New York City Department of Environmental Protection
Bureau of Water Supply

Waterfowl Management Program

October 31, 2019

Prepared in accordance with Section 4.1 of the NYSDOH 2017 Filtration Avoidance Determination

A Waterfowl Management Program was developed to evaluate and mitigate pollutant impacts (fecal coliform bacteria) from migratory and resident waterbirds (waterfowl, gulls and cormorants). The purpose of this report is to evaluate the trends in bird numbers and their effect on fecal coliform bacteria levels from August 1, 2018 to July 31, 2019

Prepared by: Christopher A. Nadareski, Section Chief, Wildlife Studies
DEP, Bureau of Water Supply
Division of Watershed Water Quality Operations

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The author, Mr. Christopher A. Nadareski, is a City Research Scientist and DEP's Section Chief of Wildlife Studies and Contract Project Manager. He is responsible for the Waterfowl Management Program development and implementation including data management, field data collection, and contract administration.

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INTRODUCTION

The management of waterbird populations at key reservoirs throughout the New York City Water Supply is essential to meet stringent water quality regulations as stated in the Environmental Protection Agency's (USEPA) Surface Water Treatment Rule (SWTR) (USEPA 1989). As a result, New York City Department of Environmental Protection (DEP) developed and implemented a comprehensive Watershed Protection Program to protect its water supply and as a requirement of Filtration Avoidance Determinations (FAD) received from USEPA and New York State Department of Health (NYSDOH). A component of the Watershed Protection Plan is DEP's Waterfowl Management Program (WMP), established to research and manage the relationship between wildlife, particularly waterbirds (geese, gulls, cormorants, swans, ducks, and other duck-like birds) that inhabit the reservoirs and fecal coliform bacteria elevations in the untreated and treated surface water. The Waterfowl Management Program, originally developed for NYC's Kensico Reservoir in 1992, was expanded to include five additional reservoirs for waterbird management under the November 2002 Filtration Avoidance Determination (FAD) (Section 4.1 – Waterfowl Management Program). The 2007 FAD (USEPA 2007) further expanded the program to include bird management at Hillview Reservoir in Yonkers, New York. The new 2017 FAD was issued to DEP in December 2017, which will remain in effect until a further determination is made (NYSDOH 2017).

The WMP was designed to study the relationship between seasonal trends in bird populations on the reservoirs as well as trends in fecal coliform concentrations both within the reservoirs and at the keypoint water sampling locations. Following several years of waterbird population monitoring, DEP's scientific staff consisting of wildlife biologists and microbiologists identified birds as a significant source of fecal coliform at the Kensico Reservoir (DEP 1993). In response, DEP developed and implemented a Waterfowl Management Program using standard bird management techniques (approved by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA) and the New York State Department of Environmental Conservation (NYSDEC)) to reduce or eliminate the waterbird populations inhabiting the reservoir system (DEP 2002). DEP has also acquired a depredation permit, a federal registration from the United States Fish & Wildlife Service (USFWS) and a License to Collect and Possess from NYSDEC to employ additional wildlife management techniques. Since the initial implementation of DEP's bird dispersal and deterrent techniques in 1993, there has been a significant reduction in both bird populations and fecal coliform bacteria levels, thus maintaining high quality water in compliance with the SWTR.

Migratory populations of waterbirds utilize NYC reservoirs as temporary staging areas and wintering grounds and therefore can significantly contribute to increases in fecal coliform loadings in the reservoirs during the autumn and winter, primarily from direct fecal deposition. These local and migrant waterbirds generally roost nocturnally and occasionally forage and loaf diurnally on the reservoirs, however, it has been determined that most of the feeding activity

occurs away from the reservoirs. Fecal samples collected and analyzed for fecal coliform bacteria concentrations from both Canada Geese (*Branta canadensis*) and Ring-billed Gulls (*Larus delawarensis*) revealed that fecal coliform concentrations are high per gram of feces. Alderisio and DeLuca (1999) sampled 236 Canada Geese and 249 Ring-billed Gulls from in and around Kensico Reservoir to determine fecal coliform counts per gram of feces. The results identified average bacteria levels as follows: Canada Geese (1.53×10^4 FC/g) and for Ring-billed Gulls (3.68×10^8 FC/g).

Water samples collected near waterbird roosting locations have shown fecal coliform increases concurrent with waterbird populations at several NYC reservoirs in annual DEP reports (DEP 1992 - 2018). Since waterbirds have been associated with elevated fecal coliform bacteria levels found in various reservoirs and lakes (Gould and Fletcher 1978, Hussong et al. 1979, Standridge et al. 1979, Benton, et al. 1983, DEP 1992 and 1993, Levesque et al. 1993, Hatch, 1996), a program to discourage waterbird activity was developed for Kensico Reservoir in the autumn of 1993 and is expected to continue indefinitely. The bird dispersal program was expanded in 2004 to allow for "as-needed" waterbird management at five additional reservoirs (Rondout, West Branch, Ashokan, Croton Falls, and Cross River). Since that time, the "as-needed" program has been implemented six times with actions at Rondout Reservoir during the winters of 2002/2003, 2003/2004 and 2005/2006, West Branch Reservoir in 2007 and 2010/2011, and at Croton Falls Reservoir (conducted under an emergency program prior to the issuance of the Final Environmental Impact Statement) during the winter of 2001/2002. To ensure DEP's program activities remained in compliance with all federal, state, and local laws including effects on local communities and environmental conditions including endangered species, an Environmental Impact Statement was completed for Kensico in 1996 and second one in the spring of 2004 that included five additional "as-needed" reservoirs. The Final Environmental Impact Statement including a "findings statement" can be found on the DEP website identifying program impacts and required mitigation to meeting implementation standards for the expanded WMP (DEP 2004). This report is a requirement of the current 2017 FAD (NYSDOH 2017).

The purpose of this report is to evaluate further the downtrend observed in waterbird populations and its impact on fecal coliform bacteria concentrations because of DEP's Waterfowl Management Program for the period August 1, 2018 through July 31, 2019.

METHODS

Waterfowl Management Program

The Waterfowl Management Program was initiated in 1992 by the City for the Kensico Reservoir in response to elevated fecal coliform bacteria levels reported in the Reservoir. DEP determined that the water leaving Kensico had higher levels of bacteria than the water entering Kensico from source reservoirs and as a result focused on identifying and mitigating local inputs of bacterial pollution (DEP 1992). Preliminary waterbird surveys conducted by DEP staff in 1992 demonstrated a seasonality effect of increased numbers of roosting birds and elevated fecal coliform bacteria levels. By December 1993, DEP initiated a daily (24-hour/day) program which was further refined to a pre-dawn to post-dusk bird dispersal effort in 1994. The bird dispersal program evolved into a tri-season effort from August through March annually. The program was subsequently expanded to include additional reservoirs.

The 2002 FAD required that the City continue this program for the Kensico Reservoir on an annual basis and expand the program to an "as-needed" basis for five additional reservoirs. Three of these five reservoirs (West Branch, Rondout, and Ashokan) routinely supply Kensico as source water (Appendix A Figures 34 and 35). The remaining two reservoirs (Cross River and Croton Falls), while in the Croton System (Appendix A Figure 34), may also provide Kensico with source water under certain conditions and with permission from the New York State Department of Health. The objective of the program is to minimize the fecal coliform loading to the reservoirs that result from roosting birds during the migratory season. The program includes four activities: avian population monitoring, avian dispersal activities (motorboats, airboats, propane cannons, physical chasing, remote control motorboats, and pyrotechnics), avian deterrence (depredation of nests and eggs, bird exclusion wires, and netting at critical intake chambers) and wildlife sanitary surveys. All avian dispersal techniques and deterrence activities have been recommended and fully approved by USFWS, USDA, and NYSDEC.

The City's 2006 Long-Term Watershed Protection Program expanded the Waterfowl Management Program to include "as-needed" avian dispersal activities for the Hillview Reservoir as well as avian deterrent measures for Hillview and other City reservoirs.
The term "as-needed" refers to implementation of avian management measures based on the following criteria:

- Fecal coliform bacteria concentrations approaching or exceeding 20 colony-forming units per 100 milliliters at reservoir effluent structures coincident with elevated bird populations;
- Current bird populations, including roosting or staging locations relative to water intakes;
- Recent weather events;
- Operational flow conditions within the reservoir (i.e. elevations and flow patterns and amounts);

- Reservoir ice coverage and watershed snow cover; and
- An assessment that active bird management measures would be effective in reducing bird populations and fecal coliform bacteria levels.

The 2017 FAD Activity and Reporting Requirements for the Waterfowl Management Program are outlined in Table 1, below.

Table 1. 2017 FAD Activity and Reporting Requirements (NYSDOH 2017).

Activity	Due Date
Active Waterbird Dispersal – Kensico Reservoir	Annually, 8/1 to 3/31
Active Waterbird Dispersal – Hillview Reservoir	Year-round
"As-needed" Bird Dispersal – West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs.	Annually, 8/1 to 4/15
"As-Needed" Bird Deterrent Measures – Kensico, West Branch, Rondout, Ashokan, Croton Falls, Cross River, and Hillview Reservoirs.	Year-round
Report Description	**Due Date**
Summary of Waterfowl Management Program activities at all reservoirs, including wildlife management at Hillview Reservoir (8/1 to 7/31).	Annually, 10/31

Waterfowl Management Program Contract Status

The current three-year Waterfowl Management Program Contract (WMP-16 Renewal) is in the second year of a two-year contract renewal period through July 30, 2020 for services that are provided by DEP contractor Henningson, Durham, and Richardson, P.C. (HDR) of Omaha, Nebraska.

Waterbird Census

The relationship between elevated waterbird counts and increased levels of fecal coliform bacteria identified from raw water samples is well established. New York City reservoirs, situated in southeastern New York State, lie in the Atlantic Flyway, an important migratory pathway for many guilds of birds including waterbirds. The NYC reservoirs may offer important areas of open fresh water used for night roosting, foraging, winter stopovers, and breeding habitat for some waterbirds species. Since the primary bacterial contribution to the water supply is from migratory waterbirds that roost overnight and defecate in the reservoirs, night census data is mostly presented throughout this report. Defecation rates of waterbirds are typically lower

nocturnally than diurnally due to reduced foraging and physical activity, and overnight roosting involves longer periods of time during which the birds habituate on the reservoirs (DEP 1993).

Daily waterbird observations were conducted at predawn hours (between 4:30am and 8:00am E.S.T.) and post dusk hours (between 5:00pm and 10:00pm E.S.T.) to determine overnight waterbird roosting populations and to evaluate the success of the dispersal activities from the previous day at surveyed reservoirs. Survey times (pre-dawn and post-dusk) vary seasonally reflecting available daylight hours. For successful data collection, ideal weather and atmospheric conditions were necessary. Some precipitation events and fog prohibited data collection and resulted in short gaps of "no data". Reservoir maps with geographic bird zones can be found in Appendix A.

The 2017 FAD, Protection and Remediation Programs, Section 4.1 specifies the frequency of active bird dispersal and "as needed" dispersal and deterrence measures as listed in Table 2 of this report. In May 2013, NYSDOH approved DEP's request to reduce bird surveys for West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs. To fulfill the NYSDOH request that DEP continue to monitor populations of birds that are roosting or staging in close proximity to reservoir water intakes, DEP performed diurnal bird population observations at Rondout, Ashokan, and West Branch Reservoir effluent chambers during routine site visits by DEP Aqueduct Monitoring staff in the form of un-aided (i.e., without binoculars) observations on a weekly basis. Table 2 lists proposed and actual DEP and contractor waterbird surveys conducted at Kensico, West Branch and Hillview reservoirs from August 1, 2018 to July 31, 2019.

Table 2. Frequency of bird observation surveys by reservoir 2018/2019[1].

Reservoir	Bird Surveys Scheduled	Proposed/Actual Surveys
Kensico	Pre-dawn to post-dusk daily August 1, 2018 to March 31, 2019; Pre-dawn and post-dusk weekly April 1 to July 31, 2019	279/270[2,3]
West Branch	Pre-dawn, midday, and post-dusk, biweekly; August 1, 2018 to April 15, 2019	17/18[3]
Hillview	Pre-dawn, midday, and post-dusk daily all year	365/361[3]

[1] Special surveys conducted at Croton Falls, Cross River, and Rondout Reservoir are summarized in the results section.

[2] Three surveys were cancelled due to holiday observances.

[3] Surveys were cancelled or overnight data not collected due to severe winter storms, fog and other weather-related events.

Reservoir-wide observational surveys for waterbirds were conducted year-round at

Kensico and Hillview Reservoirs and for part of the year at West Branch Reservoir (Table 2). Waterfowl management including population monitoring and dispersal actions are conducted only on an "as needed" basis at Rondout, Ashokan, Croton Falls, and Cross River, Reservoirs. West Branch waterbird monitoring surveys are conducted biweekly from August 1 through April 15 annually and on an "as-needed" basis for the remainder of the year.

For each survey the following parameters were recorded: species evenness (number per species), species richness (species diversity), roosting and foraging locations, flight patterns into and out of the reservoir, bird band/collar identifications, general behavior during the overnight roosting period, environmental conditions, and ice-cover. Waterbird data was collected from shoreline locations and/or watercraft (motorboat, Jon boat, or airboat) by a trained wildlife biologist, ornithologist, or wildlife technician using binoculars and spotting scopes. Both contractor and DEP personnel conducted the collection of field data using field ToughPads to record observation locations with times for each reservoir. Data was entered in an Excel spreadsheet and were checked twice for Quality Assurance/Quality Control.

Each survey data point can consist of a minimum of one or two site visits per datum reported (i.e. night before and morning after the nightly roost), and may be dependent on the field conditions (i.e. weather, fog), reservoir physical characteristics (i.e. drought, ice cover), and time of year (leaf-cover or not). Data collected during reservoir-wide surveys that were incomplete due to inclement weather were not reported. Only high counts for each category of waterbirds were used for data recording. For example, if there were a count of 20 Canada Geese during the post-dusk survey and a count of 20 ducks observed at the pre-dawn survey, the combination of 20 geese and 20 ducks would give a reservoir-wide total of 40 birds. The purpose of using two surveys for data collection is to determine the species highest concentrations over a specific time. At certain times of the year, some species were easier to count in the evening when birds are flying into roost areas (or open water) whereas other species were more efficiently counted when flying out of the reservoir in the early morning.

Waterbird population zones were delineated at all reservoirs to identify local impacts on water quality and the results have been described in previous DEP reports for Kensico and West Branch Reservoirs (DEP 1994, 1995, 1997a).

Fecal Coliform Bacteria Data

Data reported on fecal coliform bacteria concentrations for both keypoint raw water samples (aqueduct and outflows) and reservoir samples were reviewed by DEP laboratory and field personnel. The following conditions apply to the water quality data included in this report:

- Only high concentration duplicate samples are reported (for example if two keypoint samples were collected in a single day, or if more than one sample is collected at different depths at a single limnology sampling location, the highest bacteria count has

been reported)
- All water samples reported below the detection limit of 1 fecal coliform 100mL^{-1} were reported as non-detected
- All special investigation samples are reported
- Reanalysis samples are reported
- There was one samples with confluent growth reported for Ashokan Reservoir

Water quality data presented in this report were from samples collected, analyzed and reported by DEP's Watershed Water Quality Operations and Distribution Water Quality Operations personnel from four New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified laboratories in Hawthorne, Kingston, Grahamsville, and Queens, New York. DEP watershed laboratory personnel utilized the Membrane Filtration Technique (APHA 1997, 2006) for fecal coliform analyses. DEP's Distribution Laboratory personnel utilized the Colilert18 with Quantitray for *E.coli* analyses for samples collected at Hillview Reservoir. Reservoir-wide waterbird survey results are presented with fecal coliform bacteria levels from keypoint (outflow) facilities.

Precipitation Data

Precipitation data used in this report for the Kensico Reservoir were provided by DEP's Bureau of Water Supply Source Water Operations Directorate staff and were recorded at the Westchester County Airport meteorological station, located in White Plains, New York, adjacent to Kensico Reservoir and at the DEP Meteorological Station near the DEL18DT Effluent.

Waterbird Dispersal and Deterrent Techniques

The list of bird mitigation activities conducted during this reporting period is presented in Table 3. Waterbird dispersal techniques were employed at Kensico Reservoir from August 1, 2018 through March 31, 2019 using motorboats, airboats, Jon boats, physical chasing, and noisemakers (pyrotechnics include bird bangers, screamers, and CAPA's). At Hillview Reservoir, pyrotechnics, physical chasing, propane cannons, and remote-control motorboats were used as deemed necessary on a daily basis year-around during this reporting period. Dispersal techniques were conducted under a DEP Waterfowl Management Program contract (WMP-16 Renewal) and by DEP staff. Beginning at 8:00am and continuing until approximately 1.5 hours past sunset, bird dispersal activities were conducted reservoir-wide, targeting all species except those with a federal or NYS endangered or threatened status. Those species include N.Y.S. threatened Pied-billed Grebe (*Podilymbus podiceps*), Bald Eagle (*Haliaeetus leucocephalus*), N.Y.S endangered Peregrine Falcon (*Falco peregrinus*), and NYS species of special concern Osprey (*Pandion haliaeetus*) and Common Loon (*Gavia immer*).

Airboats, capable of operating over ice and water interfaces with ease, were available for bird dispersal again in 2018/2019 at Kensico. The airboats have heated cabins that allow

contractor personnel to remain on-reservoir for longer periods conducting bird dispersal operations during reservoir freezing periods throughout the winter. In addition, an Intergovernmental Cooperative Service Agreement contract has been continued with USDA to conduct lethal management of a migrant duck population at Hillview Reservoir as a last choice option. Details of the contract work are discussed in the Hillview Reservoir section of this report.

Table 3. Reservoir bird mitigation (8/1/2018 – 7/31/2019).

Reservoir	Dates of Bird Dispersal and Deterrence	Bird Dispersal and Deterrence Measures Used
Kensico	August 1, 2018 – July 31, 2019	• Bird dispersal (motorboats, airboats, Jon boats, and pyrotechnics)[1] • Shoreline meadow management and fencing • Alewife containment and collections • Maintenance of bird netting for terrestrial bird management for swallows, starlings, pigeons, sparrows, and other small birds • Wildlife excrement sanitary surveys for pre-storm events • Egg and nest depredation for geese and swans[2]
Hillview	August 1, 2018 - July 31, 2019	• Bird deterrent overhead wire system, bird dispersal (pyrotechnics, propane cannons, physical chasing, remote control motorboats) • Mammal management via trapping/euthanasia • Alewife (baitfish) collections • Maintenance of bird netting for terrestrial bird management for swallows, starlings, pigeon, sparrows, and other small birds • Maintenance of bird deterrent wires on shaft buildings and on dividing wall railings, swallow and sparrow depredation • Mallard depredation • Lethal duck management (as needed) • Egg and nest depredation for Mallards and swallows[3] • Wildlife excrement sanitary surveys as needed.

[1] **Bird dispersal actions at Kensico Reservoir were conducted from August 1, 2018 to March 31, 2019**

[2] **Egg and nest depredation for geese and swan were conducted from April 1 to May 31, 2019**

3 Egg and nest depredation for Mallards and Swallows were conducted from April 1 to August 31, 2019

All bird deterrent techniques such as bird netting on reservoir shaft buildings were maintained throughout the upstate reservoirs. Ongoing maintenance of bird deterrent equipment at Hillview Reservoir continued to improve the success of diverting waterbirds and terrestrial avian species from inhabiting the surface water (Table 3). Such measures included routine repairs to an overhead bird deterrent wire system and dividing wall bird exclusion wire system at Hillview, bird netting covering effluent building intake openings, and removal of baitfish entering the reservoir from aqueducts.

In response to the seasonal entrainment of Alewives (*Alosa pseudoharengus*) and other bait-sized fish species into the water intake structures at Ashokan Reservoir and their subsequent outflow at Kensico Reservoir, DEP's Waterfowl Management contractor installed a temporary collection boom as deemed necessary around the Catskill Influent Chamber structure (CATIC) so that dead fish could be removed. Collection of Alewives and other bait-sized fish was conducted as needed from the Hillview Reservoir dividing wall using landing nets to retrieve all dead floating fish to eliminate a potential food source for avian piscivorous species such as gulls and ducks like the Common Merganser (*Mergus merganser*).

Waterbird Reproductive Management

Egg and nest depredation activities targeted locally breeding Canada Geese, Mallards, and Mute Swans on NYC reservoir property. Canada Geese and Mute Swan (*Cygnus olor*) egg and nest depredation techniques were conducted during the spring of 2019 to help reduce fecundity at critical NYC reservoirs (Table 4). Mallard (*Anas platyrhynchos*) nests at Hillview Reservoir were depredated under a federal USFWS depredation permit. Each nest was flagged and eggs were numbered and punctured using a probe to break the membrane thereby destroying the embryo. Eggs were then replaced in the nest to allow incubation to continue but without development. A small number of goose nests are often destroyed late in the breeding season to encourage the birds to relocate off reservoir property during the annual post-nuptial molt when the birds are rendered flightless for a several weeks.

Sixty-two Canada Goose nests containing 282 eggs were depredated (punctured) at six New York City Reservoirs (Table 4) during the spring of 2019 compared to 50 Canada Geese nests containing 276 eggs in 2018. There was no goose or swan breeding activity recorded at Hillview; however, five Mallard nests containing 20 eggs were depredated by DEP in 2019 compared to three Mallard nests containing 25 eggs in 2018. There was one adult Mallard depredated in 2019. All Canada Geese egg and nest depredation activity was conducted under the terms of a Federal Registration (#RG-01040A) from the United States Department of the Interior, United States Fish & Wildlife Service. In addition, a NYSDEC permit (#2395) was acquired to depredate Mute Swans eggs and nests and a USFWS Permit (MB789947-0) covered Mallard and swallow depredation work at Hillview. DEP conducted 153 surveys for nesting

Mallards at Hillview Reservoir in 2019. DEP did not band Canada Geese or Double-crested Cormorant in 2019.

Table 4. 2019 Canada Goose, Mute Swan, and Mallard[2] nest census and egg-depredation.

Reservoir	Number of Surveys	Nests Depredated by Species	Eggs Depredated by Species	Species Depredation Success Rate
Kensico	9	Canada Geese = 20 Mute Swan = 1	Canada Geese = 79 Mute Swan = 0	95 percent (4 Canada Geese goslings) 100 percent (0 Mute Swan cygnets)
West Branch	9	Canada Geese = 8	Canada Geese = 35	100 percent (0 Canada Geese goslings)
Rondout[1]	3	Canada Geese = 3	Canada Geese = 15	65 percent (8 Canada Geese goslings)
Ashokan	4	Canada Geese = 7	Canada Geese = 39	87 percent (6 goslings)/NA/NA
Croton Falls	9	Canada Geese = 12	Canada Geese = 72	96 percent (3 goslings)
Cross River	9	Canada Geese = 12	Canada Geese = 42	100 percent (0 goslings)
Hillview[2]	153	Mallard = 5	Mallard = 20	Mallard = 80 percent (5 ducklings)

[1] Nest depredation for Canada Geese was restricted due to nesting Bald Eagles.
[2] Mallard nest depredation only conducted at Hillview Reservoir.

