New York City Department of Environmental Protection
Bureau of Water Supply

Waterfowl Management Program

October 31, 2018

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, 2017 to July 31, 2018

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ACKNOWLEDGMENTS

Special thanks to DEP wildlife biologists Mike Reid, Associate Project Manager and Sean Camillieri (Scientist, WEII), Wildlife Studies Section, who reviewed this document, assisted with data collection and analysis, and participated in contract management.

Thanks goes to the DEP contractor, HDR – Henningson, Durham, and Richardson P.C. (HDR), including James Morrison, (Vice President and contract Project Manager), Katherine Drury, (contract Assistant Project Manager), Don Henshaw, (Laboratory Director), Ben Wood, (Field Site Supervisor), and numerous other HDR contractor staff for implementing the Waterfowl Management Program Contract.

Thanks to Andrew Bader, Chief of Watershed Water Quality Operations and James Broderick, Deputy Chief (WWQO) for a review of the document and logistical support and Steven Schindler, Director of Water Quality, DEP Bureau of Water Supply (BWS), for document review. Additional thanks to Dale Borchert, former Deputy Chief, WWQO, and Brian O'Malley, Section Chief, Data Management, WWQO, and staff from WWQO field and laboratory for providing water quality data for Kensico, West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs. Thanks to the WWQO, Aqueduct Monitoring Group, WWQO for daytime bird counts. Thanks to Salome Freud, Chief, Distribution Water Quality Operations (DWQO), Virginia Murray, Deputy Chief, DWQO, Aspa Capetanakis, Research Scientist, DWQO, and DWQO staff for providing Hillview Reservoir water quality data. Thanks to Will Melendez, Chief – Water Treatment Operations South and operations staff from DEP Bureau of Water Supply for maintenance of the bird deterrent equipment at Hillview Reservoir. Thanks to the Source Water Operations Directorate (James Porter, PhD, Kenneth DeRose, and Glenn Horton) for meteorological data.

DEP would also like to acknowledge the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA), NYS Director, Allen Gosser and staff for implementation of the Hillview Duck Management Contract.

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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 reservoir 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 and federal registration from the United States Fish & Wildlife Service (USFWS) and a depredation license 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 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 reservoir. 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 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 - 2017). 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, 2017 through July 31, 2018.

METHODS

Waterfowl Management Program

The Waterfowl Management Program was initiated in 1993 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) is in the first 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 Kensico Reservoir. 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 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, 2017 to July 31, 2018.

Table 2. Frequency of bird observation surveys by reservoir 2017/2018.

Reservoir	Bird Surveys Scheduled	Proposed/Actual Surveys
Kensico	Pre-dawn to post-dusk daily August 1, 2017 to March 31, 2018; Pre-dawn and post-dusk weekly April 1 to July 31, 2018	260/252[1,2]
West Branch	Pre-dawn, midday, and post-dusk, biweekly; August 1, 2017 to April 15, 2018	18/18
Hillview	Pre-dawn, midday, and post-dusk daily all year	365/362[2]

[1] Three surveys were cancelled due to holiday observances.
[2] Three surveys were cancelled due to severe winter storms.

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 dispersal actions are conducted only on an "as needed" basis at

Rondout, Ashokan, Croton Falls, Cross River, and West Branch 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. Waterbird population surveys of Rondout, Ashokan, Croton Falls, and Cross River Reservoirs are conducted on an as-needed basis only.

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 was 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 are easier to count in the evening when birds are flying into roost areas (or open water) whereas other species are easier to count 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 have been 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 at 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, 2017 through March 31, 2018 using motorboats, airboats, Jon boats, 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) 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 2017/2018 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 the resident 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 (8/1/2017 – 7/31/2018).

Reservoir	Dates of Bird Dispersal and Deterrence	Bird Dispersal and Deterrence Measures Used
Kensico	August 1, 2017 – July 31, 2018	• 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 • Sanitary surveys for pre-storm events • Egg and nest depredation for geese and swans[2]
Hillview	August 1, 2017 - July 31, 2018	• 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 • 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]

[1] **Bird dispersal actions at Kensico Reservoir were conducted from August 1, 2017 to March 31, 2018**

[2] **Egg and nest depredation for geese and swan were conducted from April 1 to May 31, 2018**

3 Egg and nest depredation for Mallards and Swallows were conducted from April 1 to August 31, 2018

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 2018 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.

Fifty Canada Goose nests containing 276 eggs were depredated (punctured) at six New York City Reservoirs (Table 4) during the spring of 2018 compared to 53 Canada Geese nests containing 235 eggs in 2017. There was no goose or swan breeding activity recorded at Hillview; however, three Mallard nests containing 25 eggs were depredated by DEP in 2018 compared to six Mallard nests containing 38 eggs in 2017. There were no adult Mallards depredated in 2018. All Canada Geese egg and nest depredation activity was conducted under the terms of Federal Registration (#RG-01040A) from the United States Department of the Interior, United States Fish & Wildlife Service. 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 122 surveys for nesting Mallards at

Hillview Reservoir in 2018. DEP did not band Canada Geese or Double-crested Cormorant in 2018.

Table 4. 2018 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 = 13 Mute Swan = 1	Canada Geese = 70 Mute Swan = 12	100 percent (0 Canada Geese goslings) 100 percent (0 Mute Swan cygnets)
West Branch	9	Canada Geese = 7	Canada Geese = 29	100 percent (0 Canada Geese goslings)
Rondout[1]	3	Canada Geese = 4	Canada Geese = 28	100 percent (0 Canada Geese goslings)
Ashokan	4	Canada Geese = 6	Canada Geese = 33	85 percent (6 goslings)/NA/NA
Croton Falls	9	Canada Geese = 12	Canada Geese = 72	92 percent (6 goslings)
Cross River	9	Canada Geese = 8	Canada Geese = 44	98 percent (1 goslings)
Hillview[2]	261	Mallard = 3	Mallard = 25	Mallard = 78 percent (7 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 and 35). 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. 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 concentrations of gulls and other waterbirds roosting overnight from late summer through winter.

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.

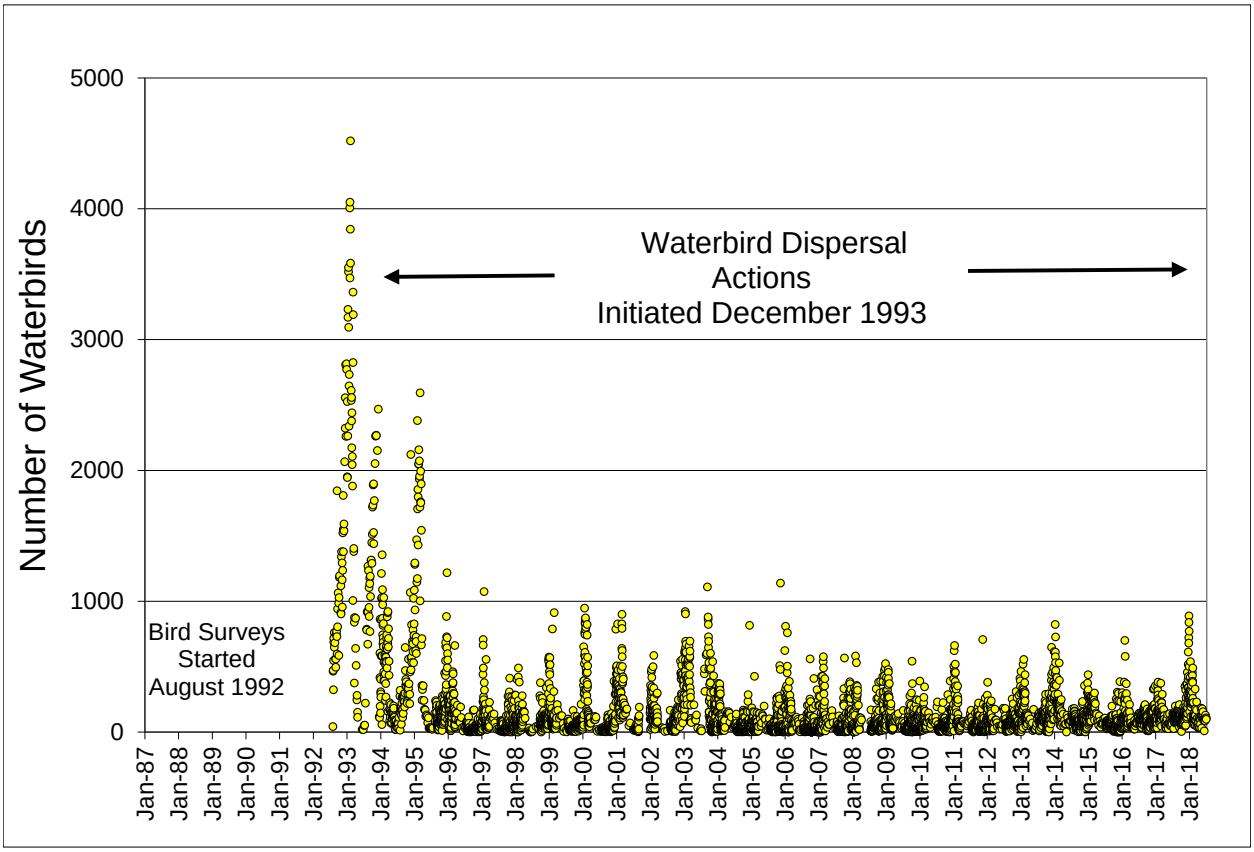

Figure 1. Kensico Reservoir waterbird totals.

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 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 which generally coincided with the onset of waterbird migration in October and remained elevated until reservoir icing in February. 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 hit with back-to-back high precipitation storms, Tropical Storms Irene and Lee.

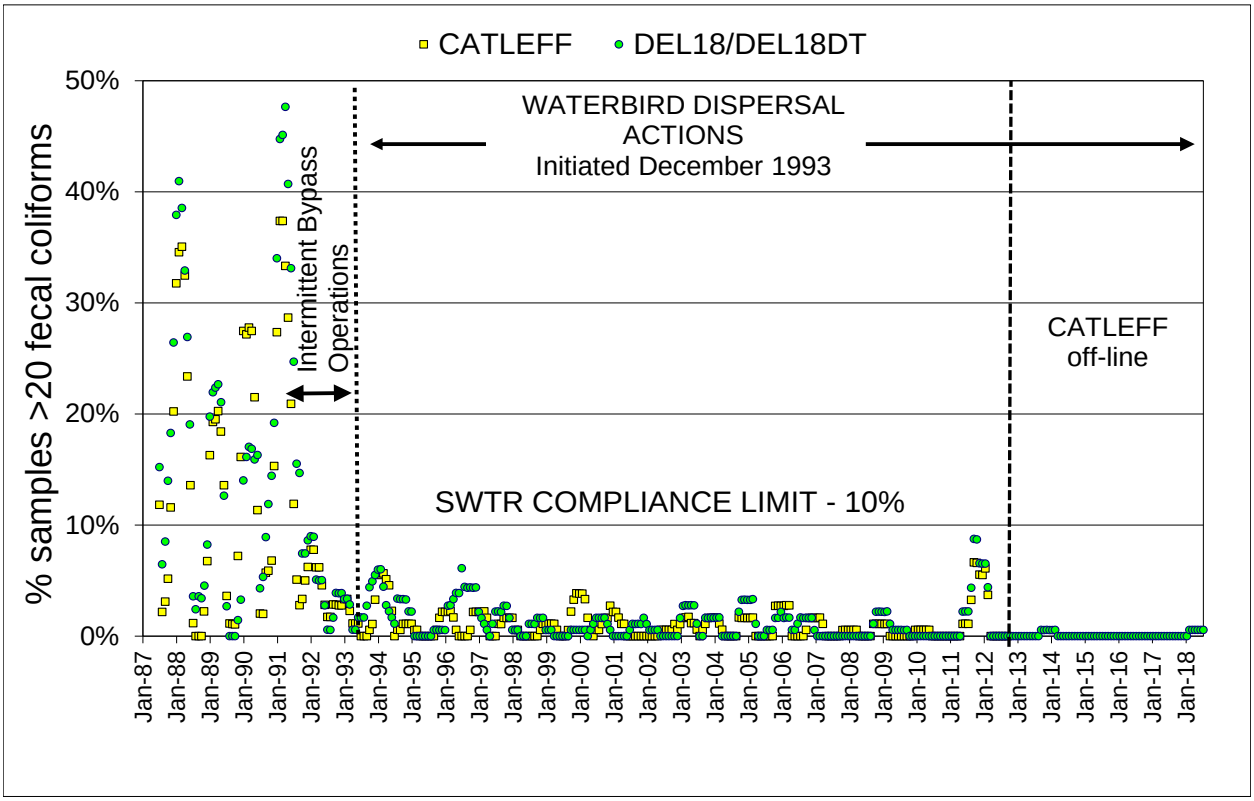

Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18/DEL18DT/DEL18DTD and CATLEFF). Kensico sanitary surveys began in 2012.

Continuous waterbird monitoring and dispersal actions using motorboats (Figure 3) combined with discharging pyrotechnics have been the primary method in reducing waterbird numbers at Kensico. During the waterbird dispersal period from August 1, 2017 through March 31, 2018 a total of 29,045 hazing actions were successfully conducted dispersing 148,307 birds. Based on the high level of waterbird dispersal numbers, it remains crucial that DEP continue to conduct these actions. Pyrotechnic actions alone were deployed 20,962 times or 72 percent of the dispersals while motorboat/airboat chasing, some accompanied by pyrotechnics, were used

for 26 percent of the dispersals while physical chasing was utilized two percent.

The WMP continued to maintain a high level of success in reducing waterbird numbers at Kensico Reservoir resulting in low fecal coliform bacteria levels from August 1, 2017 through July 31, 2018. 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 conducting waterbird dispersal actions discharging pyrotechnics at Kensico Reservoir. Photo by HDR, P.C.

Table 5 lists the six highest fecal coliform counts $100mL^{-1}$ in the double-digit range for recorded at DEL18DT in 2017/2018. Five of the six double-digit fecal coliform events were likely associated with precipitation events of more than one inch 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). Of the 365 source water samples collected over the period from August 1, 2017 to July 31, 2018, one sample was recorded above the 20 fecal coliforms collected on February 11, 2018 (Table 5) and it was likely associated with a precipitation event as there was no spike in waterbird activity during that time. One hundred and fifty out of 365 fecal coliform samples or 41 percent were non-detected (below the detection limit of one fecal coliform $100mL^{-1}$). In 2017, 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 2016 (DEP

2017). From August 1, 2017 through July 31, 2018 the percentage of source water sample results at DEL18DT above 20 fecal coliforms 100mL^{-1} remained at zero percent as with the previous reporting period. During the previous reporting period in 2016/2017, there were no double-digit fecal coliform counts. All but one of the six double-digit events may have been associated with precipitation events recorded at the Shaft 18 Met Station ranging from 1.10 inches to 4.78 inches.

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}**	**Precipitation within 3 days of elevated fecal coliform >=10 fecal coliform 100 mL^{-1} (inches rounded to the nearest 100th)[1]**		**Bird Counts on or before sample bacterial sample date**	
				Reservoir-wide totals	**Bird Zones 2, 3, and 4 totals (near the DEL18DT Effluent)**
		Westchester County Airport Met Station	DEP Kensico Reservoir Shaft 18 Met Station		
8/5/17	10	0.52	2.24	26 on 8/5/17	85 on 8/5/17
8/7/17	12	0.86	2.24	139 on 8/7/17	122 on 8/7/17
9/3/17	10	1.27	1.37	107 on 9/2/17	39 on 9/2/17
10/30/17	10	4.13	4.78	4 on 10/30/17	0 on 10/30/17
11/2/17	10	0	0	76 on 11/2/17	74 on 11/2/17
2/11/18	**33**	1.53	1.10	311 on 2/10/18	200 on 2/10/18

[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

Of the waterbird counts listed for Bird Zones 2, 3, and 4 in Table 5, there were no

waterbirds observed in Bird Zone 2 cove, closest to the DEL18DT sampling site on all six double-digit fecal coliform events Table 5.

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 2017/2018 and 2016/2017 seasons.

In 2017/2018, the DEP contractor attained 86 percent reportable data in completing reservoir-wide waterbird surveys during the bird dispersal period. Approximately 14% 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, 2017 to July 31, 2018 remained similar to the previous reporting period averaging about 110 birds per survey night when compared to counts conducted during the same period in 2016/2017 with an average of 111. Birds spiked at 887 (701 Canada Geese, 77 gulls, and 109 ducks) on January 15, 2018 compared to a high count of 381 in the previous reporting period (Figure 7). The extraordinarily high count of Canada Geese recorded on this date was observed in Bird Zone 6, furthest from the DEL18 Effluent water outlet.

