Municipal Water Supply Study for the Village of Hoosick Falls

Prepared for:

Saint-Gobain Performance Plastics
14 McCaffrey Street
Hoosick Falls, NY 12090

Honeywell
115 Tabor Road
Morris Plains, NJ 07950

Prepared by:

Environmental Resources Management
99 East River Drive, 3rd Floor
East Hartford, CT 06108

III Winners Circle
Albany, New York 12205
(518) 453-4500

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List of Acronyms

AACE	American Association of Cost Engineers
AER	Anion-Exchange Resin
AMSL	Above Mean Sea Level
ANG	Air National Guard
AWS	Alternative Water Supply
CHA	CHA Consulting, Inc.
DBP	Disinfection Byproduct
DER	Division of Environmental Remediation
ERM	Environmental Resources Management
FS	Feasibility Study
GAC	Granular Activated Carbon
GIS	Geographic Information Systems
GWUDI	Groundwater Under Direct Influence [of surface water]
HDD	Horizontal Directional Drilling
IRM	Interim Remedial Measure
MCL	Maximum Contaminant Level
MCN	Multi-Walled Carbon Nanotubes
MPA	Micro-Particulate Analysis
MWS	Municipal Water Supply
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
PAC	Powdered Activated Carbon
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic acid
PRAP	Proposed Remedial Action Plan
PRP	Potentially Responsible Party
RCDOH	Rensselaer County Department of Health
RI	Remedial Investigation
ROD	Record of Decision
SCG	Standards, Criteria, and Guidance
SDWA	Safe Drinking Water Act
SGPP	Saint-Gobain Performance Plastics
SPDES	State Pollutant Discharge Elimination System
SVOC	Semivolatile Organic Compound
US EPA	United States Environmental Protection Agency
VTDEC	Vermont Department of Environmental Conservation
VOC	Volatile Organic Compound
WTP	Water Treatment Plant

Units of Measure

MGD	Million Gallons per Day
gpm	Gallons per Minute
gpd	Gallons per Day
gpm/sf	Gallons per Minute per Square Foot
mg/l	Milligram per Liter
µg/L	Microgram per Liter
ng/L	Nanogram per Liter
ppm	Parts per Million
ppb	Parts per Billion
ppt	Parts per Trillion
lbs	Pounds

1.0 EXECUTIVE SUMMARY

This Municipal Water Supply Study for the Village of Hoosick Falls (Study) was prepared pursuant to Order on Consent and Administrative Settlement, Index No. CO 4-20160212-18 (the Order) to fulfill the requirement to prepare a study and assessment of alternate potable water sources for the Village of Hoosick Falls (Village) Municipal Water Supply (MWS).[1]

In 2014, Perfluorooctanoic acid (PFOA) was found in the Village MWS at concentrations in excess of a US Environmental Protection Agency (US EPA) temporary provisional Health Advisory (HA) of 400 nanograms per liter (parts per trillion-ppt). In May 2016, the US EPA established a drinking water HA of 70 ppt for the combined concentrations of Perfluorooctanesulfonic acid (PFOS) and PFOA. In December 2018, the New York State Drinking Water Council recommended a state drinking water standard for PFOA and PFOS of 10 ppt each. The NYSDOH issued draft regulations for public review in July 2019, proposing these values as maximum contaminant levels (MCL).

PFOA is among the 30 contaminants (28 chemicals and two viruses) for which nationwide monitoring was required as part of the EPA's third Unregulated Contaminant Rule (UCMR 3), established in May 2012, pursuant to the federal Safe Drinking Water Act (SDWA). The UCMR 3 program monitors currently unregulated contaminants that may pose risks for drinking water, and is intended to provide data for the US EPA to make determinations on whether to promulgate a national primary drinking water standard. UCMR 3 used a detection limit of 20 ppt and 40 ppt for PFOA and PFOS, respectively.

In response to the detection of PFOA in groundwater in the Village and Town, several remedial measures were implemented, including the distribution of bottled water to all residents, and installation of a temporary Granular Activated Carbon (GAC) treatment system to the existing MWS. A full capacity GAC treatment system design was subsequently approved by the NYSDOH and installed at the MWS to replace the temporary system. Regular testing since March 2016 has been performed by the NYSDOH at the GAC system's influent, midpoint, and effluent sampling points, and the system has proved effective for the past three years at removing PFAS. In addition, the New York State Department of Environmental Conservation (NYSDEC) coordinated the installation of point-of-entry treatment systems (POETs) on private drinking water supplies.

[1] Per the Order on Consent and Administrative Settlement Index No. 4-201-160212-18 the reservations of rights set forth therein are expressly incorporated herein, including, but not limited to, Paragraphs 14, II.A.2, and Appendix A, Paragraph III.E of the Order.

This Study identifies and evaluates the following five alternative drinking water sources for the Village of Hoosick Falls.

Alternative	Title
1	Development of a New Groundwater Source
2	Development of a New Surface Water Source
3	Interconnection with an Existing Water Supply Source
4	Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System
5	Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System and PFOA Remediation through the McCaffrey Street IRM

Potential options were pre-screened that could serve as either a new groundwater source, new surface water source, or an interconnection with an existing water supply. These options were screened based on their ability to comply with applicable public health and engineering standards and meet both the current average maximum day demand of 0.71 MGD and the conceptual future maximum day demand of 1.13 MGD.[2]

The NYSDOH oversees public water systems within the state. The "Recommended Standards for Water Works," commonly referred to as *Ten States Standards,* underpins the public water system regulations for New York State, among others. These standards establish a consistent design methodology for design, construction, and operation of water systems. Appropriately, *Ten States Standards* were used as the basis to screen potential options for new water sources in order to identify alternatives in the Study. *Ten States Standards* requires any new source of water must provide adequate quantity of water which will meet water quality regulations. It also states that water supplies should take raw water from the "best available source which is economically reasonable and technically possible".

This Report uses the distance between a potential new water source and the Village as the most relevant metric to establish alternatives that are "economically reasonable and technically possible". Sources that are farther away require longer transmission mains, which in turn requires more construction time, encompasses greater complexity, and higher costs. More distant sources present greater risk of service interruptions and water quality problems, and they consume greater amounts of energy for pumping. Therefore, this Study identified potential water sources that could provide an adequate quantity of water, were of sufficient quality, and were closer to the Village.