RESULTS and DISCUSSION

1. Kensico Reservoir

Kensico Reservoir, a terminal reservoir in the New York City Water Supply System, typically receives water from Rondout and West Branch Reservoirs via the Delaware Aqueduct and from the Ashokan Reservoir via the Catskill Aqueduct (Appendix A, Figures 34, 35 and 36). Water from the Delaware Aqueduct can also be delivered through the Catskill Aqueduct by way of an interconnecting shaft (Shaft 4 Interconnection). Croton Falls and Cross River Reservoirs have the capacity to send water to Kensico via the Delaware Aqueduct during times of drought or other operational changes such as aqueduct shutdowns. The NYC Aqueduct System is shown in Appendix A Figure 36.

Water leaving Kensico is disinfected with chlorine and ultraviolet light prior to being delivered to Hillview Reservoir via the Delaware and Catskill Aqueducts. Kensico Reservoir has been divided into eight geographic Bird Zones to compare bird counts and water quality in samples collected at limnological sampling locations (Appendix A Figure 37). Waterbird numbers at Kensico Reservoir remained consistently low throughout the reporting period because of continued implementation of the Waterfowl Management Program (Figure 1). The geographic configuration of Kensico includes two main open water areas, one in Bird Zone 4 and one in Bird Zone 6 (Appendix A Figure 37). These open water areas tend to attract the highest concentrations of gulls and other waterbirds roosting overnight from late summer through early spring.

Prior to the late summer of 1993, elevated levels of fecal coliform bacteria in raw water compliance samples at Kensico's two water effluent facilities caused DEP to employ water by-pass operations whereby the two primary sources of water to Kensico (i.e., Rondout/West Branch and Ashokan) were being sent directly to Hillview Reservoir. By-pass operations were implemented at Kensico to ensure compliance with the Surface Water Treatment Rule since it was determined that fecal coliform $100mL^{-1}$ levels entering Kensico from the upstate reservoirs were lower than the levels leaving Kensico. In early December 1993, at the time when DEP was utilizing the by-pass operational option at Kensico, a nor'easter with associated high precipitation caused elevated turbidity in the two upstate aqueducts entering Kensico that forced DEP to cease by-pass operations to help reduce turbidity. While operating Kensico in reservoir mode rather than bypass mode it helped minimize the risk of exceeding the SWTR criteria for turbidity, however it also placed DEP at risk for non-compliance with the SWTR criteria for water samples containing fecal coliform bacteria. To address these competing priorities, DEP developed and implemented a reservoir-wide bird dispersal program under the premise that birds were responsible for the bacterial elevations.

The initial bird dispersal program used a combination of motorboats, propane cannons, and bird-distress tapes 24 hours/day and 7 days/week. This comprehensive effort resulted in an

immediate reduction of waterbird populations and fecal coliform bacteria levels recorded at the Catskill Lower Effluent Chamber (CATLEFF) and Delaware Shaft 18 (DEL18) and allowed DEP to maintain full flow-through operations of both aqueduct systems throughout the remainder of the winter of 1993. The program was modified in subsequent years from a 24 hour/day program to a pre-dawn to post-dusk program that begins on August 1 and extends through March 31 annually to target late summer nonbreeding or failed breeding waterbirds, fall migrations, overwintering populations of geese, swans, and other waterfowl, and spring migrational stopovers.

Prior to implementing an approved bird dispersal program, DEP began collecting reservoir-wide bird census data in August 1992. Overnight waterbird counts reached several thousand during the autumnal migratory and wintering period (Figure 1) with high bird roosting counts recorded at the water intake coves at Kensico. Figure 1 continues to demonstrate a dramatic decline in waterbird counts from several thousand in 1992 and 1993 (prior to formal bird dispersal activities) to hundreds or less during the same migratory period in subsequent years and up through the present day when bird seasonal dispersal techniques were employed.

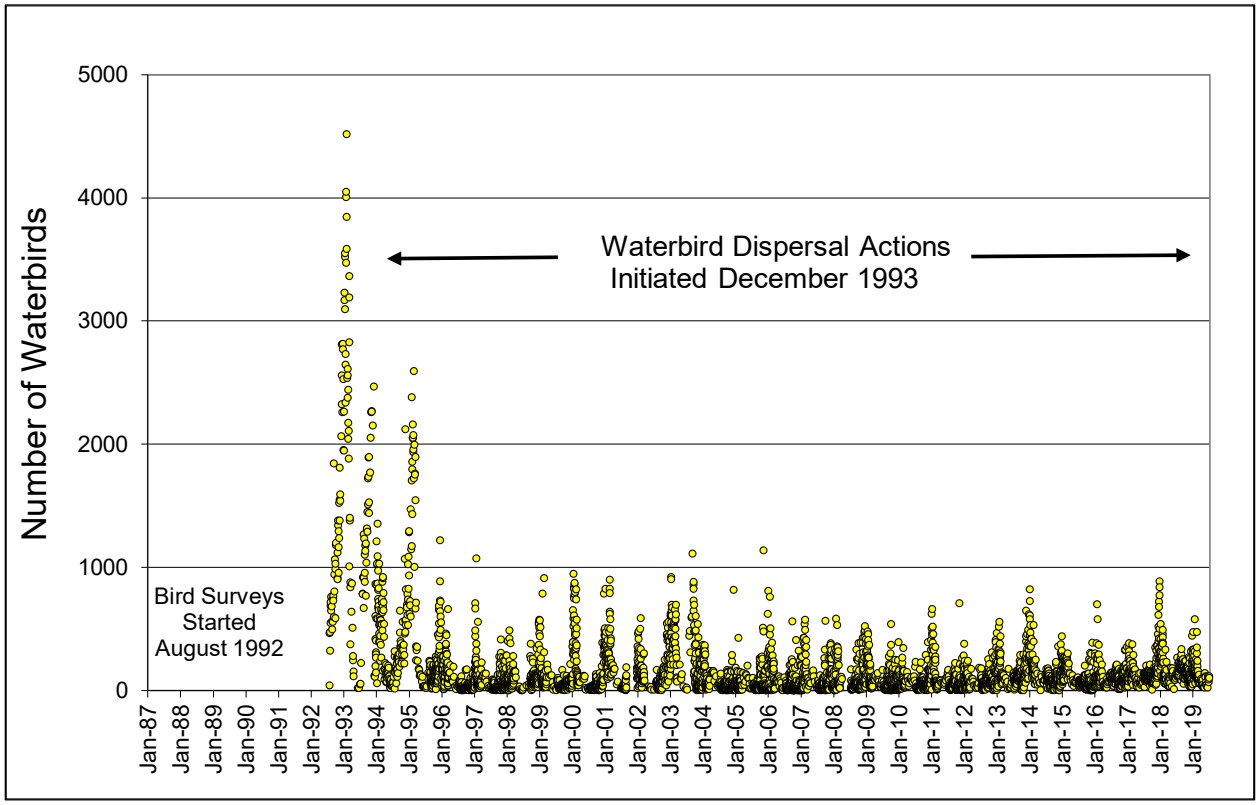

Figure 1. Kensico Reservoir waterbird totals.

Figure 2 shows a dramatic decline in fecal coliform bacteria simultaneous with the commencement of the bird dispersal efforts in December 1993, and this observation (or effect) continues through the present day. Prior to the inception of the waterbird dispersal efforts in 1993 DEP conducted intermittent bypass operations for Kensico when fecal coliform bacteria elevations occurred. This generally coincided with the onset of waterbird migrations in month of October and remained elevated until reservoir icing occurred sometime in mid-winter. In recent years, there has only been one temporary period of elevated fecal coliform bacteria that occurred during the late summer and autumn of 2011 when southeastern NYS was impacted with back-to-back high precipitation storms, Tropical Storms Irene and Lee.

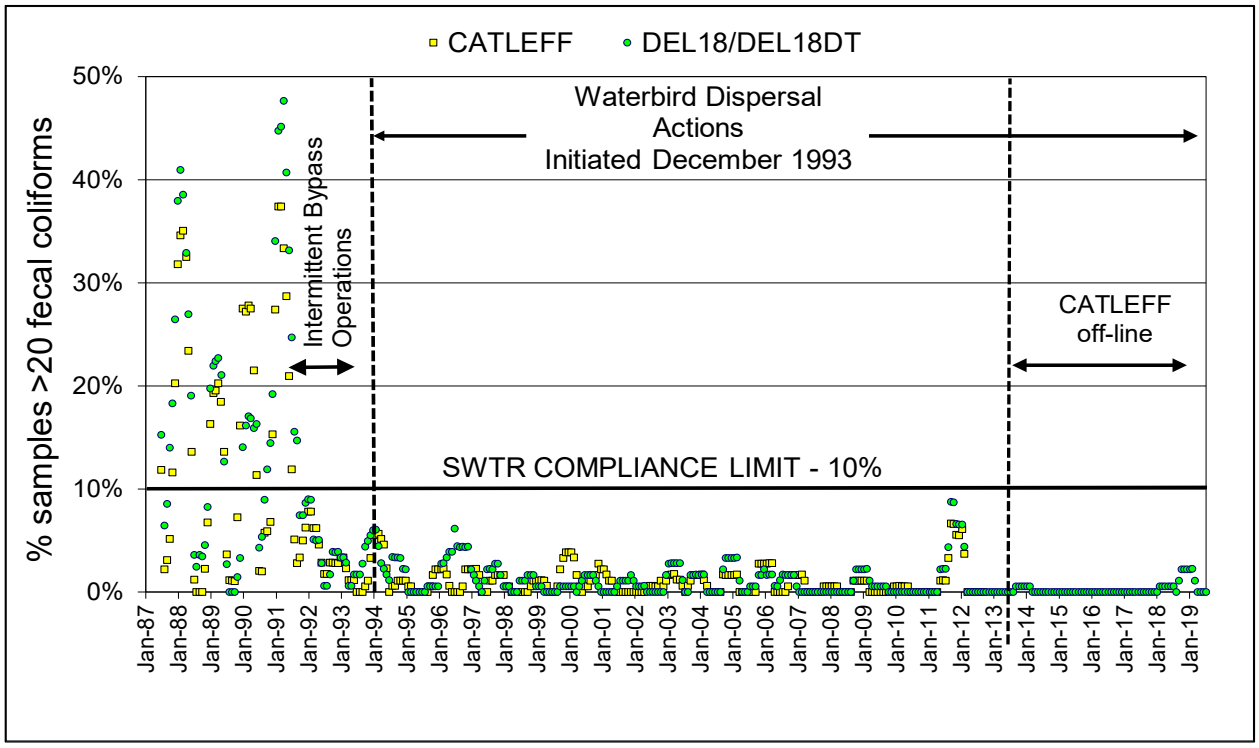

Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18/DEL18DT/DEL18DTD and CATLEFF). Kensico sanitary surveys began in 2012. Non-detect fecal coliform were not presented.

Continuous waterbird monitoring and dispersal actions using motorboats combined with discharging pyrotechnics have been the primary method in reducing waterbird numbers at Kensico.

The WMP continued to maintain a high level of success in reducing waterbird numbers at Kensico Reservoir, which resulted in low fecal coliform bacteria levels from August 1, 2018 to

July 31, 2019. The low fecal coliform levels continue to allow DEP to maintain compliance with the federal Surface Water Treatment Rule criteria for the fecal coliform bacteria parameter.

Figure 3. DEP contractor staff utilize the Kensico Reservoir Dam to conduct waterbird surveys and dispersal actions discharging pyrotechnics. Photo by DEP Police Aviation Unit.

Table 5 lists the ten highest fecal coliform counts $100mL^{-1}$ in the double-digit range recorded at DEL18DT in 2018/2019. Four of the ten elevations exceeded the 20 fecal coliform $100mL^{-1}$ Surface Water Treatment Rule, two in September 2018 and two in October 2018. Seven of the ten double-digit fecal coliform events were likely associated with precipitation events ranging from 1.63 to 4.66 inches recorded in the previous three days or longer and when bird counts remained relatively low in the bird zones closest to the water intake (Table 5). Two of the ten fecal coliform elevations are within days of a previous storm event of more than 2 inches of rain. Of the 365 source water samples collected over the period from August 1, 2018 to July 31, 2019, four samples were recorded above the 20 fecal coliforms were likely associated with a precipitation event as there was no spike in waterbird activity during that time. Of the ten double-digit fecal coliform elevations in Table 5, only one had a report of waterbirds roosting overnight in the DEL18 cove adjacent to the effluent chamber (10 ducks in Bird Zone 2 on October 3, 2019). One hundred and thirty out of 365 fecal coliform samples, or 36 percent, were

non-detected (below the detection limit of one fecal coliform $100mL^{-1}$) compared to 41 percent of the samples recorded in 2017/2018. In 2018, a coliform-restricted assessment based on compliance of the SWTR for Kensico Reservoir determined that the basin status was 'non-restricted', as was the case in 2017 (DEP 2018).

Table 5. Highest fecal coliform $100mL^{-1}$ results, precipitation events, and bird counts at Kensico Reservoir keypoint water sampling location (DEL18DT).

Bacterial Sample Date	DEL18DT fecal coliform $100mL^{-1}$ (E = estimated count based on non-ideal plate)	Precipitation within 3 days of elevated fecal coliform >=10 fecal coliform 100 mL^{-1} (inches rounded to the nearest 100th)		Bird Counts on or before sample bacterial sample date	
		Westchester County Airport Met Station[1]	DEP Kensico Reservoir Shaft 18 Met Station[2]	Reservoir-wide totals	Bird Zones 2, 3, and 4 totals (closest to the DEL18DT Effluent)
8/18/18	E12	1.63	1.84	159 on 8/18/18	119 on 8/18/18
8/19/18	E19	1.80	1.88	109 on 8/19/18	48 on 8/19/18
9/10/18	E14	1.70	1.44	203 on 9/10/18	164 on 9/10/18
9/26/18	**58**	4.66	4.02	ND on 9/26/18; 80 on 9/25/18	47 on 9/26/18
9/27/18	**38**	4.66	4.61	209 on 9/27/18	118 on 9/27/18
10/3/18	E15	2.26	2.35	209 on 10/3/18	195 on 10/3/18
10/4/18	**32**	2.31	2.41	223 on 10/4/18	211 on 10/4/18
10/5/18	**38**	0.05	0.06	104 on 10/5/18	59 on 10/5/18
10/6/18	E10	0.05	0.06	202 on 10/6/18	185 on 10/6/18
10/10/18	E13	0.05	0.03	219 on 10/10/18	191 on 10/10/18

[1] Precipitation data reported from Westchester County Airport, White Plains, New York
[2] Precipitation data reported from DEP Kensico Reservoir (Shaft 18), Valhalla, New York

Figures 4 and 5 respectively compare the regulatory source water samples collected from Delaware Shaft 18 (DEL18DT) with respect to fecal coliform bacteria and reservoir bird counts for the 2018/2019 and 2017/2018 seasons.

In 2018/2019, the DEP contractor attained 90 percent reportable data in completing reservoir-wide waterbird surveys. Approximately 10 percent of the surveys were deemed "no reportable data" due to inadequate bird observations from unsuitable environmental conditions (e.g., fog, snow, or rain). Reservoir-wide waterbird counts from August 1, 2018 to July 31, 2019 increased from previous reporting period averaging about 151 birds per survey night when compared to the same period in 2017/2018 with an average of 110. Waterbird activity spiked at 579 (195 gulls, and 384 ducks) on February 21, 2019 compared to a high count of 887 in the previous reporting period (Figure 7). The high count of Gulls and Ducks 494/579 were recorded on this date in Bird Zone 4, and there were no associated fecal coliform elevations at the DEL18 compliance sampling station.

There appears to be a general association with reservoir-wide elevated waterbird counts and fecal coliform bacteria at the DEL18 sampling location from the late summer to mid-autumn period and again from mid-January 2019 through early March 2019 as is demonstrated in Figure 4.

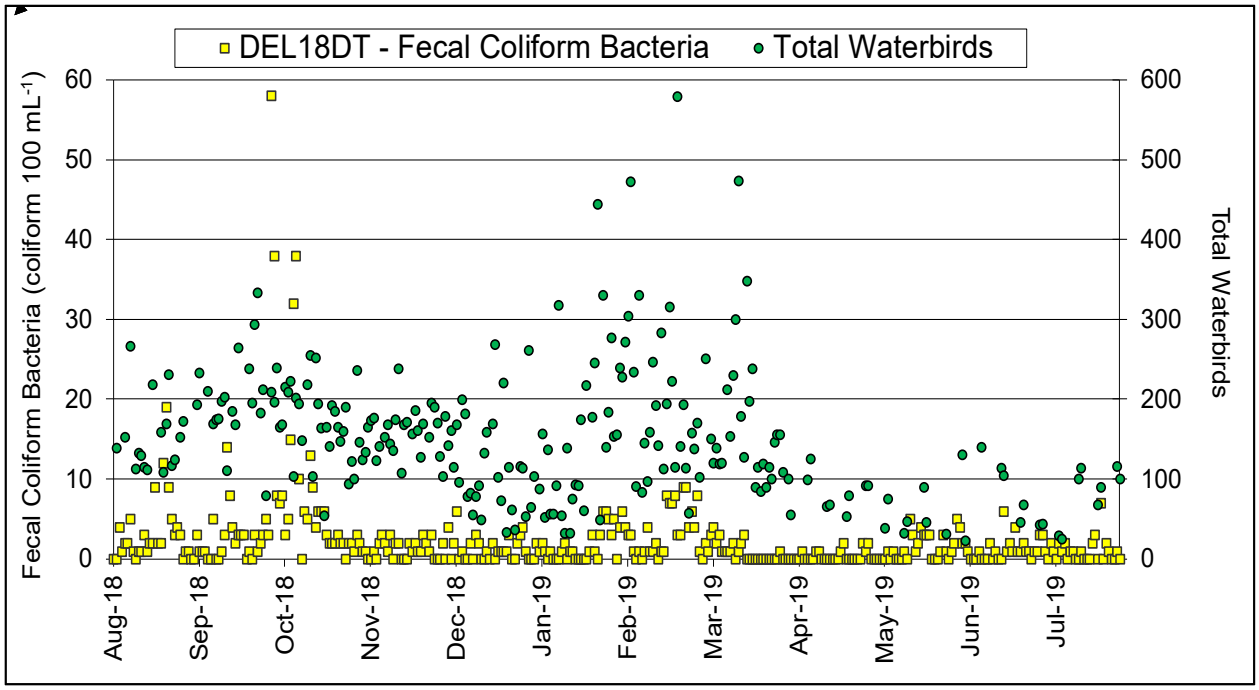

Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT vs. total waterbirds (8/1/2018 to 7/31/2019). Non-detect fecal coliform were not presented.

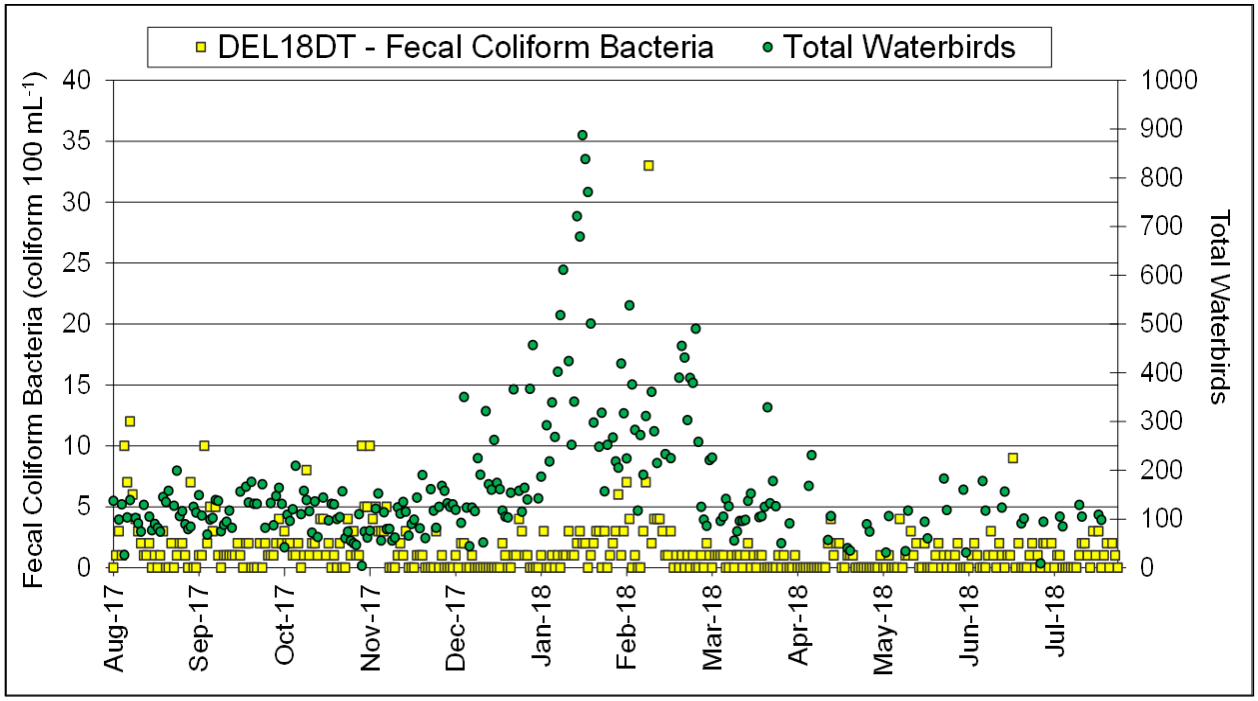

Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT vs. total waterbirds (8/1/2017 to 7/31/2018). Non-detect fecal coliform were not presented.

In Bird Zone 2, closest to Delaware Shaft 18 Effluent (DEL18DT), there were no observations of waterbirds on 235 of 269 reportable survey days (August 1 to March 31) or 87% of the time. The high overnight count of 16 Canada Geese and two waterfowl observed on November 15, 2018, in advance of a storm event at Kensico, did not cause a fecal coliform bacteria elevations in Bird Zone 2. During the non-dispersal period from April 1, 2019 to July 31, 2019, waterbirds were observed in Zone 2 on five of 36 occasions with a high count of six Canada Geese during the spring nesting season.

