

9.19 PROJECT-WIDE IMPACT ANALYSIS

This section analyzes the potential for environmental impacts associated with the Catskill Aqueduct Repair and Rehabilitation between Ashokan and Kensico reservoirs that span multiple locations, and are best analyzed on a project-wide basis rather than on an individual basis by town or study area (see **Figure 9.19-1**). Specifically, potential impacts from project-wide work activities to natural resources, and from chlorination and dechlorination to water and sewer infrastructure and public health are analyzed in this section.

9.19.1 NATURAL RESOURCES

This section analyzes the potential for the repair and rehabilitation to change natural resources as a result of the temporary disturbance of coldwater fisheries during construction and, permanent disturbance in regulated water resources as part of long-term operation, and potential alum addition at Kensico Reservoir that may be required to manage minor, temporary increases in turbidity from sloughing of biofilm into water flowing through the aqueduct after initiation of chlorination and biofilm removal.

9.19.1.1 Coldwater Fisheries

Freshwaters along the Catskill Aqueduct contain habitat and conditions suitable for coldwater fisheries. NYSDEC assigns classifications to all waters of the State to denote their best uses, and establishes water quality standards to protect these waters. Best uses may include, but are not limited to, drinking water, swimming, boating, and fishing. In addition, freshwaters with a classification of AA, A, B, and C may also be designated as trout waters (T) or suitable for trout spawning (TS), and are collectively referred to as supportive of coldwater fisheries. Waters with T and TS designations, therefore, have additional requirements in place that are intended to be protective of these resources. These include a general prohibition on in-water activities, referred to as a coldwater fisheries window, during the vulnerable spawning, incubation, and early development period (October 1 to April 30) for trout species with T or TS designations.

Alterations in stream flow associated with in-water construction as part of the repair and rehabilitation can: prevent trout from reaching spawning sites, particularly in small streams; or can leave spawning areas too shallow or exposed, which can also affect benthic macroinvertebrates, the primary food source for trout in early life stages. Similarly, uncontrolled sediment runoff and construction-generated turbidity can smother trout eggs or larvae. Finally, substantial changes in water temperature can also result in potential impacts to trout species. The repair and rehabilitation has been planned to ensure that sensitive aquatic resources within the work sites and at downstream sites are maintained and preserved during construction.

The repair and rehabilitation study areas along the approximately 74-mile-long aqueduct corridor contain surface water that would be accessed during construction. Proposed construction work has been laid out to limit, to the maximum extent practicable, in-stream work during the coldwater fisheries window. However, it is important that the contractors have as large a window as possible for execution of the necessary work. This flexibility is critical due to the amount of work required, the number of sites involved, the need for in-water construction to be completed

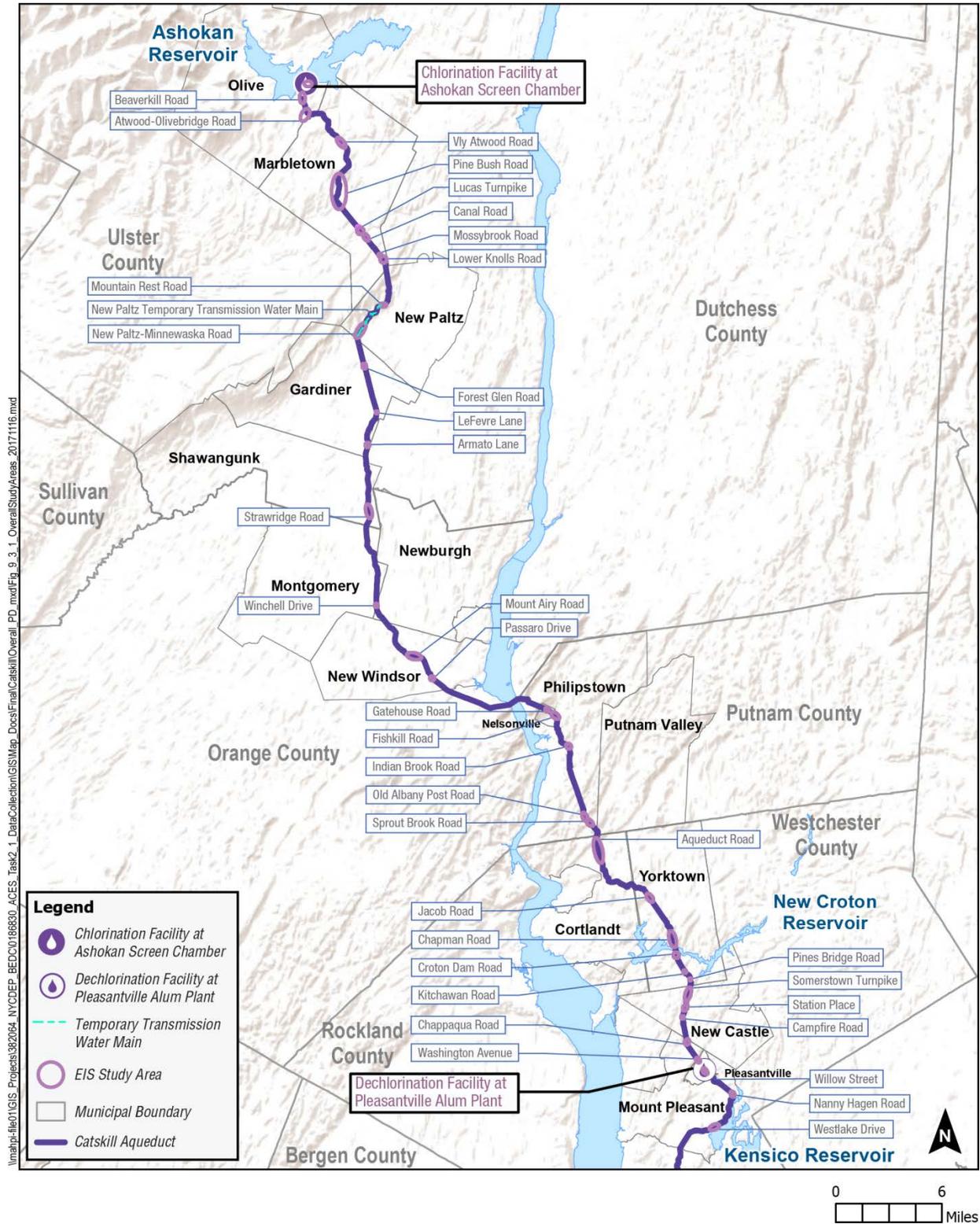


Figure 9.19-1: Catskill Aqueduct Repair and Rehabilitation Study Areas



as a precursor to accessing the aqueduct's interior, and ultimately, the need for all repair and rehabilitation efforts to be completed prior to the Rondout-West Branch Tunnel (RWBT) connection. As a result, it is possible that construction activities may need to occur earlier than, or extend later into, the coldwater fisheries window due to scheduling issues, weather conditions, or other factors that may be out of the control of DEP and its contractors. Therefore, DEP is seeking to acquire the maximum flexibility to schedule and complete work over the duration of construction while balancing this with rigorous measures to protect these natural resources.

An assessment of baseline conditions of aquatic and benthic resources was conducted with a focus on protected coldwater fisheries. The assessment was based on a review of current stream designations, consultations with NYSDEC, and proposed protective measures to be implemented. Stream classifications and standards were confirmed under 6 New York Code of Rules and Regulations (6 NYCRR) Chapter X (Division of Water) and through the use of the Environmental Resource Mapper. NYSDEC fisheries files were obtained and reviewed to further identify sensitive aquatic resources. Finally, NYSDEC 2016 trout stocking records were also reviewed. Additional site-specific input regarding these watercourses and more protective standards recommended by NYSDEC fisheries staff were acquired and incorporated as appropriate. Existing natural and man-made upstream and downstream barriers to fish passage on the watercourses of concern were also identified by a DEP fisheries biologist.

The analyses summarized in this section focused on potential impacts to coldwater fisheries. To be conservative, a total of ten streams were evaluated as coldwater fisheries based on waterbody classifications and additional input from NYSDEC Region 3 and DEP staff knowledgeable of waters along the Catskill Aqueduct. The analyses included evaluation of potential impacts to streams not currently designated as trout-supporting but that had evidence of trout (i.e., relic channel of Esopus Creek).

For waterbodies where no in-water work was anticipated and/or potential work would be avoided through changes in design and construction, no further assessment of aquatic and benthic effects was warranted. Coldwater fishery characteristics where in-water work would occur are summarized in **Table 9.19-1**. These streams would involve in-water construction, including potential activities that may occur during the coldwater fisheries window. A brief discussion of the baseline conditions of streams at and downstream of the proposed work sites is also provided below.

The potential for impacts to aquatic and benthic resources for study areas within Kensico Reservoir (see **Table 9.19-1**) is unique due to its designation as both a warmwater and coldwater fishery. As a result, an analysis of aquatic and benthic resources within Kensico Reservoir, the nature of the proposed work, and the protective measures that would be in place were assessed in Section 9.16.4, "Nanny Hagen Road Study Area Impact Analysis," and Section 9.16.5, "Westlake Drive Study Area Impact Analysis."

Table 9.19-1: Coldwater Fishery Resources with In-Water Work Associated with the Repair and Rehabilitation

Study Area	Surface Water Name	On-Site Classification ¹	Downstream Classification ^{1,2}	Available Trout Habitat in the Natural Resources Study Area
<i>Town of Olive</i>				
Beaverkill Road	Relic Channel of Esopus Creek	Class B	Class B(T)	No spawning habitat; probable trout ³
Atwood-Olivebridge Road	Tongore Creek	Class C(T)	Class B(T)	Perennial stream, no barriers; documented trout spawning ²
<i>Village of Nelsonville</i>				
Fishkill Road	Foundry Brook	Class C(T)	Class C	Perennial stream, natural barrier; stocked annually by NYSDEC; documented trout spawning ²
<i>Town of Philipstown</i>				
Indian Brook Road	Indian Brook	Class C(T)	Class B	Perennial stream, natural and man-made barriers; documented trout spawning ²
Sprout Brook Road	Canopus Creek	Class B(T)	Class B	Perennial stream, no barriers
<i>Town of Cortlandt</i>				
Aqueduct Road	Peekskill Hollow Creek	Class A(TS)	Class B	Perennial stream, no barriers; stocked annually by NYSDEC; documented trout spawning ²
<i>Town of Yorktown</i>				
Jacob Road	Hunter Brook	Class B(TS)	Class AA	Perennial stream, no barriers; documented trout spawning ²
Kitchawan Road	Unnamed Tributary 3 to New Croton Reservoir	Class B(TS)	Class AA	Documented trout spawning ²
<i>Town of Mount Pleasant</i>				
Nanny Hagen Road	Kensico Reservoir ⁴	Class AA	Not Applicable	Stocked annually by NYSDEC; lake trout reproduce naturally; documented trout spawning ²
Westlake Drive	Kensico Reservoir ⁴	Class AA	Not Applicable	Stocked annually by NYSDEC; lake trout reproduce naturally; documented trout spawning ²
<i>Village of Pleasantville</i>				
Washington Avenue	Saw Mill River	Class B(T)	Class C(T)	Perennial stream, no barriers; mud substrate
Notes:				
¹ Based on NYSDEC 6 NYCRR Chapter X.				
² Downstream classifications were noted to identify potential trout habitat downstream of proposed work sites.				
³ Data were provided as part of NYSDEC consultations.				
⁴ Work would be prohibited from September 15 to June 30 to be protective of coldwater and warmwater fisheries resources. See Section 9.16.4, "Nanny Hagen Road Study Area Impact Analysis," and Section 9.16.5, "Westlake Drive Study Area Impact Analysis," for additional analyses.				

The coldwater fisheries that would involve in-water activities associated with the repair and rehabilitation are discussed below. This discussion includes waterbody classifications at and downstream of the proposed work site, physical characteristics including the presence of potential barriers to fish movement, and additional information specific to trout resources:

- **Relic Channel of Esopus Creek** – This stream is located in the Beaverkill Road Study Area. Consultations with NYSDEC indicated that this stream, while currently classified as Class B, should be more accurately considered a Class B(T) stream. Likewise downstream of the work site at the confluence with Esopus Creek, the stream is currently classified as B(T). The relic channel of Esopus Creek within the study area features a narrow channel with a sand and gravel substrate. Based on field studies, the habitat in the study area appears too small and potentially too intermittent to support trout.
- **Tongore Creek** – This Class C(T) stream is located in the Atwood-Olivebridge Road Study Area. Stream features at the work site consist of a sand, gravel, and cobble substrate. The habitat in the study area appears suitable for trout based on the stream depth and gradient, substrate, and temperature, although no trout were observed during field studies. The creek drains to lower Esopus Creek, a Class B(T) water, approximately 1,540 feet (0.29 mile) downstream of the work site.
- **Foundry Brook** – This Class C(T) stream is located in the Fishkill Road Study Area. The stream in the study area features a sand and cobble substrate. NYSDEC recommended that this site be considered as a Class C(TS) stream. The stream is currently designated as a Class C(T) water from the proposed work site to a point approximately 5,420 feet (1.03 miles) downstream where the brook becomes a Class C stream. The stream is stocked annually by NYSDEC with brown trout. Seasonal survival (carry over) is minimal, and no evidence of successful reproduction has been observed. There are, however, both man-made (upstream) and natural (downstream) barriers to fish passage.
- **Indian Brook** – Indian Brook is a Class C(T) stream located in the Indian Brook Road Study Area. NYSDEC staff recommended that this site be considered a Class C(TS) stream because wild brown trout are present in the brook. The stream features a sand, gravel, and cobble substrate in the study area. There are both man-made and natural barriers to fish passage downstream of the work site. The stream is a Class C(T) waterbody from the proposed work site to its confluence (approximately 2,050 feet [0.39 mile] downstream) with the Hudson River (Class B).
- **Canopus Creek** – This Class B(T) stream is located in the Sprout Brook Road Study Area. The stream has little gradient and features a mud, sand, and cobble substrate at the work site. Habitat at the work site does not appear to be suitable for trout due to its low gradient and observations of warmwater fish species, including white sucker (*Catostomus commersonii*), largemouth bass (*Micropterus salmoides*), fallfish (*Semotilus corporalis*), and creek chub (*Semotilus atromaculatus*). No trout were observed during field visits. Brook trout, however, are present in the headwaters (Fahnestock State Park) of the stream. The stream is Class B(T) from the work site to a point approximately 6,530 feet (1.24 miles) downstream, where the stream designation changes to Class B.

- **Peekskill Hollow Creek** – This Class A(TS) stream is located in the Aqueduct Road Study Area and features a sand, gravel, and cobble substrate at the proposed work site. The stream is stocked annually by NYSDEC with brown trout. The streambed and its banks were observed to be heavily scoured, and no suitable trout-spawning habitat was present at the proposed work site. The stream maintains a Class A(TS) designation from the work site to a point approximately 4,920 feet (0.93 mile) downstream, where the stream is listed as Class B.
- **Hunter Brook** – Hunter Brook is designated as Class B(TS) and is located in the Jacob Road Study Area. The stream is characterized by a sand, gravel, and cobble substrate at the work site. No trout were observed during field studies, although brook trout are present in the headwaters upstream of U.S. Route 202, approximately 4,300 feet (0.81 mile) from the work site. However, an impassable barrier (Mill Pond Dam) is approximately 1,320 feet (0.25 mile) upstream of the work site. Brown trout may also ascend the stream from the receiving waterbody, New Croton Reservoir (a Class AA waterbody), that is approximately 9,158 feet (1.73 miles) downstream.
- **Unnamed Tributary 3 to New Croton Reservoir** – This Class B(TS) stream is located in the Kitchawan Road Study Area. The stream features a sand, gravel, and cobble substrate at the proposed work site. Brown trout may ascend the stream from New Croton Reservoir (Class AA) located approximately 5,040 feet (0.95 mile) downstream.
- **Saw Mill River** – This Class B(T) stream is located in the Washington Avenue Study Area. The stream has historically been stocked with trout by NYSDEC. The stream has little gradient at the proposed work site and has a mud and silt substrate and aquatic plant growth. No trout were observed during field studies. The stream maintains its Class B(T) designation to a point approximately 12,760 feet (2.42 miles) downstream of the work site, where it is listed as Class C(T). A reach of the stream approximately 60,710 feet (11.5 miles) downstream of the work site is listed as a Class A waterbody by NYSDEC. Reaches farther downstream and at its confluence with the Hudson River are designated as Class SB waters.

In the future without the repair and rehabilitation, it is assumed that aquatic and benthic resources would largely remain the same as baseline conditions, with the exception of possible changes in habitat due to natural vegetative succession and general anthropogenic influences. Ecological communities would generally remain a mix of upland and wetland habitats similar to other areas along the Catskill Aqueduct.

Analysis of Potential Effects

The waterbodies shown in **Table 9.19-1** would involve in-water work activities and/or represent locations where flexibility is required to allow for work during the coldwater fisheries window. Proposed work activities at these locations would generally include, but not be limited to, the following:

- Staging and access road improvement – tree clearing and grading, installation of temporary access measures, and erosion and sediment control features;

- General erosion control measure placement – silt fence and hay bale lines;
- Stream diversions – placement of “cofferdam” structures to create an area isolated from the stream flow to allow construction activities, consisting of jersey-barrier-type features, gabion boxes, or sandbags for partial diversions at several locations;
- Localized construction dewatering – placement of jersey barriers and sandbags, and placement of a sump pump and silt trap/unwatering bag;
- Bridge repair – repairs to the bridge crossings that house steel pipe siphons;
- Blow-off chamber reconstruction – reconfiguration of blow-off chambers and valve pipes;
- Culvert drain sluice gate replacement – streambank protection throughout the duration of construction; and
- Streambank restoration and protection – installation of permanent riprap aprons and gabion retaining walls in and along streams, and reseeding and replanting.