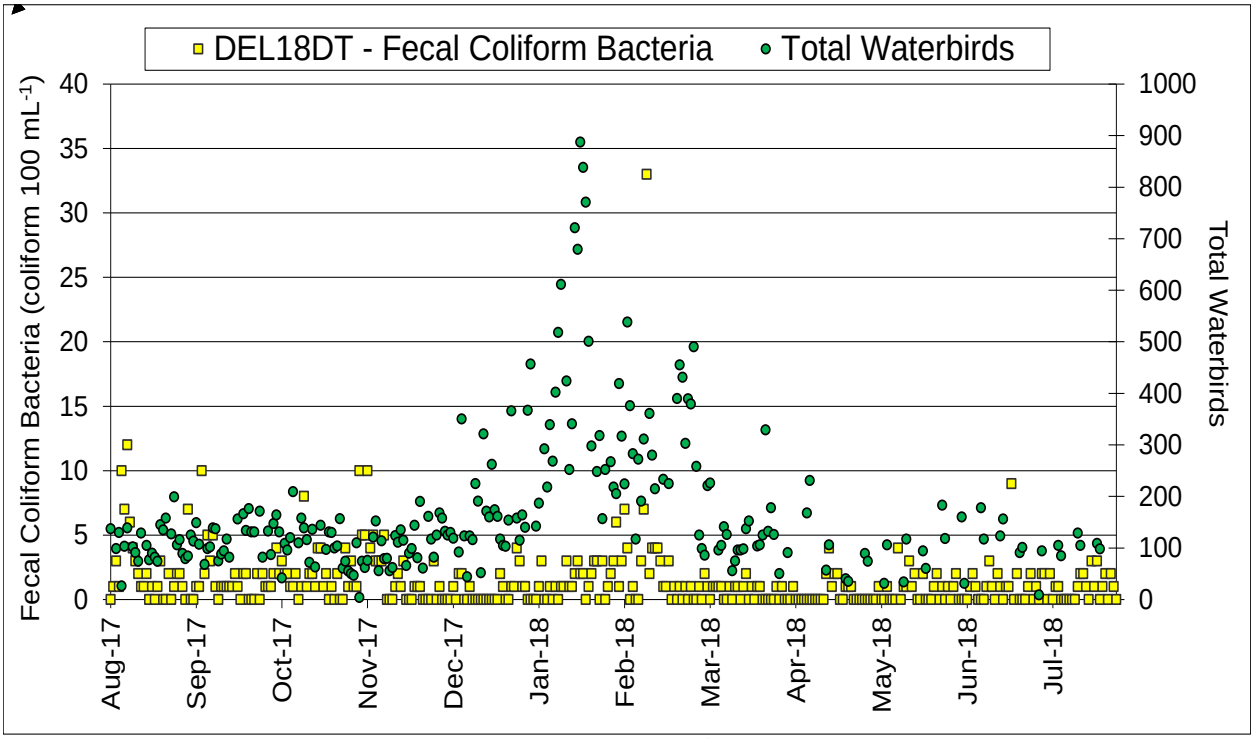

Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT vs. total waterbirds (8/1/2017 to 7/31/2018).

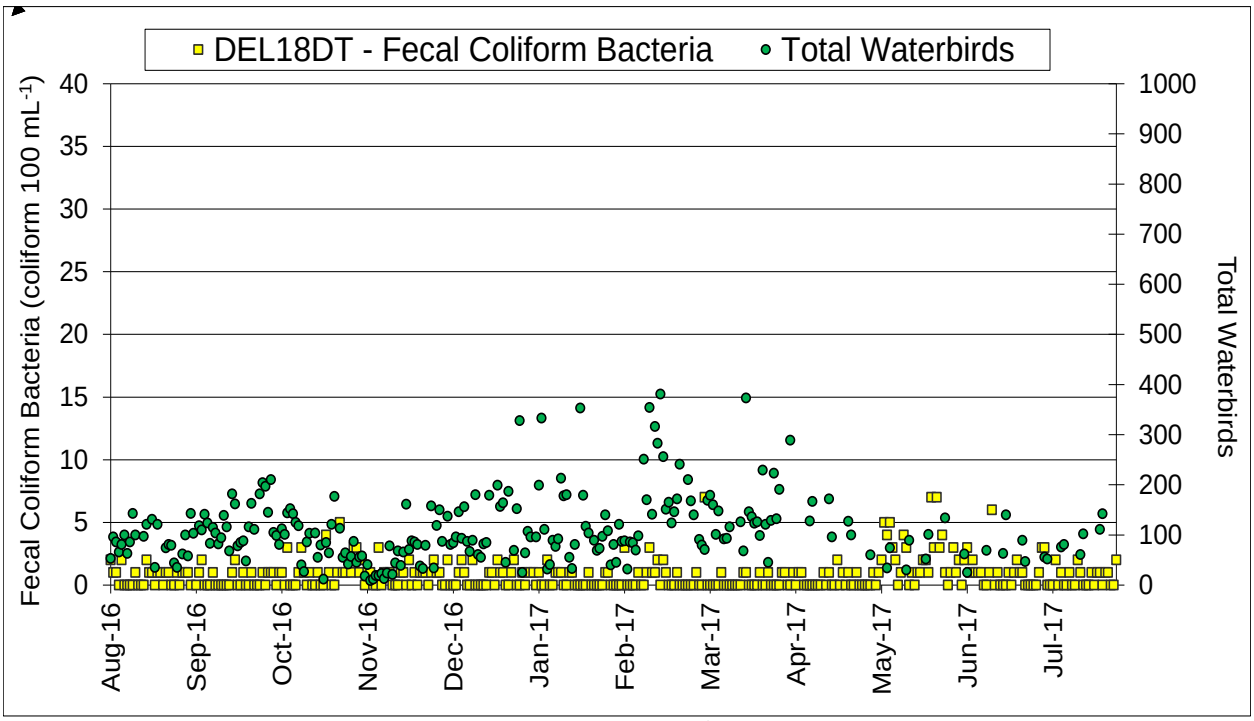

Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18/DEL18DT vs. total waterbirds (8/1/2016 to 7/31/2017).

In Bird Zone 2, closest to Delaware Shaft 18 Effluent (DEL18DT), there were no observations of waterbirds on 196 of 251 bird dispersal days (August 1, to March 31) or 78% of the time. There was an unusual overnight count of 67 Canada Geese observed on December 14, 2017, most likely a migrant flock passing through the night and using the reservoir as a temporary stopover. On January 9, 2018 a season high count of 71 total birds were observed of which 70 were ducks. Flocks of ducks were suspected to have arrived overnight past the normal hours of operation for bird dispersal activities. There were no fecal coliform bacteria elevations associated with the high overnight counts observed in Bird Zone 2. During the non-dispersal period from April 1, 2018 to July 31, 2018, waterbirds were observed in Zone 2 on three of seventeen occasions with a high count of five Canada Geese recorded on June 12, 2018.

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 spatial separation between birds and the water intake at Delaware Shaft 18 effluent at Kensico is 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. Canada Goose being dispersed by DEP contractors using motorboats at Kensico. Photo by Chris Nadareski

Waterbird surveys in Bird Zone 3, adjacent to the Bird Zone 2 cove revealed 22 occasions when birds were present out of 251 survey days during the bird dispersal period (Figure 9). A high total bird count of 119 recorded on December 14, 2017 when 115 Canada Geese was recorded (Figure 9). Zero bird counts in Bird Zone 3 were identified on 210 of the 251 surveys during the bird dispersal period from August 1, 2018 to March 31, 2018 (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 23 of the 251 or 9 percent of surveys conducted in Bird Zone 4 during the bird dispersal period. The total high count of waterbirds was recorded on February 1, 2018 when 250 ducks were observed roosting overnight (Figure 10). The total high count of 74 Canada Geese was observed on January 22, 2018 and the high gull count was on December 24, 2017 at 154 gulls.

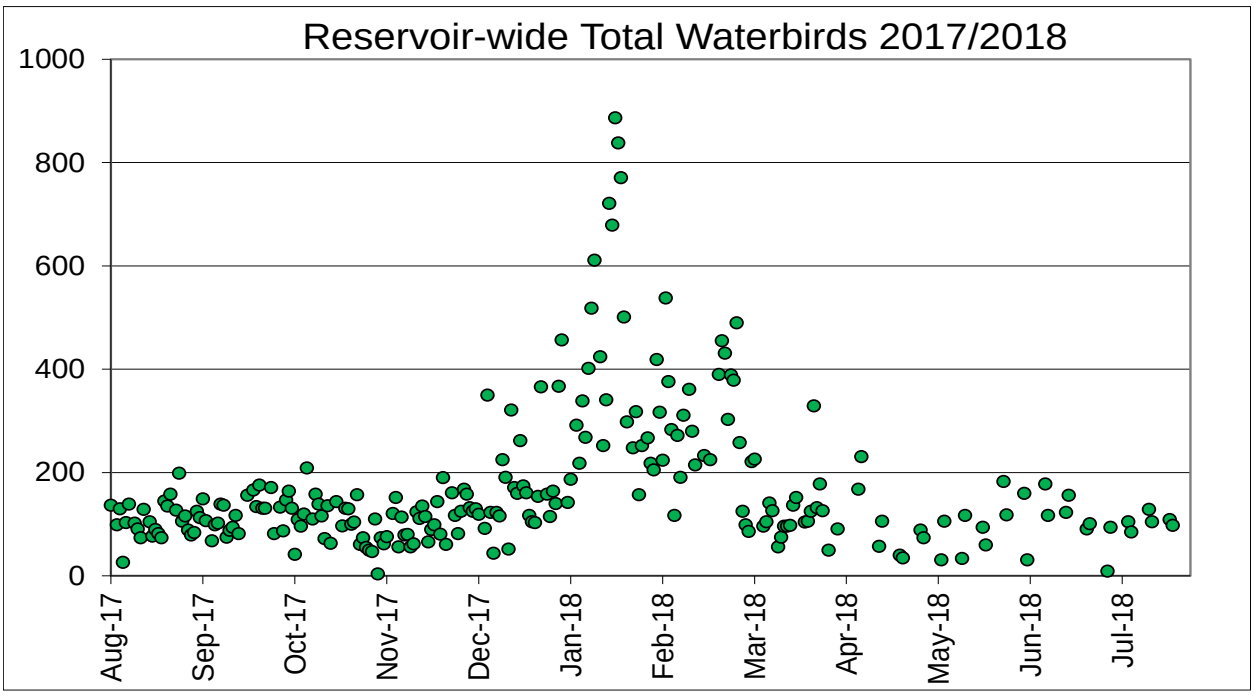

Figure 7. Kensico Reservoir total annual waterbirds (8/1/2017 to 7/31/2018).

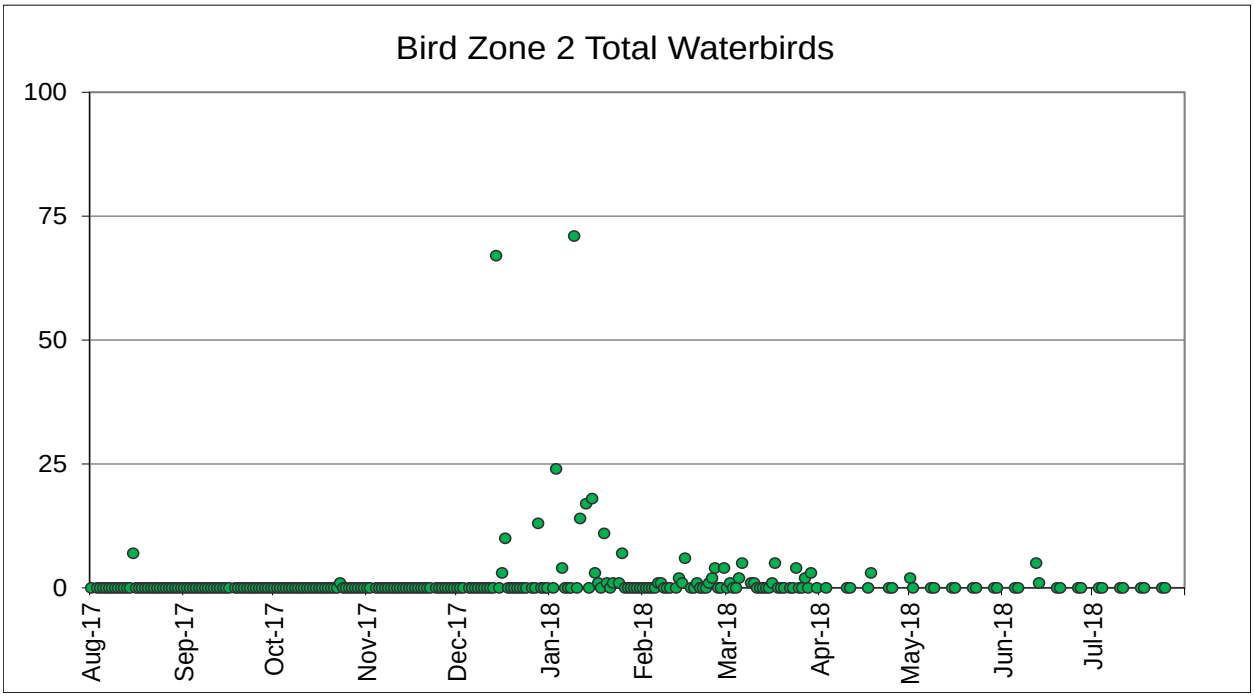

Figure 8. Kensico Reservoir Bird Zone 2 waterbirds (8/1/2017 to 7/31/2018).

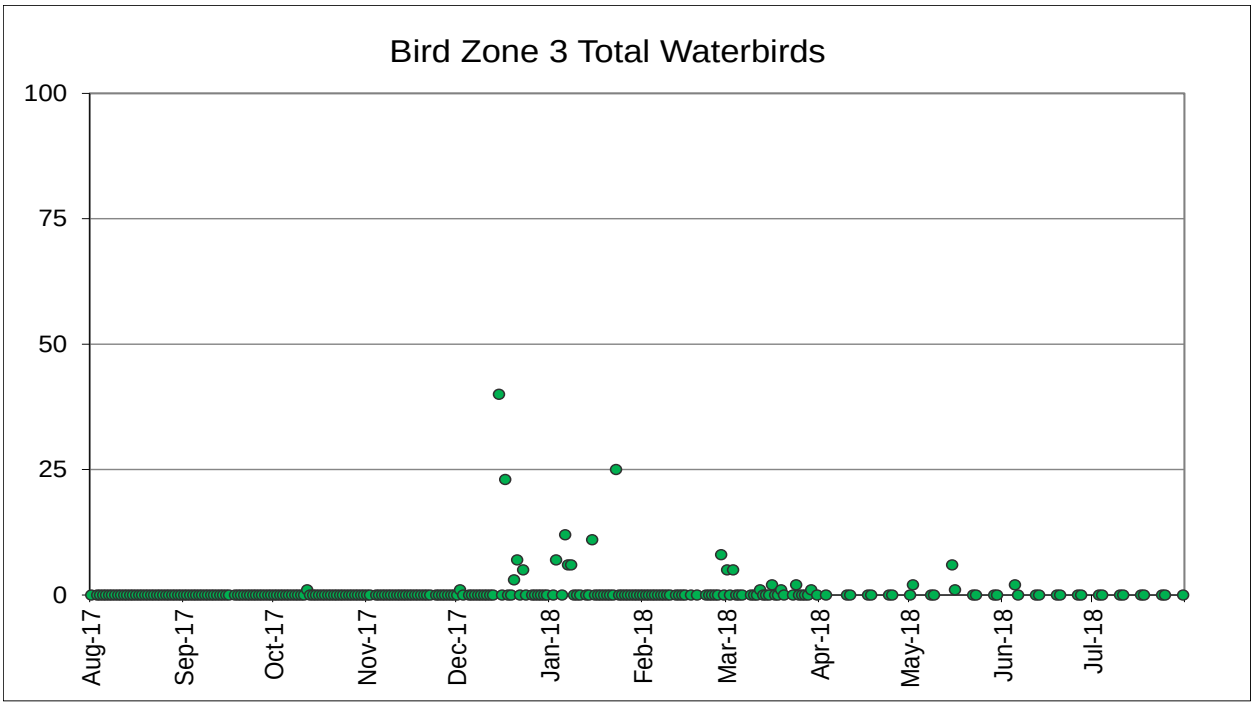

Figure 9. Kensico Reservoir Bird Zone 3 waterbirds (8/1/2017 to 7/31/2018).

