Cumulative impacts are two or more individual effects on the environment that, when taken together, are significant or that compound or increase other environmental effects. Cumulative impacts can result from a single action or multiple actions, including individually minor but collectively significant actions that take place over time. They may include indirect or secondary impacts, long-term impacts, and synergistic effects.

In addition to potential cumulative impacts from the implementation of Upstate Water Supply Resiliency, the individual components of Upstate Water Supply Resiliency that overlap in specific municipalities were considered. While each of the proposed activities would be temporary, they were evaluated herein to identify those that would occur simultaneously to determine if the combined effects would increase their level of significance or change the potential for impacts within a municipality.

12.1 CUMULATIVE IMPACTS

An analysis of potential cumulative impacts of Water for the Future (WFF) from shaft and tunnel construction (referred to as RWBT Bypass), and a preliminary review of the potential for impacts associated with four water supply augmentation were previously evaluated in a Final Environmental Impact Statement issued on May 18, 2012 (previous EIS). RWBT Bypass work has commenced.

At the time of the previous EIS publication, these augmentation projects were planned to ensure a continued supply of water to DEP's customers during the 15-month Rondout-West Branch Tunnel (RWBT) temporary shutdown anticipated at the time of publication. These projects included the New Jersey and Nassau County Interconnections, the Catskill Aqueduct Repair and Rehabilitation, and the Queens Groundwater Rehabilitation. Since publication of the previous EIS, it has been determined through ongoing planning and assessment that the amount of time required for the RWBT temporary shutdown could be reduced to a period of up to 8 months. Because of the shorter temporary shutdown period, only one augmentation project, the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation), is now required to support it. The previous EIS assumed that the locations and/or timing of impacts for shaft and bypass tunnel construction would not coincide with what is now referred to as Upstate Water Supply Resiliency. As a result, it was reasonably anticipated that any impacts resulting from Upstate Water Supply Resiliency would not exacerbate any of the impacts associated with shaft and bypass tunnel construction. This assumption remains valid based on the final locations and timing of the proposed activities associated with implementation of Upstate Water Supply Resiliency.

Compared to the description in the previous EIS, Upstate Water Supply Resiliency includes fewer augmentation components (one versus four), has a more limited geographic extent (now limited to upstate New York components), includes fewer required construction activities (predominately to support the Catskill Aqueduct Repair and Rehabilitation), and has a reduced operational duration (to support an 8-month versus a 15-month temporary shutdown).

This section provides the methodology and cumulative impact analyses for those analysis categories associated with the individual components of Upstate Water Supply Resiliency that, when combined with other project components, could potentially have more significant or far-reaching effects on the area covered or served by WFF. The categories include energy, greenhouse gas (GHG) emissions and climate change, and public health. The cumulative socioeconomic conditions analysis is focused on WFF as a whole, because it accounts for the costs associated with Upstate Water Supply Resiliency along with updated costs of shaft and bypass tunnel construction (as compared to costs presented in the previous EIS). While a cumulative water supply infrastructure analysis was identified in the Final Scope of Work, DEP has now determined that this analysis is not required because the effects on water supply infrastructure from each project component would not occur at the same time and would take place at discrete locations.

The proposed individual components of Upstate Water Supply Resiliency include the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation), WFF Shutdown System Operations (WSSO), and the RWBT Inspection and Repair (inspection and repair) including decommissioning, as detailed in Chapter 9, "Proposed Catskill Aqueduct Repair and Rehabilitation," through Chapter 11, "Proposed Rondout-West Branch Tunnel Inspection and Repair." In addition to the cumulative assessments identified above, DEP also considered the potential for overlapping effects within municipalities across impact categories associated with each component of Upstate Water Supply Resiliency. While some towns contain multiple study areas, activities in the study areas associated with each component would largely occur at different times. Most temporary impacts associated with the Catskill Aqueduct Repair and Rehabilitation and RWBT Inspection and Repair at the shaft sites would occur prior to the RWBT temporary shutdown. Impacts associated with leak repair near Wawarsing and WSSO would occur concurrently during the RWBT temporary shutdown, and impacts in Roseton would mostly occur following connection of the RWBT to the bypass (see **Figure 12.1-1**).

Where a municipality contains multiple WSSO study areas, temporary changes to reservoir elevations or flows would largely occur within the typical operating ranges or historical variations of each waterbody. For municipalities that include multiple Catskill Aqueduct Repair and Rehabilitation or RWBT Inspection and Repair study areas, significant adverse impacts would not occur due to the presence of other trees, species, or habitats surrounding the study areas, the use of Best Management Practices during construction, and the short-term nature of the work. Finally, project-wide effects from the Catskill Aqueduct Repair and Rehabilitation would not result in significant adverse impacts as discussed in Section 9.18, "Project-wide Impact Analysis." Therefore, while several activities may occur in a municipality as a result of Upstate Water Supply Resiliency, they would not result in additive or cumulative impacts, and no further analysis of overlapping effects within the various project municipalities is warranted.

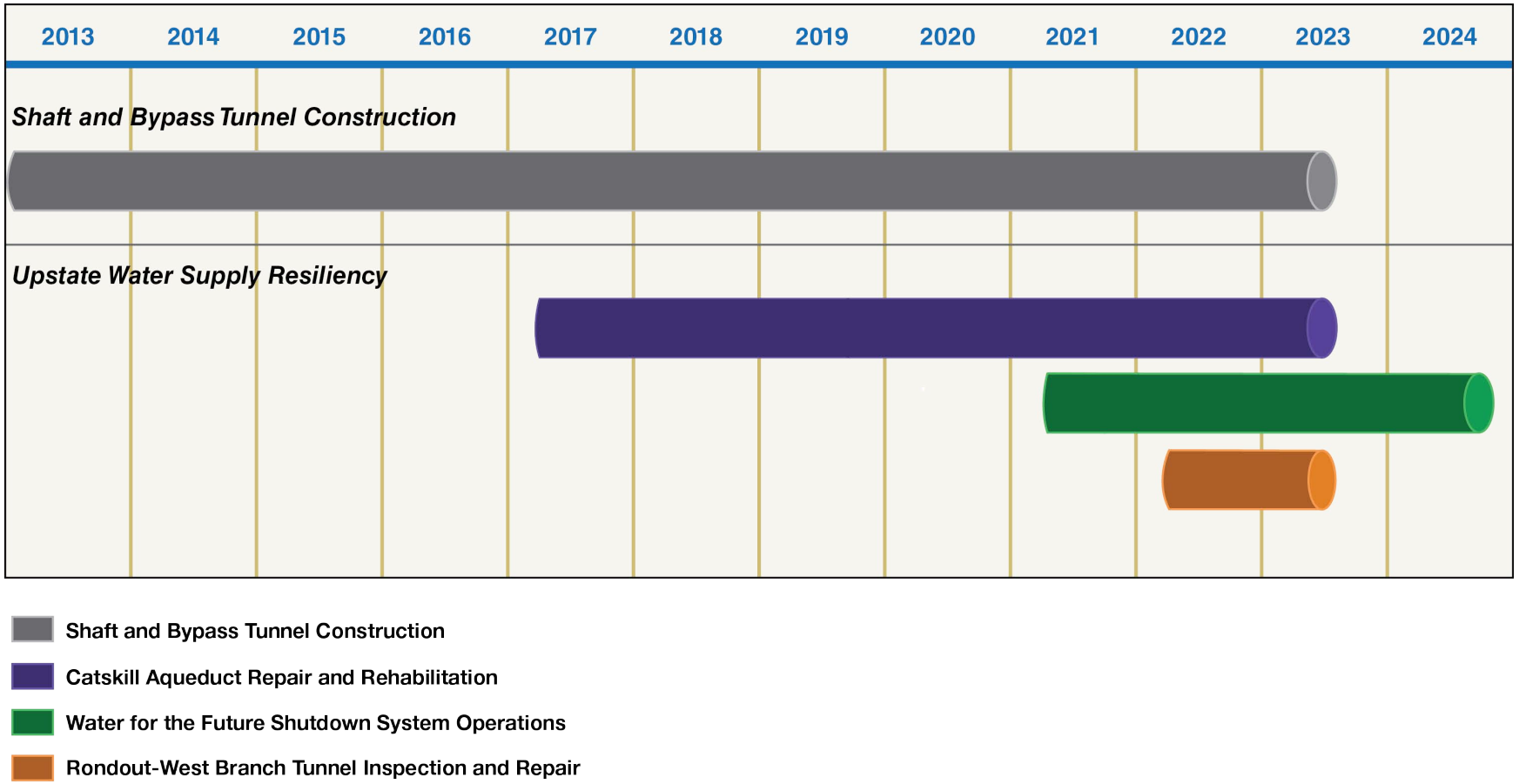


Figure 12.1-1: Water for the Future Timeline

Together, the previous EIS and this DEIS consider the full range of environmental impacts associated with WFF, including short-term and long-term impacts.

12.1.1 ENERGY

According to the *City Environmental Quality Review (CEQR) Technical Manual*, a detailed analysis of energy impacts is typically required for projects that may significantly affect the transmission or generation of energy. Most actions resulting in new construction would not create significant adverse impacts to energy, and would not require a detailed energy analysis. However, a proposed action's operational energy consumption is typically estimated as part of a CEQR analysis. This cumulative energy analysis evaluates whether Upstate Water Supply Resiliency would cause significant adverse impacts to energy.

12.1.1.1 Assessment

As described in this DEIS, there would be no long-term construction or operational activities associated with the components of Upstate Water Supply Resiliency. Energy use associated with construction activities, and construction and operation of the leak treatment systems, the chlorination facility at the Ashokan Screen Chamber, and the dechlorination facility at the Pleasantville Alum Plant as part of repair and rehabilitation would be limited. Construction and operation of the leak treatment systems would require little temporary power. Construction and operation of the chlorination facility at the Ashokan Screen Chamber and the dechlorination facility at the Pleasantville Alum Plant would rely on connections to existing power sources at these facilities, and only for a temporary period. Construction of the siphons at Merriman Dam would require little temporary power and their operation would require no power once they are primed. All power requirements associated with the inspection and repair at the shaft sites would be provided via temporary and portable on-site generators. As described in this DEIS, due to the limited scale and duration of construction activities associated with these components and the minimal energy use associated with their operation, an energy impact analysis is not warranted for Upstate Water Supply Resiliency as it relates to energy consumption or transmission. Any required power would be supplied from existing available sources. Furthermore, temporary loss of electricity generation for the East, West, and Neversink tunnels of the Delaware System, and the Ashokan Reservoir headworks of the Catskill System (each of which has hydroelectric turbines that generate electricity when these system components are in operation) during the RWBT temporary shutdown would not affect the regional availability of electricity. Therefore, Upstate Water Supply Resiliency would not result in significant adverse impacts to energy.

12.1.2 GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

Greenhouse gas (GHG) emissions are gases in the atmosphere that can absorb and then emit thermal infrared radiation. In doing so, they change the balance of heat in the atmosphere. As discussed in the *CEQR Technical Manual*, increased concentrations of GHGs in the atmosphere are changing the global climate, resulting in wide-ranging effects on the environment, including rising sea levels, increases in temperature, and changes in precipitation levels. Although this is on a global scale, the environmental effects of climate change are also likely to be experienced at the regional and local levels. The City has established initiatives and goals for both greatly

reducing GHG emissions and adapting to climate change locally. Executive Order 109 of 2007 mandated the formulation of a comprehensive plan to reduce GHG emissions from City buildings and operations by 30 percent below 2006 levels by 2017. In addition, the goal to reduce citywide GHG emissions to 30 percent below 2005 levels by 2030 was codified by Local Law 22 of 2008, also known as the New York City Climate Protection Act. GHG emissions goals were amended by Local Law 66 of 2014 in relation to reducing citywide GHG emissions to 80 percent below 2005 levels by 2050. The assessment presented below evaluates Upstate Water Supply Resiliency with the above goals, following procedures presented in the *CEQR Technical Manual*.

12.1.2.1 Assessment

The *CEQR Technical Manual* lists six GHGs that could be evaluated in an EIS: carbon dioxide (CO_2), nitrous oxide (N_2O), methane, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). There would be no significant direct or indirect sources of HFCs, PFCs, or SF_6 associated with Upstate Water Supply Resiliency, since these pollutants are emitted primarily from non-combustion sources, such as refrigeration and industrial sources.

Upstate Water Supply Resiliency activities with the potential to produce GHGs include: (1) repair and rehabilitation, including construction and operation of the chlorination facility at the Ashokan Screen Chamber and dechlorination facility at the Pleasantville Alum Plant; (2) construction and operation of the siphons at Merriman Dam as part of WSSO; and (3) activities associated with inspection and repair at the shaft sites. Typically, projects with larger-scale activities include a GHG analysis focused mainly on CO_2, N_2O, and methane, pollutants associated with fossil fuel combustion. However, since no major stationary fossil fuel combustion sources are proposed for use as part of Upstate Water Supply Resiliency, there would be no significant direct or indirect sources of these compounds. Furthermore, upstream emissions related to the production of construction materials would be negligible and electricity use would also be temporary and minimal, and would not require any additional power supply from the local grid. Moreover, the proposed water supply augmentation largely relies on existing infrastructure; the water supply is conveyed by gravity and thereby does not rely on energy sources. Therefore, there would be no significant direct or indirect sources of CO_2, N_2O, and methane associated with Upstate Water Supply Resiliency.

Upstate Water Supply Resiliency was also evaluated for consistency with the GHG reduction goal, as defined in the *CEQR Technical Manual*, which requires examination of the way in which a project would reduce its carbon intensity. Under such an analysis, a proposed project is weighed against the considerations listed for the following five goals: building efficient buildings, using clean power, creating transit-oriented development and sustainable transportation, reducing construction activity emissions, and using building materials with low carbon intensity.