[2] Current water demand was estimated from empirical data of average and maximum daily use over a five year period (2010 to 2014) before perfluorooctanoic acid (PFOA) was discovered in the Village water supply. Conceptual future maximum day demand estimate was based on a 2016 concept study completed by MRB Group on behalf of the Village and the Town.

All five alternatives described in this Report are able to meet the current and future water demands of the Village, so there was no need to consider any combination of alternatives. A summary of each alternative is provided below.

Alternative 1 – Development of a new groundwater source

Under this alternative, two new wells would be converted from test wells into full production wells, approximately one mile south of the current Village wellfield at the LaCroix and Wysocki properties. An overview figure of Alternative 1 is provided in Figure ES.1. The existing Well #7, microfiltration membranes, and full capacity GAC system would be maintained to satisfy NYSDOH source water redundancy[3] requirements, but the new wells would be assigned priority.

The LaCroix well and Wysocki well produced a yield of 450 gpm and 300 gpm, respectively, for a combined capacity of 750 gpm (1.08 MGD). Higher levels of production are considered feasible (especially in the LaCroix well), which would meet the conceptual future maximum day demand of 1.13 MGD. Well #7 would also provide additional supply to meet conceptual future maximum day demands.

Water from the Wysocki test well showed trace concentrations of PFOA that are below the current health advisory (as well as the draft NYSDOH regulations of 10 ppt). Water from the LaCroix test well was non-detect for PFAS. Additional testing would be required during detailed design to confirm these preliminary results. Nevertheless, groundwater quality evaluations and monitoring are included as part of this alternative to assess the potential for PFAS (or any other contaminants) migration during operation of the new wells.

Water from the new wells would be pumped to the Village water treatment plant (WTP) for manganese removal and disinfection. Water quality data suggests that both wells would not be classified as groundwater under the direct influence of surface water (GWUDI), which means no filtration would be required to satisfy drinking water regulations; however, NYSDOH would make the final GWUDI determination. If the groundwater is not classified as GWUDI, the existing microfiltration units at the WTP would be bypassed for the new wells. Similarly, the full capacity GAC system would not be required for the new wells, but would remain operational in the event Well #7 is needed in the future. Periodic use of Well #7 through the microfiltration units and GAC media would be necessary to maintain both in readily usable condition.

[3] Other groundwater supply sources may exist instead of Well #7 that would require further study. For example, these could include proving additional production capacity in the Wysocki and/or LaCroix wells, or installation of another productive well.

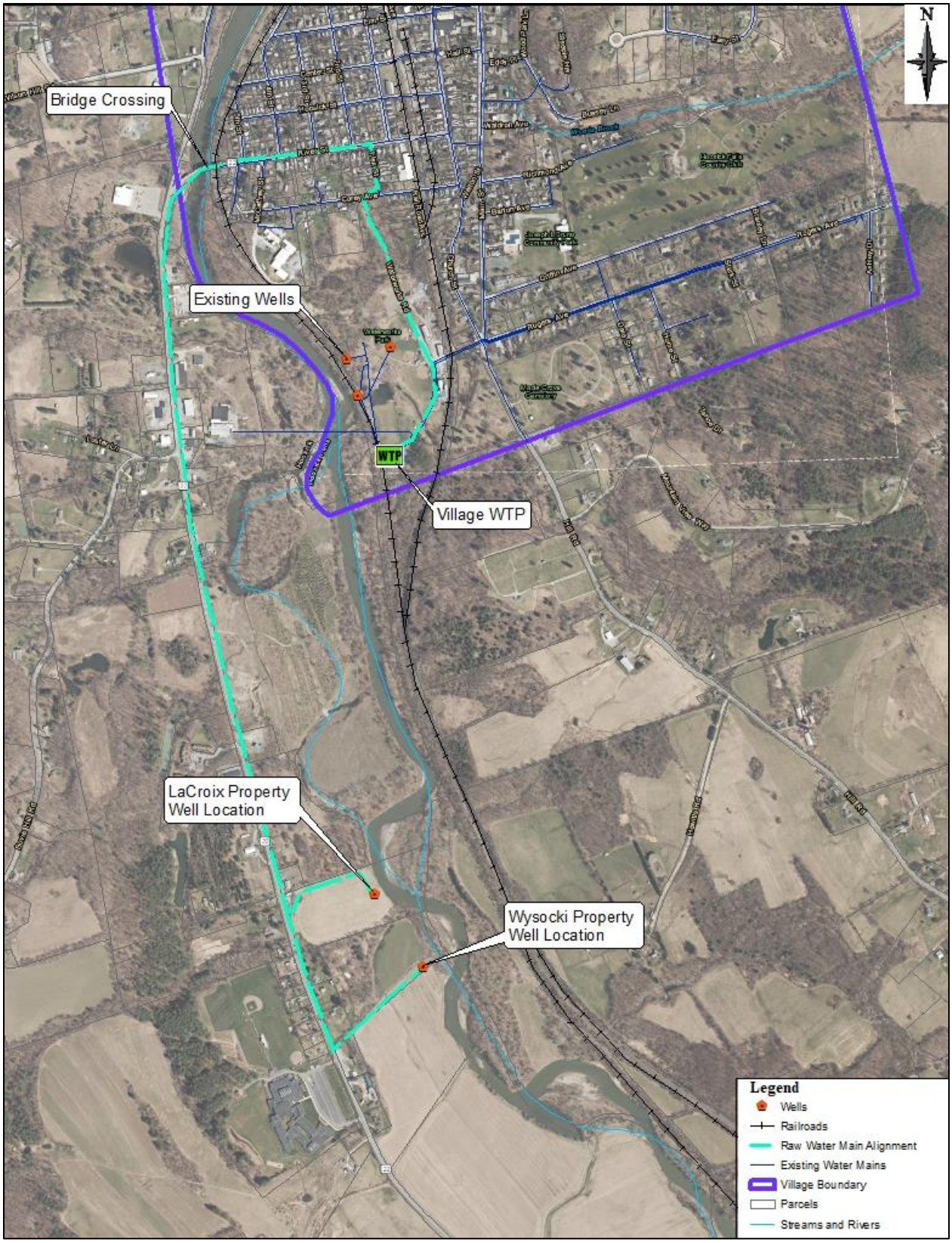

Figure ES.1 – Alternative 1 – New Groundwater Source

Alternative 2 – Development of a new surface water source

Surface water bodies that could potentially provide an alternate water supply extend west to the Hudson River as well as potential sources to the east in Vermont and Massachusetts. These surface water bodies were the Hoosic River, the Walloomsac River, the Tomhannock Reservoir, the Hudson River, and Broad Brook. The location of these sources is shown in Figure ES.2.

