New York City Department of Environmental Protection
Bureau of Water Supply

Waterfowl Management Program

September 30, 2016

Prepared in accordance with Section 4.1 of the NYSDOH
Revised 2007 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 the study reported here, for the period August 1, 2015 to July 31, 2016, is to evaluate further the trends observed in bird numbers and their effect on fecal coliform bacteria levels as a consequence of DEP's Waterfowl Management Program.

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NYC Environmental Protection

TABLE OF CONTENTS

List of Figures	4-7
List of Tables	8
Acknowledgments	11
Introduction	13-14
Methods	15-22
Results and Discussion	23-63
Conclusions	65-66
References	69-72
Appendix A (reservoir maps with bird zones and water sampling locations)	75-85

LIST OF FIGURES

Page Number

Figure 1. Kensico Reservoir waterbird totals. 23

Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18/DEL18DT and CATLEFF). 24

Figure 3. DEP contractor staff conducting waterbird observations at Kensico Reservoir. 25

Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT/DEL18DTD vs. total waterbirds (8/1/2015 to 7/31/2016). 27

Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18/DEL18DT vs. total waterbirds (8/1/2014 to 7/31/2015). 27

Figure 6. Kensico Reservoir total annual waterbirds (8/1/2014 to 7/31/2015). 28

Figure 7. Kensico Reservoir total annual waterbirds (8/1/2015 to 7/31/2016). 28

Figure 8. Kensico Reservoir Bird Zone 2 waterbirds (8/1/2015 to 7/31/2016). 29

Figure 9. Kensico Reservoir Bird Zone 3 waterbirds (8/1/2015 to 7/31/2016). 29

Figure 10. Kensico Reservoir Bird Zone 4 waterbirds (8/1/2015 to 7/31/2016). 30

Figure 11. Biondo Airboat in operation for bird dispersal activities. 31

Figure 12. Kensico Reservoir total waterbirds by groups (8/1/2014 to 7/31/2015). 31

Figure 13. Kensico Reservoir total waterbirds by groups (8/1/2015 to 7/31/2016). 32

Figure 14. DEP conducting Canada goose egg depredation via puncturing method at Kensico Reservoir. 34

Figure 15. West Branch Reservoir total waterbirds (8/1/2014 to 4/15/2015). 36

Figure 16. West Branch Reservoir total waterbirds (8/1/2015 to 4/15/2016). 37

LIST OF FIGURES (continued) **Page Number**

Figure 17. West Branch Reservoir fecal coliforms 100mL^{-1} at CWB1.5 vs. total waterbirds (8/1/2011 to 7/31/2016). 38

Figure 18. Bird deterrent netting is maintained annually at the West Branch Effluent Shaft 10. 38

Figure 19. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys were discontinued on 4/30/2013. 39

Figure 20. Adult Bald Eagle in roost adjacent to Canada Goose nesting locations at Rondout Reservoir. 41

Figure 21. Ashokan Reservoir fecal coliforms 100mL^{-1} at Ashokan Effluent (EARCM) vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys were discontinued on 4/30/2013. 44

Figure 22. Bald Eagle nest at the Ashokan Reservoir West Basin. 45

Figure 23. Croton Falls Reservoir fecal coliforms 100mL^{-1} at Croton Falls Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys were discontinued on 4/30/2013. 46

Figure 24. Pair of Mute Swans nesting on NYC Reservoirs. 47

Figure 25. Cross River Reservoir fecal coliforms 100mL^{-1} at Cross River Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys were discontinued on 4/30/2013. 48

Figure 26. Canada Goose nest found on a reservoir island after eggs were punctured. 49

Figure 27. Hillview Reservoir use of remote control motorboats to disperse Ruddy Ducks. 51

Figure 28. Hillview Reservoir live capture of adult Ruddy Duck for relocation. 52

Figure 29. Hillview Reservoir total waterbirds nocturnal counts (8/1/2015 to 7/31/2016). 53

LIST OF FIGURES (continued) **Page Number**

Figure 30. Hillview Reservoir total waterbirds diurnal counts (8/1/2015 to 7/31/2016). 53

Figure 31. DEP conducts dissections of depredated Ruddy Ducks to determine diets of the diving birds. 55

Figure 32. Hillview Reservoir number of positive *E. coli* (grab sample) at water Sampling Site 1 (8/1/2015 to 7/31/2016). 56

Figure 33. Hillview Reservoir number of positive *E. coli* (grab sample) at water Sampling Site 3 versus total waterbirds (8/1/2015 to 7/31/2016). 56

Figure 34. Mammal species trapped at Hillview Reservoir (8/1/20145 to 7/31/2016). 61

Figure 35. Striped Skunk and Feral Cat captured on camera inside reservoir fence. 62

Figure 36. Occurrences of remote nighttime photography of animals recorded on the reservoir catwalk and dividing wall versus trapping success (8/1/2015 to 7/31/2016). 63

LIST OF FIGURES (continued) **Page Number**

Appendix A. 75

Figure 37. Map of New York City Water Supply – East of Hudson. 76

Figure 38. Map of New York City Water Supply – West of Hudson. 77

Figure 39. Map of Kensico Reservoir bird zones. 78

Figure 40. Map of West Branch Reservoir bird zones. 79

Figure 41. Map of Rondout Reservoir bird zones. 80

Figure 42. Map of Ashokan Reservoir bird zones. 81

Figure 43. Map of Croton Falls Reservoir bird zones. 82

Figure 44. Map of Cross River Reservoir bird zones. 83

Figure 45. Map of Hillview Reservoir bird zones. 84

Figure 46. Map of Hillview Reservoir water sampling locations. 85

List of Tables **Page Number**

Table 1. Revised 2007 FAD Activity and Reporting Requirements (NYSDOH 2014) 16

Table 2. Frequency of bird observation surveys by reservoir 2015/2016 17

Table 3. Reservoir bird mitigation (8/1/2015 – 7/31/2016) 20

Table 4. 2016 Canada Geese, Mute Swan, and Mallard nest census and egg-depredation 22

Table 5. Highest fecal coliforms $100mL^{-1}$ results, precipitation events, and bird counts at Kensico Reservoir keypoint water sampling locations (DEL18DT/DEL18DTD) 26

Table 6. West Branch Reservoir - daytime bird observations at Delaware Effluent (Shaft 10) 35

Table 7. Rondout Reservoir - daytime bird observations at Rondout Effluent 40

Table 8. Ashokan Reservoir - daytime bird observations at Ashokan East Effluent 42

Table 9. Ashokan Reservoir - daytime bird observations at Ashokan West Effluent 43

Table 10. Mammal trapping summary 8/1/2015 through 7/31/2016 59

Table 11. Trapping success summary for Hillview Reservoir (August 2011 to July 2016) 60

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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). It was 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 program to include bird management at Hillview Reservoir in Yonkers, New York. A Revised 2007 FAD was issued in May 2014 (NYSDOH 2014).

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 depredation permit and federal registration from the United States Fish & Wildlife Service (USFWS) and a depredation license from NYSDEC to implement 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 - 2015). 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 a total of 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 during the winter of 2001/2002. To assure 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 for the five additional "as-needed" reservoirs. A 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 Revised 2007 FAD.

The purpose of this report is to evaluate further the down-trend observed in waterbird populations and its impact on fecal coliform bacteria concentrations as a consequence of DEP's Waterfowl Management Program for the period August 1, 2015 through July 31, 2016.

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 contained in the Reservoir. DEP determined that the water leaving Kensico reported 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 with increased numbers of roosting birds and elevated fecal coliform bacteria levels. By December 1993, DEP started 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 with its source water (Figures 37 and 38). The remaining two reservoirs (Cross River and Croton Falls), while in the Croton System (Figure 37), 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 three activities: avian population monitoring, avian dispersal activities (motorboats, airboats, propane cannons, physical chasing, remote control motorboats, and pyrotechnics) and avian deterrence (depredation of nests and eggs, bird exclusion wires, and netting at critical intake chambers). All avian dispersal techniques and deterrence activities have been recommended and approved by 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 Revised 2007 FAD requirements for the Waterfowl Management Program are outlined in Table 1, below.

Table 1. Revised 2007 FAD Activity and Reporting Requirements (NYSDOH 2014)

Requirements	**Due Date**
Active bird harassment – Kensico Reservoir	Annually, 8/1 to 3/31
Active bird harassment – Hillview Reservoir	Year-around
"As-needed" bird harassment – 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 for all reservoirs, including contract status.	Annually, 9/30

Waterfowl Management Program Contract Status

The current Waterfowl Management Program Contract (WMP-16) is a three-year contract for services that are provided by Henningson, Durham, and Richardson, P.C. (HDR) of Mahwah, New Jersey for the term of August 1, 2015 through July 30, 2018 with an option to renew for an additional two years through July 31, 2020.

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 it has been well documented that the primary bacterial contribution to the water supply is from migratory waterbirds that roost overnight and defecate in the reservoirs, night census data is presented throughout this report. Defecation rates of waterbirds are typically lower nocturnally than diurnally due to reduced foraging and physical activity, however 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 (where applicable) at all reservoirs. Survey times vary seasonally reflecting available daylight hours. For successful bird observation 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 Revised 2007 FAD, Section 4.1 specifies the frequency of reservoir surveys and is listed in Table 2. 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 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. Proposed and actual DEP and contractor waterbird surveys conducted from August 1, 2015 to July 31, 2016 are also listed in Table 2.

Table 2. Frequency of bird observation surveys by reservoir 2015/2016

Reservoir	Bird Surveys Scheduled	Proposed/Actual Surveys
Kensico	Pre-dawn to post-dusk daily August 1 to March 31; Pre-dawn and post-dusk weekly April 1 to July 31	261/256[1,2]
West Branch	Pre-dawn, midday, and post-dusk, biweekly; August 1 to April 15 annually	17/17
Hillview	Pre-dawn, midday, and post-dusk daily all year	366/366

[1] Three surveys were cancelled due to holiday observances.
[2] Two surveys were cancelled due to severe winter storms on 1/23/16 and 1/24/16.

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 will only be conducted on an "as needed" basis annually at Rondout, Ashokan, Croton Falls, Cross River and West Branch. DEP's program-reduction request was approved by NYSDOH on March 13, 2013, and West Branch surveys were changed from weekly to biweekly from August 1 through April 15 annually and on an "as-needed" basis for the remainder of the year. Surveys were modified to "as-needed" for Rondout, Ashokan, Croton Falls, and Cross River Reservoirs.

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 were 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. DEP amended the collection of field data progressing from data sheets to field ToughPads to record observation locations with times for each reservoir. Data were entered in an Excel spreadsheet and were checked twice for Quality Assurance/Quality Control.

Each survey data point can consist of a minimum of one or two site visits per datum reported (i.e. night before and morning after the nightly roost), and may be dependent on the field conditions (i.e. weather, fog), reservoir physical characteristics (i.e. drought, ice cover), and time of year (leaf-cover or not). Data collected during reservoir-wide surveys that were incomplete due to inclement weather were not reported. Only high counts for each category of waterbirds were used for data recording. For example, if there were a count of 20 Canada Geese at a bird observation location and zero for the rest of the reservoir for the night before count and a count of 20 ducks at another location on the morning after survey, a 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 ascertaining species highest concentrations over a specific time period. Some species at certain times of the year are easier to count in the evening when birds are flying into roost areas (or open water) whereas other species are more efficiently counted when flying out of the reservoir in the early morning.

Waterbird population zones were delineated at all reservoirs to identify local impacts on water quality and 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 outflow 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 reported:

- 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 used for charting)
- All water samples reported below the detection limit of 1 fecal coliform $100mL^{-1}$ were censored
- All special investigation samples are reported
- Reanalysis samples are reported
- There were no samples with confluent growth reported

Water quality data presented in this report were collected by DEP's Watershed Water Quality Operations and Distribution Water Quality Operations personnel, and analyzed and reported by four New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified laboratories in Valhalla, Kingston, Grahamsville, and Queens, New York. DEP watershed laboratory personnel utilized the Membrane Filtration Technique 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 at keypoint (outflow).

Precipitation Data

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

Waterbird Dispersal and Deterrent Techniques

The list of bird dispersal activities conducted since 2002 is presented in Table 3. Waterbird dispersal techniques were employed at Kensico Reservoir from August 1, 2015 through March 31, 2016 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 such as N.Y.S. threatened Pied-billed Grebe (*Podilymbus podiceps*), Bald Eagle (*Haliaeetus leucocephalus*), and N.Y.S endangered Peregrine Falcon (*Falco peregrinus*).

Airboats, capable of operating over ice and water interfaces with ease, were available for

bird dispersal in 2015/2016 at Kensico. The airboats have heated cabins that allow contractor personnel longer time periods of 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. Details of the contract work will be discussed in the Hillview Reservoir section of this report.

Table 3. Reservoir bird mitigation (8/1/2015 – 7/31/2016)

Reservoir	Dates of Bird Dispersal and Deterrence	Bird Dispersal and Deterrence Measures Used
Kensico	August 1, 2015 – March 31, 2016	• Bird dispersal (motorboats, airboats, Jon boats, and pyrotechnics) • Shoreline meadow management and fencing • Alewife containment and collections • Egg and nest depredation for geese and swans, and • Maintenance of bird netting for terrestrial bird management for swallows, starlings, pigeons, sparrows, and other small birds • Sanitary surveys for pre-storm events
Hillview	August 1, 2015 - July 31, 2016	• 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, and • Lethal duck management • Egg and nest depredation for Mallards and swallows

All bird deterrent techniques such as bird netting on reservoir shaft buildings continue to be 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 include 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. The other five reservoirs included in this report are covered under the "as-needed" section for the expanded reservoirs.

In response to entrainment of Alewives (*Alosa pseudoharengus*) and other fish species into the water intake structures at Ashokan Reservoir and their subsequent outflow at Kensico Reservoir, DEP's Waterfowl Management contractor annually install a temporary collection boom as deemed necessary around the Catskill Influent Chamber structure (CATIC) so that dead fish can be removed. Collection of Alewives is also conducted as needed from the Hillview Reservoir dividing wall using landing nets to retrieve all dead floating fish. Alewives and other bait-sized fish are an attractive food source for avian piscivorous species such as gulls and some species of ducks such as the Common Merganser (*Mergus merganser*). Therefore, when large numbers of fish are flushing into the reservoir, removal of the fish helps to eliminate the attractiveness to the birds.

Waterbird Reproductive Management

Canada Geese and Mute Swan (*Cygnus olor*) egg and nest depredation techniques were conducted during the spring of 2016 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. Egg and nest depredation involved locating all Canada Geese and Mute Swan nests within NYC reservoir property, numbering each nest and egg, and puncturing each egg with a probe to break the membrane thereby destroying the embryo. Eggs were then replaced in the nest to allow incubation to continue, but unsuccessfully 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 few weeks.

A total of 49 Canada Geese nests containing 230 eggs were depredated (punctured) at six New York City Reservoirs (Table 4) during the spring of 2016 compared to 39 Canada Geese nests containing 178 eggs in 2015. There was no goose or swan breeding activity recorded at Hillview; however, four Mallard nests containing 15 eggs were depredated by DEP in 2016 compared to two Mallard nests containing 10 eggs in 2015. All Canada Geese 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 #3-16-75) was acquired for Mute Swans egg and nest depredation and a USFWS Permit (MB789947-0) covered Mallard and swallow depredation work at Hillview. DEP conducted 303 surveys for nesting Mallards in 2016 compared to 306 in 2015. DEP did not conduct Canada Geese or Double-crested Cormorant banding in 2016.

Table 4. 2016 Canada Geese, Mute Swan, and Mallard[2] nest census and egg-depredation

Reservoir	Number of Surveys	Canada Geese/Mute Swan/[2]Mallard Nests	Canada Geese/Mute Swan/[2]Mallard Eggs Depredated	Canada Geese/Mute Swan/Mallard Depredation Success Rate
Kensico	9	15/1/NA	75/8/NA	99 percent (1 goslings)/100 percent (0 cygnets)/NA
West Branch	8	5/0/NA	24/0/NA	100 percent (0 goslings)/NA/NA
Rondout[1]	4	5/0/NA	24/0/NA	100 percent (0 goslings)/NA/NA
Ashokan	4	7/0/NA	21/0/NA	78 percent (6 goslings)/NA/NA
Croton Falls	8	9/1/NA	46/8/NA	100 percent (0 goslings)/89 percent (1 cygnet)/NA
Cross River	8	8/0/NA	22/0/NA	96 percent (1 goslings)/NA/NA
Hillview	303	0/0/4	0/0/15	NA/NA/21 percent (55 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, receives water from Rondout and West Branch Reservoirs via the Delaware Aqueduct and from the Ashokan Reservoir via the Catskill Aqueduct (Appendix A, Figures 37 and 38). Water leaving Kensico is disinfected with chlorine and ultraviolet light prior to being delivered via aqueduct to Hillview Reservoir. Kensico Reservoir has been divided into eight Bird Zones to compare bird counts with water quality in samples collected at limnological sampling locations (Appendix A, Figure 39). 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 39). These open water areas tend to attract concentrations of gulls and other waterbirds roosting overnight.

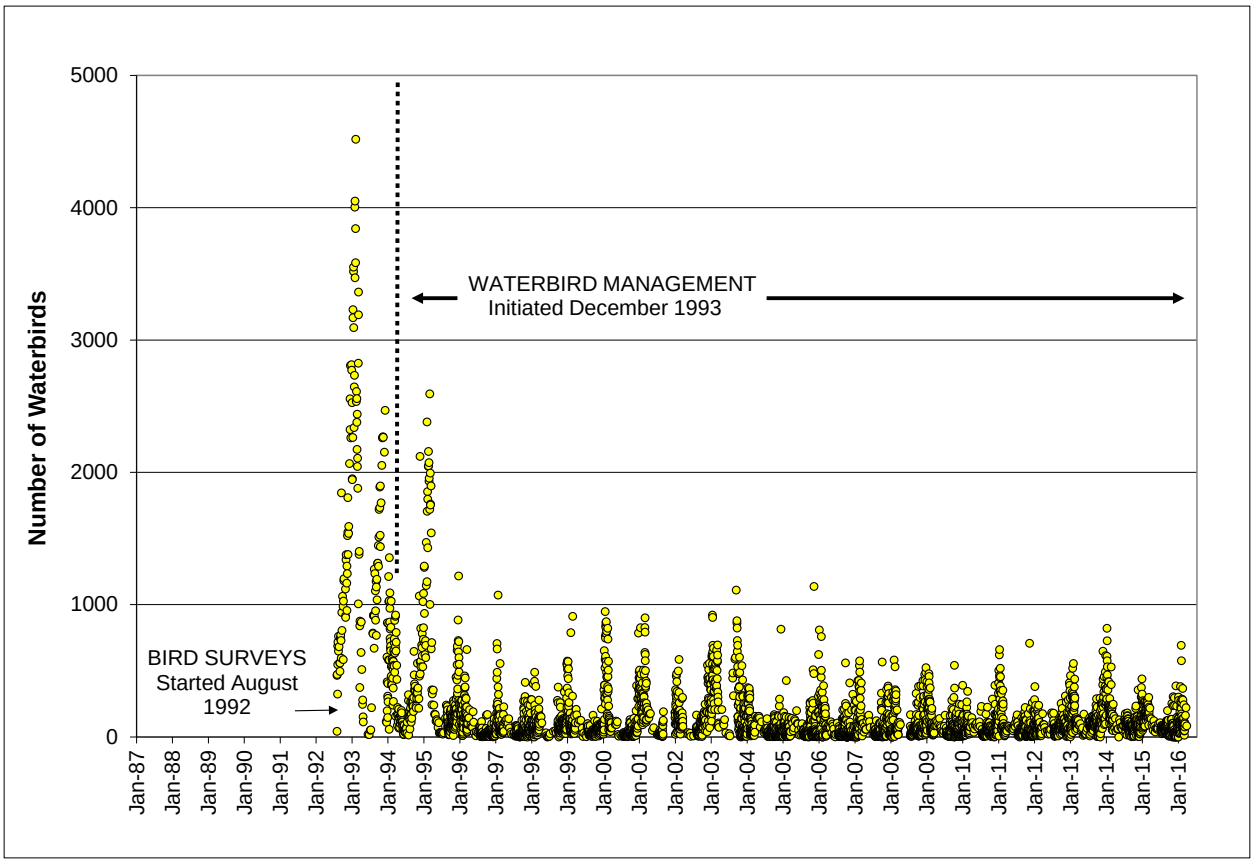

Figure 1. Kensico Reservoir waterbird totals.