As described, there would be negligible construction and operational GHG emissions associated with Upstate Water Supply Resiliency. Therefore, Upstate Water Supply Resiliency would not result in significant adverse impacts to GHGs or climate change.

12.1.3 SOCIOECONOMIC CONDITIONS

The socioeconomic character of an area includes its population, housing, and economic activity. As discussed in Section 8.2.2, "Socioeconomic Conditions," a socioeconomic analysis should be conducted if a project is reasonably expected to generate substantial socioeconomic changes that would not occur without the proposed project. While socioeconomic effects were not the primary consideration in selecting the various components of WFF, the most cost-effective solution for addressing the leaking section of the RWBT was the construction of the bypass tunnel and two associated shafts to permanently circumvent the leaking section at the Roseton crossing, coupled with the selected components of Upstate Water Supply Resiliency. WFF would be limited to a defined geographical extent and duration, and would not affect existing or proposed development, or other buildings or structures. Therefore, WFF would not displace existing residents or businesses, or result in any new development in the surrounding area that could lead to higher property values or rents, nor would it generate a significant increase in employment during construction or operation.

This section analyzes the potential cumulative socioeconomic impacts of the future cost increases that would occur as a result of the incremental increase in water costs associated with WFF, including Upstate Water Supply Resiliency. The changes to water and sewer costs to pay for the capital and operating costs of WFF, including Upstate Water Supply Resiliency, would be minor. The previous EIS provided an estimate of the water rate increases that would occur as a result of shaft and bypass tunnel construction based on capital cost estimates available at the time of publication (2012). Since that time, construction cost information for shaft and bypass tunnel construction has been updated and refined, and, therefore, is captured in the following analysis. In addition, capital costs that would be associated with implementation of Upstate Water Supply Resiliency are available and are included in this analysis. The methodology and cumulative analysis of socioeconomic conditions associated with Upstate Water Supply Resiliency are presented in the following sections.

The City's water supply and wastewater (sewer) systems are supported by water and sewer charges. These operating expenses and debt service (further described below) on new and existing capital improvements are estimated by DEP annually for the entire system. Water capital improvements include those programs and activities associated with water treatment, transmission, distribution, and maintenance of the water supply system in a state of good repair. Wastewater and sewer service capital improvements include those programs and activities associated with wastewater and stormwater service, including conveyance and treatment, and maintenance of sewer and stormwater systems in a state of good repair.

To finance these water and wastewater capital programs, the City's Municipal Water Finance Authority issues revenue bonds to finance the City's water and wastewater capital programs. The costs associated with DEP's debt service to the City's Municipal Water Finance Authority consume a significant portion of its revenues. The City's Water Board is responsible for determining the rates, charges, and fees of water and wastewater for users sufficient to cover the costs of operating these systems. Each year, water and sewer rates are adjusted to ensure that

annual operating revenues equal the costs based on projected demand.[1] In accordance with this practice, the Water Board would adjust water rates to pay for the capital and operating costs of WFF, including Upstate Water Supply Resiliency.

To assess the projected increases in costs to both City and upstate wholesale customers as a result of WFF, the incremental increase in costs in the Future Without WFF was first calculated through 2023 when WFF would be complete. To determine this increase, the baseline costs in 2016 were compared to projected cost increases in the Future Without WFF. The average water and sewer usage per household was conservatively assumed to remain the same as baseline conditions. Next, the projected rate increase was applied to the average water and sewer usage per household to determine the projected average annual water and sewer charge per household in the Future Without WFF. The incremental average annual cost of water to residential households in upstate wholesale customer areas was calculated based on: the estimated increases through 2023 of wholesale rates that the City charges to municipalities outside of the City of New York, and average usage per household. Rates for upstate wholesale customers account for the cost of water only (no wastewater) and do not include costs associated with service within the City. The projected incremental cost increases in the Future Without WFF were then compared to the projected incremental increases in water costs associated with WFF.

The projected increases associated with WFF include the costs associated with the amortization of revenue bonds over 30 years. In addition, because the majority of City and upstate wholesale customers are residential, and because WFF would not displace businesses or industries, the socioeconomic analysis presented below was conducted for residential customers only.

12.1.3.1 Assessment

For 2016, the baseline year for this analysis, most City customers are charged a uniform water rate of $0.51 per 100 gallons of water. Wastewater charges are levied at 159 percent of water charges (i.e., $0.81 per 100 gallons). **Table 12.1-1** presents 2016 residential costs and average monthly and annual water and wastewater bills for City residential users by household type.

Table 12.1-1: Estimated Baseline Household Water and Sewer Costs for City Residential Customers

Household Type	Average Annual Bill	Average Monthly Bill
City Single-family Dwelling	$1,058	$88.17
City Multi-family Dwelling	$688	$57.33

In addition to in-City customers, DEP provides water on a wholesale basis to some municipalities outside of the City of New York (Outside Community Connections or upstate wholesale customers), accounting for approximately 10 percent of DEP's total water consumption. These upstate wholesale customers are charged wholesale prices for water use up to their entitled amount (based on per capita use). The upstate wholesale customers receive water at the upstate rate for consumption below their entitlement amount, which is set at the equivalent of City per capita consumption multiplied by each upstate wholesale customer's population.

[1] Demand equates to the amount of water sold and is also used to estimate sewer service charges.

Water usage in excess of this entitled amount is charged at a rate equivalent to the City water rate. **Table 12.1-2** presents 2016 costs and average monthly and annual bills for upstate wholesale customers and applies only to water.

Table 12.1-2: Estimated Baseline Water Costs for Upstate Communities Based on Wholesale Water Rates for Municipalities Outside of the City of New York

Household Type	Estimate of Average Annual Bill Based on Wholesale Water Rate	Estimate of Average Monthly Bill Based on Whole Water Rate
Upstate Single-family Dwelling	$138	$11.50

DEP has a robust capital improvement plan to pursue State- and federally mandated projects and to fund critical state of good repair and other projects to maintain the City's water and wastewater infrastructure. Accordingly, future water and wastewater rates are forecasted in line with the anticipated costs of these projects and other required investments. As shown in **Table 12.1-3**, based on preliminary capital forecasting estimates, household bills for City residents are expected to increase by approximately 3 percent to an average annual of $1,301 by the year 2023 for single-family residences, while multi-family residences are anticipated to increase by approximately 3 percent to an annual average of $845. Note that the average annual usage (in gallons) is assumed to remain the same as in 2016.

Table 12.1-3: Estimated Future Without WFF Household Water and Sewer Costs for City Residential Users

Household Type	Projected Average Annual Bill	Projected Average Monthly Bill
City Single-family Dwelling	$1,301	$108.40
City Multi-family Dwelling	$845	$70.41

As shown in **Table 12.1-4**, based on preliminary capital forecasting estimates, household bills for upstate communities are estimated to increase to an average annual of $175 by the year 2023 based on wholesale water rates for municipalities outside of the City of New York. Water rates for upstate service to communities account for the cost of water only and do not include sewer service.

Table 12.1-4: Estimated Future Without WFF Water Costs for Upstate Communities Based on Wholesale Water Rates for Municipalities Outside of the City of New York

Household Type	Estimate of Projected Average Annual Bill Based on Wholesale Water Rates	Estimate of Projected Average Monthly Bill Based on Wholesale Water Rates
Upstate Single-family Dwelling	$175	$14.58

Costs presented in this section reflect the revised cost estimate for shaft and bypass tunnel construction in addition to new or refined estimates for expenditures associated with construction and additional debt service for Upstate Water Supply Resiliency. Refined estimates for Upstate Water Supply Resiliency activities include the repair and rehabilitation (including construction and operating costs associated with addition of a chlorination facility at the Ashokan Screen

Chamber and a dechlorination facility at the Pleasantville Alum Plant) and siphon construction at Merriman Dam as part of WSSO. Including these costs, the total capital cost of WFF is estimated to be $1.16 billion. Based on this information, **Table 12.1-5** presents the estimated total average annual residential bill for City residential users and the incremental cost increase attributable to WFF. Similar to the Future Without WFF, it is assumed that the average annual usage would remain the same as in 2016. As shown in **Table 12.1-5**, the projected costs for City single- and multi-family units reflect an annual increase of approximately $40 and $26, respectively, or a percent difference of approximately 3 percent, compared to the Future Without WFF.

Table 12.1-5: Estimated Household Water and Sewer Costs for City Residential Users in the Future With WFF Compared to the Future Without WFF

Household Type	Average Annual Bill With WFF	Increase of Average Annual Bill With WFF over Future Without WFF	Percent Increase of Average Annual Bill With WFF over Future Without WFF
City Single-family Dwelling	$1,341	$40	3.1%
City Multi-family Dwelling	$871	$26	3.1%

As shown in **Table 12.1-6**, for upstate wholesale customers, increases in water bills relative to costs in the Future Without WFF are estimated to be approximately $23 higher on an annual basis, equating to a 13 percent change compared to the Future Without WFF based on wholesale water rates for municipalities outside of the City of New York. It is important to note that the upstate wholesale bill values are substantially lower than City residential users, resulting in a higher percentage increase.

Table 12.1-6: Estimated Water Costs for Upstate Communities in the Future With WFF Compared to the Future Without WFF Based on Wholesale Water Rates for Municipalities Outside of the City of New York

Household Type	Estimate of Average Annual Bill With WFF Based on Wholesale Water Rate	Increase of Estimated Average Annual Bill With WFF over Future Without WFF	Percentage Increase of Estimated Average Annual Bill With WFF over Future Without WFF
Upstate Single-family Dwelling	$197.80	$22.80	13%

12.1.3.2 Conclusion

In conclusion, the cumulative impact of WFF on future water and sewer costs would be minor. The increases in water costs associated with WFF, including Upstate Water Supply Resiliency, would contribute only a small percentage to the total projected average annual bill increase. The projected increases attributed to WFF would be too small to adversely affect the socioeconomic and financial well-being of the City residential users and upstate wholesale customers that rely on the City's water supply system. Additionally, the estimated increases in costs would occur

gradually over the duration of the analysis period. The nominal increases in costs that would be attributed to WFF would not cause displacement of residents or businesses, nor would they affect the continued viability of businesses.

As described throughout this DEIS, WFF (including Upstate Water Supply Resiliency) is necessary to ensure the continued reliability of the City's water supply system for years to come. As determined through DEP's iterative planning process involving complex modeling and considerations for both repair time and cost, the selected alternative for addressing the leaking section of the RWBT, coupled with the selected components of Upstate Water Supply Resiliency, represents the optimal approach for meeting this goal. While socioeconomic effects were not the primary consideration in selecting the various components of WFF, the overall approach is the most cost-effective solution, especially as opposed to the reactive approach of initiating repairs or upgrades should an emergency event affect the City's ability to supply water reliably. Furthermore, WFF (in particular, the repair and rehabilitation) presents a more cost-effective solution than the Interconnections to Water Supplies in New Jersey Alternative, because this alternative would entail construction of entirely new infrastructure, whereas the repair and rehabilitation is an upgrade of existing infrastructure. The City's ability to implement WFF is partly a result of the citywide Demand Management Plan, which was selected for both its relatively low cost and its ability to account for, manage, and protect the City's water resources during WFF and on a long-term basis. In this way, construction and operation of the RWBT Bypass, as well as the ability to rely entirely on DEP water supply during the RWBT temporary shutdown, minimizes the potential impact to City residential users and upstate wholesale customers.

Therefore, Upstate Water Supply Resiliency would not result in significant adverse impacts to socioeconomic conditions.

12.1.4 PUBLIC HEALTH

The City of New York has a fundamental obligation to provide a reliable potable water supply that meets all public health and regulatory requirements, and is mandated under the federal Safe Drinking Water Act and New York Sanitary Code, as well as its obligations under the FAD. On behalf of the City, DEP is responsible for ensuring the safe and reliable transmission of drinking water from the watershed to consumers 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 are 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 Section 8.2.19, "Public Health," a public health analysis 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. The public health analysis consists of identifying the potential for Upstate Water Supply Resiliency to result in changes to the quality or quantity of water available from the City's water supply system. No significant unmitigable changes to air quality, water supply (quantity or quality), hazardous materials, or noise are anticipated. An assessment of the potential for Upstate Water Supply Resiliency to result in significant adverse impacts to the overall public health conditions is presented below.

12.1.4.1 Assessment

The RWBT segment of the Delaware Aqueduct is leaking up to 35 mgd, primarily in the area known as the Roseton crossing under the Town of Newburgh, Orange County, New York. A second leaking section is located near the Town of Wawarsing, Ulster County, New York. To address these leaks, an iterative planning process involving complex modeling and considerations for water supply availability and potential environmental impacts was undertaken to determine the optimal method of repair. As a result of this planning process, DEP elected to construct a bypass tunnel and two associated shafts to permanently circumvent the leaking section at the Roseton crossing, and to conduct internal repairs to the section near Wawarsing (this project was evaluated in the previous EIS).

As described in Chapter 2, "Purpose and Need for the Proposed Water Supply Resiliency," WFF was developed to respond to the need to repair and improve resiliency in the RWBT, a vital piece of the City's overall water supply system. WFF would ensure continued water supply service for current and future generations of DEP customers. The repair and rehabilitation and WSSO would allow DEP to continue to meet water demand during the approximately 8-month RWBT temporary shutdown, and would support inspection and repair. Each of these components was carefully selected to optimize existing City water resources and to enhance key infrastructure while managing the cost of WFF. Chapter 4, "Water for the Future Background and Planning," explains how these components were selected.