To minimize potential in-water effects at all locations and, in particular, those associated with coldwater fisheries, the repair and rehabilitation integrated methods to avoid the need for and/or reduce the duration of in-water work. Typical and enhanced protective measures were identified that would be put in place as part of the proposed work activities to minimize potential effects associated with in-water activities that were required. Proposed diversions would be limited, and where practicable, only partial diversions would be used. For understream steel pipe siphon sites, blow-off chamber reconstruction and streambank protection, work would require a partial diversion. Likewise, at the over-stream steel pipe siphon sites (i.e., Tongore, Foundry Brook, and Indian Brook bridges), bridge repairs, while primarily conducted from the top of the aqueduct (upgradient), and work required to widen existing 12-inch-diameter drains to 24-inch-diameter drains to accommodate larger discharge pipes would also require a partial diversion. Partial diversions required at all steel pipe siphon sites would be limited to no more than 40 percent of the existing stream width, leaving adequate area for both flood flow and aquatic life passage.

In addition, the Peekskill Steel Pipe Siphon in the Aqueduct Road Study Area is anticipated to require construction during the coldwater fisheries window, and enhanced protective measures would be implemented to protect in-stream habitat. In-stream work at Peekskill Hollow Creek would consist of repairs to the blow-off chambers and installation of riprap aprons along the southern streambank. A partial diversion with a turbidity curtain to maintain fish passage would be installed prior to October 1 to avoid impacts to possible trout-spawning habitat in the immediate work site. Based on observations made during field visits, the work site contains marginal habitat for trout based on shallow water depth, lack of in-stream cover, and a primarily sand substrate. Therefore, no adverse impact to trout or trout spawning is expected should in-stream work be required within the coldwater fisheries window.

Proposed work associated with the existing 24-inch-diameter culverts at the culvert drain sluice gate sites does not lend itself to a partial diversion. While installation of a diversion system for the smaller watercourses would involve some stream disturbance, it is preferable to complete the short-term work quickly and restore the area as expeditiously as possible. Therefore, it would be

less disruptive to fully divert these watercourses for short periods of time. The unnamed tributary 3 to New Croton Reservoir in the Kitchawan Road Study Area has a coldwater fisheries designation and requires a full diversion. However, DEP would complete this work outside of the coldwater fisheries window (e.g., during the summer months). Therefore, no full diversions would result in impact to coldwater fisheries.

In-water work involving a full diversion would not commence if heavy rainfall is forecast within the next 24 hours or if a heavy rainfall has occurred within the past 48 hours. Required full diversions, where necessary, would likely be for no more than a few days. It is also probable that some of the smaller watercourses would not be flowing during the preferred construction timeframe (summer), and there would be no potential effects associated with turbidity and sedimentation.

Potential water temperature changes related to construction and unwatering (in-water or upland) activities are not anticipated. In the short term, discharges of decant water would be low in volume and would not affect the ambient stream temperature. The seals on any in-water diversion structures would also limit water infiltration, thus reducing the volume and duration of decanting required. Water associated with any construction unwatering would be removed on an ongoing basis and not be allowed to accumulate in any considerable volume prior to discharge. As a result, the water is not anticipated to be substantially different in temperature from the receiving waters. Likewise, release of raw water from the aqueduct during unwatering events is also not anticipated to result in substantial changes in stream temperatures. Raw water discharges would be expected in the fall and the temperature of raw water (an average of 50°F) would be comparable to fall in-water temperatures within the receiving streams.

Tree removal along streams for the repair work would be minimal and is not expected to result in any notable temperature changes. While tree removal is proposed for access along streams such as Sprout Brook, Peekskill Hollow Creek, and Hunter Brook, the area involved and existing stream flows would minimize any potential warming effect, and no measurable temperature changes are anticipated.

For sites where in-water work during the coldwater fisheries window is unavoidable, standard and enhanced protective measures, as noted previously and below, would be used to ensure that aquatic resources are protected. As applicable, these would include the following:

- Partial stream diversions would encompass no more than 40 percent of a stream width to maintain fish passage throughout construction. Partial or full stream diversions would be constructed from jersey barrier-type features, gabion boxes, or sandbags. For all three alternatives, an impermeable, flexible barrier (rubber or plastic) would be used to provide a watertight seal around the barrier to reduce infiltration into the work site. This protective measure would be used on all streams requiring some form of diversion.
- Implementation of partial and/or full stream diversion structures (e.g., jersey barriers, gabion boxes, sandbags) would be placed prior to October 1 where possible.
- Stream diversion measures would be removed as soon as in-water work and streambank stabilization is completed or as soon as practicable.

- In-water construction would avoid both critical spawning habitats and seasons to the maximum extent practicable.
- Tree removal would be kept to the minimum necessary for safe access to the work sites.
- Decant water collected from work sites (in-stream “cofferdams” or upland) would be treated prior to discharge as necessary. Flows of decant water from work sites would not cause erosion or scouring to the bed and banks of the receiving waters. Decant waters would be discharged on an ongoing basis to avoid potential temperature issues associated with longer-term retention of these waters.
- Temporary stream crossings or access points would be designed to limit or preclude any streambed or bank damage, and areas would be returned to pre-construction elevations.
- Erosion control features would be deployed and maintained during construction and would be removed upon completion of the work.
- Turbidity curtains would be used where appropriate to limit the extent of any stream disturbance or temporary increases in turbidity.
- Any construction-related debris would be removed from the watercourse as part of the repair work and disposed of at an off-site, upland location.

In addition to proposed work within or adjacent to waterbodies that are currently designated as supporting, or known to potentially support trout fisheries based on consultation with NYSDEC and DEP fisheries biologists, the NYSDEC classifications of stream reaches downstream of proposed repair and rehabilitation work activities were also considered. Particular attention was focused on waterbodies where there is a trout standard at some point downstream of the proposed work site, but not necessarily at the work site. Six stream locations have downstream trout classifications: Hendricks Killitje (Vly Atwood Road Study Area), Silver Stream (Mount Airy Road Study Area), unnamed tributary 2 to Cornell Brook (Somerstown Turnpike Study Area), unnamed tributaries 2 and 3 to Pocantico River (Campfire Road and Chappaqua Road study areas, respectively), and unnamed tributary 1 to Nanny Hagen Brook (Pleasantville Alum Plant Study Area). Work activities within the portions of these six streams that are not coldwater fisheries would primarily involve the restoration of riprap aprons at culvert drain sluice gates. The downstream coldwater fisheries, however, are approximately 1,000 feet (0.19 mile) or more from the proposed work sites. As a result, potential effects to these coldwater fisheries would not be expected due to: their distance from the work sites; the protective measures that would be in place that would limit potential effects to the immediate vicinity of the work sites; the short-term nature of the work; and the expectation that the work at these locations could be accomplished during the summer under low-flow conditions. Likewise, no substantial change in stream temperatures is anticipated, as decant waters would be discharged on a recurring basis rather than being allowed to accumulate.

Summary

Protective measures would be put in place at all locations that involve proposed in-stream work or work in close proximity to coldwater fisheries. Likewise, as noted, partial diversions would provide adequate area for both flood flow and fish passage, and would not result in significant adverse impacts to fish. These, and additional protective measures, would be implemented for in-water work and work adjacent to streams supporting coldwater fisheries. This, in conjunction with the flexibility to conduct work during the coldwater fisheries window where needed, would allow construction of the repair and rehabilitation to eliminate or minimize potential impacts to these resources and reduce the overall timeframe for in-water work. This approach would also ensure that the work is completed prior to the RWBT temporary shutdown, and would preclude the possibility of splitting the work season to accommodate the coldwater fisheries window. Splitting the work season would potentially result in the need for additional mobilization and demobilization at the work sites that would impact schedule and potentially result in additional disturbance at these sites.

Upon completion of the repair and rehabilitation, operation of the Catskill Aqueduct would be similar to baseline conditions, and temporarily disturbed areas would be restored to baseline conditions. No measurable, long-term effects are anticipated to water resources or the aquatic and benthic communities they support, and any short-term disturbance during construction would be restricted to the active work sites.

9.19.1.2 Excavation and Fill in Regulated Water Resources

The repair and rehabilitation study areas along the approximately 74-mile-long aqueduct corridor contain numerous wetlands and waterbodies and their associated State- and town-regulated buffers and adjacent areas. Work activities associated with the repair and rehabilitation would require minor fill and excavation within these regulated water resources. DEP has taken measures to avoid and minimize these impacts to the extent possible. Wherever practical, work would be conducted from within the aqueduct tunnel to avoid temporary and permanent disturbance to regulated water resources. Construction and operational access routes were selected to avoid or minimize impacts to these resources. All new structures generally would be built within the footprint of existing structures. Following work activities, most study areas would be restored to baseline conditions unless otherwise noted, and all construction equipment would be removed from the sites.

Any new and rehabilitated structures would also be designed to reduce and avoid watercourse impacts when compared to baseline conditions, in many cases by replacing prior scour control measures that existed at the sites in the past. Newly reconfigured piping would be located below grade and discharged to an outlet protected with riprap to prevent potential future scouring.

While potential impacts are discussed within each study area, a summary of overall permanent disturbance to wetlands, watercourses, and their NYSDEC- or municipal-regulated buffers or adjacent areas is presented in this section on a project-wide basis. Permanent disturbance was generally defined as permanent cut or fill associated with access road improvements or blow-off chamber reconstruction, new streambank restoration and protection, and permanent changes to water resources following leak repair. The anticipated permanent disturbance to water resources is presented by study area and resource type in **Table 9.19-2**. A total of approximately 1.59 acres

of regulated water resources (wetlands, watercourses, and buffers) across 37 study areas would be permanently affected by the repair and rehabilitation. No effects are anticipated in 22 of the study areas, and only minor permanent disturbances are anticipated in the remaining 15 study areas. Approximately 0.08 acre of this total would encompass direct disturbance to wetlands and 0.08 acre would involve watercourses. The majority of this wetland disturbance would be associated with only one location, the Croton Dam Road Study Area (0.07 acre). The remaining 1.43 acres would involve disturbances only within municipal and/or NYSDEC-regulated wetland and watercourse buffers that primarily would be established to provide protection to the higher value wetlands or streams that they border.

The majority of the permanent disturbance to watercourses would be due to grading activities at steel pipe siphon sites that would result in the temporary loss of vegetation and the modification of existing topography at individual sites. Regraded areas associated with blow-off chamber reconstruction and piping would be revegetated with native species that would largely restore these sites to baseline or improved conditions and restore habitat value at these sites. The remaining estimated permanent disturbances would be comprised of riprap aprons, which would be installed to protect streambanks from potential scour during an aqueduct-unwatering event, and gabion retaining walls, which would protect the upgraded infrastructure immediately adjacent to these streams. Approximately 0.03 acre of the buffer disturbance, or 2 percent of the total buffer area, would be associated with these streambank protection measures. As a result, while these would represent a permanent effect or change due to the repair and rehabilitation, the impact to existing natural resources in these areas would be largely temporary in nature as the majority of the buffer area at these locations would be planted with native species at the conclusion of the proposed work and/or would revegetate naturally, representing a restoration to baseline conditions in these regraded locations. With the exception of a new access road at the Sprout Brook Road Study Area in the Town of Philipstown and the streambank protection (i.e., riprap and gabion retaining walls), no new structures or impervious surfaces would be constructed within regulated watercourses or their associated buffers.

The largest anticipated effect to wetlands during the repair and rehabilitation would primarily be due to changes in wetland hydrology following repair of a leak in the Catskill Aqueduct. In the Croton Dam Road Study Area, the location of the largest anticipated wetland disturbance, an unmapped wetland (Wetland 7-WL, 0.07 acre) has developed and been artificially sustained by flow from Leak 7. Following leak repair of the existing water supply infrastructure, this wetland is anticipated to gradually transition to upland habitat. The wetland is currently protected within 100 feet of its boundary by Town of Yorktown regulations, and after the wetland transitions to upland habitat, this municipal wetland buffer would no longer be applicable. Wetland 7-WL provides the following functions and values: groundwater recharge, nutrient removal, and wildlife habitat.

As Wetland 7-WL changes over time in response to the cessation of leak flows, it is assumed that these wetland functions would be eliminated and the site would remain vegetated. Therefore, there are no anticipated adverse habitat changes within the existing municipal wetland buffer. Naturally occurring wetlands along New Croton Reservoir and its tributaries would be unaffected by the leak repair and would continue to provide functions and values following the repair and rehabilitation.

Table 9.19-2: Catskill Aqueduct Repair and Rehabilitation – Permanent Water Resources Disturbance

Study Area	Location	Wetland (Acres)	Watercourse (Acres)	Municipal Buffer (Acres)	State Watercourse Buffer (Acres)	State Wetland Buffer (Acres)
Aqueduct Road	Peekskill Steel Pipe Siphon	0.00	0.01	0.16	0.11	0.00
Atwood-Olivebridge Road	Tongore Steel Pipe Siphon	0.00	0.00	0.00	0.06	0.00
Beaverkill Road	Esopus Steel Pipe Siphon	0.00	< 0.01	0.00	0.10	0.00
Chapman Road	Turkey Mountain Steel Pipe Siphon	0.00	< 0.01	0.09	0.09	0.00
Croton Dam Road	Leak 7	0.07	0.00	0.00	0.00	0.00
Fishkill Road	Foundry Brook Steel Pipe Siphon	0.00	< 0.01	0.00	0.07	0.00
Indian Brook Road	Indian Brook Steel Pipe Siphon	0.00	0.01	0.25	0.19	0.00
Jacob Road	Hunters Brook Steel Pipe Siphon	0.00	0.03	0.08	0.08	0.00
Lucas Turnpike	Leaks 3A, 3B, 4, and Private Well	0.00	0.01	0.00	0.00	0.00
Mossybrook Road	Shaft 7 Leak	< 0.01	0.00	0.00	0.00	0.00
Mount Airy Road	Washington Square Steel Pipe Siphon	0.00	0.01	0.14	0.14	0.00
Nanny Hagen Road	Catskill Influent Chamber	< 0.01	0.00	0.07	0.04	0.00
Sprout Brook Road ¹	Sprout Brook Steel Pipe Siphon	0.01	0.00	0.19	0.18	0.19 ³
Washington Avenue	Harlem Railroad Steel Pipe Siphon	0.00	< 0.01	0.19	0.19	0.00
Westlake Drive	Catskill Kensico Bypass	0.00	0.00	0.02	0.02	0.00
Total		0.08	0.08	0.48 ²	0.76 ²	0.19 ^{2,3}
Total Wetland Disturbance		0.08				
Total Watercourse Disturbance			0.08			
Total Buffer Disturbance					1.43 ³	
Total Disturbance to Regulated Water Resources (Wetlands, Watercourses, and Buffers)				1.59 ³		

Notes:

Excludes temporary disturbance and repairs to leak flowpaths; all estimates have been rounded to the nearest hundredth.

¹ NYSDEC-regulated wetland.

² In instances where regulated buffers are imposed by both NYSDEC and a municipality, estimated disturbance to the buffers is duplicative because they cover the same footprint. For example, both NYSDEC and the Town of New Windsor regulate a 50-foot buffer along protected watercourses in the Mount Airy Road Study Area; therefore, the 0.14-acre State watercourse buffer was included in the total (bold value), while the overlapping area regulated by the town (non-bold) was excluded from this analysis. Bold values represent the largest of these buffer areas, which were summed to represent the total regulated buffer disturbance excluding duplicative areas of regulated buffers.

³ State wetland buffer captures the overlap with the estimated municipal buffer disturbance (0.18 acre). In addition, the total value is inclusive of an additional 0.01 acre of State wetland buffer disturbance for a total disturbance of 0.19 acre.

Similarly, the largest anticipated affect to State-regulated wetland buffers would occur in the Sprout Brook Road Study Area. A portion of the Class I NYSDEC Wetland PK-3 is located in this study area, and Canopus Creek (NYSDEC Class B[T]) flows through the study area. These resources are further protected by the regulation of activities within 100 feet of their boundaries by NYSDEC and/or the Town of Philipstown. Development of an access road necessary to maintain the Sprout Brook Blow-off Chambers would result in approximately 0.19 acre of permanent disturbance to these resources (wetland and stream buffer/adjacent areas). Wetland impacts at this site would be approximately 0.01 acre.

The natural resources study areas for the repair and rehabilitation contain approximately 66 acres of regulated wetlands, watercourses, and their associated buffers. Most of these water resources extend well beyond the boundaries of the study areas. Avoidance and minimization measures have resulted in work plans that would result in relatively minor permanent effects to water resources. It is estimated that less than 1 percent of the on-site wetlands and about 2 percent of the watercourses would be permanently disturbed by the repair and rehabilitation activities. Further discussion of the work activities and potential impacts to water resources in each town or village can be found in Section 9.4, “Town of Olive,” through Section 9.18, “New Paltz Temporary Transmission Water Main.” 9.17, “Village of Pleasantville.”

9.19.1.3 Biofilm-Related Alum Application at Kensico Reservoir

Biofilm sloughing could occur as a result of temporary chlorination at Ashokan Reservoir in advance of biofilm removal as part of the repair and rehabilitation. Likewise, the majority of biofilm would be removed through mechanical biofilm removal, but there may be minor amounts of residual biofilm remaining after mechanical biofilm removal is complete that could cause temporary increases in turbidity within water flowing through the aqueduct.