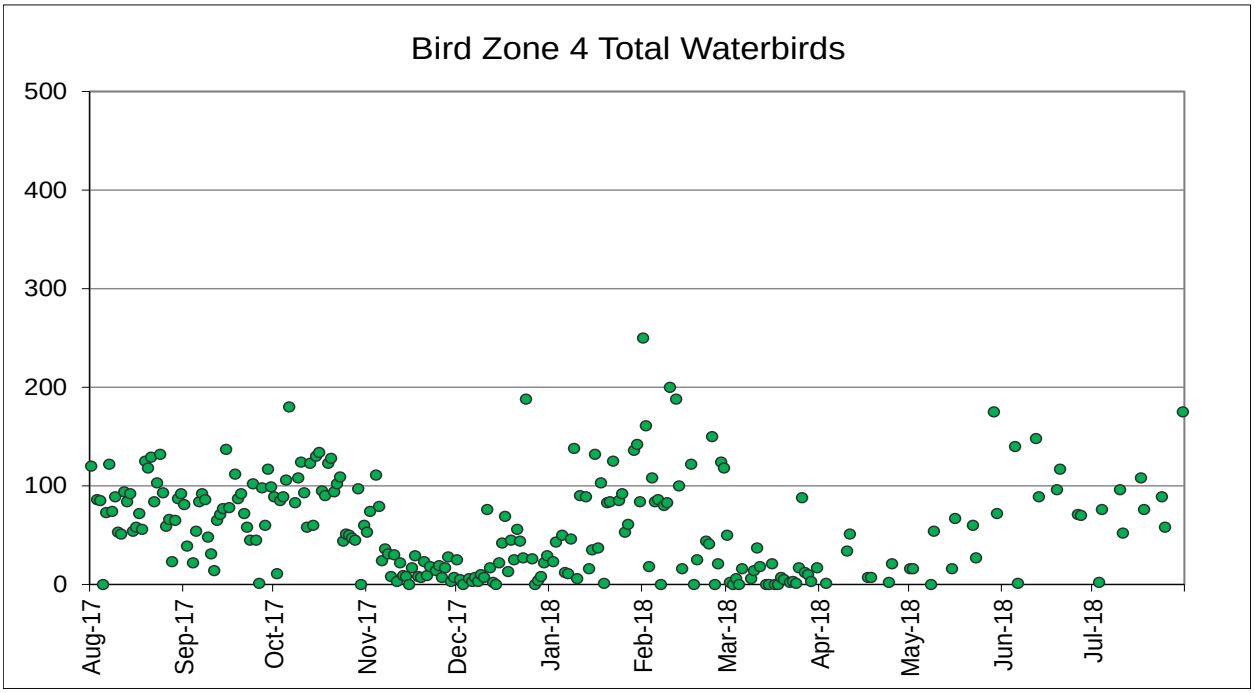

Figure 10. Kensico Reservoir Bird Zone 4 waterbirds (8/1/2017 to 7/31/2018).

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 2017/2018, the first detection of ice was observed on December 16, 2017 with approximately 1% ice cover, while the maximum ice cover reached more than 75 percent at Kensico on January 11, 2018. Ice cover diminished back to 1% by March 25, 2017. Overall, there was only a minimal periods of partial ice-cover, which allowed continuous motorboat operations combined with 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 60 birds per night or 53 percent of the total counts. Overnight duck counts decreased from a daily average of 64 per birds overnight count in 2016/2017 (August 1 to March 31) to 60 birds per overnight count in 2017/2018. Gulls were the second most common group with an average nightly count of 39 birds (34 percent) down from 42 birds per night in 2016/2017. Gulls peaked at 337 on February 20, 2018. Canada Geese numbers increased from a daily overnight count of 14 (13 percent) birds in 2017/2018 compared to six birds/night in 2016/2017 (Figure 11).

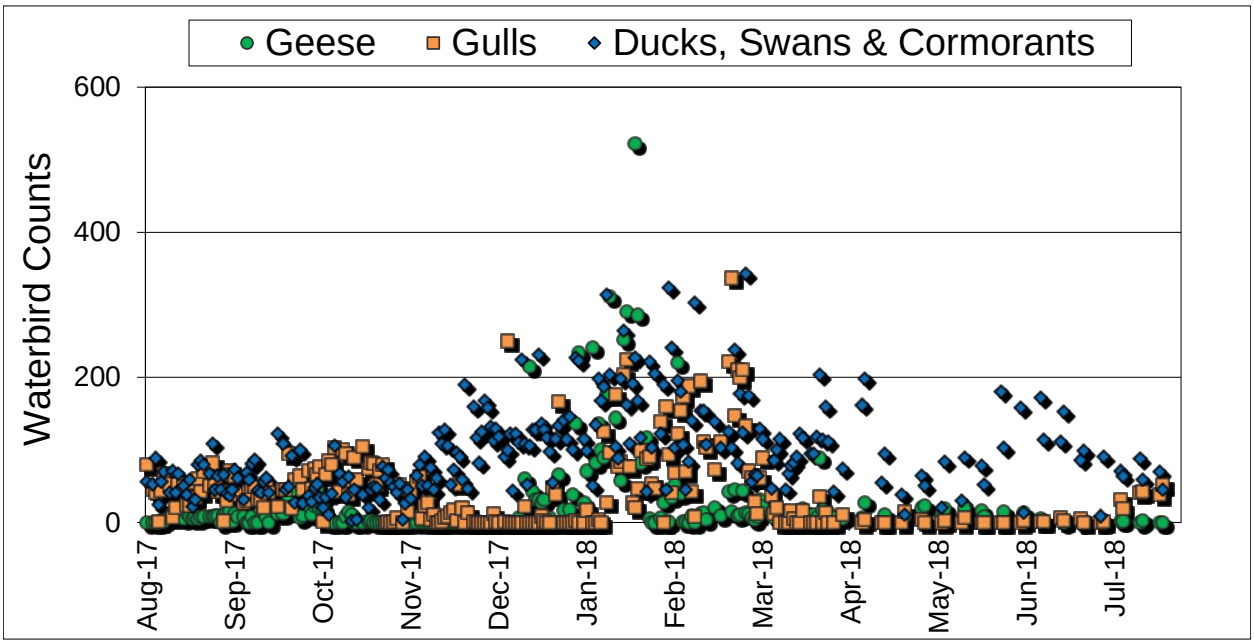

Figure 11. Kensico Reservoir total waterbirds by groups (8/1/2017 to 7/31/2018).

Throughout the non-dispersal period from April 1 to July 31, 2018, geese averaged four birds per night, gulls averaged nine birds per night and ducks averaged 75 birds per night. Total average bird counts decreased slightly in 2017/2018 to 89 compared to 119 birds per night

during 2016/2017 representing a 20% decline in bird activity reported at Kensico. DEP determined there were no bird-associated increases in fecal coliform bacteria levels at the Kensico Shaft 18 effluent location during this reporting period. Most of the overnight bird roosting activity was spatially 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 Airboat for bird dispersal activities at Kensico. Photo by Chris Nadareski.

The Westchester County Airport (WCA), located immediately east of the Rye Lake area (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. 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 to avoid potential airstrikes with birds and pilot confusion with the use of aerial low-grade explosives. 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 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 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 2018. Results of the USDA survey indicated that no geese were present on the Kensico Reservoir property and USDA did not remove any Canada Geese. USDA did conduct removals of local Canada Geese at other properties within the 7-mile radius around the airport property in 2018.

In the spring of 2018, 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 pyrotechnic usage 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 present during the autumn/winter period of 2017/2018. 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 2017/2018 was 644 pounds compared to 22 pounds collected in 2016/2017 and 104 pounds collected in 2015/2016.

In the spring of 2018 a total of 13 Canada Goose nests were found along the reservoir shoreline and on islands compared to 17 in 2017 (Table 4). Among the nests, 70 eggs were depredated and placed back in the nest to allow the nesting geese to continue to incubate compared to 75 eggs in 2017 (Figure 13). The average number of eggs per nest in 2018 was 5.4, up slightly when compared to 4.4 in the previous year. No goslings were observed in 2018

similar to what was reported in the previous year rendering the egg depredation success at 100 percent in 2018. 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.

One Mute Swan nest with 12 eggs was depredated at Kensico in 2018 compared to one nest with 13 eggs in 2017 with a 100 percent depredation success in both years (Table 4). DEP biologist have to cautiously approach active Mute Swan nest due to their aggressive behaviors (Figure 14). There were no Double-crested Cormorant nests observed at Kensico during the 2018 nesting season.

Figure 13. DEP conducted surveys for nesting Canada Geese along shorelines and on islands at Kensico Reservoir. Photo by Chris Nadareski.

Figure 14. DEP conducted Mute Swan nest management to depredate the nest and eggs at Kensico. Photos by Ben Wood (HDR) and Chris Nadareski.

DEP Wildlife Studies staff conducted three 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. The results of the three sanitary surveys are shown in Table 6. Whitetail deer, raccoon, eastern cottontail rabbit and Canada Goose feces were identified in the highest concentrations on the sanitary surveys. Larger mammals like coyotes are often observed throughout the Kensico Watershed (Figure 15).

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	E. Gray Squirrel	Domestic Dog	Other/Unknown	Total (all species)
10/23/17	21	18	25	0	1	1	1	1	0	3	**71**
10/28/17	19	6	9	0	0	0	0	0	0	0	**34**
3/1/18	6	5	22	24	0	0	0	0	1	1	**59**

Figure 15. Coyote 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 throughout 2017/2018 dating back to 1993 and throughout the 2017/2018 reporting period.

2. West Branch Reservoir

The 2007 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, 2017 through April 15, 2018 to record annual trends that aids in identifying sources of elevated fecal coliform bacteria levels. In 2017/2018 during the overnight surveys, gulls were recorded on seven out of 19 surveys with a high count of 79 on October 6, 2017 compared to only 11 of 18 surveys in 2016/2017 with a high count of only 63.

Reservoir-wide total birds reached a high seasonal count of 2,582 on December 15, 2017 compared to 3,503 on December 30, 2016 in the previous report (Figures 16 and 17). Counts increased again from late-September through the end of December (up to the onset of reservoir ice-cover) coincided with the waterbird southward migration movements. Duck counts, mostly Common Mergansers, generally increase annually from mid-March to late April along with the northward springtime migration.

Reservoir ice-cover conditions ranged from approximately 25 percent by December 14, 2017 to a maximum coverage of 100 percent by January 12, 2018. The ice cover diminished to zero percent by March 8, 2018. Duck counts peaked on December 15, 2017 at 2,562 then decreased to nine by January 12, 2018 about the time when ice cover reached 100 percent on January 11, 2018.

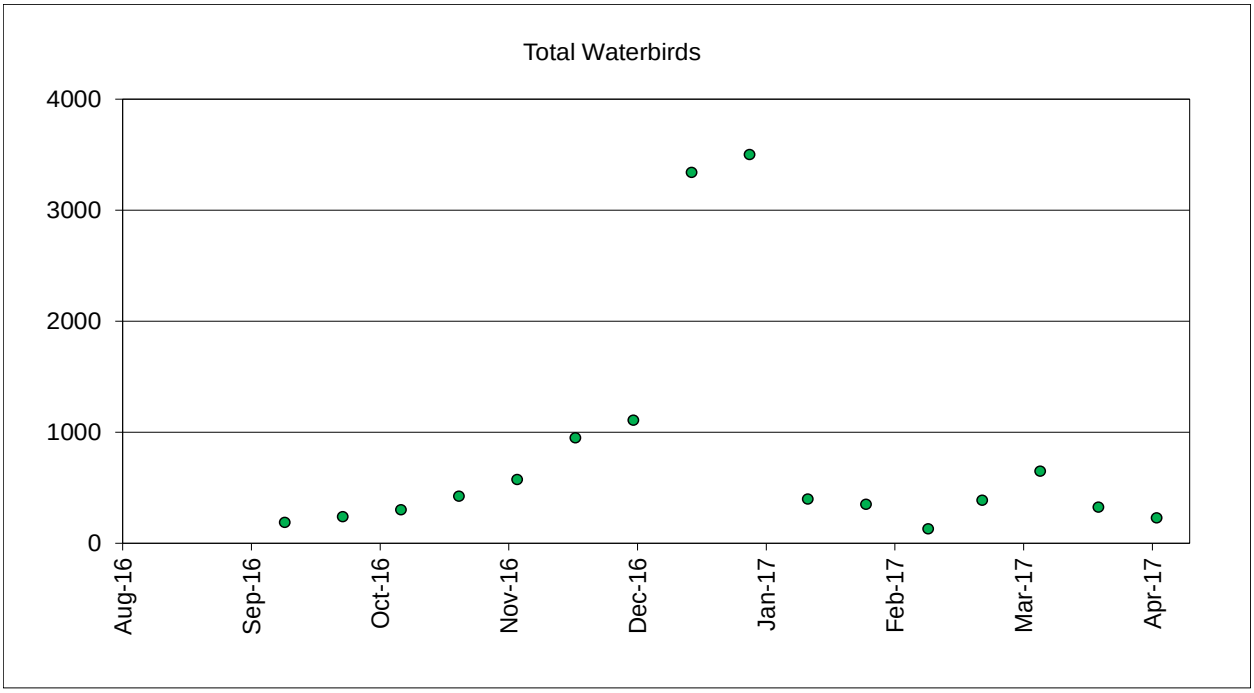

Figure 16. West Branch Reservoir total waterbirds (8/1/2016 to 4/15/2017).

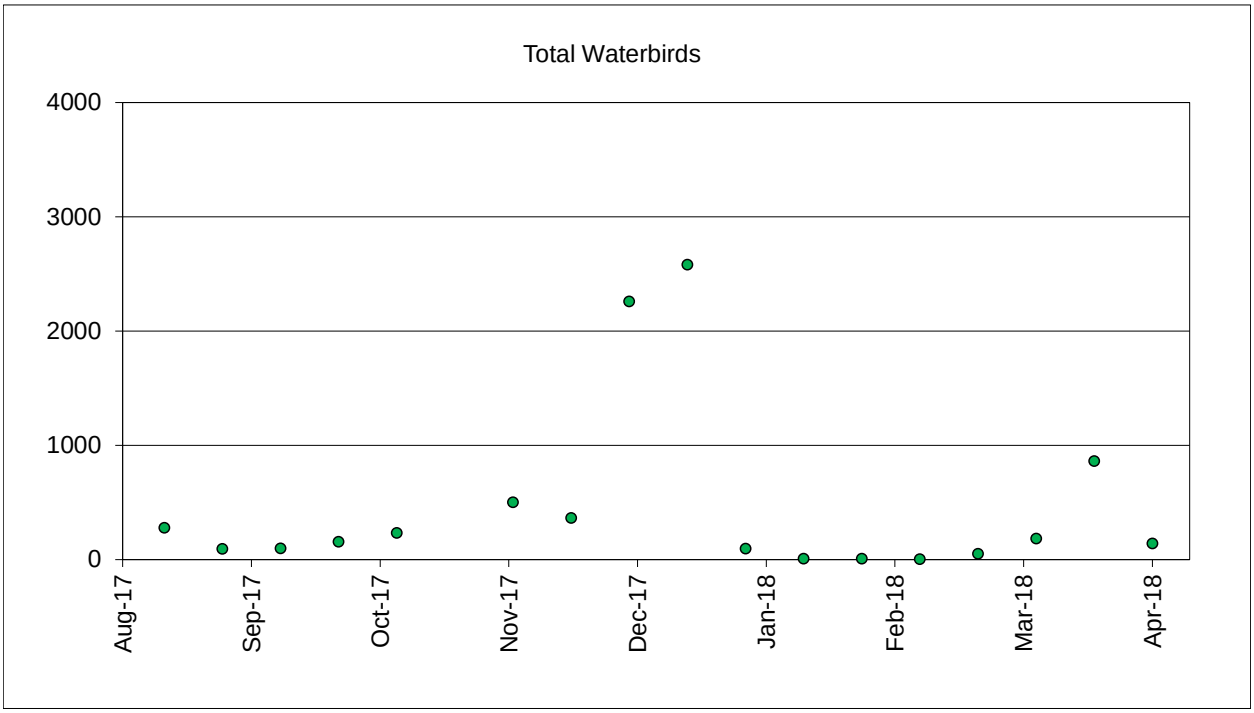

Figure 17. West Branch Reservoir total waterbirds (8/1/2017 to 4/15/2018).

Additional daytime (un-aided eye) bird observations (54) were conducted by DEP Aqueduct Monitoring staff during routine site visits for water quality sampling. The dates, times and counts for birds 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-three out of 54 observations or 61 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).