The Tomhannock Reservoir and Hudson River were identified as the two surface water sources that could supply a sufficient quantity of water to serve the current and potential future needs of the Village. Since the distance from the Hudson to the Village is almost twice the distance from the Tomhannock, the Tomhannock Reservoir was selected as the surface water alternative for further evaluation in this Study.

An updated safe yield analysis for the Tomhannock Reservoir was completed by CDM Smith in August 2018 and indicated a capacity of 36.3 MGD. Given the maximum daily demand of the City of Troy (30.1 to 33.57 MGD), sufficient capacity exists to meet the current and conceptual future water needs of the Village.

This alternative would require construction of a new raw water intake, pump station, and 13.4 mile transmission main to connect the reservoir to the Village Water Treatment Plant (WTP), where the water would be treated. An overview of Alternative 2 is provided in Figure ES.3 and Figure ES.4.

Much of the new transmission main would be installed within the public right of way, though some easements would be required from the City of Troy for the pump station on the east shore of the Tomhannock Reservoir, as well as from National Grid to construct a water main within its corridor. Easements from private property owners would also be needed, which would add cost and possible delay in the implementation of this alternative.

The raw-water transmission main would connect to the existing Village WTP for treatment consisting of microfiltration and disinfection. Additional pretreatment in the form of a coagulant additive may be required to prevent natural organic matter and other constituents in the reservoir from fouling the microfiltration membranes.

Testing of surface water from the Tomhannock Reservoir by NYSDEC identified trace concentrations of PFAS below the current health advisory level of 70 ppt. The concentrations detected were also below the proposed maximum contaminant levels of 10 ppt for PFOA and PFOS as recommended in the draft NYSDOH regulations.

Although there were some detections of PFAS in the Tomhannock Reservoir, none have been detected in finished water leaving the City of Troy water treatment plant. Like Alternative 1, the full capacity GAC system would be retained but bypassed under normal operations. Periodic operation and maintenance (O&M) associated with cycling of potable water through the GAC media would be necessary to maintain it in readily usable condition and is included in this alternative.

