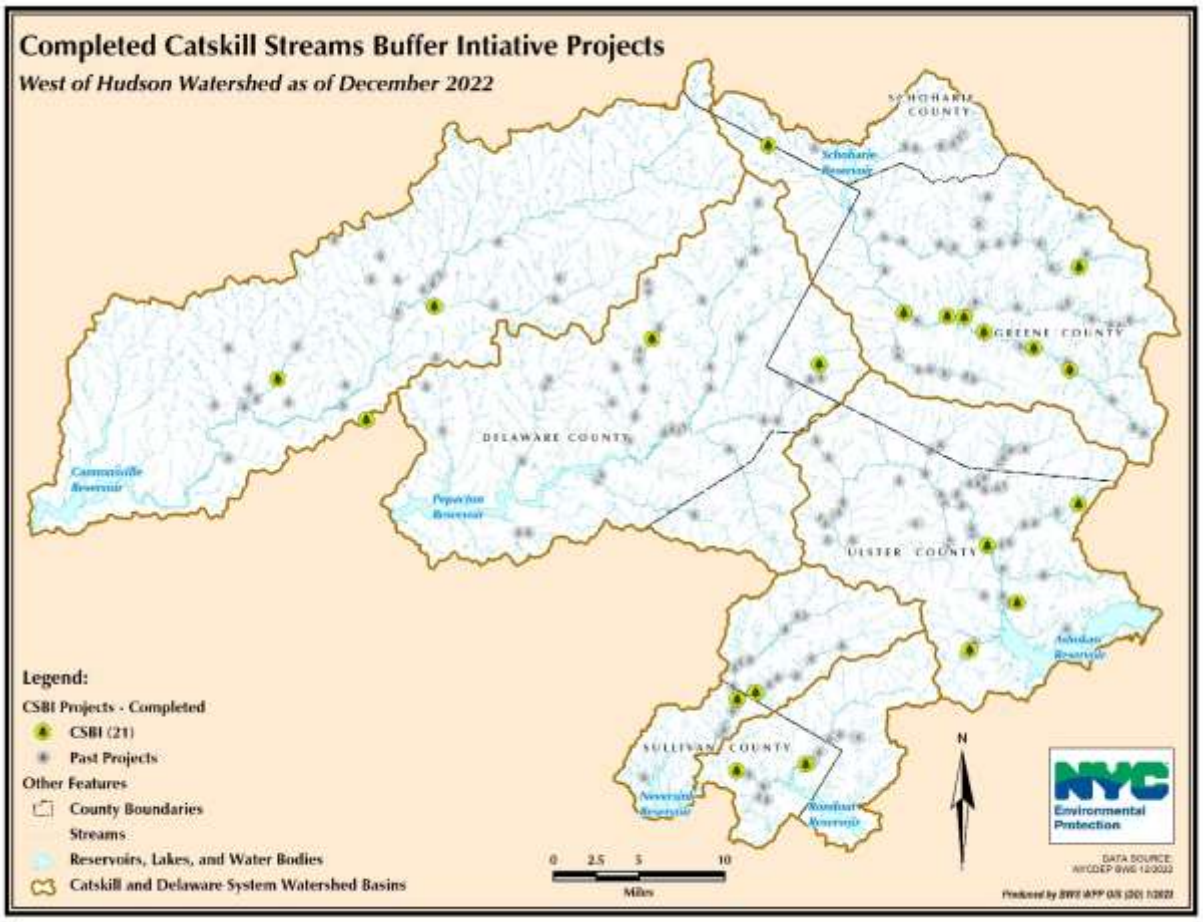

Figure 4.12 Locations of CSBI projects completed, 2009-2021

Japanese Knotweed Survey on Upper Rondout and Chestnut Creeks

The 2010 Rondout Stream Management Plan prepared by the Rondout Neversink Stream Program (RNSP) established a goal of stopping the spread of Japanese knotweed based on its limited and potentially manageable distribution. The RNSP began mapping and managing the spread of Japanese knotweed in 2014 on Upper Rondout and Chestnut creeks, with repeat mapping followed by annual herbicide treatment during 2015-2018. Updated mapping was undertaken in 2022. Of the 60 knotweed clusters mapped in 2015, seven remained at the close of 2018. The 2022 survey found 31 clusters comprising 0.43 acres, with more than 38% of these clusters located on roadways. The RNSP plans to treat these 31 clusters in 2023, pending landowner approval and applicator availability.

Delaware County CREP/CSBI Pilot Program

A CREP/CSBI pilot program is underway to assess the potential for implementing greater numbers of riparian buffer planting projects that combine the benefits of both programs,

including federal incentive payments from CREP and enhanced planting resources from CSBI. To date, six projects have planted 2.5 miles of stream length and revegetated nearly 38 acres. Pursuant to the Revised 2017 FAD, the CREP/CSBI pilot program has been extended through 2025, at which time it will be evaluated and considered for permanent establishment or discontinuation.

In 2022, the CREP/CSBI pilot focused on comprehensive maintenance and monitoring at all six project sites. A team of six interns inspected all tree and shrub tubes, replacing or repairing them as needed. Monitoring efforts found that all sites exceeded the 60% plant survival standard set by the CREP. Additional accomplishments in 2022 included repair of a streambank stabilization project at the 2019 East Brook CREP/CSBI project following a high-water event, as well as a subsequent CSBI planting to fill in the remaining portions of the riparian buffer. Site preparation was also completed for the Palen CREP/CSBI project, to be planted in 2023.

4.8 Ecosystem Protection Program

4.8.1 Wetlands Protection Program

DEP protects wetlands through regulatory means, land acquisition, and multiple stewardship programs. Wetland mapping and monitoring programs provide baseline information to support these protection efforts.

Regulatory Review

DEP receives notification of applications filed in the watershed under Article 24 of the New York State (NYS) Environmental Conservation Law, Section 404 of the Clean Water Act, and Connecticut town wetland regulations (Conn. Gen. Stat. Sec. 22a-42f). A subset of New York towns within the EOH watershed voluntarily forward filed wetland permit applications to DEP for review. DEP reviews these submittals and provides comments when alternatives that would avoid, minimize, or mitigate wetland and water quality impacts are identified. DEP's comments often lead to project plan modifications, resulting in less impact and/or improved mitigation than originally proposed.

In 2022, DEP reviewed six NYS Article 24 wetland permit applications, one of which was also reviewed as a U.S. Army Corp of Engineers (USACE) pre-construction notification (PCN), and two town permit applications for activities within FAD basins (Figure 4.13 and Figure 4.14). None of these applications involved permanent wetland impacts. The remaining applications were activities such as aquatic nuisance species control, installation of a new water main at Westchester County Airport, and installation of plantings.

DEP reviewed an additional 27 wetland permit applications in the Croton System, including 14 NYS Article 24, 2 USACE and 11 town permit applications (Figure 4.13). Only four applications involved permanent wetland loss, all of which were under 0.002 acre. The remainder involved temporary wetland impacts and/or adjacent area impacts for activities such

as aquatic nuisance species management, individual residence improvements, communication tower construction, gas line investigation, pond dredging, small dam repair, and well installation.

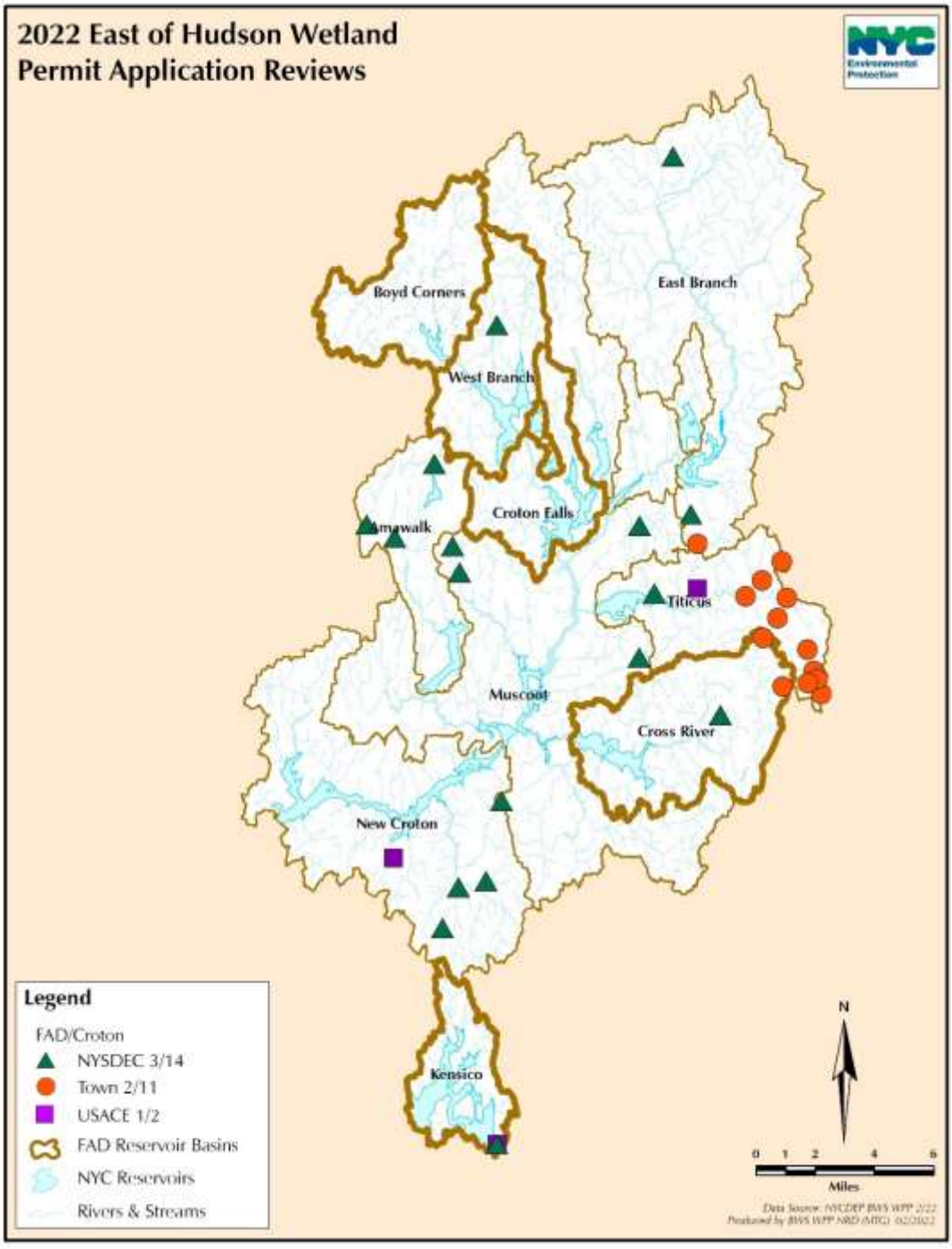

Figure 4.13 Locations of wetland permits reviewed EOH in 2022.

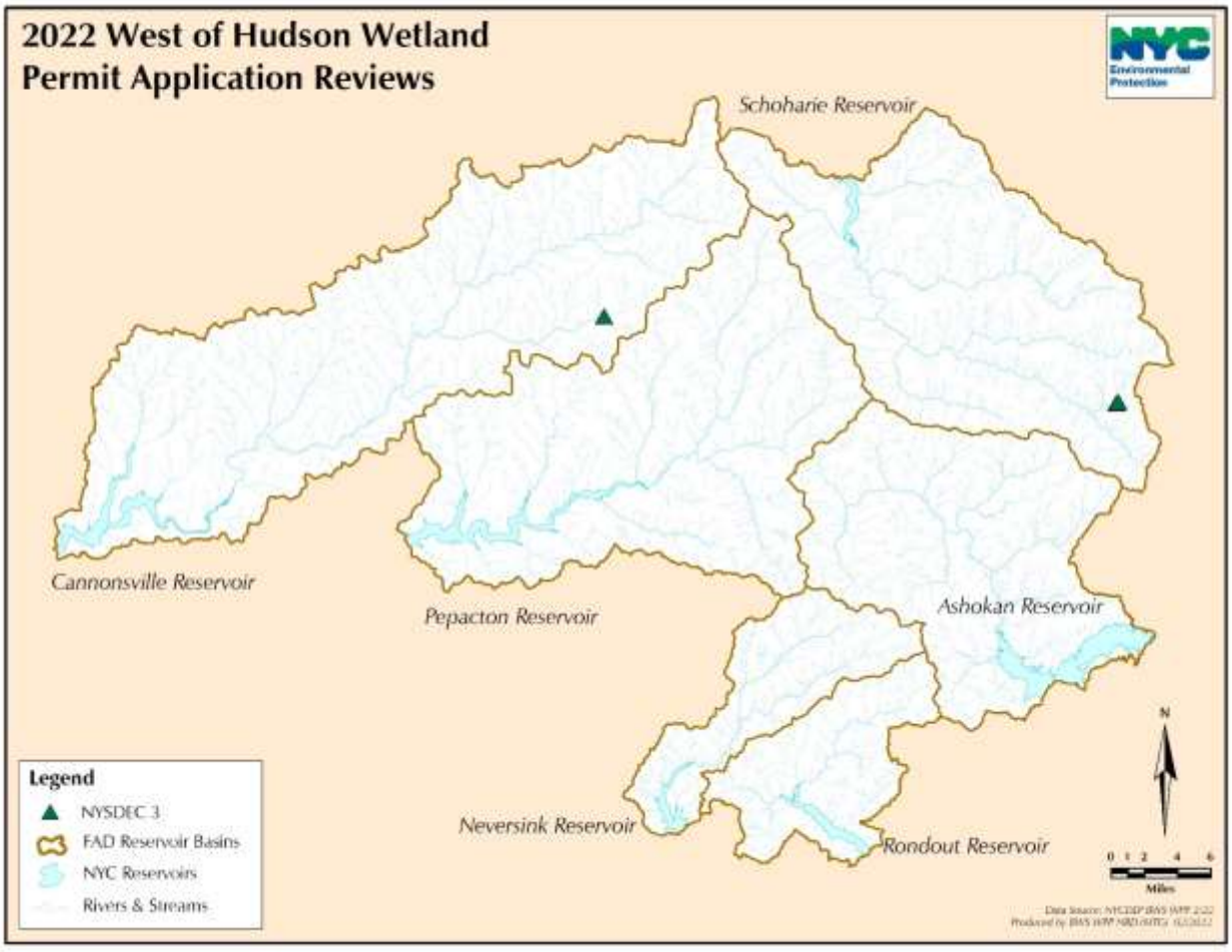

Figure 4.14 Locations of wetland permits reviewed WOH in 2022.

DEP continued to track issues surrounding the scope of regulated waters under Section 404 of the Clean Water Act. In 2022, DEP was a member of one of 10 regional roundtables selected by the U.S. Environmental Protection Agency and U.S. Department of the Army to inform their implementation of the scope of "waters of the United States." DEP provided the agencies with an overview of the New York City watershed and discussed the importance of source water protection, including broad protection of wetlands, in maintaining the City's unfiltered supply. (See EPA's website for additional information about the roundtables).

Land Acquisition

According to the National Wetlands Inventory (NWI) and New York State Department of Environmental Conservation (NYSDEC) freshwater wetland maps, there are approximately 15,190 acres of wetlands in the Catskill/Delaware (CAT/DEL) watershed. Since 1997, DEP has protected 3,052 acres or 20.1% of these wetlands through its Land Acquisition Program (See

Section 4.2 for details of the Land Acquisition Program). In the CAT/DEL watershed, pre-MOA DEP lands contain an additional 968 acres (6.4%) of wetlands, with an additional 1,316 acres (8.6%) of wetlands located on state or other protected lands. This amounts to roughly 35% of wetlands in the CAT/DEL watershed being located on protected lands. Table 4.8 summarizes the acreage of wetlands protected through acquisition for both the CAT/DEL and Croton watersheds.

Table 4.8 Wetlands and deepwater habitats acquired or protected by the NYC Land Acquisition Program (LAP) in the Catskill/Delaware and Croton systems as of December 31, 2022*

Description	*Acres*	*% of Total Watershed Acreage*	*% of Total Land Acquired*	*% of Total Wetlands or Deepwater Habitats in System*
For Catskill/Delaware (Ashokan, Schoharie, Rondout, Neversink, Pepacton, Cannonsville, West Branch, Boyd Corners, Kensico basins):				
Total acreage of entire watershed	1,048,660			
Total acreage of wetlands (both NWI and DEC-regulated) in entire watershed (excluding deepwater habitats**)	15,190	1.45%		
Total acreage of deepwater habitats in entire watershed	28,335	2.70%		
Total Acreage of wetlands and deepwater habitats in entire watershed	43,526	4.15%		
Total lands under contract or closed by NYCDEP as of 12/31/21†*:	152,266	14.52%		
Within those total lands under contract or closed:				
Total acreage of wetlands (both NWI and DEC-regulated, excluding deepwater habitats**)	3,052		2.00%	20.09%
Total acreage of deepwater habitats**	201		0.13%	0.71%
Total acreage of wetlands and deepwater habitats**	3,253		2.14%	7.47%
For Croton:				
Total acreage of entire watershed	212,700			
Total acreage of wetlands (both NWI and DEC-regulated) in entire watershed (excluding deepwater habitats**)	20,025	9.41%		
Total acreage of deepwater habitats in entire watershed	10,808	5.08%		
Total acreage of wetlands and deepwater habitats in entire watershed	30,834	14.50%		
Total lands under contract or closed by NYCDEP as of 12/31/21†*:	1,984	0.93%		
Within those total lands under contract or closed:				
Total acreage of wetlands (both NWI and DEC-regulated, excluding deepwater habitats**)	97.1		4.89%	0.48%
Total acreage of deepwater habitats**	1.6		0.08%	0.02%
Total acreage of wetlands and deepwater habitats**	98.7		4.97%	0.32%

** Source: WLCP GIS, December 31, 2022. Note: Acres are calculated directly from areas of GIS polygons and therefore may not match exactly other acreage totals submitted by DEP. Watershed statistics calculated from LiDAR-derived 1m basin boundaries updated in 2014.*

*** Categories considered "deepwater habitats" include reservoirs or large lakes (L1), unconsolidated bottom (L2UB), riverbeds (RUB & RRB) or streambeds (RSB). Categories considered wetlands include palustrine*

systems and exclude the deepwater habitats classes as well as all upland (U), and unconsolidated shore (L2US).

† Includes fee, conservation easements, and farm easements. Excludes non-LAP and pre-MOA land.

Statistics produced by J. Tuscanes, BWS WPP GIS, 1/18/2023

Wetland Mapping

Work was completed on the contract to expand the 2015 light detection and ranging (LiDAR) wetland mapping pilot study to the entire watershed. The pilot study demonstrated that incorporating LiDAR-derived datasets and high-resolution aerial photography in object-based image assessment (OBIA) increased the completeness and accuracy of wetland mapping. The pilot also developed methods to improve detection and mapping of connections between wetlands and stream features in the National Hydrography Dataset (NHD).

Like the pilot, the acreage of vegetated wetlands mapped by these protocols throughout the watershed was significantly higher than in the most recent (2005) National Wetlands Inventory (NWI). Mapped vegetated wetland acreage nearly doubled as compared to the NWI WOH and increased by approximately 70% EOH. In addition, by amending the local resolution NHD with over 400 miles of new connecting features, the percentage of wetlands estimated to be unconnected to the stream network decreased from 10% to 2% EOH, and from 8% to 3% WOH. This is a significant decrease from the 35% and 54% of wetlands that would be predicted to be unconnected using the medium resolution NHD.