Prior to implementing an approved bird dispersal program, DEP began collecting bird census data in August 1992. Overnight waterbird counts reached several thousand during the migratory/wintering period (Figure 1) with high bird roosting counts recorded at the water intake coves at Kensico. Figure 1 shows a dramatic decline in waterbird counts from several thousand in 1992 and 1993 to hundreds or less during the same migratory period in subsequent years when bird 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.

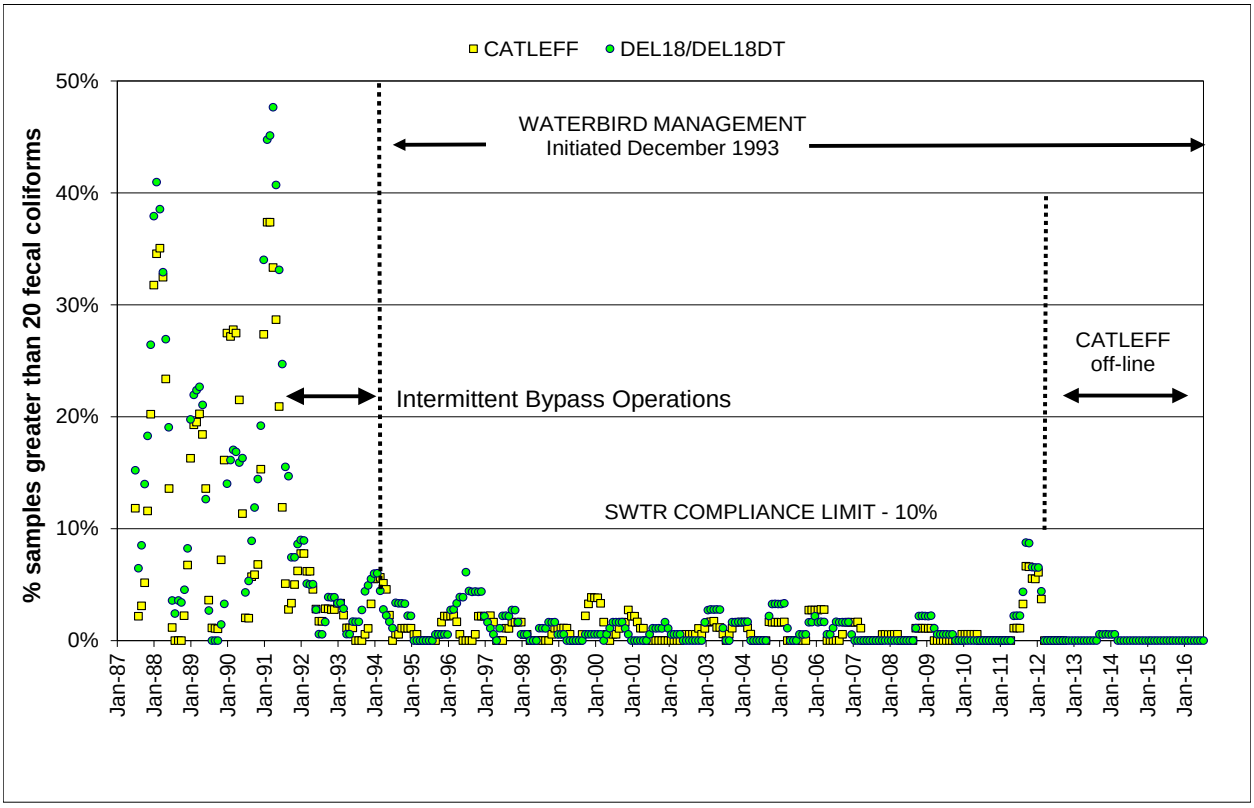

Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18/DEL18DT/DEL18DTD and CATLEFF).

Continuous waterbird monitoring and dispersal actions using motorboats (Figure 3) combined with discharging pyrotechnics has been the primary method in reducing waterbird numbers at Kensico.

The WMP continued to maintain a high level of success reducing waterbird numbers resulting in low fecal coliform bacteria levels from August 1, 2015 through July 31, 2016 managing waterbirds at Kensico Reservoir.

Figure 3. DEP contractor staff conducting waterbird observations at Kensico Reservoir. Photo by HDR, P.C.

Figures 4 and 5 compare the regulatory source water samples collected from Delaware Shaft 18 (DEL18DT and DEL18DTD) with respect to fecal coliform bacteria and reservoir bird counts for the 2015/2016 and 2014/2015 seasons. Of 366 samples collected over the period from August 1, 2015 to July 31, 2016, 229/366 or 63 percent were censored (below the detection limit of 1 fecal coliform $100mL^{-1}$). In 2015, 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 2014 (DEP 2014). From August 1, 2015 through July 31, 2016 the percentage of source water sample results at DEL18DT/DEL18DTD above 20 fecal coliforms $100mL^{-1}$ over the previous six months remained at zero percent similar to the previous reporting period. During the current reporting period there was no double-digit fecal coliform counts compared to only one in 2014/2015. Table 5 lists the four highest fecal coliform counts recorded in 2015/2016. Three of the four events were likely associated with precipitation events of more than one inch recorded in the previous three days (Table 5) and when bird counts remained relatively low in the bird zones closest to the water intake. There were no waterbirds observed in Bird Zone 2 cove, closest to the DEL18DT sampling site on each of the four dates when nine and

four fecal coliforms 100 mL^{-1} were recorded. For comparison purposes, there was no samples collected from DEL18DT that exceeded 20 fecal coliform 100mL^{-1} in the 2014/2015 reporting period (Figure 5).

Table 5. Highest fecal coliform 100mL^{-1} results, precipitation events, and bird counts at Kensico Reservoir keypoint water sampling location (DEL18DT/DEL18DTD)

Date	**DEL18DT fecal coliform 100mL^{-1}** (Bold indicates more than 20 fecal coliform 100mL^{-1})	**Precipitation within 3 days of elevated fecal coliform >=9 fecal coliform 100 mL^{-1} (inches rounded to the nearest 100th)[1]**	**Bird Counts on or before sample date**	
			Reservoir-wide totals	**Bird Zones 2, 3, and 4 totals (closest to the DEL18DT Effluent)**
10/1/15	9	2.45	60 on 7/2/14	48 on 7/2/14
10/30/15	4	3.18	86 on 7/9/14	72 on 7/9/14
12/18/15	4	2.60	355 on 12/10/14	32 on 12/10/14
2/19/16	4	0.65	66 on 6/10/15	15 on 6/10/15

[1] Precipitation data reported from Westchester County Airport, White Plains, New York

In 2015/2016, the DEP contractor attained 90% reportable data in completing waterbird surveys. Approximately 10% of the surveys were deemed “no reportable data” due to inadequate bird observations from unsuitable environmental conditions. Reservoir-wide waterbird counts were considerably lower from August 1, 2015 to July 31, 2016 when compared to counts conducted during the same time period in 2014/2015. In 2015/2016 (August 1, 2015 to March 31, 2016) overnight waterbird counts averaged about 88 birds per survey night and spiked at 700 (2 geese, 435 gulls, and 263 ducks) on February 22, 2016 compared to an average of 112 birds/night in 2014/2015 (Figures 6 and 7).

In Bird Zone 2, closest to Delaware Shaft 18 (DEL18DT/DEL18DTD), waterbirds were observed 18 times in 2015/2016 of which 13 of those observations occurred during the bird dispersal period from February 15, 2016 to March 30, 2016. Flocks of ducks were suspected of arriving overnight past the normal hours of operation for bird dispersal activities (Figure 8). Ducks were the only bird guild observed in bird zone 2 during the dispersal period and ranged from a count of one to 12 ducks/night. All birds in the water intake cove (Bird Zone 2) observed during the pre-dawn period were immediately dispersed using motorboats. A high count of 12 waterbirds was observed in Bird Zone 2 on February 16, 2016 but was not associated with a fecal coliform bacteria elevation. Waterbird surveys in Bird Zone 3, adjacent to the Bird Zone 2 cove revealed 15 occasions when birds were present out of 261 survey days (Figure 9). A high count of 71 Canada Geese was recorded on March 9, 2016 (Figure 9). Bird counts spiked at 254 waterbirds recorded on December 31, 2015 in Bird Zone 4 of which 250 were gulls (Figure 10).

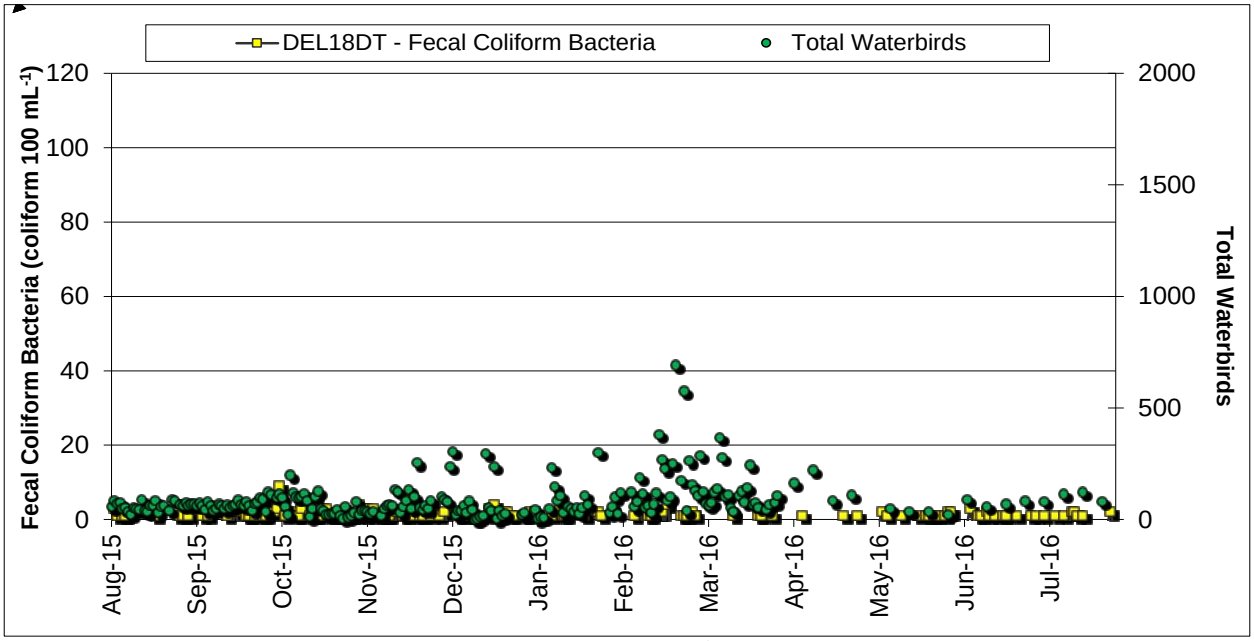

Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT/DEL18DTD vs. total waterbirds (8/1/2015 to 7/31/2016).

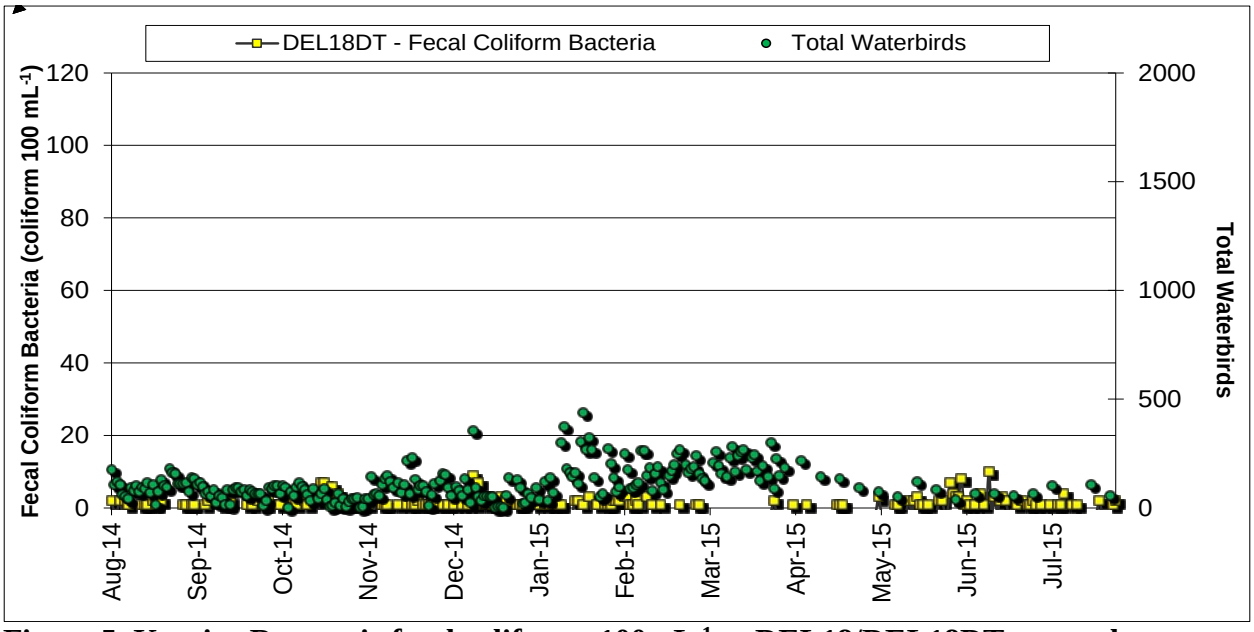

Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18/DEL18DT vs. total waterbirds (8/1/2014 to 7/31/2015).

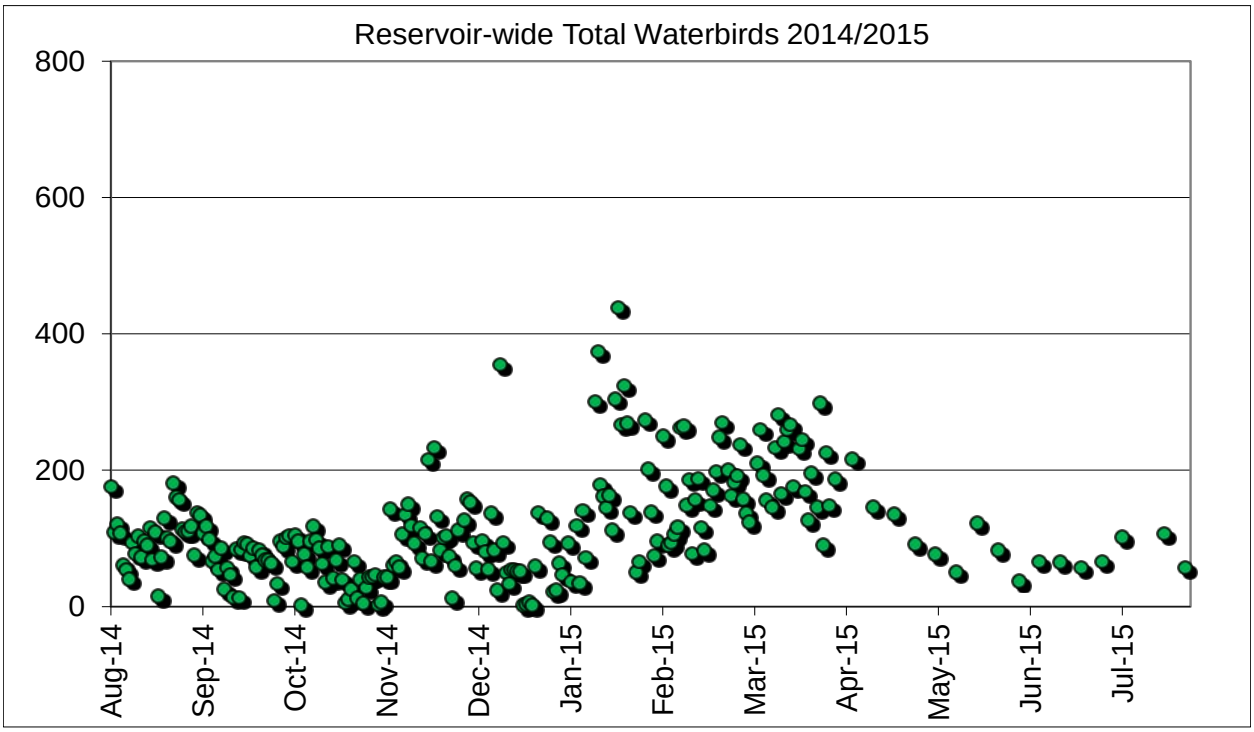

Figure 6. Kensico Reservoir total annual waterbirds (8/1/2014 to 7/31/2015).

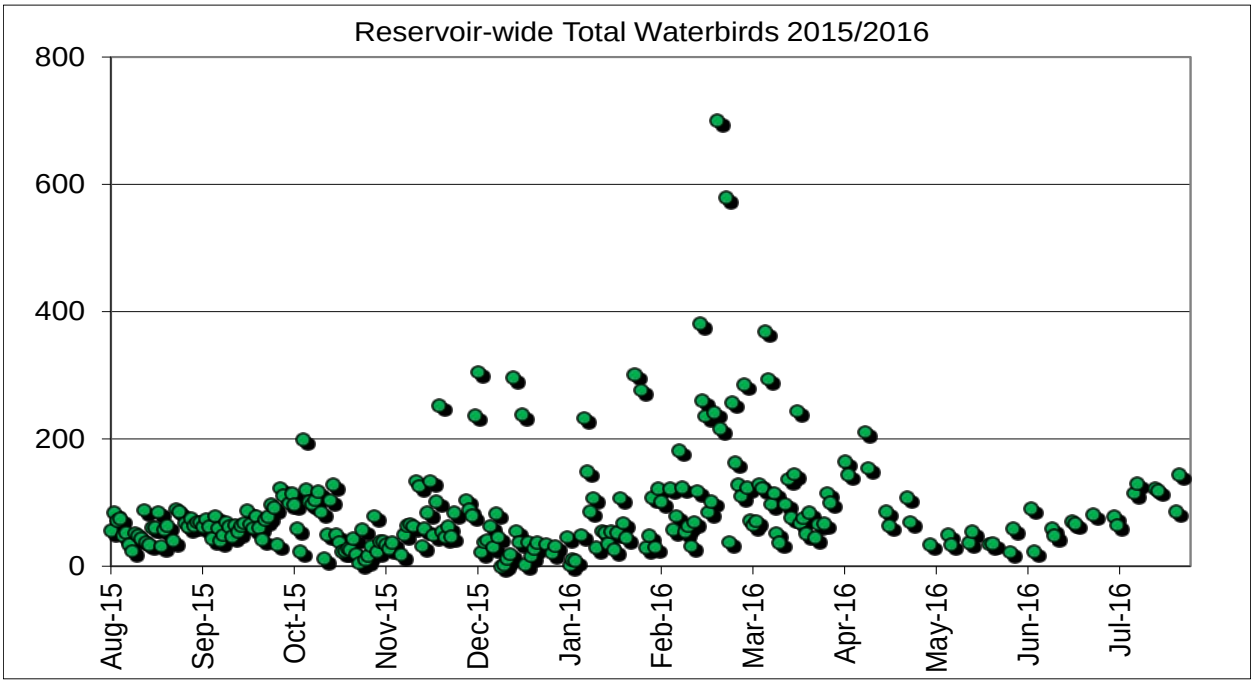

Figure 7. Kensico Reservoir total annual waterbirds (8/1/2015 to 7/31/2016).