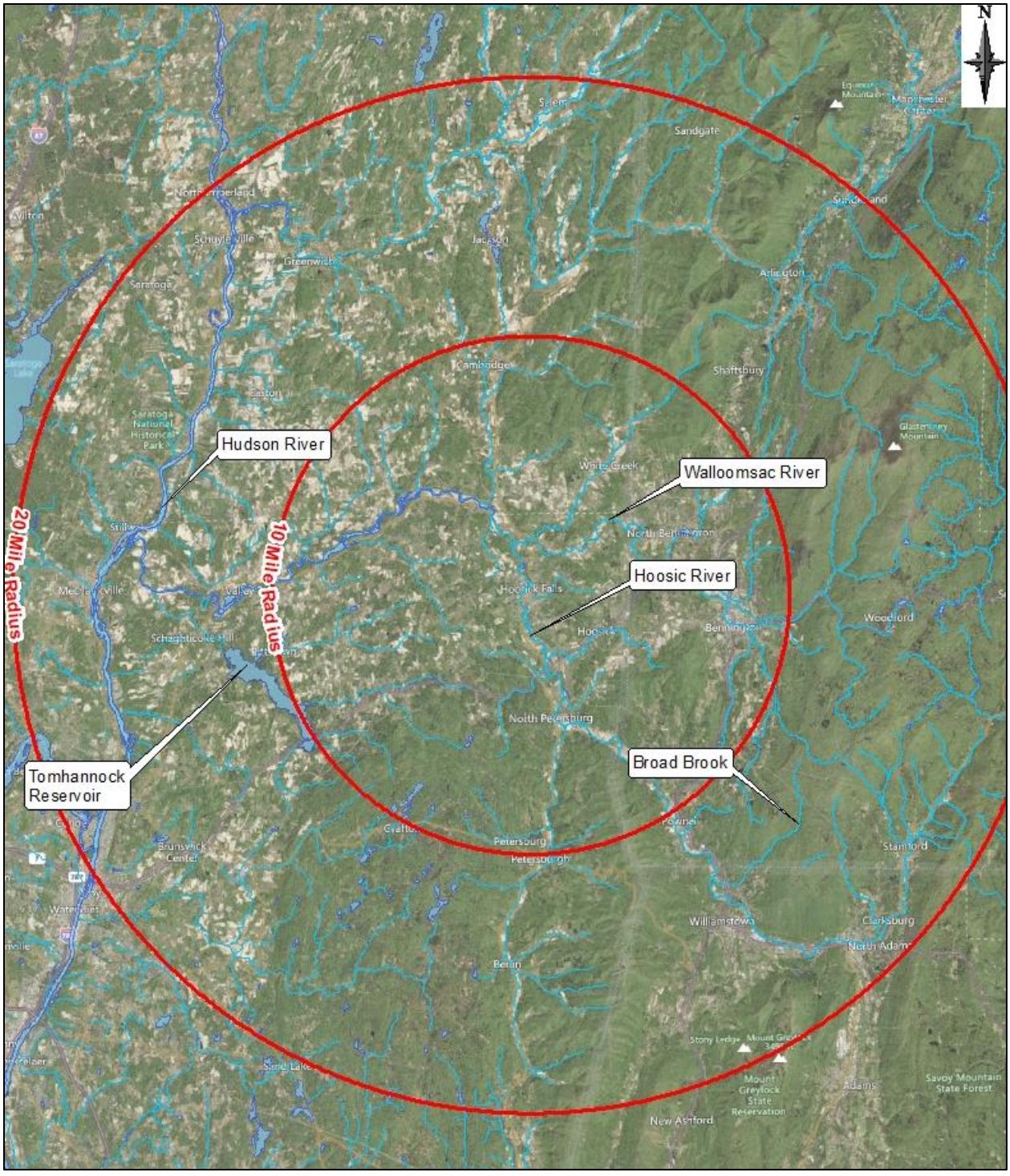

Figure ES.2 – Surface Water Sources Near Hoosick Falls

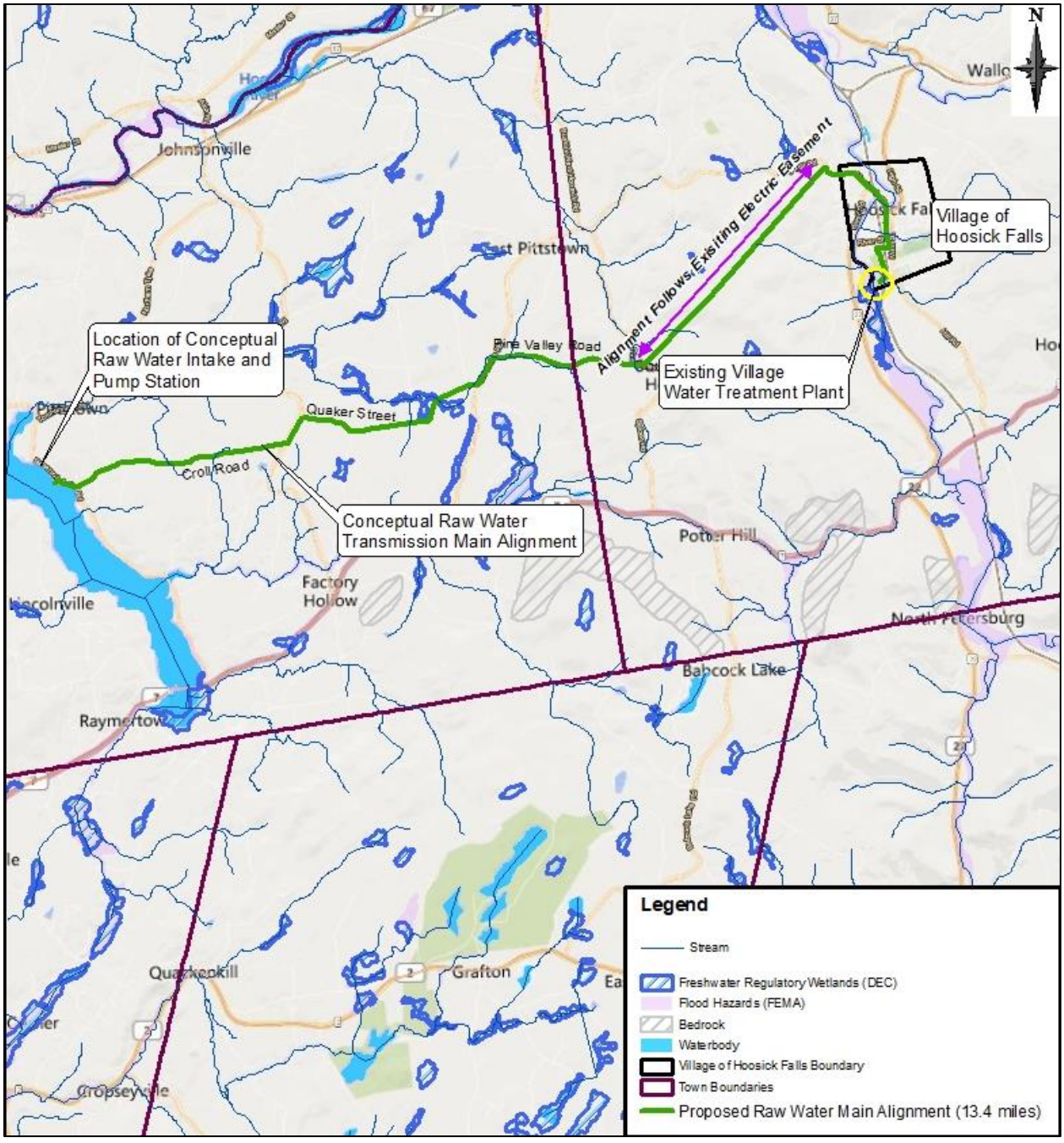

Figure ES.3 – Alternative 2 – New Surface Water Source

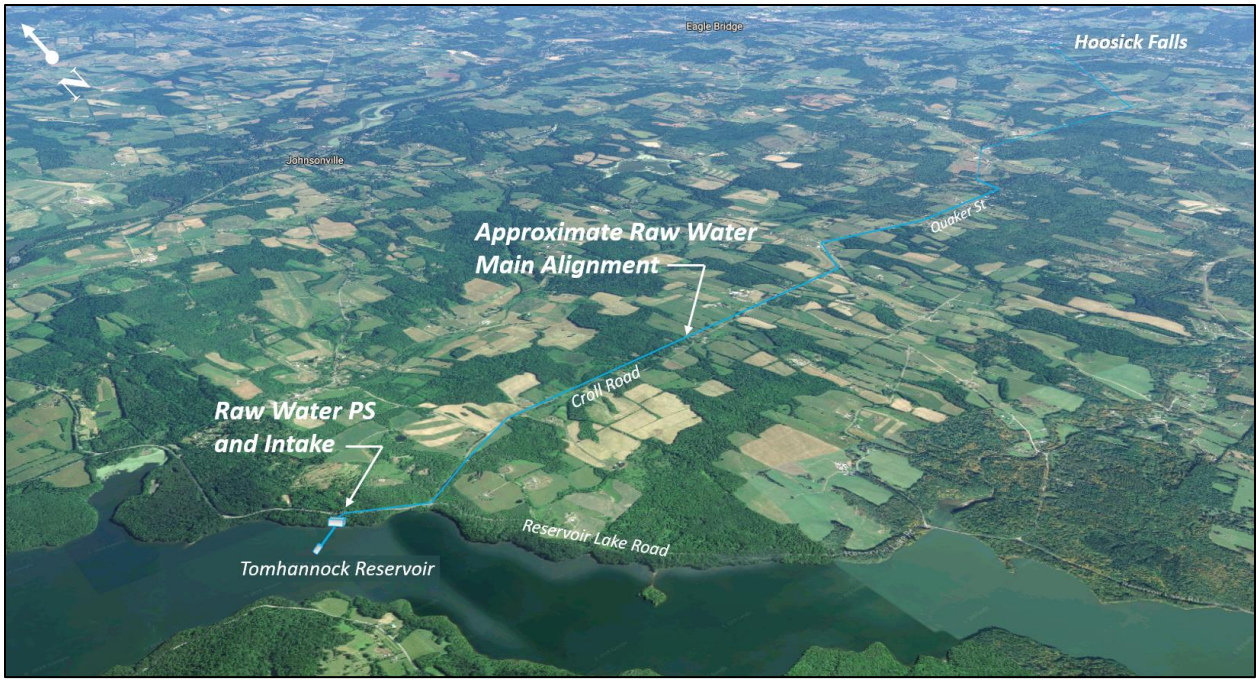

Figure ES.4 – Aerial View of Alternative 2 – New Surface Water Source

Alternative 3 – Interconnection with an existing water supply source

Fourteen (14) public water supplies reaching west to the Hudson River and east to the nearest moderate-sized communities in Vermont and Massachusetts were identified and evaluated as potential water supplies for the Village. The neighboring water supplies are listed in Table ES.1, and they are mapped in Figure ES.5. Most of them are too small to serve the water needs of the Village. The nearest public water supply that best meets the screening criteria is operated by the City of Troy, which derives its drinking water from the Tomhannock Reservoir.

Table ES.1 – Neighboring Public Water Supplies

Location	Distance from Hoosick Falls	Location	Distance from Hoosick Falls
Greenwich, NY	18 miles	Bennington, VT	10 miles
Cambridge, NY	10 miles	North Bennington, VT	8 miles
Town of Schaghticoke, NY (WD #1)	16 miles	Pownal, VT (Fire District 2)	12 miles
Town of Schaghticoke, NY (WD #2)	16 miles	Pownal, VT (Fire District 3)	12 miles
Town of Schaghticoke, NY (WD #3)	16 miles	Williamstown, MA	17 miles
Village of Schaghticoke, NY	16 miles	North Adams, MA	22 miles
Petersburg, NY	12 miles	Troy, NY	18 miles

This alternative contemplates purchasing treated water from the City of Troy, constructing an interconnection with the City's water supply and constructing an 18-mile transmission main to the Village WTP. The closest connection to Troy is along Route 278 (Brick Church Road) in Cropseyville. An overview of Alternative 3 is shown in Figure ES.6.

A booster pump station and wholesale water meter would be installed at the new connection. Although much of the new water transmission main will be installed within public right-of-way corridors, some easements will be required for the pump station in the Town of Brunswick and for the transmission main within the National Grid right-of-way corridor. The transmission main would deliver water to the Village WTP, where it would be re-chlorinated and pumped into the distribution system using the finished water pumps.

Although NYSDEC testing detected low levels of PFAS in the Tomhannock Reservoir, testing by the NYSDOH found none in the finished water for the City of Troy[4]. Since Alternative 3 proposes to purchase treated water, in the event any future PFAS treatment became necessary it would be centralized at the City of Troy WTP for sale to all of its customers, including the Village. The microfiltration units and the full capacity GAC system at Village WTP would be bypassed under this alternative.

[4] *Final Tomhannock Reservoir, Rensselaer County Per- and Polyfluoroalkyl Substances Trip Report,* NYSDEC, Revised June 2019. Refer to Appendix D.