Estimates of biofilm sloughing over a short time period (i.e., 1 week) and under low-flow conditions, which would correlate with higher concentrations of resulting turbidity, indicate the anticipated reasonable worst-case scenario turbidity level is around 30 Nephelometric Turbidity Units (NTU). The chances of the sloughing occurring over such a short timeframe is conservative and would be different from anything reported in the literature or through utility surveys conducted as part of a desktop study. Significant dilution of biofilm that may be associated with sloughing would be anticipated even if it enters the water. Potential turbidity levels from biofilm sloughing are anticipated to be more in the range of 3 to 7 NTU at a maximum.

Potentially small increases in turbidity from residual biofilm are anticipated to be comparable to turbidity associated with shutdown and restarting of the Catskill Aqueduct that occurs during routine maintenance and inspection activities. These have not resulted in significant increases in turbidity in the past. Likewise, the level of dilution that would occur within the aqueduct would also be significant once raw aqueduct water is reintroduced at the completion of each 10-week shutdown. This would further reduce the potential for high (or even measurable) turbidity within water flowing through the aqueduct.

The Catskill Aqueduct discharges into a small cove in Kensico Reservoir. To address potential turbidity increases at Kensico Reservoir from biofilm sloughing or residual biofilm, DEP, as an extra precaution, would have the ability to use alum in small volumes over short periods of time

(e.g., less than a week following each 10-week shutdown), to respond to any elevated levels of turbidity, should they be observed. When alum has been added to water as it leaves the Catskill Aqueduct, the primary area of alum deposition at Kensico Reservoir is within the cove itself. DEP has used alum as a treatment strategy for controlling turbidity entering Kensico Reservoir for many years. Geophysical surveys of the reservoir bottom conducted by DEP indicate that alum deposition is constrained to the northwest corner of the reservoir. Alum deposition accumulates on the reservoir bottom. Benthic sampling conducted in 2007 and 2014 identified no significant adverse impact to the benthic community from prior alum treatment by DEP and corresponding alum deposition (WSSO Section 10.4.6.10).

As discussed in WSSO Section 10.4.6.10, alum addition necessary to support the temporary RWBT shutdown did not have a significant adverse impact to the benthic community within the reservoir. The minor amount of alum addition that may be required to treat temporary increases in turbidity from biofilm sloughing or residual biofilm is anticipated to be far less than alum addition required to respond to increased turbidity within water diverted through the Catskill water supply system to support the RWBT temporary shutdown. Any additional deposition of alum as a result of treating biofilm sloughing or residual biofilm would be limited and only if alum is required, and would occur within the same area in the cove as prior events. Therefore, it is not anticipated that the addition of alum to Kensico Reservoir, if needed, to respond to turbidity that may be associated with potential biofilm sloughing or residual biofilm would have a significant adverse impact on benthic resources within Kensico Reservoir.

9.19.2 CHLORINATION AND DECHLORINATION

Biofilm removal is the primary activity that would allow for additional capacity in the Catskill Aqueduct during the RWBT temporary shutdown. Therefore, to remove biofilm and limit regrowth for the duration of the temporary shutdown, one of two chlorine-based chemicals, sodium hypochlorite or chlorine dioxide, would be added to the aqueduct via a proposed chlorination facility located at the Ashokan Screen Chamber and removed via a proposed dechlorination facility located at Pleasantville Alum Plant (see Section 9.2, “Project Description”). Only one of these chemicals would be added at any given time (for the purposes of this FDEIS, the term chlorination is used to address the use of either chemical by DEP). To ensure that water delivered via the Catskill Aqueduct is in compliance with safe drinking water standards as regulated by the New York State Department of Health, the chemical added and its corresponding dose would vary depending on seasonal and operating conditions, as described below. Construction of both the chlorination and dechlorination facilities would commence in 2018~~2017~~, and the facilities are anticipated to be completed and in operation by mid-2020~~2019~~ in advance of biofilm removal.

Chemical oxidants and disinfectants such as those proposed to be added at the Ashokan Screen Chamber are commonly used to control biofilm and prevent bacteria growth in water systems. The excess amount of oxidant remaining after oxidation reactions are complete is referred to as a residual.

While both chemicals can be used to control biofilm, during some hydrologic conditions (e.g., late summer when average water temperature is higher), sodium hypochlorite forms a greater amount of disinfection by-products (DBPs) than chlorine dioxide. DBPs are undesirable compounds that form when oxidants react with other naturally occurring materials in the water.

Accordingly, chlorine dioxide would be used under appropriate conditions as an alternative to sodium hypochlorite to limit DBP formation.

The particular DBPs that form would depend on which one of the two chemicals is added, and the location of the water along the Catskill Aqueduct. This potential for DBP formation is relevant for the City and Kensico Reservoir and for the Outside Community Connections that draw water at various points along the Catskill Aqueduct north of Kensico Reservoir (see “Outside Community Connections” in Section 9.19.2.3, “Public Water Supply Infrastructure”) and for other locations along the aqueduct where discharges would occur.

To ensure that water discharged into Kensico Reservoir meets State water quality standards, sodium bisulfite would be added at a new dechlorination facility at the Pleasantville Alum Plant to remove sodium hypochlorite, chlorine dioxide, and/or chlorine residuals from the treated water. In addition, several leaks along the length of the aqueduct would be repaired as part of the repair and rehabilitation. These repairs, if successful, would eliminate existing leaks from the aqueduct. This, in turn, would prevent the discharge of treated water before it enters the environment during testing and operation of the chlorination facility. Local dechlorination systems would be installed at locations where leak repairs are not feasible or prove unsuccessful, and at two connection chambers for the City of Newburgh and the Village of New Paltz water supply systems. While residuals would be removed via dechlorination at the leak locations, chambers, and Pleasantville Alum Plant to meet applicable standards, there would be a discharge of sodium hypochlorite and chlorine dioxide-related DBPs and chloride at these locations.

A maximum dose for both sodium hypochlorite and chlorine dioxide was selected to achieve the goals of the project and are at or below applicable MRDLs, while limiting the potential effects to Outside Community Connections, the City, and natural resources. These maximum doses were determined through comparison of potential residual and DBP concentrations with applicable Safe Drinking Water Act and Clean Water Act standards, and are analyzed herein. However, it is important to note that the maximum doses of either chemical necessary to potentially reduce the extent of biofilm in advance of its removal would be required only for a relatively short duration. Maintaining the aqueduct’s capacity would represent the more typical operating condition, which would require a low dose of either chemical to maintain the increased capacity of the Catskill Aqueduct and limit biofilm regrowth. As noted earlier, only one chemical would be used at any time. The proposed doses, relative to the two operating conditions, are as follows:

- Potentially reducing the extent of the biofilm in advance of biofilm removal would correspond to a maximum dose of 1.25 mg/L of sodium hypochlorite or 0.8 mg/L of chlorine dioxide.
- Maintaining the increased Catskill Aqueduct capacity after biofilm removal to limit regrowth would require a low dose, ranging from approximately 0.25 mg/L to 0.5 mg/L for both sodium hypochlorite or chlorine dioxide.

Finally, several days before any unwatering of the Catskill Aqueduct (e.g., for biofilm removal during the third 10-week shutdown), chlorination would temporarily cease. As discussed previously, this would ensure that no sodium hypochlorite, chlorine dioxide, and/or chlorine residuals are in the aqueduct when it is unwatered (i.e., raw aqueduct water would be suitable for discharge to surface water).

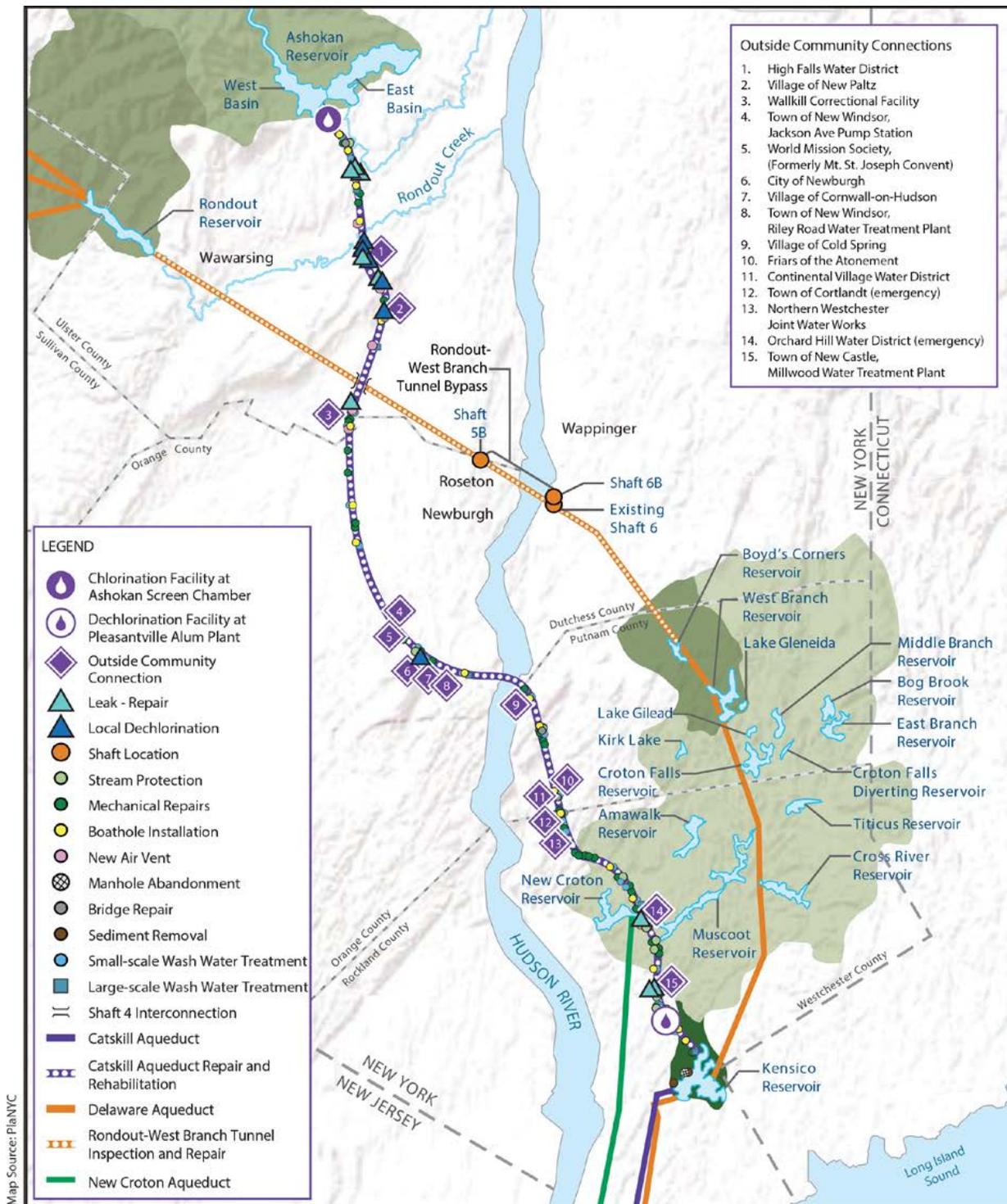
Chlorination would commence by mid-~~2020~~2019, in advance of biofilm removal during the third 10-week shutdown of the Catskill Aqueduct. The water quality resulting from implementation of the proposed chlorination and dechlorination is anticipated to be well within regulated drinking water limits, as further described in Section 9.19.2.5, “Public Health.” Nonetheless, there is the potential for sodium hypochlorite, chlorine dioxide, and/or chlorine residuals, chloride and DBPs to affect the 15 Outside Community Connections that receive water supply from the Catskill Aqueduct and which serve approximately 20 communities (see **Table 9.19-3** and **Figure 9.19-2**). In addition, there is a potential for impacts from discharges of DBPs and chloride formed within the aqueduct as a result of chlorination at locations where water from the aqueduct enters the surrounding environment. Therefore, a project-wide analysis of the potential for repair and rehabilitation to result in significant adverse impacts to water supply infrastructure is presented in this section.

Table 9.19-3: Outside Community Connections to the Catskill Aqueduct

Location	Water Supply Connections
West-of-Hudson	High Falls Water District ¹
	Village of New Paltz ¹
	Wallkill Correctional Facility
	Town of New Windsor, Jackson Avenue Pump Station ¹
	World Mission Society (formerly Mount Saint Joseph Convent)
	City of Newburgh ¹
	Village of Cornwall-on-Hudson ¹
	Town of New Windsor, Riley Road Water Treatment Plant ¹
East-of-Hudson	Village of Cold Spring
	Friars of the Atonement
	Continental Village Water District ¹
	Town of Cortlandt (emergency)
	Northern Westchester Joint Water Works ¹
	Orchard Hill Water District (emergency)
	Town of New Castle, Millwood Water Treatment Plant ¹
Note:	
¹ These Outside Community Connections rely on the Catskill Aqueduct as their primary supply of drinking water (primary users). All other communities use the Catskill Aqueduct as a back-up supply (secondary users). Note that the City of Newburgh, which typically uses the Catskill Aqueduct as a back-up water supply source, will begin to use this water as a primary source for the foreseeable future.	

9.19.2.1 Background on Disinfection By-products (DBPs) and Chloride

The DBPs formed as a result of sodium hypochlorite addition to water include a class of compounds collectively identified as trihalomethanes (THMs) and haloacetic acids (HAAs) (see **Table 9.19-4**). These constituents are regulated under the Safe Drinking Water Act through the EPA’s Stage 2 Disinfectant and DBP Rule (Stage 2 D/DBP Rule), which sets a Maximum Contaminant Level (MCL) for chlorinated DBPs within distribution systems. The Stage 2 D/DBP Rule sets MCLs for chlorinated DBPs within the distribution system as 80 µg/L for THMs and 60 µg/L for HAAs. The formation of THMs and HAAs is closely tied to temperature, pH, and water quality. Based on historical DBP results for New York City, there may be a potential for the proposed addition



Map Source: PlaNYC

Note: Fourteen identified leaks are located along the upper Catskill Aqueduct. Should any additional leaks be identified along the Catskill Aqueduct, DEP will repair the leak or provide local dechlorination. Biofilm removal is proposed along the interior of the aqueduct within cut-and-cover tunnels, grade tunnels, and steel pipe siphons. Access to the aqueduct would be provided by access manholes, new and existing boatholes, duntake chambers, and other locations that allow entry into the aqueduct. These locations are not all shown on this figure for clarity.

Not To Scale
For Illustrative Purposes Only

Figure 9.19-2: Outside Community Connections to the Catskill Aqueduct



of sodium hypochlorite at the Ashokan Screen Chamber to cause an exceedance of the Stage 2 D/DBP MCLs under certain conditions. Since implementation of the Stage 2 D/DBP Rule, operation and treatment of the City's water supply system has been adjusted to lower the potential for exceedances of the HAA MCL. Although the City is continuing to adjust operations to minimize DBP concentrations, the repair and rehabilitation has the potential to increase concentrations of HAAs in the distribution system, and must be closely analyzed.

Table 9.19-4: Disinfection By-products

Disinfection Agent	Disinfection By-products
Sodium Hypochlorite	THMs
	HAAs
Chlorine Dioxide	Chlorite
	Chlorate

While THMs and HAAs are the main DBPs associated with sodium hypochlorite addition, chlorite and chlorate are well-documented by-products of chlorine dioxide treatment. They are formed as chlorine dioxide reacts with reduced inorganic compounds and naturally occurring organic matter in water supplies (see **Table 9.19-4**). While not a DBP, chloride is also formed. Therefore, the Stage 1 DBP Rule was promulgated in 1998 with a Maximum Residual Disinfectant Level (MRDL) for chlorine dioxide of 0.8 mg/L and an MCL for chlorite of 1.0 mg/L. Chlorate levels that form as a by-product of chlorine dioxide dosing are typically lower than those for chlorite, at or below approximately 20 percent of the original chlorine dioxide dose (Andrews et al. 2005). A 2009 University of Toronto study for the Catskill Aqueduct water supply showed less than 10 percent of the chlorine dioxide that had reacted within 24 hours was converted to chlorate. Though not currently regulated, chlorate is included in the EPA's monitoring of unregulated contaminants and is on the agency's Contaminant Candidate List. Chlorate can form as a by-product of chlorine dioxide treatment, and as a by-product of the system used to generate the chlorine dioxide. However, the chlorine dioxide generation system proposed at the Ashokan Screen Chamber (i.e., the Purate® system), uses a method that does not result in chlorate formation during generation. Therefore, this analysis considers only the potential for chlorate formation through treatment with chlorine dioxide.

Unlike DBP concentrations for drinking water, the majority of DBPs are not regulated under the Clean Water Act, which sets forth water quality standards and the concentrations for various contaminants of concern in the environment. There is, however, a State water quality standard for chloroform, a THM. For Class A waters this is 7 µg/L. There are also guidance values set for two other THMs, dibromochloromethane and bromodichloromethane, under the State's Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1. These guidance values are 5 µg/L and 50 µg/L, respectively. Chlorine dioxide-based DBPs do not have specific State water quality standards.

In addition to DBPs, chloride would also be formed when either sodium hypochlorite or chlorine dioxide are added to the aqueduct. Chloride does have a standard of 250 mg/L.

For the impact analysis, regulatory limits were compared to anticipated concentrations of these DBPs and chloride as a result of chlorination. For the purposes of this analysis, projected

conservative estimates of DBP concentrations and chloride associated with chlorination are as follows:

- At the maximum sodium hypochlorite dose of 1.25 mg/L, concentrations are anticipated to be slightly less than 30 µg/L for THMs and 30 µg/L for HAAs, depending on flow and associated time of travel time for water within the aqueduct.
- A maximum chlorine dioxide dose of 0.8 mg/L would limit the maximum chlorate concentration to 0.08 mg/L.
- A maximum chlorine dioxide dose of 0.8 mg/L would limit the maximum chlorite concentration to 0.68 mg/L.
- At the maximum sodium hypochlorite dose of 1.25 mg/L, concentrations of chloride are anticipated to be 0.86 mg/L. At the maximum chlorine dioxide dose of 0.8 mg/L, the anticipated chloride concentration is anticipated to be 0.16 mg/L.