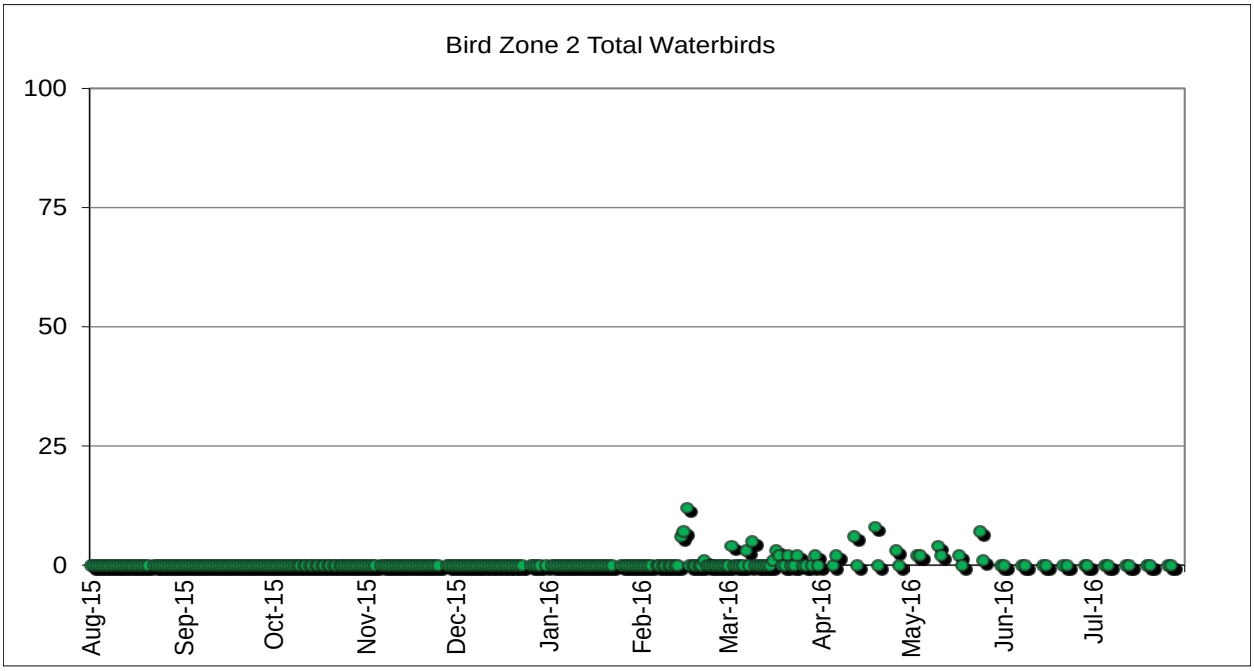

Figure 8. Kensico Reservoir Bird Zone 2 waterbirds (8/1/2015 to 7/31/2016).

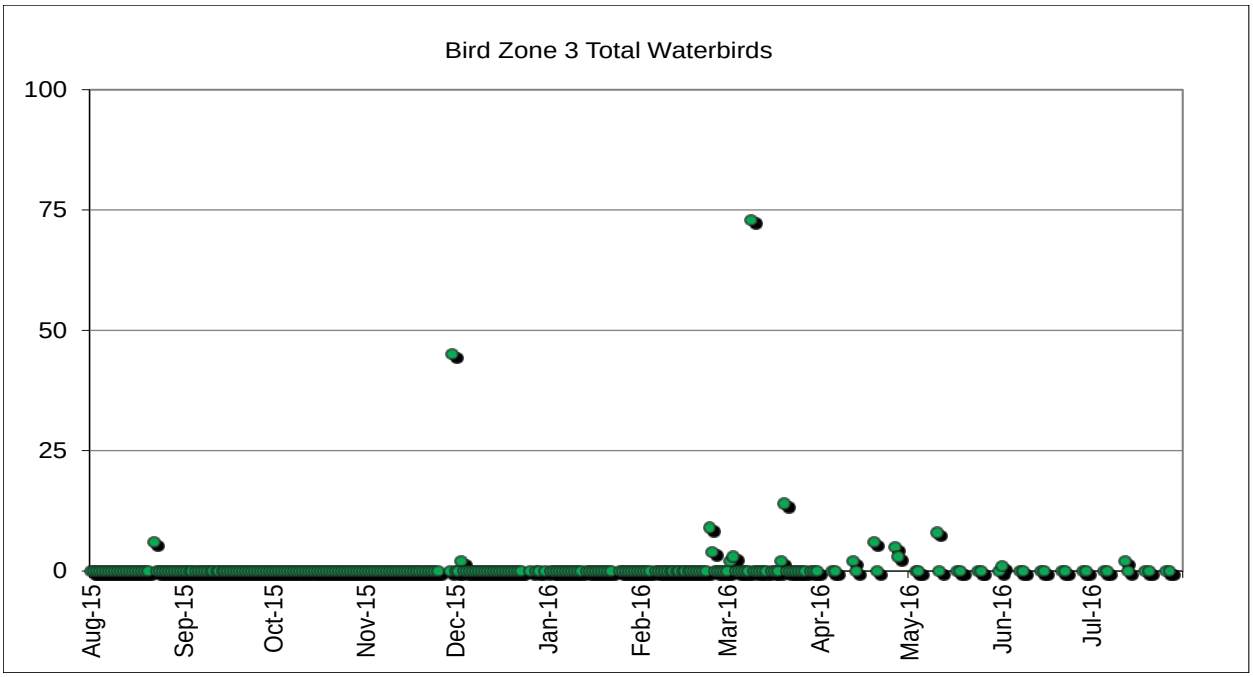

Figure 9. Kensico Reservoir Bird Zone 3 waterbirds (8/1/2015 to 7/31/2016).

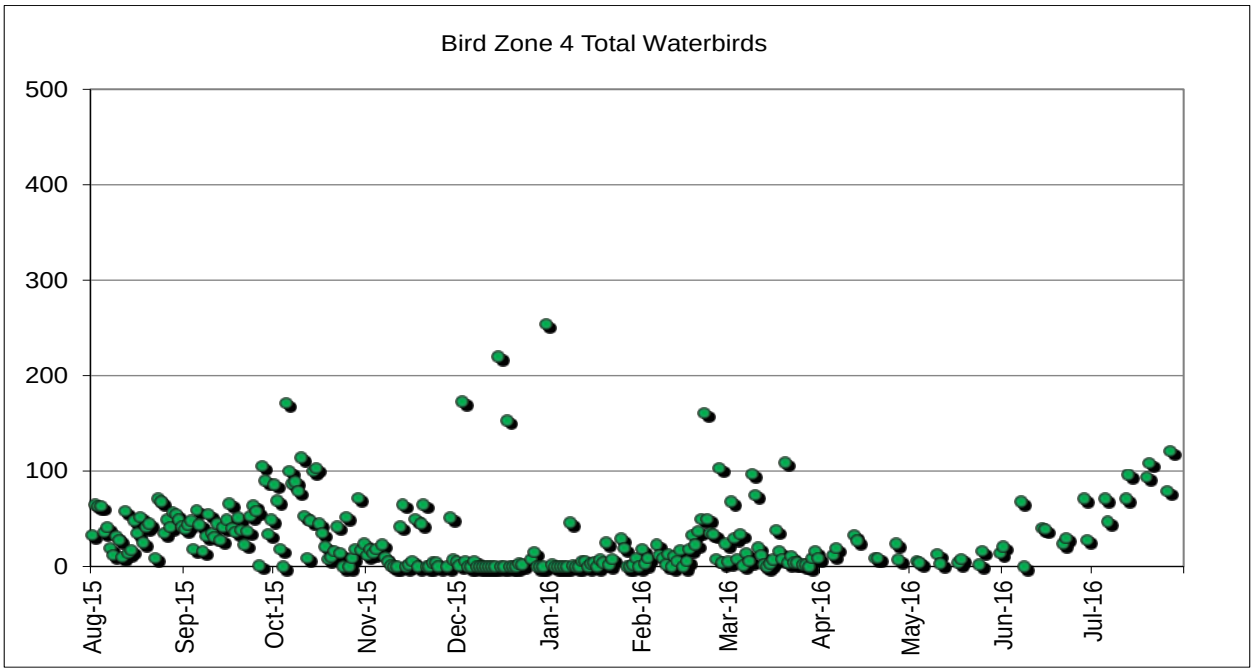

Figure 10. Kensico Reservoir Bird Zone 4 waterbirds (8/1/2015 to 7/31/2016).

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 are generally determined by extent of ice-cover. During 2015/2016 the breakdown of waterbird groups was as follows: Canada Geese 8 percent, Gulls 38 percent, and other waterbirds (ducks, grebes, loons, swans and cormorants) 54 percent. Gull counts started rising at the end of July 2015 and peaked in February 2016 and started declining in March 2016 largely due to the lack of ice cover at Kensico. There was limited use of the two Biondo Airboats for bird dispersal activities due to a low degree of ice-cover reported during this period (Figure 11).

During the bird dispersal period from August 1 to March 31, ducks were the most commonly observed bird group averaging 46 bird per night or 53 percent of the total counts. Gulls were the second most common group averaging 35 birds per night or 40 percent and Geese averaged seven birds per night or seven percent. Gulls peaked at 435 on February 24, 2016 and increased slightly averaging 35 per night compared to 30 per night in 2014/2015. Overnight duck counts decreased from a daily average of 62 per overnight count in 2014/2015 (August 1 to March 31) to 46 per overnight count in 2015/2016 and Canada Geese numbers decreased from a daily overnight count of 21 in 2014/2015 compared to seven in 2015/2016 (Figures 12 and 13).

During the non-dispersal period from April 1 to July 31, 2016, geese averaged eight birds per night, gulls were 14 birds per night and ducks accounted for 74 birds per night representing 54% of the bird activity reported at Kensico.

Figure 11. Biondo Airboat for bird dispersal activities. Photo by HDR, P.C.

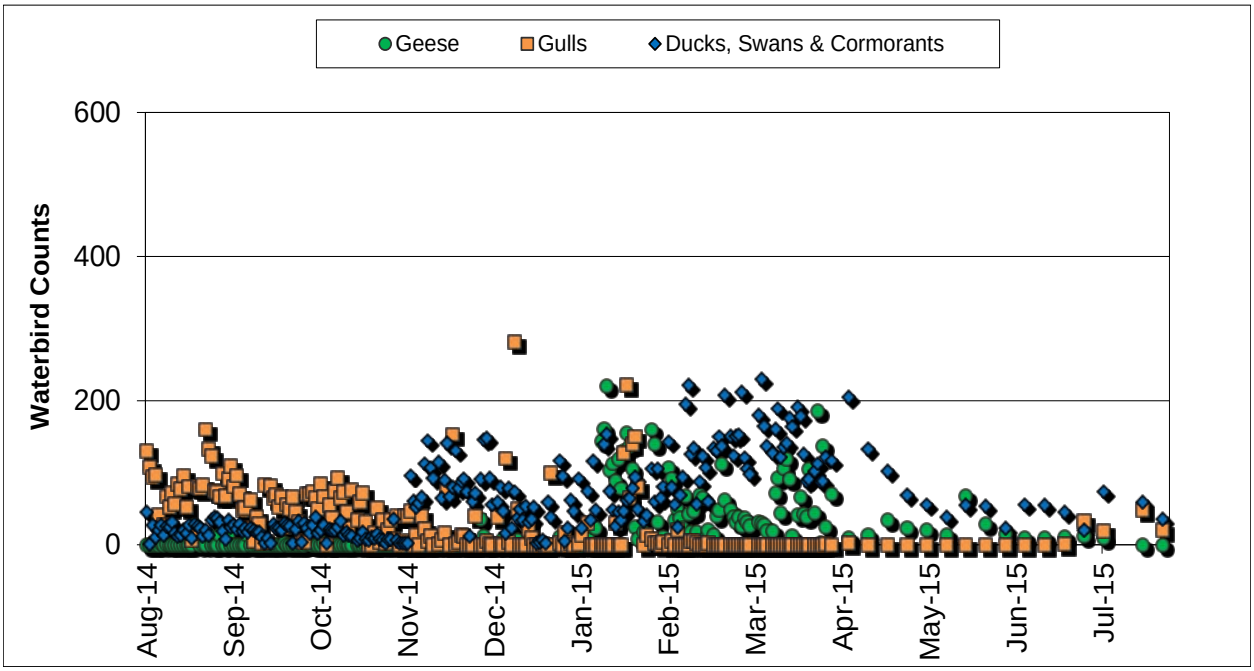

Figure 12. Kensico Reservoir total waterbirds by groups (8/1/2014 to 7/31/2015).

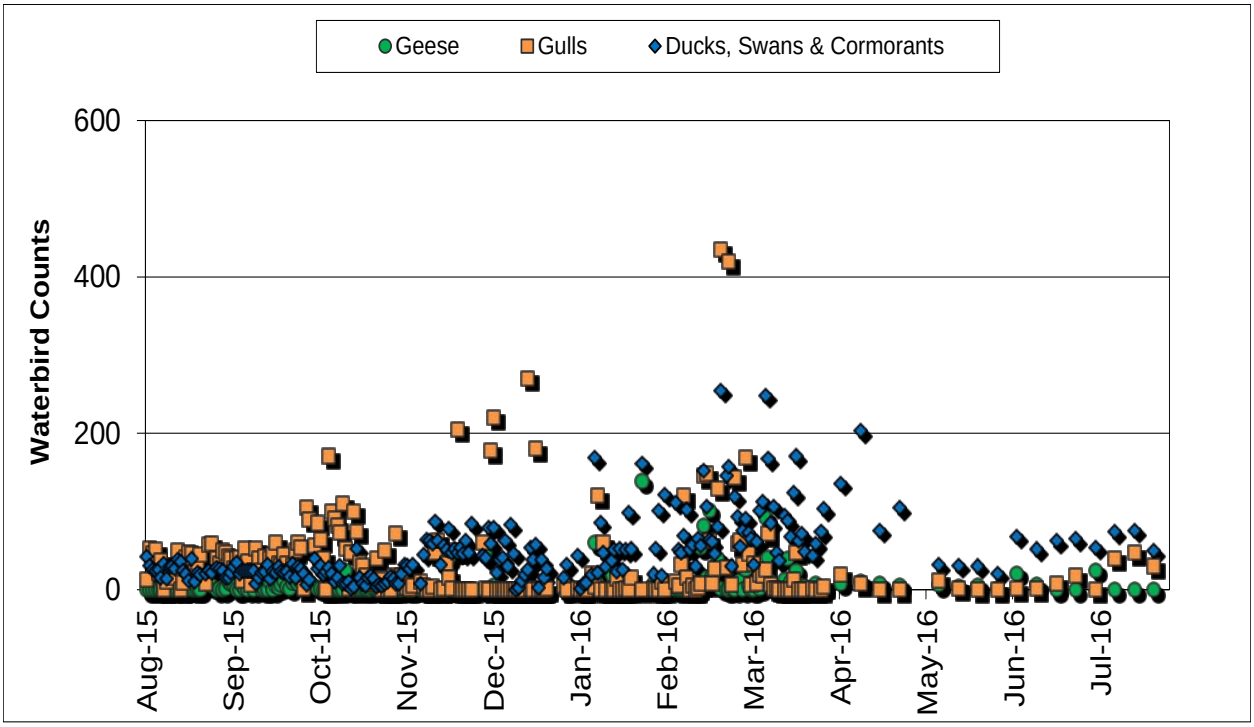

Figure 13. Kensico Reservoir total waterbirds by groups (8/1/2015 to 7/31/2016).

The Westchester County Airport, located immediately east of the Rye Lake area (Bird Zone 6 in Figure 39) continued to manage birds for air-traffic safety. As part of the airport's Wildlife Hazard Management Plan (Airport Depredation Orders – Resident Canada Goose nest and egg depredation order, 50 CFR 12.50 and Control order for resident Canada Geese at airports and military airfields 50 CFR 12.49), Westchester County has contracted with USDA to depredate geese at select off-airport properties within a seven-mile radius around the airport property which includes all of the Kensico Reservoir. During this reporting period, DEP allowed USDA officials under contract with the Westchester County Airport access to NYC-owned property at Kensico Reservoir to determine if there were geese present during the annual goose molt period in the spring of 2016. Results of the USDA survey indicated that six geese were present on the Kensico Reservoir property, however USDA did not remove any Canada Geese as the birds remained flighted and did not complete their post-nuptial molt on City property to allow removal to occur.

DEP's bird management activities have to 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 (Figure 39). Bird dispersal crews are instructed to abstain from discharging pyrotechnics with approaching aircraft to avoid potential airstrikes with birds and pilot confusion with the use of aerial low-grade explosives. DEP maintains routine

communication with airport officials and participates as a technical advisor to the airport's Wildlife Hazard Bird Strike Task Force on any changes in bird management activities conducted at the reservoir.

It is suspected that the increased spatial separation between birds and the water intake at Delaware Shaft 18 at Kensico is an important factor that helps reduce the threat of increases in fecal coliform bacteria. As a result, bird dispersal activities were heavily concentrated in the vicinity Delaware of Shaft 18 and the lower main basin of Kensico (Bird Zones 2, 3, and 4, Figure 39). Overall, waterbird numbers continue to be sufficiently managed at Kensico to maintain compliance with the federal Surface Water Treatment Rule for fecal coliform bacteria levels.

Alewives and other baitfish transported through upstate aqueducts to Kensico were present during the autumn/winter period of 2015/2016. 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. The volume of fish observed, collected, and disposed of from Kensico Catskill Influent Chamber (CATIC) in 2015/2016 was 104 pounds compared to 36.8 pounds collected in 2014/2015 and 41 pounds collected in 2013/2014. The relatively low volume of fish observed in 2015/2016 reduced the amount of bird dispersal efforts necessary in the vicinity of the CATIC.

In the spring of 2016 a total of 15 Canada Geese nests were found along the reservoir shoreline and on islands compared to 16 in 2015 (Table 4). Among the nests, 75 eggs were depredated (punctured, Figure 14) and replaced back to the nest to allow the nesting geese to continue to incubate compared to 76 eggs in 2015. The average number of eggs per nest in 2016 was 5.07 compared to 4.75 in the previous year. One gosling was observed in 2016 compared to no goslings reported in the previous year rendering the egg depredation success at 99 percent in 2016. Adult breeding geese or failed breeders generally disperse from the reservoir prior to the post-breeding season molt which begins in June (annually) however if goslings are hatched some of the adults tend to remain at the reservoir during the molt (flightless period) which can last three to four weeks. 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 eight eggs was observed at Kensico in 2016 compared to eight eggs in 2015 with a 100% depredation success in both years (Table 4).