While the wetland mapping datasets produced from this effort are more complete than the 2005 NWI, errors of commission and omission undoubtedly remain, as is the case with any remote sensing product. Since this is a novel approach, further assessment is required to understand the degree of such errors, and how they may affect application of these data. DEP will complete a full accuracy assessment of this geodata to determine whether there are systematic issues in accuracy and classification that require revision and to understand how to best incorporate these data into watershed protection programs.

Wetland Monitoring

DEP gains information on the characteristics and functions of watershed wetlands through its wetland monitoring program. DEP has collected vegetation, soils, and long-term hydrologic data from numerous wetlands and seasonal pools throughout the CAT/DEL watershed for over a decade (Figure 4.15). These data provide benchmarks to guide wetland

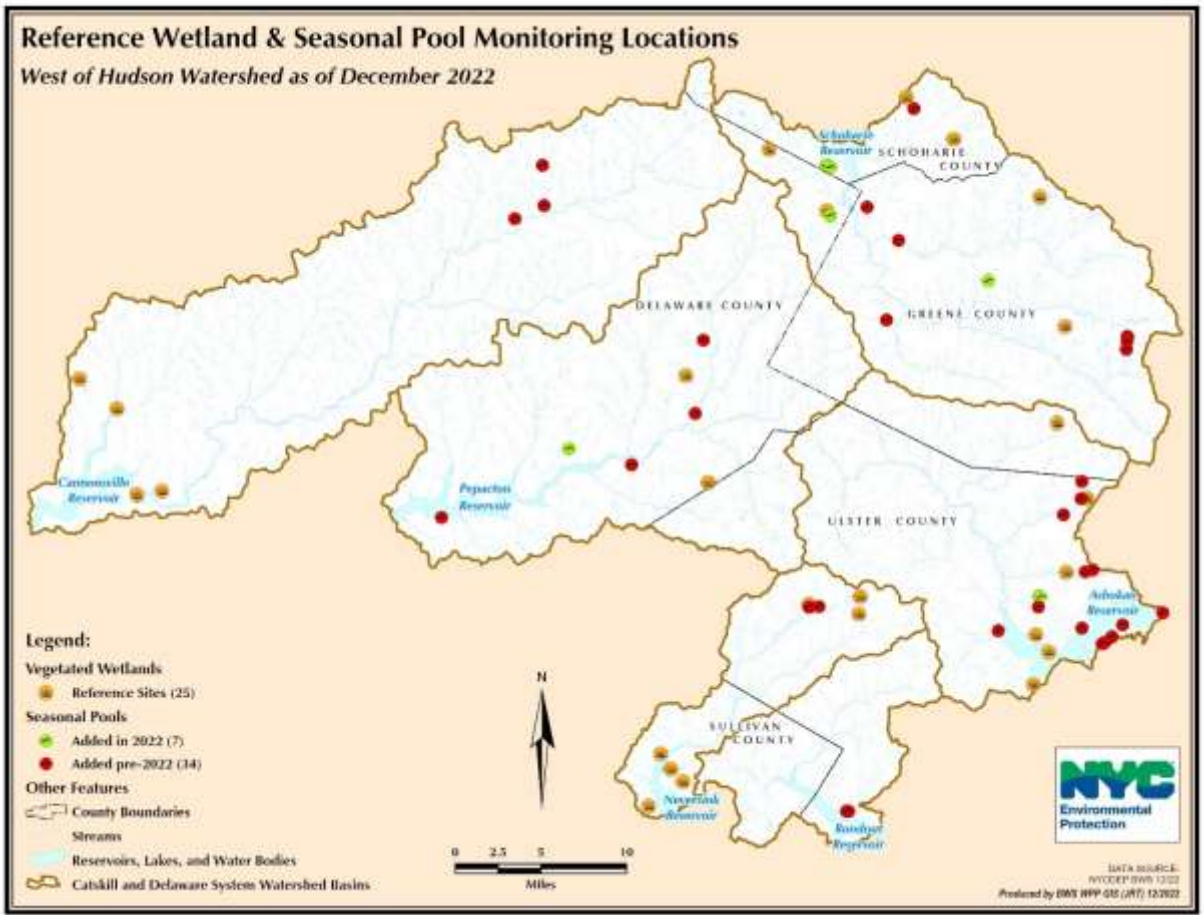

Figure 4.15 Reference wetland and seasonal pool monitoring sites in the CAT/DEL watersheds.

protection and management efforts and identify ecological trends from factors such as surrounding land use, climate change, or invasive species.

In 2022, DEP added seven seasonal pool wetlands to its monitoring program, bringing total pools in the program to 41. In addition, DEP conducted kinematic surveys on two seasonal pool wetlands in the Ashokan Reservoir watershed.

The surveys were done to obtain true bottom elevation and horizontal profiling to provide information on water storage capacity to assess cumulative hydrologic functions of these important, yet largely unmapped and unregulated, systems.

DEP added two vegetated reference wetlands in 2022: one in the Schoharie basin and the other in the Neversink basin. Six-hour interval water-level data were collected from 13 wells located in select reference vegetated wetlands and seasonal pools. Water quality data (pH, dissolved oxygen, temperature, and specific conductivity) were collected from seasonal pool

sites throughout the growing season. Spring adult breeding amphibian and invertebrate surveys, and amphibian egg mass counts were also conducted at seasonal pool sites.

In 2022, DEP continued its partnership with New York Natural Heritage Program (NYNHP) to help develop statewide wetland assessment methodology (https://www.nynhp.org/epa-wetland-condition). To date, DEP has evaluated 11 wetlands using this methodology. Activities in 2022 centered on quality control and submission of data collected to date, and selection of five sites for future survey under a wetlands program grant awarded to NYNHP by EPA for a project entitled "Developing a Wetland Program Plan and strengthening assessment tools for floodplain wetlands in New York State." This partnership supports DEP's goal to develop its wetlands monitoring program by using standardized and streamlined sampling and assessment protocols while contributing to NYNHP's database as that program further develops tools to guide wetland protection and stewardship. Conditional and functional assessment tools can help prioritize wetlands for enhanced protection, identify restoration opportunities and performance targets, and provide benchmarks for evaluating trends.

DEP Forest Management Program

DEP conducts an interdisciplinary review of its proposed forest management projects to ensure long-term responsible stewardship of natural and cultural resources on City lands. As part of this review, DEP wetland scientists delineate on-site wetlands, which are treated as exclusion zones in which no disturbance is permitted under normal circumstances. Moreover, the 100-foot-wide area surrounding wetlands is considered a special management zone, within which tree removal and equipment operation are limited. In 2022, DEP delineated 35 wetlands comprising 11.1 acres at six proposed forest management projects on City lands. These delineations also provide DEP with field-scale data on the characteristics of wetlands on City lands and inform remote wetland mapping efforts.

Education and Outreach

In 2022, DEP staff led an education program for SUNY Ulster field ecology students at a wetland mitigation site near Ashokan Reservoir. DEP also gave presentations on seasonal pool wetland monitoring and LiDAR-based wetlands mapping at the annual NY Water Environment Association's Watershed Science and Technical Conference. Findings of the LiDAR-based wetland mapping project were also presented at the annual meeting of National Association of Wetland Managers in Shepherdstown, WV. A summary of DEP's wetlands program activities in the Catskills to date was presented at the Catskill Environmental Research and Monitoring Conference held at Big Indian, NY.

4.8.2 Forest Management

DEP implements its Watershed Forest Management Plan to maintain a healthy, resilient forest on NYC watershed lands that will continue to protect water quality. Much of this work is achieved through commercial timber harvests that are publicly bid and overseen by project foresters. Considerable planning goes into the selection, development, and review of these forest

management projects (FMPs) which includes drawing on in-house expertise through DEP's Forestry Interdisciplinary Technical Team (FITT).

In 2022, the Forestry Program successfully awarded five new FMPs (Table 4.9). Two EOH FMPs were also advertised in 2022 but received no bids, likely due to market conditions, relatively fewer harvesters operating EOH, and challenges to commercial viability due to intense stressors, such as invasive species, on the EOH watershed forest. The Forestry Program also initiated and advanced the planning of eight additional FPMs that are planned to be bid out in 2023. (Table 4.10)

Table 4.9 FMPs awarded in 2022.

Project Name	FMP #	Basin	Acres
Neversink Flats	5182	Neversink	124
Scutt Mountain North	5203	Cannonsville	149
Shavertown Heights	5200	Pepacton	327
Southslope	5193	Schoharie	270
Morning Willow	5176	Ashokan	300
		Total	**1,170**

Table 4.10 FMPs in planning in 2022 for award in 2023.

Project Name	FMP #	Basin	Acres
Rocky Knob	5054	Pepacton	70
Hollow Brook	5177	Neversink	327
Carpenter's Eddy Phase 1	5202	Cannonsville	154
Wright Brook	5209	Cannonsville	108
Bungalow Brook	5208	Neversink	61
Bradley	5181	Neversink	171
Tonche Gap	5207	Ashokan	122
Quarried Coves	5206	Ashokan	171
		Total	**1,184**

In addition to planning and bidding out new FMPs, forestry program staff oversaw eight FMPs that were active during 2022. These projects involved over 1,000 acres of forest land throughout the WOH watershed. Active FMPs ranged from a 149-acre ridge top site in the Town of Stamford which included thinning, ash salvage and 27 acres of invasive/interfering species treatments, to a 152-acre thinning and firewood sale in the Town of Neversink on the west shore of Neversink Reservoir, and a 168-acre ash salvage and thinning treatment near Cannonsville Reservoir in the Town of Tompkins.

To manage active FMPs, the project foresters are in regular contact with contractors, and make frequent site visits to ensure compliance with best management practices incorporated in the harvest plan. The dry 2022 summer made for ideal harvesting conditions in most parts of the

watershed and projects such as the Neale Hollow FMP near Pepacton Reservoir, where work started in June, were already completed by November.

The Neale Hollow FMP occupies approximately 210 acres of forested Pepacton Reservoir buffer lands in the towns of Colchester and Andes, NY (Figure 4.16). This FMP was proposed to address forest health concerns that create a high risk of transitioning to an undesirable forest state in the future. The on-site inventory identified red oak mortality throughout the project area along with a high risk of white ash mortality due to the emerald ash borer. The primary species found in the understory of the project area, American beech, is ultimately undesirable as it interferes with the regeneration of other species and is also universally affected by beech bark disease in Delaware County. The project employed variable density thinning that included salvage of the white ash and the thinning of other species to create canopy gaps for seedling development and encourage the growth of residual trees. This harvest should both promote a healthy and diverse cohort of regeneration in the areas where heavy salvage or group selection occurred and increase the growth and vigor of the residual trees in the areas where thinning occurred. Employing variable density thinning is a deliberate strategy to create more resilient forest structure that can adapt to a warming climate.

Figure 4.16 Skidder utilizing bridge to cross regulated stream on Neale Hollow FMP.

Forest Inventory and Planning

While the wave of ash mortality influenced FMP selection over the past few years, significant effort was spent in 2022 conducting forest inventory work at multiple scales to help inform future management priorities. DEP foresters developed an intake process to characterize fee lands acquired since completion of the LandVest inventory contract in 2017. This process involves a desktop GIS review of remote imagery to draft stand boundaries, followed by ground truthing to prioritize the stands for further inventory. Stands are assigned to one of three different priority classes: (A) for “mature” forest with canopy closure of >60% and >30% acceptable growing stock; (B) for generally “immature” forest with <60% canopy closure and dominated by pole and small-sawtimber size classes; and (C) for generally non-forest landcovers including shrub wetlands and early successional “old field” sites. Using this process, DEP foresters evaluated and prioritized over 6,000 acres of land acquired since the 2017 inventory.

DEP also continued to make progress in evaluating and reconfiguring its continuous forest inventory (CFI) program. CFI involves long-term monitoring of a network of permanent plots to assess how the watershed forest is changing over time with respect to tree demographics, growth, mortality, forest structure, and composition. Additionally, it aims to assess the functioning of critical forest processes including tree regeneration, carbon sequestration, and response to disturbance (resilience). DEP re-evaluated its CFI program in 2020 and 2021 and identified several inconsistencies. The project was redesigned in 2022 to include stratification of the plots based on forest type and watershed basin to focus sampling effort on portions of the watershed forest with the greatest variability and interest. Additionally, plot figuration was changed from a single circular plot to a constellation of four circular sub-plots to allow for the consideration of a larger area, which will inherently incorporate more forest variability than the previous design and is anticipated to allow for sampling of fewer plots overall. Finally, the sample measurements were revised to tailor the measurements to the objectives. Each of these steps were taken to improve the accuracy and efficiency of the CFI program.

4.8.3 Invasive Species

In 2022, DEP updated and implemented the Invasive Species Management Strategy, originally submitted as a FAD deliverable at the end of 2016. The strategy outlines actions to prevent new introductions of invasive species; to detect new infestations early and respond to them rapidly; to control and manage existing populations to support specific projects; to mitigate the impacts of species that cannot be otherwise managed; and to restore sites to prevent further impacts. This work is predominantly accomplished through intra-agency collaboration and external partnerships.

Intra-Agency Collaboration

The Invasive Species Working Group (ISWG) was formed within DEP in 2008 to develop and implement a science-based, comprehensive plan to identify, prioritize, and address invasive species threats to the water supply. The ISWG met three times in 2022 to discuss ongoing projects and updates, the update to the Invasive Species Management Strategy, and other new initiatives.

Partnerships

New York State Invasive Species Advisory Committee

DEP has a seat on the New York State Invasive Species Advisory Committee (ISAC), created through state legislation in 2007 to provide information, advice, and guidance to the New York State Invasive Species Council (ISC) on invasive species impacts, prevention, regulation, detection, and management. In 2022, ISAC covered such topics as climate change and invasive species, forest health priorities, and the implementation of the New York Invasive Species Comprehensive Management Plan. DEP attended three ISAC meetings in 2022.

Catskill Regional Invasive Species Partnership

DEP continued to work regionally with partners on invasive species management in the Catskill region. In 2022, DEP worked with the Catskill Regional Invasive Species Partnership (CRISP) to create a volunteer program to manage invasive species along the Ashokan Rail Trail. DEP participated in CRISP quarterly meetings and served as chair on the steering committee. New York State Invasive Species Advisory Committee

Lower Hudson Partnership for Regional Invasive Species Management (PRISM)

DEP continued to partner with the Lower Hudson PRISM and NYSDEC to survey for giant hogweed (*Heracleum mantegazzianum)* within the watershed. Due to the risk of serious injury and blindness, the state has been working to eradicate giant hogweed since 2008. No plants were found for the fifth consecutive year on City lands in the Croton Falls Reservoir basin in the Town of Carmel. These sites will continue to be monitored periodically moving forward but are now considered eradicated. DEP and the Lower Hudson PRISM continued to partner on the removal of silver vine (*Actinidia polygama*), an early detection species for New York State, that crosses City and private lands in the New Croton Reservoir basin. DEP also serves on the steering committee for the PRISM.

Early Detection and Rapid Response

In addition to partnering with the Lower Hudson PRISM on the giant hogweed and silver vine responses, DEP initiated several other rapid response efforts to attempt to eradicate early detection species.

In 2022, DEP continued the full-scale treatment of the *Hydrilla* (*Hydrilla verticillata*) infestation in New Croton Reservoir. Contractors with SOLitude Lake Management treated 250 acres of nearshore area with a granular fluridone herbicide (Sonar H4C and Sonar One). The results from the second year of treatment dramatically reduced the population with only six detections of plants in post-treatment surveys. DEP also continued to collaborate with NYSDEC on the final year of *Hydrilla* management efforts in the Croton River downstream of the New Croton Reservoir dam.

For the fifth consecutive year, DEP controlled a small infestation of water chestnut (*Trapa natans*) in New Croton Reservoir just below the Muscoot Dam. Ulster County Community College interns, with support from DEP staff, hand-pulled the infestation for one afternoon. This infestation was smaller than 2021 but some areas were inaccessible due to depth. Future efforts may involve a return visit to ensure no plants are missed. An additional population was found downstream in New Croton Reservoir that was not removed and will need to be addressed in 2023.

The spotted lanternfly (*Lycorma delicatula*) was found more broadly in the watershed in 2022 than in 2021. This invasive plant pest poses a threat to many hardwood species. DEP worked with NYS Department of Agriculture and Markets to deploy and monitor traps in areas where individuals have been detected. DEP also participated for the third year in a spotted lanternfly multi-agency coordination task force and treatment work group to explore different treatment options for the state. DEP staff caught over 1,000 nymphs and adult spotted lanternflies in traps at Hillview Reservoir, breeding populations were confirmed at Kensico Reservoir, and Neversink and Ashokan reservoirs continued to only have individual sightings (Figure 4.17).

Figure 4.17 Spotted lanternfly in trap at Hillview Reservoir.

Control and Management

DEP continued to manage priority invasive species on City lands through manual and mechanical removal, herbicide applications, and biological control in 2022. DEP has contracted with Cornell University to assess and improve the viability of biological control agents for hemlock woolly adelgid control. Cornell released silver flies (*Leucopis* spp.) and *Laricobius nigrinus* in East of Hudson locations, and in the Neversink basin. Releases and recapture surveys will continue in 2023.

Migration of Impacts

DEP continued to participate in a Monitoring and Managing Ash (MaMA) project to identify lingering ash trees in 2022. DEP staff and Ulster County Community College interns monitored four ash mortality plots throughout the WOH watershed. More information about the MaMA project is available at https://www.monitoringash.org/.

Zebra mussels are another species that can have a significant negative impact on the water supply. DEP first received reports of mussels present in Lake Mahopac, an upstream lake that feeds the Muscoot River and Amawalk Reservoir, in 2015. Veligers were found in the Muscoot River and Amawalk Reservoir in 2018. In 2021, DEP detected adult mussels attached to sampling equipment and rocks within Amawalk Reservoir (Figure 4.18). In 2022, DEP found adult zebra mussels attached to rocks along the shoreline throughout New Croton Reservoir. DEP is collaborating across directorates to track this infestation through continued monitoring efforts and development of plans to mitigate negative impacts to water quality and water supply infrastructure. Infestation risk of the FAD reservoirs by zebra mussels is considered low at this

time. Water chemistry in these reservoirs, especially calcium and alkalinity, is limiting for veliger and adult survival.

Figure 4.18 Adult zebra mussels at Amawalk Reservoir.

In 2022 the invasive species program received grant funding from the Forest Ecosystem Monitoring Cooperative to collaborate with Harvard Forest on developing a tool that remotely monitors forest canopy cover and health in the WOH and EOH watersheds. DEP will use this web-based tool to view a map that highlights areas in which the forest canopy is "less green" than normal. This will serve as an early detection tool for invasive forest pests in the watershed. DEP will also be able to look back in time to see locations and magnitudes of forest canopy condition change over several years. Several other factors can cause declines in forest canopy health (disease, temperature, and moisture stress) and cover (clearing, blowdowns). Many of these disturbances are expected to become more severe and common under climate change. This tool will enable DEP to target field visits to investigate the causes of forest canopy condition and investigate the relationship between forest condition and select water quality parameters.

Restoration

The Restoration Ecology Program developed a restoration plan for the removal of the Chia Lin Dam in East Fishkill in 2021 to restore native vegetation to the former lake impoundment. In 2022, a contracted licensed pesticide applicator treated the *Phragmites australis* present on the site to provide the best conditions for success of the restoration planting site while post-breach hydrologic conditions normalize at the site. Establishing a native plant community will stabilize the basin, reduce the spread of invasive plant species, and restore the ecosystem services of a forest system.

4.9 East of Hudson Non-Point Source Pollution Control Program

The EOH Nonpoint Source Pollution Control Program seeks to address nonpoint pollutant sources in the four EOH FAD basins: West Branch, Croton Falls, Cross River, and Boyd Corners. The program supplements DEP's existing regulatory efforts and nonpoint source management initiatives.