These values would represent a reasonable worst-case scenario, as they correspond to the higher doses that DEP would introduce into the aqueduct to reduce the extent of biofilm in advance of biofilm removal. More typical doses of sodium hypochlorite or chlorine dioxide are anticipated to be approximately 0.5 mg/L to maintain the increased aqueduct capacity after biofilm removal and limit biofilm regrowth. For a sodium hypochlorite dose of 0.5 mg/L, DBPs are projected to be much lower: non-detectable for THMs and 12 µg/L for HAAs. For a chlorine dioxide dose of 0.5 mg/L, chlorite concentrations are anticipated to be 0.35 mg/L and chlorate concentrations are anticipated to be 0.05 mg/L. The chloride concentration associated with the low dose is anticipated to be approximately 0.1 mg/L for chlorine dioxide and 0.03 mg/L for sodium hypochlorite.

9.19.2.2 Biofilm Sloughing and Turbidity

In addition to increases in DBPs and chloride in water treated through the Ashokan Screen Chamber as part of chlorination, there is a potential for biofilm sloughing (i.e., the release of biofilm from aqueduct walls) as a result of chlorination. Results of laboratory bench-scale and desktop studies related to turbidity revealed some level of biofilm release could occur within the Catskill Aqueduct as a result of chlorination at the Ashokan Screen Chamber. The potential impact of these potential changes in turbidity to water supply infrastructure and public health are presented in Section 9.19.2.3, “Public Water Supply Infrastructure,” and Section 9.19.2.5, “Public Health,” respectively.

9.19.2.3 Public Water Supply Infrastructure

This section analyzes the potential for the repair and rehabilitation to affect water supply infrastructure for both the City and Outside Community Connections’ water supply on a project-wide basis. Water supply infrastructure comprises the structures, such as water mains, treatment systems, and storage facilities, used to support treatment and delivery of drinking water. The repair and rehabilitation has the potential to affect water supply infrastructure. The analysis of the potential for the repair and rehabilitation to affect water and sewer infrastructure

on a project-wide basis, focused primarily on discharges to surface water and changes to water supply, is discussed in Section 9.19.2.4, “Water and Sewer Infrastructure.”

Methodology

To understand the potential effects of the proposed chlorination on the treatment and distribution systems of the Outside Community Connections, data collected through bench-scale studies and desktop reviews of potential DBP formation and pH changes to raw Catskill Aqueduct water associated with chlorination and dechlorination were compared to data collected through surveys of each community. Specifically, the evaluation considered the potential impacts to each Outside Community Connection’s raw water storage, water treatment systems (including pre-treatment and post-treatment), and distribution systems.

Specific measures were then developed, as described below, that could be undertaken to minimize the potential for impacts to these communities during the period when DEP would be adding sodium hypochlorite or chlorine dioxide to the aqueduct at the Ashokan Screen Chamber.

Assessment

The assessment of chlorination on water supply infrastructure presented below includes an analysis of the potential effects of chlorination on water supply infrastructure. It considers implementation of measures identified to minimize the effects of water quality changes for the City and Outside Community Connections for both the City and Outside Community Connections’ water supply infrastructure. Elevated chloride concentrations could occur as a result of chlorination; however, the increase in chloride concentrations in the future with the repair and rehabilitation would be minor compared to the chloride concentration naturally occurring in the raw aqueduct water. For example, the average chloride concentration of Ashokan Reservoir water is 4.0 mg/L. The maximum chloride concentration that may be contributed by the addition of the maximum sodium hypochlorite dose of 1.25 mg/L is 0.86 mg/L, and for the maximum chlorine dioxide dose of 0.8 mg/L, the chloride concentration would be approximately 0.16 mg/L. Therefore, no assessment of the potential for impacts from chloride on the distribution system is warranted.

New York City Distribution System

Any sodium hypochlorite, chlorine dioxide, and/or chlorine residuals introduced into Kensico Reservoir through the Catskill Aqueduct would be dechlorinated at the Pleasantville Alum Plant. During temporary chlorination, DEP would continuously monitor chlorine dioxide and sodium hypochlorite residuals in the Catskill Aqueduct just downstream of the point of addition and at the Pleasantville Alum Plant prior to the aqueduct’s discharge into Kensico Reservoir. Depending on monitoring results, DEP would adjust the dose of sodium hypochlorite or chlorine dioxide to meet the goal of the operating condition (i.e., reducing the extent of the biofilm in advance of biofilm removal, or preventing biofilm regrowth). These monitors would be on line and are similar to existing monitors DEP uses to help operate its water supply system. Therefore, there would be no significant adverse impacts to the City’s water supply infrastructure as a result of chlorination at the Ashokan Screen Chamber.

In addition, DEP routinely monitors the concentration of HAAs and THMs in the water supply system and, in the event that compliance with the EPA's Stage 2 D/DBP Rule becomes uncertain, sodium hypochlorite doses would be adjusted. Additional in-City DBP compliance monitoring would not be required beyond what is currently practiced and would not otherwise interfere with how DEP operates the water supply system. Minor changes to water quality that could occur, such as minor changes in pH or slight reductions in oxidant demand, are not anticipated to have an effect on the City's treatment system (i.e., ultraviolet [UV] disinfection and chlorine addition) since treated water from the Catskill Aqueduct would be blended with other water within Kensico Reservoir. Therefore, it is not anticipated that the addition of sodium hypochlorite or chlorine dioxide would have a significant adverse impact on the City's water supply infrastructure. Finally, there would also be DBPs and chloride present in dechlorinated water from the leak sites, one of which enters New Croton Reservoir. However, the amount of water entering New Croton Reservoir via this leak would be negligible (0.05 mgd) compared to the volume of water within the receiving stream and reservoir and the City's Croton Water Supply System. Therefore, an assessment of the potential for impact from chlorination on New Croton Reservoir is not warranted.

Outside Community Connections

The analysis below considers the potential impacts to each Outside Community Connection's raw water storage, water treatment systems (including pre-treatment and post-treatment), and distribution systems as a result of the proposed chlorination at the Ashokan Screen Chamber.

Raw Water Storage and Conveyance

Under baseline conditions, two Outside Community Connections (High Falls Water District and the Wallkill Correctional Facility) (see **Table 9.19-3**) indicated that they use a raw water storage tank to provide operational flexibility for their system once water is drawn from the Catskill Aqueduct. The Village of New Paltz is the only Outside Community Connection dependent on the Catskill Aqueduct as its primary water source that stores water in an open reservoir prior to treatment and distribution. In addition, the City of Newburgh, which typically uses the Catskill Aqueduct as a back-up water supply source but will begin to use this water as a primary source for the foreseeable future, currently conveys raw Catskill Aqueduct water through an open channel (Silver Stream) prior to treatment. In the future without the repair and rehabilitation, it is assumed that these communities would continue to use these storage tanks and reservoirs as part of their water supply systems.

In the future with the repair and rehabilitation, DBPs would form within the aqueduct upstream of the taps that serve these communities depending on the chemical added at the Ashokan Screen Chamber, water quality conditions (e.g., temperature), and travel time to the Outside Community Connection. Based on a literature review, chlorite and chlorate concentrations associated with the use of chlorine dioxide, are not expected to change appreciably as a result of extended storage time (Loveland et al. 2005). While chlorine dioxide and its by-products are not anticipated to increase in concentration within storage tanks, long water detention time in these tanks for water treated with sodium hypochlorite would increase formation potential for THMs and HAAs, since their formation increases with time. As a result, the Outside Community Connections with raw water storage tanks may need to operate these tanks in a manner that reduces water age to the

maximum extent practicable within the storage tanks to limit DBP formation and keep total THM and HAA concentrations below regulatory limits in their distribution systems. Through discussions with operators of the Outside Community Connections, use of these storage tanks provides system flexibility, but a specific amount of residence time is not required to maintain pressure or otherwise support the distribution system (i.e., fire flows). Therefore, changing the amount of time that water is stored within the tanks is not anticipated to impact the ability of these communities to supply water.

As with raw water storage in tanks, storage in reservoirs also has the potential to increase water age and associated formation potential for THMs and HAAs. Therefore, as previously stated, dechlorination systems would be installed for Outside Community Connections that receive or store water within open waterbodies, and prior to water entering Kensico Reservoir at the Pleasantville Alum Plant. This would ensure that sodium hypochlorite, chlorine dioxide, and/or chlorine residuals are removed prior to water discharge into the reservoirs. Removal of these residuals would also halt the formation of additional DBPs. Operation of these dechlorination facilities would be temporary and would not have an impact to overall water treatment.

Therefore, the addition of sodium hypochlorite or chlorine dioxide through chlorination at the Ashokan Screen Chamber would not have a significant adverse impact on water supply infrastructure related to raw water storage and conveyance.

Pre-Treatment

The Outside Community Connections each have different configurations and methods for treating the Catskill Aqueduct water supply, which can include pre-treatment with an oxidant. Pre-treatment with an oxidant such as chlorine, chlorine dioxide, potassium permanganate, or ozone (referred to as pre-oxidation), is often practiced by utilities to remove iron and manganese, and to address taste, odor, and color. Pre-oxidation is often used to improve coagulation and flocculation within a treatment plant. Many of the Outside Community Connections use pre-oxidation under baseline conditions. It is assumed these users would continue their existing pre-oxidation practices in the future without the repair and rehabilitation.

In the future with repair and rehabilitation, the oxidant demand at Outside Community Connection's water treatment plants may be reduced due to the addition of chlorine dioxide or sodium hypochlorite upstream at the Ashokan Screen Chamber since they would reduce the organic DBP-precursor material through chemical reactions. As a result, Outside Community Connections currently using chlorine for pre-oxidation may be able to reduce their required chlorine dose, representing a benefit for water supply infrastructure in reduced chemical use. Therefore, it is not anticipated that the addition of sodium hypochlorite or chlorine dioxide through chlorination at the Ashokan Screen Chamber would have a significant adverse impact to pre-treatment water supply infrastructure.

Clarification, Filtration, and Oxidation

Most Outside Community Connections that use the Catskill Aqueduct supply as a primary or secondary supply under baseline conditions also include clarification and filtration facilities as part of their primary treatment processes. These primary users include:

- High Falls Water District – Clarification and filtration
- Village of New Paltz – Clarification and filtration
- Town of New Windsor Jackson Avenue and Riley Road Water Treatment Plant – Filtration
- City of Newburgh – Clarification and filtration
- Village of Cornwall-on-Hudson – Clarification and filtration
- NWJWW – Dissolved air flotation (clarification) and filtration
- Town of New Castle/Millwood – Dissolved air flotation (clarification) and filtration

The secondary users that have clarification and filtration facilities include Wallkill Correctional Facility and the Village of Cold Spring. In the future without the proposed repair and rehabilitation, it is assumed these clarification and filtration treatment processes would remain the same. Other treatment processes used by the Outside Community Connections include ozonation and UV disinfection. Ozonation is used solely by the Town of New Castle/Millwood, and the Wallkill Correctional Facility is the only Outside Community Connection to report treatment with UV.

As noted in the analysis of pre-treatment, water suppliers often use pre-oxidation to improve clarification and filtration, typically in the form of sodium hypochlorite. Some utilities observe a decrease in particle counts in filtered water with the use of chlorine as a pre-oxidant representing an improvement over treatment processes where a pre-oxidant is not applied (Becker et al. 2004).

There is limited literature investigating the impacts of pre-oxidation with chlorine dioxide on clarification and sedimentation. However, bench-scale and pilot testing performed at the East Bay Municipal Utility District as part of a comprehensive study of the impacts of chlorine dioxide on transmission, treatment, and distribution system performance indicated there could be a reduction in settled water turbidity with use of chlorine dioxide as a pre-oxidant (Andrews et al. 2005), indicating improved treatment. These effects would likely be dependent on the raw water quality and the particular treatment process (Gates, Ziglio, and Ozekin 2009). Similarly, UV treatment would not be affected due to the presence of chlorine, chlorine dioxide, or associated DBPs since the efficacy of UV treatment is largely based on water clarity.

In the future with the repair and rehabilitation, chlorite, THM and HAA formation could potentially affect Outside Community Connections that utilize ozonation in their treatment of Catskill Aqueduct water. As part of work under the aforementioned pilot testing performed in the East Bay Municipal Utility District, the presence of chlorite in the water was found to potentially increase the ozone demand. Though the presence of chlorite in the water increased the ozone demand, the study found an overall decrease in ozone demand when compared to no

pre-oxidation (Andrews et al. 2005). This occurred due to oxidation of organics by the chlorine dioxide when applied as a pre-oxidant. Chloroform, one of the regulated THMs, is a volatile compound. Studies at the East Bay Municipal Utility District reported reductions in concentrations of chloroform following coagulation/filtration and ozonation, which was likely due to volatilization. The facility reported approximately 35 to 50 percent removal of chloroform with ozone. Bench-scale testing indicated that the same chloroform removal rate could be achieved by bubbling oxygen as by bubbling ozone through the water, suggesting that volatilization was the primary removal pathway (Andrews et al. 2005). Ozonation has not been shown to be effective in removal of HAAs (Wang et al. 2009). Therefore, only concentrations of chlorite and THMs are anticipated to decrease as a result of ozonation.

~~Finally, as~~ As discussed in Section 9.19.2.2, “Biofilm Sloughing and Turbidity,” there is a potential for biofilm sloughing as a result of chlorination. Results of laboratory bench-scale and desktop studies related to turbidity revealed some level of biofilm release could be expected within the Catskill Aqueduct as a result of the proposed chlorination at the Ashokan Screen Chamber. However, even at conservative estimates that consider biofilm releases from the walls of the Catskill Aqueduct over a short time period (i.e., 1 week) and under low-flow conditions, which would correlate with higher concentrations of resulting turbidity, the Outside Community Connections and Kensico Reservoir have historically treated water at this anticipated reasonable worst-case scenario turbidity level, around 30 Nephelometric Turbidity Units (NTU). In addition, the chances of the removal occurring over such a short timeframe is conservative and would be different from anything reported in the literature or through utility surveys conducted as part of the desktop study. Potential turbidity levels from biofilm sloughing are anticipated to be more in the range of 3 to 7 NTU at a maximum.

In addition, DEP would advance biofilm removal as part of the Proposed Project. While the majority of biofilm would be removed mechanically from the Catskill Aqueduct during the 10-week shutdowns, there is the potential for minor amounts of residual biofilm to remain after mechanical biofilm removal is completed that could result in temporary increases in turbidity within the aqueduct.

Potentially small increases in turbidity from residual biofilm are anticipated to be comparable to turbidity associated with shutdown and restarting of the Catskill Aqueduct that occurs during routine maintenance and inspection activities. These have not resulted in significant increases in turbidity in the past. Likewise, the level of dilution that would occur within the aqueduct would also be significant once raw aqueduct water is reintroduced at the completion of each 10-week shutdown. Significant dilution of biofilm that may be associated with sloughing would also be anticipated. This would further reduce the potential for high (or even measurable) turbidity within water flowing through the aqueduct.

Any minor increases in turbidity due to potential biofilm sloughing or residual biofilm would be managed by the clarification and filtration processes at each Outside Community Connection; ~~which~~. Clarification processes at the Outside Community Connections are designed to handle a range of water quality conditions and are not anticipated to be impacted by minor changes in turbidity.

In order to address potential turbidity increases at Kensico Reservoir from biofilm sloughing or residual biofilm, DEP, as an extra precaution, would have the ability to use alum in small volumes over short periods of time (e.g., less than a week following each 10-week shutdown), to respond to any elevated levels of turbidity, should they be observed. To ensure proper treatment at the Pleasantville Alum Plant, DEP would obtain biofilm samples and conduct jar tests to determine the initial dosing requirements.. Any potential minor increases in turbidity are not anticipated to impact water quality at Kensico Reservoir or DEP's ability to meet its drinking water quality and/or effluent requirements for the system.

Therefore, it is not anticipated that the addition of chlorine dioxide or sodium hypochlorite at the Ashokan Screen Chamber or potential increases in turbidity from biofilm sloughing or the transport of residual biofilm after removal activities are completed would have a significant adverse impact on water supply infrastructure related to clarification, filtration, or oxidation processes at any of these facilities or Kensico Reservoir.

Post-Treatment

Under baseline conditions, all of the Outside Community Connections add chlorine to their water supply after it is treated and before it enters the distribution system. In the future without the repair and rehabilitation, it is anticipated that this practice would continue. In the future with the repair and rehabilitation, addition of sodium hypochlorite or chlorine dioxide may reduce the dose of the pre-oxidant used by some Outside Community Connections, as chlorination at the Ashokan Screen Chamber may reduce the overall oxidant demand of the water once it reaches these communities. Similar to the potential reduction in pre-oxidant use that the Outside Community Connections may be able to take advantage of, a reduction in the chlorine dose that must be applied as water enters their distribution systems may also be possible due to the repair and rehabilitation.