The ongoing implementation of the WMP has been critical in allowing DEP to maintain compliance with the SWTR standard for fecal coliform bacteria throughout 2015/2016 and dating back to 1993.

Figure 14. DEP conducting Canada Goose egg depredation via the puncturing method at Kensico Reservoir.

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 associated with reservoir water quality sampling locations (Figure 40).

Waterbird population surveys were conducted from August 1, 2015 through April 15, 2016 on a biweekly frequency for this reporting period (Table 2). Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits for water quality sampling. Fifty-five additional bird observations were conducted during this reporting period. The dates, times and counts for birds observed at the West Branch Effluent (Shaft 10) are listed in Table 6 unless counts were zero or no data were collected due to environmental conditions or field errors. Forty out of 55 observations were reported as "0" or no birds present and one of 55 observations there was no data collected.

Table 6. West Branch Reservoir-daytime bird observations at Delaware Effluent (Shaft 10)

Date	Time of Observation	Bird Count Range
August 6, 2015	0901	1 - 50
August 13, 2015	0919	1 - 50
October 8, 2015	0954	1 - 50
December 30, 2015	0955	1 - 50
March 23, 2016	0930	1 - 50
March 30, 2016	1009	1 - 50
April 6, 2016	0944	1 - 50
April 27, 2016	1014	1 - 50
May 18, 2016	0935	1 - 50
June 15, 2016	1053	1 – 50
June 22, 2016	0939	Observed 5 birds
July 6, 2016	0940	1 - 50
July 27, 2016	1050	1-50

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 is 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, 2015 through April 15, 2016 to record annual trends that aids in identifying sources of elevated fecal coliform bacteria levels. In 2015/2016 during the overnight surveys, gulls were recorded on six of 17 surveys with a high count of '288' on November 20, 2015 compared to only four of 18 surveys in 2014/2015 with a high count of only '11'.

Reservoir-wide total birds reached a high seasonal count of 1,440 on December 18, 2015 compared to 3,132 on December 5, 2014 in the previous report (Figures 15 and 16). Duck counts, mostly Common Mergansers, generally increase annually from mid-March to late April that encompasses the northward springtime migration and again from late-September through the end of December or up to reservoir ice-cover, which includes the southward migrational movements. Minimal periods of ice-cover were reported during the winter of 2015/2016 that might help explain the consistent elevated numbers of ducks from January through March unlike the previous year.

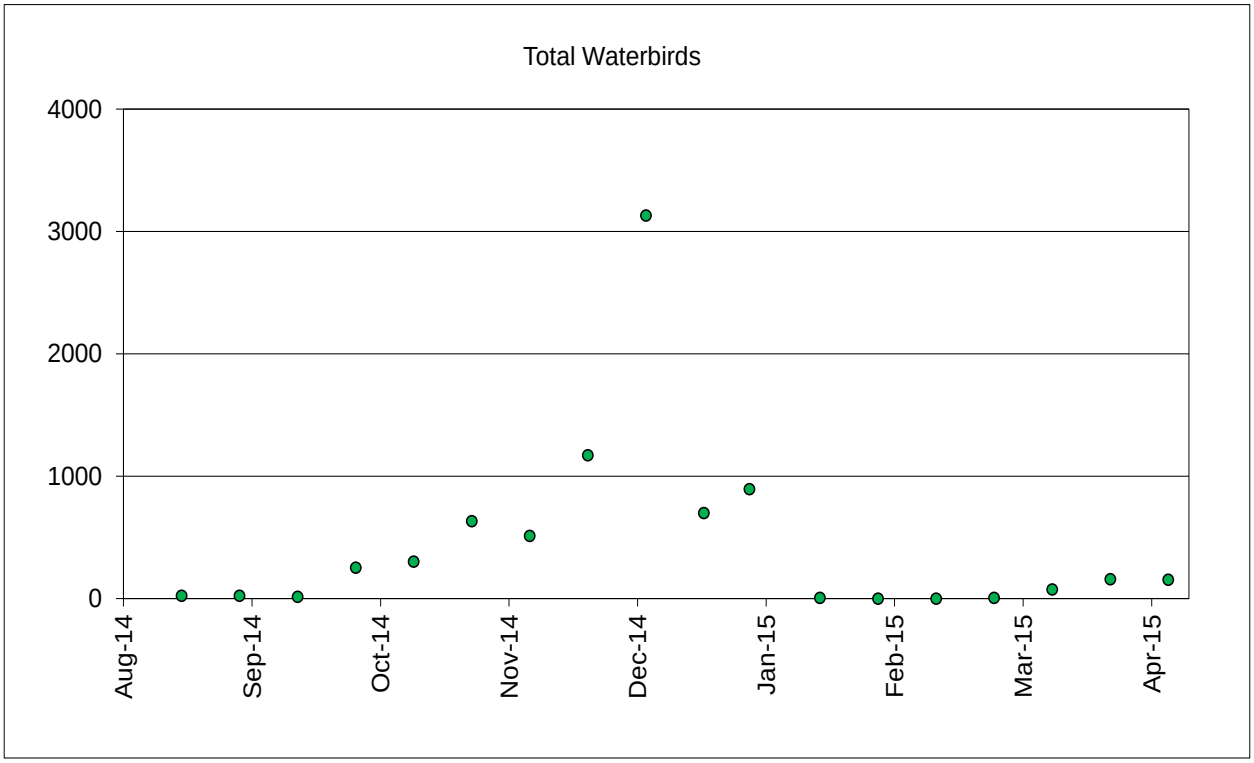

Figure 15. West Branch Reservoir total waterbirds (8/1/2014 to 4/15/2015).

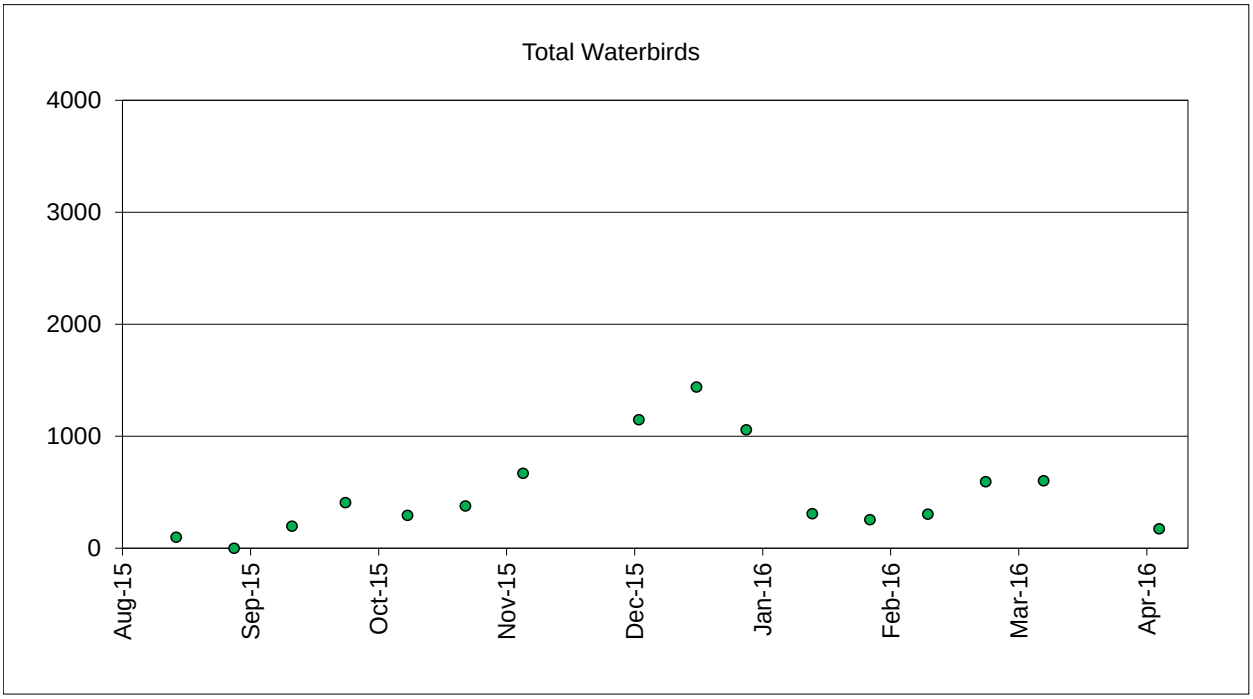

Figure 16. West Branch Reservoir total waterbirds (8/1/2015 to 4/15/2016).

There were three fecal coliform bacteria counts at or above 20 fecal coliforms $100mL^{-1}$ recorded at the reservoir-sampling site CWB1.5 located near Delaware Shaft 10 (DEL10) from August 1, 2015 through July 31, 2016 compared to three counts during the same reporting period in the previous year (Figure 17). Of 260 samples collected over the period from August 1, 2015 to July 31, 2016, 138/260 or 53 percent were censored (below the detection limit of 1 fecal coliform $100mL^{-1}$). The CWB1.5 water sampling location represents the quality of water at West Branch Reservoir as the reservoir is often placed in 'float mode' most of the year. Since the primary trigger to implement "as needed" bird dispersal actions is the fecal coliform bacteria concentrations, DEP determined there was no need to take action during the reporting period. In 2015, a coliform-restricted assessment based on compliance of the SWTR for West Branch Reservoir determined that the basin status was 'non-restricted'.

DEP conducted reproductive control on Canada Geese from April 1 through May 31, in 2016 to reduce productivity at West Branch Reservoir. In 2016, five nests with 24 eggs were depredated compared to three nests and 17 eggs depredated in 2015 (Table 4). The egg-depredation was 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 in 2016 and therefore not subject to depredation actions.

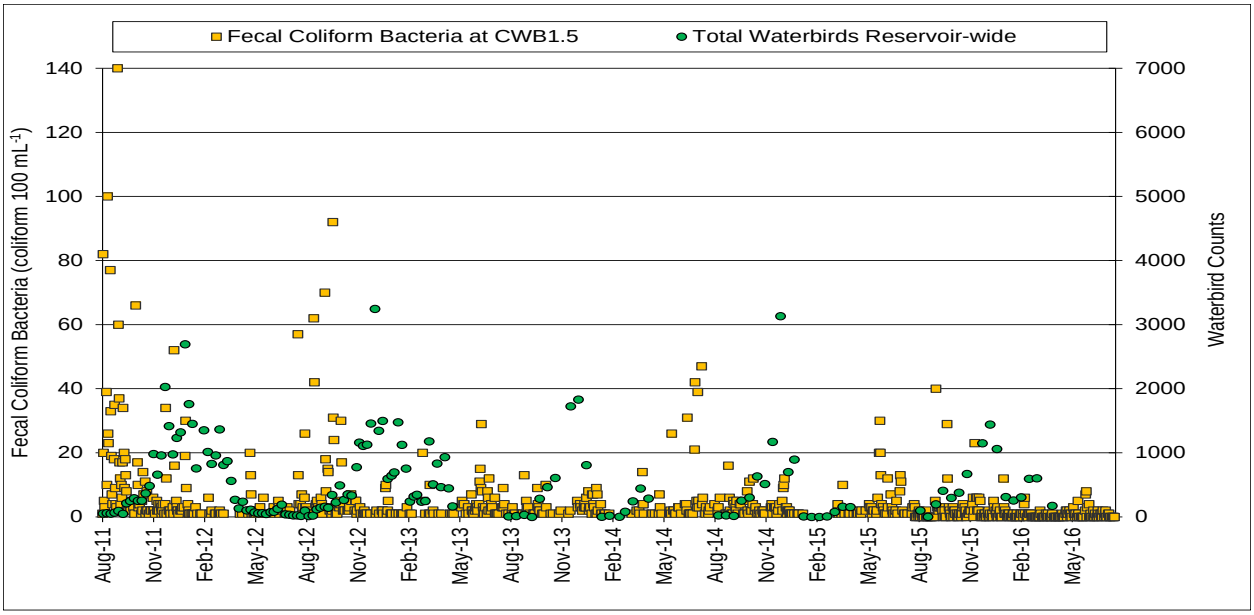

Figure 17. West Branch Reservoir fecal coliforms 100mL^{-1} at CWB1.5 vs. total waterbirds (8/1/2011 to 7/31/2016).

DEP continues to maintain bird deterrent netting installed on the West Branch shaft buildings to deter terrestrial bird nesting and roosting (Figure 18). Targeted species include Barn Swallows, Cliff Swallows, Rock Pigeons, House Sparrows, and European Starlings.

Figure 18. Bird deterrent netting is maintained annually at the West Branch Influent Shaft 10 to prevent birds from nesting.

3. Rondout Reservoir

Rondout Reservoir is a terminal or 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 sampling geographic zones (Figure 41).

Routine nocturnal waterbird population surveys were not conducted during this reporting period. 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 a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

In 2015/2016, there were no Rondout Effluent samples above 20 fecal coliforms 100mL^{-1} similar to the previous reporting periods dating back to 2011 (Figure 19). In 2015, a coliform-restricted assessment based on compliance of the SWTR for Rondout Reservoir determined that the basin status was 'non-restricted'. Of 181 samples collected over the period from August 1, 2015 to July 31, 2016, 122/181 or 68 percent were censored (below the detection limit of 1 fecal coliform 100mL^{-1}).

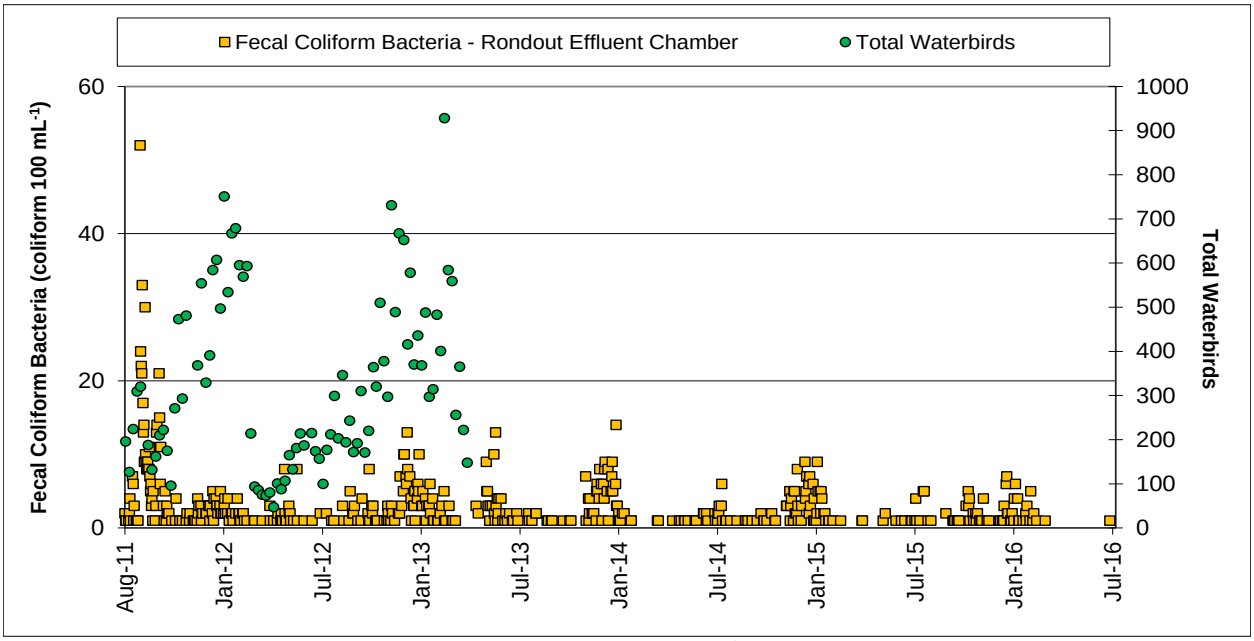

Figure 19. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys discontinued on 4/30/2013.

Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. Fifty-two additional 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 7 unless counts were zero or no data were collected due to environmental conditions or field errors. Twenty-eight out of 52 observations were reported as "0" or no birds present.

Table 7. Rondout Reservoir – daytime bird observations at Rondout Effluent

Date	Time of Observation	Bird Count Range and Actual Bird Counts
August 10, 2015	0923	Observed 5 Geese
August 31, 2015	1020	1 - 50
September 8, 2015	1000	1 - 50
September 21, 2015	1025	1 – 50
September 28, 2015	0952	Observed 1 bird
November 23, 2015	1014	1 – 50
December 21, 2015	1053	1 – 50
December 28, 2015	0926	1 – 50
January 19, 2016	1053	1 - 50
February 22, 2016	1015	1 - 50
March 14, 2016	1020	1 - 50
March 21, 2016	1005	1 - 50
April 4, 2016	0958	1 – 50
April 25, 2016	0955	1 - 50
May 2, 2016	1020	1 - 50
May 9, 2016	0920	1 - 50
May 16, 2016	1010	1 - 50
May 23, 2016	1100	1 - 50
May 31, 2016	0919	1 - 50
June 6, 2016	1005	1 - 50
June 20, 2016	1020	1 - 50
June 27, 2016	1021	1 - 50
July 5, 2016	0935	1 - 50
July 11, 2016	0938	1 - 50
July 18, 2016	0807	1 - 50

DEP conducted routine monitoring and maintained full compliance with a protection plan for Bald Eagles (*Haliaeetus leucocephalus*) 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 Canada Geese at Rondout in the spring of 2016. Due to the close proximity of some Canada Geese 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 (Figure 20). Five Canada Geese nests with 24 eggs were depredated during the spring of 2016 compared to four nests with 12 eggs depredated in 2015 (Table 4). No goslings were documented in 2016 as the depredation effort was deemed 100 percent successful. There were no Mute Swan nests identified at Rondout Reservoir in 2016.

Figure 20. Nestling Bald Eagle in nest adjacent to Canada Goose nesting locations at Rondout Reservoir. Photo by Peter Nye.

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 main basins each with a water intake chamber located at the Dividing Weir (Figure 42). There are six waterbird sampling geographic zones, three within each basin (Figure 42).

Daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. Fifty-two additional 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 8 and those for the Ashokan West Basin Effluent are listed in Table 9 unless counts were zero or no data were collected due to environmental conditions or field errors. Forty-one out of 52 observations were reported as zero or no birds present at the East and West Basin Effluents.

Table 8. Ashokan Reservoir – daytime bird observations at Ashokan East Effluent

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range and Actual Bird Counts
August 3, 2015	1332	Observed 18 birds
August 10, 2015	1020	Observed 12 birds
September 21, 2015	1214	1 – 50
September 28, 2015	1047	1 - 50
October 5, 2015	1255	Observed 1 gull
October 19, 2015	1126	Observed 1 duck
October 26, 2015	1047	1 - 50
November 9, 2015	1146	1 - 50
November 23, 2015	1043	1 - 50
May 2, 2016	1316	1 - 50

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

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range and Actual Bird Counts
August 10, 2015	1022	Observed 1 bird
August 24, 2015	1148	1 - 50
August 31, 2015	1059	Observed 6 birds
September 21, 2015	1216	Observed 3 Geese
October 5, 2015	1257	Observed 3 gulls
October 13, 2015	1405	Observed 2 birds
October 26, 2015	1049	1 - 50
May 2, 2016	1315	Observed 10 birds
May 23, 2016	1059	1- 50
May 31, 2016	1115	1 - 50
July 5, 2016	1100	1 - 50

There were two fecal coliform samples collected at the water effluent sampling location at Ashokan (EARCM) that exceeded 20 fecal coliforms $100mL^{-1}$ on September 14 and September 30, 2015 (Figure 21). The Aqueduct Monitoring staff reported three geese observed on the East Basin and 1-50 birds on the West Basin each on September 21 and September 28, 2015. There were no corresponding overnight bird counts to report during the time period of August 1, 2015 through July 31, 2016. In 2015, a coliform-restricted assessment based on compliance of the SWTR for Ashokan Reservoir determined that the basin status was 'non-restricted'. Of 202 samples collected over the period from August 1, 2015 to July 31, 2016, 118/202 or 58 percent were censored (below the detection limit of 1 fecal coliform $100mL^{-1}$).