All birds observed in the water intake cove (Bird Zone 2) during the pre-dawn period (0500 hours) were immediately dispersed using motorboats or physical chasing from the shoreline (Figure 6). Since increased spatial separation between birds and the water intake at Delaware Shaft 18 effluent at Kensico tends to be a factor that reduces fecal coliform bacteria, bird dispersal activities were heavily concentrated in the vicinity Delaware Shaft 18 and the lower main basin of Kensico (Bird Zones 2, 3, and 4, Appendix A, Figure 37). DEP contractors demonstrated a greater degree of success using motorboats with pyrotechnics for bird dispersals (Figure 6).

Figure 6. DEP contractors using motorboats to disperse waterbirds at Kensico. Photo by Chris Nadareski

Waterbird surveys in Bird Zone 3, adjacent to the Bird Zone 2 cove revealed 12 occasions when birds were present out of 228 reportable survey days during the bird dispersal period from August 1, 2018 to March 31, 2019 (Figure 9). A high total bird count of seven was recorded on three dates (Figure 9). Zero bird counts in Bird Zone 3 were identified on 216 of the 228 surveys (95 percent) during the bird dispersal period (Figure 9).

Waterbirds tend to utilize larger open expansive areas of open water found in Bird Zone 4 for nighttime roosting. There was no reportable data on 13 of the 243 or 5 percent of surveys conducted in Bird Zone 4 during the bird dispersal period. The total high count of waterbirds was recorded on February 21, 2019 when 494 waterbirds were observed roosting overnight (Figure 10). The total high count of 78 Canada Geese was observed on March 15, 2019 and the high gull count was on February 21, 2019 at 165 gulls.

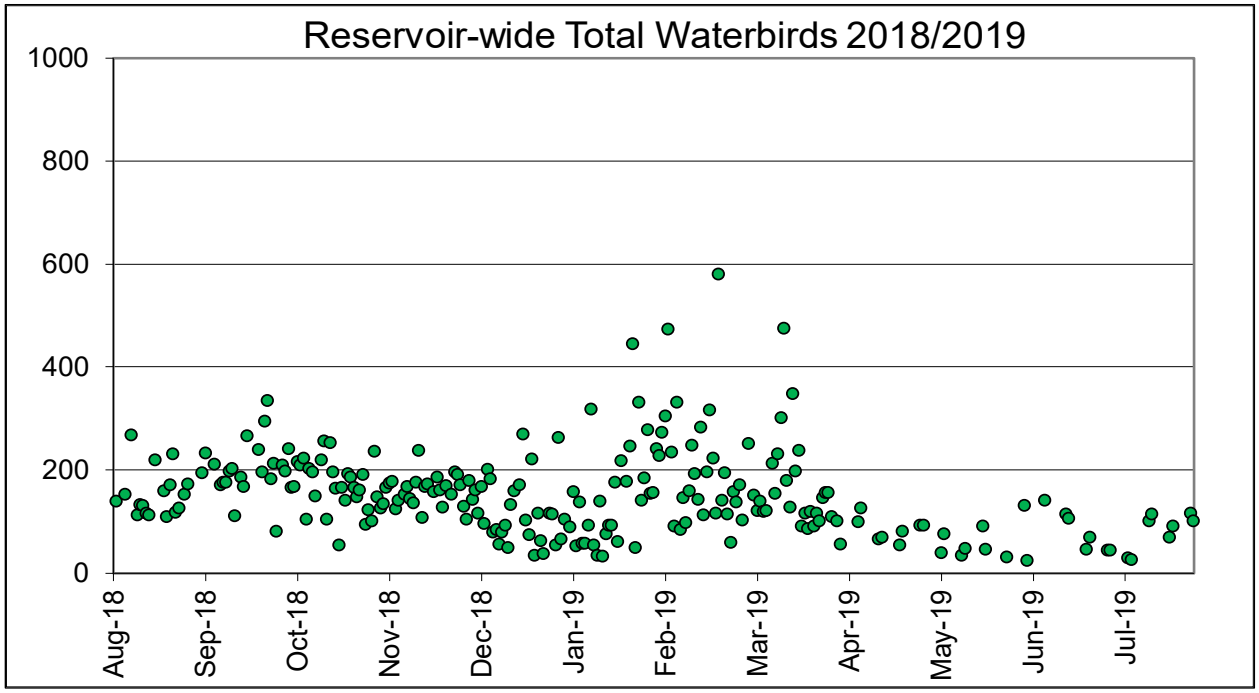

Figure 7. Kensico Reservoir total annual waterbirds (8/1/2018 to 7/31/2019).

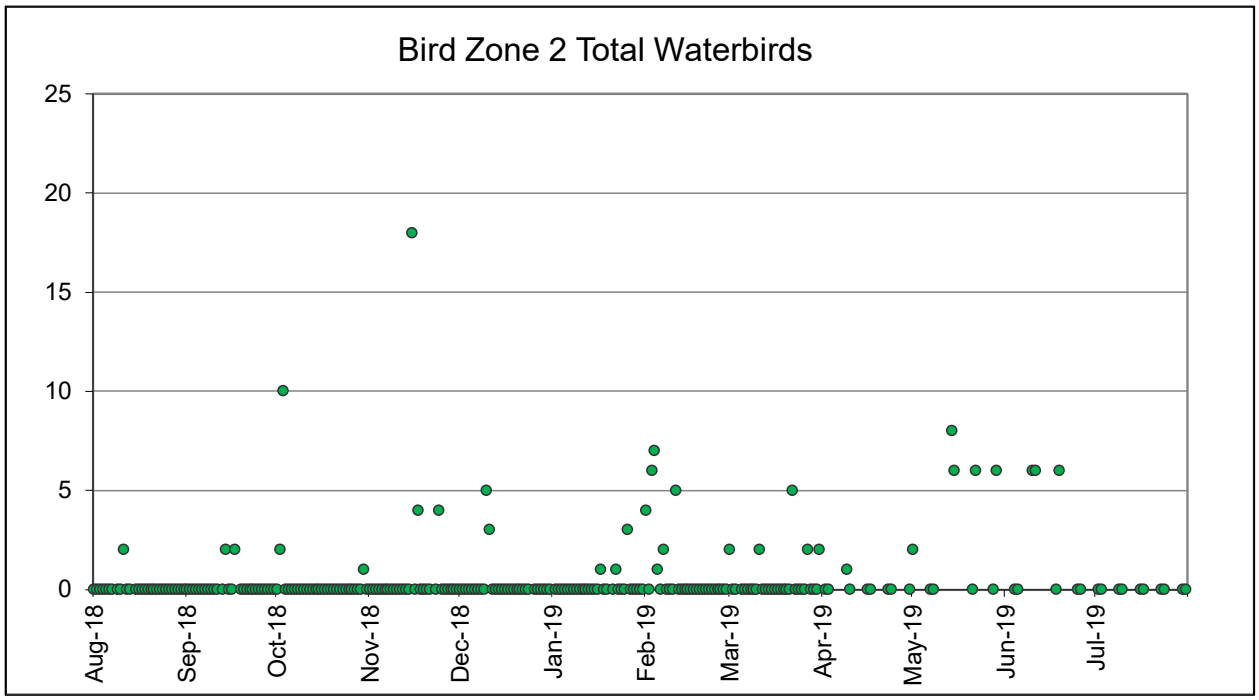

Figure 8. Kensico Reservoir Bird Zone 2 waterbirds (8/1/2017 to 7/31/2018).

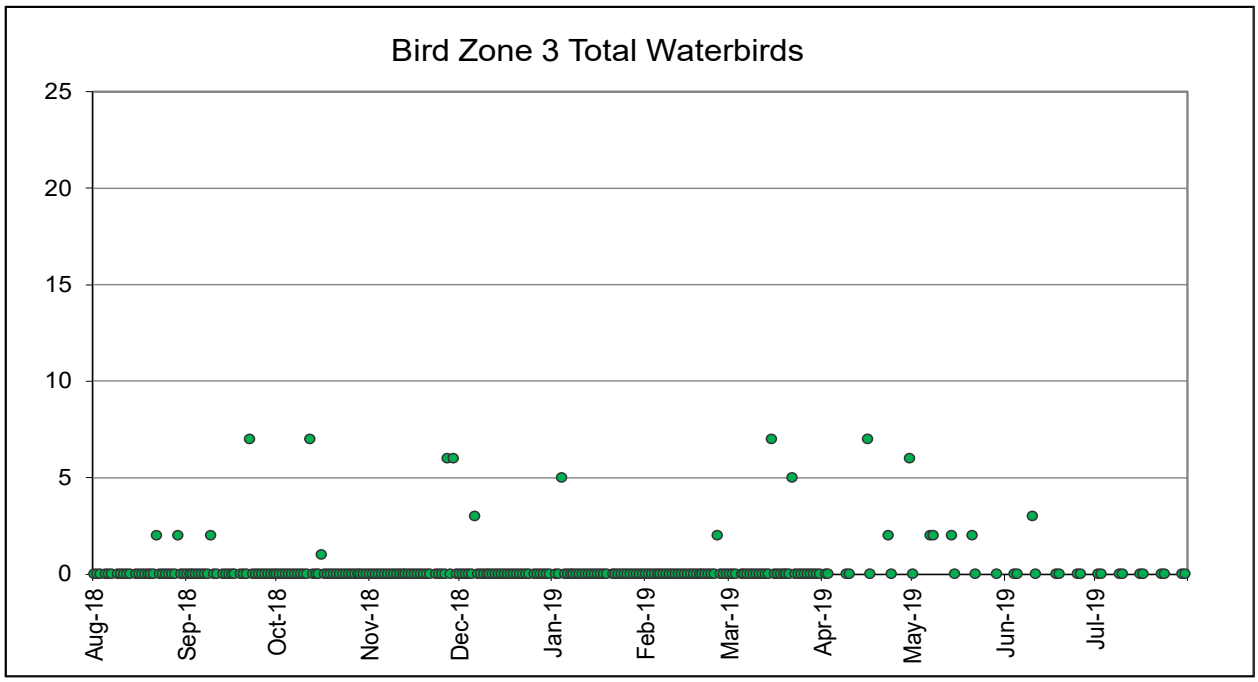

Figure 9. Kensico Reservoir Bird Zone 3 waterbirds (8/1/2018 to 7/31/2019).

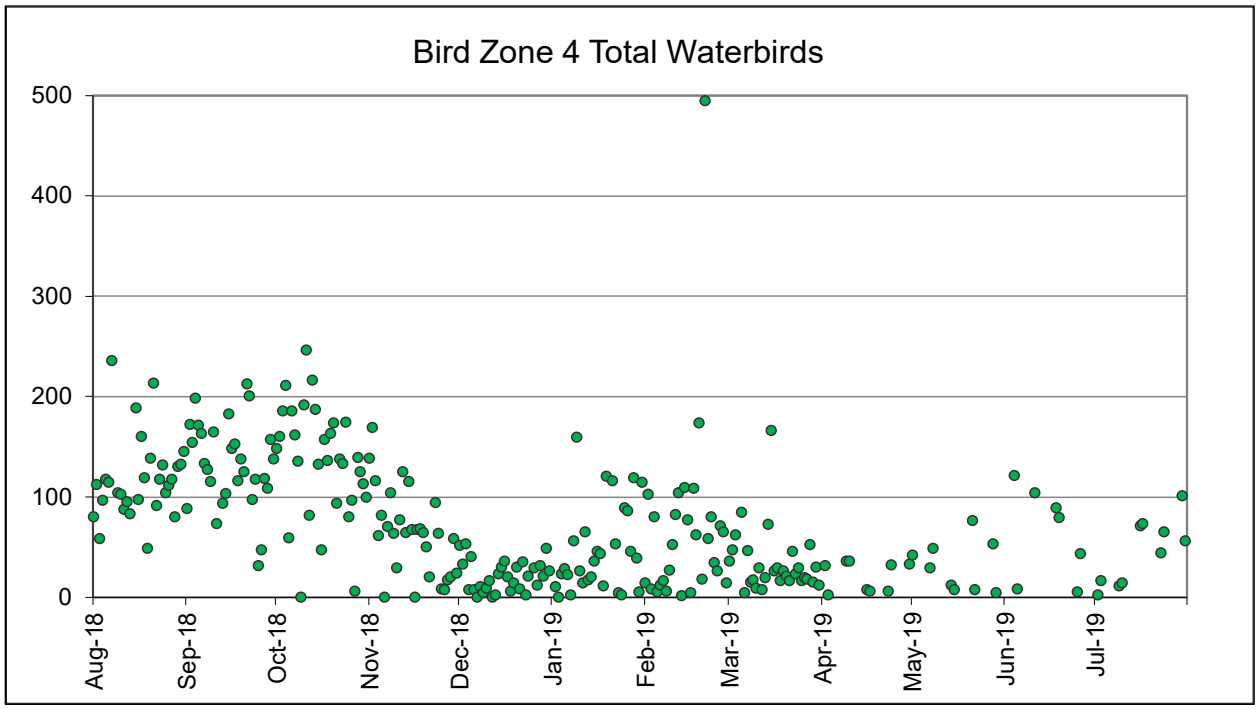

Figure 10. Kensico Reservoir Bird Zone 4 waterbirds (8/1/2018 to 7/31/2019).

The incidence of specific groups of waterbirds continues to follow trends for annual migration and over-wintering patterns. Waterbird roosting locations during the winter period were generally determined by extent of ice-cover although on occasion the birds were observed roosting on the ice sheets. During the winter of 2018/2019, the first detection of ice was observed on December 19, 2018 with approximately 5% ice cover, while the maximum ice cover extended to more than 90 percent at Kensico on February 5, 2019. Ice cover diminished back to 5% by March 28, 2019. Overall, there was only a minimal period of partial ice-cover, which allowed continuous motorboat operations and airboat use for bird dispersal activities.

During the bird dispersal period from August 1 to March 31, ducks continued to be the most commonly observed bird group averaging 102 birds per night or 85 percent of the total counts, an increase from a daily average of 60 birds per overnight count in 2017/2018. Gulls were the second most common group with an average nightly count of 45 birds (34 percent) up from 39 birds per night in 2017/2018. Gulls peaked at 240 on January 9, 2019. Canada Geese numbers increased from a daily overnight count of 16 birds (12 percent) in 2018/2019 compared to 14 birds/night in 2017/2018 (Figure 11). The reservoir high count of geese at 314 birds occurred on January 23, 2019.

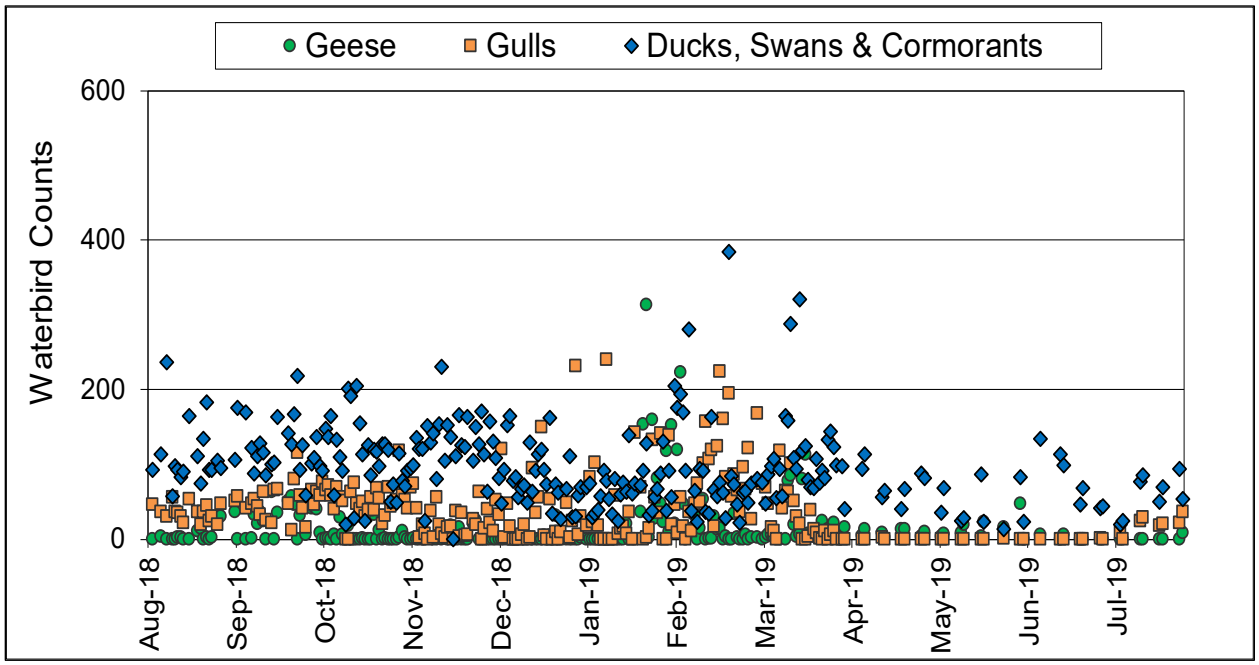

Figure 11. Kensico Reservoir total waterbirds by groups (8/1/2018 to 7/31/2019).

Throughout the non-dispersal period from April 1 to July 31, 2019, geese averaged seven birds per night, gulls averaged five birds per night and ducks averaged 63 birds per night. Total

average bird counts decreased slightly in 2018/2019 to 75 compared to 89 birds per night during 2017/2018 representing a 16% decline in bird activity reported at Kensico.

DEP determined that no bird-associated increases were responsible for the four fecal coliform bacteria levels above the SWTR compliance level at the Kensico Shaft 18 effluent location during this reporting period. Most of the overnight bird roosting activity was observed at distances far from the effluent at DEL18DT. There was limited need for the operation of the two Biondo Airboats for bird dispersal activities due to a low degree of ice-cover reported during this period (Figure 12).

Figure 12. Biondo Airboats for bird dispersal activities at Kensico. Photo by Chris Nadareski.

The Westchester County Airport (WCA), located immediately east of the Rye Lake area at Kensico (Bird Zone 6 in Appendix A, Figure 37) manages birds and other wildlife for air-traffic safety both on-airport and at off-airport locations. One of the off-airport locations posing highest risk to the aircraft is bird activity at the Kensico Reservoir. As a result, DEP maintained routine communication with airport officials and participated with the airport's Wildlife Hazard Bird Strike Task Force to stay apprised of any changes in bird management activities conducted

at the reservoir. DEP's bird management activities must prevent dispersal of waterbirds into the flight paths of arriving and departing aircraft at Westchester County Airport as the airport lies adjacent to the eastern shoreline of Kensico Reservoir (Appendix A, Figure 37). Bird dispersal crews abstain from discharging pyrotechnics when aircraft are approaching and departing to avoid potential airstrikes with birds and pilot confusion with the use of aerial low-grade explosives (pyrotechnics).

DEP participated in the annual review of the airport's Wildlife Hazard Management Plan for air-traffic safety. WCA is tasked with the implementation of an Airport Depredation Order for resident Canada Goose nest and egg depredation (50 CFR 12.50) and Control Order for resident Canada Geese at airports and military airfields (50 CFR 12.49). Westchester County Airport has contracted with USDA, Animal Plant Health Inspection Services, Wildlife Services to manage wildlife species, including the depredation of geese at select off-airport properties within a 7-mile radius that includes all of the Kensico Reservoir. During this reporting period, DEP allowed USDA personnel under contract with the WCA to access NYC-owned property at Kensico Reservoir to determine if there were geese present to be targeted for removal during the annual goose molt period in the late spring of 2019. Results of the USDA survey identified six Canada Geese present on the Kensico Reservoir property. On June 21, 2019 with the onset of the post-nuptial molt rendering the geese flightless, USDA conducted removals of two adults and four immature Canada Geese.

In the spring of 2019, DEP reconfirmed a nesting pair of Bald Eagles on the eastern side of Kensico Reservoir within ½ mile of the Westchester County Airport. Under federal (USFWS) and state (NYSDEC) guidance for the protection of nesting Bald Eagles, DEP maintained compliance with special protective provisions for eagle management in this area of the reservoir. This guidance limited work activity within a 660' protection buffer radius around the eagle's nest abstaining from using pyrotechnics within a ½-mile buffer radius so as not to disturb the eagles from January 1 through September 30. Due to the location of the eagle's nest, all dispersal activities using boating operations were allowed to continue as the 660' protective buffer zone does not extend into the reservoir. DEP also maintained direct communication with the NYSDEC and Westchester County Airport officials and their contractor (USDA Wildlife Services) regarding the status of the nesting eagles.

Alewives and other baitfish transported through upstate aqueducts to Kensico were not observed during the autumn/winter period of 2018/2019. When present, the dead and dying Alewives typically attract foraging gulls and diving ducks. DEP and its contractor continued to monitor fish concentrations and collected dead/dying baitfish as they entered Kensico Reservoir. A surface retention boom was placed around the Catskill Influent Chamber (CATIC) to concentrate the baitfish and allow for easy collection and disposal. The poundage of fish

observed, collected, and disposed of from CATIC in the previous reporting period of 2017/2018 was 644 pounds.

In the spring of 2019 a total of 20 Canada Goose nests were found along the reservoir shoreline and on islands compared to 13 in 2018 (Table 4); a 24% increase in nesting activity. Among the nests, 79 eggs were depredated and placed back in the nest to allow the nesting geese to continue to incubate compared to 70 eggs in 2018 (Figure 13). The average number of eggs per nest in 2019 was 4.2, down slightly when compared to 5.4 in the previous year. Four goslings were observed in 2019 compared to no goslings reported in the previous year rendering the egg depredation success at 95 percent in 2019. Adult breeding geese or failed breeders generally disperse from the reservoir prior to the post-breeding season molt, which begins in June (annually). Canada Geese that do remain at Kensico during the molt period are subject to removal through depredation by the Westchester County Airport contract.

One Mute Swan nest was observed at Kensico in 2019, however due to natural predation of one of the adult pair there was no need for depredation activities. In 2018, there was one nest with 12 eggs. There were no Double-crested Cormorant nests observed at Kensico during the 2019 nesting season.

Figure 13. Canada Goose incubating eggs on an island nest. DEP conducted surveys for nesting Canada Geese along shorelines and on islands at Kensico Reservoir. Photo by Chris Nadareski.

Figure 14. Canada Goose nest located on an old concrete piling at Kensico Reservoir. Photo by Chris Nadareski.

DEP Wildlife Studies staff and contractor staff conducted sixteen wildlife sanitary surveys on the reservoir property adjacent to the Delaware Shaft 18 effluent at Kensico Reservoir. Sanitary surveys were conducted when substantial precipitation events were predicted to prevent wildlife excrement piles or latrines from being washed into the reservoir in close proximity to the water intake. All wildlife excrement samples (mammals and birds) were collected, speciated, and disposed of off reservoir property. Results of the sanitary surveys are shown in Table 6. Whitetail deer, Canada Goose, passerine birds, and eastern cottontail rabbit feces were identified in the highest concentrations on the sanitary surveys.

Table 6. Wildlife sanitary surveys conducted adjacent to DEL18DT Effluent.