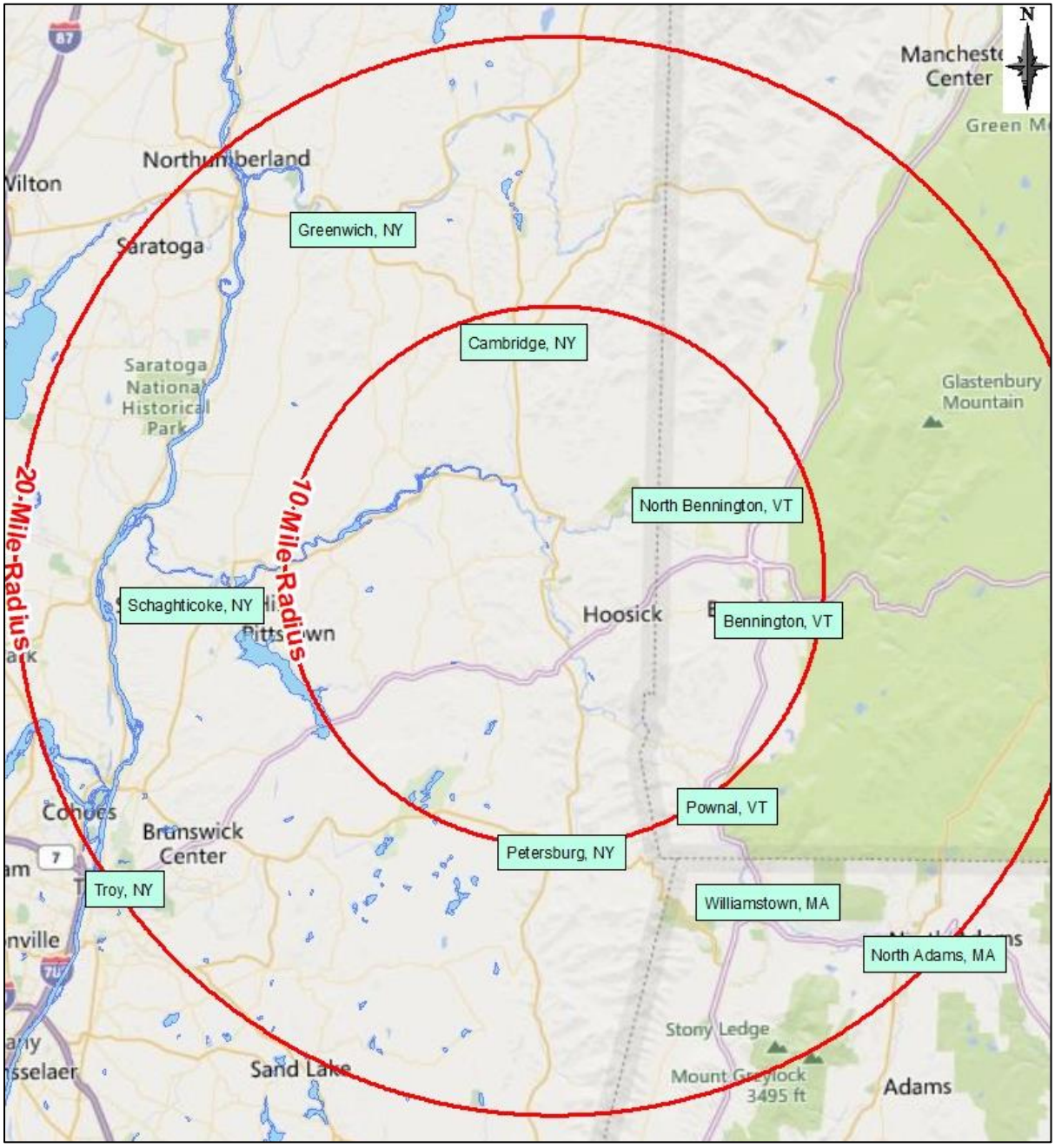

Figure ES.5 – Public Water Supplies near Hoosick Falls

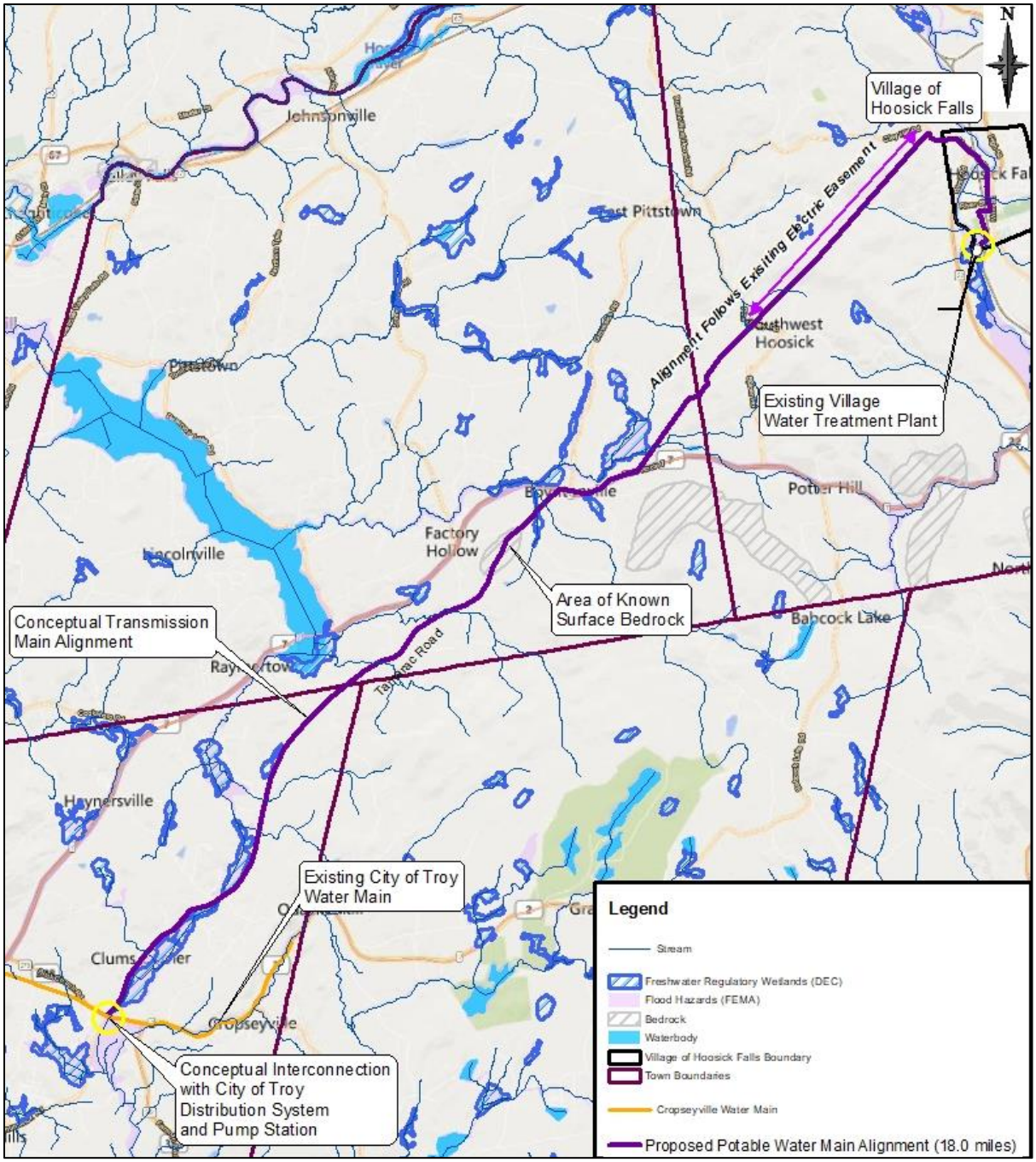

Figure ES.6 – Alternative 3 – Interconnection with Existing Water Supply

Alternative 4 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System would use the existing Village WTP and include the already operational full capacity GAC treatment system to remove PFOA from the existing groundwater supply wells. Water from the wells is pumped to the water treatment plant for removal of manganese, filtered through microfiltration membranes, and disinfected using chlorine. In addition, the full capacity GAC system involves pumping water sequentially though two steel vessels, each containing 40,000 pounds of GAC media. An example of a typical two-vessel GAC system is provided in Figure ES.7.