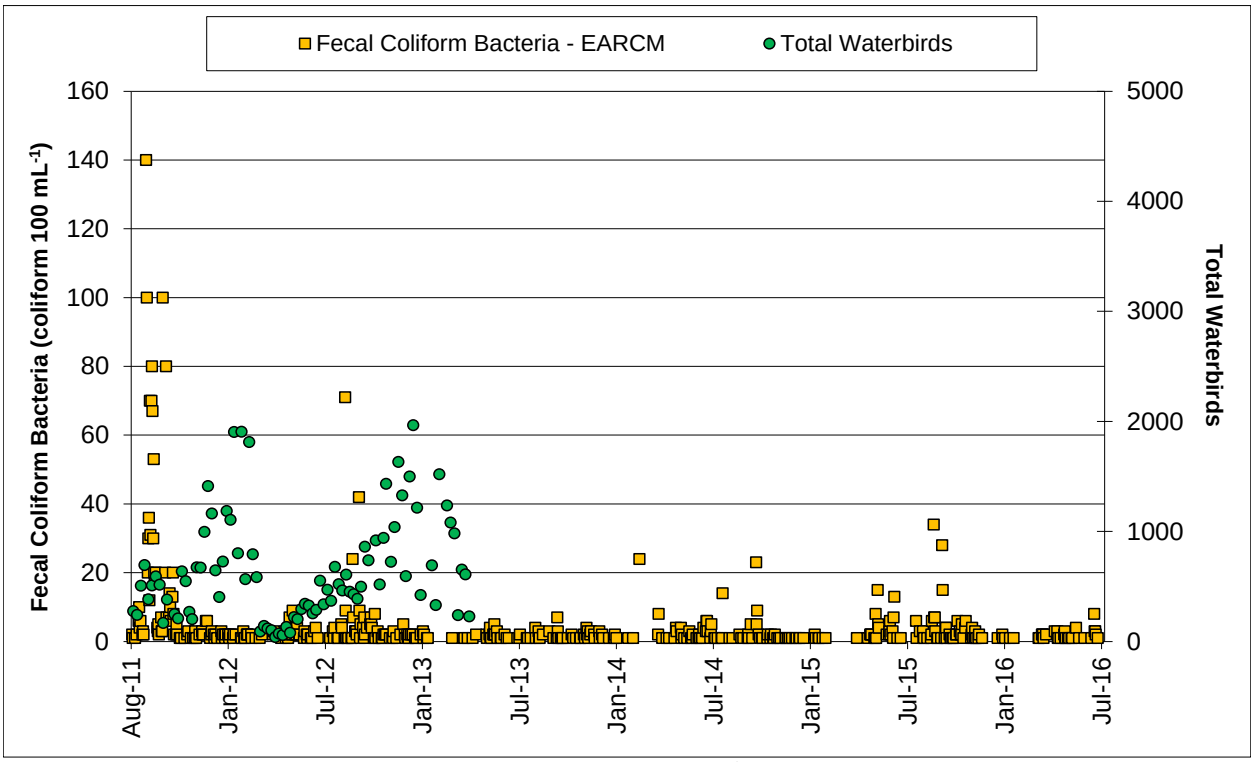

Figure 21. Ashokan Reservoir fecal coliforms 100mL^{-1} at Ashokan Effluent (EARCM) vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys discontinued on 4/30/2013.

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 waterbird counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

DEP conducted reproductive control on Canada Geese from April 1 through May 31, 2016 to reduce productivity at Ashokan. In 2016, seven Canada Geese nests were identified and 21 eggs addled (Table 4). In 2015, three Canada Geese nests were observed with 14 eggs destroyed. The egg-depredation success rate at the Ashokan Reservoir in 2016 was 78 percent compared to a 70 percent success in 2015. Six goslings were observed in late spring 2016 compared to sixteen observed in spring 2015. There were no Mute Swans found nesting in 2016.

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. Bald Eagle nest on the Ashokan Reservoir West Basin.

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. Croton Falls Reservoir is divided into five bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 43).

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 using contractor personnel to eliminate a water quality threat.

Nocturnal waterbird counts were not conducted during this report period. There were a total of two fecal coliform bacteria samples measured at the Croton Falls release in 2015/2016 above 20 fecal coliforms 100mL^{-1} similar to that recorded in 2014/2015 (Figure 23). The activation of the "as-needed" waterbird dispersal program was unnecessary during this reporting period. Of 12 samples collected over the period from August 1, 2015 to July 31, 2016, 3/12 or 25 percent were censored (below the detection limit of 1 fecal coliform 100mL^{-1}).

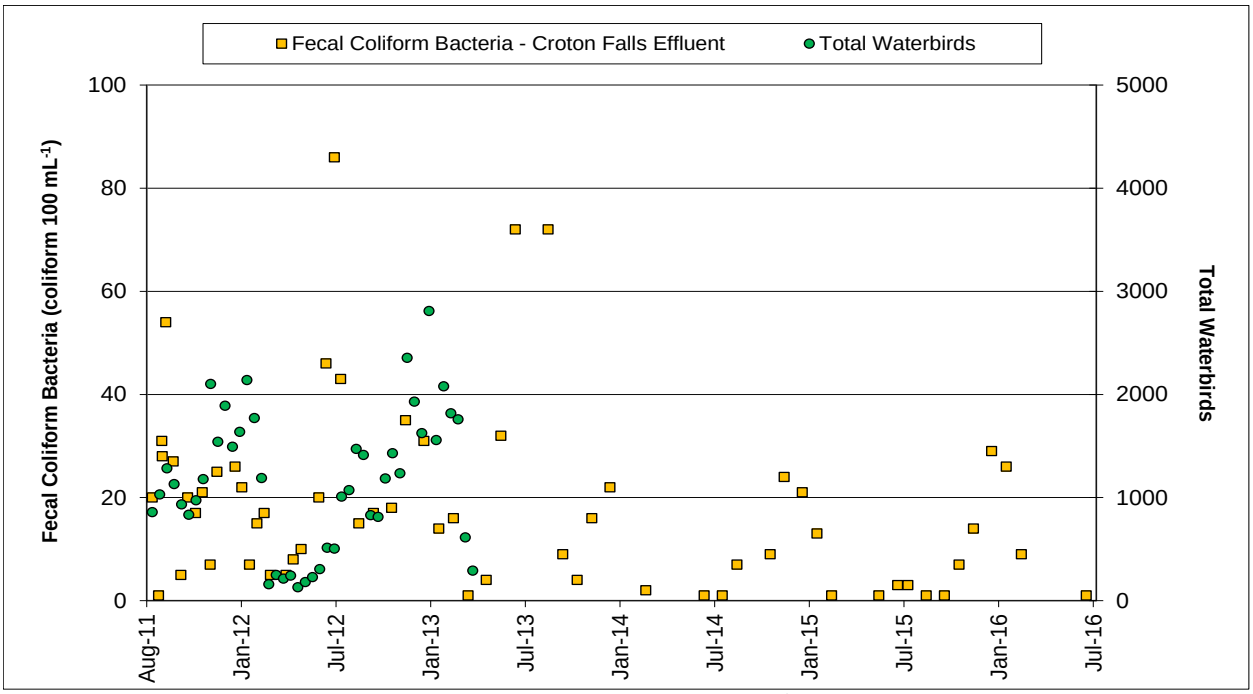

Figure 23. Croton Falls Reservoir fecal coliforms 100mL^{-1} at Croton Falls Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys discontinued on 4/30/2013.

DEP conducted reproductive control on Canada Geese from April 1 through May 31 in the spring of 2016 to reduce productivity at Croton Falls (Table 4). In 2016, nine Canada Geese nests were identified and 46 eggs were depredated compared to seven nests with 37 eggs in 2015. The Canada Goose egg-depredation success rate at Croton Falls for 2016 was 100 percent with no goslings that hatched. There was one Mute Swan nest depredated with a total of eight eggs found in 2016 and one swan nest with six eggs depredated in 2015.

Mute Swans are considered an invasive species are not native to the United States and therefore not protected under the federal Migratory Bird Treaty Act but are protected under NYS Environmental Conservation Law. DEP acquired a regional permit from the NYSDEC to conduct the egg and nest depredation for Mute Swans (Figure 24).

Figure 24. Pair of Mute Swans nesting on NYC reservoirs.

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 sampling geographic zones associated with reservoir water quality sampling locations (Figure 44). 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 a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

Nocturnal waterbird counts were not conducted during the reporting period. Fecal coliform bacteria concentrations are reported for August 1, 2011 through July 31, 2016 (Figure 25). Fecal coliform bacteria levels in water samples at Cross River Reservoir did not exceed the 20 fecal coliforms 100mL^{-1} level from August 1, 2015 through July 31, 2016 similar to the previous reporting period 2014/2015 (Figure 25). Of 24 samples collected over the period from August 1, 2015 to July 31, 2016, 15/24 or 63 percent were censored (below the detection limit of 1 fecal coliform 100mL^{-1}).

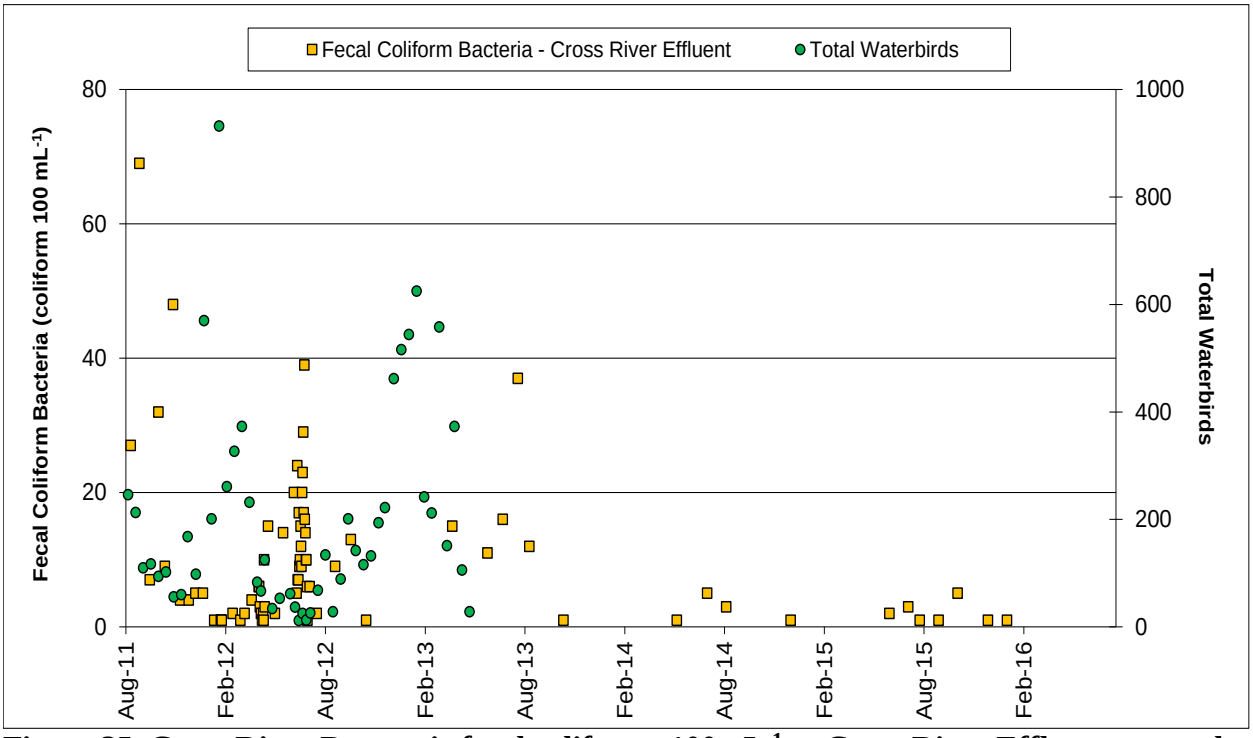

Figure 25. Cross River Reservoir fecal coliforms 100mL^{-1} at Cross River Effluent vs. total waterbirds (8/1/2011 to 7/31/2016). Waterbird surveys discontinued on 4/30/2013.

The Cross River Pump Station was not utilized during this reporting period, and activation of the "as-needed" waterbird dispersal program was unnecessary.

DEP conducted reproductive control on Canada Geese from April 1 through May 31 in 2016 to reduce productivity at Cross River. In 2016, eight nests were identified and 40 eggs addled compared to six nests and 22 eggs in 2015 (Table 4). The Canada Goose egg-depredation success rate for Cross River in 2016 was 98 percent with one gosling reported compared to 80 percent in 2015 when four goslings were observed. Reservoir nesting Canada Geese can be difficult to locate and require a thorough inspection of shoreline areas and islands (Figure 26). There were no Mute Swans observed nesting in either year.

Figure 26. Canada Goose nest found on a reservoir island, labeled after eggs were punctured.

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. Hillview Reservoir is divided into two bird sampling geographic zones associated with the reservoirs two distinct basins and water quality sampling stations (Figures 45 and 46). Waterbird population survey frequencies have varied through the years but generally had been conducted at a minimum on a weekly basis and in recent years on a daily basis. 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 infrequently employed a variety of noisemakers (bottle rockets and shotgun blasts) to eliminate birds roosting diurnally at Hillview. 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 on reservoir shaft buildings. DEP consulted with the United States Department of Agriculture, Animal and Plant Inspection Services, Wildlife Services (USDA) to discuss an overhead bird deterrent wire system. In July 1994, a 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 grid was strung along the shoreline fences spanning a distance of nearly 1,200 feet. From 1994 to 2006, DEP staff maintained this wire grid system until a contract was let in 2006 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 continue 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 remote-operated propane cannons along the reservoir's dividing wall to keep gulls and other birds from roosting on the dividing wall railings. 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 wall railing to keep gulls and other species from landing and defecating in the water. The railing wires are routinely 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.

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. New 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 (Figure 27), swallow spp. and sparrow management; and continued monthly reporting on wildlife management activities at Hillview Reservoir.

Figure 27. Hillview Reservoir use of remote control motorboats to disperse Ruddy Ducks. Photo by Chris 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 29 and 30). Prior to bird wire mitigation in 1994, gulls comprised more than 70 percent of the night-roosting species on the reservoir. In 2015/2016, night-roosting guilds of birds comprised the following breakdown: Canada Geese 0.2 percent, Gull Spp. 0.8 percent, and ducks about 99 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.

Ruddy Ducks are a diving duck species and often do not respond to conventional bird dispersal measures. DEP has had limited success in live trapping the ducks by means of chasing and netting by boat. When captured DEP transports the ducks to licensed wildlife rehabilitators or releases them back to the wild under federal and state approval (Figure 28).

Figure 28. Hillview Reservoir live capture of adult Ruddy Duck for relocation. Photo by Chris Nadareski

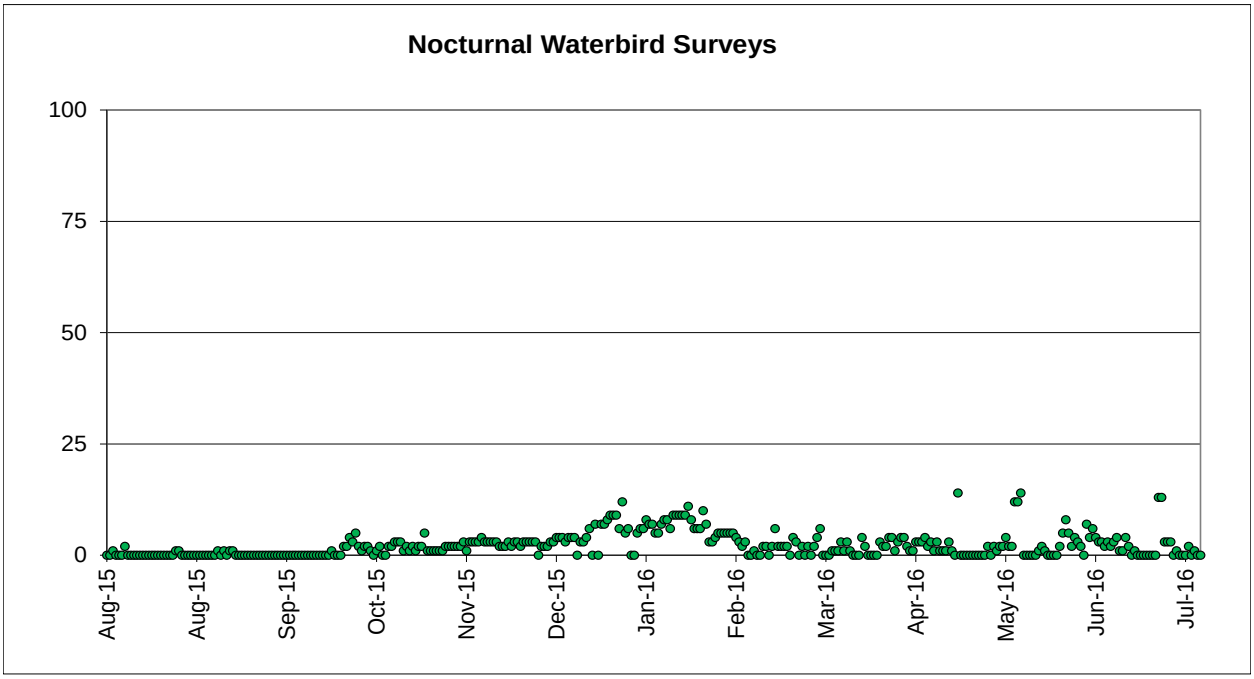

Figure 29. Hillview Reservoir total waterbirds nocturnal counts (8/1/2015 to 7/31/2016).