Since releasing the previous EIS, DEP has optimized the scope and schedule associated with implementing WFF by refining the design of the bypass tunnel connection construction, thereby reducing the temporary shutdown period from the original estimate of up to 15 months disclosed in the previous EIS to 8 months. To ensure the continued supply of clean drinking water during the RWBT temporary shutdown, DEP is proposing Upstate Water Supply Resiliency as part of WFF. Prior to, during, and just following the RWBT temporary shutdown, DEP would implement WSSO, a specific and substantially different operating protocol that is designed to maintain reliability of the water supply system during an extended shutdown of the RWBT. In addition, WSSO includes a provision to ensure that favorable hydrologic conditions are present prior to commencing the RWBT temporary shutdown based on hydrologic forecasts at certain reservoirs.

Throughout the RWBT temporary shutdown, DEP would rely entirely on the Catskill and Croton systems while continuously monitoring and evaluating water supply and demand. As described in Section 9.2, "Project Description," if, at any given time, system demand exceeds predicted available supply, demobilization from the RWBT bypass tunnel connection would be initiated, the RWBT would be brought back into service, and the water supply systems would be allowed return to baseline conditions. The repair would be continued in a subsequent year, when the hydrologic condition of the water supply system allows.

Once inspections of and repairs to the RWBT are complete and the bypass tunnel is connected to the existing RWBT, the bypass tunnel would become a permanent component of the RWBT. At that time, the bypassed segment would be permanently decommissioned. When the connection and repairs are complete, water flow would be restored to the Delaware Aqueduct. DEP would

temporarily rely more heavily on the Delaware System to allow the water supply system to return to the baseline conditions that existed prior to the RWBT temporary shutdown.

As described above, WFF is inherently designed to be protective of public health. Implementation of WFF would allow the City to continue to meet and respond to variable water supply and demand conditions, even after WFF is complete and essential City infrastructure has been repaired. Cessation of leaks along the RWBT would reduce water losses in the Delaware water supply system, thus contributing to its long-term sustainability. In addition, through implementation of the above measures, DEP would ensure that no unmitigable impacts to public health would occur as a result of WFF.

Therefore, Upstate Water Supply Resiliency would not result in significant adverse impacts to public health.

As part of the proposed project, DEP has incorporated commitments and protective measures into the project components that would avoid or minimize the potential for significant adverse impacts. Through implementation of these commitments and/or protective measures, no significant adverse impacts would result from the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation) and Water for the Future Shutdown System Operations (WSSO). Therefore, mitigation is not required for these components.

In addition, commitments and protective measures are incorporated into the Rondout-West Branch Tunnel Inspection and Repair (inspection and repair) that would also avoid or minimize the potential for significant adverse impacts. Significant adverse impacts associated with the inspection and repair that could not be avoided or minimized through incorporation of commitments and protective measures would be mitigated as described in Chapter 14, "Mitigation."

Upstate Water Supply Resiliency commitments are described below and in greater detail within this DEIS.

13.1 CATSKILL REPAIR AND REHABILITATION

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 the repair and rehabilitation are summarized below and discussed in further detail within Chapter 9, "Proposed Catskill Aqueduct Repair and Rehabilitation."

13.1.1 OPERATIONS

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

13.1.2 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 species relocation as discussed in detail in Section 9.4, "Town of Olive Impact Analysis," through Section 9.18, "Project-wide Impact Analysis."

- 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.

13.1.3 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 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.[2]

[2] 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.

13.1.4 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.

13.1.5 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.[3]

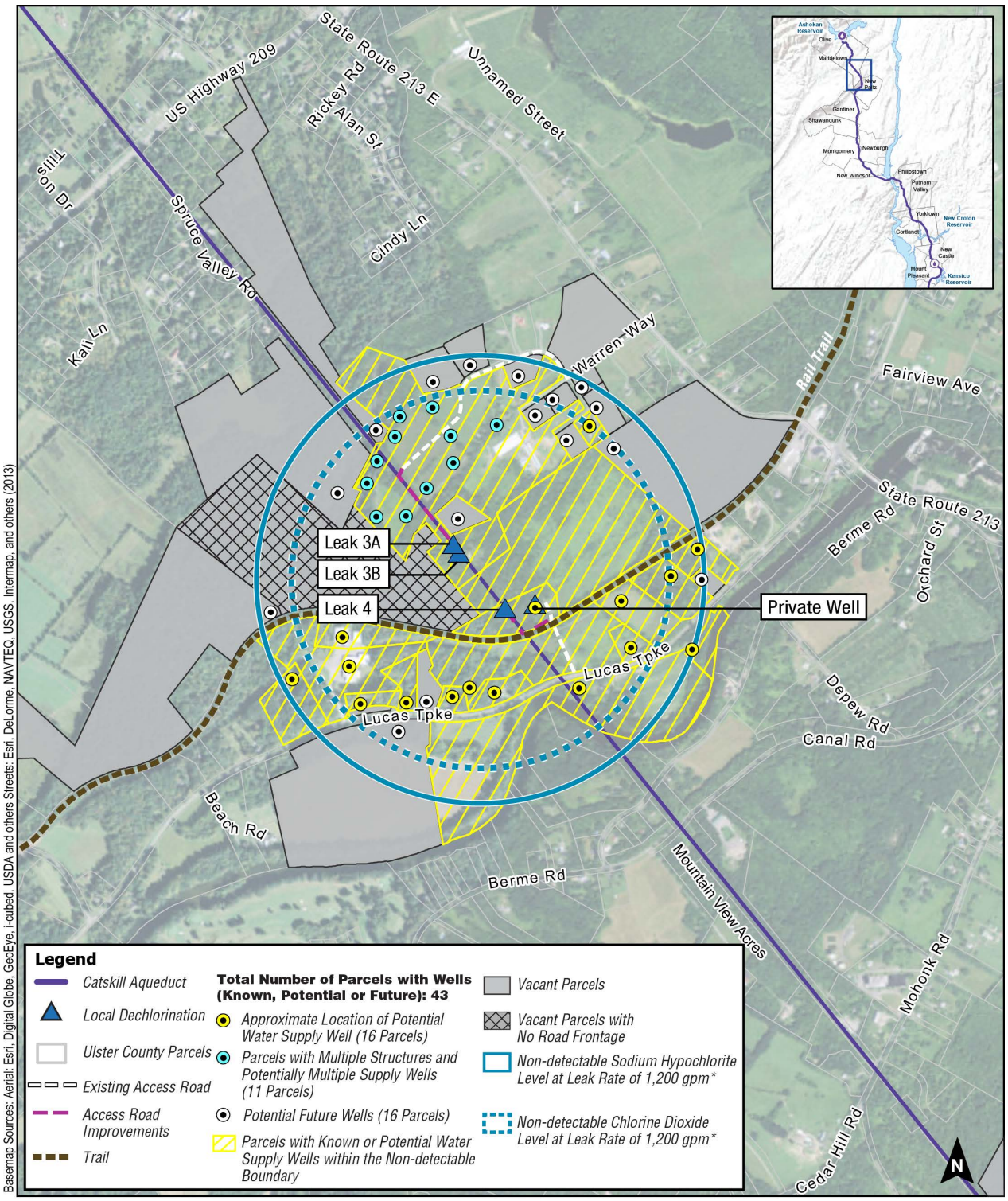
13.1.6 PUBLIC HEALTH

- 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.

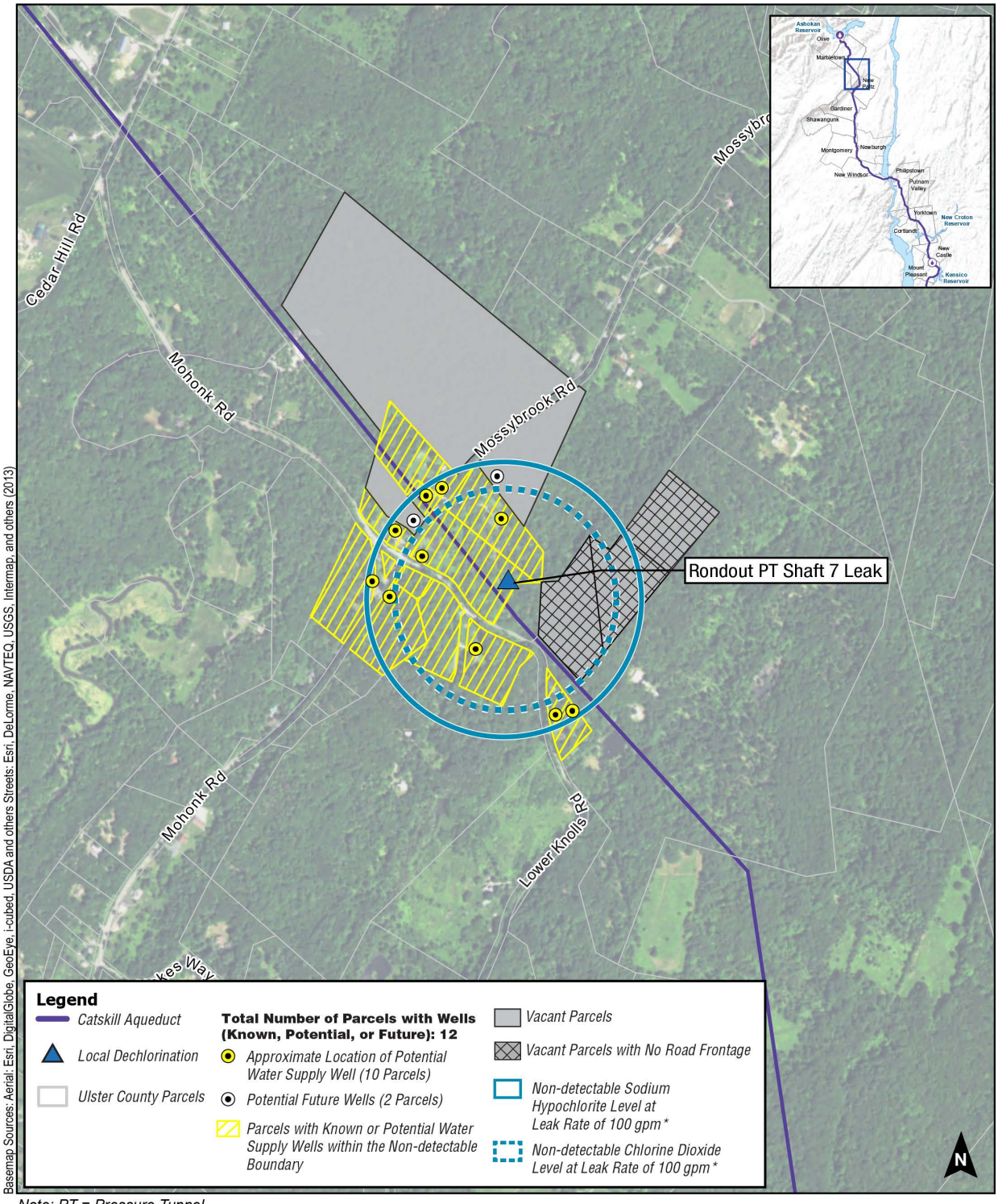
- DEP is committed to developing and working with owners to implement an Action Plan for potentially affected private drinking water supply wells within the Lucas Turnpike and Mossybrook Road study areas (see **Figure 13.1-1** and **Figure 13.1-2**), if required.

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



*Note: * Detection limit of 0.01 mg/L*
Sodium Hypochlorite residual levels calculated for winter conditions.
Chlorine Dioxide residual levels calculated for summer conditions.
Radius of residual disinfectant levels based on leak origin at-depth.
These compounds would be used at doses that are at or below the NYSDOH maximum residual disinfectant levels.

Figure 13.1-1: Well Action Plan – Lucas Turnpike Study Area, Town of Marbletown, Ulster County



Note: PT = Pressure Tunnel

** Detection limit of 0.01 mg/L*
Sodium Hypochlorite residual levels calculated for winter conditions.
Chlorine Dioxide residual levels calculated for summer conditions.
Radius of residual disinfectant levels based on leak origin at-depth.
These compounds would be used at doses that are at or below the NYSDOH maximum residual disinfectant levels.

Figure 13.1-2: Well Action Plan – Mossybrook Road Study Area, Town of Marbletown, Ulster County

13.1.6.1 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.

13.1.6.2 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 13.1-1** and **Figure 13.1-2**.

- 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.

13.2 WATER FOR THE FUTURE SHUTDOWN SYSTEM OPERATIONS

As part of the proposed project, DEP identified and incorporated specific commitments within the Water for the Future Shutdown System Operations (WSSO) component of Upstate Water Supply Resiliency to avoid and/or minimize the potential for significant adverse impacts to the maximum extent practicable. Commitments and protective measures that have been incorporated into WSSO are summarized below and discussed in further detail in Chapter 10, "Proposed Water for the Future Shutdown System Operations."

13.2.1 OPERATIONS

- DEP would only commence the RWBT temporary shutdown under favorable hydrologic conditions and when the aqueduct system is entering a period of lower demand.

- While DEP would use the existing exception from the Interim Ashokan Release Protocol in accordance with Section 7.c. of the New York State Department of Environmental Conservation (NYSDEC)/DEP Interim Ashokan Release Protocol for the Ashokan Reservoir (September 27, 2013), DEP would continue to maintain community releases from the Ashokan Release Channel.[4]

13.2.2 NATURAL RESOURCES

- Siphons at Rondout Reservoir would be available for the duration of the temporary shutdown. Siphons would operate continuously while the reservoir water surface elevation is above the minimum operating level. However, to not contribute to downstream flooding, DEP would temporarily cease operation of the siphons when flows at the U.S. Geological Survey Rosendale Gauge reach within 1 foot of the flood action stage. Following a temporary curtailment of flows, the siphons would be reactivated and flow control valves would be used to ramp flows back up slowly over a number of days.

