Water for the Future: Upstate Water Supply Resiliency

Final Environmental Impact Statement

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ADV − acoustic Doppler velocimeter

ArcGIS – A suite of geographic information system software provided by Esri

ASTM − American Society for Testing and Materials

AUV − autonomous underwater vehicle

BANCS − Bank Assessment for Non-point Source Consequences of Sediment

BGPA − Bald and Golden Eagle Protection Act

BMP − Best Management Practice

BWS − Bureau of Water Supply

CATIC − Catskill Aqueduct at the Catskill Influent Chamber

CEA − Critical Environmental Area

CEC − cation exchange capacity

CEQR − City Environmental Quality Review

CMP − Coastal Management Program

COC − contaminant of concern

CPUE − catch per unit effort

CSSO − Combined Seasonal Storage Objective

dBA − A-weighted decibels

dbh – diameter at breast height

DBP − disinfection by-product

DEIS − Draft Environmental Impact Statement

DEP − Department of Environmental Protection

DGPS − Differential Global Positioning System

EFH − Essential Fish Habitat

EIS − Environmental Impact Statement

EPA − U.S. Environmental Protection Agency

EPT − Ephemeroptera, Plecoptera, Trichoptera

ESA − Environmental Site Assessment

FAD – Filtration Avoidance Determination

FEIS – Final Environmental Impact Statement

FEMA − Federal Emergency Management Agency

FFMP − Flexible Flow Management Program

FIRM − Federal Insurance Rate Map

FP − flowpath

GAC − granular activated carbon

GHG − greenhouse gas

gpm − gallons per minute

HAA − haloacetic acids

HBI − Hilsenhoff's Biotic Index

HDDV − heavy-duty diesel vehicle

HEC-RAS – Hydrologic Engineering Center – River Analysis System

HFC − hydrofluorocarbon

HGL − hydraulic grade line

HUC − Hydrologic Unit Code

IESNA − Illuminating Engineering Society of North America

IPaC − Information for Planning and Conservation

IRP − Interim Ashokan Release Protocol

Leq − equivalent average noise level

LiDAR − Light Detection and Ranging

Lmax – maximum noise level

MBTA − Migratory Bird Treaty Act

MCL – maximum contaminant level

mgd − million gallons per day

mg/L − milligrams per liter

MRDL − maximum residual disinfectant level

NAAQS − National Ambient Air Quality Standards

NAVD 88 − North American Vertical Datum of 1988

NJDEP − New Jersey Department of Environmental Protection

NMFS − National Marine Fisheries Service

NOAA − National Oceanic and Atmospheric Administration

NPDES − National Pollutant Discharge Elimination System

NPL − National Priority List

NRCS − Natural Resources Conservation Service

NTU – Nephelometric Turbidity Units

NWI − National Wetlands Inventory

NWS − National Weather Service

NYC − New York City

NYCRR − New York Code of Rules and Regulations

NYISO − New York Independent System Operator

NYNHP − New York Natural Heritage Program

NYS − New York State

NYSDEC − New York State Department of Environmental Conservation

NYSDOH − New York State Department of Health

NYSDOS − New York State Department of State

NYSDOT − New York State Department of Transportation

NYSOPRHP − New York State Office of Parks, Recreation and Historic Preservation

O&W − Ontario and Western

OSHA − Occupational Safety and Health Administration

OSL − Official Species List

OST − Operations Support Tool

PCB − polychlorinated biphenyl

PCE − Passenger Car Equivalent

PEM − palustrine emergent

PFC − perfluorocarbons

pH − potential of hydrogen

PM_{10} − particulate matter less than 10 microns in diameter

PM_{25} − particulate matter less than 2.5 microns in diameter

PMA − Percent Model Affinity

REC − Recognized Environmental Condition

ROW − right-of-way

RWBT − Rondout-West Branch Tunnel

SEQRA − State Environmental Quality Review Act

SHPA – New York State Historic Preservation Act

SHPO − State Historic Preservation Office

SPDES − State Pollutant Discharge Elimination System

SPS − steel pipe siphon

SUNY − State University of New York

SWPPP – Stormwater Pollution Prevention Plan

THM − trihalomethanes

TSD − treatment, storage, and disposal

µg/L − micrograms per liter

USACE − United States Army Corps of Engineers

USDA – United States Department of Agriculture

USFWS − United States Fish and Wildlife Service

USGS − United States Geological Survey

UV − ultraviolet

WFF − Water for the Future

WL − Wetland

WSSO − Water for the Future Shutdown System Operations

air vent − Flue-like structure to be incorporated at pressure tunnels, siphon chambers, and cut-and-cover segments to allow release of trapped air.