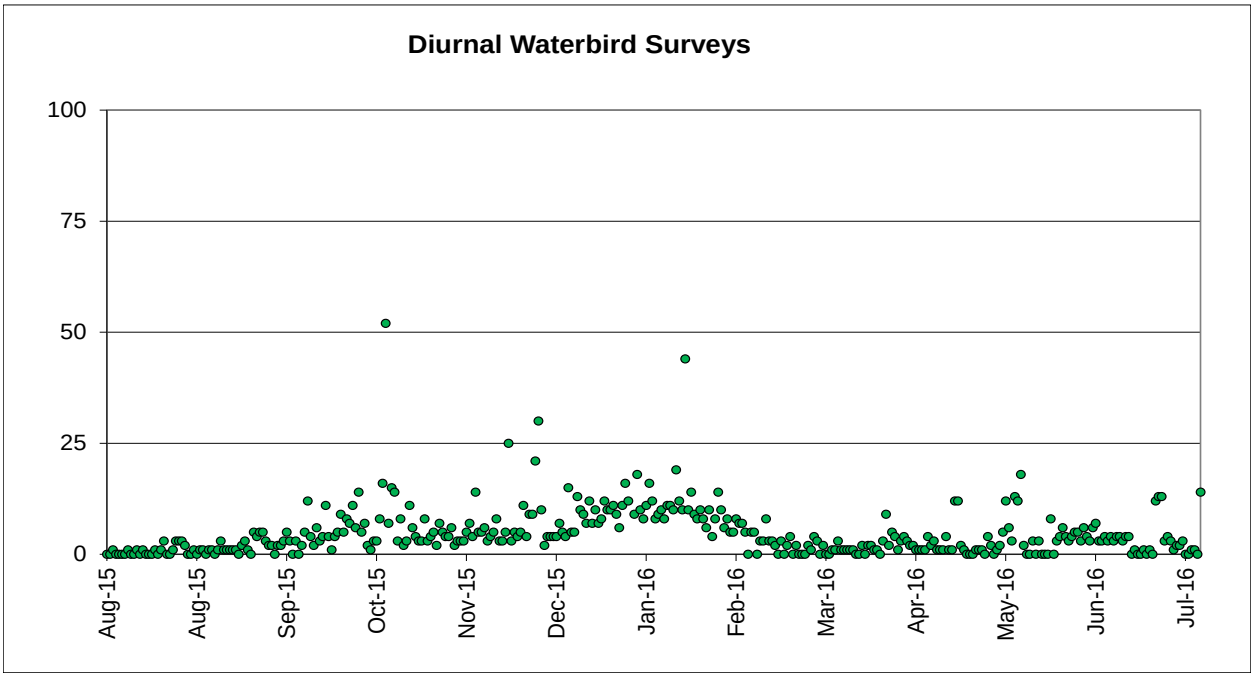

Figure 30. Hillview Reservoir total waterbirds diurnal counts (8/1/2015 to 7/31/2016).

The diving ducks (Ruddy Ducks and Bufflehead (*Bucephala albeola*)) continue to remain unaffected by the variety of bird deterrent and dispersal measures used by DEP to date. 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 is conducted on an as-needed basis, mostly during the autumn and winter periods and when the ducks are in migration and attempt to overwinter. USDA sharpshooters lethally removed a total of 12 Ruddy Ducks, two Bufflehead, and two Lesser Scaup (*Aythya affinis*) during this reporting period. An additional four Ruddy Ducks were live-captured and relocated off reservoir property by DEP staff. DEP also conducts stomach content analysis on a select number of Ruddy Ducks that are depredated (Figure 31). To date, most of the stomach content has consisted of "grit" and some invertebrate remains. Leeches also appear to be part of their diet at Hillview. Some of the Ruddy Ducks evaluated appeared to be in "poor" health showing signs of starvation as the reservoir may not offer and adequate food source.

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. All 366 overnight surveys conducted were deemed successful in 2015/2016. An insignificant number of gulls were observed during the overnight period on six of 366 surveys compared to three during the same time period in 2014/2015. On all gull nights', there was only one gull observed roosting in the reservoir. There were two observations of a single Canada Goose recorded during the overnight observation on December 4, 2015 and July 21, 2016. Overnight waterbird counts peaked at 14 on May 11 and June 1, 2016 compared to a high of 16 in the previous report. Mallard duck counts on May 11 and June 1 comprised of 14/14 birds just prior to a successful capture and relocation of the ducks.

The behavior patterns of the waterbirds utilizing Hillview Reservoir are different from the other upstate reservoirs reported in the document as Hillview is situated in a highly urbanized area and surrounded by large populations of breeding gulls throughout the NYC metropolitan area. 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 two species of ducks remain the target of active dispersal activity.

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 32-33). *E. coli* (grab samples) levels remained at no detection entering Hillview at water quality sampling locations Site 1. On two occasions, one each during May and June 2016 there was one positive *E. coli* sample reported respectively at sampling Site 3; as the water leaves Hillview Reservoir for distribution. Total reservoir-wide nightly waterbird count averages for the two months of detectable *E. coli* were as follows: May 2016 was two waterbirds/night and June 2016 was three waterbirds/night. Based on the relatively low number of waterbirds observed and the daily bird dispersal activities, it is unlikely that the waterbirds influenced the detectable *E. coli* levels.

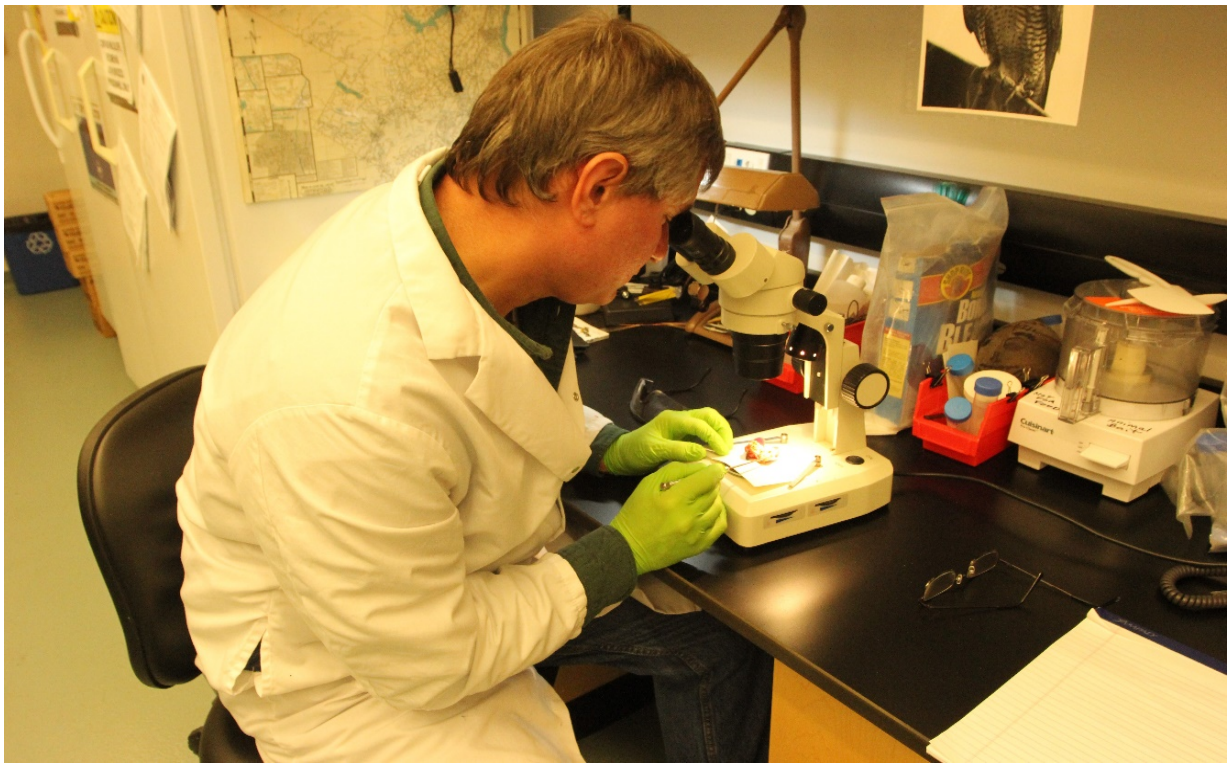

Figure 31. DEP conducts dissections of depredated Ruddy Ducks to determine diets of the diving ducks.

DEP has continued an active swallow depredation program to eliminate the nesting Cliff Swallows and Barn Swallows on the reservoir buildings and is conducted under a US Fish and Wildlife Service Depredation Permit. In 2016, there was a marked decrease in nesting activity associated with these two species of swallows. Only four Cliff Swallow nests with 12 eggs were depredated (physically removed from the eaves of the reservoir shaft buildings) compared to 11 nest and 10 eggs depredated in 2015. There were no Barn Swallow nests observed during the spring and summer period of 2016 unlike previous years. The near-drought conditions during the spring and summer of 2016 may have affected both species in acquiring enough mud from nearby puddling to construct the nests.

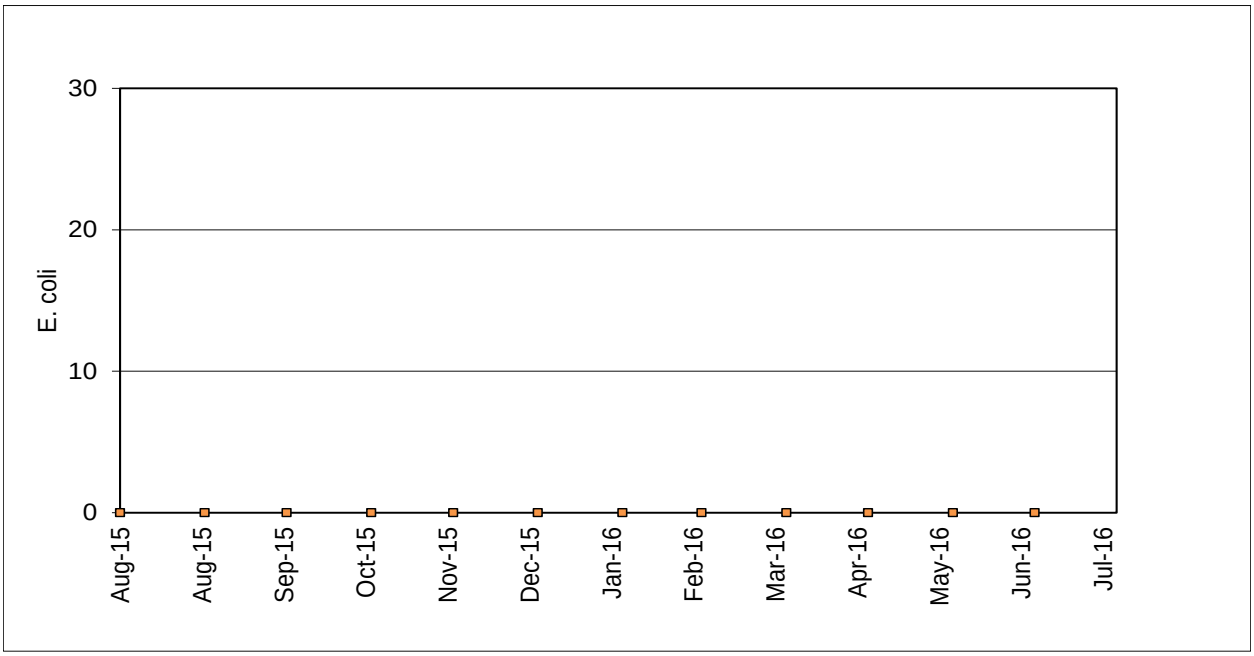

Figure 32. Hillview Reservoir number of positive *E. coli* (grab sample) at water Sampling Site 1 (8/1/2015 to 7/31/2016).

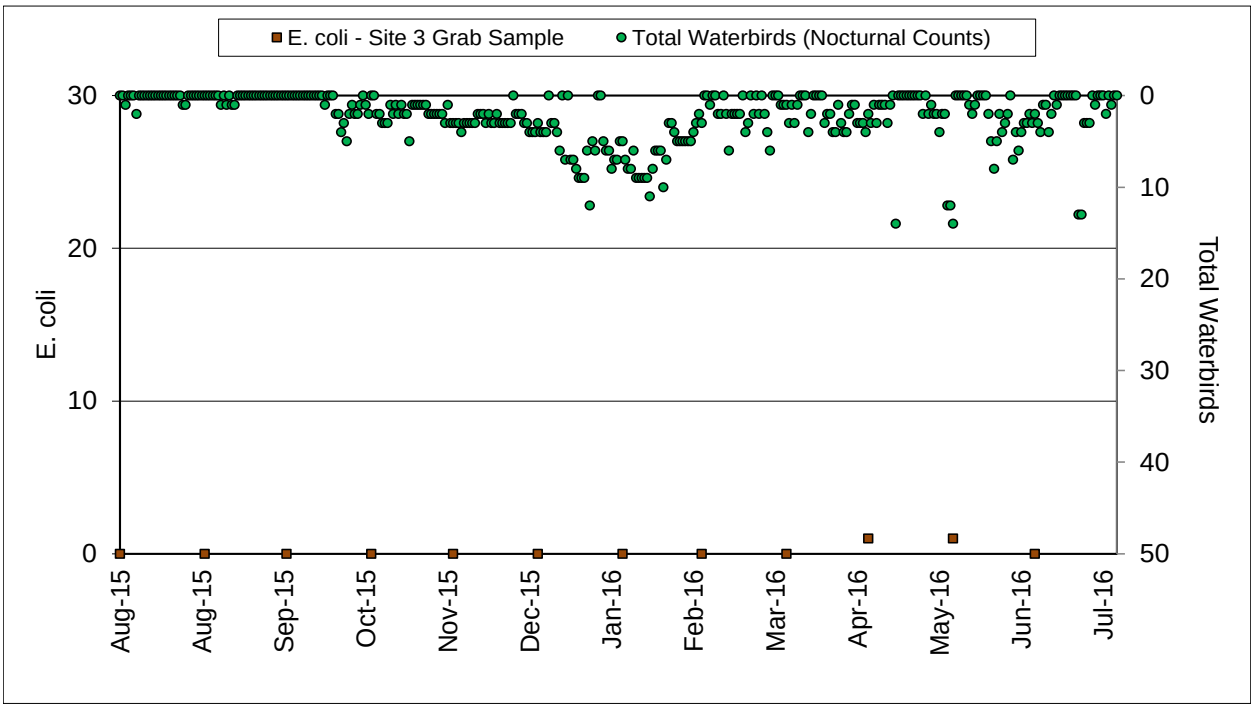

Figure 33. Hillview Reservoir number of positive *E. coli* (grab sample) at water Sampling Site 3versus total waterbirds (8/1/2015 to 7/31/2016).

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 implemented on an as-needed basis.
- August 2011 – Present: Under the USEPA Administrative Order and enhanced wildlife management program was implemented and 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 on the reservoir dividing wall.
    - Weekly small mammal trapping inside the reservoir perimeter fence and on the dividing wall.
    - Removal of Barn and Cliff Swallow nests on the reservoir shaft buildings and Osprey nests along the dividing wall bird wire stanchions. Nest removal activity approved by USFWS following the birds' breeding season in autumn of 2011 and 2012.
    - 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.

Mammal Trapping

DEP initiated a year-around mammal trapping program in August 2011 and currently conducts trapping efforts for raccoons and other mammals each week of the year. Traps were generally set around the Downtake 1 and Uptake facility and 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 into the reservoir from trapped animals. All traps are secured with wires to the shoreline fence to prevent trap rollovers. To date, mice and raccoons (*Procyon lotor*) 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*), Virginia opossum (*Didelphis virginiana*), mice (*Peromyscus* Spp.), meadow vole (*Microtus pennsylvanicus*), eastern gray squirrel (*Sciurus carolinensis*), Norway rat (*Rattus norvegicus*), northern short-tailed shrew (*Blarina brevicauda*), house mouse (*Mus musculus*) and feral/domestic cat.

A total of 4,606 traps were set during the period August 1, 2015 to July 31, 2016 (Table 10). The success of the trapping program is displayed in Table 11 and Figure 34. One hundred and sixty-one mammals from nine species plus one domestic animal (cat) have been live-trapped inside the reservoir perimeter fence from August 1, 2011 to July 31, 2016 (Table 11). All trapped specimens were euthanized and subsequently composted at the DEP Animal Compost Facility located in Ulster County. A total of 12,619 mammal-trapping nights have been set since August 2011. A single mammal trapping night consists of one trap baited for one night. In 2016, DEP set out additional small mammal (snap-traps) that were set along the reservoir shoreline and most likely accounts for the increase in trapping success for *Peromyscus* Spp. from 13 captured in 2015 to 35 during the first half of 2016. Overall, trapping success from 41 specimens in 2016 up from 34 in 2015.

Table 10. Mammal trapping summary August 2015 through July 2016

Month/Year	Number of Live-traps Set	Trapping Success
August 2015	352	1 Raccoon and 1 *Peromyscus* Spp. removed
September 2015	396	1 *Peromyscus* Spp. removed
October 2015	422	2 *Peromyscus* Spp., 4 Norway Rats, 1 Striped Skunk removed, and 1 Feral Cat relocated.
November 2015	344	1 Raccoon removed and 1 Domestic Cat relocated
December 2015	352	1 *Peromyscus* Spp. removed
January 2016	352	No animals removed
February 2016	308	8 *Peromyscus* Spp. removed
March 2016	418	1 *Peromyscus* Spp. removed
April 2016	396	3 *Peromyscus* Spp. and 1 Gray Squirrel removed
May 2016	351	5 *Peromyscus* Spp. removed
June 2016	395	9 *Peromyscus* Spp. and 1 Opossum removed
July 2016	520	10 *Peromyscus* Spp., 1 Norway Rat, 1 Meadow Vole, and 1 Short-tailed Shrew removed
Annual Trap-Night Totals	**4,606**	**8 Wildlife Species** **1 Domestic Animal**

Table 11. Trapping success summary for Hillview Reservoir (August 2011 to July 2016)

Species Trapped	**2011 (August 1 to December 31)**	**2012**	**2013**	**2014**	**2015**	**2016 (January 1 to July 31)**	**Trapping totals by species**
Raccoon	8	5	6	6	5	**0**	**30**
Striped Skunk	0	1	0	7	3	**0**	**11**
Opossum	0	0	0	4	6	**1**	**11**
Mice (*Peromyscus* Spp.)	7	0	11	7	13	**35**	**73**
Meadow Vole	0	0	4	0	0	**1**	**5**
Short-tailed Shrew	0	0	1	0	0	**1**	**2**
House Mouse	0	0	0	21	2	**0**	**23**
Norway Rat	0	0	0	1	4	**1**	**6**
Gray Squirrel	0	0	0	1	0	**1**	**2**
Feral or Domestic Cats (relocated)	0	0	0	4	1	**1**	**6**
Annual Trapping totals	**15**	**6**	**22**	**51**	**34**	**41**	**169**

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 35 shows two species caught on camera during the overnight hours. Figure 36 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 appear to peak in November, December, and July during this reporting period. Similar to the 2015 report, many camera hits during November and December represent nights of repeated visits by a feral cat. The increase in camera hits during July 2015 were primarily of Norway rats, a species that is a prolific breeder and often rears young throughout the year. The late winter of 2015, (March) coincides with the raccoon breeding cycles and young present.