4.9.1 Wastewater Programs

Septic Programs East of Hudson

DEP supports Westchester and Putnam counties in their efforts to reduce the potential impacts of improperly functioning or maintained septic systems. Westchester County, Putnam County, and their respective municipalities continue to implement the septic requirements of the NYSDEC MS4 General Permit, which obligates municipalities and counties to implement programs for the inspection, maintenance, and rehabilitation of septic systems.

DEP continues to partner with the New York State Environmental Facilities Corporation (EFC) to implement the Septic System Rehabilitation Reimbursement Program in priority areas of the EOH Catskill/Delaware watershed and basins hydrologically connected to the Croton Falls Reservoir (i.e., Bog Brook, Diverting, East Branch, and Middle Branch). DEP continues to conduct annual direct mailings to eligible residents to promote the program's funding availability and disseminate EFC's contact information. In 2022, the program issued reimbursements for 11 septic repairs; 10 were completed in the West Branch and Boyd Corners reservoir basins with the remaining one in the Croton Falls basin.

EOH Community Wastewater Planning Grant Program

The 2017 FAD required DEP to develop and administer a grant program to provide funding to municipalities for preliminary planning of community wastewater solutions for areas in the EOH FAD basins where septic systems may impact water quality. DEP contracted with NEIWPCC to administer the program and fund engineering studies and reports to assist identified municipalities in evaluating wastewater treatment options.

The 2017 FAD identified eight areas to be studied: Lake Waccabuc, Lake Truesdale, and Lake Kitchawan in the Cross River Reservoir basin; and Palmer Lake, Lake Gilead, Lake Casse, Lake View Road, and Mud Pond Brook in the Croton Falls Reservoir basin. Participating communities included the towns of Carmel, Kent, Lewisboro, and Pound Ridge. All eight reports were completed in 2021, thus providing a roadmap for municipalities to seek financing through state or federal funding sources. DEP completed a summary report in June 2022.

Video Sanitary Sewer Inspections

DEP implements an inspection program for targeted portions of the sanitary sewer system located within the West Branch and Croton Falls reservoir basins. In the first half of 2022, the contractor completed a comprehensive summary report of selected areas and identified possible areas of concern during prior video inspection of sanitary infrastructure. DEP notified the Town of Carmel of the inspection results in June 2022.

4.9.2 Stormwater Retrofit and Remediation

DEP completed the two nonpoint source pollution reduction projects at Maple Avenue (Town of Bedford, Westchester County) and Drewville Road (Town of Carmel, Putnam County) in 2020.

4.9.3 Stormwater Facility Inspection and Maintenance

The Facility Inspection and Maintenance Program ensures that previously constructed stormwater remediation facilities continue to function as designed through routine inspections. Maintenance is completed under the warranty in each facility's construction contract during the first year and thereafter under DEP's maintenance program contract. Inspection and maintenance follow procedures contained in the maintenance contract. During 2022, DEP inspected all facilities, with 82 facilities requiring vegetation removal, 69 requiring sediment and debris removal, nine requiring seed and mulch, 12 requiring tree removal, and 16 requiring stone riprap repairs. All stormwater facilities are functioning as designed.

4.9.4 Stormwater Retrofit Grant Program

DEP funds a grant program through the EOH Watershed Corporation (EOHWC) for eligible municipalities to construct the stormwater retrofits needed to satisfy municipal permit obligations under Section IX.A.5.b of the NYSDEC MS4 General Permit. The MS4 Permit mandates that EOH watershed municipalities achieve nonpoint source phosphorous reductions through the construction of stormwater retrofits. As required by the 2017 FAD, DEP contracted with the EOHWC to provide an additional $22 million to support the design and construction of stormwater retrofits in the EOH FAD basins and those basins upstream of the Croton Falls Reservoir. Through 2022, EOHWC expended or committed approximately $4.9 million of the initial payment for retrofit projects in the West Branch, Boyd Corners, Cross River, Croton Falls, and upstream hydrologically connected basins. Since inception, EOHWC's retrofit program has removed an estimated 673 kg P/yr. from these basins.

4.10 Kensico Water Quality Control Program

Kensico Reservoir in Westchester County is a terminal reservoir that provides the last impoundment of Catskill/Delaware water prior to entering the City's distribution system. As such, DEP prioritizes water quality protection efforts in the Kensico basin.

4.10.1 Septic Reimbursement Program

DEP implements the Kensico Septic System Rehabilitation Reimbursement Program through a contract with EFC. Through EFC, DEP reimburses homeowners a portion of the costs to rehabilitate eligible failing septic systems or connect those systems to an existing sewage collection system. The program is voluntary, with the goal of encouraging property owners to inspect their septic systems and, if failing, rehabilitate them. During 2022, EFC mailed the annual program reminder letter to all eligible residents and issued six septic reimbursements to homeowners.

4.10.2 West Lake Sewer

The West Lake sewer trunk line, owned and maintained by Westchester County, conveys untreated wastewater to treatment facilities located elsewhere in the county. DEP previously funded the installation of a sanitary sewer remote monitoring system for the trunk line to provide

real-time detection of problems such as leaks, system breaks, overflows, and blockages. To date, there have been no overflows or concerns and the units appear to be working well. In 2022, DEP conducted an annual visual inspection of the trunk line to assess the condition of exposed infrastructure. DEP also conducted routine partial inspections throughout the year related to ongoing maintenance of Kensico stormwater BMPs near the line. DEP noted no defects or abnormalities.

4.10.3 Video Sanitary Sewer Inspection

DEP implements an inspection program for targeted portions of the sanitary sewer system located within the Kensico basin. In the first half of 2022, DEP's contractor completed a comprehensive summary report of selected areas and identified possible areas of concern during prior video inspection of sanitary infrastructure. DEP notified the Town of Mount Pleasant of the inspection results in June 2022.

4.10.4 Stormwater BMPs

DEP has constructed stormwater management and erosion abatement facilities throughout the Kensico basin to reduce pollutant loads to the reservoir. DEP and its contractor inspected and maintained these facilities throughout 2022, according to the O&M guidelines (Figure 4.19). Maintenance consisted of grass mowing, seeding, and mulching, vegetation removal, fallen tree removal, fence repair, swale repair, and sediment and debris removal. All BMPs are performing as designed.

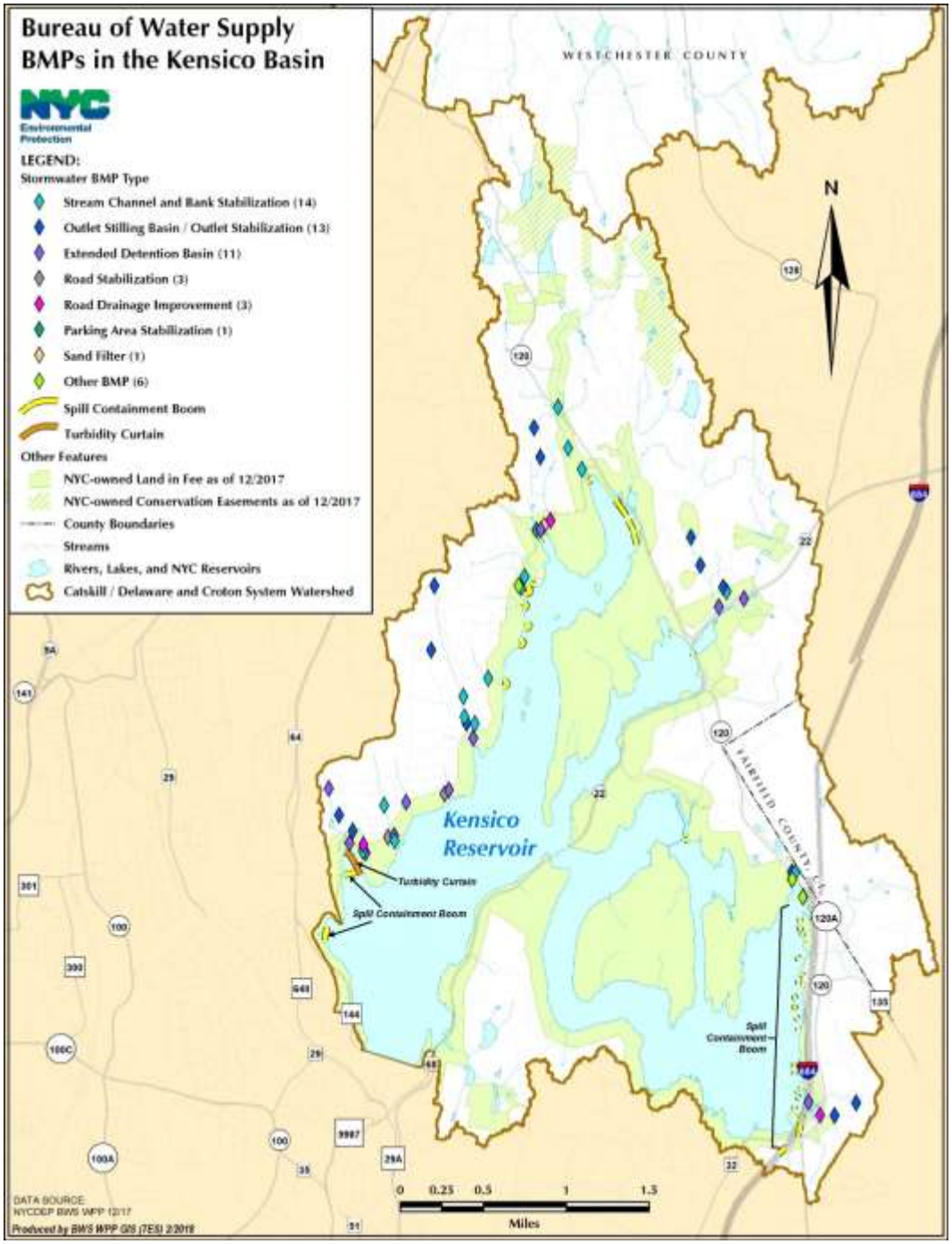

Figure 4.19 BMPs within the Kensico Reservoir basin.

4.10.5 Wildlife Sanitary Surveys

DEP conducts sanitary surveys at Kensico Reservoir approximately 24 to 48 hours prior to significant precipitation events as a proactive measure to identify and remove wildlife

excrement before it washes into the water supply and potentially elevates fecal coliform levels. During 2022, DEP and its contractor conducted 26 wildlife sanitary surveys at Kensico Reservoir (Table 4.11). Of the 1,682 fecal samples collected, 80.1% were attributed to white-tailed deer, 4.4% to rabbits, 0.5% to bobcat, 0.4% to raccoons and coyote, and approximately 1.4% to other mammals. Avian species excrement included 6.1% from Canada geese and 6.7% from passerine bird species.

Table 4.11 Kensico Reservoir 2022 wildlife sanitary surveys.

Date of Survey	White-tail Deer	Raccoon	Rabbit	Canada Goose	Coyote	Bobcat	Passerine (birds)	Other/ Unknown Mammal	Total (all species)
1/16/2022	101	0	0	0	0	0	0	0	**101**
1/28/2022	148	0	0	0	1	0	0	2	**151**
2/2/2022	6	0	1	0	0	0	0	0	**7**
2/16/2022	68	0	2	0	0	0	0	1	**71**
2/21/2022	29	0	0	0	0	0	0	0	**29**
3/6/2022	78	0	1	3	1	0	0	0	**83**
3/11/2022	29	0	0	0	0	0	0	1	**30**
3/23/2022	18	0	1	0	0	0	0	1	**20**
4/5/2022	7	0	4	9	0	0	19	0	**39**
6/7/2022	0	0	0	91	0	0	7	0	**98**
7/20/2022	19	0	0	0	0	0	0	0	**19**
8/5/2022	38	1	1	0	1	0	13	0	**54**
8/21/2022	81	0	2	0	0	0	0	0	**83**
8/30/2022	8	0	0	0	0	3	0	0	**11**
9/5/2022	26	0	3	0	0	1	0	0	**30**
9/11/2022	10	1	10	0	0	0	0	1	**22**
9/21/2022	11	0	0	0	0	0	20	0	**31**
9/30/2022	68	2	10	0	0	0	3	0	**83**
10/12/2022	57	0	3	0	0	0	38	0	**98**
10/16/2022	0	1	0	0	0	0	0	0	**1**
10/23/2022	263	0	0	0	0	1	0	8	**272**
11/10/2022	35	0	2	0	0	0	0	5	**42**
11/27/2022	87	1	0	0	0	1	0	3	**92**

Date of Survey	White-tail Deer	Raccoon	Rabbit	Canada Goose	Coyote	Bobcat	Passerine (birds)	Other/ Unknown Mammal	Total (all species)
11/29/2022	62	0	23	0	2	0	10	2	**99**
12/15/2022	57	0	6	0	1	0	0	0	**64**
12/22/2022	42	0	5	0	1	2	2	0	**52**
Total by species	**1,348**	**6**	**74**	**103**	**7**	**8**	**112**	**24**	**1,682**

4.10.6 Spill Containment Facilities

DEP maintains spill containment facilities in and around Kensico Reservoir to improve spill response and recovery. In 2022, DEP conducted routine maintenance at the spill boom sites to ensure they are available in the event of a spill. Four minor events occurred in the Kensico basin, including one event on June 1, 2022, when 15 gallons of jet fuel was accidentally released at the Westchester County Airport and one event on November 15, 2022, when two quarts of motor oil was accidentally released at DEP's former Lime Plant at Nanny Hagen Road. No spills impacted the reservoir or required the deployment of the spill containment booms.

4.10.7 Shaft 18 Shoreline Stabilization

Since the Catskill/Delaware Ultraviolet Light Disinfection Facility (CDUV) began operating, all Kensico water flows through the Delaware Effluent Chamber at Shaft 18 on the reservoir's southwest shore. Increased reliance on Shaft 18, together with changing weather patterns, necessitate shoreline stabilization measures near the effluent chamber to maintain turbidity levels in compliance with state and federal water quality standards. Stabilization measures include approximately 700 feet at the western shoreline and approximately 475 feet at the cove area. Work included construction of sediment control measures, installation of a sheet-pile cofferdam, installation of rip-rap shoreline protection, and site restoration. DEP completed all work at the cove in 2020 and all work at the western shoreline in 2022 (Figure 4.20).

Figure 4.20 Aerial photograph showing the stabilization sites at the cove (background) and western shoreline (foreground).

4.10.8 Other Activities

Turbidity Curtain

In 2022, DEP continued to monitor and inspect the extended primary curtain and the backup turbidity curtain that are designed to direct flows from Malcolm Brook and Young Brook farther out to the main body of Kensico Reservoir. Based on the most recent inspection, no repair work was required. The curtains appear to be functioning as intended.

Westchester County Airport

DEP continues to review activities proposed at or in relation to the Westchester County Airport due to its proximity to Kensico Reservoir.

In 2022, Westchester County relaunched a public engagement program on the Airport Master Plan and held two public meetings in September. The supplement to the Airport Master Plan is moving forward, though there is currently no deadline for completion.

The Rye Lake Filtration Plant is proposed by Westchester Joint Water Works (WJWW) on airport property in the Town of Harrison. The Stormwater Pollution Prevention Plan (SWPPP) application was submitted to DEP in July 2022 and determined to be incomplete. DEP awaits resubmission of revised SWPPP documents and an application for sewer extension approval from WJWW.

Westchester County is proposing to install a new 12-inch water main in the vicinity of the airport on New King Street. The action will require NYSDEC Article 24 and Article 15 permits and additional minimal disturbances to a NYSDEC Class A tributary of Kensico Reservoir. DEP reviewed the permit applications and offered comments and recommendations to NYSDEC in October 2022.

Park Place at Westchester is a private 980-space parking garage proposed in the Town of North Castle. DEP commented on the project through the SEQRA process and continues to await resubmission of final plans prior to issuing SWPPP approval under the New York City Watershed Rules and Regulations (WR&R).

In accordance with a 2019 NYSDEC consent order, Westchester County prepared a site characterization work plan to assess PFOS, PFOA, and other groundwater contaminants on and near the airport, which was accepted into the state's Brownfield Program. NYSDEC released a draft remedial investigation work plan (RIWP) in October 2022 on which DEP reviewed and commented. The RIWP is currently under review by NYSDEC.

Since identifying an uncapped landfill at the airport in 2015, Westchester County has performed sampling and laboratory analysis of groundwater, surface water, landfill soils, and accumulated iron flocculent. Results of soil samples collected from eight test pits indicate exceedances for certain metals and mercury. The landfill/soil mound is expected to be addressed through Westchester County's participation in NYSDEC's Brownfield Cleanup Program. The landfill is still under investigation and has been incorporated into the RIWP mentioned above. At this time, NYSDEC cannot make any determination on the nature or extent of remedial measures planned for the landfill.

4.11 Catskill Turbidity Control

Due to the nature of the underlying geology, the Catskill watershed is prone to elevated levels of turbidity in streams and reservoirs. High turbidity levels are associated with high flow events, which can destabilize stream banks, mobilize streambeds, and suspend the glacial clays beneath the streambed armor. The design of the Catskill System considers local geology and provides for settling within Schoharie Reservoir, Ashokan West Basin, Ashokan East Basin, and the upper reaches of Kensico Reservoir. Under normal circumstances, the extended detention

time in these reservoirs is sufficient to allow the turbidity-causing clay solids to settle out and the system easily meets the SWTR turbidity standards (5 NTU) at the Kensico effluent. Occasionally after extreme rain/runoff events in the Catskill watershed, DEP has used aluminum sulfate (alum) as chemical treatment to control high turbidity levels.

Since 2002, DEP has undertaken several studies and implemented significant changes to its operations to better control turbidity in the Catskill System. DEP has implemented many of these measures pursuant to the 2002 and 2007 FADs and the Shandaken Tunnel and Catalum State Pollutant Discharge Elimination System (SPDES) permits. A comprehensive analysis, the Catskill Turbidity Control Study, was conducted by DEP with the Gannett-Fleming-Hazen and Sawyer JV in three phases between 2002 and 2009. DEP implemented several alternatives based on the results of this study: a system-wide Operations Support Tool (OST) that allows DEP to optimize reservoir releases and diversions to balance water supply, water quality, and environmental objectives; an interconnection of the Catskill Aqueduct at the Delaware Aqueduct Shaft 4 to improve overall system dependability; and structural improvements to the Catskill Aqueduct stop-shutter facilities. The Catskill-Delaware Interconnection and the Catskill Aqueduct stop-shutter facilities projects achieved functional completion in 2016.

Catalum Consent Order and Environmental Review

Rain events in October and December 2010 caused elevated turbidity levels in the Ashokan Reservoir. In addition to alum at Kensico, DEP also utilized the Ashokan Release Channel as part of a strategy previously approved by NYSDOH and EPA to ensure all drinking water standards were met. Using the channel raised concerns from communities along the Esopus Creek downstream of the reservoir.

In February 2011, NYSDEC commenced an administrative enforcement action against the City for alleged violations of the Catskill Aqueduct Intake Chamber Catalum SPDES Permit (NY0264652) regarding operation of the Ashokan Release Channel and alum addition. NYSDEC and DEP negotiated a consent order to resolve the alleged violations, which took effect in October 2013. The consent order included penalties, environmental benefit projects, a schedule of compliance, and an Interim Release Protocol for the channel's operation.

Consistent with the consent order, DEP requested a modification to the Catalum SPDES Permit in 2012 to incorporate turbidity control measures in water diverted from Ashokan Reservoir and to postpone dredging of alum floc at Kensico Reservoir until completion of certain infrastructure projects. The proposed modification is subject to environmental review under the State Environmental Quality Review Act (SEQRA), for which NYSDEC is lead agency. Below is a timeline for the Catalum environmental impact statement (EIS) development:

NYSDEC released a draft scope for the Catalum EIS for public comment from April 9, 2014, to August 29, 2014. More than 550 commenters submitted more than 900 comments.