13.2.3 NOISE

- DEP would use generators and fans during construction of the siphons at Rondout Reservoir. Generators would not exceed a maximum noise emission of 75 dBA L_{eq} 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 L_{eq} at 50 feet from the fans.[5]

[4] Section 7 c. of the Interim Ashokan Release Protocol for Ashokan Reservoir states "DEC, or DEP with concurrence by DEC, determines that releases must be changed or interrupted as necessary for inspection, maintenance, testing and repairs (including Delaware Aqueduct repairs)."

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

13.3 RONDOUT-WEST BRANCH TUNNEL INSPECTION AND REPAIR

As part of the proposed project, DEP identified and incorporated specific commitments and protective measures within the Rondout-West Branch Tunnel Inspection and Repair (inspection and repair) component of Upstate Water Supply Resiliency. Commitments and protective measures were incorporated to avoid and/or minimize the potential for significant adverse impacts to the maximum extent practicable. Commitments and protective measures that have been identified are summarized below and discussed in further detail in Chapter 11, "Proposed Rondout-West Branch Tunnel Inspection and Repair."

13.3.1 NATURAL RESOURCES

- For federal/State Threatened, Endangered Species, and Candidate Species, State Species of Special Concern, protective measures include perimeter fencing and species relocation.

13.3.2 NOISE

- Construction associated with the inspection and repair would require operation of fans and generators. Generators would not exceed a maximum noise emission of 75 dBA L_{eq} 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 L_{eq} at 50 feet from the fans.

13.3.3 WATER AND SEWER INFRASTRUCTURE

- DEP would implement a Well Action Plan for potentially affected private drinking water supply wells within the applicable study areas, as described further below.

13.3.3.1 Well Action Plan

To commence the Well Action Plan, a survey would be prepared and sent to landowners to obtain information on available well construction details, water use, and occupants, for the following parcels:

- Within the Wawarsing Leak Repair Study Area, there are 145 total parcels with known, potential or future private drinking water supply wells identified in the Estimated Bedrock Aquifer Groundwater Influence Area (see **Figure 13.3-1**). One hundred and two (102) of these parcels currently have structures with potential wells. Forty three (43) of these parcels are vacant parcels that may be developed in the future and could require a private drinking water supply well; and

Within the Roseton Study Area, there are 27 parcels with known, potential or future potential private drinking water supply wells identified in the Estimated Bedrock Aquifer Groundwater Influence Area (see **Figure 13.3-2**). Twenty five (25) of these parcels currently have structures with potential wells (one parcel has both a known supply well and a potential drinking water supply well). Two (2) of these parcels are vacant parcels that may be developed in the future and could require a private drinking water supply well. There are 28 known, potential, or future wells, as one parcel (Cedar Hill Cemetery) has two existing wells.

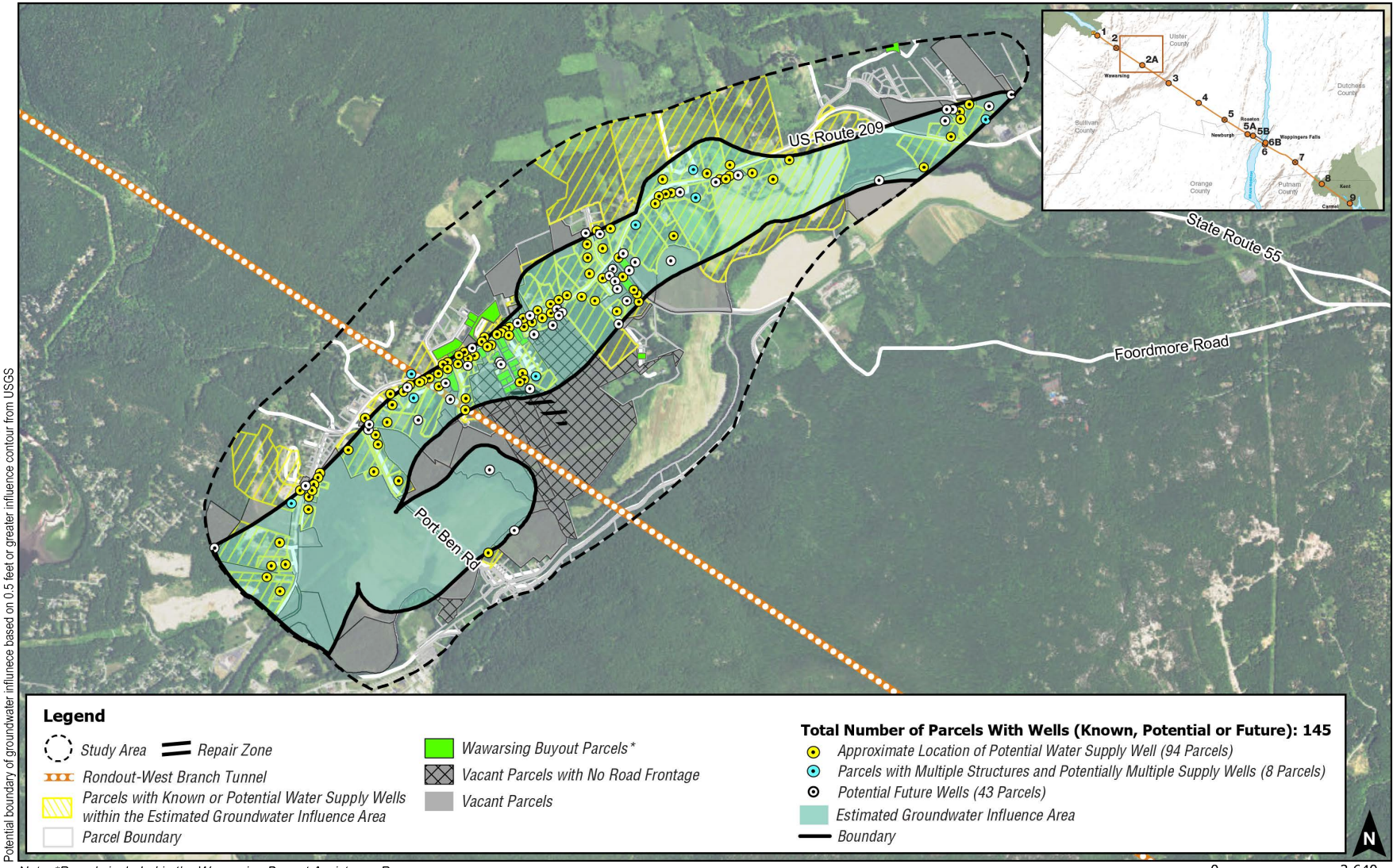
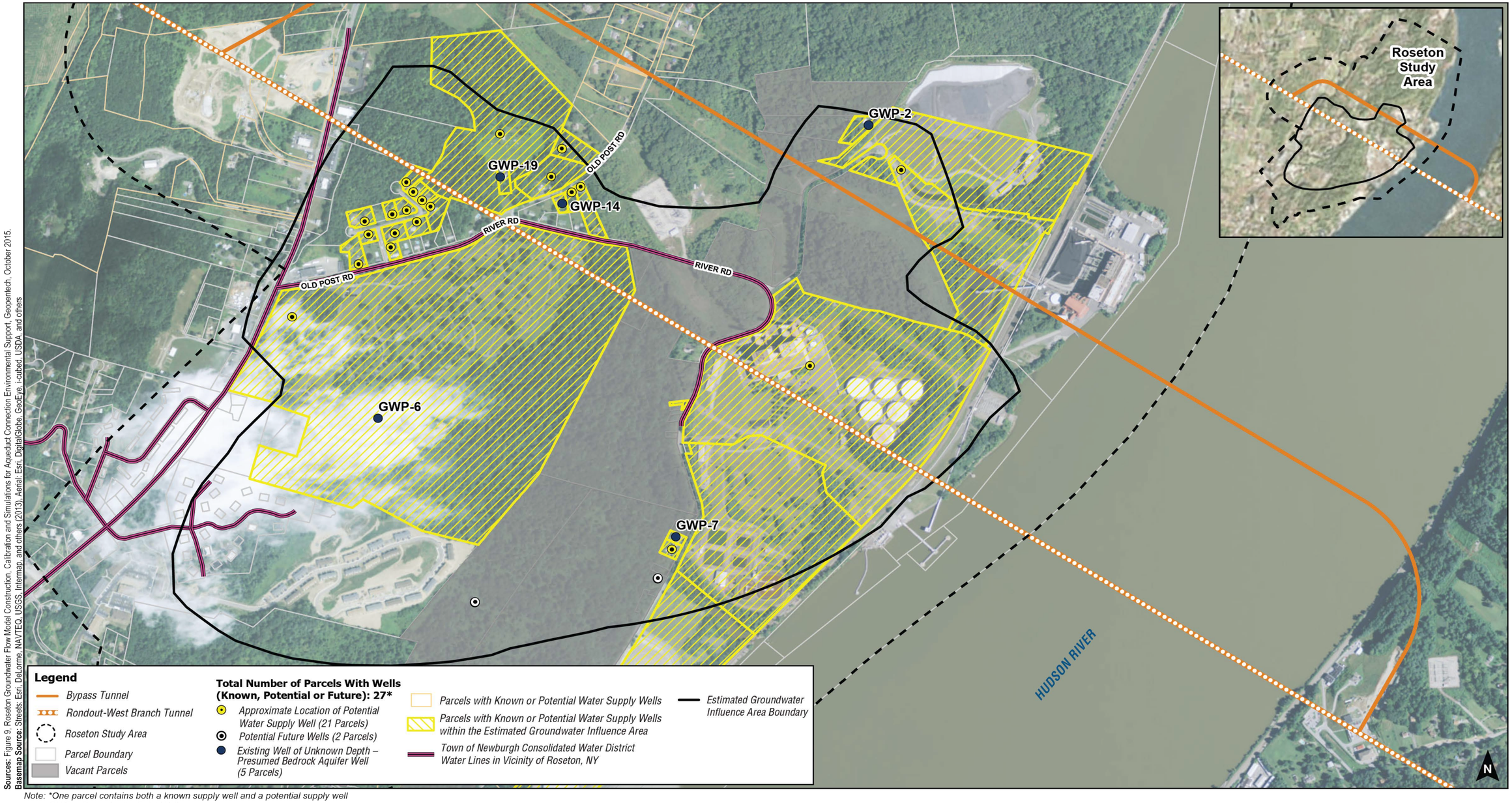


Figure 13.3-1: Well Action Plan – Wawarsing Leak Repair Study Area



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

*Note: *One parcel contains both a known supply well and a potential supply well*
GWP = Groundwater Point Well

0 800
Feet

Figure 13.3-2 : Well Action Plan – Roseton Study Area Estimated Groundwater Influence Areas

If the landowner provides the applicable well characteristics (e.g., depth and yield), they would be compared to the well monitoring criteria described further below. If a landowner does not have or cannot provide sufficient information for comparison to the well monitoring criteria, DEP would, with their approval, determine the water supply well characteristics (e.g., depth and yield) approximately one year before the RWBT temporary shutdown.

13.3.3.2 Well Action Plan Criteria

The criteria below were created to identify wells or parcels with future wells that have the potential for water level changes due to the inspection and repair and decommissioning. They were created based on a combination of well characteristics. These include the type of aquifer, well depth, well yield, water usage rates, well storage, and well pump setting, and whether a lower groundwater level could affect the well's ability to meet the water supply needs of its users.

The criteria are based on NYSDOH Individual Water Well recommendations. A well that yields 5 gpm or more is capable of meeting the peak-day demand and the average day demand for a home. For wells that yield less than 5 gpm, it is necessary to store a sufficient volume of water in the well and in the pressure tank for the home to meet peak demands. The NYSDOH recommends a minimum storage volume that ranges from 100 gallons for a two-bedroom home to 300 gallons for a five-bedroom home based on the yield of the well. To put this into perspective, a standard 6-inch drilled bedrock well contains 1.5 gallons per foot, or 150 gallons for every 100 feet of water in the well. These factors were used to create the well monitoring eligibility criteria as described below.

Before the start of the temporary shutdown, the wells would be evaluated to determine if they meet the criteria below. Each well would be evaluated to determine the well yield (in gallons per minute [gpm] over a 4-hour period), depth to water, depth to pump intake, and depth to bottom of well. These data would be used to evaluate the well performance characteristics of each well and would be compared to the criteria below:

- Wells with yield greater than 5 gpm:
  - NOT MONITORED - would not be monitored.
- Well with yield greater than 3 but less than 5 gpm:
  - NOT MONITORED - would not be monitored if the well stores greater than 300 gallons;
  - MONITORED - would be monitored if the well stores less than 300 gallons;
  - ALTERNATIVE SUPPLY - would be provided an alternative water supply if the well stores less than 100 gallons.
- Well with yield greater than 1 but less than 3 gpm:
  - NOT MONITORED - would not be monitored if the well stores greater than 350 gallons;
  - MONITORED - would be monitored if the well stores less than 350 gallons;

- ALTERNATIVE SUPPLY - would be provided an alternative water supply if the well stores less than 200 gallons.

- Well with yield less than 1 gpm:
  - ALTERNATIVE SUPPLY - would be provided an alternative water supply.

These criteria were established by adding 50 gallons to the NYSDOH storage recommendations (Individual Water Supply Wells – Fact Sheet No. 2) for a five-bedroom home for each well yield range (e.g., 1 to 3 gpm and 3 to 5 gpm). Fifty gallons of storage was added to the NYSDOH recommended water storage to account for the water storage that could be lost (e.g., 25 feet of water in a 6-inch diameter well equates to 37.5 gallons) during the temporary shutdown and over the long term from repair of the leaks.