As described in Section 9.19.2.1 “Background on Disinfection By-products (DBPs) and Chloride,” the addition of chlorine dioxide results in the formation of chlorite. When chlorite and chlorine are mixed, as would occur when water entering the distribution system of each Outside Community Connection is disinfected, chlorine dioxide would re-form. This reaction has been confirmed by a study analyzing the concentrations of chlorine dioxide, chlorite, and chlorate through the Roanoke County, Virginia Spring Hollow Water Treatment Facility. In this study, chlorate and chlorine dioxide concentrations were found to increase following the chlorine addition, and were attributed to the reaction between chlorine and chlorite (Hoehn et al. 2003). The range of doses of chlorine dioxide that would be applied under chlorination considers the potential for this reformation of chlorine dioxide within the distribution systems of the Outside Community Connections. As such, the maximum chlorine dioxide dose was established to ensure reformation of chlorine dioxide would not exceed the drinking water MCL (see Section 9.19.2.5, “Public Health”). No changes to water supply infrastructure at the Outside Community Connections are required to limit or quench the chlorite present in the treated water.

Therefore, the addition of sodium hypochlorite or chlorine dioxide at the Ashokan Screen Chamber would not have a significant adverse impact on post-treatment water supply infrastructure.

Distribution System

Under baseline conditions, the Outside Community Connections indicated that the water age in their distribution systems ranges from hours to weeks. The water age, pipe material, and presence of organics in the distribution system of each Outside Community Connection in the future without the repair and rehabilitation are anticipated to remain the same. In the future with the repair and rehabilitation, these parameters would collectively affect the fate and transport of any remaining sodium hypochlorite, chlorine dioxide, DBPs, and chloride in the treated water through each Outside Community Connection's distribution system. In addition, these distribution system characteristics could affect whether corrosion could occur, or taste and odor concerns could arise as a result of chlorination. The addition of sodium hypochlorite or chlorine dioxide would have minor impacts on pH in the water within each Outside Community Connection's distribution system, which is known to be one of the factors that affects the rate of corrosion.

Therefore, historical pH conditions within the Outside Community Connection's distribution system would need to be maintained to minimize the potential for chlorination at the Ashokan Screen Chamber to cause corrosion. This may require a minor change in the total amount of pH adjusting chemical added by each Outside Community Connection. Likewise, as would be the case for any utility considering a change in source water supply, the Outside Community Connections that currently use the Catskill Aqueduct as a secondary supply must consider impacts on corrosion before switching from their primary supply, even without the introduction of oxidants at the Ashokan Screen Chamber. In the future with the repair and rehabilitation, addition of a corrosion inhibitor may also be required prior to water entering the communities' distribution systems to prevent corrosion. The addition of a corrosion inhibitor would be a change to the water supply infrastructure of the Outside Community Connections, either because it may require changed concentrations of an existing corrosion inhibitor be added to the supply or the use of new chemical dosing facilities. Monitoring and adjustment of pH, combined with the addition of a corrosion inhibitor, would ensure there would be no potential adverse impacts from corrosion on the distribution systems of the Outside Community Connections.

Therefore, the addition of sodium hypochlorite or chlorine dioxide at the Ashokan Screen Chamber would not have a significant adverse impact on the distribution systems of the Outside Community Connections.

Monitoring

For all Outside Community Connections, monitoring would be required to show that the water treated and delivered by these systems continues to comply with applicable drinking water regulations and standards with chlorination at the Ashokan Screen Chamber. For Outside Community Connections that add chlorine as a pre-oxidant, an online chlorine dioxide monitor should be installed prior to their treatment facilities to measure excess chlorine dioxide that is re-formed. For example, Continental Village adds granular sodium hypochlorite, but does not provide downstream treatment. Therefore, a chlorine dioxide monitor should be located after their point of chlorination to detect chlorine dioxide reformation. This monitoring would also allow the Outside Community Connections to adjust oxidant doses, if possible, due to reductions in oxidant demand that could occur. In addition, since chlorate is formed when chlorite is

oxidized (i.e., exposed to chlorine, ozone, etc.), monitoring this parameter through grab sampling should be undertaken at all Outside Community Connections. Finally, pH monitoring, as described above, would allow the communities to monitor and adjust treatment, as needed. This monitoring would largely be online and similar to other monitoring conducted by operators of the Outside Community Connections. It would also improve the ability for DEP and the Outside Communities to report water quality conditions and make minor adjustments to treatment in response to any changes in water quality as a result of chlorination.

Therefore, while chlorination would require additional monitoring by the Outside Community Connections, since this additional monitoring is similar to that currently practiced and would be temporary in nature, the addition of sodium hypochlorite or chlorine dioxide at the Ashokan Screen Chamber would not have a significant adverse impact on the level of existing monitoring as part of water supply operations.

Conclusions

To ensure that all water that enters Kensico Reservoir meets water quality standards, sodium bisulfite would be added at a new dechlorination facility at Pleasantville Alum Plant to remove sodium hypochlorite, chlorine dioxide, and/or chlorine residuals prior to discharge into Kensico Reservoir. The new chlorination and dechlorination facilities would operate until the repair and rehabilitation is completed in 2023. Similarly, dechlorination facilities would be constructed at the Village of New Paltz and City of Newburgh prior to discharge of water into their open water storage and conveyance systems. DEP would continue to rely on existing operational turbidity control measures as needed.

In the future with the repair and rehabilitation, some operational and treatment changes may need to be undertaken at certain Outside Community Connections to minimize any potential effects of DBPs and other water quality changes as a result of chlorination at the Ashokan Screen Chamber. Utilities storing raw water may need to modify operations to minimize the total length of storage time for Catskill Aqueduct water treated with sodium hypochlorite to limit associated formation of THMs and HAAs. Doses of pre-oxidant added upstream of treatment at the Outside Community Connections and disinfectant added as water enters the distribution system may be reduced as a result of chlorination. Changes in the dose of pH adjusting chemicals and a corrosion inhibitor, or the addition of facilities to apply these chemicals for Outside Community Connections who do not have them, would be required to respond to potential minor changes in pH and water quality that may occur as a result of chlorination at the Ashokan Screen Chamber. Finally, monitoring for chlorine dioxide, chlorate, and pH is recommended to allow operators to implement minor adjustments to the treatment system in response to any changes in water quality as a result of adding chlorine dioxide.

As described above, it is anticipated that the dose of sodium hypochlorite or chlorine dioxide applied at the Ashokan Screen Chamber would be the low dose of these chemicals used to maintain the capacity of the aqueduct and limit biofilm regrowth.

Therefore, since higher doses of the chemicals would occur less frequently and measures would be in place to monitor and respond to any changes in quality of water supplied through the Catskill Aqueduct, the addition of sodium hypochlorite or chlorine dioxide at the Ashokan

Screen Chamber would not have a significant adverse impact on water supply infrastructure for the Outside Community Connections.

9.19.2.4 Water and Sewer Infrastructure

This section analyzes the potential for the repair and rehabilitation to affect water and sewer infrastructure on a project-wide basis. No physical changes are proposed to sewer infrastructure that would affect capacity and/or treatment. Therefore, this analysis focuses primarily on discharges to surface water and changes to water supply on a project-wide basis. New or different discharges that would result from the repair and rehabilitation within the study areas during construction, temporary chlorination/dechlorination, and operations are presented below. This discussion is followed by an assessment of the potential effects of these changes on water and sewer infrastructure as a result of chlorination at the Ashokan Screen Chamber under the repair and rehabilitation.

For the study areas encompassing the repair and rehabilitation, only those work activities and infrastructure changes in the Ashokan Screen Chamber, Lucas Turnpike, Mossybrook Road, and Pleasantville Alum Plant study areas warrant evaluation in the “Water and Sewer Infrastructure” sections within the respective study area analyses. Specifically, construction and upgrading of facilities associated with chlorination at the Ashokan Screen Chamber in the Town of Olive and dechlorination at Pleasantville Alum Plant in the Village of Pleasantville would alter water supply infrastructure. These study areas are analyzed in Section 9.4.3, “Ashokan Screen Chamber Study Area Impact Analysis,” and Section 9.17.4, “Pleasantville Alum Plant Study Area Impact Analysis.” Additionally, private drinking water supply wells in the Lucas Turnpike and Mossybrook Road study areas in the Town of Marbletown may be affected by leaks in the Rondout Pressure Tunnel, which is approximately 500 feet below the ground surface in these areas, and these wells have the potential to exhibit water quality changes due to the repair and rehabilitation. These study areas are analyzed in Section 9.5.5, “Lucas Turnpike Study Area Impact Analysis,” and Section 9.5.7, “Mossybrook Road Study Area Impact Analysis.” The remaining study areas were assessed on a project-wide basis in the following sections.

Repair and Rehabilitation Discharges

Repair and rehabilitation activities would include discharges of treated biofilm wash water, dechlorinated aqueduct/leak water, and raw water unwatering. As described in Section 9.3.11, “Water and Sewer Infrastructure,” most study areas required an analysis related to these anticipated discharges. **Table 9.19-5** summarizes the type and location of anticipated discharges associated with the study areas (see **Figure 9.19-1**). Analysis of these study areas determined that effects associated with the discharges would be similar across the sites and that all discharges to surface water would be required to meet applicable water quality standards. Based on the general characteristics, similarities of the effects associated with the discharges, and discharge requirements, it was determined that the study areas would be assessed on a project-wide basis.

In the future without the repair and rehabilitation, it is assumed that existing water and sewer infrastructure would remain the same as baseline conditions, with the exception of possible changes due to new development in the study areas.

Biofilm Wash Water

During biofilm removal and condition assessment, biofilm wash water would be treated to meet applicable discharge limits, water quality standards, and/or other requirements for reuse in the removal operation, or for discharge back into the Catskill Aqueduct or to a local surface water. Potential effluent parameters associated with the discharge of treated wash water would primarily be turbidity and suspended and settleable solids which would be removed by treatment systems constructed specifically for these discharge areas. Biofilm removal and condition assessment is anticipated to last approximately 10 weeks, with treated wash water discharged for the duration of this work activity. The aqueduct would be unwatered in advance of biofilm removal efforts primarily through the use of blow-off chambers. While the majority of blow-off chambers would remain closed during biofilm removal, the Esopus Steel Pipe Siphon Blow-off Chambers in the Beaverkill Road Study Area would remain open for the duration of biofilm removal to allow discharge of residual raw water so there would be less water in the tunnel affecting downstream biofilm removal operations. At this site, discharges of residual water would have low flows of approximately 700 to 1,400 gpm (1 to 2 mgd).

All biofilm wash waters would be treated and would meet applicable discharge requirements for discharge to the Catskill Aqueduct or local surface water. No discharge to public or private wastewater treatment systems would occur. Therefore, the proposed discharges would not result in impacts to existing sewer infrastructure (i.e., collection and treatment systems). Likewise, discharges to the Catskill Aqueduct or surface water that provides drinking water to communities near the Mount Airy Road, Aqueduct Road, and Chapman Road study areas would not result in impacts to existing water supplies. Because all discharges would meet applicable discharge requirements for release to the aqueduct or surface water, all discharges would be limited in duration, and these water supply systems are located approximately 2,500 or more feet downstream of the proposed discharge locations, no impact to water supply infrastructure is anticipated from the repair and rehabilitation.

Table 9.19-5: Discharge Type for the Repair and Rehabilitation Study Areas

Municipality	Study Area	Receiving Water	Type of Discharge		
			Chlorination/ Dechlorination	Raw Water	Wash Water ⁶
Town of Olive	Ashokan Screen Chamber	Catskill Aqueduct	X ³	-	-
	Beaverkill Road	Relic Channel of Esopus Creek	-	X	X
	Atwood-Olivebridge Road	Tongore Creek	-	X	X
Town of Marbletown	Vly Atwood Road	Leak Flowpath	X ¹	-	-
	Pine Bush Road	Catskill Aqueduct	-	-	X
	Lucas Turnpike	Leak Flowpath	X ⁴	-	-
	Canal Road	Rondout Creek	X ¹	-	-
	Mossybrook Road	Leak Flowpath	X ⁴	-	-
	Lower Knolls Road	NA	-	-	-
Town of New Paltz	Mountain Rest Road	New Paltz Reservoir	X	-	-
	New Paltz-Minnewaska Road	Catskill Aqueduct	-	-	X
	<u>New Paltz Temporary Transmission Water Main</u>	<u>Kleine Kill, Unmapped Stream flows into Kleine Kill, Unnamed Tributary to Walkkill River</u>	=	<u>X</u>	=
Town of Gardiner	Forest Glen Road	Walkkill River	X ¹	-	-
	Le Fevre Lane	NA	-	-	-
	Armato Lane	NA	-	-	X
Town of Shawangunk	Strawridge Road	Catskill Aqueduct	-	-	X
Town of Montgomery	Winchell Drive	Catskill Aqueduct	-	-	X
Town of New Windsor	Mount Airy Road	Silver Stream	X	X	X
	Passaro Drive	Catskill Aqueduct	-	-	X
Village of Nelsonville	Gatehouse Road	Catskill Aqueduct	-	-	X
	Fishkill Road	Foundry Brook	-	X	X
Town of Philipstown	Indian Brook Road	Indian Brook	-	X	X
	Old Albany Post Road	Catskill Aqueduct	-	-	X
	Sprout Brook Road	Canopus Creek	-	X	X
Town of Cortlandt	Aqueduct Road	Peekskill Hollow Creek	-	X	X

Table 9.19-5: Discharge Type for the Repair and Rehabilitation Study Areas

Municipality	Study Area	Receiving Water	Type of Discharge		
			Chlorination/ Dechlorination	Raw Water	Wash Water ⁶
Town of Yorktown	Jacob Road	Hunter Brook	-	X	X
	Chapman Road	Turkey Mountain Brook	-	X	X
		New Croton Reservoir/ Catskill Aqueduct	-	X	X
	Croton Dam Road	Leak Flowpath	X ¹	-	-
	Kitchawan Road	Unnamed Tributary 3 to New Croton Reservoir	-	X ²	
	<u>Pines Bridge Road</u>	<u>Unnamed Tributary 4 to New Croton Reservoir</u>	≡	≡	≡
Town of New Castle	Somerstown Turnpike	Unnamed Tributary 1 to Cornell Brook	-	X ²	-
	Station Place	Catskill Aqueduct	-	-	X
	Campfire Road	Unnamed Tributary 2 to Pocantico River	-	X ²	-
Town of Mount Pleasant	Chappaqua Road	Unnamed Tributary 3 to Pocantico River	-	X ²	-
	Nanny Hagen Road	Kensico Reservoir	X	X	X
	Westlake Drive	NA	-	-	-
Village of Pleasantville	Washington Avenue	Saw Mill River	-	X	X
	Pleasantville Alum Plant	Unnamed Tributary to Nanny Hagen Brook	X ⁵	X ²	-
	Willow Street	Catskill Aqueduct	-	-	X

Notes:

- = No discharge to receiving water. Does not warrant an impact analysis.

NA = Not applicable. Refers to study areas with no discharges to receiving waters.

¹ Dechlorinated aqueduct water, if leak repair is not feasible.

² Groundwater may infiltrate the aqueduct and be discharged through the sluice gate.

³ See Section 9.4, "Town of Olive."

⁴ See Section 9.5, "Town of Marbletown."

⁵ See Section 9.17, "Village of Pleasantville."

⁶ As part of biofilm repair and general interior aqueduct repairs, incidental construction waters that may be generated would be treated to meet applicable regulatory requirements prior to discharge.

Temporary Chlorination/Dechlorination

As discussed in Section 9.2, “Project Description,” several leaks along the Catskill Aqueduct provide pathways for water from the aqueduct to enter the surrounding environment. Upon the initiation of chlorination at the Ashokan Screen Chamber, sodium hypochlorite, chlorine dioxide, and/or chlorine residuals would be present in the aqueduct and could be released through the leaks. If repairs to these leaks are not feasible or are unsuccessful, local dechlorination systems would be installed within the existing flowpaths to treat and dechlorinate leak water before it enters the environment. These systems would not result in any change in existing leak flow volumes.

Discharges from the proposed dechlorination of leaks would meet applicable discharge limits and/or water quality standards for discharge to surface water. Discharges from the leak dechlorination systems in these study areas would not impact water or sewer infrastructure because all discharges would be to surface water resources.

During temporary chlorination, discharges from the dechlorination facility at the Pleasantville Alum Plant would be treated to ensure compliance with all applicable discharge limits and/or water quality standards for discharge to the Catskill Aqueduct and ultimately Kensico Reservoir. Once the Catskill Aqueduct returns to baseline conditions in 2023, the chlorination facility would not be operated, and accordingly the dechlorination facility would no longer be needed. Discharges of dechlorinated water to Kensico Reservoir would cease, and aqueduct flows and water quality to Kensico Reservoir in the study area would be consistent with baseline conditions.

Because discharge requirements would be met for surface water discharges and no dechlorinated leak waters would enter a private or public wastewater treatment system or would potentially impact a water supply system except as noted previously (see Section 9.5.5, “Lucas Turnpike Study Area Impact Analysis,” and Section 9.5.7, “Mossybrook Road Study Area Impact Analysis”), the repair and rehabilitation would not result in significant adverse impacts to water and sewer infrastructure.

Unwatering

Unwatering the aqueduct would be achieved by discharging into nearby surface water in the study area. Unwatering to surface water would occur during construction of the repair and rehabilitation and would also occur at any time in the future during DEP’s typical operations to conduct maintenance or inspection. Raw aqueduct water would be discharged to surface water via steel pipe siphon blow-off chambers or culvert drain sluice gates when unwatering of the aqueduct is required as part of the repair and rehabilitation or for future maintenance needs. Unwatering events would vary in duration based on the length of tunnel being unwatered and the extent to which the valves or gates are opened (e.g., partially or fully open). Unwatering at blow-off chambers is generally completed in less than a day and more typically several hours, while unwatering at sluice gates, which is more uncommon, may take several days due to the lower discharge rates.