alum floc − The resulting mass of alum and natural particles that bind together during alum treatment, settle out of the water column, and deposit on the reservoir bed.

alum system − A system by which alum is added to water to remove turbidity.

aquifer − A formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs.

artesian – Water under pressure where the water level rises above the top of the aquifer.

atmospheric deposition − Deposition of air pollutants to water or land.

Autonomous Underwater Vehicle (AUV) − A robot that travels underwater without an operator. The vehicle is controlled from the surface and used to record various data during deployment.

Bank Assessment for Non-point Source Consequences of Sediment (BANCS) − A modeling tool to determine erodibility of stream banks.

bankfull flow − Flow that fills only the stream channel to the top of its banks, and is statistically equivalent to the 1.5-year flood.

bar – An elevated mass of sediment (such as sand or gravel) that has been deposited by the flow in a stream.

bedding planes − A visible change in rock type or color that marks a division between distinct successive layers in sedimentary rocks.

bedrock aquifer − An aquifer composed of consolidated material such as limestone, sandstone, shale, or other rock type.

bedrock geology − The rock formations found on the earth that can be found exposed at the surface or below the unconsolidated deposits or water.

biofilm – An assemblage of microbial cells that forms when bacteria adhere to surfaces in aqueous environments. It typically consists of a matrix of materials (e.g., polysaccharides) produced by the bacteria and also can contain non-cellular material such as mineral crystals, silt, or other materials.

blow-off chamber − See *siphon drain blow-offs and blow-off valves*.

blow-off valve − See *siphon drain blow-offs and blow-off valves*.

boathole − A large access opening in cut-and-cover tunnel segments to allow personnel and large equipment access to the interior of the aqueduct.

Catskill Influent Chamber − Located at the southern terminus of the Pleasantville Cut-and-Cover Tunnel and through which Catskill Aqueduct water discharges to Kensico Reservoir.

chlorination – For the purposes of this EIS, chlorination is the process of adding chemical oxidants/disinfectants to water, commonly to control biofilm and prevent bacteria growth in water systems. One of two chlorine-based chemicals would be added to the Catskill Aqueduct at Ashokan Screen Chamber: sodium hypochlorite or chlorine dioxide.

chlorine residuals – That portion of applied chlorine, whether from sodium hypochlorite or chlorine dioxide, that remains free and available for disinfection or oxidation reactions. It includes the portion of the chlorine dose that remains after all oxidation and other immediate reactions are complete.

City – New York City

Classification of Waters[1] − A class and standard designation assigned to all waters of the State based on existing or expected best usage of each water or waterway segment.

- Class A and AA: The best usages of Class A and Class AA waters are as a source of water supply for drinking, culinary, or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish, shellfish, and wildlife propagation and survival.

- Class B: The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival.

- Class C: The best usage of Class C waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

- Class D: The best usage of Class D waters is fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish, shellfish, and wildlife survival. The water quality shall be suitable for

[1] State of New York, New York Codes, Rules and Regulations, 6 NYCRR 701.5, 701.6, 701.7, 701.8,701.9, and 701.25.

primary and secondary contact recreation, although other factors may limit the use for these purposes.

- The symbol (T) means that the classified waters are trout waters. Any water quality standard, guidance value, or thermal criterion that specifically refers to trout or trout waters applies.

- The symbol (TS) means that the classified waters are trout spawning waters. Any water quality standard, guidance value, or thermal criterion that specifically refers to trout, trout spawning, trout waters, or trout spawning waters applies.