A well that yields 5 gpm or greater would be excluded from the Action Plan. If a water supply well meets the criteria for monitoring and the landowner allows, DEP would conduct well monitoring for groundwater level and groundwater quality 12 months before, during, and up to 12 months after the temporary shutdown. Monitoring would include installing a water level transducer in each well to measure and record the water level fluctuation in each well. Monitoring would also include collecting water samples quarterly and analyzing the water samples for metals and inorganic parameters.

A well in the monitoring program would receive an alternative supply based on the following criteria:

- If the water level in the monitored well is within 20 feet of the pump intake at its typical lowest operating point.

- If a metal or inorganic water quality parameter result exceeds the NYSDOH Part 5 Standards as confirmed by a second sample collected as soon as practical once sampling results indicate a possible exceedance. In the event the baseline water quality monitoring prior to the temporary shutdown demonstrates an existing water quality exceedance, an increase in the concentration of that parameter would also result in alternative supply (see Section 13.3.4, “Public Health”).

If a water supply well meets the alternative supply criteria, and where the landowner allows, DEP would provide an augmented or alternative water supply. The augmented or alternative supply may include the following options:

- Install an above ground pneumatic storage tank to increase water storage capacity;

- Lower the pump intake in the well to increase water storage capacity in the well;

- Drill the well deeper and lower the pump intake in the well to increase water storage capacity in the well if it is a bedrock well and the well is judged to be suitable to be deepened; or

- Drill a new deeper well and lower the pump intake in the well to increase storage capacity in the well if it is an unconsolidated well.

If the water quality results show that quality exceeds the NYSDOH Part 5 drinking water standards, DEP would provide treatment to treat or remove contaminants to below the NYSDOH Part 5 drinking water standards (see Section 13.3.4, "Public Health").

The Town of Wawarsing has initiated the planning studies for the formation of a municipal water supply district that would provide a public water supply for the local residents. For those properties that connect to the water district, this would result in the abandonment of the existing water supply wells, and the need for a Monitoring Action Plan would no longer be necessary. For any additional parcels that may become connected to either a local or municipal water supply district within the study area, well monitoring would no longer be necessary.

13.3.4 PUBLIC HEALTH

As further described above under Section 13.3.3.2, "Well Action Plan Criteria," if the water quality results from the Well Action Plan show that quality exceeds the NYSDOH Part 5 drinking water standards, DEP would provide either an alternate supply or treatment to treat or remove contaminants to below the NYSDOH Part 5 drinking water standards.

13.3.5 GEOLOGY AND SOILS

Decommissioning would result in a change of ground water levels, which could result in areas that could be subject to settlement within the Roseton Study Area. DEP is developing and working with owners to implement preventative Action Plans for structures within this area, as described further below.

13.3.5.1 Action Plans for Structures

DEP is developing, and working with owners to implement, preventative Action Plans for areas within the area that could be subject to settlement during and after the RWBT temporary shutdown (see shaded parcels in **Figure 13.3-3**). Where structures and infrastructure are located in areas that have the potential to be subject to ground settlement, the specific Action Plans would identify measures that could be implemented prior to, during, and after the temporary shutdown to protect the potentially affected structures or infrastructure based on their type, function, and estimated magnitude of change. These measures could include: additional investigations; development of engineering techniques; and further assessment against structure-specific thresholds to evaluate whether additional engineering techniques are required.

Prior to the temporary shutdown, additional investigations that could be conducted include the following:

- Pre-condition surveys of existing structures and infrastructure within the targeted area of potential settlement to establish structure/infrastructure-specific baseline conditions; and

- Additional structure/infrastructure-specific geotechnical investigations (field explorations and laboratory testing) for specific structure/infrastructure.

Figure 13.3-3: Action Plan Parcels in Roseton

Results from these investigations would be used to assess the estimated values for stress, strain, and distortion the structure or infrastructure could experience as a result of the changing physical condition of the ground as settlement occurs. These estimated values would be compared with structural or empirical criteria to further identify the potential response of the structure or identified infrastructure to the estimated ground settlement.

If results from these additional investigations identify potential settlement that could affect the integrity of a structure or infrastructure, DEP would work with owners to provide protective engineering techniques that would be implemented prior to the temporary shutdown. All of the structures and infrastructure in the Estimated Unconsolidated Aquifer Groundwater Influence Area could be stabilized, if necessary, using readily available engineering techniques. For example, structures or infrastructure that could be subject to differential settlement (e.g., rigid structure subjected to bending or tilting) can be stabilized using grouting techniques such as jet, compaction, or compensation grouting. Additional commonly used engineering techniques for stabilization include providing additional structural supports, providing flexible connections for utilities, and rerouting critical infrastructure.

Some structures or infrastructure could be subject to differential settlement because of differing foundation types used within the same or connected structures (e.g., building founded on piles and soil, or a building founded on piles with utility connections founded on soil). For these, stabilizing techniques that could be applied consist of compaction grouting to prevent ground movements or modification of connections to accommodate potential differential settlement.

Linear structures and infrastructure that could be subject to differential settlement (e.g., railroad tracks, utilities, or pipelines) could be stabilized to stabilize and reinforce the soil.

Prior to the temporary shutdown, a settlement monitoring program would also be developed and implemented during the temporary shutdown as part of the Action Plans. The monitoring program would be specific to the type and function of each potentially impacted structure or infrastructure. It would include monitoring to measure settlement and movements or changes to structures or infrastructure that could be subject to settlement for comparison to estimated changes. The monitoring could include the following measures:

- Surface/subsurface instrumentation such as high-precision settlement survey markers, piezometers, extensometers, and inclinometers; and
- Structural/infrastructure monitoring with instruments such as tiltmeters, crack gauges, and vibration monitors.

In addition to these engineering techniques, the Action Plans could include implementation of similar techniques for specific structures or infrastructure if threshold values of changes associated with estimated settlement or structure/infrastructure distress are exceeded during monitoring (e.g., vibration level, crack size, or new observed distresses). As applicable, the Action Plans would include threshold action values that would be agreed upon with the owners based on the anticipated potential settlement or structure/infrastructure stress levels. For example, for structures or infrastructure that could be subject to differential settlement, compaction grouting or modification of connections would be initiated if the anticipated settlement reaches the agreed-upon threshold action values.

As described in Chapters 9 and 10 respectively, no potential significant adverse impacts are anticipated from the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation) and Water for the Future Shutdown System Operations (WSSO). Therefore, no mitigation is required for those components. There remains the potential for significant adverse impacts to non-regulated (USACE and NYSDEC) wetlands in the Roseton Study Area associated with the inspection and repair. For these potential impacts, mitigation measures would be developed as discussed below.

14.1 RONDOUT-WEST BRANCH TUNNEL INSPECTION AND REPAIR

14.1.1 WETLANDS

A total of approximately 1.2 acres of existing delineated non-regulated wetlands within the Roseton Study Area are estimated to be lost as a result of the cessation of leaks from decommissioning on surface water and shallow groundwater levels that are the source of water to these wetlands, including Wetlands A, B, D, and E (see **Figure 14.1-1**).

DEP commits to developing a wetland monitoring program that would be implemented prior to, during, and after the RWBT temporary shutdown to assess the impacts to Wetlands A, B, C, D, and E, and riparian areas adjacent to Stream Segments 3, 3B, and 4. The monitoring program would consist of continuous hydrologic monitoring for up to 5 years following decommissioning, and biennial vegetation monitoring, wetland delineation, wetland functional assessment, and photographic documentation of fixed monitoring plots during the first, third, and fifth years following decommissioning. The objective of the monitoring program would be to document changes to wetland communities and their size and function, and to compare changes to local reference wetlands to determine if significant adverse impacts have occurred as a result of decommissioning. The monitoring of reference wetlands would allow for comparison to determine if any change at the potentially impacted wetland is a result of decommissioning or other source (e.g., climatological). Should permanent impacts to wetland size and/or function be measured, DEP would perform compensatory mitigation.

Compensatory mitigation for permanent impacts to wetlands would include wetland creation, restoration, and/or enhancement, with a minimum one to one mitigation ratio (i.e., 1 acre of wetland creation, restoration, or enhancement for every acre of wetland permanently lost as a result of the project). Once the compensatory mitigation site is established, DEP would monitor the site for a minimum of 3 years to confirm that the site meets the objective to compensate for the permanent loss of wetlands in the Roseton Study Area.

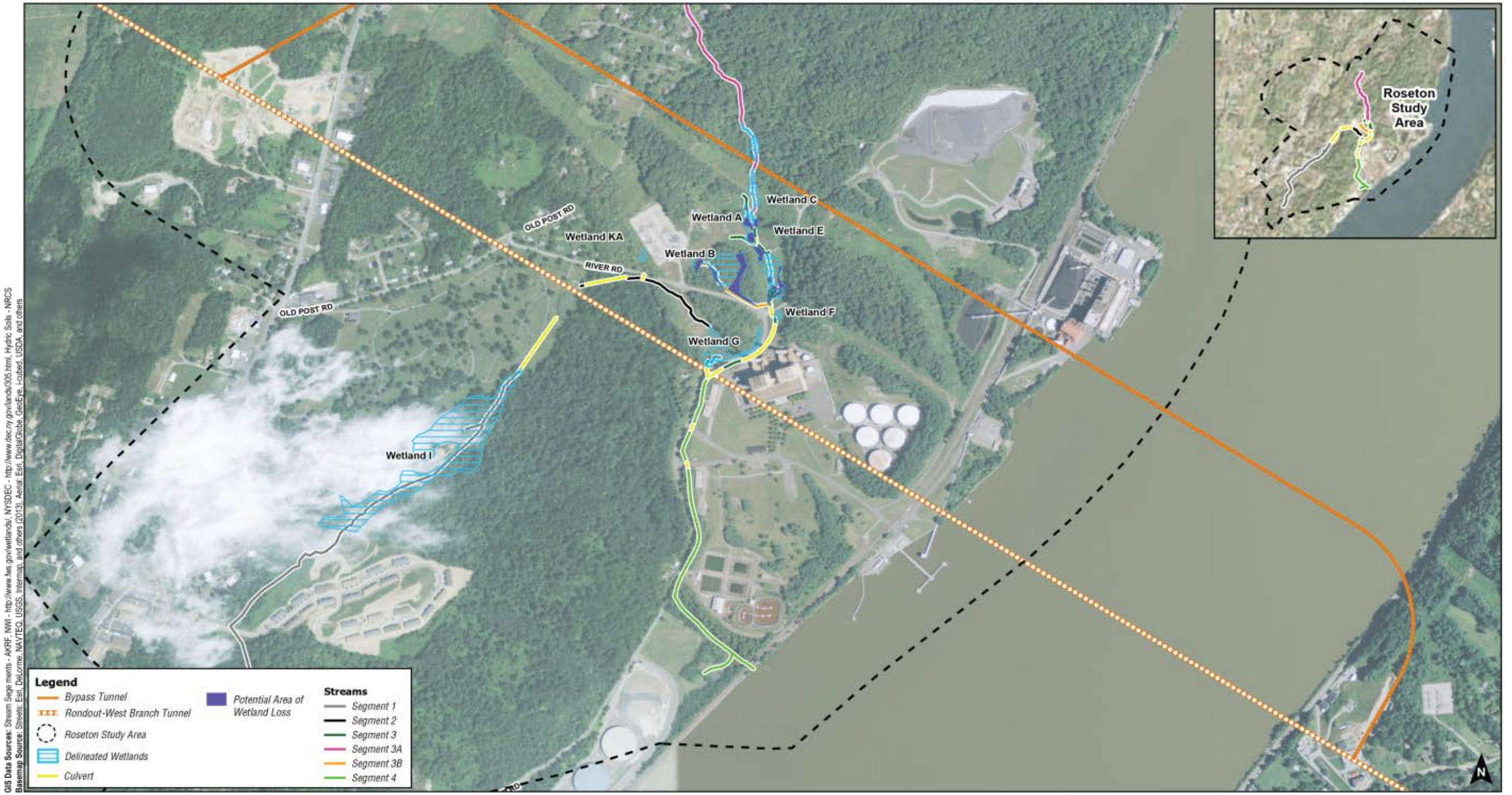


Figure 14.1-1: Estimated Impacts to Non-regulated Wetlands - Roseton Study Area

15.1 INTRODUCTION

State Environmental Quality Review Act (SEQRA) and City Environmental Quality Review (CEQR) require that alternatives to a proposed project or action be identified and evaluated in an EIS, including a No Action Alternative to present environmental conditions that would exist if the proposed project were not implemented. The previous EIS provided a detailed impact analysis of the RWBT shaft and bypass connection, and also included a review of several alternatives to WFF that are not repeated in this DEIS (see Section 4.2, "Water Supply Augmentation Planning," for a description of the alternatives selection process). The alternatives analysis for this DEIS focused on the potential for impacts associated with three alternatives to Upstate Water Supply Resiliency: the No Action Alternative, Interconnections to Water Supplies in New Jersey, and RWBT Leak Stabilization.

15.2 UPSTATE WATER SUPPLY RESILIENCY ALTERNATIVES ANALYSIS

As described in Chapter 5, "Program Description," Upstate Water Supply Resiliency is necessary to enable DEP to temporarily shut down the RWBT for inspection, for conducting repairs near Wawarsing and bypass tunnel connection. In accordance with SEQRA and CEQR, review of the potential for adverse environmental impacts from implementation of Upstate Water Supply Resiliency has been presented in Chapters 9 through 11 of this DEIS. SEQRA also requires that alternatives to a proposed project be identified and evaluated as part of the EIS process. CEQR procedures, established pursuant to SEQRA, therefore also require that an EIS include a discussion of alternatives to a proposed project, and the comparable impacts and effects of such alternatives.