During aqueduct shutdowns at culvert drain sluice gate locations, groundwater may infiltrate the aqueduct. Groundwater would flow by gravity to the culvert drain sluice gate and could also be discharged to the receiving stream. Chlorination at the Ashokan Screen Chamber would temporarily cease several days before a scheduled shutdown to ensure that no sodium hypochlorite, chlorine dioxide, and/or chlorine residuals are present in the discharged water, and that no discharge permit would be required. Because normal unwatering of the aqueduct would involve the discharge of raw, untreated waters, no discharge permits are required. Likewise, because all unwatering discharges would be to surface water, no direct impacts to existing water and sewer infrastructure would occur. Therefore, there would be no significant adverse impacts to water and sewer infrastructure from the repair and rehabilitation.

In addition to an assessment of unwatering discharges to water and sewer infrastructure, an evaluation of the potential effects of these releases to surface water was also completed because discharges of this nature, while uncontaminated by pollutants, still represent unnatural releases. **Table 9.19-6** and **Table 9.19-7** provide results of detailed analyses for unwatering discharges associated with steel pipe siphon blow-off chambers and culvert drain sluice gates, respectively. An analysis was conducted using the USGS StreamStats Program to determine if the discharge associated with an unwatering event would be greater than the bankfull stream flow of the receiving stream. Bankfull flow, which is shown in these tables, is the flow that fills the stream channel to the top of its banks (i.e., stream capacity) and to the point at which water begins to flow onto the floodplain. If the discharge associated with an unwatering event is greater than the bankfull flow or contributes to a bankfull condition, indirect downstream effects, such as reductions in water quality due to increases in erosion or flooding, could occur.

Based on the data shown in these tables, with the exception of four study areas—Campfire Road, Fishkill Road, Chapman Road, and Pleasantville Alum Plant—the bankfull flow for the streams within the study areas would not be exceeded during the reasonable worst-case scenario with the steel pipe siphons or culvert sluice gates fully opened in combination with the occurrence of a 1.5-year storm. For example, the bankfull flow associated with the receiving stream for the Tongore Steel Pipe Siphon discharge has a bankfull flow of 200,200 gpm. With the steel pipe siphon fully open, the discharge to the stream would be 17,500 gpm, well within the bankfull flow of the stream.

The flows associated with only the 1.5-year storm would result in stream flow of 94,700 gpm, which would also not exceed the bankfull flow of 200,200 gpm. Based on this analysis, if an unwatering discharge and the 1.5-year storm were to occur at the same time, the flow would be 112,200 gpm, which would not exceed the bankfull flow of 200,200 gpm. Therefore, based on the same analysis for each study area (see **Figure 9.19-1**) listed in **Table 9.19-6** and **Table 9.19-7**, no bankfull events would occur. The four sites that have the potential to experience bankfull events as a result of discharges to surface water would use operational controls to prevent these bankfull events, as noted below.

Table 9.19-6: Discharge Analysis Associated with Study Areas along Steel Pipe Siphons of the Catskill Aqueduct

Study Area	Steel Pipe Siphon	Max Fully Open (gpm)	1.5-Year Storm (gpm)	Unwatering during 1.5-Year Storm (gpm)	Bankfull Flow (gpm)	Potential for Bankfull Event
Beaverkill Road	Esopus	22,000	NA	NA	NA	NA
Atwood-Olivebridge Road	Tongore	17,500	94,700	112,200	200,200	No
Washington Avenue	Washington Square	18,900	NA	NA	NA	NA
Fishkill Road	Foundry Brook North	11,700	14,400	26,100	23,300	Yes, implement operational controls
	Foundry Brook South	28,700	74,100	102,800	105,500	No
Indian Brook Road	Indian Brook	17,500	88,400	105,900	109,100	No
Sprout Brook Road	Sprout Brook	31,900	171,500	203,400	218,100	No
Aqueduct Road	Peekskill North	38,200	382,900	421,100	498,200	No
	Peekskill South	5,400	7,600	13,000	14,800	No
Jacob Road	Hunters Brook	21,100	100,100	121,200	131,500	No
Chapman Road	Turkey Mountain	19,300	21,500	40,800	39,000	Yes, implement operational controls
Washington Avenue	Harlem Railroad	15,300	51,200	66,500	88,900	No
Note: NA = Not Applicable. USGS StreamStats Program calculation does not apply due to the presence of upstream control structures.						

Table 9.19-7: Discharge Analysis Associated with Study Areas at Culvert Drain Sluice Gates of the Catskill Aqueduct

Study Area	Culvert Drain Sluice Gate	Max Fully Open (gpm)	1.5-Year Storm (gpm)	Discharge during 1.5-Year Storm (gpm)	Bankfull Flow (gpm)	Potential for Bankfull Event
Kitchawan Road	MHS28	2,638	10,996	13,600	38,106	No
Somerstown Turnpike	MHS29	2,515	4,188	6,700	9,919	No
Somerstown Turnpike	MHS30	2,803	1,243	4,000	4,017	No
Campfire Road ¹	MHS31	2,452	10,907	13,400	5,521	Yes, implement operational controls
Chappaqua Road	MHS32	2,167	7,361	9,500	14,677	No
Pleasantville Alum Plant ¹	MHS33	2,505	23,698	26,200	310	Yes, implement operational controls
Notes: MHS = Manhole Sluice Gate ¹ MHS31 and MHS33 were calculated based on a 2-year storm.						

During unwatering events, the following operational controls would be implemented at steel pipe siphon sites to prevent a bankfull event. Flows from steel pipe siphons through the use of blow-off valves would be moderated by throttling the valves, and flows would be monitored by an on-site crew to prevent the receiving stream from becoming inundated by discharges of raw water. In the event that inundation appears to have a potential to occur during unwatering, the on-site crew would have the ability to cease unwatering at any time to allow streamflows to subside to baseline flows. Moreover, blow-off discharges would be restricted from occurring within 12 hours of predicted rain events, during rain events, and for a period of 48 hours after rain events or after streamflow returns to normal.

Unwatering at culvert drain sluice gates would not occur on a routine basis because raw aqueduct water in these segments of the Catskill Aqueduct is more easily discharged to Saw Mill River at the Harlem Railroad Steel Pipe Siphon Blow-off Chambers. Rather, the sluice gates may be used to discharge infiltrated groundwater during the repair and rehabilitation, and future maintenance that could have flows of 50 to 100 gpm. Therefore, discharges would be rare, typically low in flow, and several hours or days in duration, depending on the length of the shutdown of the aqueduct, and are not anticipated to contribute to water quality impacts in the receiving streams. When unwatering through the sluice gates, two of the six sluice gate sites (Campfire Road and Pleasantville Alum Plant) that would be operational following the repair and rehabilitation could experience a bankfull event. To unwater the aqueduct at these locations and avoid a bankfull event, operational controls would include opening the sluice gates to approximately 1 inch to

limit unwatering flows to approximately 300 gpm while visually monitoring streambank flow. The sluice gate would be further opened as initial discharge velocities decrease, and flows would continue to be monitored to limit flows to 300 gpm.

Water released from the aqueduct during unwatering would be raw water. No treatment would be required. Therefore, there would be no significant adverse impact to water quality as a result of the discharge. As noted previously, three study areas have water supplies located downstream of blow-off chambers: Mount Airy Road, Aqueduct Road, and Chapman Road. These water supplies are used by local municipalities to provide drinking water. The unwatering would be raw water which does not require treatment, and any water taken out of these receiving streams by the water suppliers would be treated in accordance with applicable requirements by a municipal water treatment plant prior to distribution. Chlorination at the Ashokan Screen Chamber would temporarily cease several days before a scheduled shutdown to ensure that no sodium hypochlorite, chlorine dioxide, and/or chlorine residual chlorines are present in the discharged water.

Based on the above assessment, there would be no significant direct adverse impact to water and sewer infrastructure or indirect impacts to existing stream flows or downstream water suppliers.

9.19.2.5 Public Health

On behalf of the City, DEP is responsible for ensuring the safe and reliable transmission of drinking water from the watershed to its customers in sufficient quantity to meet all present and future water demands. As previously discussed, Upstate Water Supply Resiliency would help ensure that this goal and obligation is met.

Public health is defined by the *CEQR Technical Manual* as “the activities that society undertakes to create and maintain conditions in which people can be healthy.” As discussed in Chapter 8, “Analytical Framework,” a public health assessment is warranted if a proposed project would result in a significant unmitigated adverse impact to air quality, water supply (quantity or quality), hazardous materials, or noise. This public health assessment consists of identifying the potential for the repair and rehabilitation to result in changes to the quality or quantity of water available from the City’s water supply system.

Methodology

The doses for sodium hypochlorite and chlorine dioxide were selected to limit the potential for public health effects to the City’s water supply and Outside Community Connections that rely on the Catskill Aqueduct as a primary or secondary drinking water supply.

Sodium Hypochlorite Disinfection By-Products

To determine potential impacts of the proposed chlorination at the Ashokan Screen Chamber to the City’s distribution system, a disinfection study was conducted in 2013. During this study, raw water was collected at Ashokan Reservoir and sodium hypochlorite was added at various doses (0.25 and 2.0 mg/L) to evaluate potential increases in DBP formation. The ratio of DBPs in the pre-chlorinated samples (chlorinated and held for the actual maximum and minimum

Catskill Aqueduct travel times from Ashokan Reservoir to Kensico Reservoir) were compared to the control samples (no chlorine) to determine the DBP formation. Following measurement of DBPs at the simulated entry to Kensico Reservoir, the travel through Kensico Reservoir to the larger distribution system was simulated in this study (24 and 55 hours), prior to adding a second sodium hypochlorite dose of 1.45 mg/L to simulate an average tunnel entrance dose as water enters DEP's distribution system. The samples were then held an additional 90 hours after the second sodium hypochlorite dose to simulate the travel time through the City's distribution system.

Similarly, there was a need to further investigate the potential for DBP increases to occur at Outside Community Connections and how this could affect total DBP levels in these systems. In addition, more information was also required to understand DBP formation at a range of doses for both the Outside Community Connections and the City, rather than the two investigated as part of the initial disinfection study. As a result, additional bench-scale DBP testing was conducted in 2016 to evaluate DBP production at doses of sodium hypochlorite between the 0.25 mg/L and 2.0 mg/L doses originally tested as part of the previous disinfection study. Experiments were performed in May 2016 using water samples taken from Ashokan Reservoir. The assessment below presents the results of these studies and the potential impacts of HAA and THM formation as a result of the repair and rehabilitation.

Chlorine Dioxide Disinfection By-Products and Chloride

As previously described, the MRDL for chlorine dioxide and the regulatory limit for chlorite were considered when establishing the proposed maximum chlorine dioxide dose. In addition, although chlorate is not currently regulated, potential chlorate concentrations were compared with EPA's proposed chlorate MCL, as summarized below. The concentrations of chloride formed are anticipated to be low at far less than the initial sodium hypochlorite dose. The EPA sets a secondary MCL for certain compounds, including chloride, that: pose no human health risk below the standard; are non-mandatory; are voluntarily reported by water supply systems; and are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations such as taste, color, and odor. The secondary MCL for chloride in drinking water is 250 mg/L. Any chloride present in the water after dosing with chlorine dioxide up to the highest dose rate would be too low in concentration to have any impact to Outside Community Connections or the City, and, therefore, is not assessed further.

pH

In addition to increasing the concentrations of certain DBPs within Catskill Aqueduct water, treatment with chlorine dioxide could affect the pH of the Catskill Aqueduct water supply. Historical Catskill Aqueduct data (collected between 2005 to 2014 at Ashokan Reservoir effluent chamber) indicate an average pH of 6.96 for raw water from Ashokan Reservoir. To determine potential public health impacts that could occur as a result of chlorine dioxide addition at the Ashokan Screen Chamber across the selected operating ranges, a bench-scale study was conducted also included modeling changes in pH. The results of this pH modeling and analysis of the potential impacts to Outside Community Connections and the City are presented in the assessment below.

Turbidity

Biofilm sloughing could occur as a result of temporary chlorination at Ashokan Reservoir in advance of biofilm removal as part of the repair and rehabilitation. A biofilm sloughing study was conducted to evaluate the potential for biofilm detachment as a result of temporary chlorination, which could increase turbidity within the aqueduct. This study included a literature review, utility survey, test loop monitoring, a bench-scale study, and a desktop analysis of potential turbidity changes. The literature review and survey of utilities were conducted to gather existing information regarding effects of treatment with oxidants specific to biofilm control on turbidity. A bench-scale test was also conducted to develop a relationship between Catskill Aqueduct biofilm solids loading and turbidity potential. This relationship was then applied to an order-of-magnitude turbidity model, which was developed to simulate a range of potential biofilm solids loading scenarios for the Catskill Aqueduct. In addition, a quantitative sloughing analysis was conducted as part of the pilot. ~~The results of the biofilm sloughing study and potential impacts to Outside Community Connections and the City are presented below.~~

In addition, while the majority of biofilm would be removed mechanically, it is anticipated there may be minor amounts of residual biofilm remaining after mechanical biofilm removal is completed that could cause temporary increases in turbidity within water flowing through the aqueduct. The analysis of potential impacts from the minor increases in turbidity that could occur to Outside Community Connections and the City are presented below.

Assessment

Based on the 2013 and 2016 disinfection studies, it is not anticipated that sodium hypochlorite addition would have an impact on DBP formation in the City's distribution system. These studies showed no significant increase in HAAs or THMs at the low sodium hypochlorite dose. The highest doses applied during the studies (higher than the maximum dose that would be applied as under the temporary chlorination) resulted in increases in the concentration of DBPs (HAAs and THMs) that could result in Stage 2 D/DBP Rule violations in the City under certain water quality conditions, particularly for HAAs. Therefore, chlorine dioxide would be used during these conditions (i.e., warmer water temperature conditions). It should be noted that increases in HAAs were less at the proposed maximum dose of 1.25 mg/L investigated as part of the 2016 study, and the HAA MCL is based on an annual average taken quarterly at specific locations within the distribution system, so the higher modeled HAA concentrations would likely be reduced to less than the MCL due to seasonal averaging. Although increases in THM formation were observed at the highest sodium hypochlorite doses tested for some of the scenarios investigated, the final THM concentrations were well below the regulatory MCL of 80 µg/L for all conditions.

For the Outside Community Connections, DBP concentrations measured as part of the disinfection studies were added to concentrations historically reported by each Outside Community Connection. This method is conservative because it does not account for the reduction in naturally occurring organic matter that would be oxidized through the first dose of sodium hypochlorite, which would ultimately limit the amount available to form DBPs further downstream where additional chlorine is added at each community. Concentrations of DBPs for all but two Outside Community Connections, Continental Village for HAAs and City of Yorktown for THMs, were found to fall below the Stage 2 D/DBP MCLs at chlorine doses at and

below the 1.25 mg/L that would be applied under the repair and rehabilitation. However, for these two communities and all of the Outside Community Connections, the operational changes (e.g., potential reduction in the pre-oxidant or post-treatment sodium hypochlorite dose), discussed in Section 9.19.2.3, “Public Water Supply Infrastructure,” would further limit or reduce the formation of sodium hypochlorite-based DBPs and is not assumed for the calculation of DBP formation discussed above. In addition, DEP plans to only use the maximum sodium hypochlorite dose intermittently, and plans a switch to chlorine dioxide during water quality conditions when formation potential for THMs and HAAs in Ashokan Reservoir supply is increased (i.e., during the summer). These actions would further limit the potential for DBP formation from sodium hypochlorite addition to exceed the drinking water MCLs.

With respect to pH, a chlorine dioxide operating range of 0.25 mg/L to 0.8 mg/L would correlate to a decrease of 0.02 and 0.3 pH units, respectively in water drawn from the Catskill Aqueduct based on DEP bench testing and a pH modeling study. In contrast, sodium hypochlorite addition would result in a pH increase. For the proposed operating range of 0.25 mg/L to 1.25 mg/L, pH modeling estimated an increase of 0.03 to 0.17 pH units over baseline conditions. In addition, similar changes in pH due to sodium hypochlorite addition would occur under baseline conditions since all of the Outside Community Connections apply chlorine at some point in their treatment process. These changes in pH are relatively minor and would be reduced at the doses of sodium hypochlorite and chlorine dioxide addition that are anticipated to be used more frequently under the repair and rehabilitation associated with maintaining the capacity of the aqueduct and limiting biofilm regrowth. These changes could have effects on Outside Community Connections’ treatment processes, as discussed in Section 9.19.2.3, “Public Water Supply Infrastructure,” and, therefore, pH monitoring and associated corrosion control should be undertaken to ensure conditions remain consistent with those historically experienced, eliminating the potential for a public health impact from these slight variations in pH.

Chlorine dioxide tests performed in September 2009 for the Catskill Aqueduct water supply showed that approximately 85 to 90 percent of the chlorine dioxide that reacted over 24 hours was converted to chlorite. This yield is relatively high when compared with other studies, but was used in order to be conservative. Based on the study and the potential for chlorine dioxide reformation, it was determined that the chlorine dioxide dose of 0.8 mg/L would limit the chlorite concentration to 0.68 mg/L, well below the chlorite MCL of 1.0 mg/L and, even if there was reformation of chlorine dioxide, would result in concentrations well below the MRDL of 0.8 mg/L at any of the Outside Community Connections and in the City. Therefore, chlorite introduced due to chlorine dioxide addition would not impact public health.

Regarding potential impacts to public health as a result of chlorate formation, research indicates that a potential regulatory threshold may be established at 0.7 mg/L (Alfredo, Stanford, Roberson, & Eaton 2015). The chlorate concentration anticipated as a result of chlorine dioxide addition would be 0.08 mg/L, well below this potential drinking water MCL.