Classification of Wetlands[2] – Class rankings of wetlands protected by the State based on the benefits and values provided by each wetland. Higher class wetlands provide the greatest level of benefits and are afforded a higher level of protection. New York State defines four classes of wetlands (Class I, II, III, and IV) that are further defined under NYCRR Part 664.5.

cohesionless soils – Soils including gravel, sands, and some silts that allow water to drain rapidly from the pore spaces.

cohesive soils – Soils including clayey silt, sandy clay, silty clay, clay, and organic clay that allow water to drain very slowly from the pore spaces.

compaction grouting – The process of injecting grout under high pressure to displace and compact soils to underpin (stabilize) potentially impacted structures.

conductive − A relative measure of an aquifer's ability to allow groundwater to flow through the aquifer material.

confined aquifer − An aquifer that is below the land surface that is saturated with water. Layers of impermeable material are both above and below the aquifer, causing it to be under pressure so that when the aquifer is penetrated by a well, the water will rise above the top of the aquifer in an artesian condition.

connection chambers − Chambers connected to the aqueduct where aqueduct water is provided to outside communities.

consolidated − Solid rock that has formed by various geologic processes that result in a rigid solid matrix.

consolidation settlement − A time-related process in saturated soil where the draining of water results in the reduced volume of the soil layer.

culvert drain sluice gates − Located where cut-and-cover tunnels pass over a drainage culvert, and consist of a 10-inch-diameter rising stem sluice gate located in the Catskill Aqueduct. When

[2] State of New York, New York Codes, Rules and Regulations, 6 NYCRR 664.5

open, the sluice gate allows aqueduct water to drain from the aqueduct into underneath culverts and into streams or drainage channels.

cut-and-cover tunnel − Segments of the aqueduct that are in horseshoe-shaped concrete arches that generally lie a few feet below the ground surface and are approximately 17 feet high and 17.5 feet wide.

dataset mean – The average value for a parameter (e.g., release, spill, water surface elevation) calculated from a collection of model simulations.

dead storage – The water surface elevation below which water cannot be hydraulically accessed and transferred through the water supply system based on intake elevation, which typically indicates low reservoir water surface elevations but may not represent a completely drained reservoir.

dechlorination – The process of removing chlorine residuals from water. Facilities or systems would be constructed to remove chlorine residuals prior to discharge into Kensico Reservoir or other surface waters along the upper Catskill Aqueduct.

dechlorination facility – A larger treatment unit that would remove chlorine residuals from aqueduct water prior to release to Kensico Reservoir.

dechlorination system – Treatment units that will be used at aqueduct leaks or connection chambers for the removal of chlorine residuals prior to release to the environment or receiving waters.

decommission – To remove infrastructure from functional service. Buried infrastructure (e.g., pipelines and tunnels) can be decommissioned in place by disconnecting and sealing, while above grade infrastructure, such as dams, require breaching or removal.

decommissioning – Decommissioning of the bypassed section of the Rondout-West Branch Tunnel and the cessation of existing aqueduct leaks.

depressurization − The act of unwatering the Rondout-West Branch Tunnel by opening a blow-off valve and subsequently closing the blow-off valve to gradually restore flow and re-pressurize the Rondout-West Branch Tunnel.

dewatering – Construction water control that may involve the removal or draining of groundwater or surface water from a construction site or streambed, typically by pumping. On a construction site, dewatering may be implemented before subsurface excavations to temporarily lower the water table during the work effort. This frequently involves the use of submersible pumps.

disinfection – Removal, deactivation, or killing of pathogenic or other microorganisms in water and wastewater.

disinfection by-product – Chemical, organic, and inorganic substances that can be formed during a reaction of a disinfectant (i.e., sodium hypochlorite or chlorine dioxide) with naturally

present organic matter in the water. These may include trihalomethanes (THM), haloacetic acids (HAA), chlorite, and/or chlorate.

diversion – Controlled movement of water between reservoirs or systems through tunnels or aqueducts that would not otherwise be connected.

downtake chamber − A chamber located at the start of a pressure tunnel segment and that is a connection point with an adjacent aqueduct segment.

effective discharge − An index that describes the streamflow responsible for carrying the most sediment over time and forming the geometry of the channel.

emitting property line − The property line nearest to the work activities.

entrainment − The ability of the flow of water to move or transport particles downstream.

flashboards − Removable vertical boards used to prevent backflow of water to facilitate access to the aqueduct for the repair and rehabilitation and future maintenance.

floodplain – The area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high flow.

FRAC3DVS Model – A groundwater flow and transport model that can be used for discretely fractured porous bedrock aquifers.

free field conditions − An environment free from obstructions that could affect the way sound travels away from a noise source.

functional feeding groups – Feeding categories assigned to macroinvertebrates by the NYSDEC based on main sources of food. Feeding groups consist of generalist feeders such as gathering collectors, filtering collectors, and predators, and specialized feeders such as scrapers and shredders.

grade tunnel − Unpressurized horseshoe-shaped tunnel segments that are up to 17 feet high and 13 feet wide, with steeper grades than cut-and-cover tunnels.

granular soils – Soils including gravel, sand, or silt with little or no clay content that have no cohesive strength.