According to CEQR, an EIS must include a description and evaluation of the range of reasonable alternatives that are feasible, including an alternative that presents environmental conditions that would exist if the proposed project was not implemented (the No Action Alternative), and considering the objectives and capabilities of the project sponsor. The alternatives analysis should present reasonable options for reducing or eliminating project impacts or effects, while substantively meeting project goals and objectives, demonstrating a reasonable range of options to the proposed project, and comparing potential impacts or effects with alternative approaches for meeting project objectives. The range of alternatives that should be considered is determined by the nature, goals, and objectives of the specific action and its potential impacts or effects, as disclosed by the technical impact analysis in this DEIS. In general, since the alternatives analysis compares each alternative's impacts or effects to those of the proposed project, the level of detail in the analysis depends on the alternative and the project's impacts or effects. When limited impacts of the proposed project are disclosed, a screening or qualitative assessment is appropriate. Where a potential significant adverse impact of the proposed project has been identified or where the alternative may disclose a potential significant adverse impact in an area where the proposed project would have none, it is appropriate to provide additional detail on the potential for impacts of the alternative. To that end, analysis of the No Action Alternative (Alternative 1) and two additional alternatives to Upstate Water Supply Resiliency: Interconnections to Water Supplies in New Jersey (Alternative 2) and Leak Stabilization (Alternative 3) are presented in the following sections.

15.3 ALTERNATIVE 1: NO ACTION ALTERNATIVE

Under the No Action Alternative, Upstate Water Supply Resiliency would not be implemented. Specifically, the Catskill Aqueduct Repair and Rehabilitation (repair and rehabilitation), WFF Shutdown System Operations (WSSO), and the RWBT Inspection and Repair (inspection and repair) would not be undertaken. Therefore, there would be no construction or operational changes related to any of these components during the RWBT temporary shutdown or over the long term, and the RWBT would continue to function as it does currently. The RWBT diverts water from the Delaware System. If the RWBT bypass were not connected, access to the Delaware System would be compromised, the leaks would continue, water would be lost, and there is a potential for the leaks to worsen in the future. Under the No Action Alternative, DEP would continue to plan and undertake discrete projects for emergency repair of the RWBT, should such repairs be necessary. The No Action Alternative would not result in any of the environmental impacts or effects associated with Upstate Water Supply Resiliency and its individual components, specifically the loss of approximately 1.2 acres of non-regulated wetlands in the Roseton Study Area. However, the No Action Alternative would not address RWBT reliability or issues related to the continued leakage from the tunnel, such as a reduction in water available for the City's drinking water system. Therefore, the No Action Alternative would not allow DEP to continue ensuring the safe and reliable transmission of drinking water from the Delaware System to consumers in sufficient quantity to meet all present and future water demands. In addition, if the tunnel is not repaired and the leaks are allowed to continue, there is a potential for a failure of the RWBT, which could cut off the water supply to the City. In this case, water could stop flowing through the RWBT and could still result in effects to water supply wells and wetlands, and changes in stress to soils from lower groundwater levels that could result in areas that could be subject to settlement within the Roseton Study Area.

15.4 ALTERNATIVE 2: INTERCONNECTIONS TO WATER SUPPLIES IN NEW JERSEY

The Interconnections to Water Supplies in New Jersey Alternative would include the development of up to three new water system interconnections between certain New Jersey water suppliers and the City's distribution system in Staten Island, New York. The purpose of this alternative would be to provide alternate or additional sources for augmentation of the City's water supply during the temporary shutdown of the RWBT. Because the amount of water available from New Jersey water supply purveyors is unknown at this time, and may not be sufficient to meet the augmentation needs of the RWBT temporary shutdown, Interconnections to Water Supplies in New Jersey Alternative may not function as a stand-alone alternative. However, should sufficient water supply be available it could be developed as an alternative to the repair and rehabilitation component of Upstate Water Supply Resiliency and is analyzed accordingly. The following sections describe the New Jersey water supplies that could be diverted to the City and details related to the project components necessary to facilitate interconnections between New Jersey and Staten Island that would be advanced under this alternative to support the impact analysis.

15.4.1 NEW JERSEY WATER SUPPLY

New Jersey's water supply is owned or operated by different entities including: the State of New Jersey, municipalities, public commissions, or investor-owned utility companies. In all cases, the systems are subject to rules and regulations enforced by the New Jersey Department of Environmental Protection (NJDEP) and the EPA. The NJDEP enforces the Safe Drinking Water Act regulations and the withdrawal of water from both surface water and groundwater resources. Similar to the City, most of the major regional water systems in northern and central New Jersey use surface water supply to meet the majority of their water system demand. In addition, many of the New Jersey systems are already interconnected or have identified future interconnection points. The potential candidates for interconnection with the City's distribution system in Staten Island include the North Jersey District Water Supply Commission, which draws water from the Passaic Basin, and New Jersey American Water, and the Middlesex Water Company, which both draw water from the Raritan Basin (see **Figure 15.4-1**).

Both the Passaic Basin and Raritan Basin are susceptible to flooding, drought, and pollution from surrounding land use. In addition to the Passaic and Raritan basins providing a key water source for New Jersey, the basins are also home to important wetland ecosystems and provide natural habitat for a large variety of flora and fauna. As a result, the quantity of water that can be diverted from both basins is limited by safe yield requirements, water allocation permits, and in some cases, contracts with member municipalities. Therefore, interconnections with these systems would need to be carefully developed and planned.

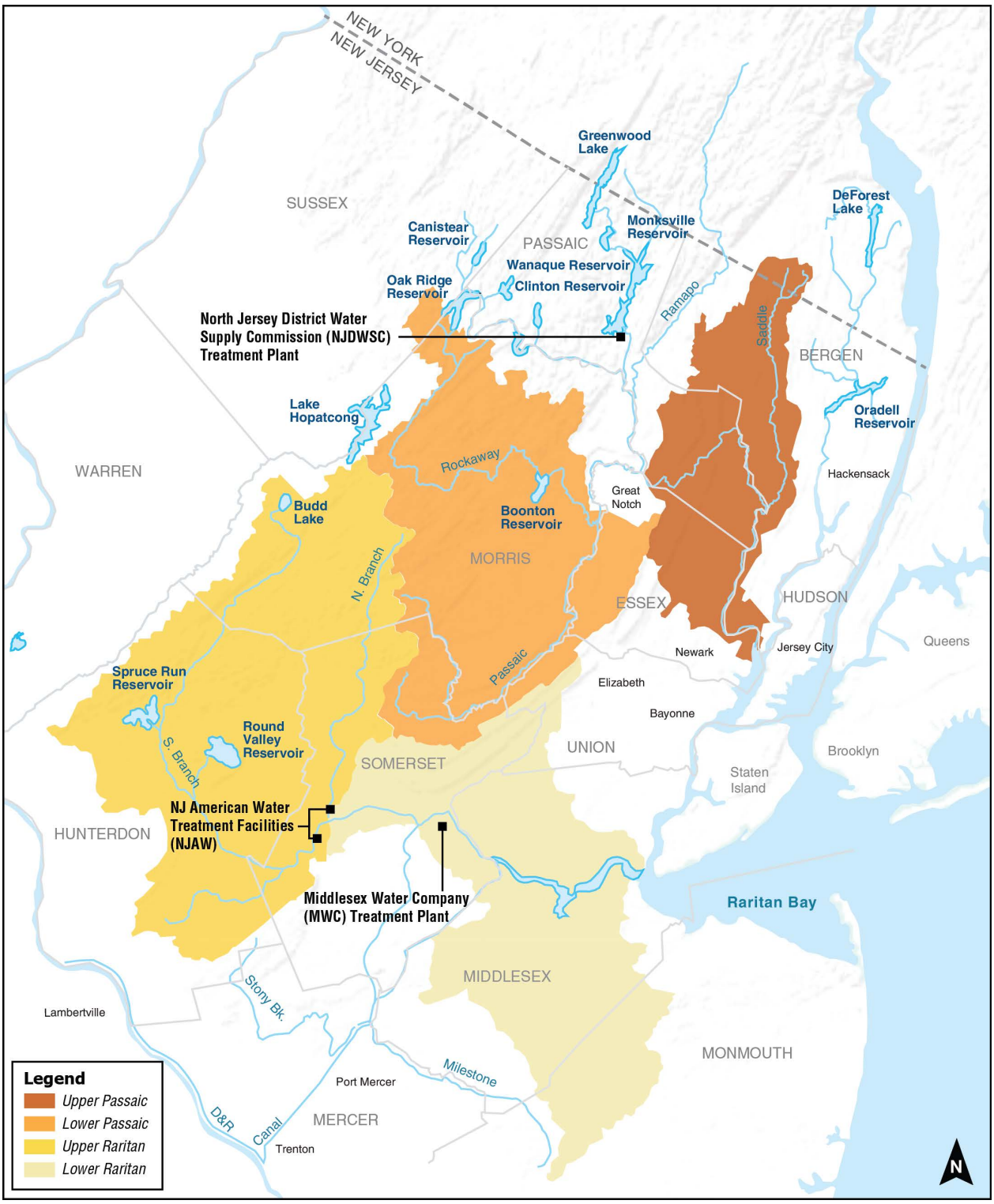


Figure 15.4-1: Potential Candidates for Interconnection with New York City

15.4.1.1 Possible Interconnections

Interconnections to the New Jersey systems would involve transferring water from New Jersey to Staten Island. Staten Island is connected to the City's distribution system via three interconnection points in Brooklyn, New York, with a new interconnection under development to replace two of the three older connections. Because Staten Island is at the far end of the City's distribution system, the chlorine residual here can be low. Chlorine can be boosted locally to provide additional disinfection to control bacteria growth in Staten Island's distribution system and meet regulatory requirements to maintain minimum disinfectant residuals. The chlorine is added to the distribution system at a chlorination facility located on the eastern shore of Staten Island, and a new chlorination facility was constructed in association with the new interconnection to Brooklyn that is under development.

An interconnection to the New Jersey systems would involve the installation of new transmission lines between existing distribution systems in New Jersey and Staten Island. Water from New Jersey would be supplied to Staten Island and blended with City water. The connection to the City's distribution system through Brooklyn would be maintained to allow for bidirectional flow. To allow for conveyance from Staten Island to the City's distribution system, equipment and operating practices would need to be upgraded, and the existing chlorination facilities on Staten Island would need to be used for treatment to ensure uniform water quality and avoid aesthetic concerns associated with mixing water from New Jersey and the City's distribution system.

15.4.2 KEY COMPONENTS OF THE ALTERNATIVE

Overall, the Interconnections to Water Supplies in New Jersey Alternative would require the installation of transmission mains to transport water from New Jersey, construction of a booster pumping station, and changes to existing chlorination facilities to manage water quality. It is anticipated that interconnections from New Jersey would cross the Arthur Kill through transmission mains installed underwater to connect with the City's distribution system on Staten Island. In general, construction effects, while temporary in nature, would likely last more than 2 years.

15.4.2.1 Transmission Main Installation

DEP worked with the New Jersey suppliers to determine how water could likely be supplied from New Jersey to the City's distribution system. Based on previous designs, it is likely that a transmission main would be constructed to cross the Arthur Kill. It is anticipated the Arthur Kill crossing would be completed using trenchless technologies to avoid disturbance of the waterbody or surrounding wetland and shoreline areas (the transmission main would be pulled through the ground with a tunneling device to reduce surface disturbance). The new 54-inch transmission main would start at the new booster pumping station near the Howland Hook Marine Terminal in Staten Island and continue approximately 15,000 feet until it would interconnect with existing DEP water distribution mains near the intersection of Forest and Richmond Avenues in Staten Island. A sample configuration is shown on **Figure 15.4-2** and represents one option for connection to the existing distribution system on Staten Island.