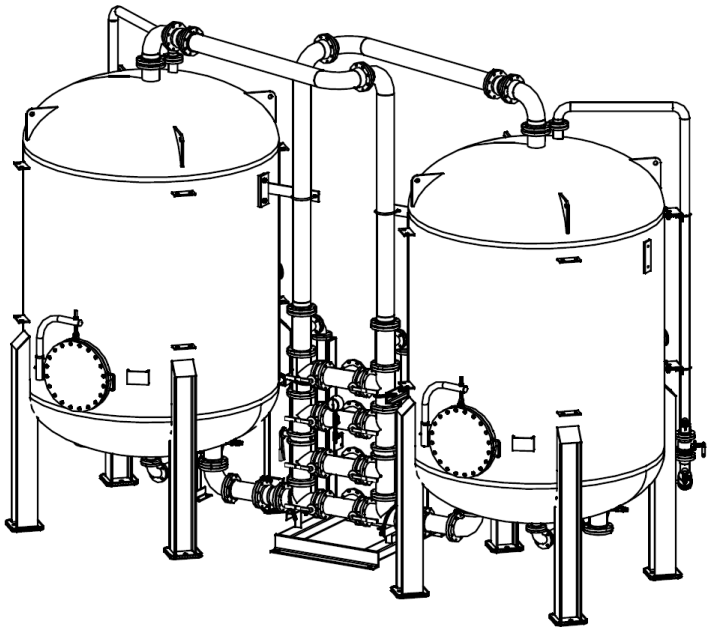

Figure ES.7 – Typical GAC System Arrangement

GAC treatment systems are commonly used in drinking water applications. GAC is a form of activated carbon, a class of materials with a very high surface area compared to mass. The high surface area ratio makes GAC an effective adsorbent, causing molecules to adhere to the surface. There is extensive technical literature documenting the use of GAC to effectively remove a broad range of constituents from drinking water supplies, including PFOA. NYSDOH approved the full capacity GAC treatment system, which has been operational since February 2017 and has been proven effective at removing PFOA and other trace PFAS compounds from the Village water distribution system.

Alternative 5 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System and PFOA Remediation through the McCaffrey Street IRM involves all the components of Alternative 4, plus an interim remedial measure (IRM) to capture and treat PFAS-impacted groundwater at the McCaffrey Street site, thereby preventing further migration of PFOA to the Village wellfield. The IRM has been implemented and is operating. The IRM pumps groundwater from two extraction wells located at the southeastern portion of the McCaffrey Street facility. The extracted water is treated with GAC and discharged to the Hoosic River. The anticipated capture zone of the IRM is shown in Figure ES.8.

Figure ES.8 – McCaffrey Street IRM Estimated Hydraulic Capture Zone

Alternative 5 includes all the elements in Alternative 4 plus the IRM. The full capacity GAC treatment system is already constructed and operational; therefore, the IRM is, in effect, independent of the alternative chosen.

The five alternatives described in this Study were evaluated based on criteria set forth in 6 NYCRR 375-1.8(f), in conjunction with guidance provided for each criterion in subdivisions (b) through (j) of Section 4.2 of DER-10 (Technical Guidance for Site Investigation and Remediation Issued on May 3, 2010).

Alternatives 1, 2, and 3 each represent options to replace the existing Village water supply. Alternative 4 uses the full capacity GAC treatment system currently in operation and serves as the "no further action" alternative in the Order. Alternative 5 considers the McCaffrey Street IRM operating in tandem with the full capacity GAC system. The IRM is anticipated to reduce the influent concentrations of PFOA and associated PFAS reaching the Village wellfield over time, and therefore improve the operation of the full capacity GAC process. With respect to all criteria (except for reduction of toxicity, mobility and volume through treatment and cost effectiveness), Alternative 5 would mirror Alternative 4.

There are two threshold criteria that any alternative must meet to be considered as a viable option:

- Overall protectiveness of the public health; and
- Compliance with applicable standards, criteria and guidance (SCGs).

All the alternatives would be protective of public health and comply with SCGs for both the Village's current and conceptual future water needs. Drinking water would be provided that meets state and federal regulations under each alternative.

The remaining six (6) criteria listed are referred to as balancing criteria. These are intended to guide and inform the remedial selection process based on the relative merits of each alternative.

Long-term effectiveness and permanence: All of the alternatives would provide a permanent drinking water supply; however, there are differences between the alternatives in their long term maintenance needs and future risk mitigation considerations.

Alternative 1, which proposes new groundwater wells to replace the existing Village supply wells includes normal O&M of the new water supply wells and associated transmission lines. In addition, Alternative 1 requires the existing Well #7 to meet redundancy requirements; therefore, periodic O&M of the microfiltration units and the full capacity GAC system are included to keep this supply well active and available for use. Alternative 1 presents some potential risk of contaminants being drawn into the new groundwater wells in the future; therefore, groundwater quality evaluations and monitoring are included as part of this alternative to assess the potential for PFAS (or any other contaminants) migration during operation of the new wells.

Alternatives 2 and 3 utilize a surface water source, which has risks associated with drought conditions and potential chemical or biological contamination. In addition, Alternatives 2 and 3 have long-term maintenance requirements, as they rely on a lengthy water transmission main to supply the Village with water. Alternative 2 also has the additional maintenance for a new surface water intake structure, the existing microfiltration system at the WTP, and additional pre-treatment ahead of the microfiltration membranes. Under Alternative 2, the full capacity GAC system would be retained if it becomes needed in the future by cycling potable water through the media.

Alternative 4 has long-term maintenance requirements relating to the monitoring and change-out of the full capacity GAC system. These O&M requirements have been routine since system installation. Similarly, Alternative 5 includes the same long-term maintenance requirements associated with Alternative 4 (i.e., O&M of the full-capacity GAC). The O&M of the McCaffrey Street IRM under Alternative 5 involves routine activities typically associated with remedial systems. Since the IRM is implemented and operating it is independent of the alternative chosen.

Reduction of toxicity, mobility or volume of site contamination through treatment: This criterion is not evaluated in detail in this report.

Alternative 5 includes an IRM that will reduce the mobility and volume of contamination. The IRM, which has been implemented and is operating, is independent of the alternative chosen.

Short-term effectiveness: The full capacity GAC system would remain in place during the design and construction period associated with any of the other alternatives.