Date of Survey	White-tail Deer	Raccoon	E. Cottontail Rabbit	Canada Goose	Coyote/ Fox	Virginia Opossum	Mink	Striped Skunk	Passerine (birds)	Domestic Dog	Mallard Duck	Other/Unknown Mammal	Total (all species)
9/17/18	7	0	4	1	1	0	0	2	4	0	0	2	**21**
10/10/18	11	1	13	0	0	0	0	0	0	0	0	0	**25**
10/26/18	26	1	0	0	1	1	2	0	3	0	0	0	**34**
11/1/18	31	0	5	1	0	0	0	0	0	0	0	0	**37**
11/1/18	46	5	15	0	0	16	0	0	7	0	0	0	**89**
12/14/18	40	0	0	2	0	3	0	2	3	0	0	11	**61**
12/20/18	37	1	1	0	0	0	4	0	1	0	0	0	**44**
1/17/19	39	0	0	0	0	0	0	0	0	0	0	0	**39**
1/23/19	26	0	9	0	0	0	0	0	0	0	0	0	**35**
2/11/19	47	0	0	0	0	0	0	0	7	0	0	6	**60**
1/23/19	36	0	0	0	0	0	0	0	2	0	0	2	**40**
3/20/19	18	1	5	0	1	0	1	0	0	0	0	6	**32**
4/5/19	6	3	4	33	0	0	0	0	0	0	0	0	**46**
4/19/19	3	1	1	1	0	0	0	0	0	0	0	0	**6**
5/3/19	0	0	0	45	1	0	0	0	0	1	1	0	**48**
7/16/19	4	2	0	18	0	0	0	0	64	0	0	2	**90**
Total by species	**377**	**15**	**57**	**101**	**4**	**20**	**7**	**4**	**91**	**1**	**1**	**29**	**707**

Figure 15. Mammal scat identified and collected at Kensico for pre-storm sanitary surveys.

The ongoing implementation of the WMP has been critical in allowing DEP to maintain compliance with the federal Surface Water Treatment Rule criteria for fecal coliform bacteria at Kensico dating back to 1993 and throughout the 2018/2019 reporting period.

2. West Branch Reservoir

The 2017 FAD lists West Branch Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Since the implementation of the WMP program, only two "as-needed" actions have been implemented at West Branch. West Branch Reservoir is divided into four bird survey zones that are associated with reservoir water quality sampling locations (Appendix A Figure 38).

During this reporting period, DEP was not required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event a bird dispersal action was required, DEP would implement a program using contractor personnel to eliminate the presence of waterbirds deemed as a water quality threat.

Migratory and wintering waterbird populations at West Branch were surveyed biweekly from August 1, 2018 through April 15, 2019 to record annual trends that aid in identifying sources of elevated fecal coliform bacteria levels. In 2018/2019 during the overnight surveys, gulls were recorded on seven out of 18 reportable surveys with a high count of 70 on January 11, 2019 compared to seven of 19 surveys in 2017/2018 with a high count of 79.

Reservoir-wide total birds reached a high seasonal count of 2,677 on November 30, 2018 compared to 2,582 on December 15, 2017 in the previous report (Figures 16 and 17). Ducks were most numerous during the high count representing 2,671 of the 2,677 waterbirds observed.

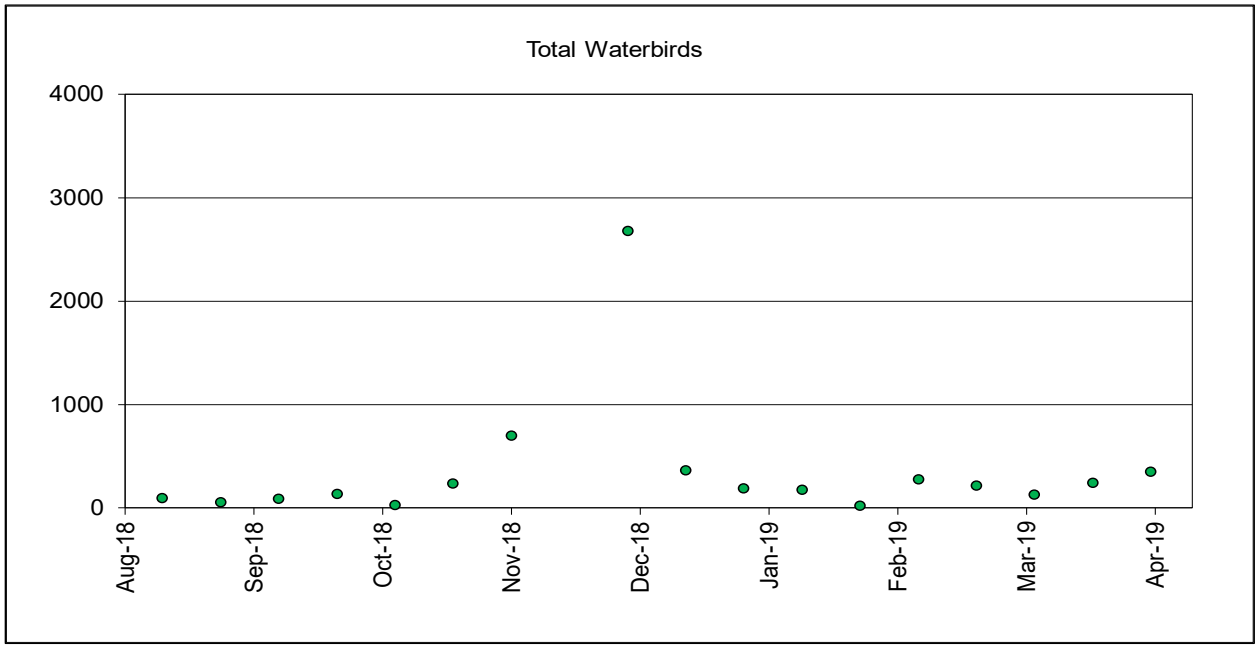

Figure 16. West Branch Reservoir total waterbirds (8/1/2018 to 4/15/2019).

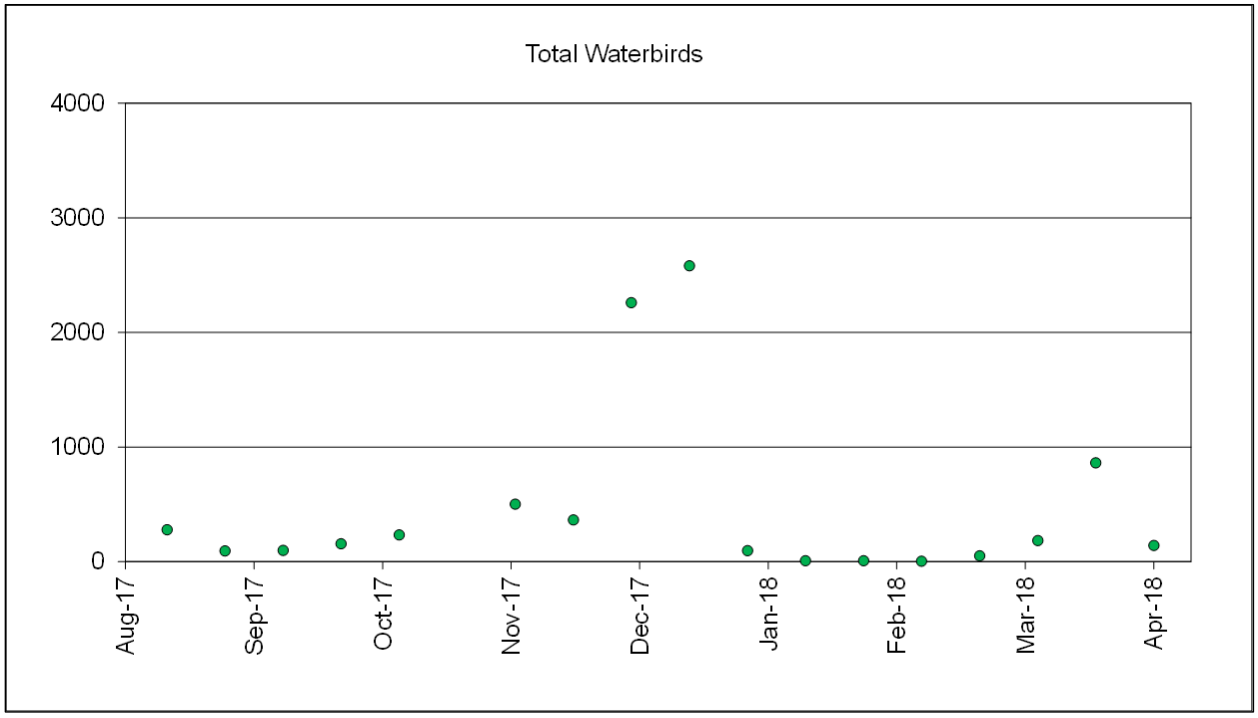

Figure 17. West Branch Reservoir total waterbirds (8/1/2017 to 4/15/2018).

Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits for water quality sampling. The dates, times and counts when birds were observed at the West Branch Effluent (Delaware Shaft 10) are listed in Table 7 unless counts were zero or no data were collected due to environmental conditions or field errors. Thirty-seven out of 58 observations or 36 percent of the observations were reported as "0" or no birds present.

Table 7. West Branch Reservoir - daytime bird detections at Delaware Shaft 10 (DEL10).

West Branch Reservoir 37 reportable observations of 58 Total Surveys		
Date	**Time of Observation**	**Bird Count Range or Actual Bird Counts**
08/01/18	10:55	1-50
08/08/18	09:30	1-50
08/22/18	10:24	1-50
09/05/18	11:06	1-50
09/19/18	10:27	1-50
09/26/18	09:55	1-50
10/03/18	11:50	1-50
10/17/18	13:27	1-50
10/24/18	11:06	1-50
11/07/18	10:55	1-50
11/13/18	11:19	1-50
11/14/18	10:19	1-50
12/19/18	10:06	1-50
01/09/19	09:42	1-50
02/06/19	11:50	1-50
02/13/19	11:17	1-50
02/20/19	12:33	1-50
02/27/19	11:02	1-50
03/06/19	11:01	1-50
03/08/19	09:50	1-50
03/14/19	11:58	1-50
03/20/19	10:46	1-50
04/03/19	10:04	1-50
04/05/19	10:14	1-50
04/09/19	10:39	1-50
04/10/19	10:49	1-50
04/22/19	10:52	1-50
04/24/19	11:31	1-50
04/25/19	11:32	1-50
05/29/19	09:40	1-50
06/05/19	10:37	1-50
06/19/19	10:43	1-50
06/26/19	09:29	1-50
07/03/19	10:08	1-50
07/10/19	10:30	1-50
07/23/19	10:16	1-50
07/30/19	12:18	1-50

There were 11 fecal coliform bacteria counts above 20 fecal coliforms 100mL^{-1} in samples collected from the in-reservoir sampling site CWB1.5 from August 1, 2018 through July 31, 2019 compared to two counts during the same reporting period in the previous year (Figure 18). Of 358 water samples collected over the period from August 1, 2018 to July 31, 2019, 97 (27 percent) were non-detect for fecal coliform bacteria. The CWB1.5 water sampling location reported in Figure 18 represents the quality of water near the Delaware Shaft 10 intake as the reservoir is often placed in 'float mode' most of the year.

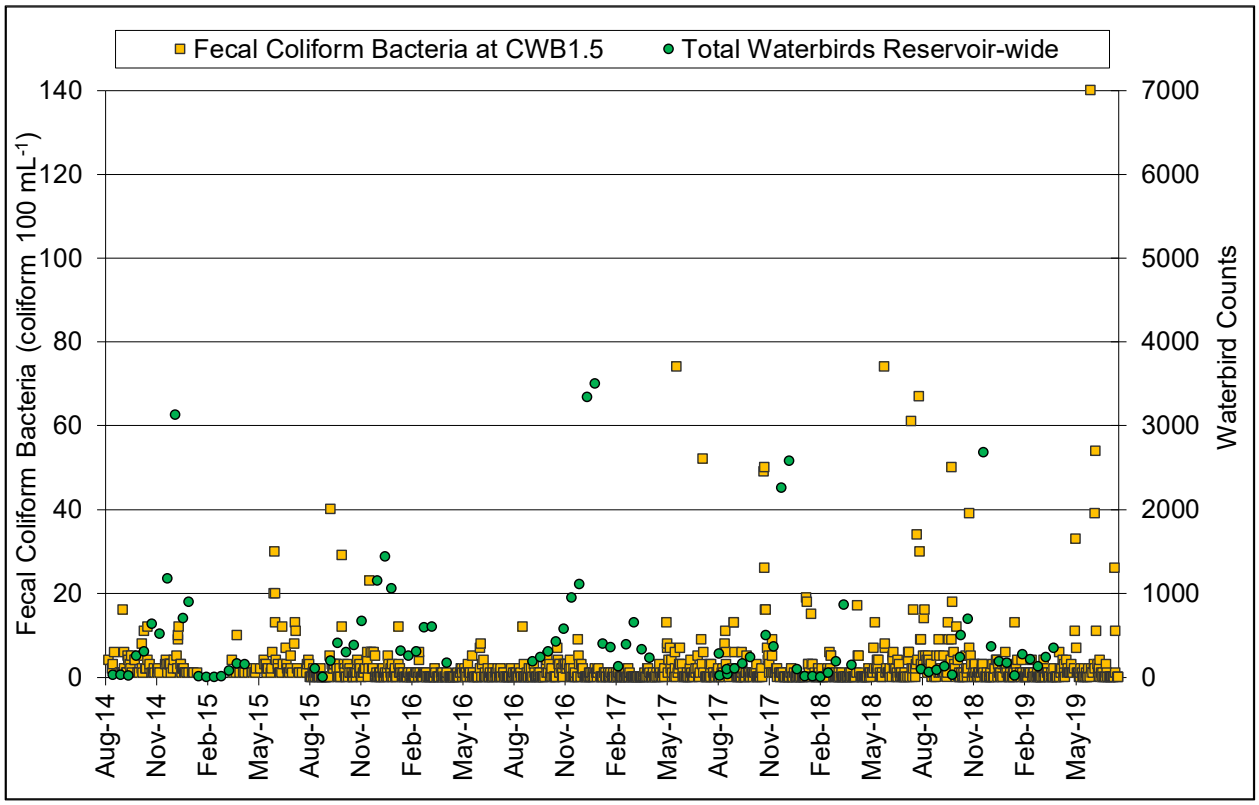

Figure 18. West Branch Reservoir fecal coliforms 100mL^{-1} at CWB1.5 vs. total waterbirds (8/1/2014 to 7/31/2018). Non-detect fecal coliform were not presented.

Since the primary trigger to implement "as needed" bird dispersal actions are fecal coliform bacteria concentrations, DEP determined there was no need to take action during the reporting period. In 2018, a coliform-restricted assessment based on compliance of the SWTR for West Branch Reservoir determined that the basin status was 'non-restricted'.

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31, in 2019 to reduce reproductive success at West Branch Reservoir. In 2019, eight nests with 35 eggs were depredated compared to seven nests and 29 eggs depredated in 2018 (Table 4).

Egg depredation efforts were deemed 100 percent successful for both years as no goslings were observed following the nesting period. There were no Mute Swans or Double-crested Cormorants observed nesting at West Branch during the spring of 2019 and therefore no depredation actions were needed.

DEP continues to inspect and maintain bird deterrent netting that was installed on the West Branch shaft building to deter terrestrial bird nesting and roosting. The bird exclusionary netting targeted the following species: Barn Swallows, Cliff Swallows, Rock Pigeons, House Sparrows, and European Starlings.

3. Rondout Reservoir

Rondout Reservoir is a terminal source water reservoir to both Kensico and West Branch. Located west of the Hudson River, Rondout is part of the Delaware System of reservoirs. The 2017 FAD lists Rondout as one of five reservoirs covered under the "as-needed" criteria for Waterfowl Management. Since the inception of the WMP, only three "as-needed" actions have been implemented at Rondout, the last being in 2006. The Rondout Reservoir is divided into nine bird zones (Appendix A Figure 39).

In 2018/2019, there were no bacteria counts above 20 fecal coliforms 100mL^{-1} in samples collected from the Rondout Effluent Chamber (Figure 19). There was a slight increase in bacteria from December 17, 2018 through the first week in January when levels reach the double-digits ranging from 4 to 19 fecal coliforms 100mL^{-1}. Only one overnight waterbird survey was conducted during this reporting period on December 14, 2018. Six hundred and twenty-nine waterbirds were observed reservoir-wide on that date. In 2018, a coliform-restricted assessment determined that the Rondout basin status was 'non-restricted'. Of 201 water samples collected over the period from August 1, 2018 to July 8, 2019, no fecal coliform bacteria were detected in 83 (41 percent) of the samples.

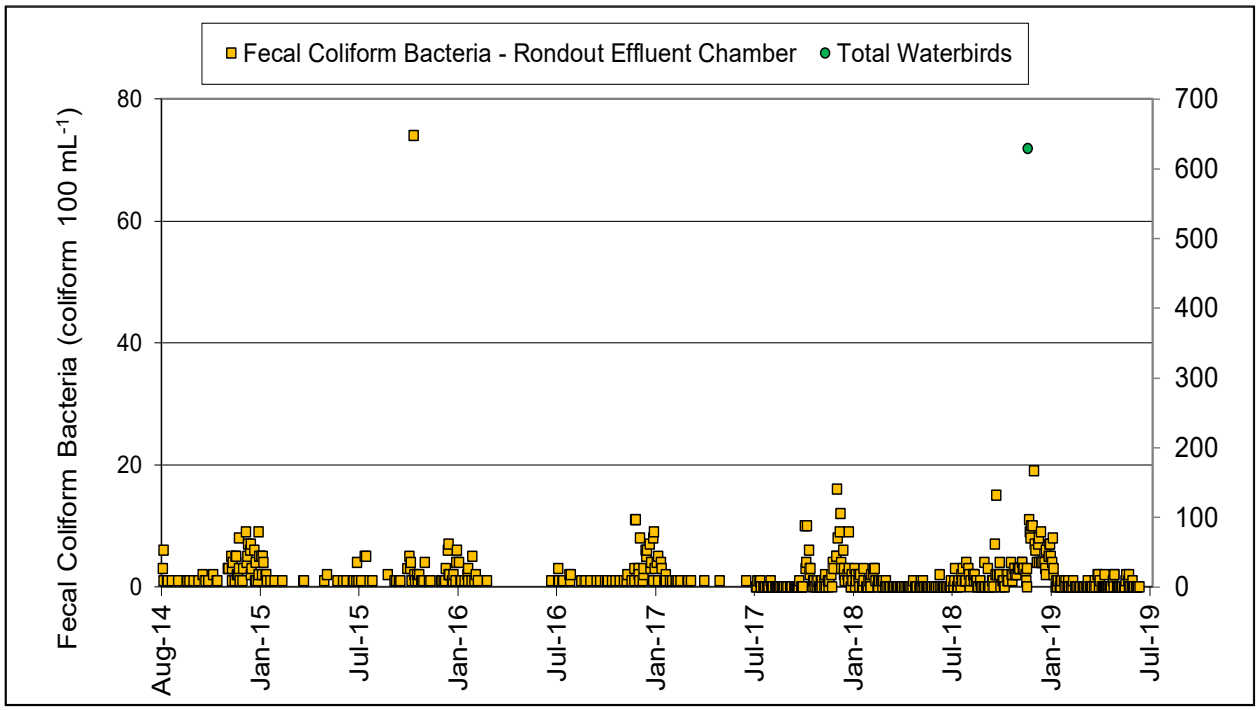

Figure 19. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent (8/1/2014 to 7/31/2019). Non-detect fecal coliform were not presented. One waterbird survey reported on 12/14/18.

DEP was not required to initiate an "as-needed" bird dispersal action as there were no elevated fecal coliform bacteria to report. In the event bird dispersal actions were required, DEP would implement a program using contractor personnel to reduce waterbird numbers to eliminate any water quality threat.

During this reporting period daytime (un-aided eye), bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. Fifty-two bird observations were conducted during this reporting period. The dates, times and count ranges for birds observed at the Rondout Effluent Chamber are listed in Table 8 unless counts were zero or no data were collected due to environmental conditions or field errors. Thirty-one out of 52 observations (60%) were reported as "0" or no birds present.

Table 8. Rondout Reservoir – daytime bird detections at Rondout Effluent.

Rondout Reservoir - 16 reportable observations of 54 surveys		
Date	**Time of Observation**	**Bird Count Range or Actual Bird Counts**
08/07/18	09:51	1-50
08/20/18	09:55	1-50
09/04/18	09:18	1-50
09/10/18	11:24	1-50
09/24/18	10:10	1-50
01/14/19	09:57	1-50
03/04/19	08:50	1-50
03/11/19	11:25	1-50
04/15/19	10:10	1-50
04/22/19	11:13	1-50
06/03/19	10:20	1-50
06/17/19	08:28	1-50
06/24/19	10:52	1-50
07/08/19	11:05	1-50
07/22/19	13:10	1-50
07/29/19	11:30	1-50

DEP conducted Bald Eagle (*Haliaeetus leucocephalus*) nest site monitoring and maintained full compliance with a protection plan as required by the NYSDEC and United States Fish and Wildlife Service in preparation for any "as-needed" bird dispersal activity as stated in the Findings Statement of the Environmental Impact Statement (N.Y.S. Environmental Conservation Law, Art. 8 (§8101 et seq.)) on file.

DEP also conducted reproductive control of nesting Canada Geese at Rondout in the spring of 2019. Due to the close proximity of some Canada Goose nests to active Bald Eagle

nests DEP abstained from some goose egg and nest depredation work to maintain compliance with the New York State Endangered Species Protection Laws and USFWS Bald and Golden Eagle Protection Act.

Three Canada Goose nests containing 15 eggs were depredated during the spring of 2019 compared to four nests with 28 eggs depredated in 2018 (Table 4). Figure 20 shows the immediate location around the Rondout Effluent Chamber (REC) where Canada Goose nests are often found including along the reservoir spillway channel. Eight goslings were documented in 2019 so the depredation effort was deemed 65 percent successful. There were no Mute Swan or Double-crested Cormorant nests identified at Rondout Reservoir in 2019.

Figure 20. DEP wildlife biologist conduct late winter and early spring Canada Goose nest searches along spill channel and dam at Rondout Reservoir. Photo by Chris Nadareski.

4. Ashokan Reservoir

The 2017 FAD lists Ashokan Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Since the implementation of the WMP, no "as-needed" actions have been necessary at Ashokan. Ashokan Reservoir is divided into two basins each with a water intake chamber located at the Dividing Weir (Appendix A Figure 40). There are three bird zones on each of the two basins (Appendix A, Figure 40).

Daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. Forty-eight bird observations were conducted each at the Ashokan East Basin Effluent and at the Ashokan West Basin Effluent during this reporting period. Twenty-three of the 48 surveys had reportable data on the East Basin representing 48 percent of the observations. The dates, times and count ranges for birds observed near the Ashokan East Basin Effluent and Ashokan West Basin Effluent are listed in Tables 9 unless counts were zero or no data were collected due to environmental conditions or field errors.