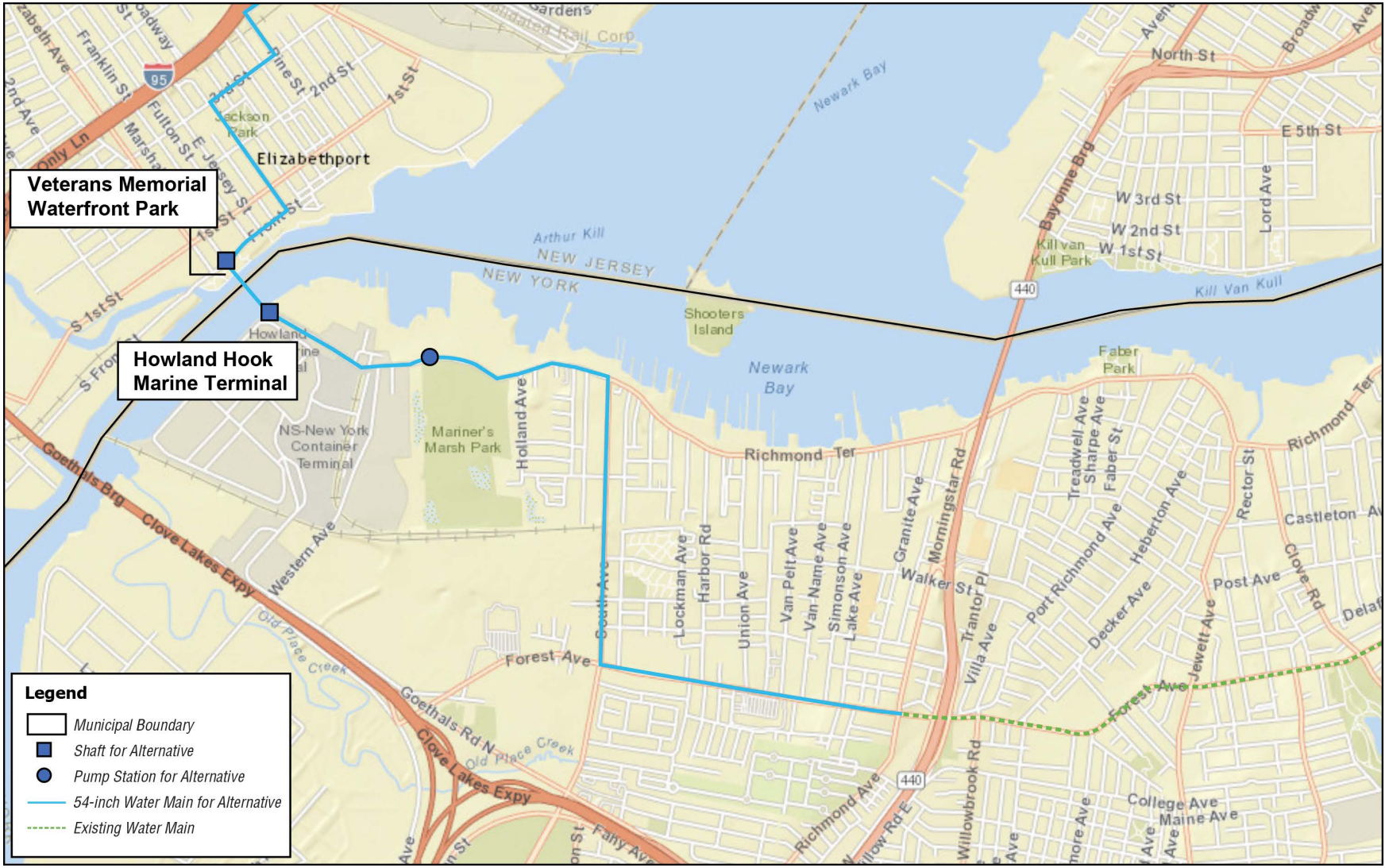


Figure 15.4-2: Configuration of Key Components of the Staten Island Interconnections to New Jersey Water Supply Alternative

The transmission main would be installed via open-cut construction. Under traditional open-cut construction methods an open trench is constructed, the transmission main is placed in the trench, and then the trench is backfilled within utility easements along existing asphalt roadways. Once it leaves the marine terminal property, the main would run east from the new pump station along Richmond Terrace until South Avenue then south until Forest Avenue and turn east. Construction would take place largely within the westbound traffic lane for the bulk of the Richmond Terrace Path and trenchless methods of construction would occur to bring the new transmission main under existing train tracks along the route.

15.4.2.2 Booster Pumping Station

To facilitate the connection and ensure adequate delivery of water to the City, it would be necessary to construct a new booster pump station. The station would help to boost the flow capacity of the water traveling from New Jersey to New York on Staten Island. The locations of any necessary booster pump station would likely require property acquisition and construction of the buildings to house the pump systems. It is anticipated that the pump station would be approximately 45 by 120 feet and house up to 6 pumps.

15.4.2.3 Treatment

In addition to transport of water, consideration would also need to be given to treatment that may be necessary prior to the water from the New Jersey suppliers entering the City's distribution system. Since different treatment methods are in use by many of the New Jersey water suppliers, additional disinfection facilities would likely need to be constructed to achieve consistency in water treatment. Any treatment regime selected as part of the Interconnections to Water Supplies in New Jersey Alternative must be in full compliance with federal and State drinking water requirements. Because of the different treatment methods mixing the supplies would need to be carefully coordinated to protect public health. It is anticipated that existing chlorination facilities on Staten Island could be used in order to add any additional chemicals to support blending of the New Jersey and New York City water supplies with only minor improvements and/or expansions at these locations.

15.4.3 POTENTIAL IMPACTS OF THE INTERCONNECTIONS TO WATER SUPPLIES IN NEW JERSEY ALTERNATIVE

This section provides a qualitative description of the potential for impacts or effects associated with the Interconnections to Water Supplies in New Jersey Alternative. A discussion of how the potential environmental impacts or effects from the construction and operation of the Interconnections to Water Supplies in New Jersey Alternative compare to repair and rehabilitation is provided below for project areas in the State. Since the Interconnections to Water Supplies in New Jersey Alternative would provide increased augmentation to support temporary shutdown of the RWBT, temporary effects associated with inspection and repair and WSSO would still occur even with the interconnection project. The interconnection project would replace augmentation that would be supplied by the repair and rehabilitation under Upstate Water Supply Resiliency. Therefore, only a comparison of impacts and effects between Interconnections to Water Supplies in New Jersey and the repair and rehabilitation are provided

in this analysis. A discussion of community facilities and services, historic and cultural resources, and hazardous materials is not provided as the effects of the alternative would be similar to Upstate Water Supply Resiliency. A discussion of Critical Environmental Areas, shadows, solid waste and sanitation services, and greenhouse gas (GHG) emissions and climate change is not provided, as these impact categories were screened out from further assessment.

15.4.3.1 Land Use, Zoning, and Public Policy

Repair and rehabilitation would consist of construction and operation of an active water supply use in lands already designated for such activities. As compared to the repair and rehabilitation, the components of the Interconnections to Water Supplies in New Jersey Alternative are expected to be less compatible with surrounding land uses since there would be multiple sites where work is required that could be closer to sensitive uses or resources. Unlike the repair and rehabilitation, which has a large geographic extent and is contained largely within existing water supply properties, the interconnections would concentrate associated facilities over a more populated and dense land use area in the City and may result in temporary adverse impacts if access to properties is limited during the construction of new facilities. The interconnections could require acquisition of new properties for water supply purposes, and it is possible that the new transmission lines, pump station, or expansions of existing chlorination facilities would need to be sited in areas that require zoning reviews for compliance and/or Uniform Land Use Review Procedure approvals. The work could occur in closer proximity to sensitive receptors than the repair and rehabilitation and the active construction period would be concentrated to a smaller area and last longer. This alternative would not have any effects on public policy. Unlike the repair and rehabilitation, there may be temporary impacts to land uses and zoning in the City. Therefore, the Interconnections to Water Supplies in New Jersey Alternative would not likely result in significant adverse impacts to land use, zoning, and public policy.

15.4.3.2 Open Space and Recreation

Construction of the repair and rehabilitation may have temporary effects to open space and recreation since construction activities may temporarily limit or change access to recreational areas at a limited number of study areas. As compared to the repair and rehabilitation, the components of the Interconnections to Water Supplies in New Jersey Alternative may cause impact to open space and recreational resources. Construction of the booster pumping station may require the acquisition of parkland on Staten Island and construction of the transmission main from the pump station to the existing water supply distribution system in Staten Island may require a crossing of parkland. The work could also occur in closer proximity to parkland than the repair and rehabilitation. As shown in **Figure 15.4-2**, Mariner's Marsh Park (comprised of approximately 107 acres) on the northwestern tip of Staten Island is located adjacent to the transmission main that would be installed under this alternative. Furthermore, the active construction period for this alternative would be concentrated over a smaller area and last longer compared to the repair and rehabilitation. Therefore, the Interconnections to Water Supplies in New Jersey Alternative may have temporary and/or permanent impacts to open space and recreation.

15.4.3.3 Urban Design and Visual Resources

If new treatment systems are required adjacent to existing chlorination facilities or a new booster pumping station is required in association with the Interconnections to Water Supplies in New Jersey Alternative, the new structures could have the potential to change the views from public spaces, or affect the urban design of the neighborhoods in which they would be located. While the buildings would be constructed to be visually compatible with existing buildings, and subject to local approvals, including the Public Design Commission, similar construction is not warranted to support the repair and rehabilitation. For the repair and rehabilitation, a chlorination facility would be required at the Ashokan Screen Chamber and a dechlorination facility would be required at the Pleasantville Alum Plant. The first would take place within the existing facility and the second would only require a small structure to be added to the existing DEP-owned site. Comparatively, the construction of potentially new and larger structures on Staten Island could alter some views from public spaces on Staten Island and have a greater potential for impact to urban design and visual resources as compared to the repair and rehabilitation.

15.4.3.4 Natural Resources

Unlike the repair and rehabilitation that has the potential for temporary effects to natural resources from leak repair or treatment, the Interconnections to Water Supplies in New Jersey Alternative would require: the construction and installation of new transmission mains to transport water across the Arthur Kill between New Jersey and Staten Island, the construction of a booster pumping station, installation of a transmissions main via open trench construction to connect the new booster pumping station to the existing distribution system in Staten Island, and the expansion of existing chlorination facilities. Depending on the exact location of the transmission main, the construction could potentially lead to the alienation of, or impacts to, existing parkland, and potential effects on tidal wetland areas due to the construction of the transmission main across the Arthur Kill. Therefore, compared to the repair and rehabilitation, this alternative could result in greater impacts or effects to natural resources.

15.4.3.5 Water and Sewer Infrastructure

The Interconnections to Water Supplies in New Jersey Alternative would require construction of a greater amount of new, larger, and more complex facilities than the repair and rehabilitation including the construction of a booster pumping station, transmission mains, and expanded treatment systems within Staten Island. Treatment systems would be required, and most likely consist of chlorination facilities to ensure uniform water quality that meets regulatory standards for all systems. The Interconnections to Water Supplies in New Jersey Alternative would provide system redundancy for droughts and other emergencies, but would not repair or rehabilitate existing critical infrastructure. Following the RWBT temporary shutdown, it is anticipated that the Interconnections to Water Supplies in New Jersey Alternative would be available to provide water during the off-peak seasonal water demand period from September to May, with some potential availability in the peak season. This alternative would also benefit New Jersey water purveyors by providing additional transmission capacity to New Jersey. Interconnections could make the City's water supply available to New Jersey as an emergency source. At the same time, the amount of water available from New Jersey water supply purveyors is unknown at this time, and may not be sufficient to meet the augmentation needs of the RWBT temporary shutdown as

a stand-alone alternative. There is also potential risk associated with the use of water supply resources currently managed by other water purveyors. It is anticipated that new structures or facilities constructed to support the project would not significantly increase stormwater load and wastewater generation, and new or additional flows could be handled by the existing collection systems. Repair and rehabilitation would limit the ability of certain upstate customers to draw water from the Catskill Aqueduct during project-associated 10-week shutdowns of these facilities and would require potential changes to water treatment at upstate user taps in order to respond to the addition of chemicals at the Ashokan Screen Chamber. However, DEP is working to ensure adequate back-up supply is available to these customers prior to initiating any shutdowns. Therefore, the Interconnections to Water Supplies in New Jersey Alternative would likely result in slightly greater effects to water and sewer infrastructure as compared to the repair and rehabilitation during operation of the system under the RWBT temporary shutdown.

15.4.3.6 Energy

Compared to the repair and rehabilitation, Interconnections to Water Supplies in New Jersey Alternative would require greater power needs. For the repair and rehabilitation, additional energy demand could be required to support the chlorination facility at the Ashokan Screen Chamber and dechlorination facility at the Pleasantville Alum Plant, and the Catskill Aqueduct inspection. For Interconnections to Water Supplies in New Jersey Alternative, energy would be required to support the operation of multiple pumps at the booster pumping station, and any potential expanded treatment facilities on Staten Island. In addition, power from Staten Island may be required to drive equipment used to facilitate the trenchless crossing of the Arthur Kill. Therefore, the Interconnections to Water Supplies in New Jersey Alternative would have a higher overall energy demand to provide augmentation during the temporary shutdown.

15.4.3.7 Transportation

With respect to construction-related trips, there would be more worker trips to more locations in Staten Island for construction of the booster pumping station, transmission mains, and expanded treatment facilities in the vicinity of neighborhoods or other sensitive receptors, and this could result in temporary increases in traffic when compared to the repair and rehabilitation. Unlike the repair and rehabilitation, public roadways in the City may need to be closed for street activities associated with construction of in-road transmission mains, which would also result in increased traffic on adjacent roadways. In addition, the activities would displace any permitted on-street parking and potential bus service currently permitted in the construction area. Potential impacts to traffic could also occur as a result of increased worker and construction vehicle traffic and delivery of equipment, lane closures, and other construction-related effects.

Traffic associated with the Interconnections to Water Supplies in New Jersey Alternative during the RWBT temporary shutdown would use small local streets for employee traffic to access the potential expanded treatment facilities and any associated chemical deliveries on Staten Island. This could result in traffic impacts to the local network even if mitigation measures could be developed to address any significant adverse traffic impacts associated with the Interconnections to Water Supplies in New Jersey Alternative. Therefore, traffic associated with Interconnections to Water Supplies in New Jersey Alternative is anticipated to have greater impacts and effects than the repair and rehabilitation during both the construction and temporary operation phases.

15.4.3.8 Air Quality

Air quality effects would be greater under the Interconnections to Water Supplies in New Jersey Alternative than under the repair and rehabilitation. These greater air quality effects would predominately result from increased traffic (which could increase mobile air emissions), construction of new facilities, and the installation of transmission mains, which could result in increased dust and other emissions. In addition, construction as part of the Interconnections to Water Supplies in New Jersey Alternative is anticipated to take place for a longer period of time and in closer proximity to more sensitive receptors as compared to the repair and rehabilitation, where construction would be spread out along mostly rural areas and last for a period of less than 2 years. Therefore, the Interconnections to Water Supplies in New Jersey Alternative would likely result in slightly greater effects to air quality as compared to the repair and rehabilitation during operation of the system under the RWBT temporary shutdown.