Date	Time of Observation	Bird Count Range or Actual Bird Counts
August 10, 2017	0931	1 - 50
August 16, 2017	1022	1 - 50
August 24, 2017	1021	1 - 50
September 13, 2017	1545	1 - 50
October 18, 2017	1010	1 - 50
February 21, 2018	1019	1 - 50
February 28, 2018	0925	1 – 50
March 14, 2018	1019	1 – 50
April 11, 2018	1127	1 - 50
May 3, 2018	0959	1 – 50
May 9, 2018	1032	1 – 50
May 23, 2018	1057	1 – 50
June 6, 2018	1127	1 – 50

There were six fecal coliform bacteria counts above 20 fecal coliforms $100mL^{-1}$ in samples collected from the in-reservoir sampling site (CWB1.5) which is located near Delaware Shaft 10 water outflow facility from August 1, 2017 through July 31, 2018 compared to two counts during the same reporting period in the previous year (Figure 18). Of 262 water samples collected over the period from August 1, 2017 to July 31, 2018, one hundred and twenty five (48 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.

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 2017, a coliform-restricted assessment based on compliance of the SWTR for West Branch Reservoir determined that the basin status was 'non-restricted'.

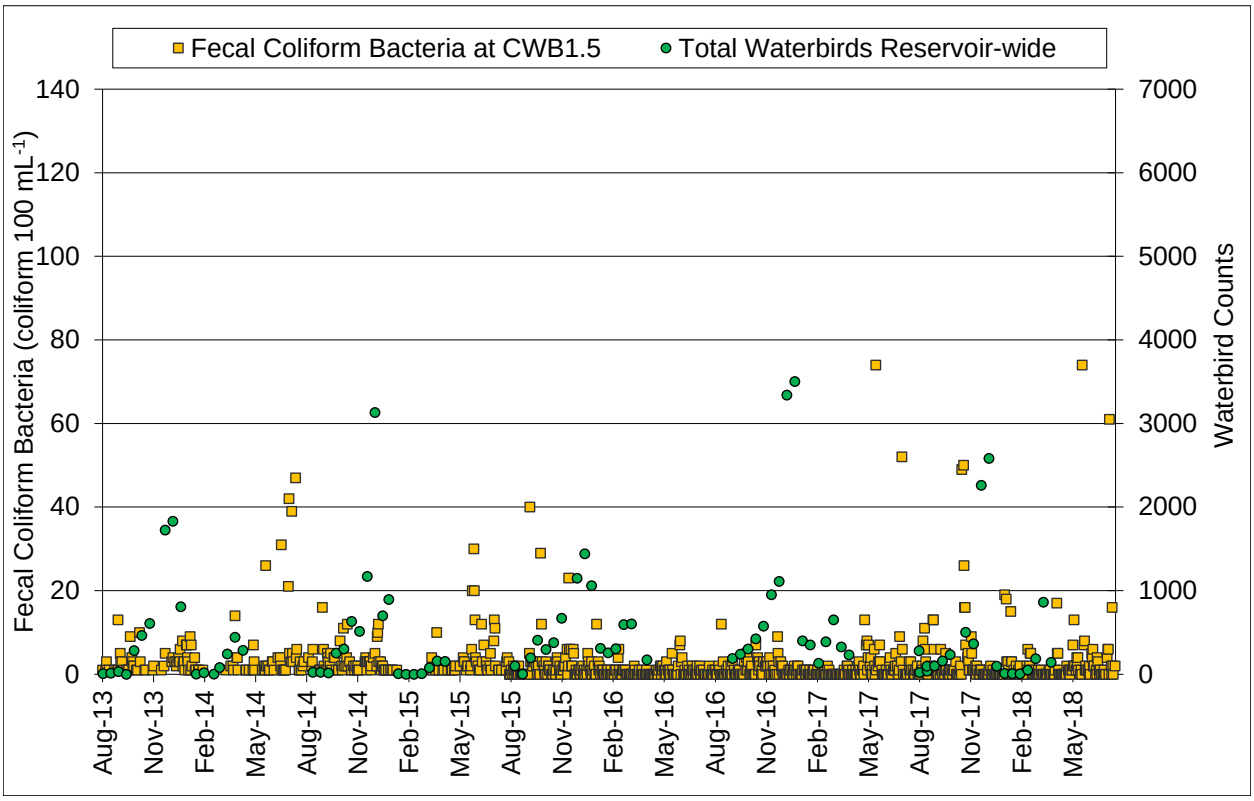

Figure 18. West Branch Reservoir fecal coliforms 100mL^{-1} at CWB1.5 vs. total waterbirds (8/1/2013 to 7/31/2018).

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31, in 2018 to reduce productivity at West Branch Reservoir. In 2018, seven nests with 29 eggs were depredated compared to six nests and 29 eggs depredated in 2017 (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 2018 and therefore no depredation actions were needed.

DEP continues to 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 2007 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 Rondout Reservoir is divided into nine bird zones (Appendix A Figure 39).

There were no overnight waterbird surveys conducted during this reporting period. In 2017/2018, there were no bacteria counts above 20 fecal coliforms 100mL^{-1} in samples collected from the Rondout Effluent Chamber (Figure 19). In 2017, a coliform-restricted assessment determined that the basin status was 'non-restricted'. Of 208 samples collected over the period from August 1, 2017 to July 31, 2018, no fecal coliform bacteria were detected in 136 (65 percent) of the samples.

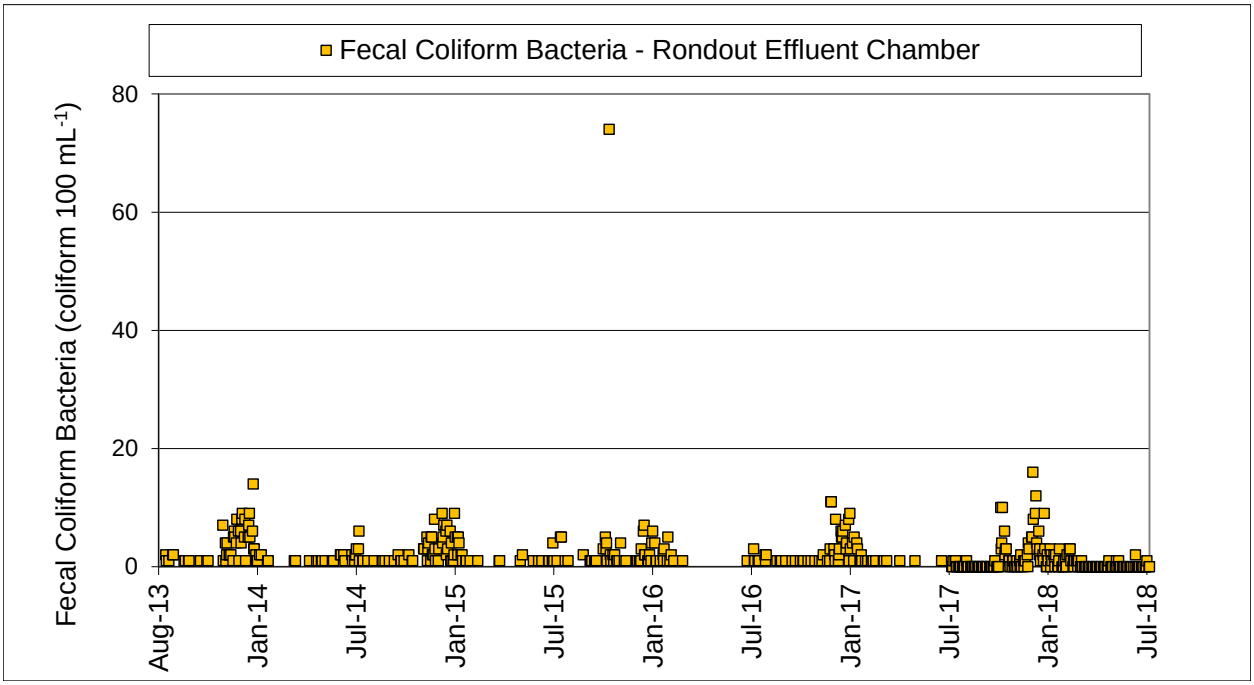

Figure 19. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent (8/1/2013 to 7/31/2018). Non-detect fecal coliform were not presented. Waterbird surveys discontinued on 4/30/2013.

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 eliminate any water quality threat.

During this reporting period only daytime (un-aided eye), DEP Aqueduct Monitoring staff conducted bird observations 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.

Date	Time of Observation	Bird Count Range or Actual Bird Counts
August 7, 2017	0832	1 – 50
August 14, 2017	0833	Observed 3 birds
August 21, 2017	1208	1 - 50
September 18, 2017	1035	1 – 50
October 10, 2017	1006	1 – 50
November 6, 2017	1055	1 – 50
November 2, 2017	0836	Observed 4 birds
December 11, 2017	0824	Observed 2 birds
December 26, 2017	1111	1 - 50
March 12, 2018	1042	1 - 50
March 26, 2018	1058	1 - 50
April 3, 2018	0907	1 - 50
April 11, 2018	0907	1 - 50
April 23, 2018	1240	1 - 50
April 30, 2018	1031	1 - 50
June 11, 2018	1149	1 - 50
June 25, 2018	1005	1 - 50
July 9, 2018	1031	1 - 50
July 16, 2018	1039	1 - 50
July 30, 2018	1055	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 on nesting Canada Geese at Rondout in the spring of 2018. 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. Four Canada Goose nests containing 28 eggs were depredated during the spring of 2018 compared to four nests with 11 eggs depredated in 2017 (Table 4). Figure 20 shows a Canada Goose nest found along the reservoir spillway channel. No goslings were documented in 2018 so the depredation effort was deemed 100 percent successful. There were no Mute Swan or Double-crested Cormorant nests identified at Rondout Reservoir in 2018.

Figure 20. Canada Goose nest along spill channel at Rondout Reservoir. Photo by Chris Nadareski.

4. Ashokan Reservoir

The 2007 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. Fifty-one bird observations were conducted each at the Ashokan East Basin Effluent and at the Ashokan West Basin Effluent during this reporting period. The dates, times and count ranges for birds observed at the Ashokan East Basin Effluent are listed in Table 9 and those for the 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. Thirty-six of 51 (71 percent) observations were reported as zero birds at the East Basin Effluent and 35 out of 51 (69 percent) observations were zero birds observed on the West Basin Effluent.

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

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range or Actual Bird Counts
August 7, 2017	1029	Observed 1 bird
August 14, 2017	1033	Observed 1 bird
August 28, 2017	1036	1 – 50
September 11, 2017	1045	Observed 1 bird
September 25, 2017	1029	1 - 50
October 23, 2017	1001	1 - 50
January 29, 2018	1047	1 - 50
February 26, 2018	1115	1 - 50
April 23, 2018	1115	1 - 50
April 30, 2018	1102	1 - 50
May 7, 2018	1027	1 - 50
May 29, 2018	1106	1 - 50
June 4, 2018	1111	1 - 50
June 11, 2018	1029	Observed 4 birds
June 25, 2018	1039	1 - 50

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

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range or Actual Bird Counts
August 14, 2017	1032	Observed 1 gull
October 23, 2017	1000	1 - 50
February 26, 2018	1113	Observed 3 birds
March 12, 2018	1143	Observed 2 birds
March 19, 2018	1111	1 - 50
March 26, 2018	1035	1 - 50
April 9, 2018	1113	1 - 50
April 16, 2018	1152	1 - 50
April 23, 2018	1114	1 - 50
April 30, 2018	1101	1 - 50
May 7, 2018	1026	51 - 100
May 14, 2018	1104	1 - 50
May 21, 2018	1017	1 - 50
May 29, 2018	1105	1 - 50
June 4, 2018	1108	1 – 50
July 9, 2018	1006	1 – 50

There was only one water quality sample collected at the water effluent sampling location at Ashokan (EARCM) that exceeded 20 fecal coliforms $100mL^{-1}$ recorded on October 30, 2017 (Figure 21) and a Confluent+ sample on July 25, 2018. The Confluent water sample only represents a qualitative description when too many bacterial colonies cannot be distinguished from one another.

The Aqueduct Monitoring staff reported no birds observed on the East Basin and West Basin each on October 30, 2017. There were no bird surveys conducted within a reasonable time of the July 25, 2018 fecal elevation to determine if it could be attributed to increased bird activity.

In 2017, a coliform-restricted assessment for Ashokan Reservoir determined that the basin status was ‘non-restricted’. Of 206 fecal coliform bacteria samples collected over the period from August 1, 2017 to July 31, 2018, one hundred and twenty-four (60 percent) had no fecal coliform bacteria present.

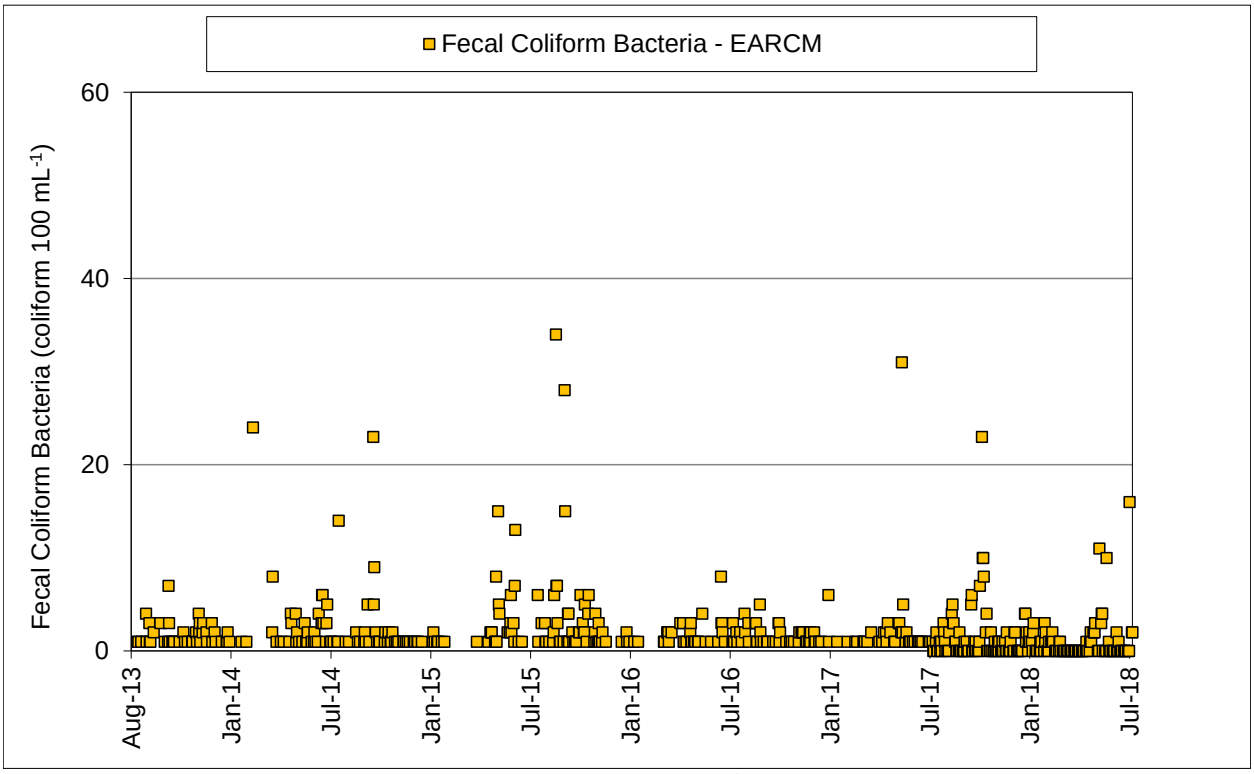

Figure 21. Ashokan Reservoir fecal coliforms 100mL^{-1} at Ashokan Effluent (EARCM) (8/1/2013 to 7/31/2018). Waterbird surveys discontinued on 4/30/2013.

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 eliminate a water quality threat.

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31, 2018 to reduce productivity at Ashokan. In 2018, six Canada Goose nests were identified and 33 eggs were depredated (Table 4). In 2017, eleven Canada Goose nests were identified with 54 eggs depredated. The egg-depredation success rate at the Ashokan Reservoir was 85 percent in 2018 compared to 78 percent in 2017. Six goslings were observed in late spring 2018 compared to 15 observed in spring 2017. There were no Mute Swans or Double-crested Cormorants found nesting in 2018.

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. Immature Bald Eagle. Photo by Lou Busher.

5. Croton Falls Reservoir

The 2007 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 locations (Appendix A Figure 41).

There were no nocturnal waterbird counts conducted during this reporting period at Croton Falls Reservoir as 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 two water quality samples collected from the Croton Falls release in 2017/2018 that had fecal coliform counts above 20 fecal coliforms 100mL^{-1} (Figure 23); 36 fecal coliforms 100mL^{-1} on November 14, 2017 and 55 fecal coliforms 100mL^{-1} on January 16, 2018.