Table 9. Ashokan Reservoir – daytime bird observations at Ashokan East Effluent.

Ashokan Reservoir, East Basin - 17 reportable observations of 48 surveys		
Date	**Time of Observation**	**Bird Count Range or Actual Bird Counts**
08/06/18	10:43	1-50
08/20/18	10:54	1-50
09/10/18	10:46	1-50
09/24/18	11:17	1-50
10/22/18	11:12	51-100
10/29/18	10:54	1-50
11/05/18	10:21	1-50
11/19/18	10:47	1-50
12/14/18	11:16	1-50
12/31/18	12:16	1-50
01/07/19	10:35	1-50
02/25/19	10:18	1-50
03/04/19	10:09	1-50
03/18/19	10:04	1-50
03/20/19	11:36	1-50
03/26/19	09:41	1-50
03/26/19	09:41	1-50
04/15/19	13:14	1-50
04/29/19	10:51	1-50
05/06/19	11:40	1-50
05/13/19	13:08	1-50
06/17/19	10:45	1-50
06/24/19	10:40	1-50

Seventeen of the 48 surveys had reportable data on the West Basin representing 35 percent of the observations. The dates, times and count ranges for birds observed near the Ashokan East Basin Effluent and Ashokan West Basin Effluent are listed in Table 10 unless counts were zero or no data were collected due to environmental conditions or field errors.

Table 10. Ashokan Reservoir – daytime bird observations at Ashokan West Effluent.

Ashokan Reservoir, West Basin - 17 reportable observations of 48 surveys		
Date	**Time of Observation**	**Bird Count Range or Actual Bird Counts**
08/06/18	10:41	1-50
08/13/18	10:41	1-50
08/27/18	10:39	1-50
09/04/18	10:20	1-50
10/22/18	11:10	1-50
10/29/18	10:55	1-50
02/19/19	11:57	1-50
03/25/19	11:00	51-100
04/08/19	12:48	1-50
05/06/19	11:41	1-50
05/13/19	13:08	1-50
05/20/19	09:50	1-50
05/28/19	11:38	1-50
06/03/19	12:41	1-50
06/10/19	10:39	1-50
06/24/19	10:38	1-50
07/29/19	10:42	1-50

There was only one water quality sample collected at the water effluent sampling location at Ashokan (EARCM) that was reported with Confluent Growth on the plate recorded on September 27, 2018 (Figure 21). The Confluent water sample only represents a qualitative description when too many bacterial colonies cannot be distinguished from one another.

In 2018, a coliform-restricted assessment for Ashokan Reservoir determined that the basin status was ‘non-restricted’. Of 174 fecal coliform bacteria samples collected over the period from August 1, 2018 to July 31, 2019, 104 (59 percent) had no fecal coliform bacteria present.

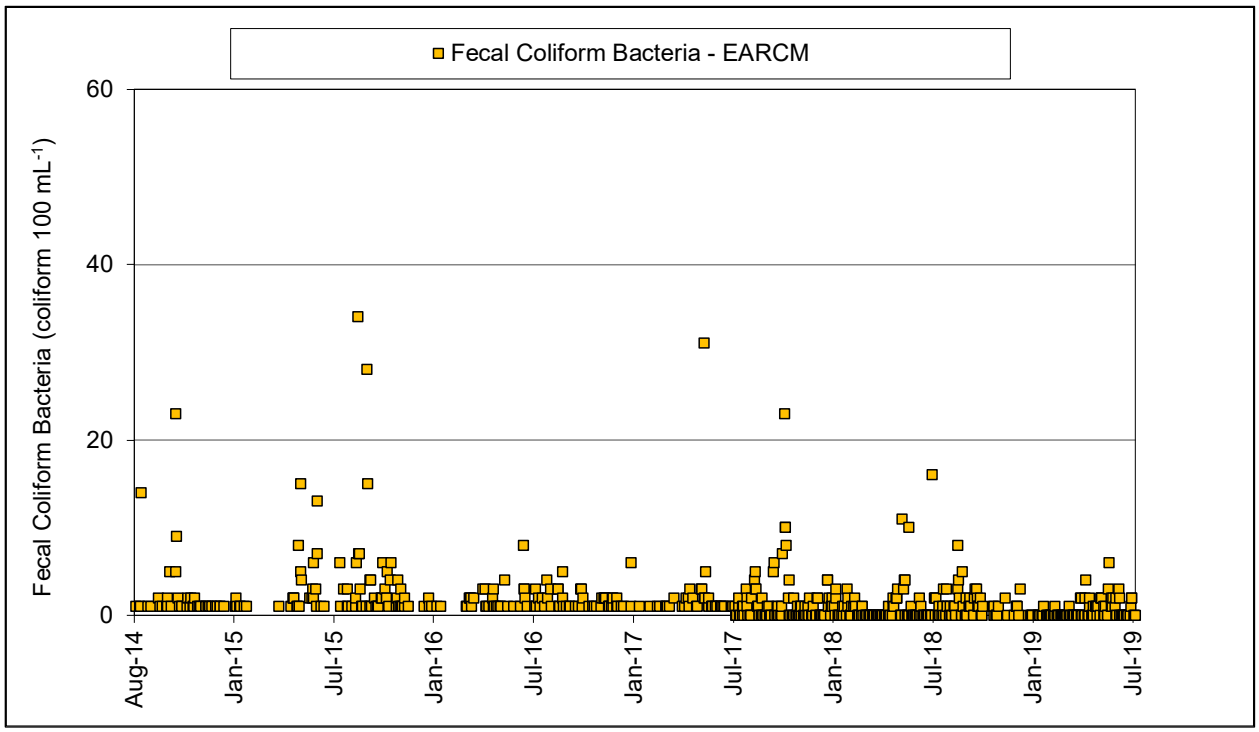

Figure 21. Ashokan Reservoir fecal coliforms 100mL^{-1} at Ashokan Effluent (EARCM) (8/1/2014 to 7/31/2019). Waterbird surveys discontinued on 4/30/2013. Non-detect fecal coliform were not presented.

Since the inception of the WMP Expanded Program at Ashokan Reservoir in March 2002, DEP has not been required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and/or waterbird counts. In the event bird dispersal actions were required, DEP would implement a program using contractor personnel to reduce waterbird numbers and eliminate a water quality threat.

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31, 2019 to reduce productivity at Ashokan. In 2019, seven Canada Goose nests were identified and 39 eggs were depredated (Table 4). In 2018, six Canada Goose nests were identified with 33 eggs depredated. The egg-depredation success rate at the Ashokan Reservoir was 87 percent in 2019 compared to 85 percent in 2018. Six goslings were observed in late spring 2019 similar to 2018. There were no Mute Swans or Double-crested Cormorants found nesting in 2019.

DEP maintains compliance with the NYSDEC endangered species regulations to protect nesting Bald Eagles on NYC reservoirs during routine water quality sampling and bird observation activities (Figure 22).

Figure 22. Adult Bald Eagle hunting on the Ashokan Dam. Photo by Bill Rose.

5. Croton Falls Reservoir

The 2017 FAD lists Croton Falls Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Since the inception of the WMP, only one "as needed" waterbird dispersal action was conducted at Croton Falls. The reservoir is divided into five bird zones associated with reservoir water quality sampling sites (Appendix A Figure 41).

There were three nocturnal waterbird counts conducted during the reporting period for compliance with DEP's Operational Guidance Plan pursuant to the 2007 Filtration Avoidance Determination Croton Falls Pump Station Operations Monitoring Plan as the plan was invoked in June 2019. Routine waterbird population surveys were suspended in May 2013 as per NYSDOH's March 13, 2013 approval to reduce routine waterbird population monitoring from biweekly surveys to an "as-needed" option. As-needed actions are based on fecal coliform bacteria levels at the effluent, operational changes in water delivery and waterbird population counts. In the event a bird dispersal action is required, DEP would initiate daily waterbird observations and dispersal activities using contractor personnel to eliminate a water quality threat.

There were twelve water quality samples collected from the Croton Falls release in 2018/2019 that had fecal coliform counts above 20 fecal coliforms 100mL^{-1} (Figure 23). The high fecal coliform elevation at 150 fecal coliforms 100mL^{-1} was recorded on October 30, 2018.

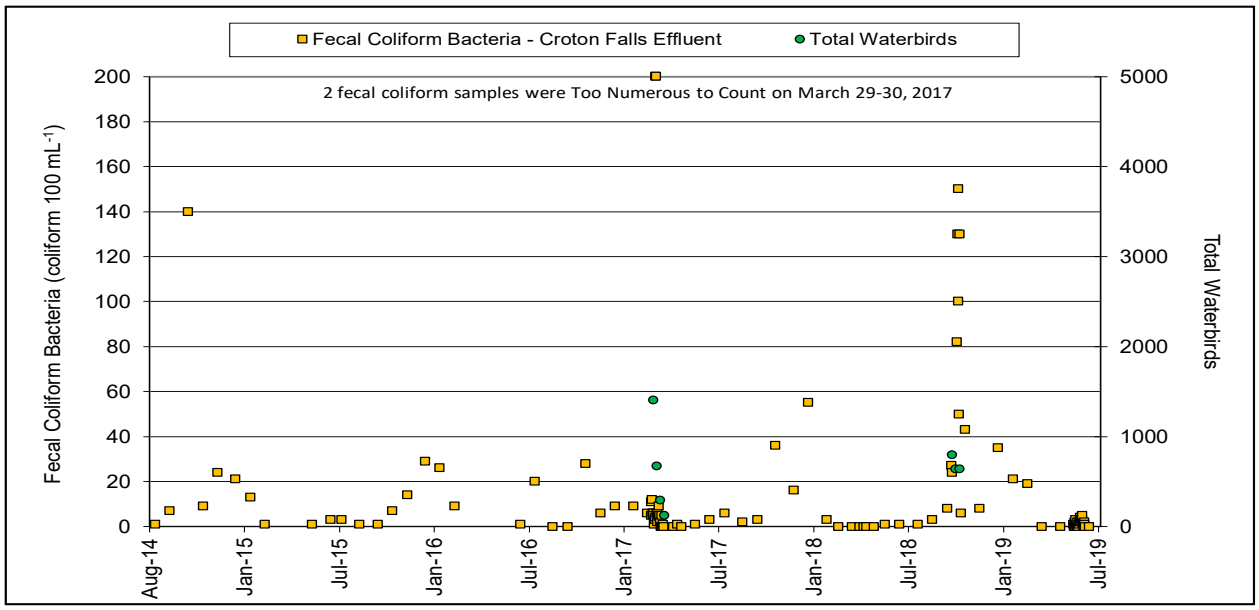

Figure 23. Croton Falls Reservoir fecal coliforms 100mL^{-1} at Croton Falls Effluent vs. total waterbirds (8/1/2014 to 7/31/2019). Routine waterbird surveys discontinued on 4/30/2013. Non-detect fecal coliform were not presented.

Of 44 water quality samples collected over the period from August 1, 2017 to July 31, 2019, 10 or 23 percent were non-detectable.

DEP conducted reproductive control of Canada Geese from April 1 through May 31 in the spring of 2019 for a total of nine site visits to reduce productivity at Croton Falls (Table 4). In 2019, 12 Canada Geese nests were identified with 72 eggs depredated compared to 12 nests and 72 eggs in 2018. The Canada Goose egg-depredation success rate at Croton Falls for 2019 was 92 percent as six goslings hatched. There were no Mute Swan nests observed in 2019.

6. Cross River Reservoir

The 2017 FAD lists Cross River Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Cross River Reservoir is divided into three bird zones associated with reservoir water quality sampling locations (Appendix A Figure 42). Waterbird population surveys were suspended in May 2013 for this reporting period as per NYSDOH's March 13, 2013 approval to reduce routine waterbird population monitoring from biweekly surveys to an as-needed option. Since the inception of the WMP Expanded Program at Cross River in March 2002, DEP has not been required to initiate an as-needed bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event bird dispersal actions were required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

There were six nocturnal waterbird counts conducted during the reporting period for compliance with DEP's Operational Guidance Plan pursuant to the 2007 Filtration Avoidance Determination Cross River Pump Station Operations Monitoring Plan as the plan was invoked in October 2019. Fecal coliform bacteria concentrations are reported for August 1, 2014 through July 31, 2019 (Figure 24). Fecal coliform bacteria levels in water samples at Cross River Reservoir exceeded the 20 fecal coliforms $100mL^{-1}$ level one time on November 5, 2018 at a high of 60 from August 1, 2018 through July 31, 2019 (Figure 24). There appears to be an

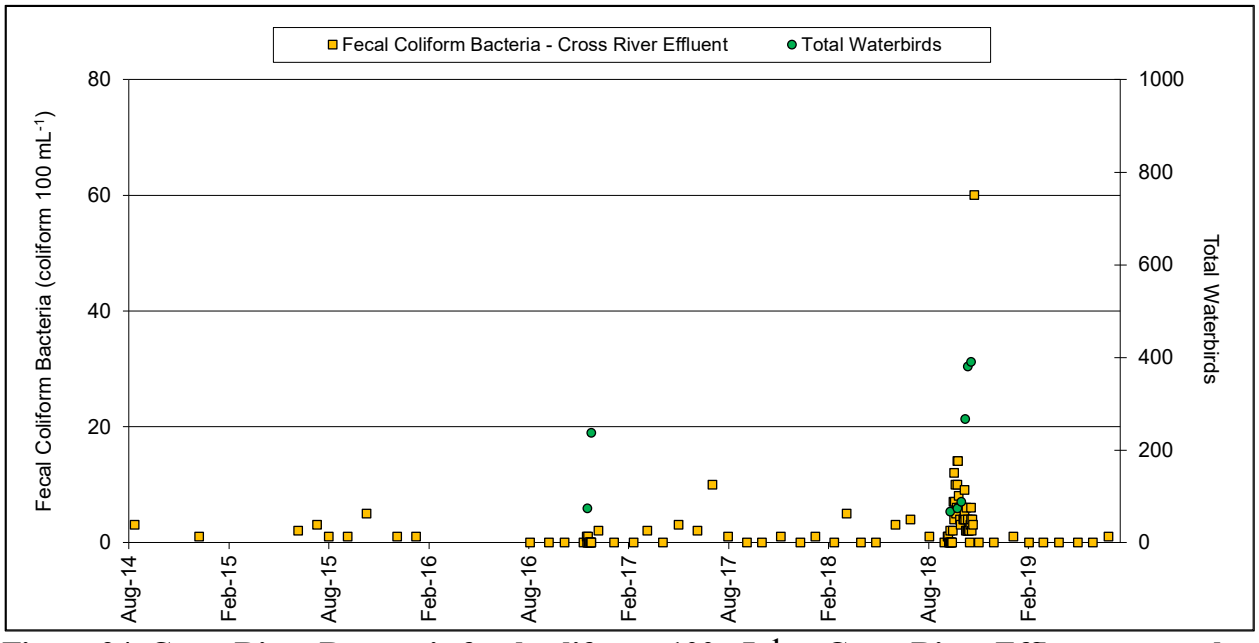

Figure 24. Cross River Reservoir fecal coliforms $100mL^{-1}$ at Cross River Effluent vs. total waterbirds (8/1/2014 to 7/31/2019). Routine waterbird surveys discontinued on 4/30/2013. Non-detect fecal coliform were not presented.

associated elevation in fecal coliform bacteria with the simultaneous increase in waterbirds from late September through late October 2018. Of 103 water quality samples collected in this reporting period, 15 or 14.5 percent were non-detectable.

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31 in 2019 to reduce productivity at Cross River. In 2019, twelve nests were identified and 42 eggs depredated during nine site visits compared to eight nests and 44 eggs in 2018 (Table 4). The Canada Goose egg-depredation success rate for Cross River in 2019 was 100 percent with no goslings observed. Reservoir nesting Canada Geese can be difficult to locate and require a thorough inspection of shoreline areas and islands. There were no Mute Swans or Double-crested Cormorants observed nesting around the reservoir in 2019.

Figure 25. DEP wildlife biologist labeling Canada Goose eggs on island used for nesting.

7. Hillview Reservoir

The City's Long-Term Watershed Protection Program (July 2007 FAD) expanded the Waterfowl Management Program to include Hillview Reservoir on an "as-needed" basis similar to the 2002 FAD expansion for five additional reservoirs discussed above. DEP initiated an in-depth program for waterbird management starting in 1993 followed by program enhancements with the 2007 FAD and again in 2011 under the Hillview Administrative Order on Consent. Hillview Reservoir is divided into two bird zones associated with the reservoirs two distinct basins and water quality sampling stations (Appendix A, Figures 43 and 44). Waterbird population survey frequencies have varied through the years but generally had been conducted weekly at minimum and daily in recent years. A variety of bird deterrent and dispersal methods have been implemented since 1993 with a high level of success reducing, and in most cases eliminating, the presence of roosting waterbirds; particularly geese, swans, cormorants, ducks, and gulls.

Prior to 1993, DEP Operations staff employed a variety of noisemakers (bottle rockets and shotgun blasts) to eliminate birds roosting diurnally at Hillview on an infrequent basis. During the summer of 1993, DEP's Wildlife Studies Section initiated a formal bird management program to monitor birds throughout the year and develop a bird deterrence/dispersal program. Pyrotechnics and propane-operated cannons were initially used to chase the birds off the water and rooftops of reservoir shaft buildings. Because of the bird populations, DEP consulted with the United States Department of Agriculture, Animal and Plant Inspection Services, Wildlife Services (USDA) on the design and installation of an overhead bird deterrent wire system. In July 1994, the bird deterrent wire system was partially installed which formed an aerial grid above the surface water to prevent birds such as swans, cormorants, geese, gulls and ducks from landing and defecating in the water. The wire grid, which was mostly completed by the spring of 1995, consisted of a combination of high-test monofilament, Kevlar wire, and twine. The wire grid was strung along the shoreline fences spanning a distance of nearly 1,200 feet. DEP staff maintained this wire grid system from 1994 to 2006, after which a contract was obtained to install state-of-the-art bird wire deterrent system using Kevlar-coated wire strung on 15' stanchions with reel tensioning devices at the base. This work was completed in 2007. DEP staff have continued to maintain the overhead bird deterrent wire system on an as needed basis.

DEP and its contractor continued to use pyrotechnics, propane cannons, remote-control motorboats, and employed physical chasing techniques to supplement the wire system to actively keep birds off the reservoir, the influent (Uptake) and the effluent (Downtake) facilities, and the reservoir-dividing wall. In the winter of 2008, DEP installed remotely operated propane cannons along the reservoir's dividing wall to keep gulls and other birds from roosting on the dividing wall railings. Discharge of cannon blasts were used mostly during times of inclement weather for personnel safety. The cannons were supplemented by installation of Daddi-Long-Legs (bird deterrent wires) placed on the tops of the 15' stanchions along the reservoir dividing wall to

prevent birds from roosting. In 2013, DEP installed a new bird deterrent wire system along the reservoir's ½ mile long dividing (Figure 26) wall railing to keep gulls and other passerine species of birds from landing and defecating in the water. The railing wires are routinely inspected and maintained and continue to prevent gulls from attempting to land on the reservoir-dividing wall and can be attributed to the reduced gull activity recorded during this reporting period.

Figure 26. Hillview Reservoir aerial view of dividing wall. Photo by DEP Police.

A USEPA Administrative Order on Consent governing the covering of Hillview Reservoir (Docket No. SDWA-02-2010-8027 Catskill Delaware System) was signed on May 24, 2010. Under this order, which went into effect on August 1, 2011, DEP began implementing an enhanced wildlife management program at Hillview to further protect the water supply. Best management practices included: increased bird census conducted daily from pre-dawn to post-dusk hours and dispersal from 5:00am until post-dusk hours, mammal population monitoring and removal, Alewife (baitfish) monitoring and removal, animal sanitation inspections (facility and grounds inspections and clean-up of animal feces), use of remote-control motorboats, swallow and sparrow management, and continued monthly reporting on wildlife management activities at Hillview Reservoir. DEP biologists routinely attempt to live-capture and relocate Ruddy Ducks and other diving waterfowl at Hillview Reservoir (Figure 27).

Figure 27. DEP wildlife biologists continue to diving ducks using nets from Jon boats as an alternative to depredations. Photo by M. Reid.

Overnight waterbird counts have been conducted since 1993 and daytime counts were initiated in the summer of 2004 with less frequent data collected from 1993 through 2004 (Figures 28 and 29).

Prior to bird wire installation in 1994, gulls comprised more than 70 percent of the night-roosting species on the reservoir. In 2018/2019, night-roosting guilds of birds comprised the following breakdown: Canada Geese less than one percent, Gull Spp. less than one percent, and ducks about 99.3 percent similar to the previous reporting period. Except for a low number of diving ducks (Ruddy Ducks, *Oxyura jamaicensis*) that arrive during fall migration, all waterbirds observed and reported on both nocturnal and diurnal surveys were dispersed from the reservoir using pyrotechnics, cannons, and physical chasing from 5:00am until post-dusk times. Physical chasing of birds occurs from the time of personnel arrival starting as early as 5:00am. DEP and

its contractor crews were largely successful in dispersing all other birds including terrestrial species such as European Starlings upon observation.

During this reporting period, there were 7,933 waterbirds dispersed at Hillview. Dispersal actions included birds that both landed in the reservoir and those attempting to land. Dispersal actions included the use of bird bangers, physical chases, remote controlled boats, and Jon boats. Propane-operated cannons were not used in 2018/2019 however; the units were available for use during inclement weather.