HEC-RAS Model – Hydrologic Engineering Center – River Analysis System model used for modeling the hydraulics of water flow through natural rivers and other channels.

hydraulic conductivity − A measurement of the ability of groundwater to flow through a material including bedrock and unconsolidated deposits.

Hydraulic Grade Line (HGL) − An aqueduct's pressure profile that is controlled by the rate of flow and the water levels in the reservoirs it connects.

hydraulic gradient − The change in groundwater level over a particular distance.

hydraulics – The applied science discipline for analyzing the mechanical properties of liquids or fluids.

hydrology – The scientific study of the movement and distribution of water.

inspection and repair – Rondout-West Branch Tunnel Inspection and Repair project.

jet grouting – The process of adding a grout mix to a column of soil to strengthen the soil.

large-scale wash water treatment system – A temporary system that would treat water used during the biofilm removal process in the Catskill Aqueduct. The system would be located before the start of a pressure tunnel or Kensico Reservoir, and would be sized to treat the anticipated volume of biofilm wash water generated from the work segments upgradient of that location.

Light Detecting and Ranging (LiDAR) – A topographic surveying technology that measures elevations of surface features with laser light, typically from an airplane.

limits of construction – The outermost area of disturbance during construction, including, but not limited to, access roads and staging areas requiring improvements, tree removal, excavation and grading, and/or temporary or permanent stream crossings.

littoral zone − The area along the shore of a reservoir.

maximum contaminant level (MCL) – Standard set by the U.S. Environmental Protection Agency for drinking water quality that establishes the limit on the amount of a substance that is allowed in drinking water.

maximum residual disinfectant limit (MRDL) – A level of disinfectant measured at a consumer's tap, above which the possibility of unacceptable health effects exists.

Nephelometric Turbidity Units (NTU) − A measure of suspended particulates using light passing through a sample of water.

Operations Support Tool (OST) Model – DEP's sole integrated water supply and water quality modeling system, used to inform daily operational decisions and support long-term planning for the water supply system.

Outside Community Connections – Also known as Upstate Water Suppliers, Water Supply Connections, upstate wholesale customers, and upstate community customers. Water is supplied via the City's aqueducts and reservoirs directly to communities north of the City via connections to DEP's water supply system. In some cases, one community connection serves multiple municipalities.

oxidant – For water supply systems, a chemical that alters or inactivates pathogens or dissolved constituents in the water, thereby minimizing public health risks and aesthetic concerns.

oxidation – For water supply systems, the chemical process involving loss of electrons by which an oxidant alters constituents present in water.

parent materials − Materials from which soils are derived and formed. A majority of the parent materials in New York are of glacial origin.

passive dechlorination system − An in-line trench constructed within an existing leak flowpath and filled with gravel and granulated activated carbon to remove chlorine residuals from leaking aqueduct water.

Pfankuch – A methodology for determining stream channel stability.

piezometric − The level to which groundwater will rise in a well installed in an unconfined aquifer.

potentiometric − The level to which groundwater will rise in a well installed in a confined aquifer.

pressure tunnel − Segments of the aqueduct located deep beneath the surface. They are circular, concrete-lined, pressurized sections that flow full, with diameters of up to 14.5 feet. They are located in rock to sustain the heavy outward pressure from the water in the tunnel. Vertical shafts are located at each end to connect pressure tunnels to other tunnel segments.

public fishing rights − Permanent easements purchased by NYSDEC from landowners reserved for the purpose of fishing only. Public fishing rights give anglers the right to fish and walk along the bank (usually a 33-foot-wide strip on one or both banks of the stream).

raw water – Untreated aqueduct water.

release – A controlled discharge of water from a reservoir to a downstream waterbody.

repair and rehabilitation − Catskill Aqueduct Repair and Rehabilitation project.

residual water – Water remaining in the aqueduct while it is out of service.

riffles − A shallow section of a stream or river with rapid current and a surface broken by gravel, rubble, or boulders.

riprap − Rock used to protect embankments, streambeds, and shorelines against scour or erosion.