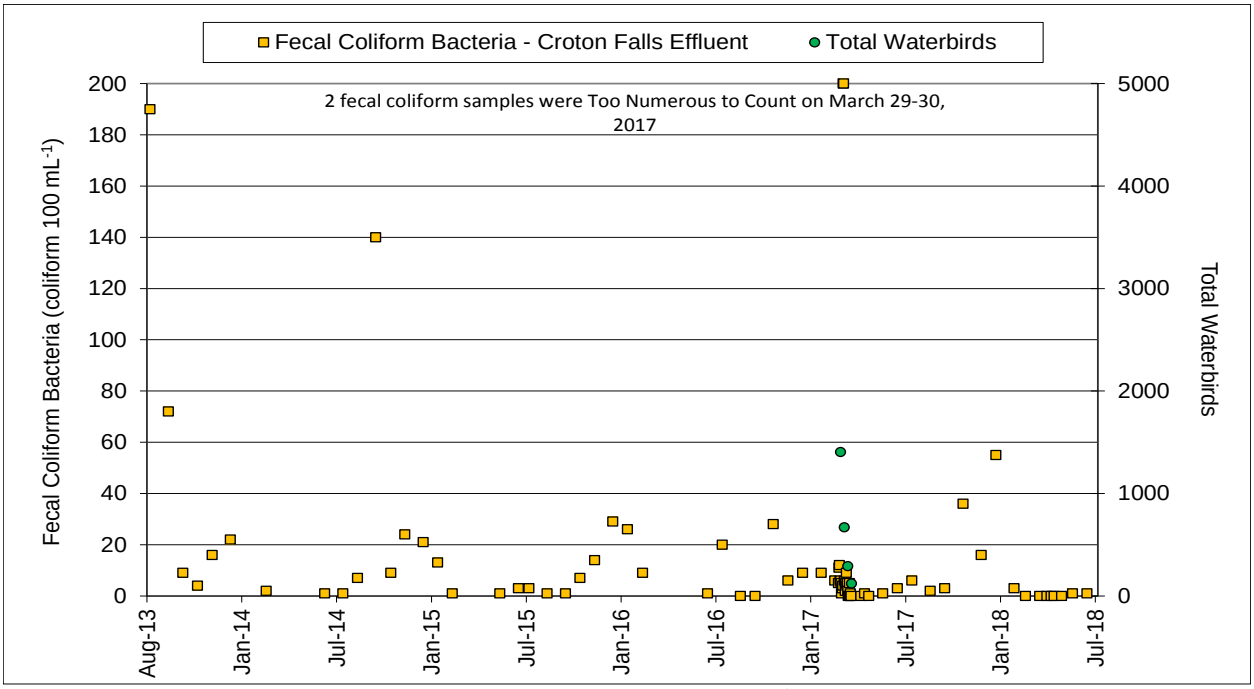

Figure 23. Croton Falls Reservoir fecal coliforms 100mL^{-1} at Croton Falls Effluent vs. total waterbirds (8/1/2013 to 7/31/2018). Routine waterbird surveys discontinued on 4/30/2013.

Of 15 water quality samples collected over the period from August 1, 2017 to July 31, 2018, six (40 percent) were non-detectable.

DEP conducted reproductive control on Canada Geese from April 1 through May 31 in the spring of 2018 to reduce productivity at Croton Falls (Table 4). In 2018, 12 Canada Geese nests were identified with 72 eggs depredated compared to nine nests and 46 eggs in 2017. The Canada Goose egg-depredation success rate at Croton Falls for 2018 was 92 percent as six goslings hatched. There were no Mute Swan nests observed in 2018.

6. Cross River Reservoir

The 2007 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 no nocturnal waterbird counts conducted during the reporting period. Fecal coliform bacteria concentrations are reported for August 1, 2013 through July 31, 2018 (Figure 24). Fecal coliform bacteria levels in water samples at Cross River Reservoir did not exceed the 20 fecal coliforms 100mL^{-1} level from August 1, 2017 through July 31, 2018 similar to the previous reporting period 2016/2017 (Figure 24). Of 12 water quality samples collected in this reporting period six or 50 percent were non-detectable.

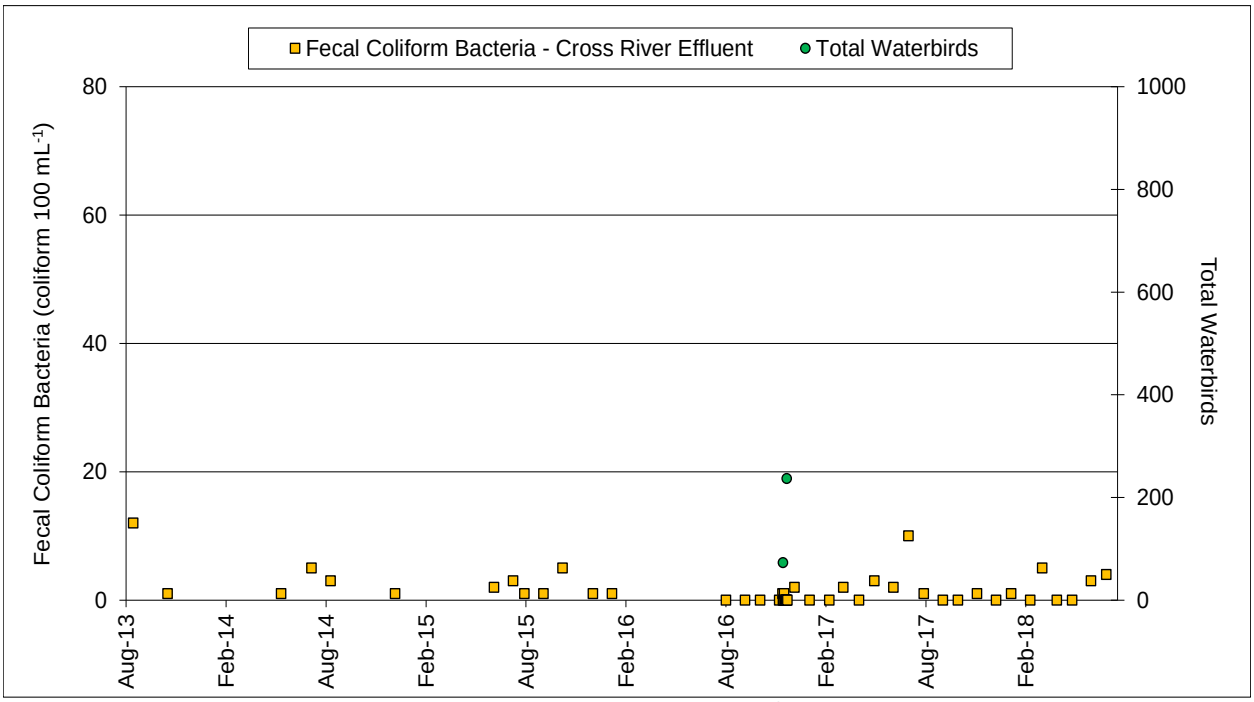

Figure 24. Cross River Reservoir fecal coliforms 100mL^{-1} at Cross River Effluent vs. total waterbirds (8/1/2013 to 7/31/2018). Routine waterbird surveys discontinued on 4/30/2013.

The Cross River Pump Station was not operationally tested during this reporting period and therefore no waterbird surveys were conducted.

DEP conducted reproductive control on nesting Canada Geese from April 1 through May 31 in 2018 to reduce productivity at Cross River. In 2018, eight nests were identified and 44 eggs depredated compared to six nests and 20 eggs in 2017 (Table 4). The Canada Goose egg-depredation success rate for Cross River in 2018 was 98 percent with one gosling that hatched from a known nest on an inaccessible cliff face over the spillway. Similarly, in 2017, the depredation success rate was 91 percent when one gosling was observed. Reservoir nesting Canada Geese can be difficult to locate and require a thorough inspection of shoreline areas and islands (Figure 25). There were no Mute Swans or Double-crested Cormorants observed nesting in either year.

Figure 25. Reservoir islands are often used by Canada Geese to nest.

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, influent (Uptake) and 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 species 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. Live capture of a Ruddy Duck using nets from Jon boats. Photo by C. Nadareski.

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 2017/2018, night-roosting guilds of birds comprised the following breakdown: Canada Geese 0.3 percent, Gull Spp. 0 percent, and ducks about 99.7 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 3,282 bird harassment actions that dispersed 4,980 waterbirds (156 Canada Geese, 2,957 Gulls, and 1,867 ducks), down approximately 44 percent in numbers. Bird harassment actions included both birds that landed in the reservoir and those attempting to land. The breakdown of harassment actions included the use of 2,792 bird bangers, 426 physical chases, 31 propane cannon discharges, 22 uses of the Remote Controlled boat, and 11 uses of a Jon boat.

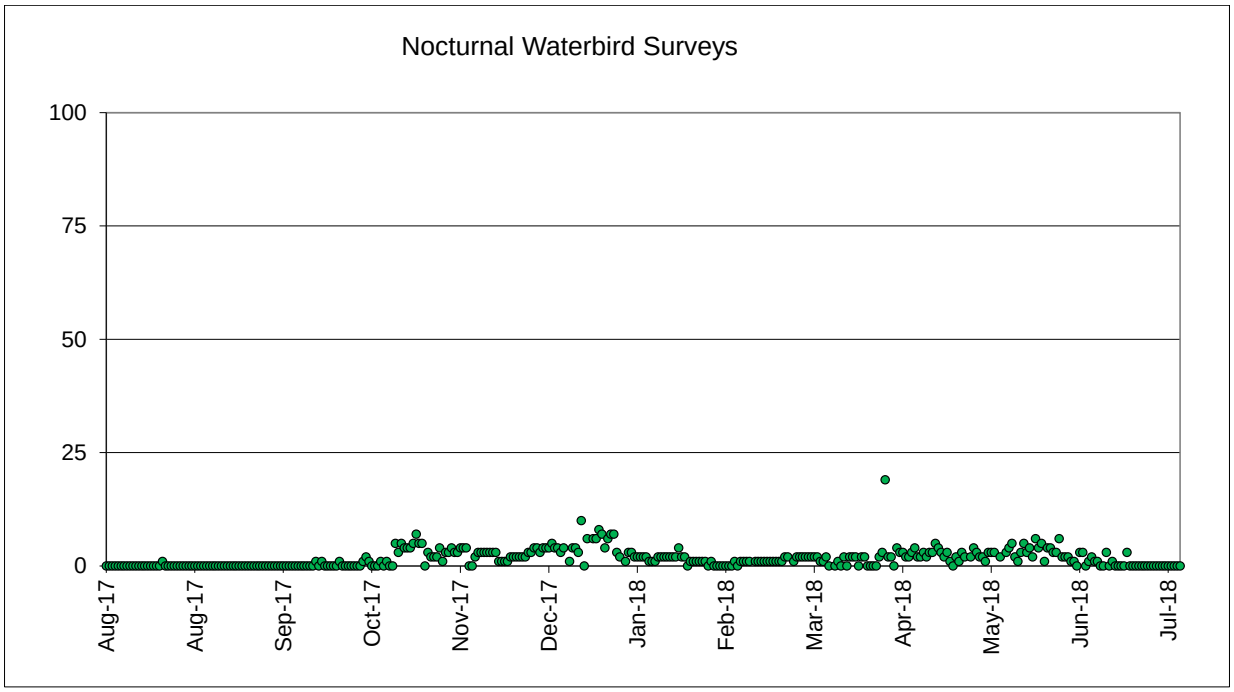

Figure 28. Hillview Reservoir total waterbirds nocturnal counts (8/1/2017 to 7/31/2018).

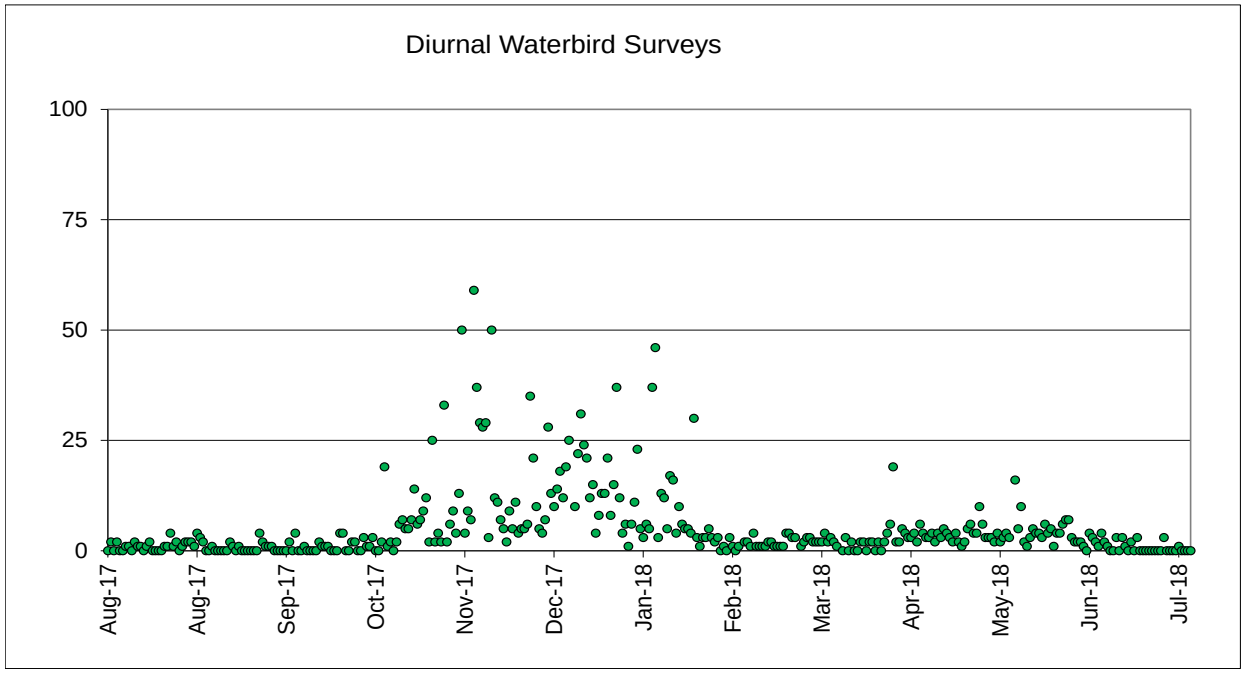

Figure 29. Hillview Reservoir total waterbirds diurnal counts (8/1/2017 to 7/31/2018).

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 (Ruddy Ducks and Bufflehead (*Bucephala albeola*)) 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 attempt to overwinter at Hillview. USDA sharpshooters lethally removed 13 Ruddy Ducks and two Bufflehead Ducks during this reporting period. An additional one Ruddy Ducks was live-captured and relocated off reservoir property by DEP staff.

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. A total of 362 out of 365 overnight surveys conducted were deemed 99 percent successful in 2017/2018. There were no gulls observed during the 356 successful overnight surveys. There was only one observation of two Canada Geese recorded during the overnight surveys. Overnight waterbird counts peaked at 19 on April 22, 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 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* (grab samples) levels remained at zero detections entering Hillview at water quality sampling locations Site 1 (Figure 30 and Appendix A Figure 44). There were no positive *E. coli* samples reported at sampling Site 3 as the water leaves Hillview Reservoir for distribution (Figure 30 and Appendix A Figure 44).

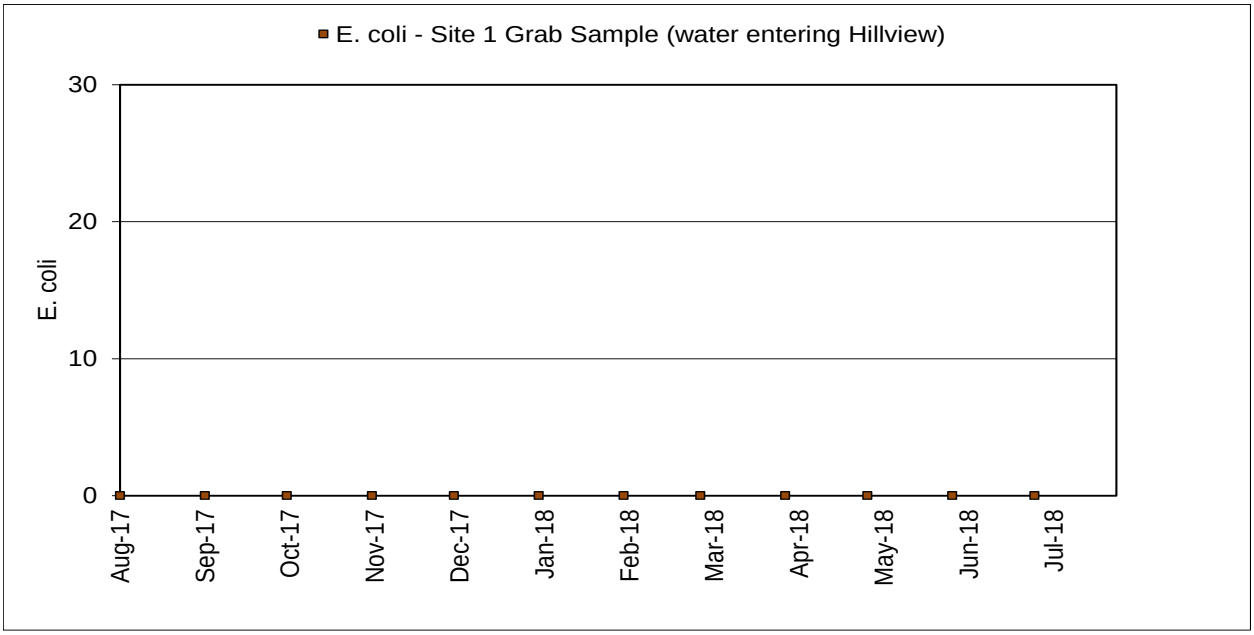

Figure 30. Hillview Reservoir number of positive *E. coli* (grab sample) at water sampling Site 1 (8/1/2017 to 7/31/2018).