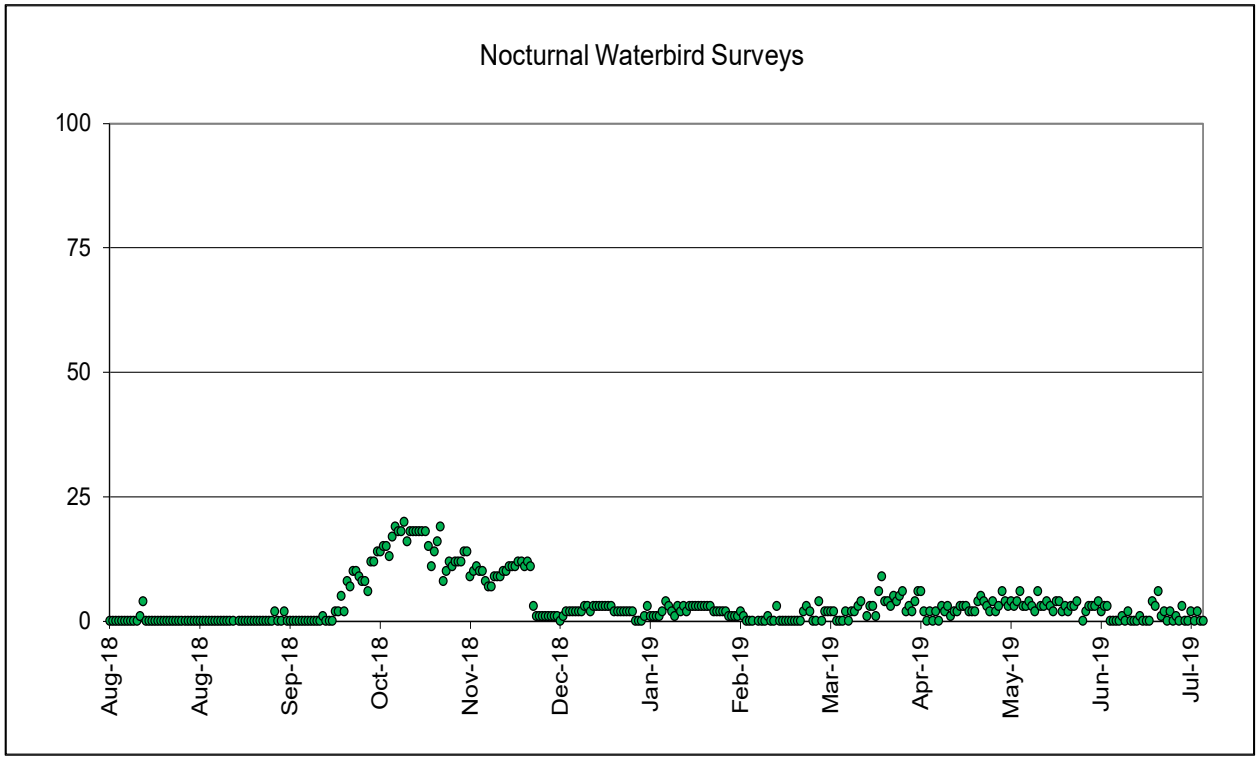

Figure 28. Hillview Reservoir total waterbirds nocturnal counts (8/1/2018 to 7/31/2019).

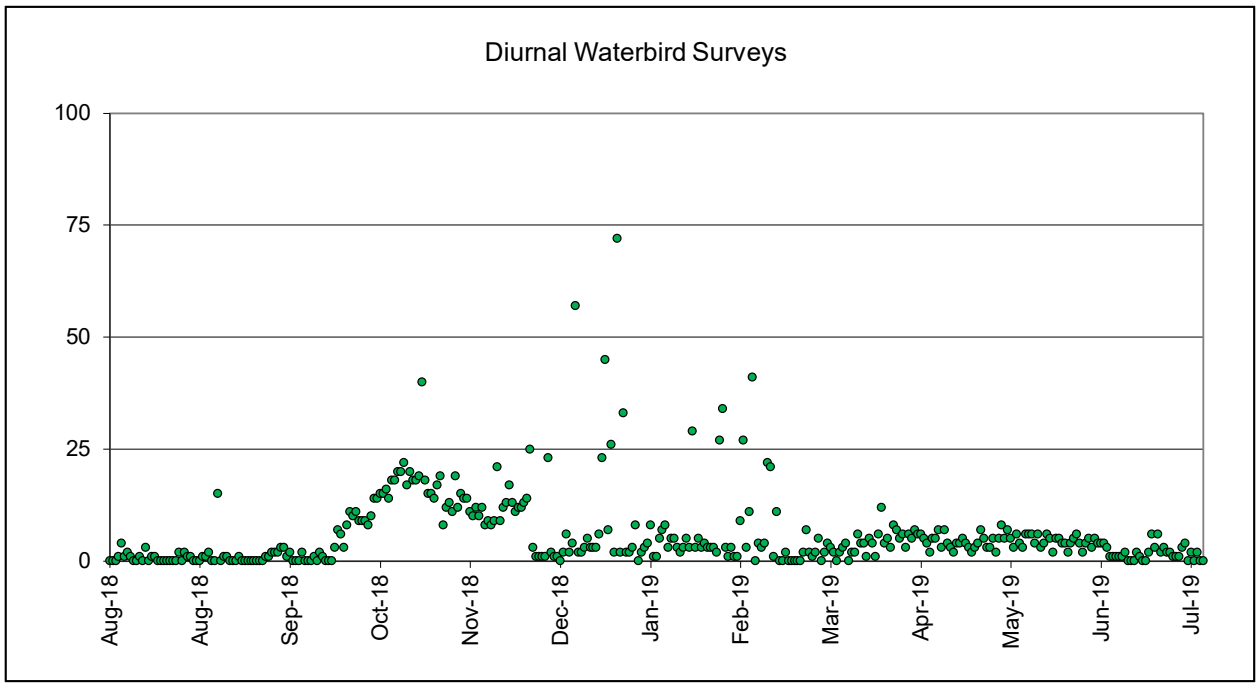

Figure 29. Hillview Reservoir total waterbirds diurnal counts (8/1/2018 to 7/31/2019).

The Ruddy Duck is a diving duck species that often does not respond to conventional bird dispersal measures. DEP has had limited success in live trapping the ducks by means of chasing and netting from boats. If live-captured, DEP transports ducks to licensed wildlife rehabilitators or releases them back to the wild under federal and state approvals.

The diving ducks continue to remain largely unaffected by the variety of bird deterrent and dispersal measures used by DEP to date. Non-lethal actions to disperse the diving ducks has led to limited success using the remote control motorboats and pyrotechnics. As a result, DEP utilized contract services with USDA for lethal removal of ducks during this reporting period. The lethal duck removal program was initiated in April 2011 and continues to be conducted on an as-needed basis, mostly during the autumn and winter periods and when the ducks are in migration and attempted to overwinter at Hillview. USDA sharpshooters lethally removed 29 Ruddy Ducks during this reporting period.

Overnight and daytime waterbird counts on both basins remained very low and were almost exclusively from a relatively small resident duck population during the autumn and winter. Three hundred and sixty-two out of 365 (99 percent) overnight surveys conducted were successful in the collection of data in 2018/2019. There were no gulls observed on 356 overnight surveys. There was only one observation of two Canada Geese recorded during the overnight surveys. Overnight waterbird counts peaked at 20 on November 7, 2018.

The behavior patterns of the waterbirds utilizing Hillview Reservoir are different from the patterns of those using other upstate reservoirs as Hillview is situated in a highly urbanized area and is surrounded by large populations of breeding gulls throughout the NYC metropolitan network of waterways and islands. This partially explains why gull activity is observed flying over the reservoir and present year-around at Hillview. Since the installation of the bird deterrent wire system in 1994, small numbers of gulls and three species of ducks remain the target of most active dispersal activity.

Daily water quality results for Hillview Reservoir are presented in this report as "number of positive *E. coli*" for each month of the reporting period at two water quality-sampling locations (Figures 30 and 31). *E. coli* levels (grab samples) remained at zero detections entering Hillview at water quality sampling locations Site 1 (Figure 30 and Appendix A Figure 44). There was one positive *E. coli* sample reported at sampling Site 3 as the water leaves Hillview Reservoir for distribution (Figure 30 and Appendix A Figure 44).

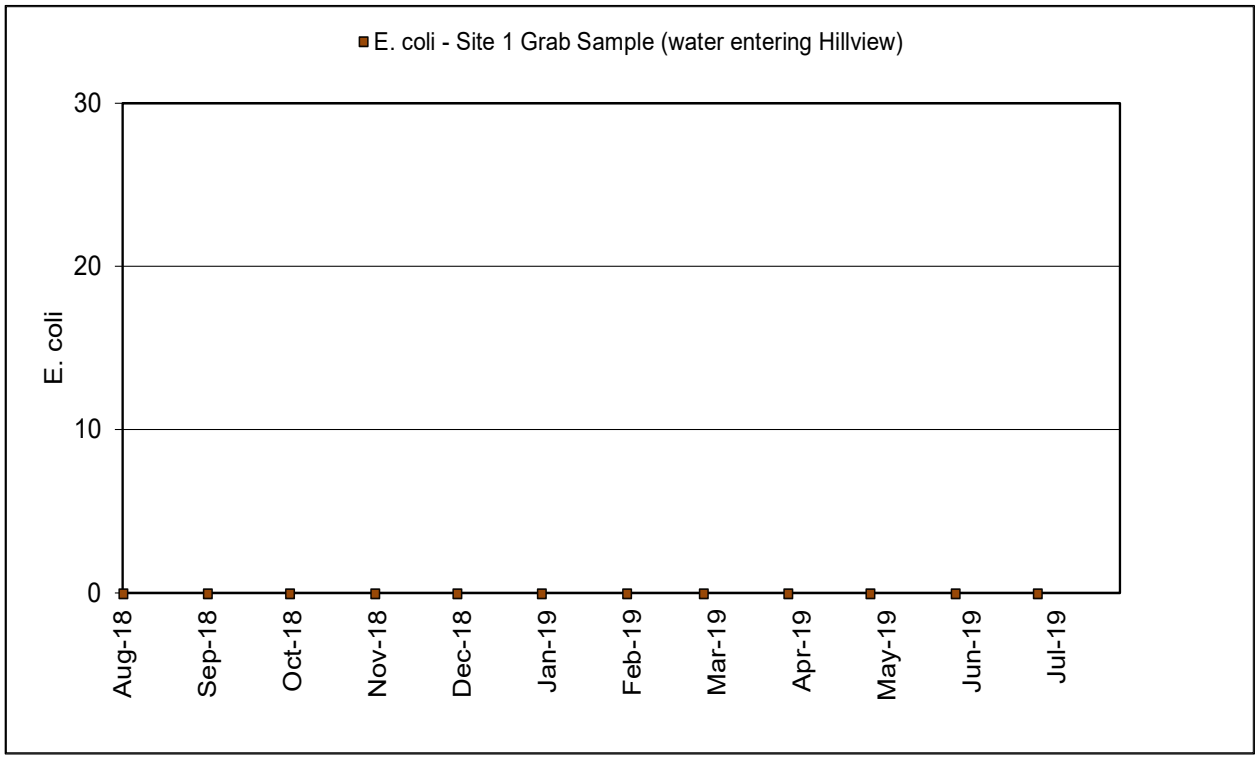

Figure 30. Hillview Reservoir number of positive *E. coli* (grab sample) at water sampling Site 1 (8/1/2018 to 7/31/2019).

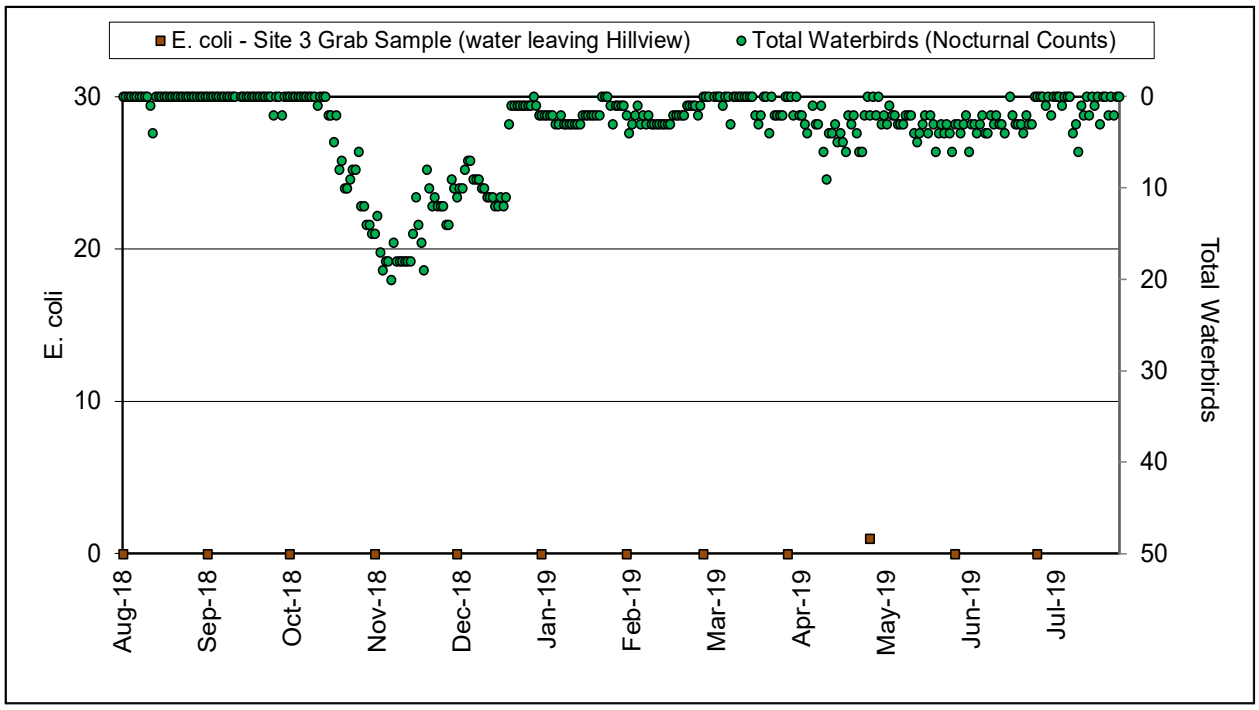

Figure 31. Hillview Reservoir number of positive *E. coli* (grab sample) at water sampling Site 3 versus total waterbirds (8/1/2018 to 7/31/2019).

Waterbirds were mainly observed during the period from late October 2018 through early summer 2019. DEP's contractor, USDA Wildlife Services, conducted several depredation actions from November 2018 through February 2019 to remove 29 diving ducks that did not respond to the conventional types of bird dispersal methods.

DEP has continued an active swallow depredation program to eliminate the nesting Cliff Swallows and Barn Swallows on the reservoir buildings. This work was conducted under a U.S. Fish and Wildlife Service Depredation Permit. In 2019, no Cliff Swallow nests or eggs were depredated (physically removed from the eaves of the reservoir shaft buildings). There were no Barn Swallow nests observed during the spring and summer period of 2019 similar to the previous year.

Additional actions employed by DEP working in conjunction with assistance of NYSDEC and USDA Wildlife Services included implementing the following mitigative activities:

- Winter 2008 - Present: Use of remote control propane cannons for bird dispersal along the reservoir-dividing wall.
- September 2008 and February 2009 - Present: Use of remote control motor boat for

dispersal.

- December 2008 - Present: Use of canoes (2008-2010 only), kayaks (2010 only), and electric motored Jon-boats for dispersal.
- September 2009 - Present: Deployment of gill nets (2010 only) and use of electric motored Jon-boats to attempt to capture ducks.
- April 2010: Experimental lethal shooting employed by the USDA Wildlife Services.
- April 2010: Nighttime spotlighting using electric motored Jon-boats for capturing ducks.
- July 2010 - Present: Bird netting installed and maintained on reservoir shaft buildings intake openings to preclude roosting and breeding swallow spp.
- January 2011 - Present: Submission of a monthly report on wildlife management activities to NYSDOH and USEPA.
- June 2011 - Present: USDA Wildlife Services Contract implemented to remove all resident ducks or other waterfowl that are unsuccessfully dispersed or removed by other non-lethal means and implemented on an as-needed basis.
- August 2011 - Present: Under the USEPA Administrative Order and enhanced wildlife management program. Includes the following:
    - Increased weekly survey shifts from 10 per week to 14 per week to allow daily, dawn to dusk coverage.
    - Daily sanitation surveys – observations and removal of animal fecal matter on the reservoir shaft buildings and on the reservoir-dividing wall.
    - Weekly small mammal trapping inside the reservoir perimeter fence and on the dividing wall.
    - Removal of Barn Swallow and Cliff Swallow nests on the reservoir shaft buildings and Osprey nests along the dividing wall bird wire stanchions.
    - Collection and disposal of Alewives (baitfish) from the Uptake 1 facility (water received from Kensico Reservoir). Removal of Alewives facilitates the elimination of waterbird foraging activity and roosting at the reservoir.
- May 2012 - Present: Expanded access for USDA Wildlife Services Contract sharpshooters to discharge firearms from reservoir dividing wall to improve duck depredation efficiency.
- January 2013 - Present: Received USFWS depredation permit for Cliff Swallows, Barn Swallows, and Mallard nest/egg/young removal during the breeding season.
- 2013 - Present: Completed installation and continued maintenance of avian deterrent wire system on reservoir dividing wall railing.
- 2013 - Present: Expanded access for USDA Wildlife Services Contract sharpshooters to discharge firearms from Jon boats to improve duck depredation efficiency.
- July 2014 - Present: Expanded number of live mammal traps along reservoir perimeter.
- 2014 - Present: Installed additional motion activated cameras to document wildlife access at gate entrances to reservoir.

- 2015 - Present: Experimented with motion activated visual and sound emission systems at wildlife access locations for deterrence. No successful application to date as most systems purchased and installed proved to be ineffective.
- 2016 - Present: Expanded mammal trapping effort year-round.
- 2017 - Present: Expanded mammal trapping effort year-round and expanded Mallard nest searches during the spring/summer period.
- 2018 - Present: Expanded use of the remote-controlled motorboat for waterbird dispersal and depredation activities.

Mammal Trapping

DEP initiated a year-around mammal trapping program in August 2011 and currently conducts trapping for raccoons (*Procyon lotor*), mice, and other mammals each week of the year (Table 11). Traps were generally set around the Downtake 1 and Uptake 1 facility catwalks and along the reservoir shoreline. A variety of commercial and supermarket-type trapping baits have been used with variable success. Traps have been outfitted with catchment plates to avoid release of fecal material and body fluids into the reservoir from trapped animals. All traps are secured with wires to the shoreline fence to prevent trap rollovers. To date, mice (*Peromyscus* Spp. and House Mouse), raccoons, and Virginia opossum (*Didelphis virginiana*) have been the most frequently trapped species.

Other mammals trapped and subsequently depredated under New York State Department of Environmental Conservation approval include striped skunk (*Mephitis mephitis*), meadow vole (*Microtus pennsylvanicus*), eastern gray squirrel (*Sciurus carolinensis*), Norway rat (*Rattus norvegicus*), and northern short-tailed shrew (*Blarina brevicauda*). If feral or domestic cats are live-trapped, they are transferred to the City of Yonkers Animal Control Unit or released off Hillview Reservoir property.

A total of 3,985 live and lethal traps were set during the period August 1, 2018 to July 31, 2019 (Table 11). The success of the trapping program by year is outlined in Table 12 and Figure 32. One hundred and forty-one animals from nine mammal species and three bird species were trapped during this reporting period. Overall and since the inception of the trapping efforts there has been a total of 584 animals trapped including 12 feral cats and several species of passerine birds trapped inside the reservoir perimeter fence from August 1, 2011 to July 31, 2019 (Tables 11 and 12). All trapped specimens were euthanized (except for the feral cats and birds) and subsequently composted at the DEP Animal Compost Facility located in Ulster County. In 2018/2019, three thousand nine hundred and eighty-five live and lethal traps were set. Since 2011, a total of 29,138 mammal trapping-nights have been set. A single mammal trapping night consists of one trap baited for one night. Thirty-two specimens from six species have been trapped in the first half of 2019. One non-target terrestrial bird species and six non-target feral cats were also trapped and subsequently released in this reporting period.

As part of the ongoing wildlife management initiatives, nighttime remote sensing cameras continue to be used to document the presence or absence of wildlife on the reservoir dividing wall and catwalks surrounding the shaft buildings at Hillview. Figure 33 represents the occurrence of nighttime remote camera photographs of animals on nights that traps were set and nights when traps were not set versus trapping success. Photographs of animals recorded during trap nights occurred during nine of 12 months and camera detections that occurred on no trap nights were recorded during seven of 12 months.

Table 11. Mammal trapping summary August 2018 through July 2019.

Month/Year	**Number of live-traps and lethal traps set**	**Trapping success**
Aug-18	463	3 *Peromyscus* Spp., 1 striped skunk, one feral cat (released)
Sep-18	404	6 *Peromyscus* Spp., and 5 Norway Rats
Oct-18	396	5 *Peromyscus* Spp., 1 opossum, and 2 Norway Rats
Nov-18	286	2 *Peromyscus* Spp., 1 Eastern Gray Squirrel, 1 feral cat (released)
Dec-18	286	1 *Peromyscus* Spp.
Jan-19	208	1 *Peromyscus* Spp.
Feb-19	292	1 *Peromyscus* Spp.
Mar-19	264	2 *Peromyscus* Spp.
Apr-19	374	1 *Peromyscus* Spp., and 1 House Mouse
May-19	374	1 *Peromyscus* Spp., 7 Eastern Gray Squirrels,1 Raccoon, 2 feral cats (released)
Jun-19	308	6 *Peromyscus* Spp., 2 Opossum, and 2 feral cats (released)
Jul-19	330	3 *Peromyscus* Spp. 2 Raccoons, 1 House Sparrow
Annual Trapping Totals	**3,985**	**9 Wildlife Species (8 mammals and 1 bird)**

Table 12. Mammal trapping success summary for Hillview Reservoir (August 2011 to July 2019).