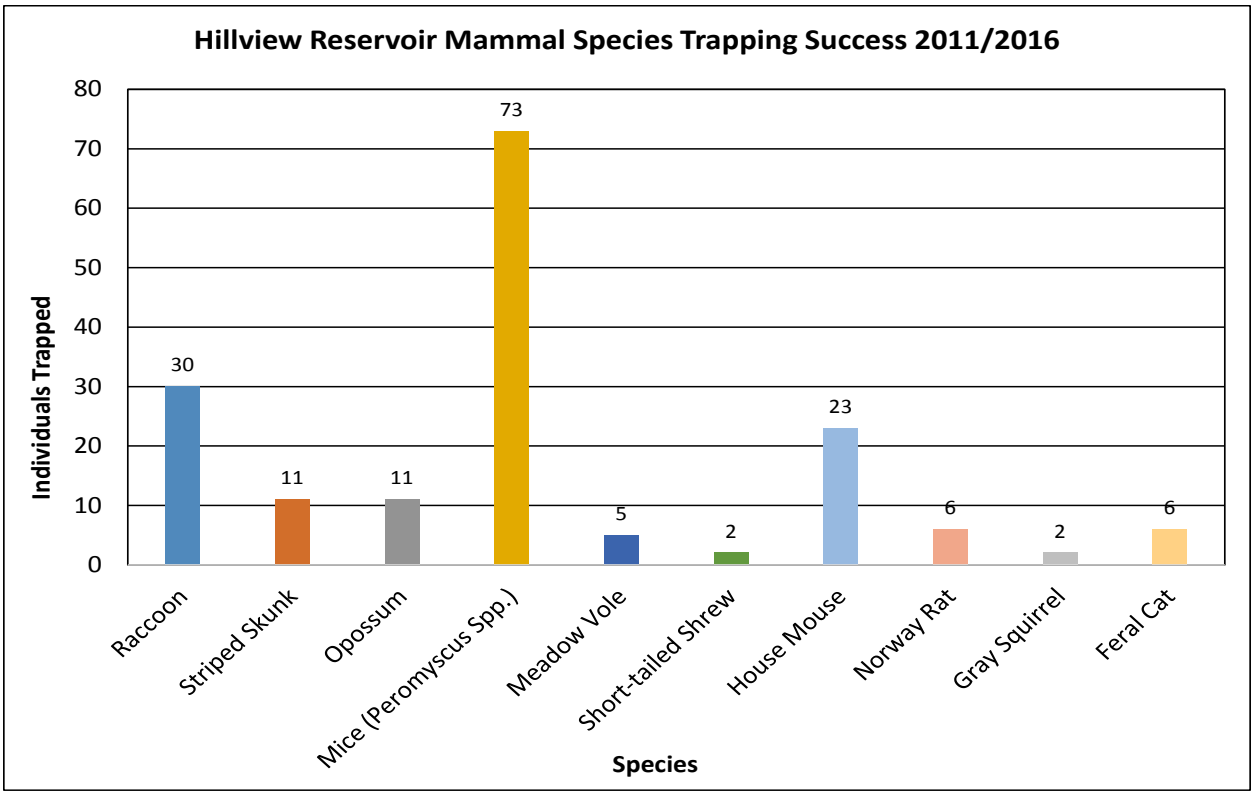

Figure 34. Mammal species trapped at Hillview Reservoir (8/1/2015 to 7/31/2016).

The low camera detection and trapping success rate during the winter may be attributed to a lack in insect-type food that may attract raccoons to the reservoir dividing wall. The low detection rate of raccoons during the summer may be a result of alternate available feeding

locations including berries and seeds found in the surrounding suburban neighborhoods and habitat.

Figure 35. Striped Skunk and feral cat captured on camera inside reservoir fence

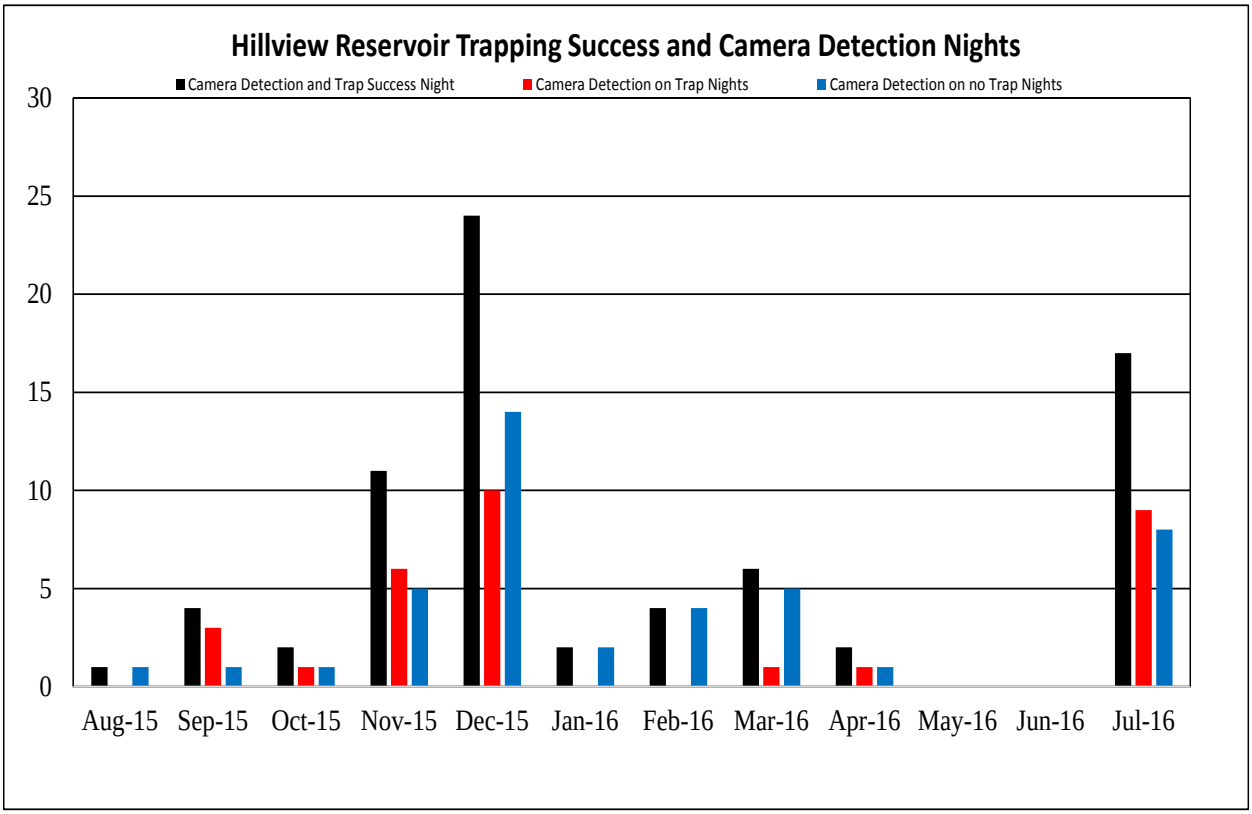

Figure 36. Occurrences of remote nighttime photography of animals recorded on the reservoir catwalk and dividing wall versus trapping success (8/1/2015 to 7/31/2016).

During the spring/summer 2016 waterbird nesting season there were no reported nesting attempts by Canada Geese or Mute Swans however, four Mallard nests were identified and 15 eggs depredated under a federal permit compared to two nests and 10 eggs depredated in 2015. Of the four nests found in 2016, fifty-five ducklings were live-captured and relocated off reservoir property compared to 12 ducklings that hatched in 2015 (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 was down to 21 percent in 2016 compared to 45 percent in 2015. DEP speculates that the urban nesting Mallards continue to adapt to the variety of bird deterrent and dispersal measures and have been found nesting in some unusual reservoir-property locations in 2016. DEP will be expanding the search of locations for nesting Mallards in 2017.

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CONCLUSION

DEP's Waterfowl Management Program is a key component to the City's continuance of Filtration Avoidance as outlined under the Revised 2007 Filtration Avoidance Determination. The program has helped DEP maximize options for delivering high quality water into distribution. The Waterfowl Management Program has been in continuous operation since 1993 and continues to effectively reduce waterbird populations and reduce fecal coliform bacteria levels which have assisted DEP in maintaining compliance with the Environmental Protection Agency's Surface Water Treatment Rule as part of the Safe Drinking Water Act (42 U.S.C. §300f et seq.) regulations.

The reduced waterbird and related 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 to bird reduction over large open areas of drinking water. To date, it remains inconclusive what the tolerable number of waterbirds is at NYC reservoirs before water quality is compromised; therefore, the objective of the Waterfowl Management Program will be to continue with the 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 source 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 2015, Kensico Reservoir was once again classified as a 'non-restricted' basin in response to compliance with the Surface Water Treatment Rule for fecal coliform bacteria. 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. It is evident 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 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. Remote-operated propane cannons have improved bird deterrence during times of inclement weather when DEP and contractor staffs 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, DEP has initiated small mammal trapping inside the reservoir perimeter fence and on the reservoir dividing wall. In 2015/2016 a total of 4,606 traps were set 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 2016 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.

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. Due to the unusually warm weather recorded during the winter of 2015/2016, waterbird activity was reported during times when ice normally precludes their activity.

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 through over two decades of routine water quality monitoring, population surveys and identifying bacteria origins. 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

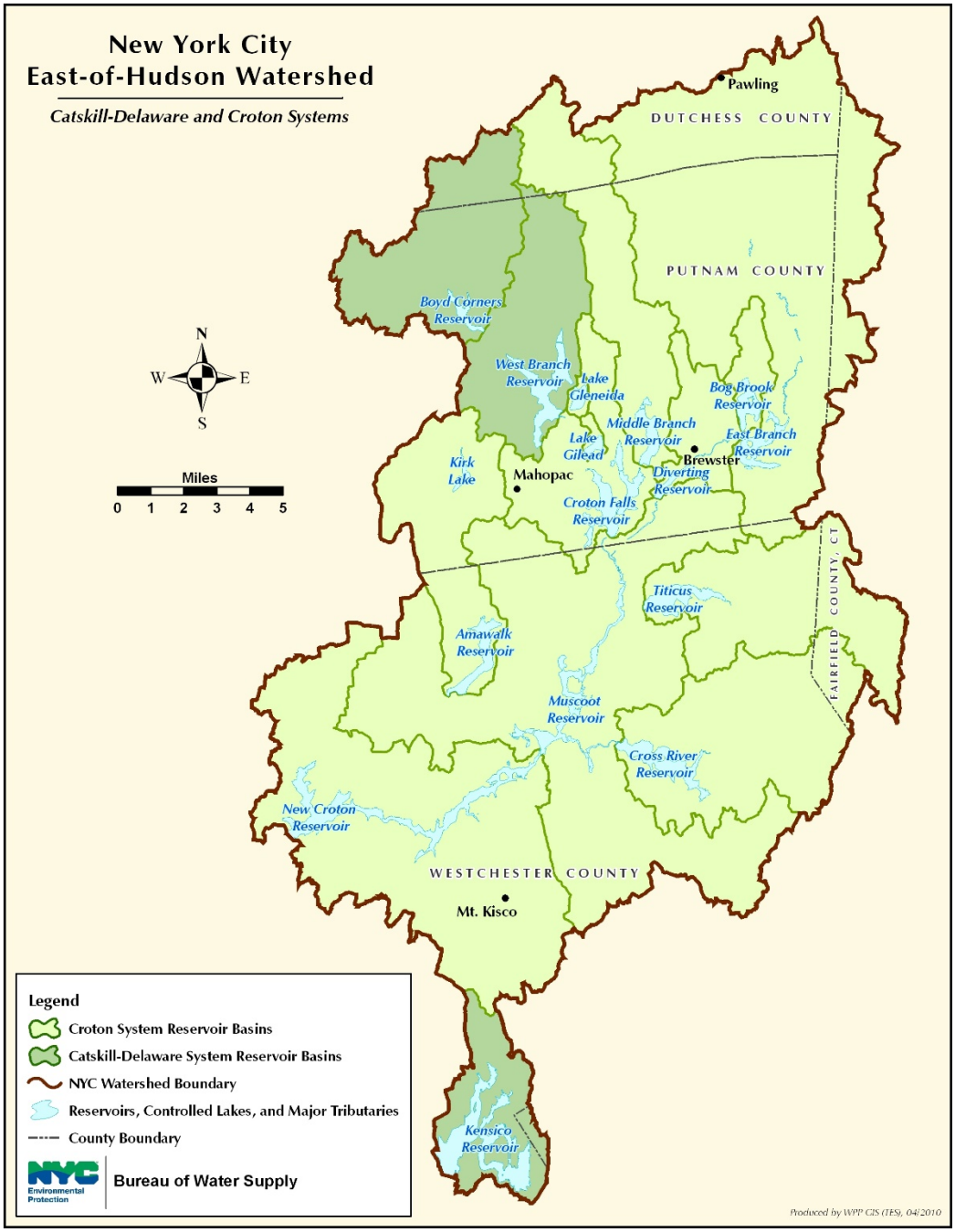

Figure 37. Map of New York City Water Supply System – East of Hudson Region.

Figure 38. Map of New York City Water Supply – West of Hudson Region.

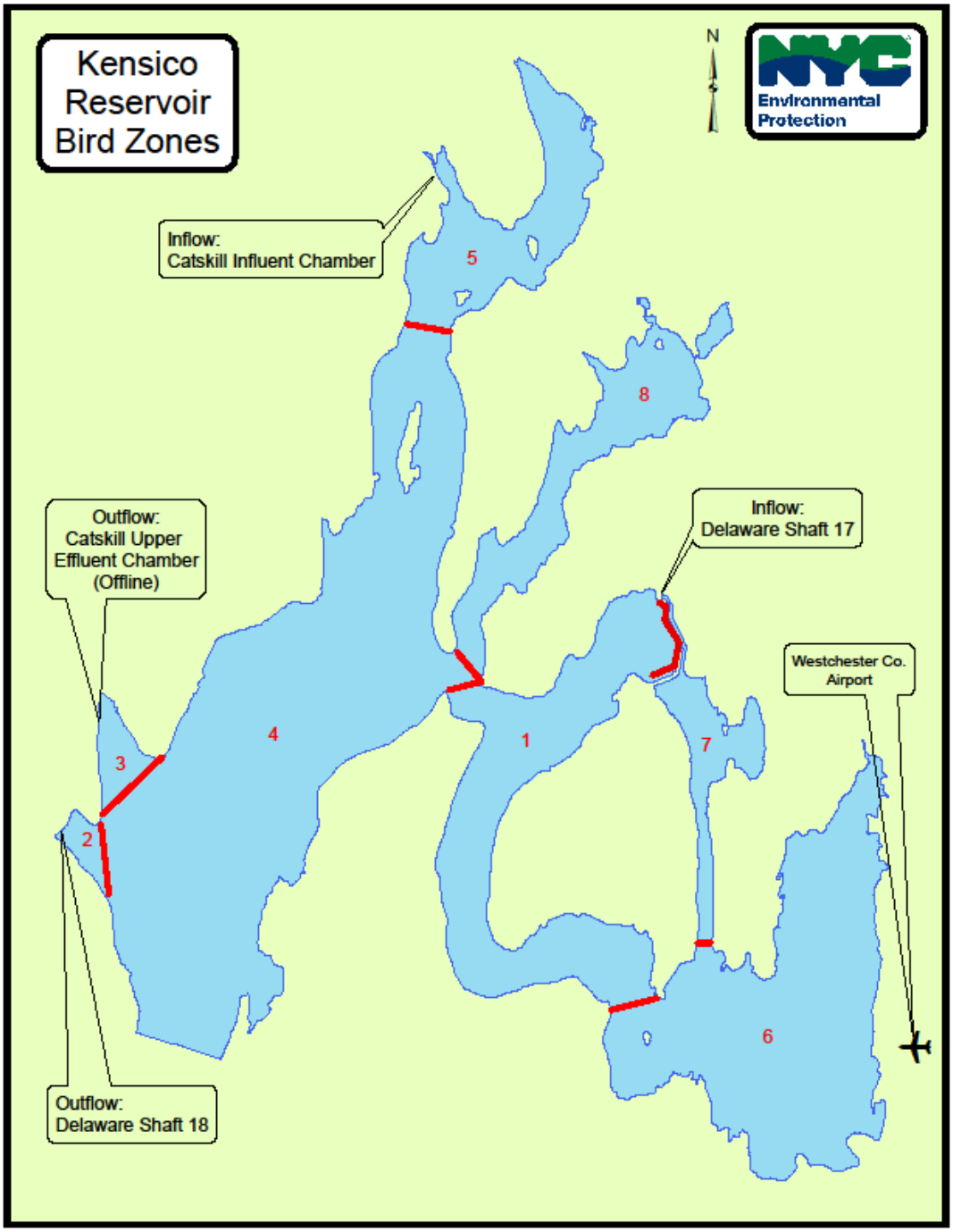

Figure 39. Map of Kensico Reservoir bird zones.

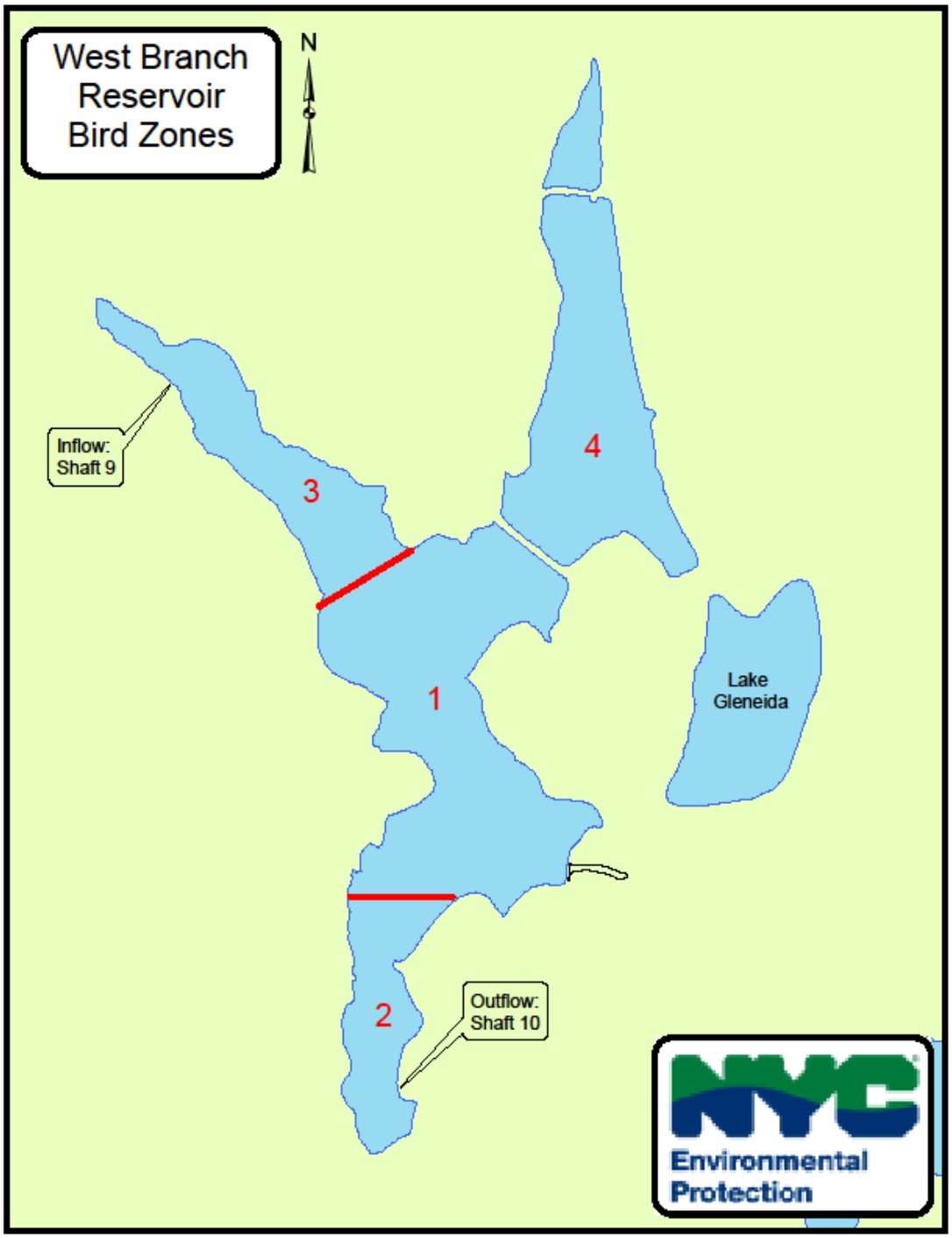

Figure 40. Map of West Branch Reservoir bird zones.