- The final scope was issued on March 22, 2017, and it took into consideration feedback from the public review process and includes responses to the comments received.
- A draft DEIS was submitted to NYSDEC on May 30, 2019.
- NYSDEC released the DEIS for public comment on December 16, 2020.
- DEIS public hearings were held on February 4, 2021, and March 3, 2021.
- The public comment period for the DEIS closed on June 16, 2021. Over 1,200 comments were received.
- On January 10, 2022, NYSDEC issued a "Scope for the Supplemental Environmental Impact Statement for the Catalum SPDES Permit Modification." This requires DEP, as the project sponsor, to prepare a Supplemental Draft Environmental Impact Statement (SDEIS) that is limited to analyzing the specific adverse environmental impacts that were not addressed or inadequately addressed in the DEIS. DEC's decision to require an SDEIS stemmed from a storm event in December 2020 that resulted in long-term turbid releases from Ashokan Reservoir while operating in accordance with the Interim Release Protocol that lasted until May 2021. DEC determined that the December 2020 storm and the resulting long-term turbid releases constituted newly discovered information that was not covered in the December 16, 2020, DEIS. (https://www.dec.ny.gov/docs/permits_ej_operations_pdf/catalumsuppeisscope.pdf)
- On February 9, 2022, NYSDEC issued a "Combined Notice of Intent to Prepare a Supplemental Draft Environmental Impact Statement (SDEIS) and Notice of Acceptance of Scope". The combined notice was published in the Environmental Notice Bulletin and reflected the January 10, 2022, scope document. (ENB Region 3 Notices 2/9/2022 - NYS Dept. of Environmental Conservation)
- During the reporting period, DEP and NYSDEC continued reviewing comments submitted in response to the DEIS. In addition, DEP and NYSDEC met to discuss the scope of the SDEIS.
- On October 5, 2022, DEC announced a draft modification to the Interim Release Protocol for review and comment by the Ashokan Release Working Group. The draft modification was still in the stakeholder comment phase as of December 31, 2022.

5. Watershed Monitoring, Modeling, and GIS

5.1 Watershed Monitoring Program

5.1.1 Routine Water Quality Monitoring

To ensure the delivery of high-quality drinking water, DEP conducts extensive water quality monitoring encompassing all areas of the watershed, including sites at aqueducts and water supply intakes (keypoints); streams; reservoirs; and water resource recovery facilities (WRRFs). DEP's monitoring objectives are documented in the Watershed Water Quality Monitoring Plan (WWQMP) (DEP 2018) and its associated addenda, which are designed to meet the broad range of DEP's regulatory and operational requirements. The overall goal is to maintain an objective-based water quality monitoring network providing scientifically defensible information to protect and manage the New York City water supply.

The plan's objectives have been defined by DEP management and program administrators, regulators, and other external agencies. The plan prescribes monitoring to achieve compliance with all federal, state, and local regulations; meet the terms of the Revised 2017 FAD (NYSDOH 2022); support water supply operation and modeling efforts; and ensure delivery of the best water quality to consumers through ongoing surveillance. Many specific objectives fall within each of these major areas.

Compliance: The compliance objectives are focused on meeting the regulatory monitoring requirements for the New York City watershed. This includes the Surface Water Treatment Rule (SWTR) (USEPA 1989) and its subsequent enhancements, the New York City Watershed Rules and Regulations (WR&R) (DEP 2019), administrative orders, and State Pollutant Discharge Elimination System (SPDES) permits. The sampling sites, analytes, and frequencies are defined in each objective according to each permit, rule, or regulation.

FAD program evaluation: The USEPA specified many requirements in the 2007 FAD (USEPA 2007) meant to protect public health and NYSDOH continued to specify requirements in the Revised 2017 FAD. These requirements form the basis for the City's ongoing assessment of watershed conditions, changes in water quality, and any modifications to the strategies, management, and policies of the Long-Term Watershed Protection Plan (DEP 2021). The City also conducts a periodic assessment of the program's effectiveness using DEP's water quality monitoring data. Program effects on water quality are reported in the Watershed Protection Program Summary and Assessment reports (e.g., DEP 2021), which are produced every five years.

Modeling support: Modeling data are used to meet the long-term goals for water supply policy and protection and to provide guidance for short-term operational strategies including reservoir balancing, establishing release rates, and managing unusual water quality events. These objectives are achieved through implementation of watershed and reservoir model improvements

based on ongoing data analyses and research results; ongoing testing of those models; updating of data necessary for the models' development; and development of data analysis tools to support modeling projects.

Stream, reservoir, aqueduct, and meteorological data are all needed to develop, calibrate, and validate models. Data acquired through stream monitoring include both flow and water quality data. Aqueduct monitoring provides flow and reservoir operations data to support reservoir water balance calculations. The water balance and reservoir water quality data are needed to test, apply, and further develop DEP's one- and two-dimensional models. The meteorological data collection provides critical input necessary to meet both watershed and reservoir modeling goals. The modeling program's 2022 activities are summarized in the Watershed Water Quality Annual Report.

Surveillance monitoring: The surveillance monitoring chapter of the WWQMP contains several objectives that focus on aqueduct monitoring to guide the short-term operation of the water supply system. Other objectives relate to maintaining a baseline understanding of potential and emerging contaminants (e.g., trace metals, organic compounds), water quality status, and long-term trends for reservoirs and streams in the Croton System.

5.1.2 Additional Water Quality Monitoring

In addition to routine monitoring, events or incidents may occur that necessitate additional water quality monitoring. Almost 720 additional watershed samples were collected for special investigations during 2022, including 70 stream samples, 310 reservoir samples, and 15 pathogen samples. In addition to the routine manual profiles conducted on routine scheduled field events, there were over 3,200 manual profile analyses conducted by staff on special limnology surveys.

These special investigations include monitoring related to the activation of the Croton Filtration Plant; taste and odor monitoring; implementation of an invasive species (*Hydrilla*) control project; Kensico shoreline stabilization; copper sulfate treatment within the Croton System and other smaller, less intensive monitoring events. The major 2022 special investigations are outlined below.

Special Investigation: Croton Taste and Odor Monitoring

In 2022, monitoring expanded to locations upstream of New Croton Reservoir to investigate the spatial distribution of taste and odor compounds in the Croton System. Locations included the releases of Croton Falls, Cross River, Diverting, Middle Branch, Titicus, Amawalk, and Boyd reservoirs. Monitoring for taste and odor compounds continued at New Croton Reservoir on a weekly basis throughout the year to further capture seasonal and long-term trends.

Special Investigation: Invasive Species Control

DEP conducted a special investigation for a third year to evaluate the fate and transport of an applied chemical herbicide in New Croton Reservoir for the treatment of the aquatic

invasive plant *Hydrilla*. A contractor applied fluridone (trade names Sonar H4C and Sonar One) in two forms (i.e., pellet and liquid) at a select treatment area in the reservoir from May through August 2022. Samples were collected in New Croton Reservoir and at keypoint sites to quantify the presence and extent of fluridone transport in the reservoir before, during, and after application. DEP collected grab samples at all sites weekly and shipped them to a contract laboratory for fluridone analysis. Monitoring continued into November.

Special Investigation: Kensico Shoreline Stabilization

In 2012, the impacts from Hurricane Sandy underscored the need to stabilize and strengthen portions of the shoreline at Kensico Reservoir near Delaware Shaft 18. Construction on this project began in 2019 and concluded in October 2022. To ensure that this construction did not negatively impact water quality at Shaft 18, the site was enclosed in three turbidity curtains with contractor-maintained turbidity sensors between the curtains. Additionally, a robust buoy monitoring system was maintained at the site by BWS personnel. The BWS buoys surrounded the outer edge of the project area to provide near real-time turbidity data to operations and management personnel. A fixed-depth robotic monitoring buoy deployed outside of the work area provided background data for ambient conditions in the reservoir, allowing for comparison of data between the sites. Weekly grab samples were collected to monitor sensor data quality.

Special Investigation: Copper Sulfate Treatment in the Croton System

DEP piloted treatment with copper sulfate to control algal growth at New Croton and Muscoot reservoirs on three separate occasions. The first treatment on June 22, 2022, targeted two areas near the intakes of New Croton Reservoir to study the algal response. A second treatment followed on June 27, 2022, at a section of Muscoot Reservoir near the Muscoot weir. The third treatment on September 22, 2022, treated the upper end of the New Croton Reservoir from the Muscoot weir down to the Croton Lake Gate House. All pilot treatments studied algal response parameters as well as taste and odor compounds.

Special Investigation: Hunter Highlands WWTP

In January 2022, a special request by West of Hudson Wastewater Treatment Program staff was made to evaluate plant function for the Hunter Highlands WWTP in consideration of a proposed increase in plant flow. The plant was sampled monthly for *Giardia* and *Cryptosporidium* from January through June, except in May when a sample could not be collected on two separate site visits due to no flow. None of the five samples were positive for *Cryptosporidium* oocysts, whereas 14 *Giardia* cysts were detected in January, and one cyst detected in each of the April and June samples.

Robotic Monitoring

DEP operates an extensive Robotic Water Quality Monitoring Network (RoboMon) as part of its routine monitoring program. The network provides high-frequency data which are

used for water supply management during routine operations as well as water quality events (e.g., storms). The network is critical for providing an early warning of water quality conditions to inform DEP management in making effective operational decisions and supporting operational models. The network includes fixed-depth buoys (including two under-ice buoys), profiling buoys, and several stream installations. The RoboMon network made over 2.7 million measurements in the watershed in 2022.

5.1.3 Wastewater Treatment Plant Protozoan Monitoring

After 20 years of quarterly monitoring, DEP has confirmed the effectiveness of DEP's Wastewater Treatment Plant (WWTP) Upgrade Program. As a result, protozoan monitoring at WWTPs in the Filtration Avoidance watersheds was suspended in 2022 with the approval of NYSDOH. DEP will conduct special investigation monitoring as needed.

5.1.4 Water Quality Reports

DEP produces a Watershed Water Quality Annual Report (WWQAR). This is submitted annually each July to NYSDOH and USEPA (e.g., DEP 2022). This document covers water quantity (e.g., the effects of droughts or excessive precipitation during the reporting period); water quality of streams and reservoirs; Kensico Reservoir water quality; pathogen monitoring and research; and a summary of the year's major water quality modeling activities. DEP's watershed monitoring effort excluding all automated (robotic) monitoring consists of 470 routinely sampled sites, resulting in 11,600 samples and approximately 200,600 analyses annually. Limnological profiles conducted during the sampling surveys added over 22,990 additional analyses.

5.2 Multi-Tiered Water Quality Modeling Program

5.2.1 Overview

Modeling and analysis continued to advance operational support and modeling capabilities in 2022. DEP's Water Quality Modeling Program further developed automated calculations of climate change indicators and presented this work at the Catskill Environmental Research and Monitoring (CERM) meeting in autumn 2022. Moreover, Water Quality Modeling published a manuscript on its technique to generate extreme weather events due to climate change that are not captured in standard, global circulation models. DEP's water quality modelers continued to invest in the development of Soil and Water Assessment Tool (SWAT) models of dissolved organic carbon (DOC) in West and East of Hudson reservoir watersheds in preparation to advance and apply models of disinfection byproduct precursors. Last, we completed a W2 model of turbidity in West Branch Reservoir and used our OST-W2 models to support operations in an extreme turbidity event that occurred on April 7, 2022.

Operations modeling made much progress in 2022 supporting operations, developing, and testing new models, and starting new contracts to enhance NYCDEP's Operations Support Tool (OST) and prepare NYCDEP's staff to take on more of the responsibilities of maintaining

OST. This included NWS Mid-Atlantic Forecast center switching their hydrologic models from Continuous API to the Sacramento model, as recommended by OST expert panel. In addition, a new version of the VoPro model that forecasts UV_{254} was released to support operations.

5.2.2 Modeling Program

DEP's Water Quality Modeling Program uses models to quantify the impact of climate change, changes in land use, individual and grouped components of the watershed protection program, operation of the water supply system, and water demand on the quantity and quality of water delivered to the City. A detailed description of water quality modeling progress and activities in 2022 will be included in the Watershed Water Quality Annual Report, which will be completed on July 31, 2023. A summary of these activities is given here.

Developing an Index of Climate Indicators

DEP has continued to build on previous work developing climate change indicators for the water supply watershed. In addition to individual trend analyses for climate metrics, an aggregated index is now calculated for each data source (e.g., meteorology using NOAA airport observations). The purpose of the index is to describe the degree of extreme conditions for a given year relative to the reference period of 1970-2000. This reference period is used to calculate 10th and 90th percentiles for each indicator, with any indicator outside these values tagged as extreme. These extreme values are summed for each year to generate the climate change index timeseries. The meteorological climate index has shown an increasing trend in extreme conditions, while the hydrologic index trend is less clear. Additional seasonal hydrologic indices have been calculated and show differences in extreme conditions between the seasons. This project is ongoing, with additional refinements to the analysis and interpretation of results continuing into 2023.

Developing Extreme Climate Scenarios

During 2022, DEP continued efforts to develop improved multiyear hydrological extreme scenarios for NYC Water Supply System resiliency studies. The use of global climate models (GCMs) for water supply system impact, vulnerability, and resiliency studies typically requires corrections for precipitation biases at sub-grid spatial scales. In the 2022 publication in the Journal of Hydrometeorology (Frei et al. 2022), DEP developed a bias correction method applied to precipitation for multi-year extremes. Such a correction is necessary because of the documented GCM underestimation of the magnitudes of multi-year precipitation extremes, resulting in an inaccurate estimation of the magnitudes of extremes in future scenarios. After the publication of the method, DEP has been applying this method to the WOH basins, developing corrections to the six WOH basins simultaneously. The plan for 2023 is to apply this method to Cannonsville Basin individually, and to all six basins together, to evaluate its usefulness for resiliency studies of our water supply system.

SWAT Modeling

In 2022, a SWAT model application was initiated to develop the capability to simulate DOC in streams of WOH watersheds. Initial testing of the SWAT-Carbon (C) model was done for the Neversink watershed. This work included 1) transforming the default model to simulate variable source area hydrology for runoff, consistent with other models being used by DEP and the dominant runoff generation mechanism in NYC watersheds; 2) model calibration to simulate DOC loads at the watershed outlet near Claryville and other tributary streams where both streamflow and water quality data are available; and 3) performing sensitivity of DOC export to changing temperature and precipitation. The DOC load simulated by the calibrated model was within 3% the observed DOC load at the watershed outlet. Ongoing work includes the application of SWAT-C in other WOH watersheds. Once developed, these models can support disinfection byproducts research and evaluation of climate change impacts on water quality in NYC watersheds.

SWAT Modeling for East of Hudson (EOH) Watersheds

The input layers necessary for SWAT include a digital elevation model (DEM), a wetness map, a land use map, and a soil type map. A DEM map was generated from resampling the elevation map with 1-meter resolution into 10-meter resolution. Using this map, a topographic index map was created and later used for wetness map extraction. The land use map was derived from simplifying the classification of the original map provided by NYCDEP and adjusting the categories based on the standardized classification provided in the SWAT model. The EOH soil map was extracted from the SSURGO database and then was overlaid with the wetness and sub-basin maps to create a new soil map with the dominant soil for each wetness class within sub-basins of each watershed.

The EOH basin consists of 15 watersheds, five of which have natural inflow draining into their associated reservoirs. These watersheds are Amawalk, Boyd Corners, Cross River, Titicus, and East Branch. Having natural inflow in a gauged watershed makes them suitable for parameter estimation which can later be generalized and applied to the rest of watersheds with regulated inflow when setting up SWAT models. The SWAT models have been set up for the Amawalk and Boyd Corners watershed outlets on the Muscoot River at Baldwin Place USGS monitoring station and on West Branch Croton River at Richardsville station, respectively. The outlook for 2023 is to complete SWAT model setups for all the five watersheds and perform calibration and validation of the models using USGS stations' records.

DBP Modeling With UV_{254}

DEP is continuing to work on a multi-year project to develop DBP formation potential models for source water streams, fate, and transport models for DBP precursors in reservoirs, and DBP model for the City's distribution system. In 2022, DEP proposed and validated a two-component, simple statistical approach to predict the formation potentials of the sum of five haloacetic acids (HAA5fp) and total trihalomethanes (TTHMfp) in inflows to Cannonsville and

Neversink reservoirs using environmental variables (streamflow, total phosphorus, and soil temperature) and UV_{254} as a surrogate for DBP precursors. The first component of the model predicts UV_{254} from streamflow, soil temperature, and total phosphorus; the second component then predicts HAA5fp and TTHMfp from UV_{254}. In 2022, we began testing of two-dimensional hydrothermal and water quality model CE-QUAL-W2 (W2) for predicting UV_{254} in Cannonsville, Neversink, and West Branch reservoirs. Preliminary results suggest that DBP precursors as represented by UV_{254} may degrade in the water column of these reservoirs, albeit at a very slow rate (~0.001 d^{-1}).

West Branch Reservoir Turbidity Model

In 2022, DEP completed the development and testing of a turbidity model for West Branch Reservoir. The model is based on W2.

Data Analysis

DEP conducted operational availability demonstration (OAD) of alum addition into Catskill Aqueduct at inflow to Kensico Reservoir (CATALUM) during May 9–May 23, and September 14–September 21. During these two intervals, DEP also monitored the effect of alum treatment on the removal of natural organic matter. The treatment reduced UV_{254} by 37% and 11%, respectively.

OST-W2 runs

A major storm impacted water quality of the Catskill System on April 7, 2022 (Esopus Creek peak instantaneous flow = 15,900 CFS; turbidity > 1400 NTU). After the storm, we conducted several OST runs to guide operations and manage water quality.

Many of these results were presented in detail at the annual progress meeting with regulators, which was held on October 13, 2022. Representatives of the New York State Department of Health, the U.S. Environmental Protection Agency, and the state Department of Environmental Conservation attended this meeting.

5.2.3 Operations Support Tool (OST)

NYCDEP OST is a software that simulates reservoir levels and water quality up to a year into the future and is used to inform NYC water supply operations. It is a decision-support system that links computer models of NYC water supply reservoir operating rules and real-time data of water quality and quantity and is driven by inflow forecasts provided by the National Weather Services (NWS). Common NYCDEP use of OST includes model simulations to support daily operational decisions, infrastructure shutdown, water supply planning, release policy evaluation and development, as well as climate change impact assessment.