Species Trapped	2011 (8/1 to 12/31)	2012	2013	2014	2015	2016	2017	2018	2019 (January 1 to July 31)	Trapping totals by species
Raccoon	8	5	6	6	5	0	4	6	3	**43**
Striped Skunk	0	1	0	7	3	0	1	1	0	**13**
Virginia Opossum	0	0	0	4	6	1	6	9	2	**28**
Mice (*Peromyscus* Spp.)	7	0	11	7	13	116	165	39	16	**374**
Meadow Vole	0	0	4	0	0	6	6	1	0	**17**
Short-tailed Shrew	0	0	1	0	0	6	10	2	0	**19**
House Mouse	0	0	0	21	2	7	11	2	1	**44**
Norway Rat	0	0	0	1	4	1	3	8	0	**17**
Gray Squirrel	0	0	0	1	0	1	1	7	7	**17**
Feral Cat	0	0	0	4	1	1	0	3	3	**12**
Annual Trapping totals	**15**	**6**	**22**	**51**	**34**	**139**	**207**	**78**	**32**	**584**

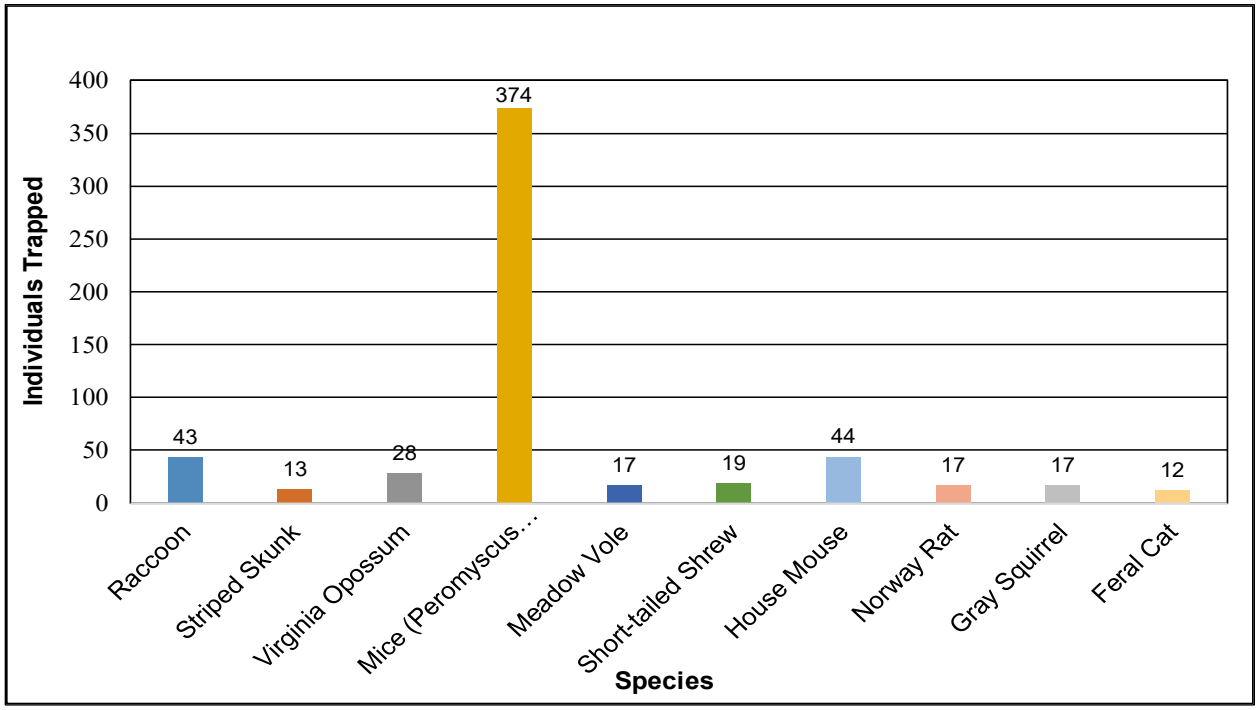

Figure 32. Mammal species trapped at Hillview Reservoir (8/1/2011 to 7/31/2019).

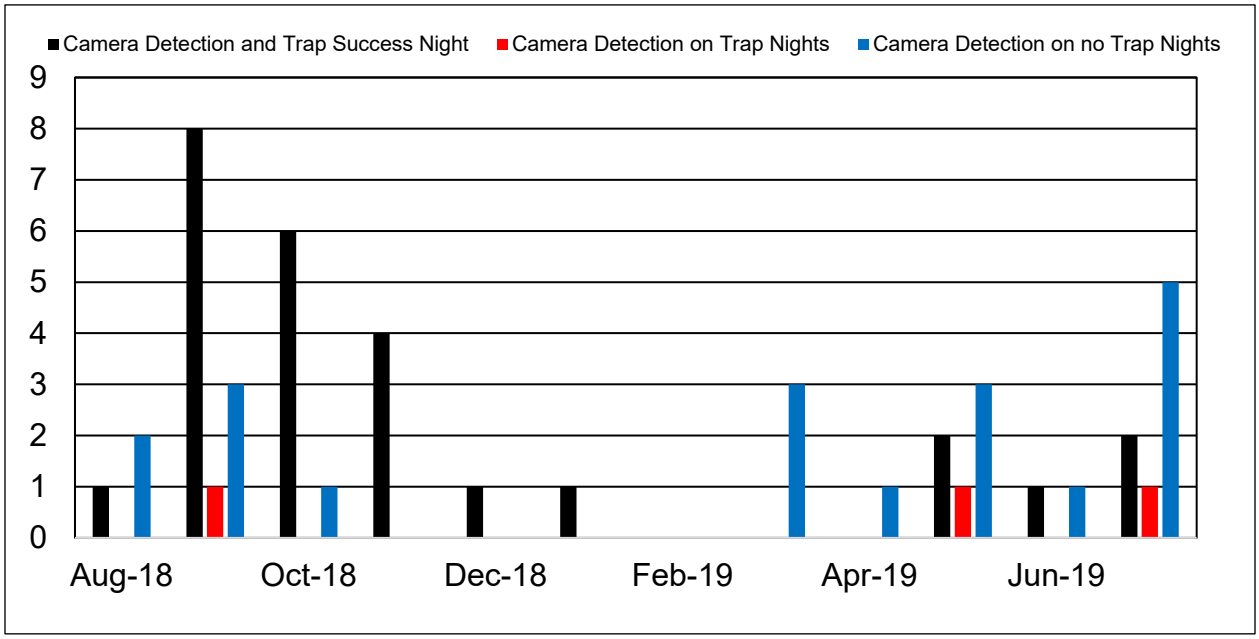

Figure 33. Occurrences of remote nighttime photography of animals recorded on the reservoir catwalk and dividing wall versus trapping success (8/1/2018 to 7/31/2019).

During the spring/summer 2019 waterbird nesting season there were no reported nesting attempts by Canada Geese or Mute Swans. However, five Mallard nests were identified and 20 eggs depredated under a federal permit compared to three nests and 25 eggs depredated in 2018. Of the five nests found in 2019, five ducklings were live-captured and relocated off reservoir property compared to seven ducklings that hatched in 2018 (Table 4). All ducklings were promptly live-captured and delivered to wildlife rehabilitators for captive raising and subsequent release at locations distant from Hillview Reservoir. The Mallard egg-depredation success rate rose to 80 percent in 2019 compared to 78 percent in 2018. DEP speculates that the urban nesting Mallards continue to adapt to the variety of bird deterrent and dispersal measures. DEP continued to expand the search of locations for nesting Mallards in 2019 combined with an expansion of lawn maintenance into areas where nests from previous years were found and on Shaft building rooftops.

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CONCLUSION

DEP's Waterfowl Management Program is a key component of the City's watershed protection efforts as outlined under the Filtration Avoidance Determination that was issued in May 2017 (NYSDOH 2017). The program has helped DEP maximize options for delivering high quality water into distribution. The waterbird dispersal efforts of the Waterfowl Management Program has been implemented since 1993 and continues to effectively reduce waterbird populations and reduce fecal coliform bacteria levels which assists DEP in maintaining compliance with the Environmental Protection Agency's Surface Water Treatment Rule which falls under the Safe Drinking Water Act (42 U.S.C. §300f et seq.).

The reduced waterbird and fecal coliform bacteria counts at Kensico Reservoir and Hillview Reservoir can be attributed directly to the variety of bird dispersal and bird deterrence techniques, wildlife sanitary surveys, and other wildlife management practices as directed under the FAD and the Hillview Administrative Order on Consent. When dispersal tools (motorboats, airboats, propane cannons, and pyrotechnics) and bird deterrent systems (overhead bird wires and netting, reproductive control, and depredation) are used in a variety of combinations they result in the most effective means of reducing bird populations over large open areas of surface water. To date, it remains inconclusive as to what the tolerable number of waterbirds is at NYC reservoirs before water quality would be compromised. As a result, the objective of the Waterfowl Management Program will be to continue with an active bird dispersal program during the bird migratory seasons for Kensico and year-around at Hillview Reservoirs and on an "as-needed" basis for reservoirs that are sources to Kensico via aqueducts.

The establishment of bird-free zones (spatial distributions) around the water intake structure at Kensico Reservoir, whether program-initiated through bird dispersal activities or by the natural process of the birds selecting roosting locations, continues to be a key influence on lower fecal coliform bacteria levels. In 2018, Kensico Reservoir was once again classified as a 'non-restricted' basin. Managing waterbird populations around the reservoir water intake areas are key to reducing the release of excrement and potential fecal coliform elevations. Managing waterbird populations around the reservoir water intake areas are key to reducing the release of excrement and potential fecal coliform elevations. The spatial distributions of the birds in relation to the flow dynamics of the reservoir appear to have the greatest influence in the transport of bacteria to the water intakes. Ongoing evaluation of bird population and fecal coliform bacteria data provide evidence that when DEP properly manages its waterbird populations, bird-related fecal coliform bacteria concentrations have remained low.

Bird deterrence measures that include waterbird reproductive management, bird deterrent netting, overhead bird deterrent wires, and shoreline fencing continued to reduce local breeding opportunities around water intake structures and eliminate fecundity during this reporting period. DEP conducted 43 springtime Canada Goose and Mute Swan nest depredation actions on six

reservoirs resulting in 62 goose nest depredations and one swan nest depredations whereby 282 eggs were addled. DEP will continue to consider options as deemed necessary for Canada Geese and Mute Swan management to reduce local breeding populations by means of "take" under federal and state depredation permits. The "take" option was utilized by the USDA as part of the Westchester County Airport depredation order to remove local Canada Geese during this reporting period. The removal of locally breeding Canada Geese helps break the strong nest-site fidelity these birds exhibit particularly with a species that may survive more than 20 years as a local breeder.

At Hillview Reservoir, DEP wildlife biologists continued to employ the use of pyrotechnics, physical chasing, remote-operated propane cannons, remote-control motorboats, Daddi-Long-Legs, bird deterrent wires and netting to prevent terrestrial and waterbird species from landing on the reservoir and reservoir-dividing wall. Additional lethal control measures to manage ducks, geese, swallows and sparrows also continue to be implemented. Although not used in 2018/2019, remotely operated propane cannons have improved bird deterrence during times of inclement weather when DEP and contractor staff are not permitted on the reservoir-dividing wall and pyrotechnics are rendered ineffective from the reservoir shoreline.

As a part of the USEPA Administrative Order on Consent, DEP has conducts small mammal trapping inside the reservoir perimeter fence and on the reservoir-dividing wall. DEP conducted 3,985 trap-nights during 2018/2019, in an attempt to eliminate small mammal activity inside the reservoir perimeter fence. DEP completed another successful year in egg and nest depredation for nesting swallows under a federal depredation permit again in 2019 with a 100 percent success rate by preventing active nests from developing and preventing nesting activity by way of maintenance of bird netting on reservoir shaft buildings. Five Mallard Duck nests were depredated along with a capture and removal of five ducklings and one adult Mallard.

Waterbird populations continue to demonstrate seasonal elevations primarily during the autumn and winter periods in all reservoirs listed in this report. Climate alterations can affect behaviors and migratory activity changes of "local" or resident birds such as Canada Geese. Gull populations are migratory and utilize the New York City Reservoir system as a migratory stopover or wintering area until local conditions (i.e. ice and snow cover) become too intolerable. The Kensico Reservoir is situated between the Hudson River to the west and the Long Island Sound to the east making it an attractive fresh water system for many species of waterbirds. Ice cover on the reservoirs and snow cover in the associated watershed or daily flight range for food often determine whether the waterbirds will continue southward in migration or utilize the reservoirs.

DEP continues to remain in compliance with SWTR regulations, with low seasonal elevations of fecal coliform bacteria recorded annually from late autumn through early winter.

Monitoring the effects that bird dispersal measures have on each reservoir has been achieved by evaluating over 25 years of routine water quality, population surveys and bacterial identification data. Avian population survey results have provided inferences about the potential effects of avian fecal matter based on the spatial and temporal aspects of the birds and have assisted DEP in evaluating the effectiveness of the dispersal measures. DEP will continue with the implementation of the Waterfowl Management Program as part of its Filtration Avoidance Program to protect water quality by managing waterbird and other wildlife populations.

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Appendix A. Reservoir maps with bird zone designations and water sampling locations

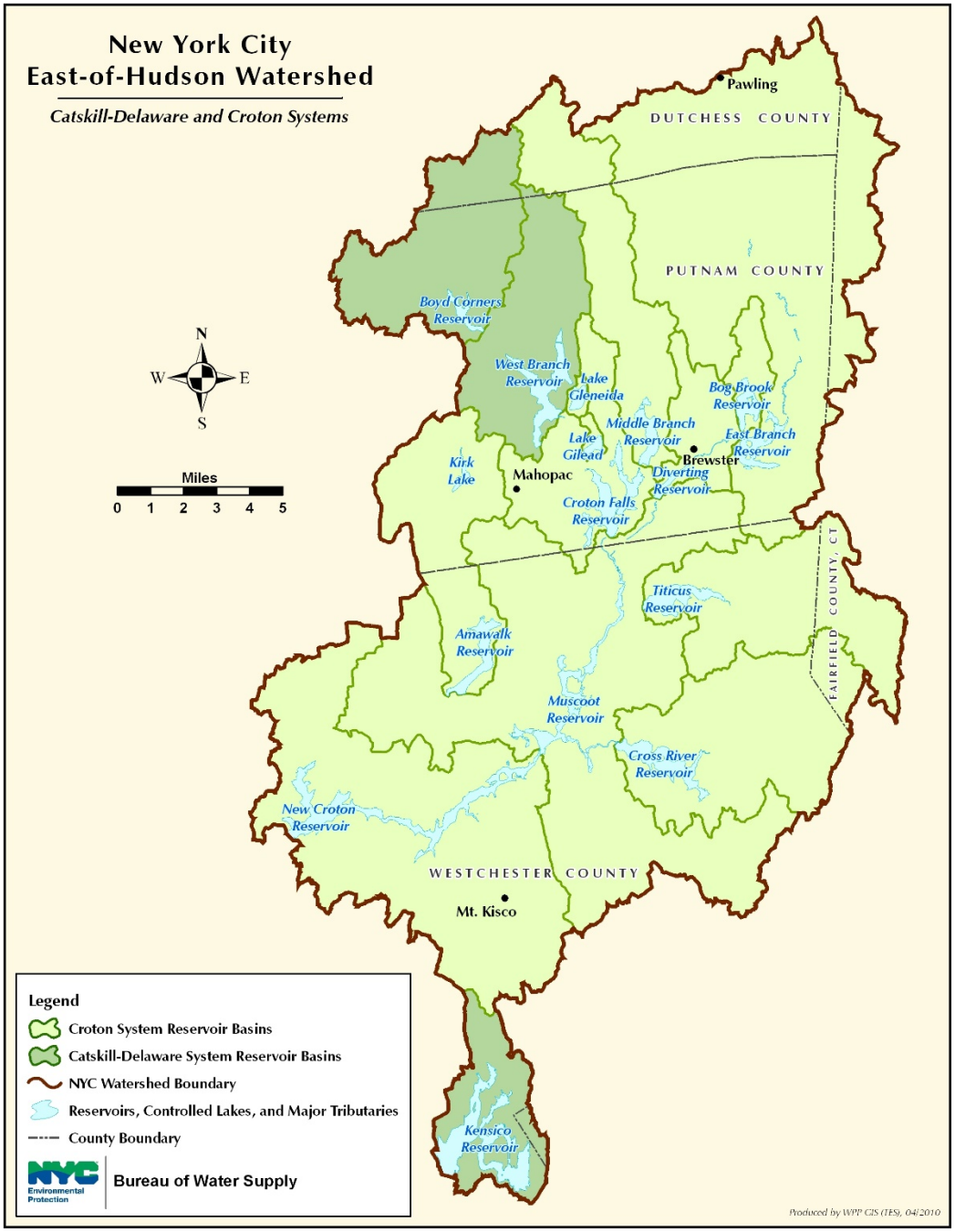

Figure 34. Map of New York City Water Supply System – East of Hudson Region.

Figure 35. Map of New York City Water Supply – West of Hudson Region.

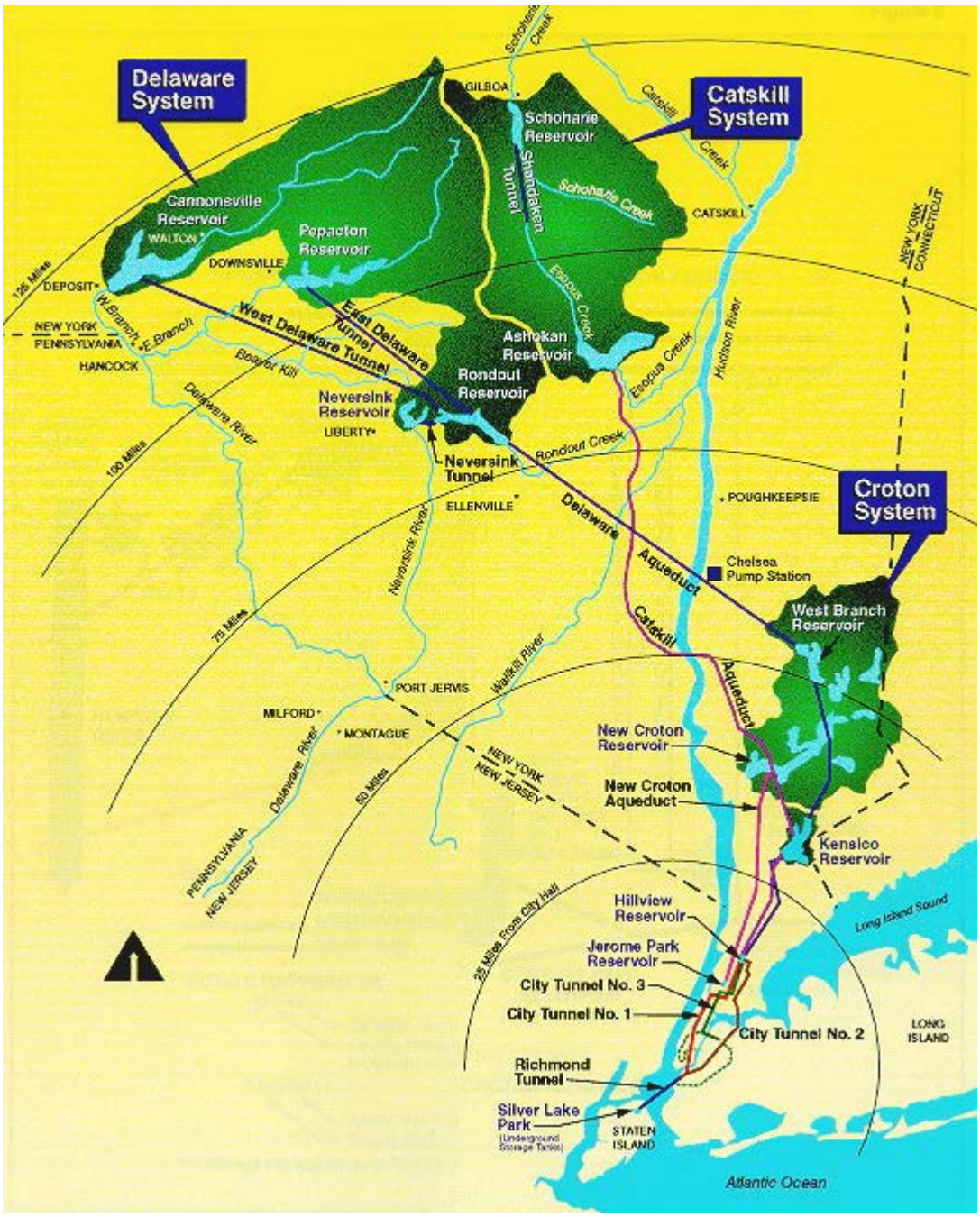

Figure 36. NYC Catskill, Delaware and Croton Aqueduct System.

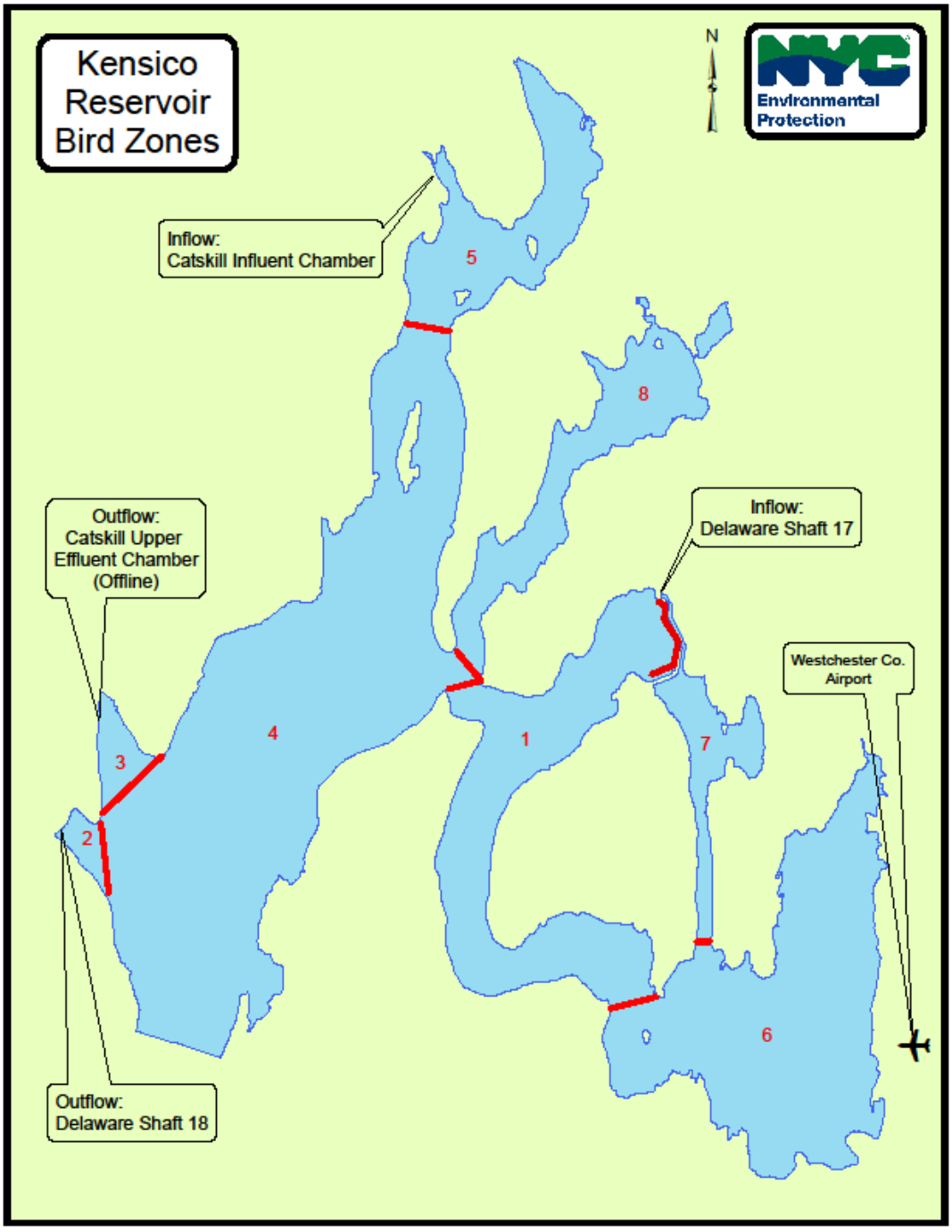

Figure 37. Map of Kensico Reservoir bird zones.