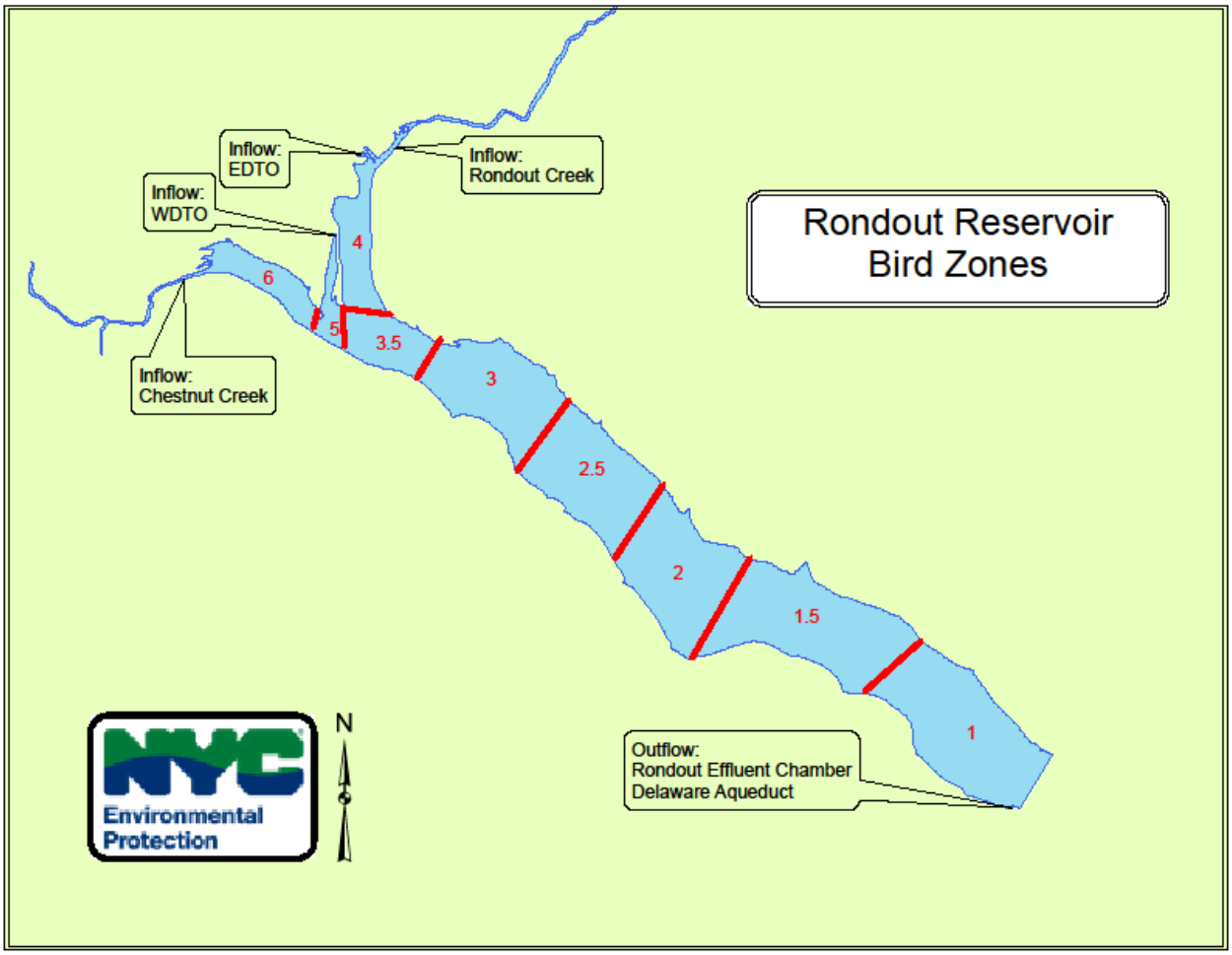

Figure 41. Map of Rondout Reservoir bird zones.

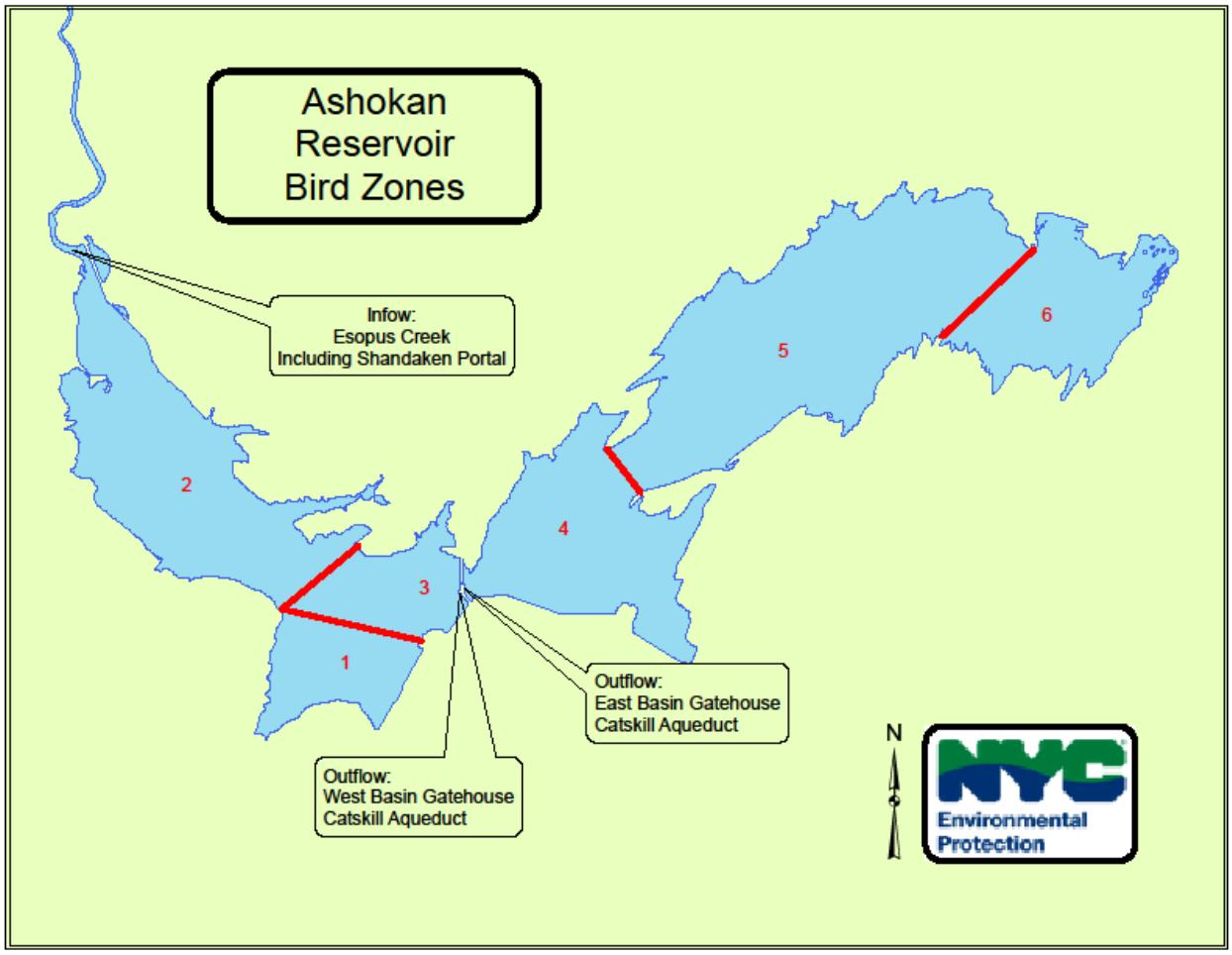

Figure 42. Map of Ashokan Reservoir bird zones.

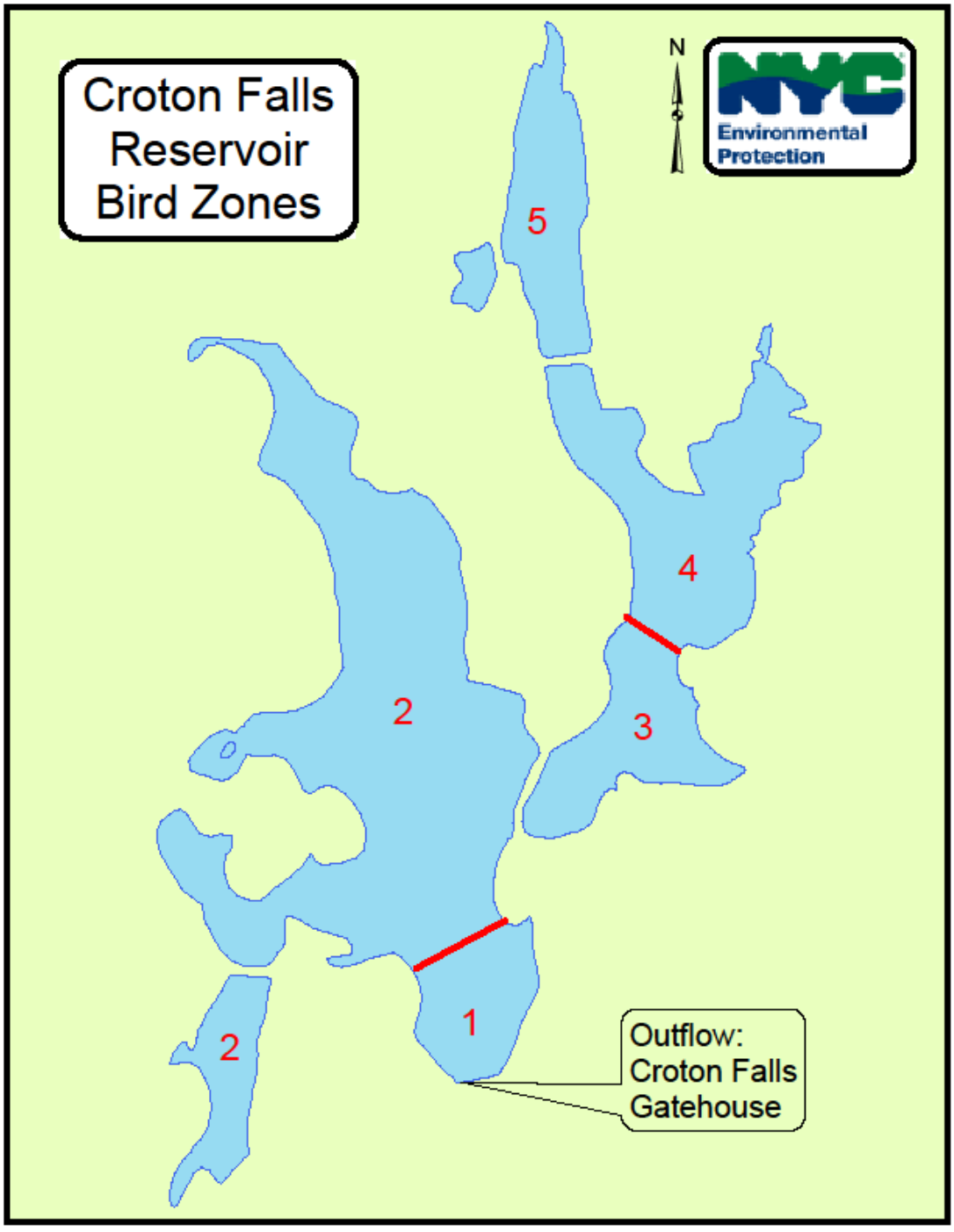

Figure 43. Map of Croton Falls Reservoir bird zones.

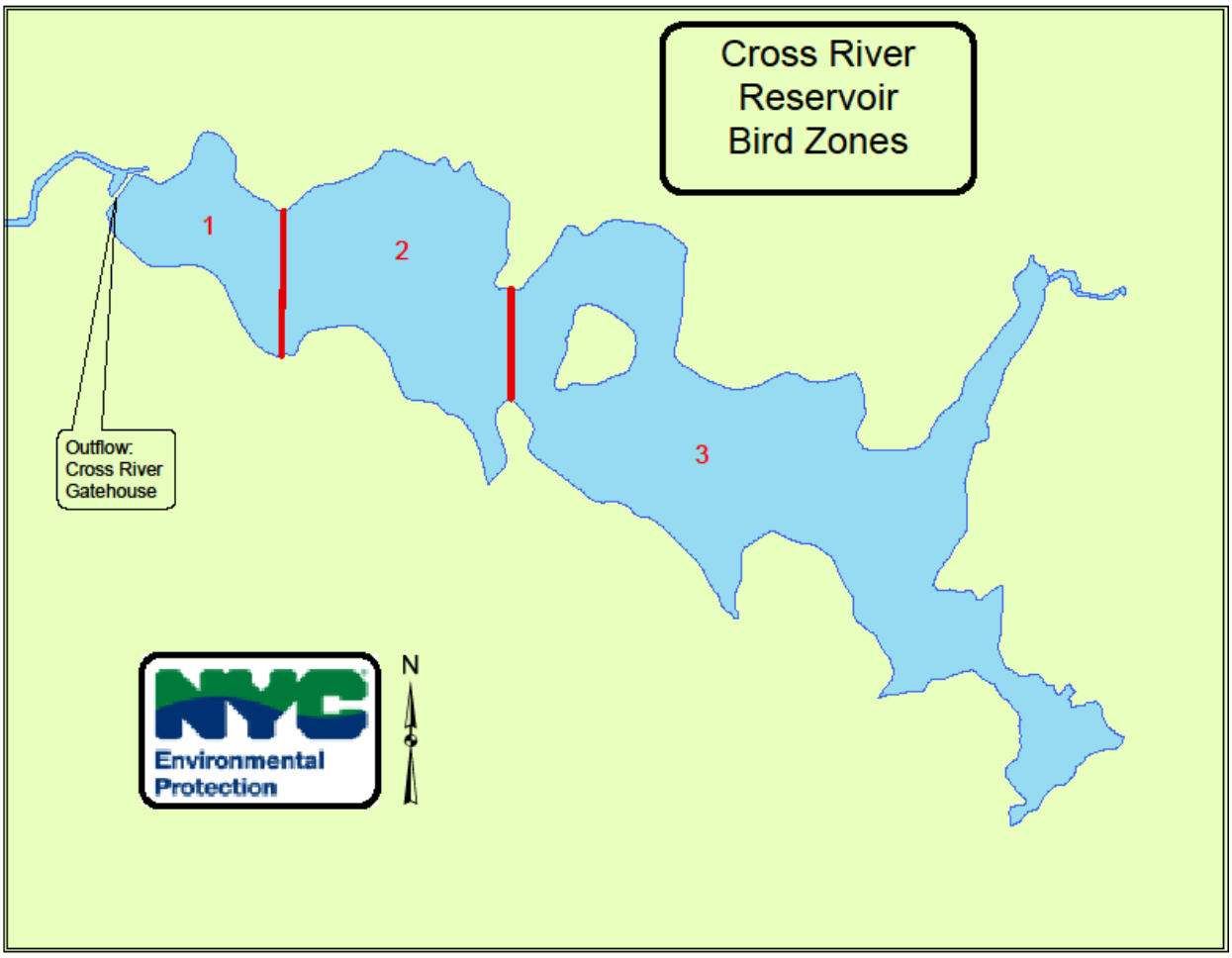

Figure 44. Map of Cross River Reservoir bird zones.

Figure 45. Map of Hillview Reservoir bird zones.

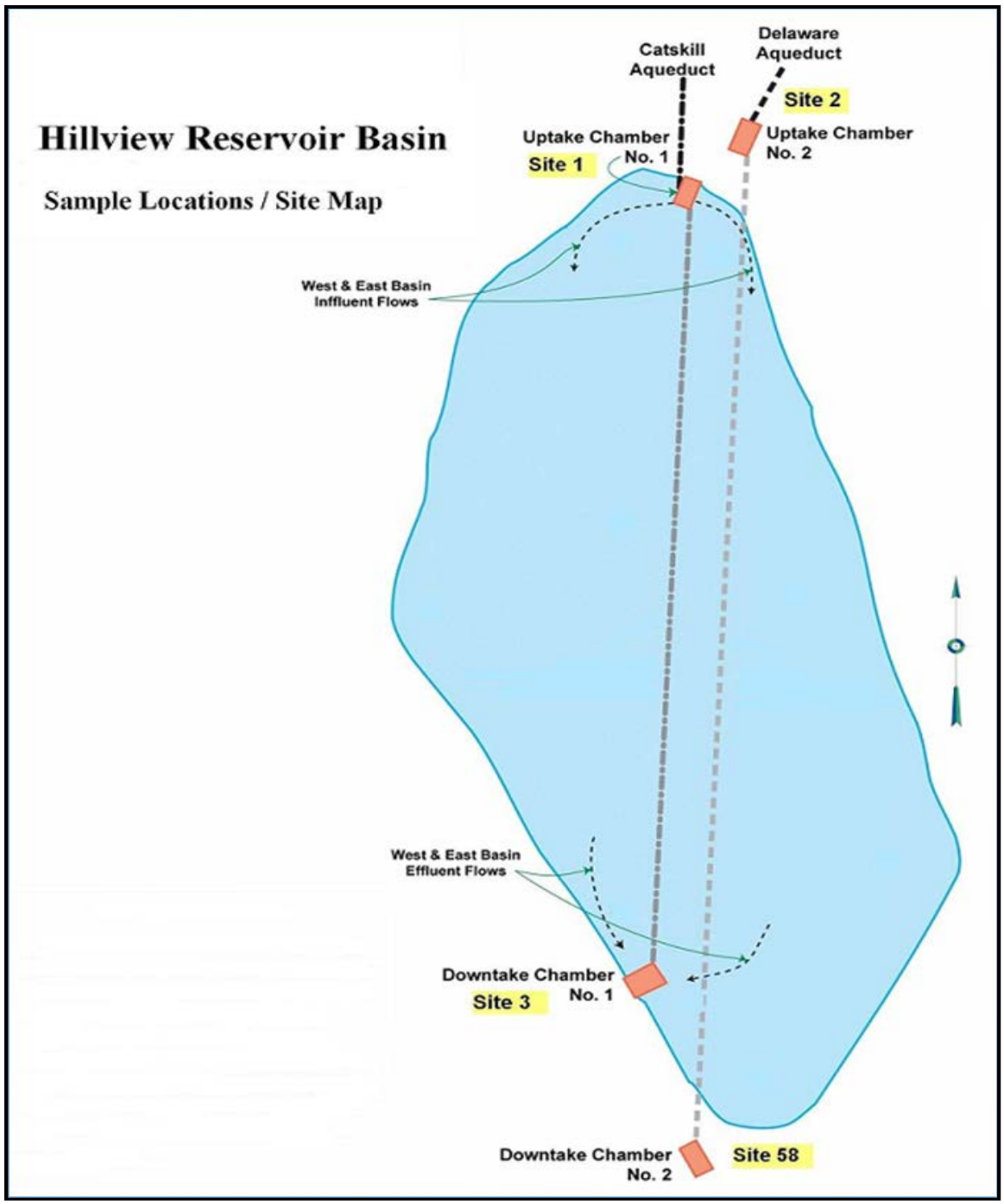

Figure 46. Map of Hillview Reservoir water sampling locations.