During 2022 DEP continued with model enhancements to make OST better reflect current water supply system rules, infrastructure status, and operations, and elevate OST flexibility to provide modeling support for various infrastructure outage applications, in

particular for the upcoming Rondout-West Branch Tunnel (RWBT) outage. The enhancements included addressing some of the National Academy of Science, Engineering and Medicine (NASEM) OST Expert Panel recommendations:

- During 2022, the NWS through its Middle Atlantic River Forecast Center (MARFC) in collaboration with the NOAA's Office of Water Prediction started recalibrating their hydrologic models in the upper Delaware River Basin. As part of this work, MARFC is replacing the Continuous-API hydrological model with the Sacramento Soil Moisture Accounting Model for use when developing daily ensemble inflow forecasts for all reservoirs and other forecast locations in the upper Delaware basin represented in OST. This work is particularly important because it is in response to one of the NASEM OST Expert Panel recommendations.
- Two long-term contracts started during 2022: (1) DEL-444: Technical Support, Training and Knowledge Transfer, and Development for OST with Hazen and Sawyer, and (2) DEL-445: OST Technical Support Services, Training and Knowledge Transfer Needs for the OST Ensemble Forecast Post-Processor (EPP), diagnostic and verification tools, with the Research Triangle Institute. As part of DEL-444 OST OASIS Graphical User Interface software was upgraded from version 5.4 to 6.1. The upgraded version provides the platform for new OST enhancements, such as moving certain OASISGUI functions to a plugin architecture. Three new independent plugins have been implemented in the newly updated OST version, including forecast data, W2 data, and scheduled-variable input. Among these, the forecast data plugin was expanded with new capabilities, while the other two still offer the same capabilities; however, all plugins will be expanded with new functionalities during the duration of the contract. The new forecast data plugin expands the capabilities for DEP staff to make changes to EPP such as create a new mixed EPP that selectively applies different EPPs for different forecast locations or add a new forecast type for use to drive OST. Until now, such changes could only be implemented by Hazen and Sawyer specialists. Work under DEL-445 is just starting. This contact will provide the necessary support to develop new EPPs, new forecast types, as well as help enhance DEP's forecast diagnostic and verification tools. One very important goal for both contracts is training for, and knowledge transfer to, DEP staff. This will allow DEP staff to plan and implement most of OST maintenance, enhancements, and OST continued development.
- In 2022, under DEL-444, Hazen and Sawyer performed QA/QC for a new OST baseline run that was developed by DEP staff through implementation of model enhancements and updates to better reflect operations and the existing operational flexibility in the Croton system. This also included a better simulation of the turbidity load from Pepacton, Cannonsville, and Neversink reservoirs into Rondout Reservoir using historical and current measures of reservoir turbidity. This new base run is

being finalized to include the new USGS bathymetry for NYC Water Supply reservoirs located East of the Hudson River.

- In 2022 DEP continued collaborating with NYSDEC using our thermal release forecast tools to design releases to maintain water temperatures at Lordville in Delaware County below maximum daily temperatures of 75 degrees Fahrenheit.
- DEP staff continued developing a new version of a Volume Projection (VoPro) model. The VoPro tool is based on mass balance and mechanistically identical to OST, and it also includes local communities water demands. This new version of VoPro provides forecasts of UV_{254} levels to guide operations in meeting DBP regulations.

Like previous years, during 2022 our focus continued to be on using OST to support daily operational decision-making, including during planning and/or implementation of various projects, including:

- Mock outage runs (Testing the model for the shutdown using 2022 hydrological conditions and subsequently briefing the management monthly.): Rondout-West Branch Tunnel Shutdown go/no-go decision
- Croton outage
- Shandaken Tunnel Intake Chamber outage
- Catskill region air monitoring (Project/Contract# 213)
- Catskill region alum operates-as-designed testing
- New Croton drawdown and inspection
- Full Delaware generation outage (bypass flows)
- First Catskill Aqueduct Pressure Tunnel ROV (Remotely Operated Vehicle) inspection (Rondout Pressure Tunnel)
- Rondout-West Branch Tunnel 2nd shutdown – valve and flowmeter work
- Second Catskill Aqueduct Pressure Tunnel ROV inspection (Wallkill Pressure Tunnel)
- Rondout-West Branch Tunnel dewatering exercise
- Kiryas Joel community connection and Catskill shutdown

5.3 Geographic Information System

DEP uses its Geographic Information System (GIS) for multiple purposes: to support numerous FAD and MOA programs; to manage the City's interests in water supply lands and facilities; to display and evaluate the efficacy of watershed protection through maps, queries, and analyses; and to support watershed, reservoir, and operational modeling efforts. Primary GIS resources include a centralized geodatabase (the GIS library), the Watershed Lands Information System (WaLIS), and Global Positioning System (GPS) technology. This report summarizes GIS technical support for programs and modeling applications; the completion or acquisition of new GIS data layers; improvements to GIS infrastructure; and dissemination of GIS data.

5.3.1 GIS Technical Support

In 2022, DEP continued to use its GIS to perform technical support and data development, including GPS fieldwork, for a variety of watershed protection programs and modeling applications, in-office full-time. A core function of the GIS is to create customized statistical reports and maps depicting land ownership, land cover extent, hydrographic and topographic features, riparian and flood zones, water supply facilities, or program implementation status over particular basins or political boundaries. Such analyses were used for program design and planning, engineering screening, regulatory jurisdiction determination, emergency response, water supply operations, and recreational outreach.

GIS staff met with Land Acquisition Program (LAP) and Streamside Acquisition Program (SAP) staff to discuss a forest cover solicitation approach. GIS layers were developed in an analysis of forested stream segments based on clusters of landcover types. Parcels were then selected for possible solicitation based on parameters they provided. These GIS layers were made available in WaLIS for further evaluation by program staff to refine their selection methods.

DEP continued using digital elevation models (DEMs) to generate custom sub-basin boundaries for specific water quality sampling locations. DEP also incorporated DEMs into global climate models to generate local predictions of future climate conditions. DEP continues to rely on data sets such as reservoir bathymetry, SSURGO2 soils, land cover, and land use to drive model analyses. DEP has included spatial data in climate change trend analysis maps using observation locations throughout the watershed. DEP updated their water quality models, Operations Support Tool, and reservoir capacity tables to reflect new EOH reservoir bathymetric data published in 2021 in partnership with USGS.

5.3.2 Completion or Acquisition of New GIS Data Layers and Aerial Products

In addition to procuring and maintaining GPS hardware and software year-round, GIS staff process and upload field-collected GPS data into GIS layers that are incorporated into the GIS Library. In the 2022 summer field season, numerous GPS datasets were collected, corrected, QA-ed, and processed into GIS layers related to wildlife and wetland studies, forestry, property management, and land acquisition.

A DEP contractor completed work on DEL-440, LiDAR-Enhanced Wetland Mapping and Connectivity Assessment, in March 2022. This project used high resolution orthoimagery, LiDAR-derived topographic datasets, and additional geospatial data to automate wetland mapping for the entire watershed. The automated output was then manually edited to produce a fully classified wetlands coverage compliant with National Wetlands Inventory standards. As expected, this novel approach significantly increased the extent of mapped wetlands both East and West of Hudson and mapped numerous previously unidentified connections between wetlands and stream features in the National Hydrography Database. Next, DEP will further evaluate the geospatial data produced from this project to determine if additional editing is required to improve its accuracy and completeness.

DEP edited and integrated GIS data deliverables for CRO-605, Sanitary Sewer Mapping and Inspection in five areas of EOH, into existing GIS layers for pipes and manholes, keeping the best data available where there are overlaps. The newly mapped sewers and manholes from CRO-605, and their associated still photos, are now viewable in WaLIS (Figure 5.1). The newly

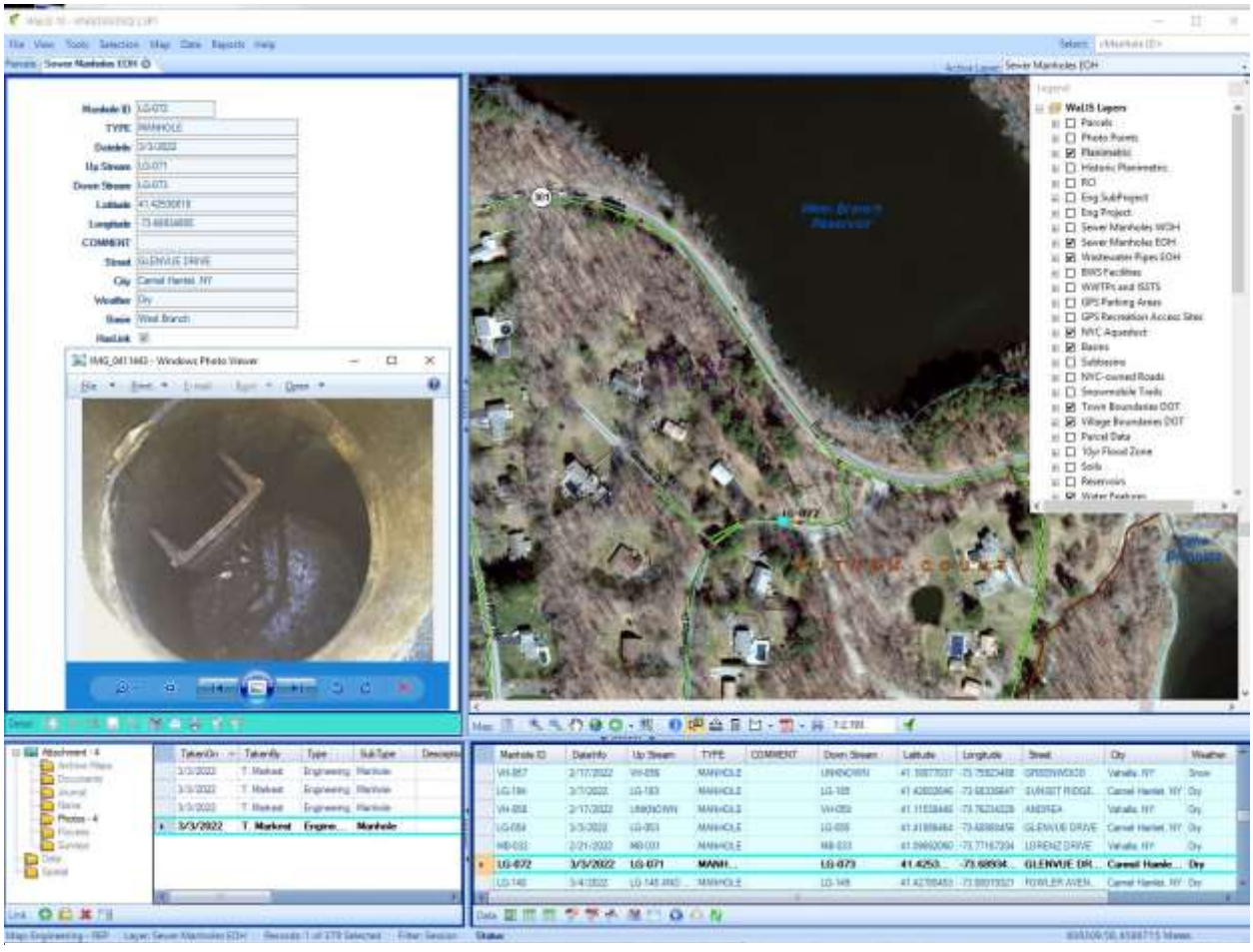

Figure 5.1 Recently mapped sewer manholes are hyperlinked to their associated inspection photos. All are viewable within the WaLIS application's map interface.

mapped pipe data are also integrated with existing pipe data and displayed on the same WaLIS map.

As part of ongoing annual GIS data maintenance, DEP regularly updated or overhauled several existing feature classes. These included mission-critical data for various DEP programs, such as countywide digital tax parcels, City-owned land or interests, state-owned land, water supply facilities, stream restoration projects, septic repairs, and engineering project locations. Annual updates on locations of sensitive, threatened, or endangered species on City-owned lands were received from the New York Natural Heritage Program (NYNHP) to supplement data collected by the DEP Wildlife Studies Program. DEP obtained the latest version of SSURGO2 soils data from USDA and numerous other updates from the NYS GIS Clearinghouse, including NYSDOT transportation features and NYSDEC layers.

5.3.3 GIS Infrastructure Improvement

During 2022, DEP continued to maintain its GIS infrastructure by upgrading ArcGIS Desktop software; diagnosing database performance issues; updating schemas and servers to improve database speed; building and testing new geodatabase scripts; evaluating and refining user security levels on servers for different databases; and backing up all databases. DEP maintained GPS units used by various programs by replacing aging units, updating data dictionaries, updating software, and tracking inventory for all GPS hardware and software.

GIS staff continued to work with DEP's Bureau of Information Technology (BIT) on an initiative to implement best practices and upgrade GIS architecture throughout all DEP bureaus in collaboration with the GIS software vendor ESRI. Upstate GIS staff continued to test GIS software via a virtual desktop in Microsoft's cloud-computing environment (Azure). A matrix of several GIS network tests was conducted in the new Arkville building for BIT after they upgraded the network from 10 Mbps (mega-bits per second) to 1 Gbps (giga-bits per second), which is 100 times faster. A synopsis of these tests was discussed with BIT to evaluate the proposed implementation of a hybrid on-premises/Azure-Cloud approach for upstate users, as well as a longer-term proof-of-concept all-Cloud-based approach. The goal of the testing is to provide remote users with a high-speed GIS and WaLIS experience. DEP received delivery in March of two new HPT2600 plotters for the Kingston and Valhalla offices to replace older models.

DEP also continued to upgrade and maintain WaLIS, which currently operates on approximately 200 DEP user workstations. DEP's developers provided routine WaLIS support throughout 2022 by creating custom server reports, customizing the WaLIS interface to resolve mapping or data entry issues, or facilitating and enhancing workflow. Staff continued to modify workflow assignments along with a vast amount of email triggers related to the large number of retirements and other staff attrition. Staff edited, normalized, and centralized Stream Management Implementation Program and Local Flood Analyses data into SQL. The goal of this

effort was to create the necessary database views, develop data entry capability within WaLIS, and create easily accessible, consistent reports stored in WaLIS.

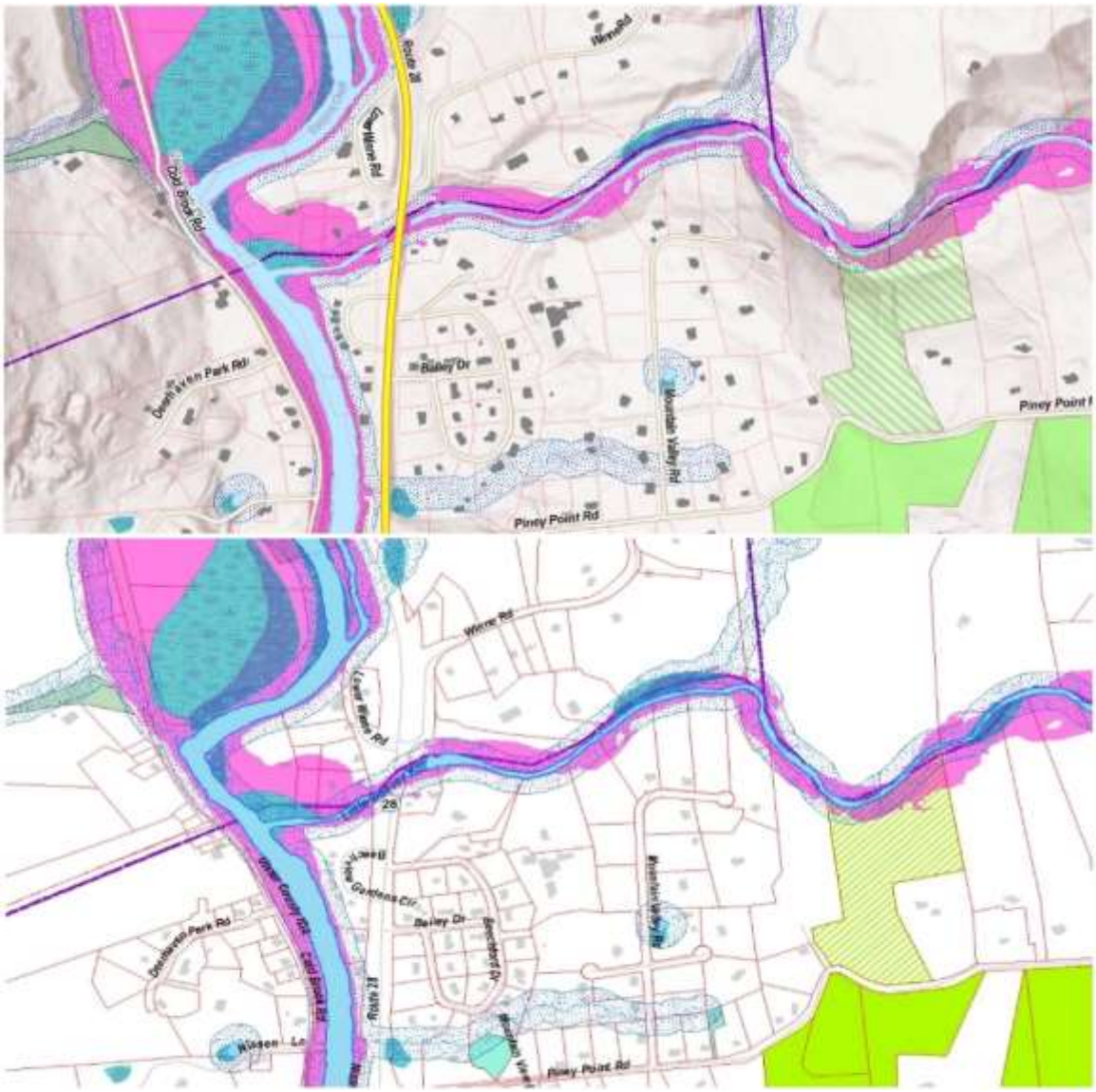

Figure 5.2 Features of the next generation of the WaLIS application now in beta development will include enhanced map quality due to better integration with Portal map services. Improved graphic rendering can be seen in output from the new beta version (top) compared with current WaLIS version (bottom).

DEP continued to focus on developing the next generation of WaLIS which is now in a beta version. This will provide most of the full desktop functionality of previous versions, while also better-integrating with the GIS data it relies on, including the latest version of ArcGIS

Portal. Most of the map functionality has been replicated in the beta version along with improved graphic quality (Figure 5.2), while staff resolve issues of limited map customization capability.

5.3.4 Data Dissemination to Stakeholders

Using established in-house data sharing policies, DEP continued to review all outside requests for GIS data and provide these data to watershed partners and interested parties as required. DEP provided over 55 stakeholders and communities with semi-annual data updates in January and July for newly acquired and existing City-owned lands. DEP shared updated watershed recreation data with Ulster County, WAC, and the Catskill Center for their recreation website mapping applications, and to the NYC Open Data Portal. Throughout 2022, DEP responded to data sharing requests from Westchester County Health Department, Harvard Forest, SUNY Albany, Greene County SWCD, NYSDOH, USDA, NYSDEC, NYS Office of the Attorney General, WAC, CWC, and various counties, towns, and consultants working on DEP-related watershed projects.

GIS staff developed a plan in late 2022 to disseminate DEP's most requested "shareable/public" watershed GIS data layers by establishing an online GIS data sharing platform using ESRI's ArcGIS Online (AGOL). This will improve quality control by preventing out-of-date data from being used by the public and will reduce overhead on staff for individual data requests. Staff plan to implement the platform sometime in 2023.

6. Regulatory Programs

A primary component of DEP's overall watershed protection strategy is the enforcement of applicable environmental regulations, which include, but are not limited to the New York City Watershed Rules and Regulations (WR&R), the NYSDOH Appendix 75-A Wastewater Treatment Standards, the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity, and the New York State Environmental Quality Review Act (SEQRA). Of these, the primary mechanism for protection of the water supply is via administration of the WR&R.

DEP's regulatory efforts are focused on three primary functions: review and approval of land development projects within the watershed; inspection of the following: wastewater treatment plants, new subsurface sewage treatment systems and active construction sites; and pursuit and resolution of violations of the WR&R.

6.1 Project Review

Land development projects in the City's watershed, including those sponsored by DEP, are reviewed to ensure compliance with the WR&R. Activities that typically require DEP review and approval include wastewater treatment plants (WWTPs), sewer collection systems, subsurface sewage treatment systems (SSTS), projects requiring the preparation of stormwater pollution prevention plans (SWPPP), and the construction of certain impervious surfaces. In addition, DEP reviews and issues individual residential stormwater permits (IRSP), and stream crossing/piping/diversion permits for other stormwater-related activities. DEP also ensures that during construction, erosion control measures are properly sited and maintained. For post-construction condition, DEP ensures projects that require SWPPPs or IRSPs have properly installed the necessary long-term best management practices. In addition, DEP reviews and offers comments on permit applications that have been submitted to NYSDEC for activities such as mining operations, timber harvesting, industrial activities, landfill closures, stream disturbance and wetland incursions. DEP's input is sought by NYSDEC in accordance with the DEP/NYSDEC Memorandum of Understanding.