15.4.3.9 Noise

If a new booster pumping station or expanded treatment facilities were built on Staten Island associated with the Interconnections to Water Supplies in New Jersey Alternative, the new structures could have the potential to generate noise that could affect sensitive resources in the vicinity of the sites where they would be located. This would be the case even if the buildings were constructed to be enclosed and subject to the requirements of local building codes, including the City noise code and performance standards. Compared to the repair and rehabilitation, there would be a greater number of receptors that would be located in closer proximity to construction activities and the construction period would be greater under the Interconnections to Water Supplies in New Jersey Alternative. Therefore, the potential for impacts to noise-sensitive receptors in the City from construction under this alternative is anticipated to be greater than those that would occur as a result of the repair and rehabilitation.

15.4.3.10 Neighborhood Character

If a new treatment system or new pumping stations were built on Staten Island associated with the Interconnections to Water Supplies in New Jersey Alternative, the new structures could have the potential to change the views from public spaces, affect urban design, and temporarily affect access to open space and recreation, traffic, and noise for the neighborhoods in which they would be located in a greater capacity than repair and rehabilitation. However, the buildings would be constructed to be visually compatible with existing buildings and subject to local code approvals, including land use and zoning regulations, performance standards, noise codes, and the Public Design Commission. Therefore, as with Upstate Water Supply Resiliency, the Interconnections to Water Supplies in New Jersey Alternative would not result in significant adverse effects to neighborhood character.

15.4.3.11 Public Health

The amount of water available from New Jersey water supply purveyors is unknown at this time, and may not be sufficient to meet the augmentation needs of the RWBT temporary shutdown as a stand-alone alternative, as is feasible with the repair and rehabilitation. In addition, connection of the New Jersey system with the City's system could require construction of new treatment

facilities to ensure uniform water quality that meets regulatory standards for all systems. However, as part of the repair and rehabilitation, new treatment chemicals would be added to control biofilm regrowth within the aqueduct in order to maintain or improve its hydraulic capacity. For upstate users who draw water from the aqueduct, additional treatment systems, operational changes, or monitoring may be required to manage changed water quality conditions. However, under both projects, all changes to treatment would meet the requirements of the Surface Water Treatment Rule and the New York State Department of Health. Therefore, adverse effects to public health are not anticipated in association with either project. Air and noise emissions may temporarily increase during construction of Interconnections to Water Supplies in New Jersey Alternative, although not to levels that are anticipated to impact public health. If found to meet the augmentation needs necessary to support the RWBT temporary shutdown, the potential for impact to public health under the Interconnections to Water Supplies in New Jersey Alternative would be comparable to the repair and rehabilitation.

15.5 ALTERNATIVE 3: RWBT LEAK STABILIZATION

In addition to the Interconnection to Water Supplies in New Jersey Alternative, WFF included a repair alternative, RWBT Leak Stabilization, which was still under investigation at the time the previous EIS was released. As presented in the previous EIS, the Leak Stabilization Alternative would include chemical treatment on the aqueduct water, in an attempt to stabilize and repair the leaking aqueduct. This alternative is based on a conceptual plan that considered the addition of lime and carbon dioxide at the Rondout Effluent Chamber, and/or at one or more RWBT shaft locations. This alternative would also include mineral acid (possibly sulfuric acid) or carbon dioxide addition just prior to water entering West Branch Reservoir to return the water's pH to a level meeting drinking water standards, and prevent precipitation of calcium carbonate prior to discharge into the Reservoir. It was anticipated that the Leak Stabilization Alternative would allow for short-term treatment where the RWBT would be operated at a low flow with a high concentration of calcium and carbonate to induce the formation of scale and deposits within the leaks and cracks of the RWBT to seal them. Following this initial "repair" period, the tunnel would be operated at normal flow rates at a maintenance dose to maintain the adjusted raw water chemistry and, thereby, maintain the crack sealing accomplished during the repair period.

At the time of the previous EIS publication, a pilot study was underway to determine the feasibility of this alternative. The primary goal of the pilot study was to investigate various chemical dosing programs that could be used to adjust the chemistry of the water to reduce the aggressiveness of the Rondout Reservoir water supply, and form a calcium carbonate scale within simulated aqueduct cracks to determine if reduced leakage through the RWBT and protection of the surrounding bedrock would be feasible by using this scaling to seal the cracks. The pilot study underway at the time of publication of the previous EIS is now completed. The following sections describe the Leak Stabilization Alternative and the results of the pilot study conducted for this alternative, and details related to Leak Stabilization that would be advanced under this alternative.

15.5.1 PILOT STUDY RESULTS

Studies investigating the RWBT leaks indicated that they are primarily a result of chemical reactions between the flowing water and the construction material of the RWBT. Because of its low pH and alkalinity, water from the Rondout Reservoir is likely to be corrosive to the cement lining of the aqueduct, and to the aqueduct's surrounding geology. Limestone within the cement lining and bedrock contains about 50 percent calcium carbonate, thus it dissolves in the slightly acidic aqueduct water. Water combined with carbon dioxide forms carbonic acid. Carbonic acid is a relatively weak acid, but given enough time, it weathers limestone, increasing the diameters of the fractures.

The use of calcium and inorganic carbon to stabilize water, reduce corrosiveness, and form a scale within cracks that would eliminate or minimize leaking is founded on sound chemistry concepts, and the studies were undertaken to further develop the chemical stabilization strategy.

The results of pilot-scale studies indicate that the Leak Stabilization Alternative could provide the City with a long-term treatment option to prevent the formation of further cracks in the

RWBT by managing the pH of the RWBT aqueduct water. The existing raw aqueduct water is characterized by a chemical composition that leads to dissolution of aqueduct scale and, where it leaks from the tunnel, to the surrounding geology. Even with the construction of the bypass tunnel, results of the study showed that Leak Stabilization could have the ability to maintain and potentially repair cracks that are located in the remaining portion of RWBT. However, as described below, the viability of this alternative to repair existing leaks on a full scale is unknown, as is the time needed for effective scaling to develop, and its integrity as a permanent solution.

Scale deposition was observed during the pilot study. However, the rate of formation of scale was not uniform throughout the length of the pilot study piping, and the efficacy and dosing of different chemical combinations varied. The dose rate that would be effective for full-scale chemical addition under the RWBT Leak Stabilization Alternative, as well as the most effective combination of chemicals to achieve a uniform scale in the aqueduct itself are unknown. Furthermore, the time that it would take for the scale to form and effectively seal the leaks along the length of the RWBT is also unknown. Therefore, there is a high degree of uncertainty regarding how effective Leak Stabilization would be as a permanent solution to repairing the leaks along the RWBT.

In addition, the RWBT water used in the pilot study was found to dissolve scale (over a period of weeks) that had deposited. If Leak Stabilization were pursued and proved successful in addressing RWBT leaks, continuous chemical addition (at a maintenance dose) would be necessary to maintain the sealed leaks and to implement long-term management of the water stability. Moreover, sudden changes in flow through sealed or partially sealed cracks were observed during disruptions to the pilot system (start-up/shut-down cycles). During future RWBT unwatering events, groundwater would be expected to seep into the tunnel and dissolve scale due to its aggressive composition. Therefore, it is not clear how future unwatering of the RWBT would affect sealed or partially sealed leaks.

While the pilot study did not reveal a greatly reduced capacity of the simulated aqueduct, there is uncertainty whether this would be the case during full-scale operations under the Leak Stabilization Alternative. There is the possibility that, if scale formed in the RWBT it could negatively affect the capacity of the tunnel and, therefore, would not meet the objectives of WFF to ensure the long-term reliability of the City's water supply.

Though initially conceived as an alternative to bypass tunnel construction, design and construction of the project would take place after the proposed repair of RWBT. Therefore, this alternative is considered as an alternative to the inspection and repair. While the Leak Stabilization Alternative could result in an extension of the life of an already aging structure, it still leaves the potential for additional leaks to occur or existing leaks to increase in the future. It may not be sufficient to meet the City's needs for a reliable high-quality water supply as a stand-alone alternative, as is feasible with the inspection and repair.

In addition, because its operation would likely be long-term and include operation and maintenance costs associated with long-term chemical addition at the Rondout Effluent Chamber and construction and maintenance of the facility, this alternative would be far less cost effective than the proposed components of Upstate Water Supply Resiliency. While overall it is

anticipated there would be fewer effects associated with construction compared to Upstate Water Supply Resiliency, potential effects to Outside Community Connections that could result from changes in water chemistry (during both short and long-term operations) would have to be investigated. Furthermore, localized monitoring at leak sites would be required to determine any natural resources effects that may result from "liming" due to the change in RWBT water chemistry.

Connection of the bypass tunnel to the RWBT, decommissioning of the leaking section of the RWBT in Roseton, and repairs of the RWBT leaks near Wawarsing are necessary to ensure DEP can continue to efficiently and effectively deliver water from its Delaware System to its customers. The RWBT diverts water from the Delaware System. If the RWBT bypass were not connected, access to the Delaware System would be at risk, the leaks would continue, water would be lost, and there is a potential for the leaks to worsen in the future. Since the Delaware System can supply up to 50 percent of the water needed to meet customer demand, alternatives that do not facilitate the complete repair or bypass of the leaking segments of the RWBT in Roseton and near Wawarsing are not feasible.

The discussion of the Leak Stabilization Alternative in the previous EIS indicated that potential impacts in all environmental impact areas for the Leak Stabilization Alternative would be fully assessed in the second EIS, or a subsequent environmental review, as appropriate, if the alternative was determined to be a feasible alternative that achieves the same goal as connection of the bypass tunnel. Since results of the pilot testing found that Leak Stabilization Alternative is not a suitable alternative to the bypass tunnel connection and repairs near Wawarsing or to the inspection and repair, the potential for significant adverse impacts is not addressed in this section.

15.5.2 SUMMARY COMPARISON OF ALTERNATIVES

A comparison of the alternatives to Upstate Water Supply Resiliency is shown in **Table 15.5-1**.

Table 15.5-1: Comparison of Alternatives

Category	Upstate Water Supply Resiliency	No Action	Interconnections to Water Supplies in New Jersey	Leak Stabilization
Purpose and Need	Allows shutdown of the RWBT to connect the bypass tunnel and supports overall WFF goal to permanently address leaks in the RWBT	Does not address overall WFF goals because it does not address leaks in the RWBT	Allows shutdown of the RWBT and supports overall WFF goal to permanently address leaks in the RWBT	Does not address overall WFF goals because its ability to both adequately repair leaks in the RWBT and maintain any leaks it does repair is unknown
Feasibility	Feasible	Not feasible	Feasible	Not feasible for Leak Repair
Risk	Acceptable	Much greater than Upstate Water Supply Resiliency	Acceptable	Greater than Upstate Water Supply Resiliency
Cost	Feasible	NA	Greater than Upstate Water Supply Resiliency	Greater than Upstate Water Supply Resiliency
Time to Complete	Feasible	NA	Greater than Upstate Water Supply Resiliency	Greater than Upstate Water Supply Resiliency (long-term operations needed)
Environmental Impacts	Potential impacts to wetlands	Possible risk to the water supply as a whole since RWBT leaks would continue	Greater than Catskill Aqueduct Repair and Rehabilitation	Possible risk to the water supply since RWBT leaks would continue for an unknown period of time after project implementation, with unknown effectiveness. Possible effects to natural resources and Outside Community Connections
Note: NA = Not Applicable				

Unavoidable significant adverse impacts are defined as those that meet the following two criteria:

- There are no reasonably practicable mitigation measures to eliminate the impacts; and
- There are no reasonable alternatives that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar significant adverse impacts.

For WFF, unavoidable significant adverse impacts - to the extent they can be identified at this time – were summarized in the previous EIS.

For Upstate Water Supply Resiliency, a potential significant adverse impact to Natural Resources in Roseton was identified. Lowering of groundwater levels as a result of the leak repairs in Roseton would potentially result in the loss of wetlands (referred to as Wetlands A, B, C, D, and E), and potential impacts to riparian areas adjacent to streams (referred to as Stream Segments 3, 3B, and 4). DEP will implement a monitoring program prior to, during, and after the RWBT temporary shutdown to assess the impacts to these wetlands and should impacts be measured, would mitigate as required. Further detail is provided in Chapter 11, "Proposed Rondout-West Branch Tunnel Inspection and Repair." Therefore, Upstate Water Supply Resiliency would not result in any unavoidable significant adverse impacts.

Construction and operation of Upstate Water Supply Resiliency to support Water for the Future (WFF) would involve the use of various construction materials, materials for operation and maintenance, fuels, and energy for construction and operation. Some of the materials that would be used for Upstate Water Supply Resiliency are nonrenewable resources, and are considered irretrievably and irreversibly committed, because reuse is not possible or is highly unlikely.

Construction materials include concrete and other materials that would be used to construct the repairs along the RWBT and Catskill Aqueduct, including access roadways and new facilities (vents, boatholes), upgrades at the Ashokan Screen Chamber and Pleasantville Alum Plant, and installation of siphons at the Rondout Reservoir. During repair of the RWBT and Catskill Aqueduct, construction of the chlorination facility at the Ashokan Screen Chamber and the dechlorination facility at the Pleasantville Alum Plant, and installation of siphons at Rondout Reservoir, fuel would be used for operation of construction equipment (e.g., various trucks, cranes, pressurized washing equipment). The RWBT and Catskill Aqueduct themselves do not require electricity to deliver water, since the water supply system relies on gravity, but chlorination and dechlorination at the Ashokan Screen Chamber and Pleasantville Alum Plant, respectively, would require the use of electricity and chemicals for operation during the RWBT temporary shutdown.

However, without Upstate Water Supply Resiliency, the bypass tunnel would not be able to be connected to the RWBT, and the RWBT would continue to leak both in the Roseton area and near the Wawarsing area. With WFF, DEP would be able to ensure the long-term safe and reliable transmission of drinking water from the watershed in sufficient quantities to consumers to meet all current and future water demands.

Therefore, Upstate Water Supply Resiliency would not result in irreversible or irretrievable impacts to resources.

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