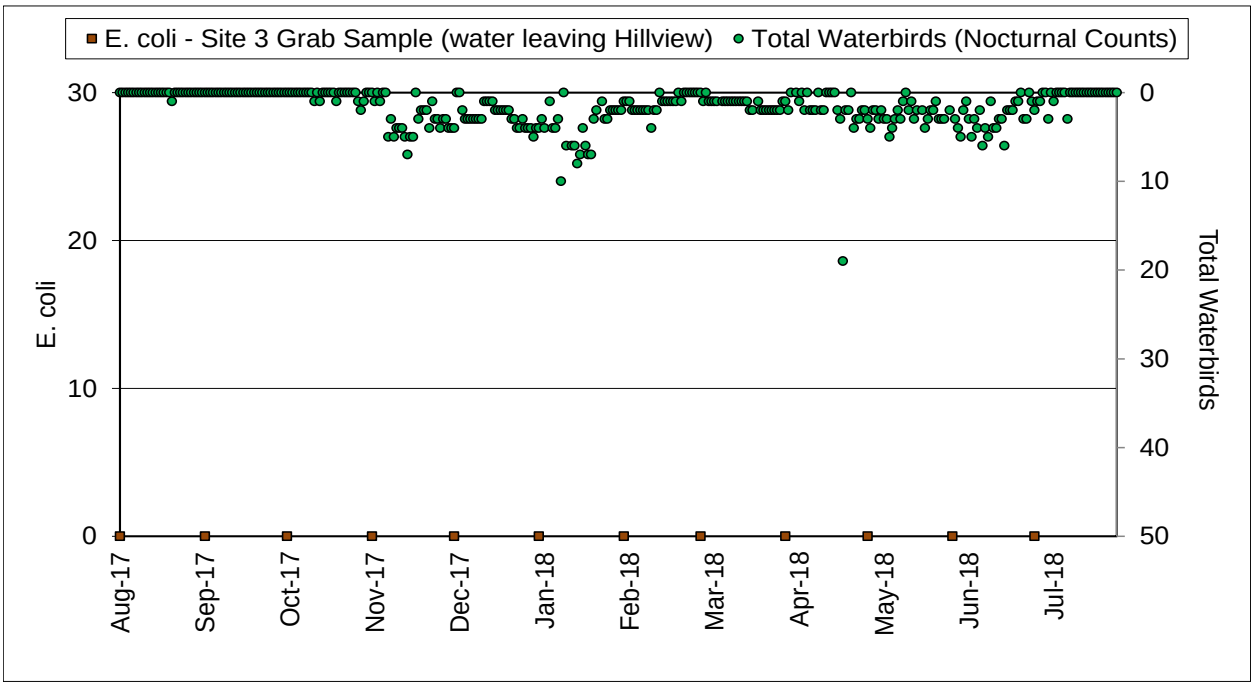

Figure 31. Hillview Reservoir number of positive *E. coli* (grab sample) at water sampling Site 3 versus total waterbirds (8/1/2017 to 7/31/2018).

Waterbirds were mainly observed during the period from late October 2017 through early summer 2018. DEP's contractor USDA Wildlife Services conducted several depredation actions from November 2017 through March 2018 to remove 15 diving ducks that did not respond to the conventional types of bird dispersal methods. An additional six ducks were found dead and removed from the reservoir and one Ruddy Duck was live-captured and removed. This small increase in duck activity did not cause any detectable *E. coli* in the compliance water samples.

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 2018, one Cliff Swallow nest with no eggs was depredated (physically removed from the eaves of the reservoir shaft buildings) compared to 13 nest and 16 eggs depredated in 2017. There were no Barn Swallow nests observed during the spring and summer period of 2018 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.

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, 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 6,152 live and lethal traps were set during the period August 1, 2017 to July 31, 2018 (Table 11). The success of the trapping program 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 since the inception of the trapping efforts there has been a total of 497 animals trapped plus six domestic animal (cats) and several species of passerine birds have been trapped inside the reservoir perimeter fence from August 1, 2011 to July 31, 2018 (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. A total of 25,153 mammal-trapping nights have been set since August 2011. A single mammal trapping night consists of one trap baited for one night. Overall, mammal-trapping success increased from 139 specimens in 2016 to 207 specimens in 2017. Twenty-three specimens from seven species have been trapped in the first half of 2018. Three non-target terrestrial bird species was also trapped 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. The number of camera hits of wildlife coincidental with a successful trapping night only occurred during two months and peaked in September 2017 during this reporting period. Photographs of animals recorded during trap nights occurred during 10 of 12 months and camera detections that occurred on no trap nights were recorded during eight of 12 months.

Table 11. Mammal trapping summary August 2017 through July 2018.

Month/Year	Number of live-traps and lethal traps set	Trapping success
August 2017	704	23 *Peromyscus* Spp., 3 meadow vole, 2 house mice, 1 Virginia opossum, 6 House Sparrows, and 1 European Starling
September 2017	580	11 *Peromyscus* Spp. 2 raccoons, 4 Virginia opossum, 2 Norway rats. 1 Eastern grey squirrel, 1 striped skunk, and 1 Palm Warbler
October 2017	634	22 *Peromyscus* Spp., 2 house mice, 5 short-tailed shrews and 1 raccoon
November 2017	588	14 *Peromyscus* Spp. , 3 short-tailed shrews, 1 raccoon, and 1 Norway rat
December 2017	532	7 *Peromyscus* Spp., 1 short-tailed shrew and 1 house mouse
January 2018	372	1 *Peromyscus* Spp.
February 2018	494	6 *Peromyscus* Spp., 2 Virginia opossum, 1 raccoon, and 1 short-tailed shrew
March 2018	336	No animals successfully trapped
April 2018	510	1 raccoon and 1 short-tailed shrew
May 2018	504	2 *Peromyscus* Spp., 1 raccoon, 1 Virginia opossum, 1 Norway rat, and 2 House Sparrows
June 2018	435	1 *Peromyscus* Spp., and 2 Virginia opossum
July 2018	463	1 meadow vole, and 1 Virginia opossum
Annual Trapping Totals	**6,152**	**141 Animals trapped from 12 Wildlife Species (9 mammals and 3 birds)**

Table 12. Trapping success summary for Hillview Reservoir (August 2011 to July 2018).

Species Trapped	2011 (8/1 to 12/31)	2012	2013	2014	2015	2016	2017	2018 (1/1 to 7/31)	Trapping totals by species
Raccoon	8	5	6	6	5	0	4	**3**	**37**
Striped Skunk	0	1	0	7	3	0	1	**0**	**12**
Virginia Opossum	0	0	0	4	6	1	6	**6**	**23**
Mice (*Peromyscus* Spp.)	7	0	11	7	13	116	165	**10**	**329**
Meadow Vole	0	0	4	0	0	6	6	**1**	**17**
Short-tailed Shrew	0	0	1	0	0	6	10	**2**	**19**
House Mouse	0	0	0	21	2	7	11	**0**	**41**
Norway Rat	0	0	0	1	4	1	3	**1**	**10**
Gray Squirrel	0	0	0	1	0	1	1	**0**	**3**
Feral or Domestic Cats (relocated)	0	0	0	4	1	1	0	**0**	**6**
Annual Trapping totals	**15**	**6**	**22**	**51**	**34**	**139**	**207**	**23**	**497**

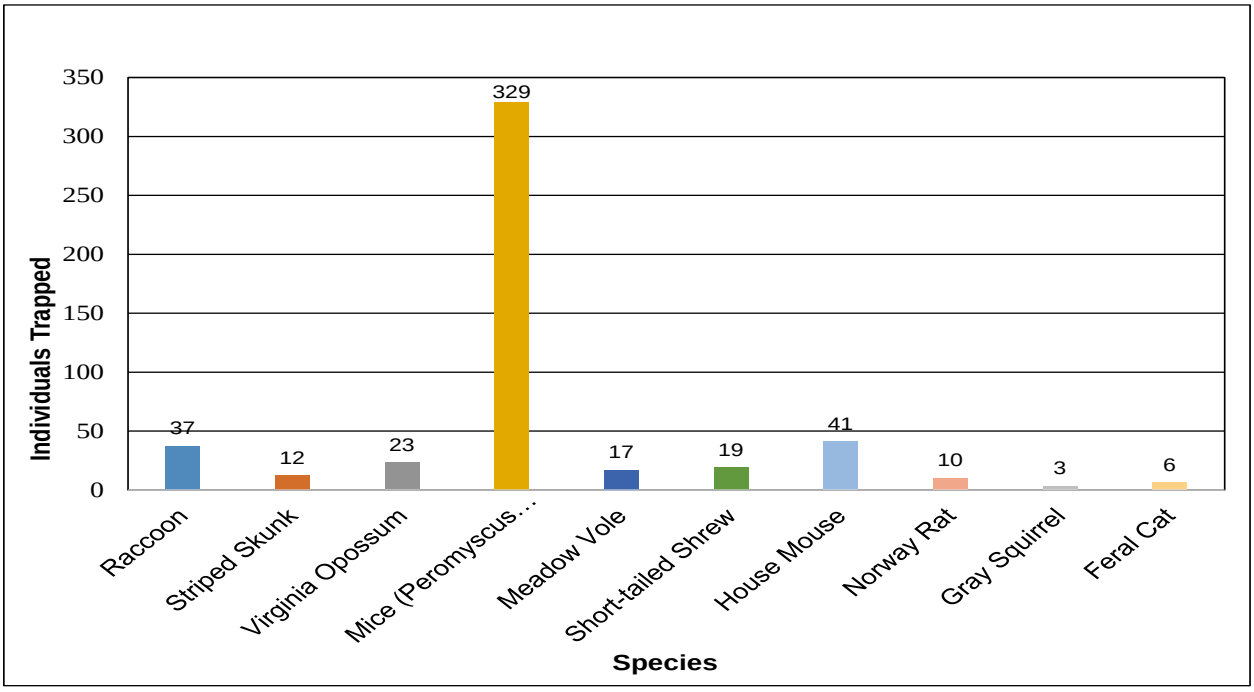

Figure 32. Mammal species trapped at Hillview Reservoir (8/1/2011 to 7/31/2018).

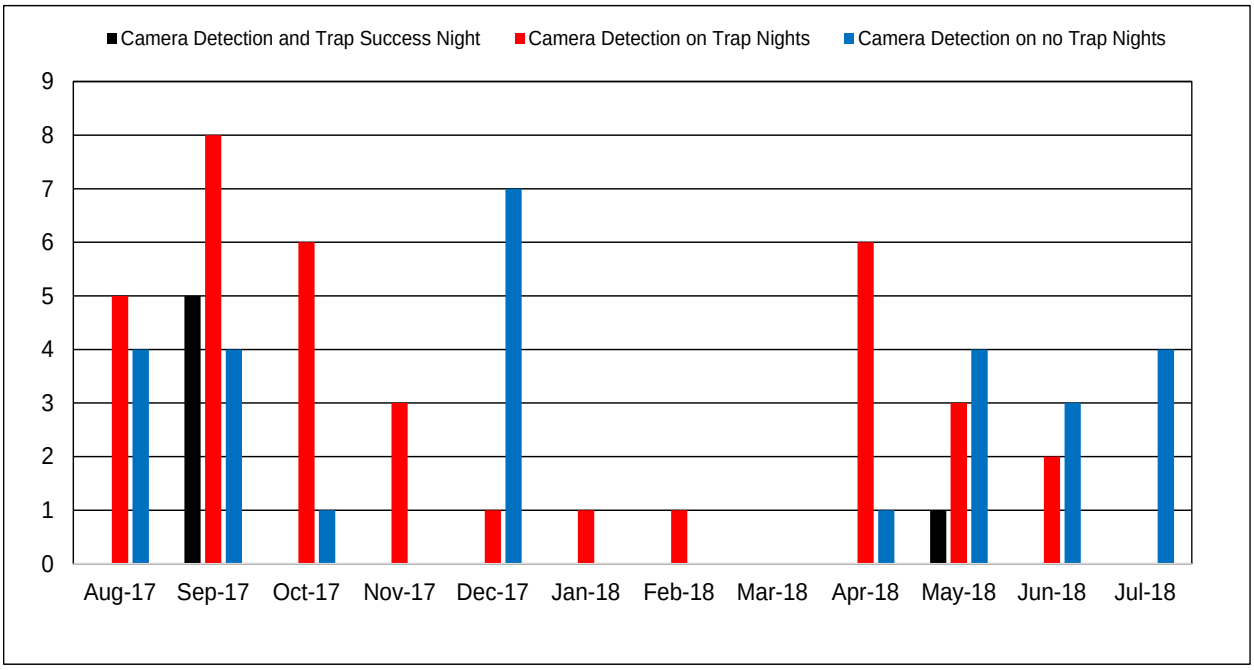

Figure 33. Occurrences of remote nighttime photography of animals recorded on the reservoir catwalk and dividing wall versus trapping success (8/1/2017 to 7/31/2018).

During the spring/summer 2018 waterbird nesting season there were no reported nesting attempts by Canada Geese or Mute Swans. However, three Mallard nests were identified and 25 eggs depredated under a federal permit compared to six nests and 38 eggs depredated in 2017. Of the three nests found in 2018, seven ducklings were live-captured and relocated off reservoir property compared to 15 ducklings that hatched in 2017 (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 78 percent in 2018 compared to 72 percent in 2017. 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 2018 combined with an expansion of lawn maintenance into areas where nests from previous years were found.

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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 Revised 2007 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 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 deterrence techniques. 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.

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 2017, Kensico Reservoir was once again classified as a 'non-restricted' basin. 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 44 goose nest and one swan nest depredations whereby 254 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 breeder.