Lists of the new projects received during the previous calendar year in both the select East of Hudson reservoir basins and all West of Hudson basins are included in the semi-annual FAD report. The Semi-Annual Project Activities report also includes summaries and maps reflecting project locations. In 2022, there were 20 new commercial septic system applications, three sewer collection system applications, two sewer connection applications, 23 SWPPP applications, one crossing, piping or diversion permit and five variance applications in addition to two mining permit reviews, two stream disturbance permit reviews, four timber harvest reviews, five NYSDOT reviews and two other-type projects within the Catskill and Delaware watersheds.

6.1.1 SEQRA Coordination

DEP reviews and provides detailed comments on all SEQRA notices received for land development projects and activities in the City's watershed. DEP's SEQRA Coordination Section tracks all applications, maintains a database of new and amended notices, tracks development trends in the watershed, and coordinates with local and state entities and authorities that regularly act as lead agencies pursuant to SEQRA Law.

The semi-annual report includes a summary and mapping of all SEQRA reviews performed by DEP during the previous calendar year. There were 44 new SEQRA applications received in FAD basins in 2022.

6.1.2 Delegation Agreements

The Westchester County and Putnam County health departments perform reviews of new, modified, and repaired SSTSs in accordance with their respective delegation agreements with DEP. The Ulster County Health Department performs reviews of new and modified SSTSs and certain intermediate repairs in accordance with its delegation agreement with DEP.

During 2022, DEP received documentation relative to 21 delegated SSTSs in FAD basins; 10 of these reviews are attributed to subsurface sewage treatment systems in the WOH watershed with the remaining 11 delegated SSTS applications located in the select EOH FAD basins.

6.2 Enforcement Activities

DEP investigates, documents and issues notices of violation (NOV) for a wide variety of errant activities including failing SSTSs, non-compliant SWPPPs, projects that commence construction without prior DEP approval, and any activity that results in a pollutant-laden discharge in the watershed. Enforcement actions are prepared with input from attorneys from DEP's Bureau of Legal Affairs and the City Law Department. In addition to coordinating with NYSDEC, county health departments, municipal code enforcement officers, and the Catskill Watershed Corporation, DEP routinely refers water quality violations to partner agencies where DEP's authority under the WR&R relative to the activity is limited or non-existent. Examples of violations that DEP fully documents and refers to NYSDEC's regional offices are discharges from sites covered by industrial SPDES Permits, such as concrete or asphalt manufacturing facilities. In 2022, DEP opened 15 new NOVs and closed seven existing NOVs. Additional detail regarding these violations is included in the semi-annual report.

The primary function of the DEP Police with respect to enforcement is regular daily patrol of the watershed documenting a wide range of potential water quality incursions. Police employees receive over 300 hours of training in environmental law and regulations, provided in part by DEP watershed protection staff, as well as 170 hours of practical field training in water supply infrastructure protection. The DEP police have the authority to issue summonses and notices of warning/violation of the New York State Environmental Conservation Law, the

WR&R, as well as other state and local codes. DEP regulatory staff work cooperatively with the DEP Police to ensure citizen complaints regarding potential illicit environmental activity are investigated and addressed in a timely manner.

6.3 Wastewater Treatment Plant Compliance and Inspection Program

DEP's Wastewater Treatment Plant Compliance and Inspection (WWTPCI) Program conducts a quarterly compliance inspection at each surface-discharging WWTP that operates on a year-round basis. A minimum of two compliance inspections per year are conducted during the operating season at seasonal surface-discharging facilities. Similarly, at least two compliance inspections per year are conducted at non-contact cooling water discharges to surface waters, groundwater remediation systems, landfills, and oil/water separators. Treated industrial waste discharges to groundwater, via ground surface application, are inspected four times per year. This does not preclude DEP from performing inspections with greater frequency. DEP may also conduct unannounced facility inspections to manage instances of non-compliance, respond to abnormal or emergency operating conditions, react to mistakes or problems with self-monitoring data or record keeping, discuss special DEP laboratory sampling results, oversee modifications or expansions to a facility, and fulfill special requests by internal agency management.

When violations are identified at WWTPs, DEP coordinates enforcement activities with NYSDEC, USEPA, NYSDOH, and the New York State Attorney General's Office through the quarterly Watershed Enforcement Coordination Committee (WECC) meetings. At these meetings, the operational status of watershed WWTPs is discussed, and steps are taken to ensure adequate enforcement activities are pursued to achieve compliance.

6.3.1 Facility Compliance in the Catskill/Delaware Watershed

DEP inspected 31 WOH WWTPs on a regular schedule in 2022. Of these, 26 are permitted for year-round discharge and five for seasonal discharge. Three of the 31 are wastewater treatment facilities permitted to discharge to groundwater. These are the hamlet of Chichester, Mountainside Farms, and Hanah Country Club. Three other facilities are classified as industrial non-contact cooling water discharges. These are FrieslandCampina, Kraft Dairy, and Saputo Foods. Altogether, DEP conducted 194 scheduled compliance and emergency response inspections in the Catskill/Delaware watersheds in 2022.

Compliance with state pollution discharge elimination system (SPDES) permits continued to improve among WWTPs in the Catskill/Delaware watersheds in 2022, due in large part to the WWTCPI Program.

As reported previously, NYSDEC issued a Notice of Violation (NOV) on February 6, 2019, for collection system overflows and late reporting relative to the Hunter Highlands Wastewater Treatment Plant. On October 28, 2021, EPA issued a significant non-compliance letter to the facility for total suspended solids violations in February and June 2021.

A NYSDEC Order on Consent, including a schedule of compliance (schedule), was fully executed on November 9, 2022. In January 2023, the initial list of compliance items in the schedule was completed, including restoring internet service, SCADA, call out functions, and effluent turbidity continuous monitoring and recording. Additionally, alarms are now fully operational, and the eyewash station is in good working order.

Several future schedule requirements are due in February and March 2023 and include completion of a unit process analysis across the entire facility with special focus on ammonia compliance, submission of updated operation and maintenance manuals for the plant and collection system, and submission of an overflow response plan and schedule for completion of sanitary sewer work which must be completed by September 2023. By November 2024, Hunter Highlands must submit a report detailing the results of inspection and cleaning of the entire sewer collection system.

DEP and NYSDEC will continue to work cooperatively to seek solutions to other issues at the facility not specifically cited in the schedule. These improvements include repairs to an inoperative dual sand tertiary filtration system train, and restoration of the plant's process flow pattern to its original design configuration, including repairs to the equalization lagoon.

DEP participates in compliance conferences (CC) with those facilities that continue to violate their SPDES permit limits and/or monitoring requirements. CCs are usually conducted after repeated attempts by DEP to remediate the problem with the facility owner and/or operator have failed. DEP, in conjunction with NYSDEC and local regulatory authorities, issues an NOV prior to calling for a CC. DEP did not participate in any CCs in 2022. Many problematic and outdated facilities, which used to exceed their permits on a regular basis, have been either consolidated and connected to another upgraded facility, upgraded as a standalone facility, converted to subsurface discharge, or totally abandoned. As a result, the number of problematic WWTPs has greatly decreased.

6.3.2 Facility Compliance in the East of Hudson Watershed

The West Branch, Boyd Corners, Croton Falls, Cross River, and Kensico Reservoir basins are of special interest because they contribute to the waters of the Delaware System. The following is a summary of the WWTPs and collection systems inspected within the West Branch, Croton Falls, and Cross River basins. There are no WWTPs in the Kensico and Boyd Corners basins, but DEP does perform inspections of the collection system/pump stations maintained by Westchester County and the towns of North Castle and Harrison within the Kensico basin. In 2022, DEP conducted 62 scheduled compliance and emergency response inspections for the WWTPs in the EOH FAD basins.

There are nine WWTPs in the West Branch, Croton Falls, and Cross River basins. All were in substantial compliance with their SPDES permit discharge limitations in 2022.

DEP performed compliance inspections of the Town of North Castle (Old Route 22, Cooney Hill Road, Route 120/Loudens Cove, New King Street, Old Orchard Street) and the Harrison (Park Lane) pump stations and collection system throughout the 2022 monitoring period. The inspections revealed no abnormal conditions.

For monitoring of the Westlake Sewer Trunk Line, see Section 4.10.2.

6.3.3 Sampling of WWTP Effluents

Wastewater treatment plants (WWTPs) and water resource recovery facilities (WRRFs) effluent results are reported to NYSDOH and USEPA semiannually in the Wastewater Treatment Plant Compliance and Inspection (WWTPCI) report as required by the 2017 FAD. Sampling data are also shared regularly with DEP's WWTPCI staff for tracking compliance with SPDES-permitted effluent limits.

Sampling and analysis of surface-discharging WWTP effluents was conducted by DEP's state-approved laboratories throughout the year at a reduced frequency due to NYSDOH-approved COVID-19 monitoring reductions. In 2022, composite samples were collected once for the year at non-City owned plants that have composite sample monitoring requirements in their SPDES permits. City-owned WRRFs were also sampled in accordance with SPDES permit monitoring requirements. In most cases, one sample was collected each month. The samples were a combination of grab and composite sample depending on the parameter and were analyzed by DEP laboratories. Results were reported to NYSDEC in SPDES discharge monitoring reports.

In the Catskill System, there were 17 WWTPs and WRRFs with active SPDES permits. The Chichester plant in the town of Shandaken in Ulster County has no discharge. It is a City-owned and operated, intermediate sized sub-surface sewage treatment system. The remaining 16 plants are comprised of three City-owned and 13 non-City-owned facilities. In 2022, 2,286 analyses were performed on 304 influent and effluent samples (as required) from WWTPs and WRRFs in the Catskill System. Of the 304 samples, 262 were collected from City plants and 42 were collected at non-City plants. These samples underwent 2,257 analyses by DEP's Kingston's laboratory and 29 analyses by a contract laboratory.

There were 13 WWTPs and WRRFs in the Delaware System with active SPDES permits in 2022 (two City-owned and 11 non-City-owned). For the Delaware System, there were 225 influent and effluent samples collected. Of the 225 samples, 171 were collected from City-owned plants and 54 were collected from non-City-owned plants. These samples underwent 1,254 analyses performed by Grahamsville (539), Kingston (711), and contract (4) laboratories.

In the EOH System, there were 62 WWTPs and WRRFs with active SPDES permits. In this system, 33 analyses were performed by the Hawthorne Laboratory on 6 WWTP samples. Mahopac is the only EOH plant with composite sampling. Nine WWTPs are in a FAD

watershed, with eight located within the Croton Falls and Cross River watersheds and one within the West Branch watershed.

The sampling of non-FAD basin treatment plants was not conducted from January through October 2021 due to COVID-19 monitoring reductions and was subsequently discontinued from that point forward in a November agreement with NYSDOH. Cross River and Croton Falls are routinely considered non-FAD basins; however, they become part of the FAD system when their pumps are in operation. During these times, WWTP and WRRF samples are required to be collected. The pumps were not activated in 2022.

6.4 Capital Replacement Program

The City is obligated to pay for capital replacement of watershed equipment and methods at eligible WWTPs required by the WR&R and not otherwise required by federal or state law. In 2022, DEP registered an amendment to the contract with NEIWPCC that provided additional program funding in future years.

During 2022, NEIWPCC made no payments to WWTPs located in FAD basins for replacement of watershed equipment. DEP provides funding to replace minor equipment (e.g., filter cartridges, membranes, pumps, meters) as needed to ensure the facility functions properly and in accordance with the WR&R. DEP can directly fund the replacement of minor equipment under established O&M agreements with each WWTP owner.

7. In-City Programs

7.1 Waterborne Disease Risk Assessment Program

The Waterborne Disease Risk Assessment Program (WDRAP) is a joint agency program involving the NYC Department of Health and Mental Hygiene (DOHMH) and DEP. The WDRAP Intra-City Agreement (ICA) lays out each agency's roles and responsibilities. In 2022, DEP and DOHMH renewed their collaboration by finalizing a new ICA which took effect July 1, 2022, and will continue through June 30, 2027.

WDRAP has two major ongoing functions:

- To obtain data on the rates of giardiasis and cryptosporidiosis in the City, along with demographic and risk factor information on cases and patients.
- To provide a system to track gastrointestinal illness (as indicated by diarrhea or vomiting) to ensure rapid detection of any outbreaks.

All data from 2022 are preliminary as of this writing and are subject to change pending the results of confirmatory laboratory testing and any other needed adjustments. In 2022, there were 963 cases of giardiasis and 347 cases of cryptosporidiosis reported to DOHMH (as of January 2023). Of these cases, epidemiologists completed 29 giardiasis patient interviews of patients in high transmission risk groups and conducted 275 cryptosporidiosis patient interviews.

In 2022, there were approximately 37 laboratories using a syndromic multiplex panels (SMP) test in the City to identify giardiasis and cryptosporidiosis. The proportion of giardiasis patients diagnosed exclusively by an SMP test at a hospital or commercial laboratory has grown from 5% in 2015 to 51.5% in 2022 (Figure 7.1). Similarly, the proportion of cryptosporidiosis patients diagnosed exclusively by an SMP test at a hospital or commercial laboratory has grown from 20% in 2015 to 83.4% in 2022.

DOHMH is confident that increased use of SMP diagnostic testing is at the core of the increased detection of both giardiasis and cryptosporidiosis and that the case increase observed is not reflective of an increase of disease transmission. Similar increases in giardiasis and cryptosporidiosis rates have been observed in several other jurisdictions in the United States where they have also experienced an increase in SMP testing.

In September 2022, routine DOHMH cluster detection algorithms detected an increase in cryptosporidiosis cases in Brooklyn. The cases were initially concentrated in Borough Park Brooklyn and later expanded to include East Flatbush-Flatbush, Canarsie-Flatlands and Bensonhurst-Bayridge. There were 47 cases investigated, and the diagnosis dates ranged from September 1- November 17, 2022. The median patient age was 28 years (range:0-75 years). Forty-five (96%) of the cases were in the orthodox Jewish communities of Borough Park and East Flatbush-Flatbush. A supplemental questionnaire was developed to ask patients about recent exposures related to water and contact with other cases in the community. Ten cases (21%)

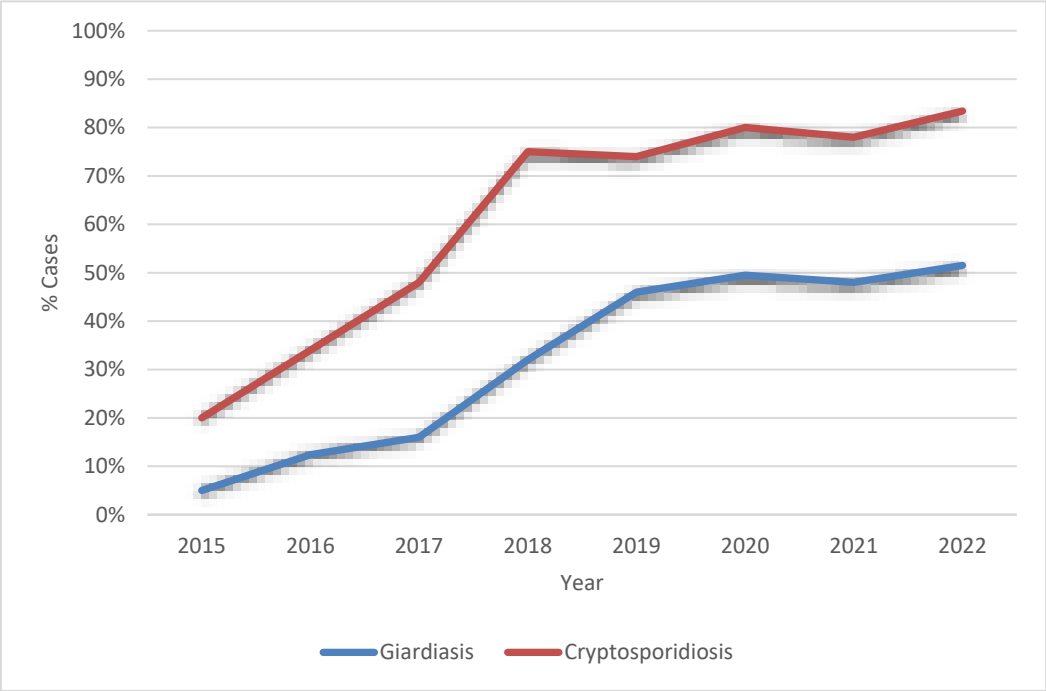

Figure 7.1 Cases of giardiasis and cryptosporidiosis diagnosed exclusively by syndromic multiplex panels (SMPs) 2015-2022

reported attending school or working in schools. Based on the job description, one of those 10 cases was subsequently excluded, pending negative test results as per the NYC health code. DOHMH staff provided health education to patients on the symptoms and transmission of cryptosporidiosis and presented on this increase to a community-based organization. Data gathered by DOHMH indicate that this outbreak was a result of person-to-person transmission and was unrelated to the City's water supply.

In addition to tracking reported cases of giardiasis and cryptosporidiosis, the City's four syndromic surveillance systems to detect outbreaks of gastrointestinal illness were maintained:

- Hospital emergency department logs are tracked electronically for chief complaint data (including gastrointestinal illness symptoms). Data from 53 hospitals is received and analyzed daily.
- Sales of over-the-counter or non-prescription anti-diarrheal medications at major pharmacies are monitored electronically. Data from >400 drug stores is received and analyzed daily.
- The number of stool specimens submitted to a large clinical laboratory for microbiological testing is tracked.

- Several sentinel nursing homes across the City are monitored for gastrointestinal disease outbreaks.

While not specifically designed to detect outbreaks of giardiasis, cryptosporidiosis, or waterborne disease, these systems are designed to broadly detect an increase in gastrointestinal illness regardless of the cause and they are useful for rapid and sensitive detection of gastrointestinal illness outbreaks. Alerts from these systems could trigger swift investigation of potential sources. In 2022 there was no evidence of a drinking water-related outbreak, consistent with findings of prior years.

In addition to the routine program requirement, DEP completed its Public Health Surveillance Systems Survey report in 2022. The report is a summary of findings from a survey conducted from 2020 to 2021 of selected U.S. cities regarding public health surveillance practices used to help assess and assure the safety of drinking water.

8. Education and Outreach

DEP collaborates with the Catskill Watershed Corporation (CWC), Watershed Agricultural Council (WAC), Cornell Cooperative Extension, Soil and Water Conservation Districts, Catskill Center, the Catskill Regional Invasive Species Partnership, the Lower Hudson Partnership for Invasive Species Management, Trout Unlimited, and other partners to increase knowledge and awareness among key audiences about source water protection, land conservation and stewardship, stream corridor protection, stormwater and wastewater, flood response and preparedness, invasive species, watershed recreation, riparian buffers, and other topics.

DEP disseminates information to a broad public audience through its website, press releases, and social media platforms. By the end of 2022, DEP was reaching over 13,000 followers on NYC Water Facebook, over 5,600 followers on NYC Watershed Facebook, 22,710 followers on NYC Water Twitter, and 6,990 followers on NYC Water Instagram (a 33% increase from 2021). DEP's NYC Water Flickr Page has 236 followers and contains over 8,985 photos and archival images.