As discussed in Section 9.19.2.3, “Public Water Supply Infrastructure,” any minor increases in turbidity would be managed by the Outside Community Connections. In addition, these increases are not anticipated to impact water quality at Kensico Reservoir or DEP’s ability to meet its drinking water quality requirements for the system. However, as an added precaution, DEP

would have the ability to use alum, in small volumes over short periods of time (e.g., less than a week following each 10-week shutdown), to respond to any elevated levels of turbidity, should they be observed. To ensure proper treatment at the Pleasantville Alum Plant, DEP would obtain biofilm samples and conduct jar tests to determine the initial dosing requirements. These would be adjusted and retested, as needed, whenever turbidity levels in the aqueduct change by more than 15 NTU. Therefore, no effect is anticipated to the Outside Community Connections or the City as a result of biofilm sloughing or the transport of residual biofilm.

Based on the above studies and research, the water quality resulting from the chlorination is anticipated to be well within regulated limits for sodium hypochlorite, chlorine dioxide, and their DBPs, and would not result in significant impacts to pH or turbidity. In addition, some operational and treatment changes would be required for certain Outside Community Connections to minimize any potential effects of the proposed repair and rehabilitation (see Section 9.19.2.3, “Public Water Supply Infrastructure”). DEP would also continue to rely on existing operational turbidity control measures as needed.

To ensure that all water that enters Kensico Reservoir meets water quality standards, sodium bisulfite would be added at a new dechlorination facility at Pleasantville Alum Plant to remove sodium hypochlorite, chlorine dioxide, and/or chlorine residuals prior to discharge into Kensico Reservoir. Similarly, dechlorination facilities would be constructed as part of the recommendations for the Village of New Paltz and City of Newburgh, which also have Catskill Aqueduct water stored in open waterbodies. The new chlorination and dechlorination facilities would operate from testing until the repair and rehabilitation is completed in 2023.

DEP would work with all Outside Community Connections to implement measures aimed at monitoring and minimizing any potential changes to water supply characteristics as a result of temporary chlorination (see Section 9.19.2.3, “Public Water Supply Infrastructure”). Therefore, the addition of sodium hypochlorite or chlorine dioxide at the Ashokan Screen Chamber would not have a significant adverse impact on public health for the City Outside Community Connections.

9.19.2.6 Natural Resources

This section analyzes the potential impacts to natural resources that could occur as a result of introducing these DBPs and chloride to the environment during repair and rehabilitation. Natural resources include geology and soils, water resources, aquatic and benthic resources, terrestrial resources, wildlife, federal/State Threatened, Endangered, Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species.

Methodology

The impact analysis consisted of qualitatively assessing the potential for impacts from discharges of DBPs and chloride formed within the aqueduct as a result of the repair and rehabilitation at locations where water from the aqueduct enters the surrounding environment. As noted above, local dechlorination systems at the leak sites and a dechlorination facility at the Pleasantville Alum Plant and connection chambers for the Village of New Paltz and City of Newburgh would be installed to remove sodium hypochlorite, chlorine dioxide, and/or chlorine residuals (referred

to as chlorine residuals within this section) from the treated water prior to discharge or release. The dechlorination systems would incidentally remove some chlorite from treated waters. The proposed chlorination and dechlorination facilities and local dechlorination systems would operate until the repair and rehabilitation is completed in 2023. While chlorine residuals would be adequately removed via dechlorination at the leak locations, connection chambers, and Pleasantville Alum Plant, there would be a potential discharge of sodium hypochlorite- and chlorine dioxide-related DBPs and chloride at these locations.

Assessment

Baseline conditions for ecological communities at leak locations are dominated by a maple-basswood rich mesic or hemlock-northern hardwood forests. The species generally found in upland areas at leak locations include eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), white snakeroot (*Ageratina altissima*), Robert geranium (*Geranium robertianum*), garlic mustard (*Alliaria petiolata*), and sticky willy (*Galium aparine*). Some contain water resources such as wetlands and surface water. Discussions on natural resources specific to individual leak sites are located in the relevant “Natural Resources” sections in the study area impact analyses. In addition, there are three surface water reservoirs fed by the Catskill Aqueduct: one in the Town of New Windsor (where the City of Newburgh’s reservoir is located); one in the Village of New Paltz (fed by Catskill Aqueduct water discharged to Silver Stream); and Kensico Reservoir (part of the City’s water supply) (see Chapter 3, “Overview of the City’s Water Supply System”). These water resources are aquatic environments that receive and store water from the Catskill Aqueduct.

In the future without the repair and rehabilitation, it is assumed that ecological communities within the study areas and the aquatic environments of the noted reservoirs would largely be the same as baseline conditions, with the exception of possible changes in habitat due to natural vegetative succession. For purposes of this assessment, it is assumed that ecological communities would remain a mix of upland and wetlands habitats similar to other areas along the Catskill Aqueduct.

In the future with the proposed repair and rehabilitation, following construction of the chlorination facility at the Ashokan Screen Chamber and dechlorination facilities at the Pleasantville Alum Plant and connection chambers for the Village of New Paltz and City of Newburgh, temporary chlorination of the Catskill Aqueduct would occur through 2023 to support the RWBT temporary shutdown. Local dechlorination systems for leaks would also be operated during this time. As discussed in Section 9.2.6.3, “Leak Repair and Local Dechlorination,” these local dechlorination systems would use granular activated carbon (GAC) for treatment, with the exception of the leak at Shaft 7 which would involve the use of chemical mats consisting of sodium bisulfite and Leak 5 which would consist of a sodium bisulfite injection system. The water dechlorinated by these systems would discharge into the existing leak flowpath and eventually to a naturally occurring receiving waterbody. Installing dechlorination systems where the leaks express at the ground surface would prevent untreated leak water from being transported through the leak flowpath and entering wetlands or naturally occurring receiving waterbodies. Additionally, the dechlorination systems would be installed

within the existing flowpaths so that treated water would continue to contribute to the natural system as it does under baseline conditions and would not alter surface or subsurface flows.

Discharge from the dechlorination systems would meet applicable State water quality standards for chlorine residuals. However, further analysis is required due to the potential formation of DBPs (chlorate and chlorite and THMs, and HAAs) and chloride within the aqueduct as a result of temporary chlorination since these constituents would not be completely removed through dechlorination.

Chlorine Dioxide DBPs

Chlorate

The chlorate concentrations anticipated as a result of chlorination are expected to be small and further reduced through dilution within surface water. Additionally, for the open water reservoirs, if anaerobic conditions exist at the reservoir floor, there is potential for chlorate removal through biodegradation. Chlorate was shown to biodegrade under anaerobic conditions producing chloride and oxygen (Shamim 2006).

Research shows that chlorate can damage leafy vegetation. For example, one study found that 50 percent of the study population experienced the more severe negative effects at 0.08 mg/L (Borges et al. 2004). While this is at the upper end of the concentration anticipated to be discharged as part of the repair and rehabilitation, chlorate would mix with existing waterbodies to further reduce overall concentrations. This study also found that, at ambient temperatures of 43°F, chlorate uptake by plants in the study population was reduced by 40 percent compared to ambient temperatures of 82°F (Borges et al. 2004). The temperature of the water coming from Ashokan Reservoir through the aqueduct is anticipated to remain on the lower range of those temperatures investigated in the study, as the average water temperature of Catskill Aqueduct water is approximately 50°F based on historical DEP monitoring data.

Chlorate levels are likely to be reduced through biodegradation, dilution, and the temperature of water within the aqueduct comparable to that in the study, which would potentially reduce plant uptake of chlorate.

Therefore, the repair and rehabilitation would not result in significant adverse impacts to vegetation or aquatic organisms due to increases in chlorate at the leak sites, within the waterbodies that receive leak water (including New Croton Reservoir), or within the waterbodies that receive aqueduct water (i.e., Silver Stream, water supply reservoirs in the Village of New Paltz and City of Newburgh, and Kensico Reservoir).

Chlorite

The chlorite concentrations anticipated as a result of chlorination are expected to be small. In addition, GAC has been shown to effectively remove chlorite and would be the main treatment component for the majority of proposed leak dechlorination systems. GAC has been shown to be effective in removal of chlorite with reported chlorite removal of 63 percent at chlorine dioxide doses of 0.8 mg/L (Hoehn et al. 2003). Bench-scale testing showed that a GAC column dosed

with 5 mg/L chlorite experiences a drop in removal efficiency from 90-100 percent with a new reactor bed down to 50-60 percent with an exhausted bed at an empty bed contact time of 10 minutes. Even with an exhausted bed, the reduction of chlorite using GAC would further reduce the potential effects on vegetation or aquatic organisms at the leak sites with dechlorination systems.

Studies have shown that chlorite is toxic to the green and blue-green algae and bacteria that typically may occur in lakes and streams of the Northeast (van Wijk et al. 1995). The lowest effective chlorite levels reviewed in the study were 0.08 mg/L for green and blue-green algae and bacteria. Limited data was available concerning chlorite toxicity in fish. In one study, only high levels of chlorite had effects on fish. Chlorite concentrations as high as 75 mg/l were found to be non-toxic to test larvae independent of the exposure duration.

Chlorite levels associated with chlorine dioxide addition are anticipated to be at most 0.68 mg/L. For the assessment of impact to plants, if all of the chlorate present after treatment with chlorine dioxide at 0.8 mg/L is conservatively assumed to be converted to chlorite once it is taken up by vascular plants, as discussed in “Chlorate” in Section 9.19.2.6, “Natural Resources,” this concentration could be as high as 0.76 mg/L within aquatic plants. The total concentration would be higher than the effective concentrations considered toxic to green and blue-green algae and bacteria, but well below the concentration found to be toxic to adult and larvae rainbow trout (Svecevičius et al. 2005).

However, two potential paths of chlorite degradation in open waterbodies have been identified: photodegradation through exposure to sunlight; and biodegradation in anaerobic conditions that may limit the amount of chlorite that may be carried through the leak flowpaths or reservoirs as part of sodium hydroxide addition. When exposed to sunlight, chlorite has a short half-life and is degraded to chloride and chlorate. In the presence of bright sunlight, chlorite has a short life-time (<10 min) (Andrews et al. 2005). The half-life is dependent on the concentration of dissolved organic material, water depth, mixing, season, latitude, and time-of-day (Cooper et al. 2007). Similar to chlorate, if anaerobic conditions exist at the reservoir floor, there is additional potential for chlorite removal through biodegradation. Chlorite was shown to biodegrade under anaerobic conditions producing chloride and oxygen (Shamim 2006).

Any potential effects associated with chlorite are likely to be reduced through GAC treatment, photodegradation, biodegradation and/or an overall reduction of concentrations when entering larger volumes of water.

Therefore, the repair and rehabilitation would not result in significant adverse impacts to vegetation or aquatic organisms due to increases in chlorite at the leak sites, within the waterbodies that receive leak water, or within the waterbodies that receive aqueduct water (i.e., Silver Stream, water supply reservoirs in the Village of New Paltz and City of Newburgh, and Kensico Reservoir).

Sodium Hypochlorite DBPs

HAAs

For HAAs, ecological risk assessments have demonstrated that algae have been the most sensitive organisms to HAA exposure, followed by macrophyte plants, a group of aquatic plants that grow in or near waters such as lakes and rivers, and may either be emergent, submergent, or floating (Boutonnet et al. 1999; OECD 1996, 2000). HAAs are not likely to bind to sediments and are, therefore, expected to be freely available in the water column for exposure to and uptake by aquatic plants and other organisms. HAAs are generally found as mixtures and their potential interactions are not fully understood (Hanson et al. 2004). Plants evaluated, including a floating monocot (*Lemna gibba*) and submerged dicots (*Myriophyllum spicatum* and *M. sibiricum*), found that HAAs did not pose a risk to freshwater macrophytes at current environmental concentrations in international studies conducted for both single compound and mixture exposures. Further, the degradation products of HAAs are carbon dioxide and halide ions, which in themselves do not pose a risk to these plants. Effects in submerged dicots and floating monocot exposed to HAAs were observed at concentrations greater than 10 mg/L, and in the greater than 1 mg/L range for HAAs at the EC₁₀ level after 14 and 4 days of exposure, respectively. Studies of the potential effect of HAAs on aquatic species were not available.

The HAA levels reviewed in the ecological risk assessments were 0.5 to 188.3 mg/L (Boutonnet et al. 1999; OECD 1996, 2000) while the HAA levels associated with sodium hypochlorite addition are anticipated to be at most 0.03 mg/L (30 µg/L). In addition, HAAs have been found to biodegrade in open water reservoirs, further reducing their ability to affect vegetation or aquatic organisms (Hozalski et al. 2010).

Therefore, the repair and rehabilitation would not result in significant adverse impacts to vegetation or aquatic organisms due to increases in HAAs at the leak sites, within the waterbodies that receive leak water, or within the waterbodies that receive aqueduct water (i.e., Silver Stream, water supply reservoirs in the Village of New Paltz and City of Newburgh, and Kensico Reservoir).

THMs

Studies of the potential effect of THMs on aquatic vegetation were not available and limited research exists on the effects of THMs on freshwater species. Those on saltwater species, such as the mud crab, have demonstrated an LC₅₀ of 1.07 mg/L (Key et al. 1986). In this study, the LC₅₀ was the point where 50 percent of the study population experienced mortality. This concentration, however, is higher than the THM levels associated with sodium hypochlorite addition, which are anticipated to be at most just below 0.03 mg/L (30 µg/L).

As discussed, the State has established guidance values for several DBPs including dibromochloromethane and bromodichloromethane, which are 5 µg/L and 50 µg/L, respectively for Class A waterbodies. This is the classification of the three open water reservoirs. In addition, the State water quality standard for the DBP chloroform for Class A waters is 7 µg/L. Chloroform, dibromochloromethane and bromodichloromethane are all THMs that would be formed through sodium hypochlorite addition. In general, chloroform represents up to 90 percent

of the total concentration of THMs, which means that conservatively up to 27 µg/L of chloroform may be formed as a result of sodium hypochlorite addition at 1.25 mg/L. Similarly, the formation of dibromochloromethane and bromodichloromethane is anticipated to be less than 10 percent, or up to 3 µg/L each.

While the concentrations of dibromochloromethane and bromodichloromethane with sodium hypochlorite addition would be below the State's guidance levels, chloroform could be present in water discharged from the aqueduct at levels above the State's Class A water quality standard. None of the receiving waters that would receive leak water currently have a Class A designation. However, Silver Stream, which would not receive leak water but does convey water from the City of Newburgh's connection on the Catskill Aqueduct to their water supply reservoir, is a Class A waterbody. While the concentration of chloroform discharged may be higher than the State water quality standard, the estimated concentration is considered conservative, and this concentration would be further diluted within the existing stream flow. Therefore, it is anticipated that the total concentration of chloroform present in Silver Stream, and ultimately the City of Newburgh's water supply reservoir, would not exceed the State water quality standard.

Studies have also shown that THMs can be removed through volatilization. Volatilization can occur as a result of turbulence through a channel, wave action, and wind, and may occur within the waterbodies connected to the leaks (including New Croton Reservoir) or the waterbodies that transfer and store water from the Catskill Aqueduct. In addition, the receiving water flows or volumes would also serve to dilute discharges from the aqueduct upon entering Silver Stream and the three surface water reservoirs. It is also important to note that the concentrations of chloroform analyzed are associated with the maximum dose of sodium hypochlorite (1.25 mg/L). It is likely that doses much lower than this (near 0.5 mg/L) would be more common during chlorination. Concentrations of THMs at this lower dose would be less than 10 µg/L for the longest travel time within the aqueduct. The longer that organics in the aqueduct water are in contact with sodium hypochlorite, the higher the concentration of THMs. Therefore, points further upstream, including those where the City of Newburgh and Village of New Paltz withdraw water, are anticipated to experience even lower concentrations of THMs (and all DBPs). As such, it is not anticipated that chlorination would preclude any receiving waterbodies from maintaining compliance with the State water quality standard for chloroform. Similarly, water quality standards or guidance levels for these DBPs have only been established for Class A waterbodies, not other classes. Therefore, a water quality standard or guidance value for these other waterbodies has not been established.

Therefore, the repair and rehabilitation would not result in significant adverse impacts to the vegetation or aquatic organisms due to increases in THMs at the leak sites, within the waterbodies that receive leak water, or within the waterbodies that receive aqueduct water (i.e., Silver Stream, water supply reservoirs in the Village of New Paltz and City of Newburgh, and Kensico Reservoir).

Chloride

While the chloride concentration resulting from chlorination is anticipated to be far less than the most stringent State water quality standard for chloride (0.16 mg/L to 0.86 mg/L as compared to

250 mg/L), a literature search was conducted to describe the potential effects of chloride on vegetation and aquatic species.

Investigations related to the effects of chloride on the natural environment have generally been through the analysis of road salt and its effect on roadside vegetation. Studies beginning in the 1960s and 1970s in New Hampshire, Minnesota, Michigan, and several other snowbelt states responded to concerns about damage to roadside trees (Lacasse and Rich 1964; Sucoff 1975; Bowers and Hesterberg 1976; Scharpf and Srago 1975). Roadside trees and other vegetation are injured by roadside salt through two primary mechanisms: increased salt concentrations in soil and soil water, which can result in salt absorption through roots; and salt accumulation on foliage and branches due to splash and spray.

Trees that are most sensitive to salt are broad-leaved species include linden, black walnut, and sugar and red maples. In roadside maples, levels of chloride greater than 0.5 percent dry weight of plant tissue have been correlated with moderate damage to leaves (e.g., discoloration) (Hall et al. 1972), and levels of 1 to 2 percent have been associated with severe leaf burn, defoliation, and even plant death (Allison 1964). Salt-resistant tree species include oak, birch, white ash, and Scotch and jack pine (Shortle and Rich 1970; Hofstra and Hall 1971). These trees tend to retain less chloride as a percentage of tissue weight. Regarding wetland vegetation, runoff of road salt into wetlands has rarely been identified in literature as a problem since salt tolerance is generally high in many prominent wetland species, such as cattails (*Typha latifolia*).