At Hillview Reservoir, DEP 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, and including additional lethal control measures to manage ducks, geese, swallows and sparrows. 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 initiated small mammal trapping inside the reservoir perimeter fence and on the reservoir-dividing wall. DEP conducted 6,152 trap nights during 2017/2018, in an attempt to eliminate small mammal activity inside the reservoir perimeter fence. DEP conducted egg and nest depredation for nesting swallows under a federal depredation permit again in 2018 with a 100 percent success rate by removing active nests and preventing nesting activity by way of maintenance of bird netting on reservoir shaft buildings. Three Mallard Duck nests were depredated along with a capture and removal of seven 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. Ice cover on the reservoirs and snow cover in the associated watershed or daily flight range for food often determine whether they will continue 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 two decades 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

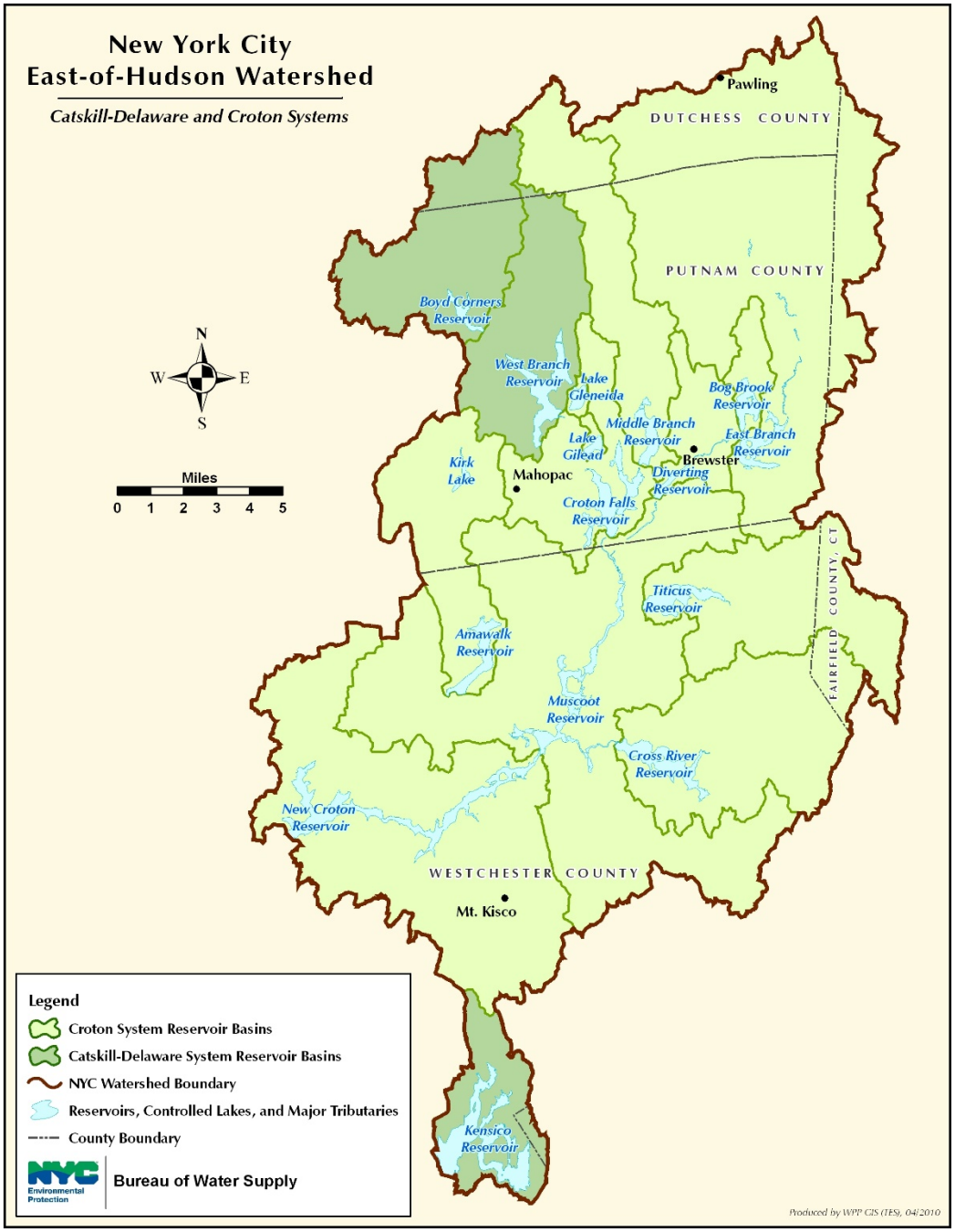

Figure 34. Map of New York City Water Supply System – East of Hudson Region.

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

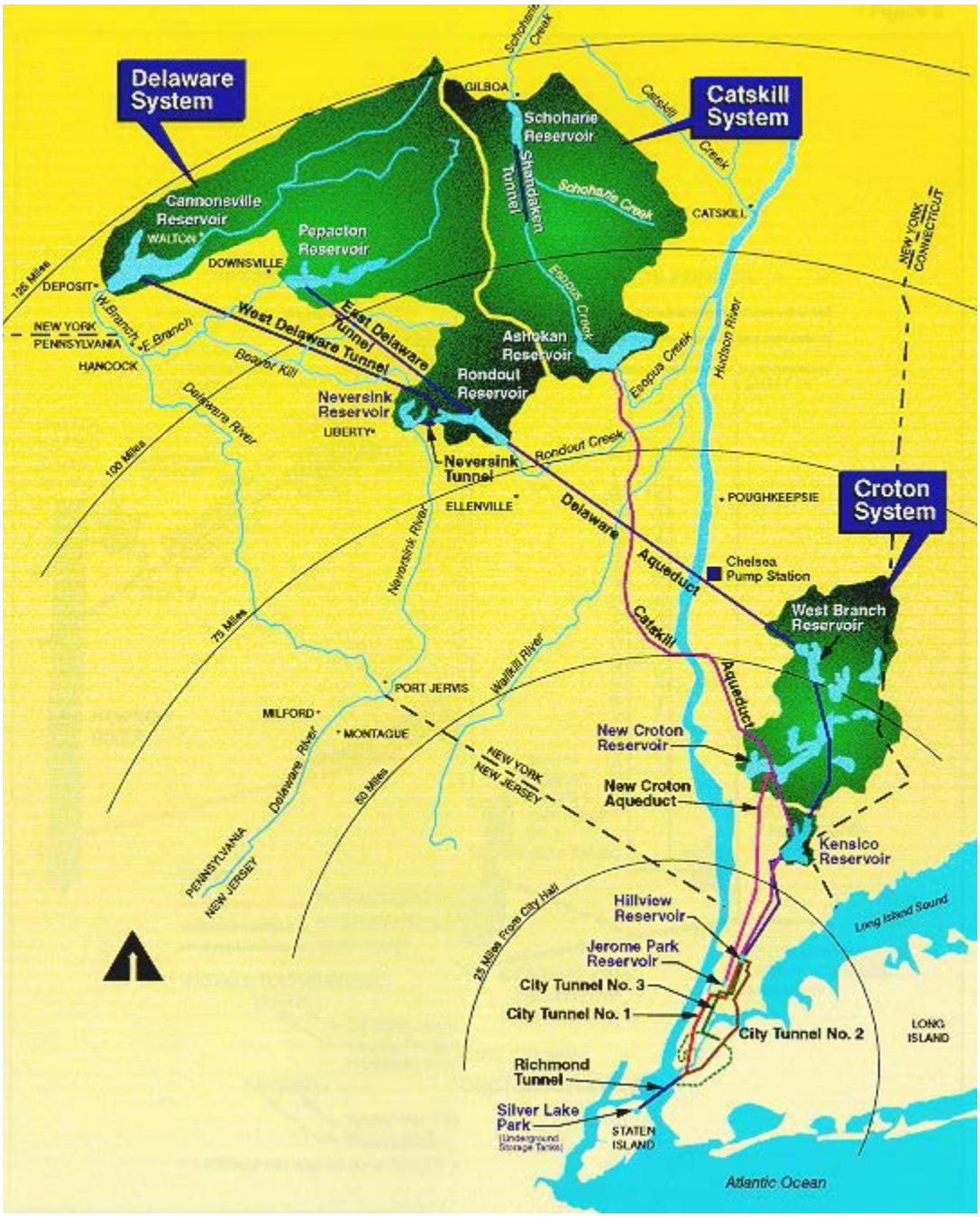

Figure 36. NYC Catskill, Delaware and Croton Aqueduct System.

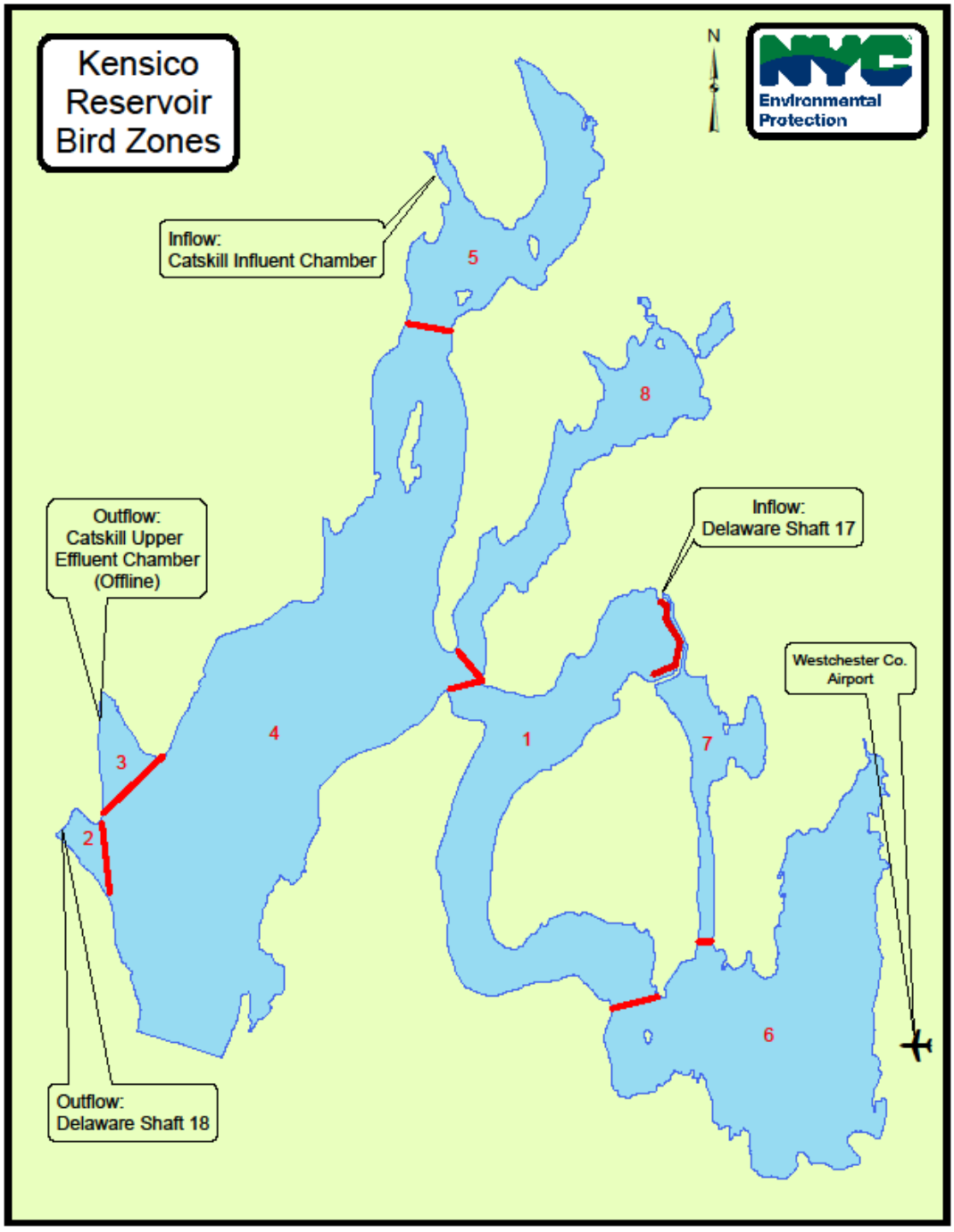

Figure 37. Map of Kensico Reservoir bird zones.

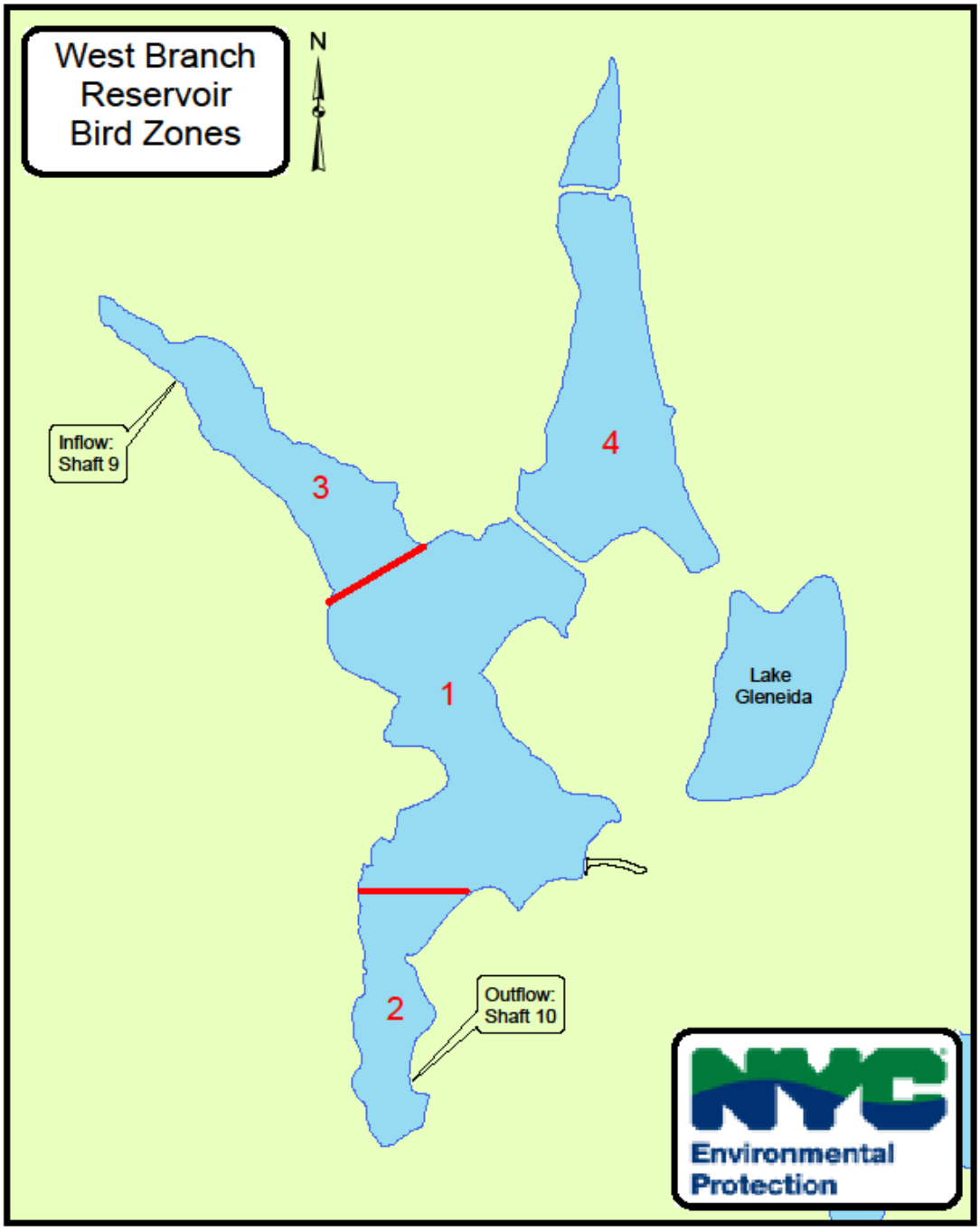

Figure 38. Map of West Branch Reservoir bird zones.

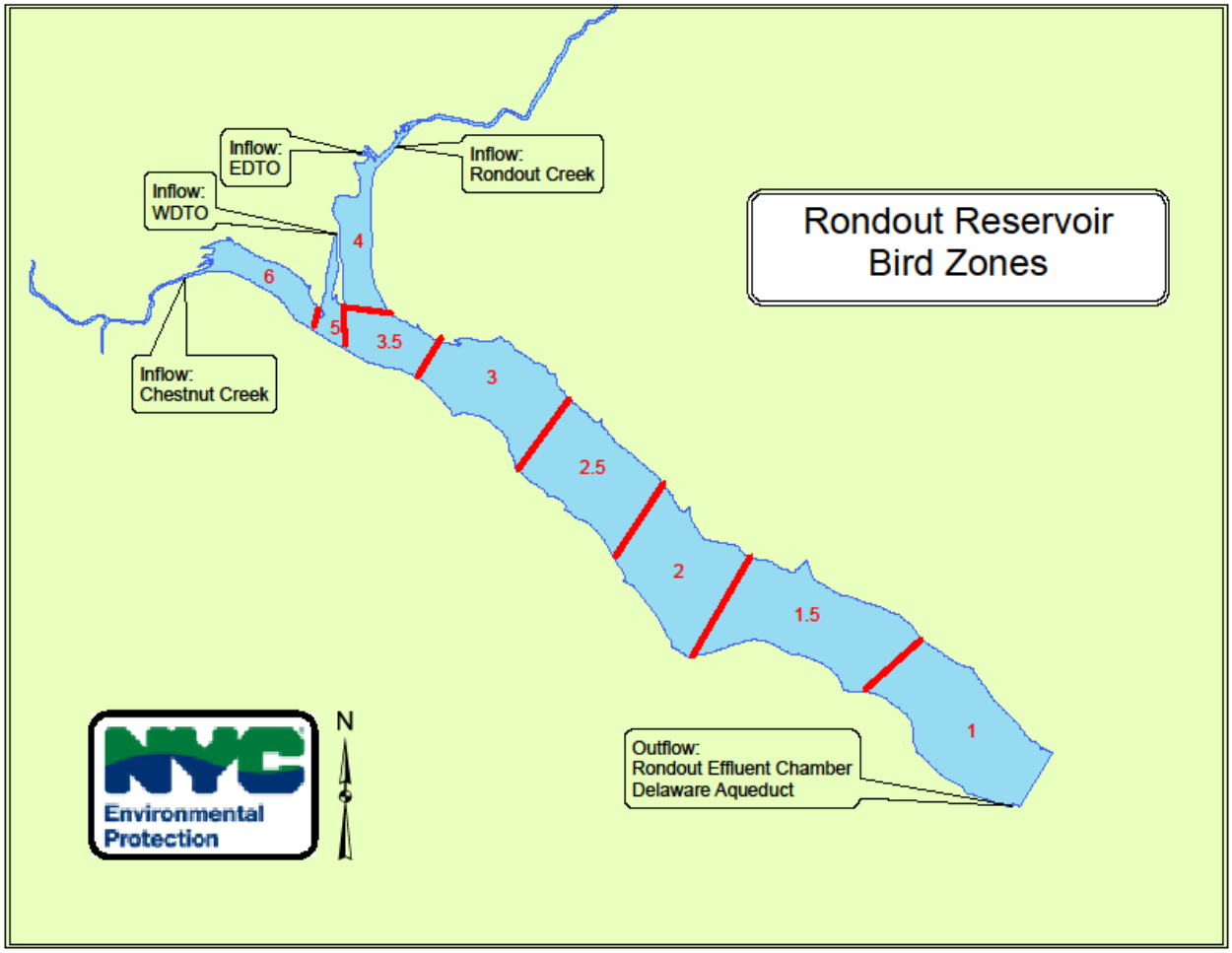

Figure 39. Map of Rondout Reservoir bird zones.