Recreation and stewardship of City-owned lands are popular ways that DEP engages with certain audiences, including over 100,000 subscribers to a Watershed Recreation e-newsletter. In 2022, DEP communicated with these subscribers to relay important recreational news and announcements related to invasive species control, safety briefings, hunting opportunities, and temporary access restrictions. Although DEP did not organize any in-person events on City lands, DEP did support numerous events on City lands as sponsored by various stakeholders. DEP also collaborated with Ulster County to continue managing and maintaining the Ashokan Rail Trail, which attracted approximately 150,000 visitors throughout 2022.

In 2022, DEP developed a new recreational permitting process for granting organizations, schools, and other groups permission to utilize City-owned lands for low-impact outreach and recreation activities. These include nature walks and interpretative hikes, geologic field trips for universities, pheasant releases and youth hunts, and historical investigatory visits. The new process provides a simple and quick application process, allowing DEP to be more responsive to community requests and facilitate more compatible educational and recreational activities.

DEP's Education Office conducted more than 300 environmental education programs in 2022 that reached over 30,000 students, educators, and other professionals; these programs included a combination of virtual and in-person field trips and professional learning opportunities, new digital resources, classroom visits, and guided tours at the Visitor Center at Newtown Creek. DEP's 2022 Water Resources Art & Poetry Contest engaged more than 1,500 students from over 90 schools in the watershed and New York City; contest winners were also featured in a new exhibit at the Catskill Water Discovery Center in Arkville, Delaware County. Trout in the Classroom engaged over 15,000 students and teachers from approximately 150 schools statewide. DEP sponsored an in-person performance of the "City That Drinks the

Mountain Sky" and continued to collaborate with local museums and community organizations to support educational exhibits related to the water supply and watershed. For the first time since 2019, DEP hosted an in-person Watershed Forestry Bus Tour for over 50 non-formal educators.

The CWC Public Education Program awarded 19 grants totaling $157,427 to schools and organizations in the watershed and New York City; the estimated audience for these programs is 3,500 people. To date, CWC has awarded 696 educational grants totaling more than $3.7 million, including 53 grants for public audiences and 643 grants for school-based audiences. CWC maintains a networking website for watershed educators and routinely posts press releases and program announcements on its main organizational website.

The Watershed Agricultural Program conducted 40 farmer education programs attended by 1,114 total participants via both virtual and in-person events. Highlights included the virtual Catskill Regional Agricultural Conference; the annual WAC Farm Tour; a series of on-farm workshops and tours; and the annual Delaware County Clean Sweep Chemical Disposal Day. WAC routinely posts program announcements on its organizational website in addition to promoting local farm and forestry products through the Pure Catskills Campaign and posting informational videos on the WAC YouTube channel. After a temporary hiatus due to COVID, the annual Taste of the Catskills food event returned to Maple Shade Farm in Delhi.

The WAC Forestry Program utilized the interactive MyWoodlot website to educate forest landowners and engage them in stewardship activities, while the watershed model forests continued to host educational events for all audiences. MyWoodlot also offers a virtual model forest Storymap tour. In 2022, WAC sponsored eight logger training workshops for 85 participants and conducted 27 in-person tours and 12 virtual bus tours for 1,510 participants, primarily New York City students. Twenty-three teachers attended the annual Watershed Forestry Teachers Institute and 133 students participated in the 2021-2022 Green Connections School Partnership Program.

The Stream Management Program offered a mix of web-based and in-person events in 2022 targeted to streamside landowners, municipal officials, watershed professionals, school-based audiences, and other stakeholders. Highlights include the biennial Catskill Environmental Research & Monitoring Conference (CERM); completion of four project case study videos to be included in the "Stream Process 101" webinar for municipal officials; in-person trainings on flood maps and related issues; an updated post-storm response and recovery training for nearly 100 municipal officials; Youth Climate Summit at SUNY Oneonta; a new curriculum for preschoolers (Toddlers and Tributaries); and a training on the Multi-Objective Stream Crossing Assessment Protocol (MOSCAP) used to assess and prioritize culvert upgrades in the Ashokan watershed. The CatskillStreams.org website continues to serve as a comprehensive resource for streamside landowners and local officials, as well as a repository for all stream management plans and local flood analyses completed to date for WOH watershed communities.

Finally, DEP and its partners attend community outreach events where staff communicate directly with the public and distribute information. Although DEP's attendance continued to be scaled back in 2022, the following events were among those attended by DEP or watershed partners: Bovina Farm Day, Delaware County Fair, Delhi Harvest Festival, Deposit Lumberjack Festival, Grahamsville Little World's Fair, Greene County Youth Fair, Margaretville Cauliflower Festival, Meredith Dairy Fest, New York Woodman's Field Days, NYC Watershed Science and Technical Conference, Olive Day, Shandaken Tunnel SPDES Permit Outreach Meeting, Ulster County Fair, Westchester County Regional Envirothon, and the West Kortright Fair.

9. Miscellaneous Reporting Provisions

9.1 Water Conservation/Demand Management

Despite a steady increase in population since the 1980s, New York City's average daily demand has decreased over the past several decades, with daily demand below the 1960s drought-of-record (1,405 MGD) since 2009 (Figure 9.1). Several factors are responsible for this decrease, such as increased efficiency and awareness of water conservation, as well as the implementation of DEP's Water Demand Management Program.

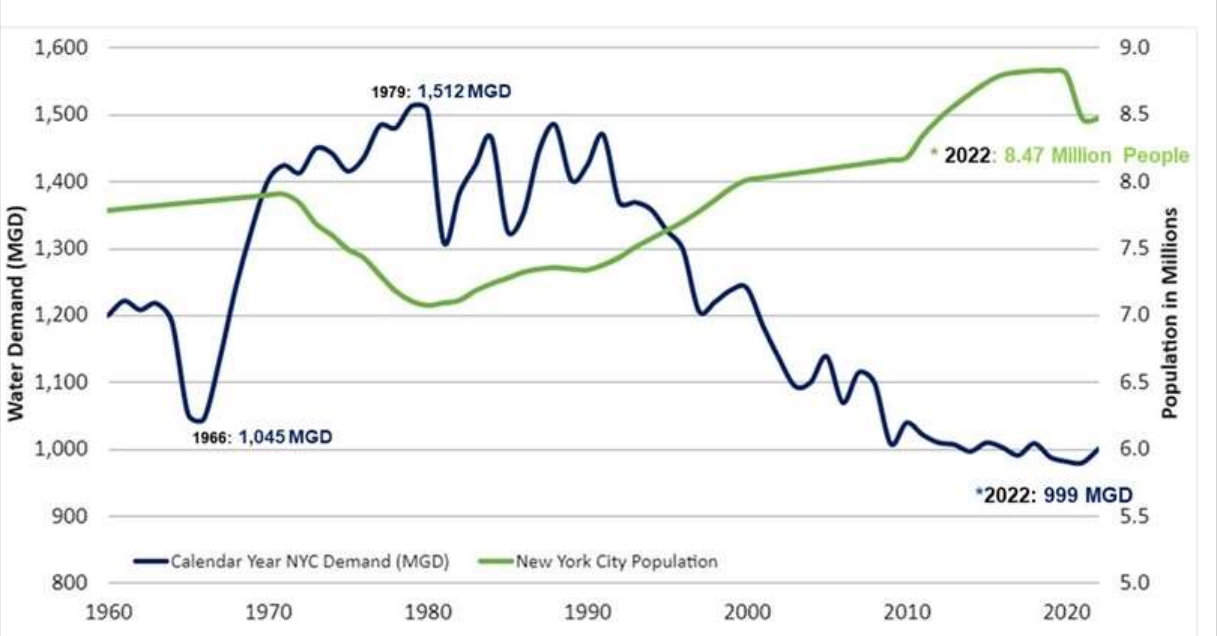

Figure 9.1 New York City water demand and population.

In 2013, DEP implemented a comprehensive Water Demand Management Program, as part of the Water for the Future Program, with the goal of reducing consumption by 50 MGD by 2022. After several years of continued declines in demand and based on the progress, the goal was revised to 20 MGD. The initial driver of the Demand Management Plan was to reduce demand through conservation to offset the effects of the Delaware Aqueduct closure for repair of the Rondout-West Branch Tunnel and ensure an adequate water supply for the city. The Demand Management Program has proven to be a cost-effective approach towards conserving water that has also created exciting opportunities and partnerships with multiple industries throughout New York City. This program has continued to provide benefits to the City, along with continued efforts to reduce nonrevenue water, optimize metering infrastructure, and reduce losses in the distribution system with continuous improvement and monitoring efforts.

9.1.1 Water Demand Management Plan

As described in the 2018 Water Demand Management Plan and subsequent annual updates (https://www1.nyc.gov/site/dep/water/water-conservation.page), DEP evaluated various options and developed a cost-effective program with a focus on water demand management through conservation to ensure an adequate supply of water. The most cost-effective options became the top demand management strategies. The plan sets forth six major strategies:

- Municipal Water Efficiency Program: Involves retrofits of city-owned properties.
- Residential Water Efficiency Program: Focuses primarily on the Toilet Replacement Program for multi-family buildings.
- Non-Residential Water Efficiency Program: Collaboration with private sector organizations including restaurants, hotels, hospitals, and universities.
- Water Distribution System Optimization: Entails system repairs and upgrades, managing water pressure, and refining water meter accuracy and leak detection.
- Water Supply Shortage Management: Encompasses the review and revision of plans to prepare for a drought and other water shortages.
- Wholesale Customers Water Demand Management Program: Targets demand management planning and implementation for wholesale customers north of the City.

The following is a summary of DEP's recent progress in implementing these strategies.

Municipal Water Efficiency Program

DEP has established partnerships and completed several projects with key municipal agencies and entities to support water efficiency measures in their facilities. Partners include the New York City Department of Education (DOE), the New York City Department of Parks and Recreation (DPR), the New York City Fire Department (FDNY), the City University of New York (CUNY), New York City Health and Hospitals Corporation (HHC), New York City Department of Citywide Administrative Services (DCAS), and New York City Department of Cultural Affairs – Cultural Institutions Group (CIG).

Through ongoing partnership with DOE, DEP has funded the replacement of over 40,000 new and efficient fixtures in over 500 school facilities across all five boroughs to date. In total, DOE retrofits are expected to save 3.86 MGD.

DEP's partnership with CUNY has included 780 fixture upgrades at City College for a demand savings of 0.04 MGD. DEP and CUNY extended their partnership and executed an interagency agreement to replace inefficient fixtures at Queens College. In total, DEP and CUNY plan on replacing over 600 fixtures across four campus buildings at Queens College for an estimated savings of 0.03 MGD. These upgrades are currently underway and are expected to be completed in 2023.

In 2022, DEP continued its partnership with DPR and the Central Park Conservancy and Prospect Park Alliance. In Central Park, the North End Recirculation Project will include a pumping and filtration system to recirculate water in the park's northern waterbodies and reduce flow to the City's combined sewer system. This project is currently in design and is anticipated to save 0.48 MGD. In Prospect Park, DEP continued coordinating with Prospect Park Alliance to replace a valve on the make-up water line for the park's lake system. In 2022, Prospect Park Alliance completed design. Once completed, the project is expected to save 0.80 MGD.

In January 2023, DEP launched its sixth Water Challenge to all 14 of the City's water resource recovery facilities (WRRFs) in the five boroughs. Similar to previous years, all facilities are being encouraged to reduce demand by 10% over a two-year baseline average from calendar years 2021 and 2022. The WRRF Challenge has the potential total savings of approximately 0.5 MGD.

DEP is also continuing to partner with HHC to complete additional HHC retrofit projects at Jacobi Hospital, Woodhull Hospital, Elmhurst Hospital, Bellevue Hospital, and North Central Bronx Hospital. Funding for these retrofits were transferred to HHC and vacuum pump retrofits are currently underway. These retrofits are expected to result in an overall savings of 0.17 MGD.

Residential Water Efficiency Program

In June 2019, DEP concluded the Toilet Replacement Program after five years of successful implementation. The program retrofitted approximately 13,300 toilets citywide for a savings of 0.63 MGD.

DEP works with Honeywell to provide building owners with complimentary household water conservation surveys to help identify opportunities for water savings and detecting leaks. Home surveys continue to be on pause since the outbreak of the COVID-19 pandemic. However, since the program started, home surveys are estimated to have saved 0.4 MGD. In total, DEP has achieved a demand savings of 1.03 MGD through these two initiatives.

Non-Residential Water Efficiency Program

The DEP Water Conservation and Reuse Grant Pilot Program incentivizes commercial and residential water conservation projects that achieve a minimum water savings of 2,740 gallons per day (1 million gallons per year). DEP has offered grant funding to one applicant and is currently in the process of confirming their funding and legal agreements. The project includes a 400,000-gallons-per-day water reuse system that contributes not only water conservation benefits, but also combined sewer overflow reductions. Overall, the pilot program is anticipated to save 0.2 MGD by 2023.

DEP has successfully completed several Water Challenges to different commercial sectors: hotels, restaurants, hospitals, and universities. Participants are encouraged to reduce their annual water consumption by at least 5% from their baseline year (measured as the 12-month period prior to the beginning of the challenge). DEP prepares monthly reports to help

participants track their consumption and their performance against the other participants. DEP also hosts quarterly workshops to help participants learn how to make their facilities more water efficient.

DEP's latest challenge, a two-year Water Challenge to universities, was completed in August 2020. Collectively, the six participants — Fordham University: Lincoln Center Campus, The New School, Long Island University: Brooklyn Campus, Pace University, St. John's University, and Weill Cornell Medicine — reduced their monthly average water consumption by 11%, surpassing the 5% Water Challenge goal, for a total savings of 0.12 MGD.

Water Distribution System Optimization

Water distribution system optimization includes system repairs and upgrades, water pressure management, refining water meter accuracy, and leak detection. In 2022, DEP surveyed a total of 811 miles of water mains. As a result of leaks proactively found and repaired, DEP estimates that 5.76 MGD of water per day were saved.

Leaking and/or vandalized fire hydrants can result in significant water waste; an illegally opened fire hydrant can release more than 1,000 gallons per minute. In 2022, DEP repaired 7,435 hydrants, replaced 822, and provided other maintenance services to 10,462 additional hydrants.

DEP continually works to improve maintenance of the pressure zones within the City's water distribution system. In 2022, DEP completed 5,079 preventive maintenance inspections/calibrations on pressure regulating valves. DEP also overhauled 48 of the 504 pressure regulating valves in use citywide. In 2022, the number of breaks per 100 miles was 6.92, slightly above the City's 10-year average of 6.58, and well below the accepted industry average of 25 breaks per 100 miles annually.

DEP's efforts to achieve universal metering of all DEP water and sewer accounts is motivated by the need to reduce non-revenue water and promote conservation among water users by providing accurate consumption information. The universal metering initiative is also critical to measuring the success of many other demand management strategies. Accurate consumption data enables DEP to determine whether target consumer groups have achieved projected consumption reductions or how demand management strategies may be adapted to improve their effectiveness. In 2022, DEP replaced 1,820 large meters.

To date, approximately 472,000customers have signed up for My DEP to view their bills, water usage, and payment history online This service also allows customers to pay their bills online and sign up for automatic billing (eBills); approximately 150,000 customers have signed up for eBills. To date, over 696,000 customers have signed up for leak alerts.

Water Supply Shortage Management

In May 2022, amendments to DEP's "Drought Emergency Rules" (15 RCNY Chapter 21) were formally adopted and promulgated. As amended, the rules are now titled the "Water Shortage Emergency Rules."

New York City's rulemaking process is governed by the procedure set forth in the City Administrative Procedure Act (CAPA). DEP first initiated the process of amending the Drought Emergency rules in July 2013. In January 2022, the Mayor's Office of Operations and the New York City Law Department certified DEP's final draft amendments to the "Drought Emergency Rules" ("Water Shortage Emergency Rules" as proposed by the amendments), and DEP subsequently noticed them for public review and comments. The City held a public hearing on the draft amendments in February 2022 as required under CAPA. The amendments to the rules were deemed final and effective as of May 13, 2022. The revisions to the rules expand their scope and applicability to include water shortages caused not only by hydrological droughts, but also other types of events such as planned and unplanned infrastructure outages.

The revisions also add, remove, and change certain water use prohibitions during the different stages of a water shortage emergency to provide more clarity and better reflect DEP's understanding of city water use. Although this action does not apply to routine residential water use such as drinking, bathing, or dishwashing, DEP expects that public awareness of the restrictions would lead to decreased residential water use during a declared water shortage emergency.

Wholesale Customers Water Demand Management Program

The Wholesale Customer Water Demand Management Program assisted DEP's seven upstate wholesale customers (utility partners) in developing demand management plans for their systems, with a target 5% reduction in consumption. All seven utility partners developed demand management plans under this program, with a total two-year sustained water demand savings of 5.21 MGD (a 9% decrease from their 2013 baseline). Due to unforeseen circumstances brought on by the COVID-19 pandemic, much of the anticipated funding for implementation of this program was reallocated. However, in 2022 DEP executed an agreement with Yonkers that will result in an additional estimated savings of 1.3 MGD.

9.2 Updates to Drought Management Plan

In 2022, monthly average precipitation was above normal for 50% of the year (based on historical average for the period 1993-2022). The NYC Delaware Basin Reservoir System storage stayed above the "Normal" storage level for the entire year. It was not necessary to invoke the City's Drought Management Plan, as the probability of refill did not fall below 50% for the Catskill or Delaware Systems.

The Drought Management Plan has three phases — Drought Watch, Drought Warning, and Drought Emergency — that are invoked sequentially as conditions dictate. The Drought Emergency phase is further subdivided into four stages with increasingly severe mandated use restrictions. Guidelines have been established to identify when a Drought Watch, Warning, or Emergency should be declared and when the appropriate responses should be implemented.

These guidelines are based on prevalent hydrological and meteorological conditions, certain operational considerations, and other factors. In some cases, other circumstances may influence the timing of drought declarations.

- Drought Watch is declared when there is less than a 50% probability that reservoirs in either of the two largest systems, the Delaware (Cannonsville, Neversink, Pepacton, and Rondout reservoirs) or the Catskill (Ashokan and Schoharie reservoirs), will fill by June 1, the start of the water year.
- Drought Warning is declared when there is less than a 33% probability that reservoirs in either the Catskill or Delaware systems will fill by June 1.
- Drought Emergency is declared when there is a reasonable probability that, without the implementation of stringent measures to reduce consumption, a protracted dry period would cause the City's reservoirs to be drained. This probability is estimated during dry periods in consultation with the New York State Drought Management Task Force and the New York State Disaster Preparedness Commission. The estimation is based on analyses of the historical record, the pattern of the dry period months, water quality, subsystem storage balances, delivery system status, system construction, maintenance operations, snow cover, precipitation patterns, use forecasts, and other factors. Because no two droughts have identical characteristics, no single probability profile can be identified in advance that would generally apply to the declaration of a Drought Emergency.

The Drought Management Plan was last revised in 2012 and DEP is currently working to update and revise the plan. DEP continues to encourage consumers to conserve water and to observe the City's year-round water use restrictions, which remain in effect. These restrictions include a prohibition on watering sidewalks and lawns between November 1 and March 31 and illegally opening fire hydrants.

9.3 Delaware Aqueduct Leak

DEP efforts to repair the Delaware Aqueduct continued in 2022 and included the following major activities:

- Completion of Shaft 5B and 6B (bypass tunnel) access shaft, final concrete lining, and significant completion of the access chambers. Final completion of the access chambers will take place following the Rondout-West Branch Tunnel (RWBT) shutdown.
- Installation, startup, and testing of the Shaft 6B drainage tunnel pump station that will be used during the RWBT shutdown connection dewatering.
- Construction of 16 new stop shutters and refurbishment of two existing leaf gates for use at the Rondout Effluent Chamber.