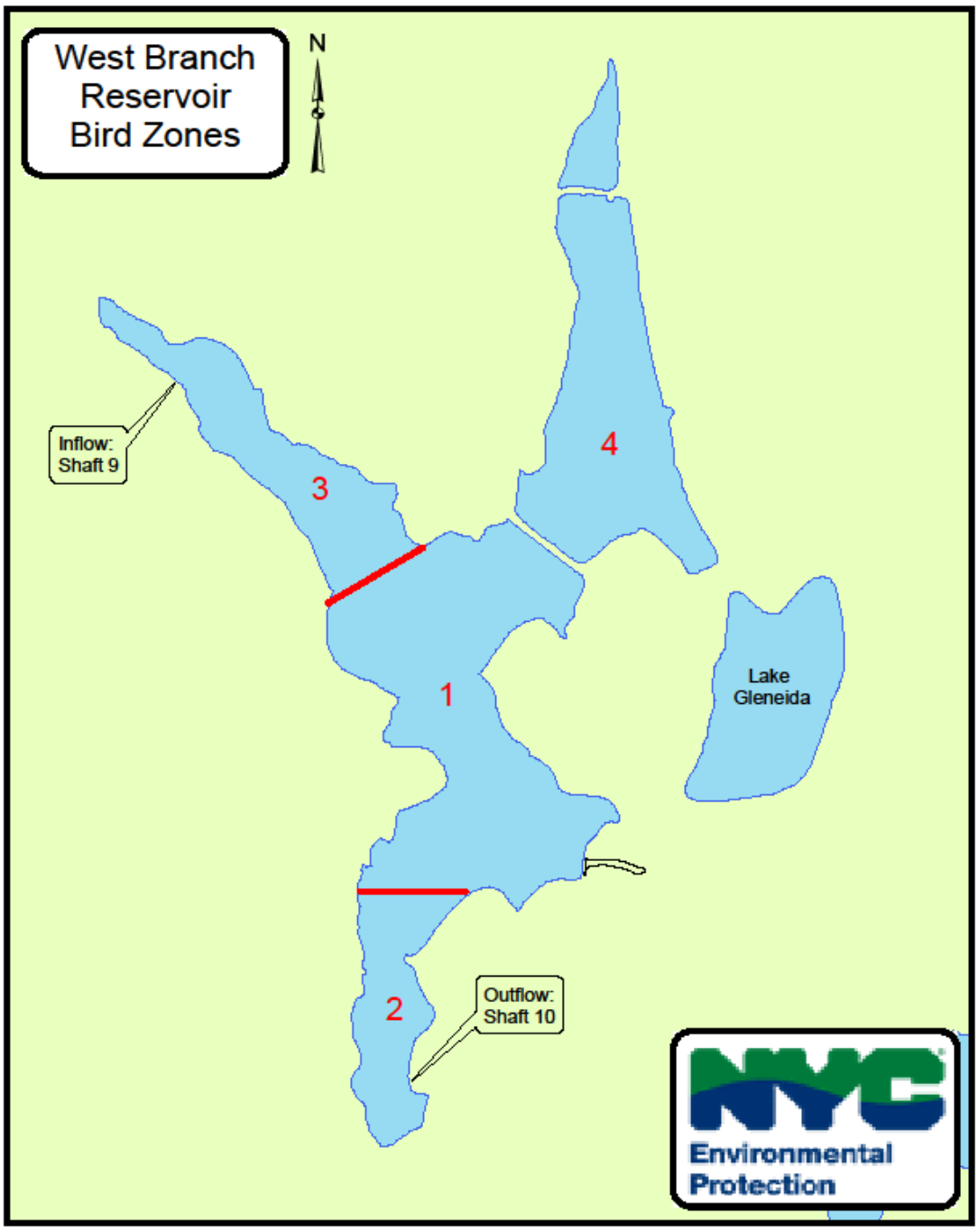

Figure 38. Map of West Branch Reservoir bird zones.

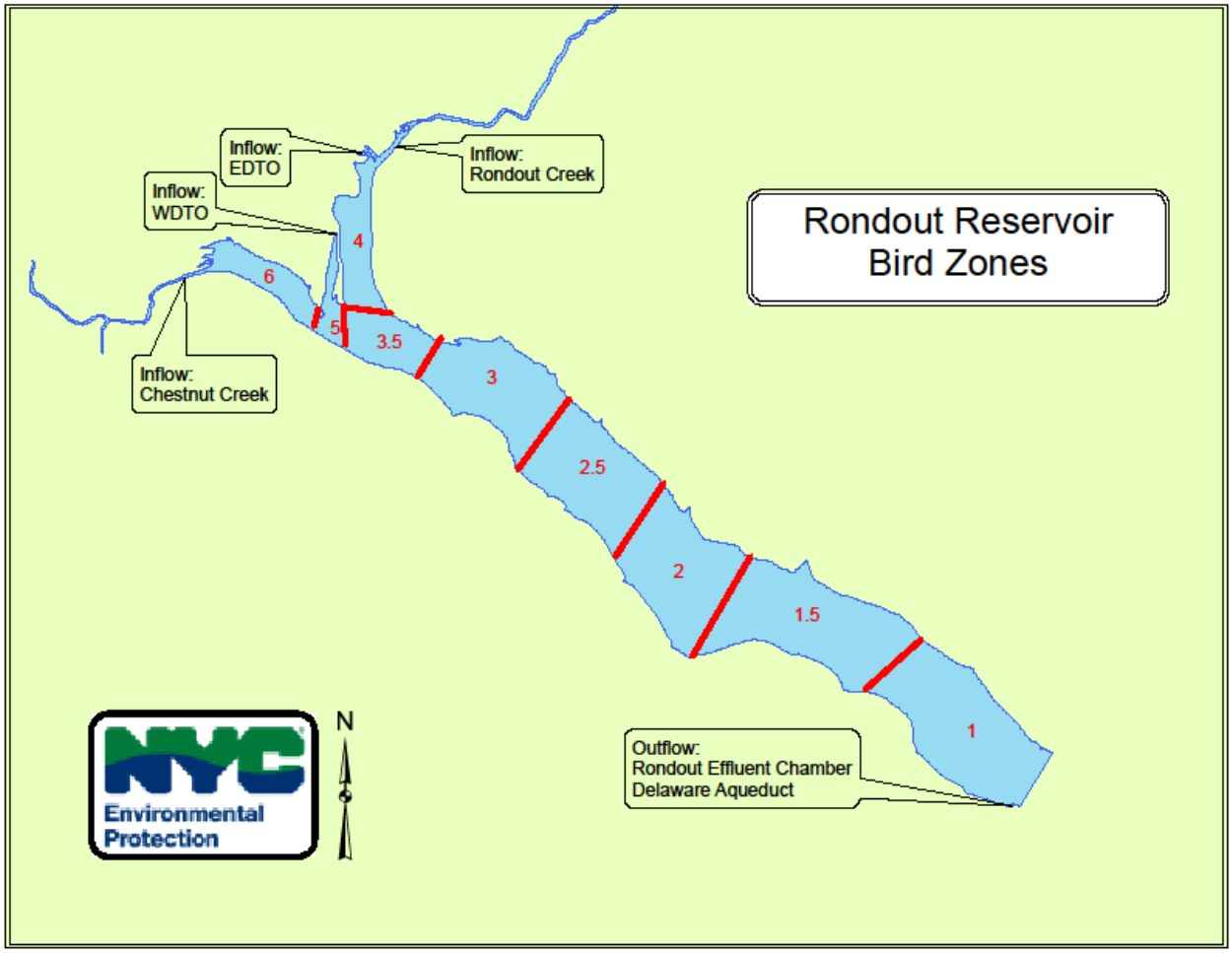

Figure 39. Map of Rondout Reservoir bird zones.

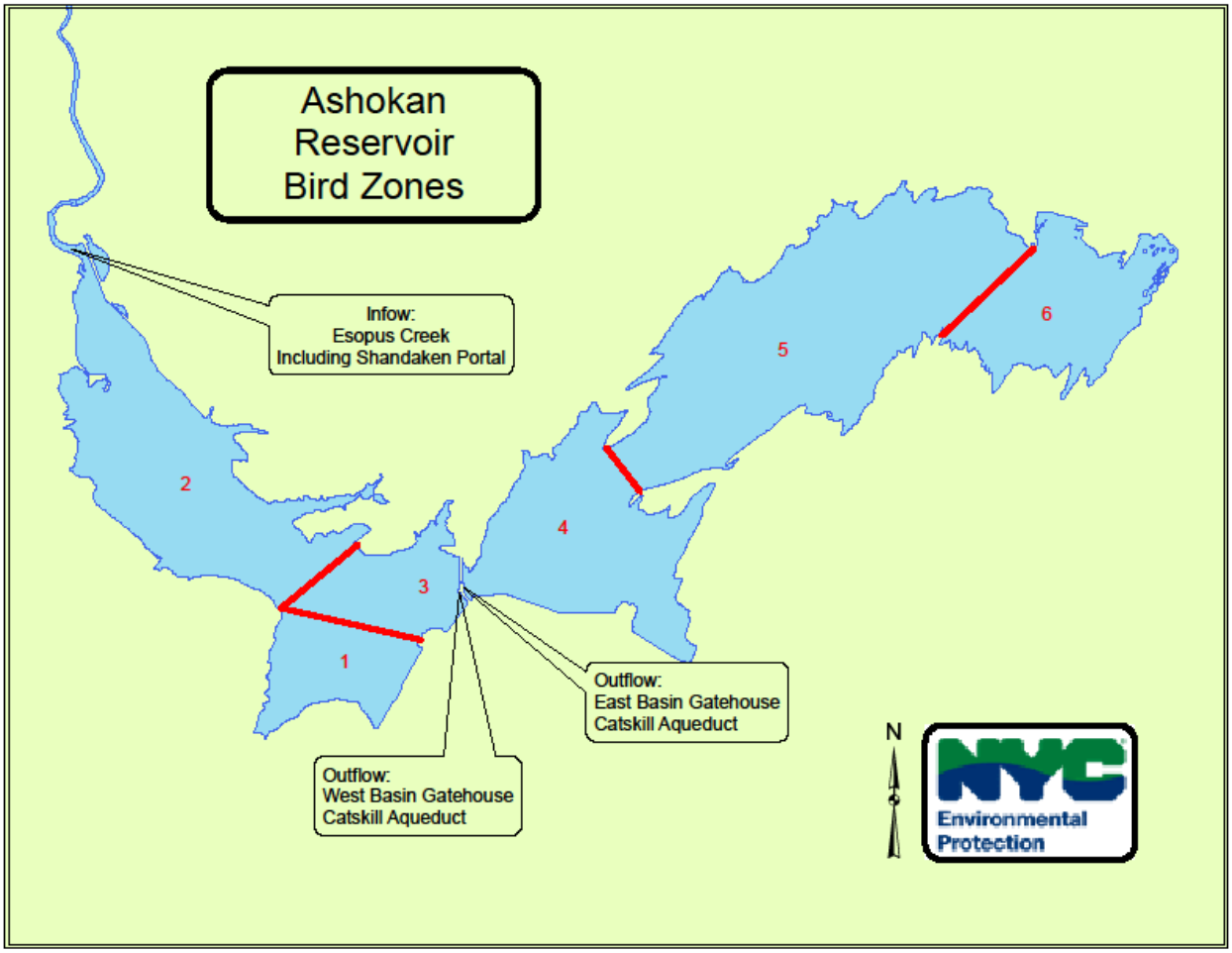

Figure 40. Map of Ashokan Reservoir bird zones.

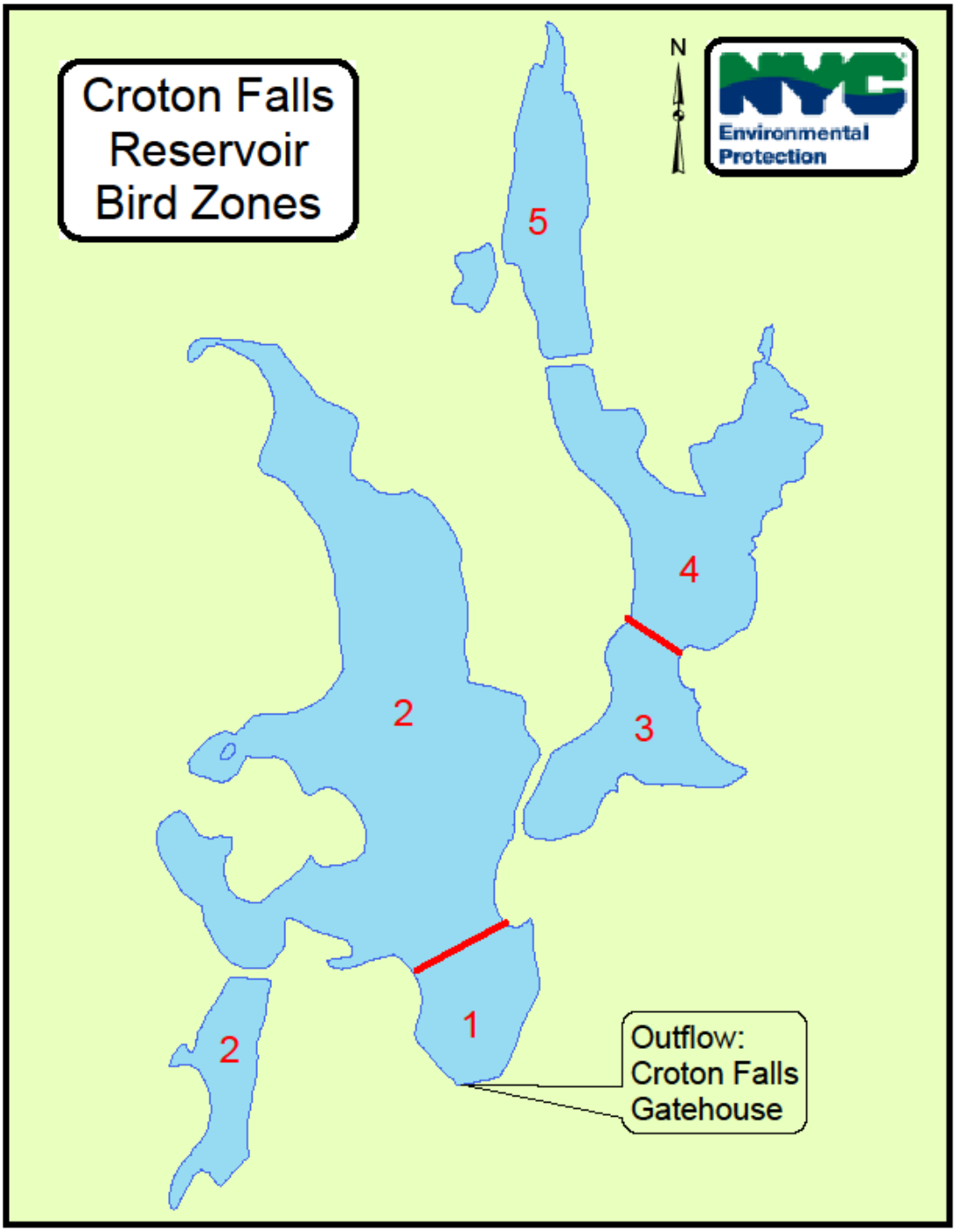

Figure 41. Map of Croton Falls Reservoir bird zones.

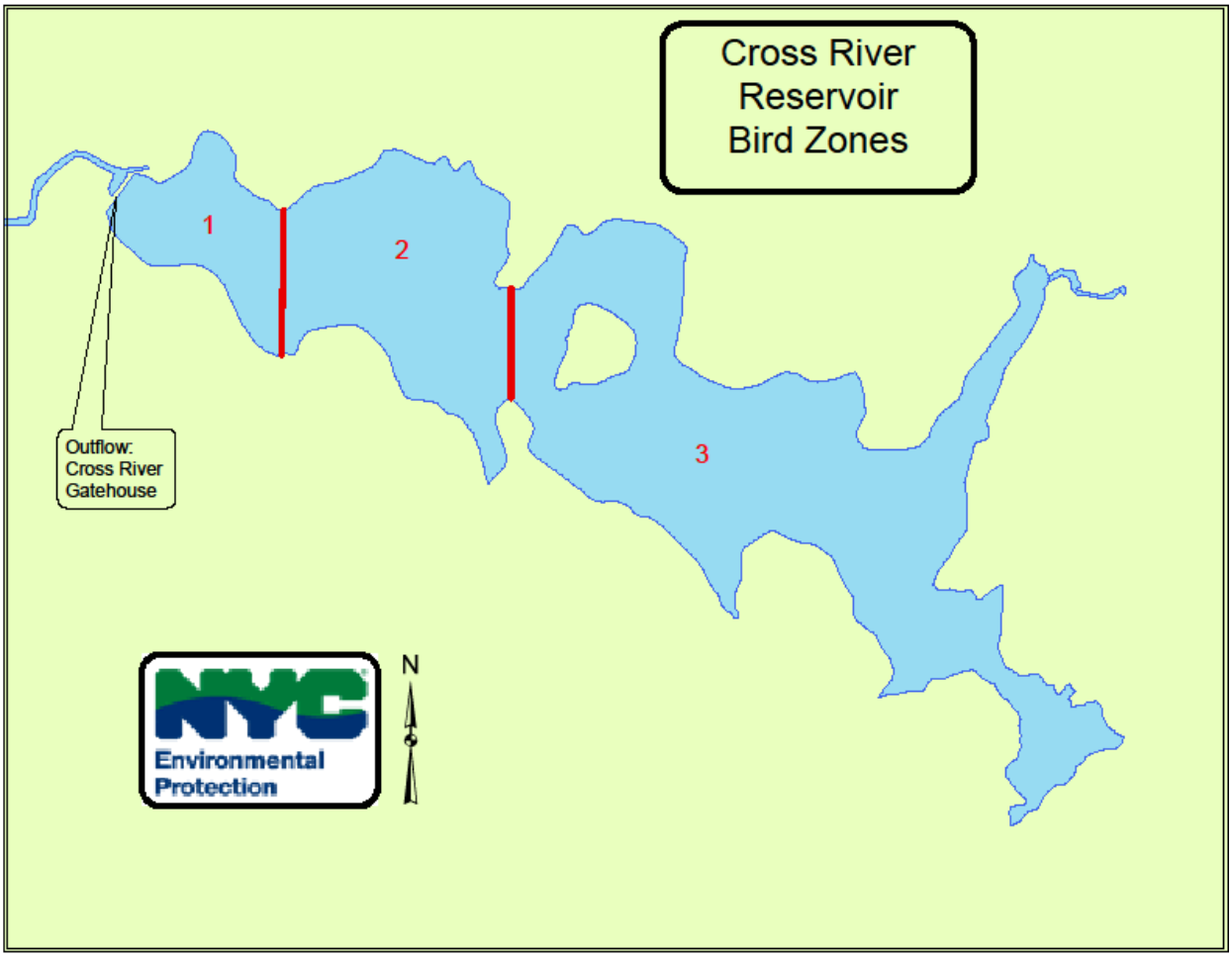

Figure 42. Map of Cross River Reservoir bird zones.

Figure 43. Map of Hillview Reservoir bird zones.

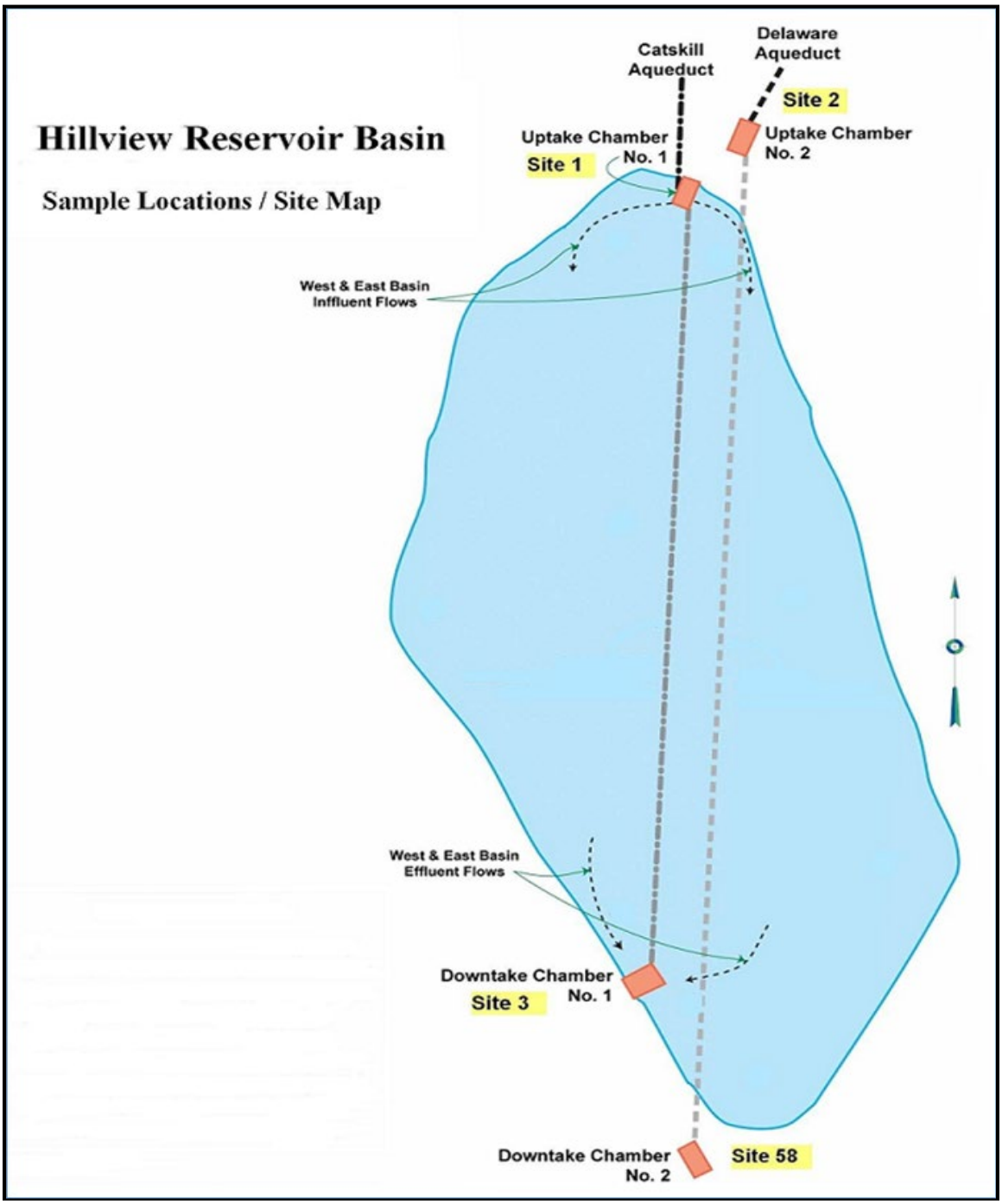

Figure 44. Map of Hillview Reservoir water sampling locations.