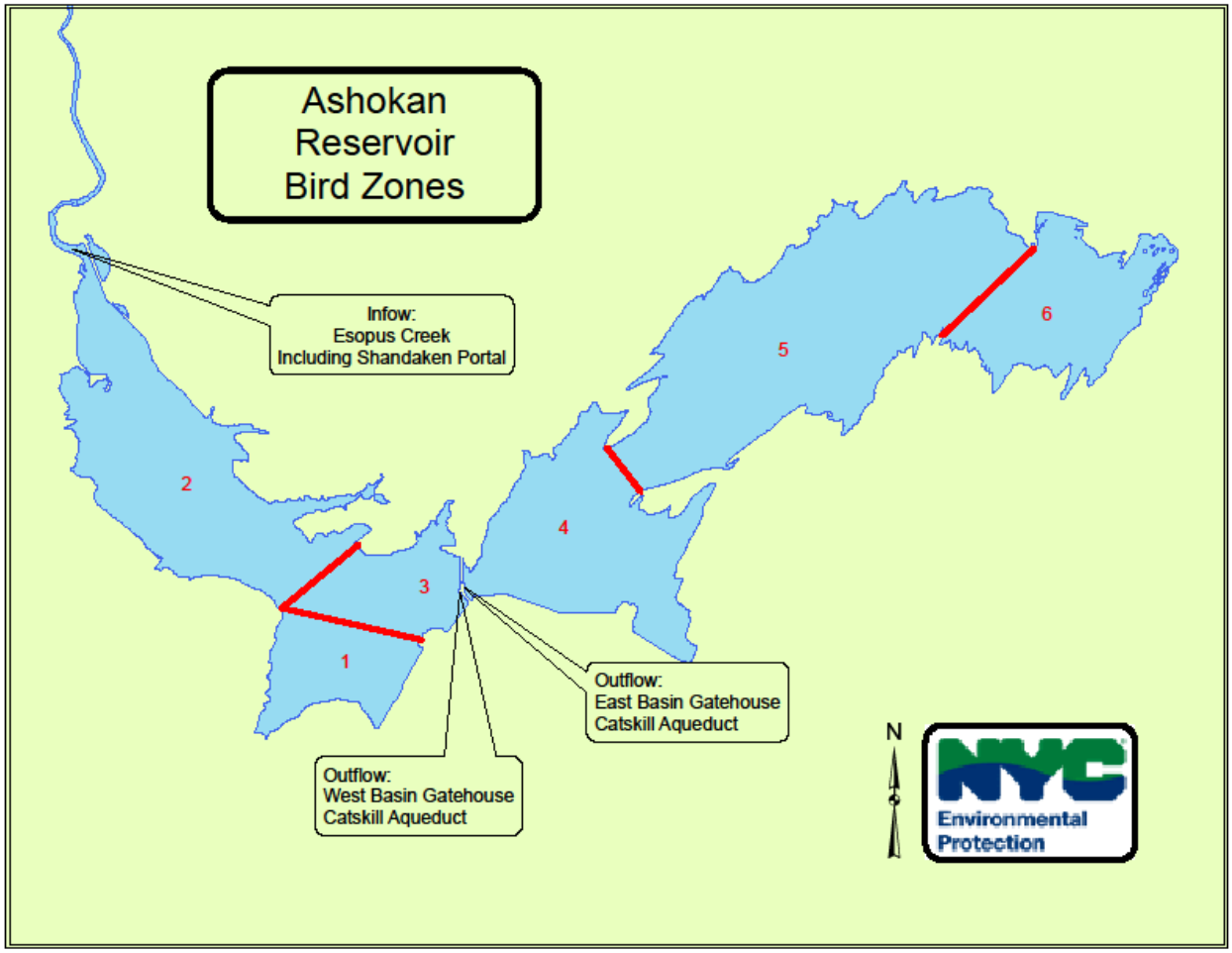

Figure 40. Map of Ashokan Reservoir bird zones.

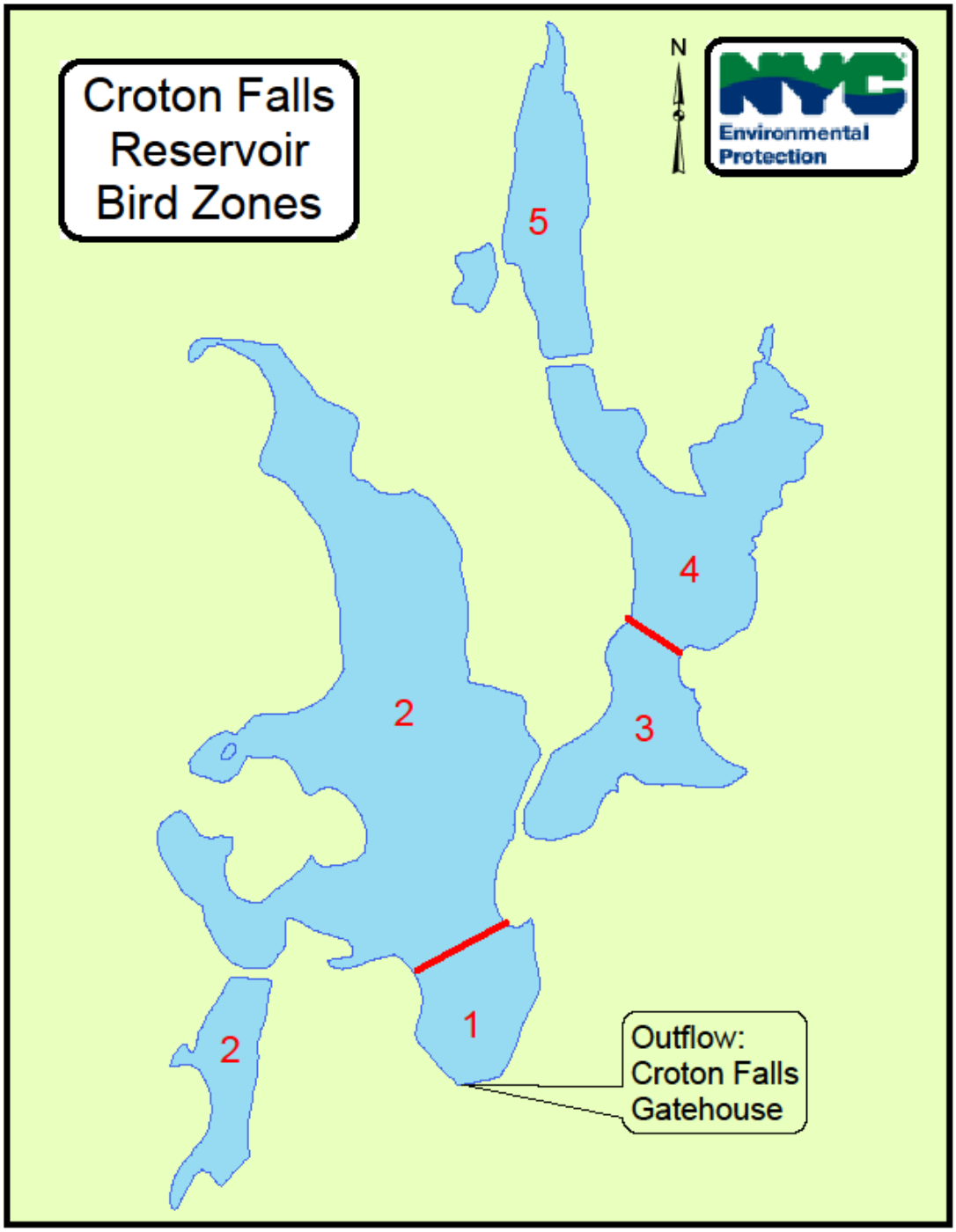

Figure 41. Map of Croton Falls Reservoir bird zones.

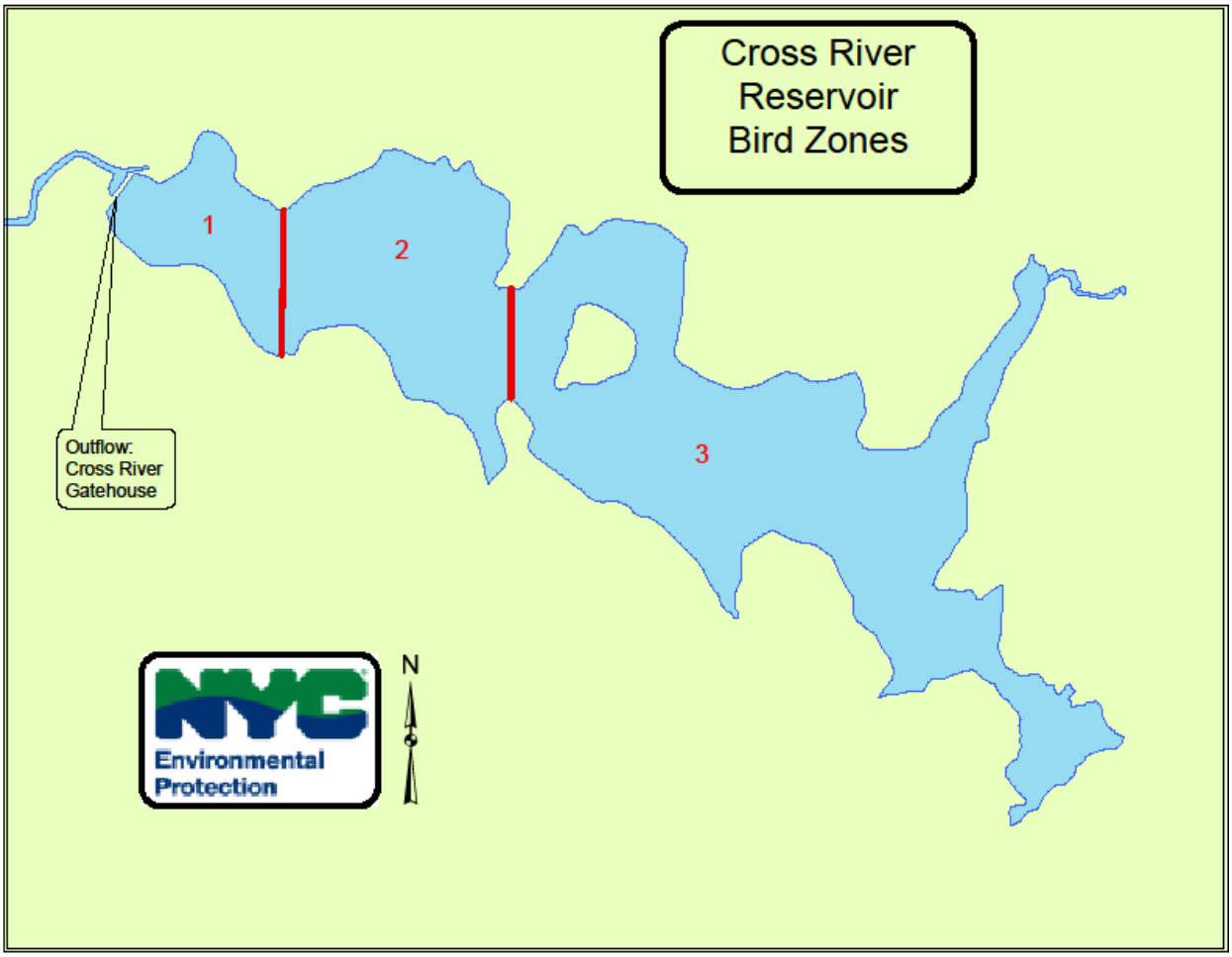

Figure 42. Map of Cross River Reservoir bird zones.

Figure 43. Map of Hillview Reservoir bird zones.

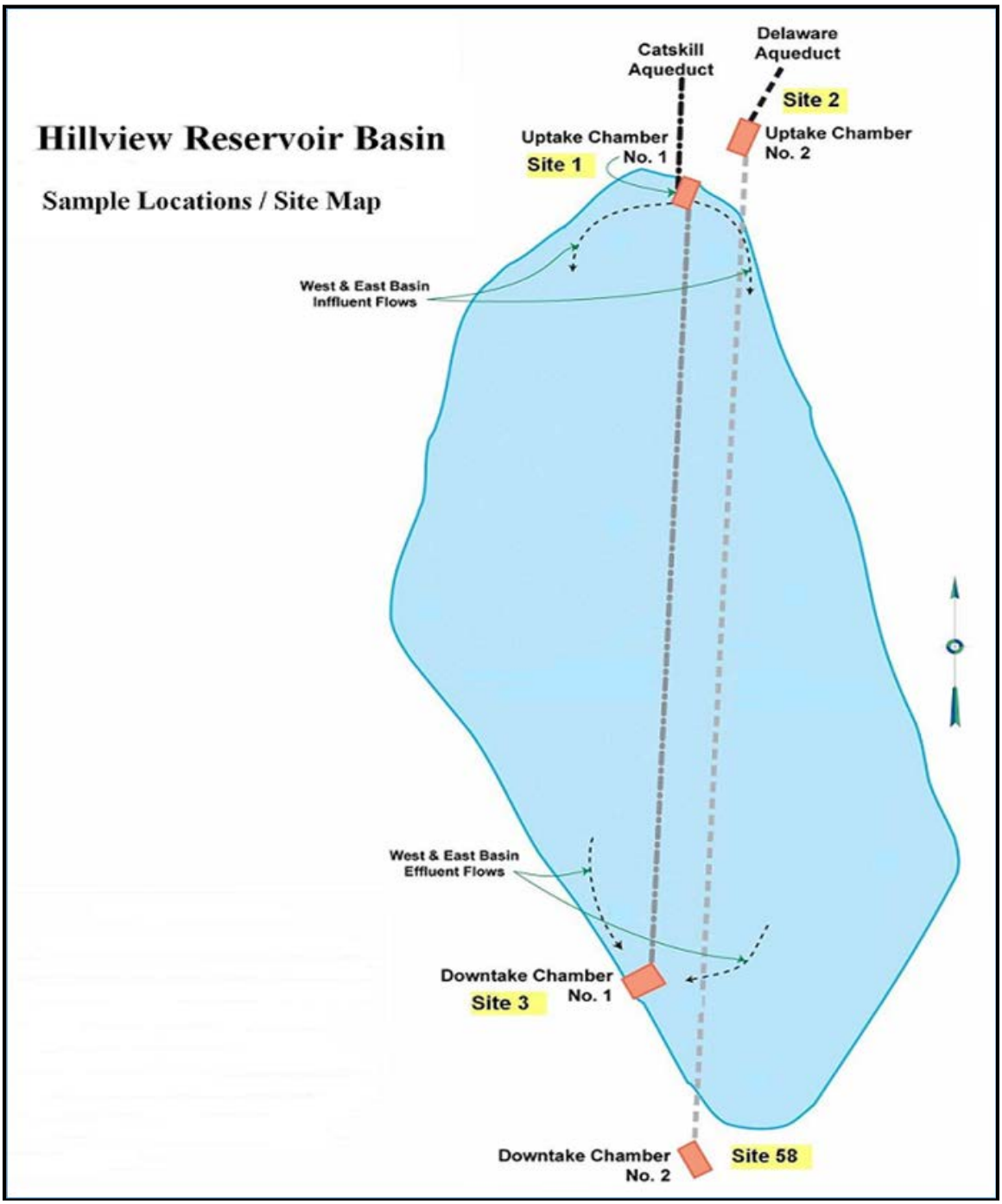

Figure 44. Map of Hillview Reservoir water sampling locations.