- Construction, startup, and testing of three 48-inch siphons to manage natural inflows to Rondout Reservoir and minimize spills during the RWBT shutdown.
- Decommissioning and reconstruction of the Honk Falls Dam (DEL-424) and restoration of the original streambed to support the increased flow from the Rondout siphons during the RWBT shutdown.

Tunnel Dewatering Preparation

The 50-million-gallons-per-day pumping station, which can dewater the RWBT under the expected conditions, is ready to operate. Quarterly meetings are held to review status of the monthly testing of the pumping station.

RWBT Bypass and Repair—Site and Shafts (BT-1) and Bypass Tunnel (BT-2)

The bypass tunnel contract, BT-2, continues to make progress. The final concrete lining of the tunnel was completed in October 2021. Final lining of the access shafts was completed in July 2022, and construction of the access chamber superstructures is significantly completed. The Shaft 6B drainage tunnel pump station installation was completed and tested in June 2022.

The shutdown of the RWBT for connection of the bypass to the existing RWBT will commence in autumn 2023. During the execution of the connection, workers will grout the leaks in the Wawarsing area of the tunnel from within the dewatered tunnel. DEP expects the bypass project to be completed by May 2024.

Hydraulic Investigations of the RWBT

Investigations of the RWBT help DEP assess the nature and degree of leakage stemming from the aqueduct. Efforts to study the nature of the leak are described below.

- The Tunnel Monitoring Program continued under DEP's DEL-LTA contract. The program's purpose is to determine if tunnel conditions are changing. DEP routinely monitors tunnel flow rates, operational trends, and surface expressions to confirm the steady-state condition of the RWBT leak. The monitoring efforts resulted in a determination of no substantial change during 2021.
- The DEL-LTA contract supports autonomous underwater vehicle and remote-operated vehicle flights within the RWBT as needed. No inspections were deemed necessary during 2022.

Catskill Aqueduct Repair and Rehabilitation

The CATRR project focuses on the section of the aqueduct between Ashokan Reservoir in Ulster County and Kensico Reservoir in Westchester County. The project's scope focuses on inspection of the entire aqueduct, repairing deficiencies (including concrete and mechanical components), and removing a biofilm layer on the interior walls to improve the hydraulic characteristics of the tunnel and restore tunnel capacity. CAT-RR construction commenced in August 2018. The fourth and final shutdown was carried out between October and mid-

December 2021 with significant scope achieved, including the stabilization of the Catskill Influent Weir at Kensico Reservoir, biofilm removal, valve replacement and repair of several steel pipe siphon locations, and wall and invert repairs in the Reynolds Grade Tunnel.

Two related projects include building chemical addition facilities at the Ashokan Screen Chamber (CAT-213E) and the Pleasantville Alum Plant (CAT-213F) to deliver chlorination and dechlorination chemicals and alum, respectively. CAT-213E reached substantial completion in October 2021. Substantial completion of CAT-213F is expected in February 2023.

9.4 Catskill/Delaware Filtration Plant

The 1997 Filtration Avoidance Determination first required the City to produce a preliminary design for filtration facilities for the Catskill/Delaware water supply. The 2002 FAD required the City to provide biennial updates to the preliminary plant design for the Catskill/Delaware (CAT/DEL) system (in addition to constructing an ultraviolet light disinfection facility that began fully operating in October 2012). The 2007 FAD continued to require the City to provide a biennial report updating the preliminary design for filtration facilities. In 2013 and 2015, the City and NYSDOH agreed no design changes to the 2009 preliminary plans for the CAT/DEL filtration facilities were necessary. In recognition that the work supporting the existing preliminary plans was over 25 years old, the 2017 FAD required the City to contract for a comprehensive review of filtration methods and technologies, resulting in a new conceptual design for a filtration facility or facilities.

DEP completed the initial phase of the design project, which included bench scale studies, in 2020. Following evaluation of the results, DEP initiated phase two of the project in 2021. The second phase includes the design, construction, and operation of large-scale pilot plants; completion of pilot studies and a report; and completion of a full-scale conceptual design. The 2022 work included finalizing the design of a Catskill Aqueduct connection needed to supply the pilot facilities, developing a conceptual design of the pilot facilities, progressing pilot testing protocols, selecting the general contractor responsible for purchasing and installing the pilot equipment, and assembling an independent technical review team.

9.5 Arkville office

DEP has committed to locate staff in a new office recently constructed in Arkville, N.Y. by the Catskill Watershed Corporation. The goal of sharing space is to further improve coordination on joint programs and to enhance accessibility for watershed communities. The FAD requires DEP to assign specific numbers of staff to the new facility in the coming years.

Construction of the new building in Arkville was substantially complete in spring 2020, and DEP staff began to take occupancy of the building later that year. As of the end of 2022, DEP had 20 full-time employees working in the building. DEP has allocated additional vacant positions to be based in Arkville; those positions will be filled as allowed by the City’s hiring process.

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Appendix A: Land Acquisition Tables

Appendix A Table 1 Status of acquisitions since January 1, 2010, by town.

Delaware County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Andes	5,835	2,029	7,865	7,690	102%			175	4,614
Walton	2,936	2,036	4,971					0	2,000
Delhi	3,173	1,397	4,570	3,951	116%			619	2,371
Middletown	2,380	839	3,218	4,983	65%	1,765		0	2,990
Roxbury	2,665	487	3,151			849		0	2,000
Bovina	2,063	402	2,466	2,785	89%	319		0	1,671
Kortright	986	1,401	2,387			1,613		0	2,000
Stamford	1,365	886	2,251	4,539	50%	2,288	473	0	2,723
Hamden	934	1,093	2,027	3,640	56%	1,613	157	0	2,184
Meredith	835	436	1,271			2,729	729	0	2,000
Tompkins	521	177	699			3,301	1,301	0	2,000
Colchester	400	110	510			3,490	1,490	0	2,000
Franklin	286	182	469			3,531	1,531	0	2,000
Masonville	332	0	332			3,668	1,668	0	2,000
Harpersfield	20	184	204			3,796	1,796	0	2,000
	24,731	**11,659**	**36,390**						

Greene County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Windham	1,631	499	2,130	2,207	97%	77		0	1,324
Lexington	1,755	155	1,911	3,771	51%	1,861	352	0	2,263
Jewett	1,548	0	1,548	2,794	55%	1,246	128	0	1,676
Hunter	1,326	0	1,326	2,726	49%	1,400	310	0	1,636
Prattsville	1,223	0	1,223	2,346	52%	1,123	185	0	1,408
Ashland	974	0	974	1,948	50%	974	195	0	1,169
Halcott	558	61	619	1,571	39%	952	324	0	943
	9,015	**715**	**9,730**						

Schoharie County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Conesville	420	405	825	2,400	34%	1,575	615	0	1,440
Gilboa	409	0	409			3,591	1,591	0	2,000
Jefferson	85	0	85			3,915	1,915	0	2,000
	914	**405**	**1,319**						

Sullivan County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Neversink	1,745	0	1,745	4,472	39%	2,727	939	0	2,683
	1,745	**0**	**1,745**						

Ulster County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Olive	925	0	925	1,899	49%	974	214	0	1,139
Denning	710	0	710	5,046	14%	4,336	2,318	0	3,028
Wawarsing	486	0	486			3,514	1,514	0	2,000
Shandaken *	474	0	474	1,450	33%		396	0	870
Woodstock	414	0	414	2,593	16%	2,179	1,142	0	1,556
Hardenburgh	84	164	249	3,641	7%	3,392	1,936	0	2,185
	3,093	**164**	**3,258**						

Putnam County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
Kent	718	0	718			3,282	1,282	0	2,000
Carmel	169	0	169			3,831	1,831	0	2,000
	887	**0**	**887**						

Westchester County Town	City Acres	WAC Acres	Total Executed	EIS Proj. thru 2022	% of EIS Proj.	Acres to No Out-Going Sol	Acres to 1/2 mile = 50%	Acres Exceeded	60% of Cap or 2k Max
North Castle	109	0	109			3,891	1,891	0	2,000
Mount Pleasant	49	0	49			3,951	1,951	0	2,000
New Castle	12	0	12			3,988	1,988	0	2,000
	170	**0**	**170**						
	40,555	**12,943**	**53,498**						

* Out-Going Solicitation is prohibited in Shandaken per the 2010 Water Supply Permit.

** SWC = Surface Water Criteria

*** "60% of Cap or 2k Max" refers to whether the LAP is limited to 60% of the town cap or 2,000 acres before solicitation constraints must be implemented.

Acquisition within 1/2 mile of designated areas is per 2018 LAP Solicitation Modifications.

Figures in blue highlights remaining acres under 1,000.

Uses DEP Acres so each parcel is counted within its respective town.

= No outgoing solicitation and >50% SWC required within 0.5-mile of Designated Hamlets

= >50% SWC required within 0.5-mile of Designated Hamlets

Appendix A Table 2 Contracts signed in the CAT/DEL System by reporting period and R.E. Type

Reporting Period: 1995 to 2021

R.E. Type	# of Contracts	Acres	Avg. Size of Project	SWC Acres	Avg. % SWC per Project	Slope Acres	Avg. % Slope per Project
City CE	170	25,933	153	7,155	28%	16,490	64%
City FBO	23	51	2	51	100%	20	39%
City Fee	1,369	96,881	71	27,371	28%	58,071	60%
FEMA	64	74	1	65	88%	16	21%
SAP	29	240	8	180	75%	108	45%
WAC CE	157	28,229	180	8,163	29%	15,087	53%
WAC FE	9	2,982	331	463	16%	2,239	75%
	1,821	**154,390**	**85**	**43,448**	**28%**	**92,029**	**60%**

Reporting Period: 2022

City FBO	3	13	4	12	91%	4	29%
City Fee	13	724	56	346	48%	362	50%
SAP	4	33	8	29	89%	20	61%
	20	**770**	**39**	**387**	**50%**	**386**	**50%**

Program-to-date Sub-Totals

City CE	170	25,933	153	7,155	28%	16,490	64%
City FBO	26	64	2	63	98%	23	37%
City Fee	1,382	97,605	71	27,717	28%	58,433	60%
FEMA	64	74	1	65	88%	16	21%
SAP	33	273	8	209	77%	128	47%
WAC CE	157	28,229	180	8,163	29%	15,087	53%
WAC FE	9	2,982	331	463	16%	2,239	75%
Grand Totals:	**1,841**	**155,160**	**84**	**43,835**	**28%**	**92,415**	**60%**

-Survey acres are used to calculate project acres for closed properties. SWC (Surface Water Criteria) acres are based on GIS and tax parcel acres and may not be as accurate.
-Pursuant to the 1997 Memorandum of Agreement, SWC includes acreage that is within (a) 300 feet of a watercourse, (b) 1,000 feet of reservoirs, (c) areas designated as 1% return interval flood (100 year base flood), and/or (d) wetlands (defined as federal jurisdiction wetlands larger than five acres, or designated by NYSDEC).
-Slope: Acres that are at or greater than 15% grade.
-In some cases SWC acres may appear to be greater than project acres, this is because SWC acres are GIS based and project acres are survey based. Therefore, they do not always align.

Appendix A Table 3 Contracts signed in the CAT/DEL System by reporting period and R.E. Type

Reporting Period: 1995 to 2021

R.E. Type	# of Contracts	Acres	Avg. Size of Project	Purchase Price
City CE	170	25,933	153	$72,229,273
City FBO	23	51	2	$3,595,069
City Fee	1,369	96,881	71	$370,568,539
FEMA	64	74	1	$453,575
SAP	29	240	8	$1,621,035
WAC CE	157	28,229	180	$41,539,880
WAC FE	9	2,982	331	$2,891,334
	1,821	**154,390**	**85**	**$492,898,706**

Reporting Period: 2022

City FBO	3	13	4	$826,000
City Fee	13	724	56	$15,759,109
SAP	4	33	8	$206,810
	20	**770**	**39**	**$16,791,919**

Program-to-date Sub-Totals

City CE	170	25,933	153	$72,229,273
City FBO	26	64	2	$4,421,069
City Fee	1,382	97,605	71	$386,327,648
FEMA	64	74	1	$453,575
SAP	33	273	8	$1,827,845
WAC CE	157	28,229	180	$41,539,880
WAC FE	9	2,982	331	$2,891,334
Grand Totals:	**1,841**	**155,160**	**84**	**$509,690,625**

Appendix A Table 4 Contracts closed in the CAT/DEL System by reporting period and R.E. Type

Reporting Period: 1995 to 2021

R.E. Type	# of Contracts	Acres	Avg. Size of Project	SWC Acres	Avg. % SWC per Project	Slope Acres	Avg. % Slope per Project
City CE	170	25,933	153	7,155	28%	16,490	64%
City FBO	22	47	2	47	100%	19	40%
City Fee	1,359	96,166	71	27,114	28%	57,605	60%
FEMA	64	74	1	65	88%	16	21%
SAP	25	198	8	145	73%	80	40%
WAC CE	157	28,229	180	8,163	29%	15,087	53%
WAC FE	9	2,982	331	463	16%	2,239	75%
	1,806	**153,630**	**85**	**43,152**	**28%**	**91,535**	**60%**

Reporting Period: 2022

City Fee	2	19	10	9	44%	7	37%
SAP	1	30	30	24	82%	23	79%
	3	**49**	**16**	**33**	**67%**	**30**	**63%**

Program-to-date Sub-Totals

City CE	170	25,933	153	7,155	28%	16,490	64%
City FBO	22	47	2	47	100%	19	40%
City Fee	1,361	96,186	71	27,122	28%	57,612	60%
FEMA	64	74	1	65	88%	16	21%
SAP	26	227	9	169	74%	103	46%
WAC CE	157	28,229	180	8,163	29%	15,087	53%
WAC FE	9	2,982	331	463	16%	2,239	75%
Grand	**1,809**	**153,678**	**85**	**43,185**	**28%**	**91,566**	**60%**

-Survey acres are used to calculate project acres for closed properties. SWC (Surface Water Criteria) acres are based on GIS and tax parcel acres and may not be as accurate.
-Pursuant to the 1997 Memorandum of Agreement, SWC includes acreage that is within (a) 300 feet of a watercourse, (b) 1,000 feet of reservoirs, (c) areas designated as 1% return interval flood (100 year base flood), and/or (d) wetlands (defined as federal jurisdiction wetlands larger than five acres, or designated by NYSDEC).
-Slope: Acres that are at or greater than 15% grade.
-In some cases SWC acres may appear to be greater than project acres, this is because SWC acres are GIS based and project acres are survey based. Therefore, they do not always align.

Appendix A Table 5 Contracts closed in the CAT/DEL System by reporting period and R.E. Type

Reporting Period: 1995 to 2021

R.E. Type	# of Contracts	Acres	Avg. Size of	Purchase Price
City CE	170	25,933	153	$72,229,273
City FBO	22	47	2	$3,510,069
City Fee	1,359	96,166	71	$367,738,299
FEMA	64	74	1	$453,575
SAP	25	198	8	$1,383,449
WAC CE	157	28,229	180	$41,539,880
WAC FE	9	2,982	331	$2,891,334
	1,806	**153,630**	**85**	**$489,745,880**

Reporting Period: 2022

City Fee	2	19	10	$128,950
SAP	1	30	30	$71,586
	3	**49**	**16**	**$200,536**

Program-to-date Sub-Totals

City CE	170	25,933	153	$72,229,273
City FBO	22	47	2	$3,510,069
City Fee	1,361	96,186	71	$367,867,249
FEMA	64	74	1	$453,575
SAP	26	227	9	$1,455,035
WAC CE	157	28,229	180	$41,539,880
WAC FE	9	2,982	331	$2,891,334
Grand Totals:	**1,809**	**153,678**	**85**	**$489,946,416**

Appendix A Table 6 Parcels eased or acquired in fee simple, 2022. newly acquired tax parcels by county and town and closing date; System = CAT/DEL

NYC Property ID	County	Town	Basin	Pri Area	Tax Map	Location	R.E. Type	Acquired Acres	Closing Date
8899	Greene	Jewett	Schoharie	4	111.00-3-7	Goshen St	Fee (City Fee)	14.1	05/25/2022
9725	Schoharie	Gilboa	Schoharie	3	207.-1-2.1	South Gilboa Rd	Fee (SAP)	29.5	12/23/2022
866	Ulster	Wawarsing	Rondout	1A	58.4-1-10.100	Mancuso Road	Fee (City Fee)	5.1	11/03/2022
Grand Totals:					Count: **3**			**48.7**	

Appendix A Table 7 Summary of LAP signed contracts program-to-date by priority area.

	1997 - 2021			2022			Program-to-Date Totals		
Priority Area	Contracts	Acres	Price ($millions)	Contracts	Acres	Price ($millions)	Contract	Acres	Price ($millions)
1A	135	5,151	$34.4	3	111	$12.7	138	5,261	$47.1
1B	339	18,757	$135.3	2	93	$0.6	341	18,850	$135.9
2	203	11,744	$37.8	3	13	$0.8	206	11,758	$38.6
3	429	43,137	$97.1	3	97	$0.5	432	43,234	$97.5
4	715	75,601	$188.3	9	455	$2.2	724	76,057	$190.5
Grand Totals:	**1,821**	**154,390**	**$492.9**	**20**	**770**	**$16.8**	**1,841**	**155,160**	**$509.7**

Appendix A Table 8 New York City-funded Flood Buyout Program - purchase contracts by county.

	ID	Municipality	Owner	Acres	Status
Delaware					
	9316	Fleischmanns, Village c	City	0.2	Closed
		County Subtotal	**1**	**0.2**	
Greene					
	8847	Hunter, Town of	City	21.5	Closed
	9243	Hunter, Town of	City	1.2	Closed
	9586	Hunter, Village of	Village	0.1	Acquired by Muni through LAP
	9621	Hunter, Village of	Village	0.1	Contract Executed
	9622	Hunter, Village of	Village	0.2	Contract Executed
	9623	Hunter, Village of	Village	0.1	Contract Executed
	8883	Jewett, Town of	City	4.8	Closed
	8934	Tannersville, Village of	Village	0.5	Acquired by Muni through LAP
	9486	Tannersville, Village of	Village	0.5	Acquired by Muni through LAP
	9487	Tannersville, Village of	Village	0.5	Acquired by Muni through LAP
	9573	Windham, Town of	Town	0.3	Acquired by Muni through LAP
		County Subtotal	**11**	**29.9**	
Schoharie					
	8884	Conesville, Town of	City	0.6	Closed
	8963	Conesville, Town of	Town	0.6	Acquired by Muni through LAP
	9306	Conesville, Town of	City	2.8	Closed
		County Subtotal	**3**	**4.1**	
Ulster					
	9309	Olive, Town of	Town	1.3	Acquired by Muni through LAP
	9311	Olive, Town of	Town	1.6	Acquired by Muni through LAP
	9315	Olive, Town of	Town	0.3	Acquired by Muni through LAP
	9374	Olive, Town of	City	1.2	Closed
	9381	Olive, Town of	City	0.9	Closed
	4988	Shandaken, Town of	City	4.4	Closed
	9393	Shandaken, Town of	City	1.6	Closed
	9406	Shandaken, Town of	Town	0.5	Acquired by Muni through LAP
	9408	Shandaken, Town of	Town	0.5	Acquired by Muni through LAP
	9419	Shandaken, Town of	City	1.2	Closed
	9551	Shandaken, Town of	Town	12.1	Contract Executed
	9665	Shandaken, Town of	City	3.4	Contract EXTENDED
	9809	Shandaken, Town of	Town	0.3	Contract Executed
	9830	Shandaken, Town of	Town	1.0	Contract Executed
		County Subtotal	**14**	**30.4**	
	Totals:	**Count: 29**		**64.6**	