RIVERMorph® − A database software for collecting and processing stream channel measurement data for river assessment/monitoring and engineering applications.

Rosgen Stream Class – A classification system used to divide river reaches into groups that share common physical characteristics as defined in Applied River Morphology (Rosgen 1996).

Scenic Area of Statewide Significance – Area designated by New York State to protect scenic qualities of coastal landscapes.

screen chamber – Structure containing screens capable of capturing debris from aqueduct/reservoir water. A screen chamber is located at the start of the Esopus Cut-and-Cover Tunnel near Ashokan Reservoir.

sedimentary rock − A layered rock, such as limestone or shale, resulting from the consolidation of sediment that has been long buried.

siphon drain blow-offs and blow-off valves − Located at low points in the steel pipe siphon segments to allow water to drain siphon pipes into nearby streams. Each blow-off valve is located in a blow-off chamber, allows water to flow through the blow-off pipes, and is intended to provide drainage of the siphon pipes through siphon drain blow-offs. Blow-off chambers are concrete structures that extend from the below-ground steel pipe siphons to the overlying ground surface.

sluice gate − See *culvert drain sluice gates*.

small-scale wash water treatment system – A temporary system that would treat water used during the biofilm removal process in the Catskill Aqueduct. The system would be located at each of the 10 steel pipe siphons and several proposed boatholes, and would be sized to treat a smaller volume of wash water generated in the immediate work area.

spill – An uncontrolled discharge of water from a reservoir to a downstream waterbody.

spillway – The structure through which excess water flows out of a reservoir when the water surface elevation is above the spillway crest elevation.

spillway rating curve – The relationship between the height of water flowing above the dam spillway (stage height) and flow.

State – New York State

steel pipe siphon chamber − Chambers located at connection points adjoining cut-and-cover tunnels and steel pipe siphons.

steel pipe siphons − Pressurized tunnel segments that run full and convey water across low-lying areas and dip under or over small valleys, railroads, or waterways. They are up to several thousand feet in length and consist of three cement and mortar-lined steel pipes with a diameter ranging from 7 to 9.5 feet that run parallel to one another.

substrate – The material that rests at the bottom of a stream.

surficial aquifer − An unconfined aquifer that is very near the land surface and whose water surface fluctuates with precipitation, evapotranspiration, well withdrawals, and other local hydrology.

toe-of-slope − The lowest part of an embankment slope and refers to the base of cut-and-cover tunnel berms.

transfers – The controlled movement of water between connected reservoirs primarily via natural flow paths for the purpose of supplying drinking water.

transmissive − A relative measure of a unit thickness of an aquifer to transmit a volume of water.

turbidity − An optical property of water influenced by the presence of higher concentrations of suspended particles that make water opaque or cloudy. These particles normally consist of suspended clay, silt, organic and inorganic material, and microscopic organisms. Turbidity is of concern primarily due to its potential effects on public health because the cloudiness could interfere with chlorine and ultraviolet-light disinfection, rendering disinfection less effective. Further, contaminants may adhere to or be encapsulated by the suspended particles.

turbidity curtain − A floating barrier used to contain silt and sediment within the construction zone when performing in-water construction.

unconfined aquifer − An aquifer whose upper water surface (water table) is at atmospheric pressure and thus is able to rise and fall.

unconsolidated − A geologic material whose particles are not cemented together in a solid matrix.

unconsolidated aquifer − An aquifer composed of loosely arranged uncemented particles and grains ranging from clay to sand.

unwater − When an aqueduct is taken out of service for maintenance. Water can be removed from the aqueduct by gravity flow, pumping to a downstream segment, or discharging to surface water through an existing drainage structure (see also *culvert drain sluice gates* and *siphon drain blow-offs and blow-off valves*).

upper Catskill Aqueduct – The first 74 miles of the Catskill Aqueduct, beginning at Ashokan Reservoir in Ulster County, New York, and ending at Kensico Reservoir in Westchester County, New York.

uptake chamber – A chamber located at the end of a pressure tunnel segment and that is a connection point with an adjacent aqueduct segment.

wash water – Water used in the biofilm removal process that would be treated prior to returning it to the Catskill Aqueduct or discharging it to a receiving waterbody.

water surface elevation – The height of the free surface of a reservoir or waterbody in relation to a defined datum.

well yield − Sustainable rate of water flow that a well can draw continuously over an extended period of time.