Generally, chloride impacts to the environment have been limited to effects in the form of road salt and in site-specific locations. However, these studies have consistently pointed toward a general conclusion that salt concentrations diminish rapidly as water volume and distance from the roadway increase. Additionally, chloride levels may be reduced by increased water flows as seen in seven Maine streams and rivers following a spring snowmelt (Hutchinson 1970). With regard to the potential for chloride increases in waterbodies connected to leaks, including New Croton Reservoir and open storage reservoirs that receive aqueduct water, chloride is likely to be diluted in larger and moving bodies of water.

The impacts of chloride concentrations on aquatic life are also reported to be minor. While high and sustained chloride concentrations in surface water at more than 1,000 mg/L have been linked to growth changes in some plankton (Stewart 1974; Antonyan and Pinevich 1967), field studies indicate that such high concentrations are uncommon. Of these high chloride concentrations, those in the range of 400 to 12,000 mg/L are likely harmful to fish (Schraufnagel 1973; Jones et al. 1986).

The increase in chloride concentrations due to the repair and rehabilitation would be minor compared to the chloride concentrations naturally occurring in the Catskill Aqueduct's raw water. For example, the average chloride concentration for the untreated Catskill supply is typically 4.0 mg/L based on historic DEP water quality data at Ashokan Reservoir. Additionally, chloride concentrations as a result of chlorine dioxide addition would be significantly lower than the harmful concentrations documented above at a maximum anticipated concentration at 0.16 mg/L. This would remain true even if the potential chlorate and chlorite present were to decompose to chloride and oxygen in the environment, thereby increasing the total potential chloride concentration to 0.92 mg/L.

Therefore, the repair and rehabilitation would not result in significant adverse impacts to vegetation or organisms due to increases in chloride at the leak sites, within the waterbodies that receive leak water, or within the waterbodies that receive aqueduct water (i.e., Silver Stream, water supply reservoirs in the Village of New Paltz and City of Newburgh, and Kensico Reservoir).

Natural Resources Impact Analysis Conclusions

Based on an analysis of the potential DBPs and chloride that would be released in leak water and discharges from the Catskill Aqueduct associated with chlorination, the levels of DBPs and chloride would be low. As described above, most of these constituents do not have a specific water quality standard or guidance value in the State. Studies show that dechlorination systems would be able to reduce chlorite concentrations. Additionally, studies show that DBP levels would be reduced by volatilization, dilution, and degradation. As a result, there may be only minor and temporary effects to the fringe vegetation of the floodplain forests, shallow emergent marshes, and vegetation along leak flow pathways.

In order to assess any potential changes, DEP would conduct a photographic survey of vegetation along a portion of the leak flowpath in proximity to the proposed leak dechlorination systems prior to initiating chlorination. DEP would then conduct a comparable photographic survey after treatment has been completed.

Therefore, there would be no significant adverse impacts to natural resources at the leak sites, Kensico Reservoir or the reservoirs and receiving waterbodies of the Village of New Paltz and City of Newburgh (including Silver Stream), as a result of chlorination. Following completion of the RWBT temporary shutdown, chlorination of the aqueduct would cease, local dechlorination systems would no longer be needed, and operation of the Catskill Aqueduct would be returned to baseline conditions.

9.20 COMMITMENTS

As part of the proposed project, DEP identified and incorporated specific commitments within the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation) component of Upstate Water Supply Resiliency to avoid and/or minimize the potential for significant adverse impacts to the maximum extent practicable. The commitments and protective measures associated with repair and rehabilitation are summarized below.

9.20.1 OPERATIONS

- DEP would only commence aqueduct shutdowns under favorable hydrologic conditions and when the water supply system is entering a period of lower demand.

9.20.2 NATURAL RESOURCES

- Tree removal would be conducted from November 1 through March 31 to avoid impacts to Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*).
- DEP would inspect structures that would be repaired prior to commencement of work to verify whether there are signs of roosting bats.
- For federal/State Threatened, Endangered Species, and Candidate Species, State Species of Special Concern, protective measures include perimeter fencing and other measures species relocation as discussed in detail in Section 9.4, “Town of Olive Impact Analysis,” through Section 9.19, “Project-wide Impact Analysis.” As an example, should any timber rattlesnakes (*Crotalus horridus*) be encountered during construction, DEP would enact an encounter plan. Among other elements, the encounter plan would include having a natural resource specialist relocate the species outside of the work area, as appropriate.
- Use of stream diversions for in-water work would be limited to the maximum extent practicable, particularly within those locations where waterbodies are supportive of coldwater fisheries (e.g., trout [T] or trout spawning [TS]). Where temporary diversions are required, DEP would employ partial diversions where feasible that would not restrict more than 40 percent of the stream width in order to maintain stream flow and fish passage throughout the duration of construction. For waterbodies where a full stream diversion may be required, this work would be done outside of any work restrictions associated with coldwater fisheries and would be limited in scope and duration to the maximum extent practicable. Permanent streambank protection measures would be installed along streams in selected areas to prevent erosion and possible scouring within receiving streams.
- Leaks along the aqueduct would be repaired or have local dechlorination systems installed prior to commencing chlorination to prevent chlorinated water from being released into the environment. DEP would conduct a photographic survey of vegetation in proximity to leak flowpaths prior to initiating chlorination and following repair and rehabilitation.

9.20.3 WATER AND SEWER INFRASTRUCTURE

- Discharges associated with unwatering of the Catskill Aqueduct would be controlled through the use of throttle valves and on-site monitoring to avoid a bankfull event in receiving waterbodies. In addition, for receiving streams that could be inundated during an unwatering event, DEP would avoid discharging at these sites within 24 hours of predicted rain events, during these rain events, and for a period of 48 hours after rain events or after which time streamflow returns to normal.
- DEP would coordinate closely with Outside Community Connections to confirm they have access to adequate water supply independent of the upper Catskill Aqueduct prior to any temporary shutdown of the aqueduct required for the repair and rehabilitation.
- DEP would add sodium hypochlorite or chlorine dioxide as part of the proposed chlorination at doses that would ensure effectiveness of the repair and rehabilitation while maintaining sodium hypochlorite and chlorine dioxide residuals and the associated formation of disinfection by-products (DBPs) below their respective maximum residual disinfection or maximum contaminant levels for all Outside Community Connections, as applicable.¹

9.20.4 TRANSPORTATION

- Use of the primary staging areas during the 10-week shutdowns would generate higher vehicle trips than during construction when the aqueduct is in service. During these periods, there would be shuttle trips between the primary staging area and study areas to reduce the volume of construction vehicles on local roads.
- To reduce truck trips during the weekend, biofilm removed from the aqueduct would be stockpiled at the Wallkill Downtake Chamber in the New Paltz-Minnewaska Road Study Area and removed from the site Monday through Friday.

9.20.5 NOISE

- DEP would use generators and fans during construction. Generators would not exceed a maximum noise emission of 75 A-weighted decibels (dBA) equivalent average sound level (Leq) at 50 feet from the generators, and may need to be equipped with protective and sound attenuating enclosures to meet this level. Fans would not exceed a maximum noise emission of 51 dBA Leq at 50 feet from the fans.²

¹ DBPs formed as a result of sodium hypochlorite addition include trihalomethanes (THM) and haloacetic acids (HAAs). For chlorine dioxide, DBPs are chlorite and chlorate. Chloride is also formed.

² These reduced noise levels for generators and fans were not used in the impact analyses.

9.20.6 PUBLIC HEALTH

- DEP would not dose chlorine dioxide above 0.8 milligrams per liter (mg/L) or sodium hypochlorite above 1.25 mg/L under the proposed chlorination. This would ensure effectiveness of the repair and rehabilitation while maintaining residuals of these chemicals and the associated formation of disinfection by-products (chlorite, chlorate, trihalomethanes [THM], and haloacetic acids [HAAs]) below their respective New York State Department of Health maximum residual disinfection or maximum contaminant standards, as applicable.
- DEP would work with Outside Community Connections to implement measures aimed at monitoring and minimizing any potential changes to water supply characteristics as a result of temporary chlorination. These measures may include operational changes to reduce water age or oxidant use; monitoring of pH, chlorine dioxide, and DBPs; and addition of a corrosion inhibitor, as applicable.
- DEP is committed to developing and working with owners to implement an Action Plan for potentially affected private drinking water supply wells within the Lucas Turnpike and Mossybrook Road study areas (see **Figure 9.20-1** and **Figure 9.20-2**), if required.

9.20.6.1 Well Action Plan

For the Lucas Turnpike and Mossybrook Road study areas, DEP would coordinate with landowners of parcels with structures that could contain drinking water supply wells. DEP would also coordinate with current and/or future landowners of vacant parcels that could contain, or be developed to contain, private drinking water supply wells that could be developed before or during the temporary chlorination of the aqueduct. The Action Plan would consist of well monitoring that would occur 12 months before, during, and up to 12 months after the temporary chlorination period. Water levels would be measured and water samples would be collected from each monitored well quarterly, if agreed to by the landowner, to determine the chlorine dioxide, sodium hypochlorite, and/or chlorine residual level in each well. Monitoring results would be compared to the criteria below.

9.20.6.2 Well Action Plan Criteria

- Point-of-use treatment would be provided to any well that has a documented hydraulic connection to the Catskill Aqueduct and has the potential for detectable levels of chlorine dioxide, sodium hypochlorite, and/or chlorine residual within the areas shown on **Figure 9.20-1** and **Figure 9.20-2**.
- Point-of-use treatment would be provided to any well that has a level above the laboratory detection limit for either chlorine dioxide, sodium hypochlorite, and/or chlorine residuals.

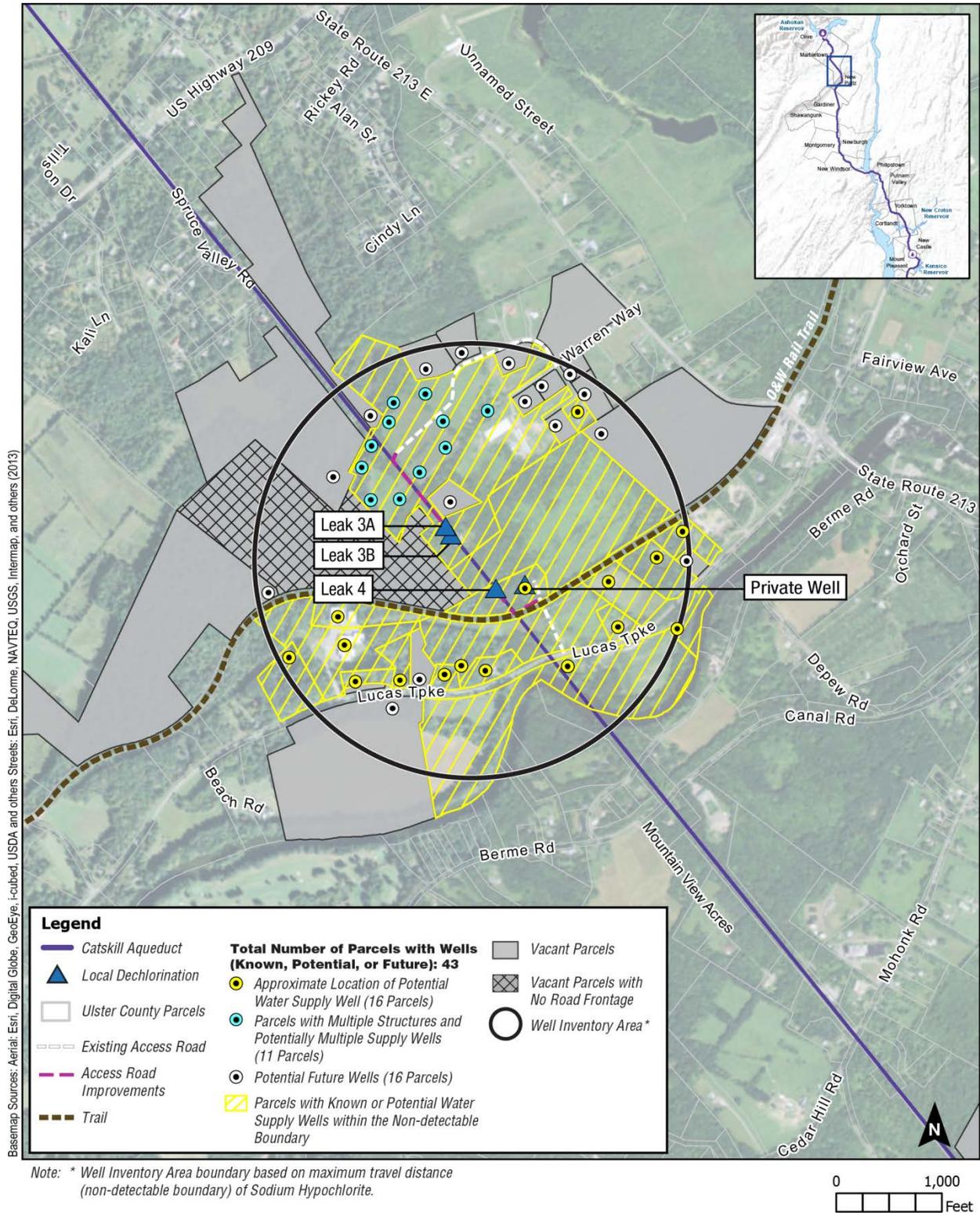
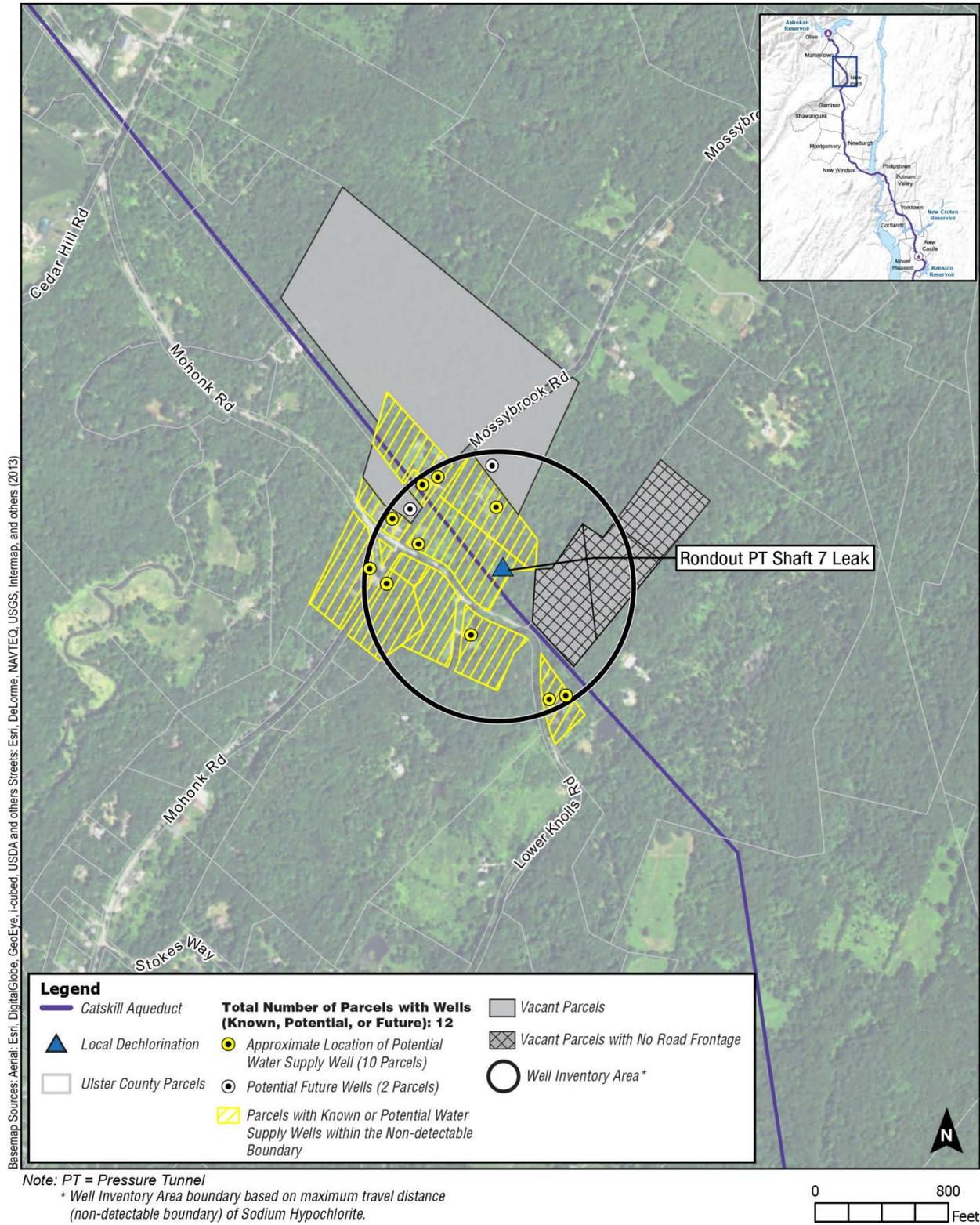


Figure 9.20-1: Well Action Plan – Lucas Turnpike Study Area, Town of Marletown, Ulster County





Basemap Sources: Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA and others Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)

Figure 9.20-2: Well Action Plan – Mossybrook Road Study Area, Town of Marletown, Ulster County