Alternatives 1, 2, and 3 would result in various short-term impacts that would not occur under Alternatives 4 or 5. These short-term impacts and potential environmental considerations would be associated with construction activities and vehicular traffic resulting from installation of water transmission mains and appurtenances over distances ranging from 2-3 miles for Alternative 1, to 13-18 miles for Alternatives 2 and 3. The short-term impacts would require mitigation measures for the duration of implementation.

Alternative 4 is already implemented and operating successfully; it has no further short-term impacts. The full capacity GAC system is also included in Alternative 5. Short-term impacts from the IRM construction have been negligible.

Implementability: Alternative 1 would require predesign investigations and survey along the water main route, access agreements across public and private property, detailed design, completion of regulatory review and approvals, conversion of test wells to production wells, and installation of 2-3 miles of water main.

Alternatives 2 and 3 would require extensive predesign engineering investigations along the transmission main routes, access agreements across public and private property, detailed design, and regulatory reviews and approvals. The new infrastructure would require significant construction, including a new raw water intake structure, pump station, and between 13 to 18 miles of water transmission main.

Alternatives 4 and 5 are already in place and provide a reliable source of drinking water, as the full-capacity GAC system for drinking water is approved, constructed, and operating as designed, and the IRM included in Alternative 5 has been implemented and is operating.

Cost effectiveness: The cost effectiveness of an alternative is evaluated based on whether its costs are proportional to the alternative's overall effectiveness. As stated in the National Contingency Plan (NCP), overall effectiveness is a balance between three of the criteria (long-term effectiveness, reduction in toxicity, mobility or volume and short-term effectiveness).

The total present value costs of the alternatives range from $6.3 million to $48.5 million. The costs are summarized in Table ES.2.

Table ES.2 – Alternative Cost Summary

Alternative	Title	Estimated Cost
1	New Groundwater Source	$ 6.9 M
2	New Surface Water Source	$ 34.4 M
3	Interconnection with an Existing Public Water Supply	$ 48.5 M
4	Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System	$ 6.3 M
5	Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System and PFOA Remediation through the McCaffrey Street IRM	$ 10.1M

Note: Construction cost for the Full Capacity GAC system, which will continued to be relied on under of these alternatives, is not included in the estimates. Construction costs for the Full Capacity GAC System under Alternatives 4 and 5 and the IRM under Alternative 5 are included in the above estimates but have already been expended.

Since all the alternatives are effective in providing drinking water for the Village that meets SCGs, the alternative with the lowest cost is expected to represent the alternative whose cost is proportional to the overall effectiveness.

Land use: All the alternatives are consistent with the current and future land uses of the areas they affect.

The last remedy selection criterion in DER-10, "Community Acceptance", will be evaluated by the NYSDEC after the close of a public comment period following issuance of this Report.

2.0 INTRODUCTION

In accordance with the approved RI/FS Work Plan for McCaffrey Street[5], the Companies have prepared this study and assessment of alternative potable water sources for the Village MWS.[6]

2.1 Background

The Village MWS is comprised of wells, a water treatment plant and a distribution system. In 2014, the Village collected samples of water from the MWS and detected PFOA. Additionally, the NYSDOH sampled residential private water wells in 2015 within the Town and detected PFOA in some of the wells.

PFOA is a synthetic fluorinated organic acid that has been used in the production of a variety of products, including non-stick cookware, carpets, clothing, and commercial firefighting foam. In 2009, the US EPA issued a provisional health advisory for PFOA. The provisional drinking water advisory level was set at 0.4 µg/L, which is equivalent to 400 ppt. In 2016, the US EPA replaced the 2009 provisional drinking water advisory with a new lifetime health advisory. The 2016 US EPA health advisory is 0.07 µg/L, or 70 ppt, expressed as the sum of PFOA and PFOS. In December 2018, the New York State Drinking Water Quality Council recommended a limit in drinking water of 10 ppt for PFOA and 10 ppt for PFOS. The NYSDOH issued draft regulations for public review in July 2019, proposing these values as maximum contaminate levels (MCL).

In response to the detection of PFOA in groundwater in the Village and Town, several interim remedial measures were implemented, including the distribution of bottled water to all residents, and installation of a temporary GAC treatment system to the existing MWS. A full capacity GAC treatment system design was subsequently approved by the NYSDOH and installed at the MWS to replace the temporary system. In addition, the NYSDEC coordinated the installation of POETs on private drinking water supplies for any Town resident who requested one. NYSDEC performs maintenance on all installed POET systems.

Regular testing since March 2016 has been performed by the NYSDOH at the GAC system's influent, midpoint, and effluent sampling points and the system has proved effective for the past three years at removing PFAS as verified by sampling data. These ongoing monitoring results are regularly submitted to the NYSDOH. Subsequent to the installation and operation of the full capacity GAC treatment system, performance testing at the MWS was expanded[7] to include 21 separate PFAS, a class of compounds that includes PFOA. The full capacity GAC system has consistently removed all of these compounds to non-detect levels.

[5] Final Remedial Investigation/Feasibility Study Work Plan, Saint-Gobain Performance Plastics Site 14 McCaffrey Street, Village of Hoosick Falls, Rensselaer County, New York (2016)

[6] This Study has been prepared pursuant to the Order on Consent and Administrative Settlement Index No. 4-201-60212-18, and the reservations of rights set forth therein are expressly incorporated herein, including, but not limited to, Paragraphs 14, II.A.2, and Appendix A, Paragraph III.E of the Order.

[7] "Protocol Work Plan – GAC WTP Addition, Hoosick Falls WTP", C.T. Male Associates, Rev. April 10, 2019

2.2 Purpose and Scope

The purpose of this Study is to assess potential alternative water sources for the MWS as described in the Order. The Study is based on currently available information and contains the following:

- A review of the MWS, including but not limited to, the average and maximum current daily water demand for the Village;
- An analysis by the Village's consultant (MRB Group) regarding the potential to expand the public water supply to areas within the Town, including the conceptual future daily demand (average and maximum);
- Available data regarding ongoing operation of the full capacity GAC treatment system;
- A study of available information on surface water drainage characteristics, surficial and bedrock geology, flood zones, zoning, land use, and topography in the study area being considered for new groundwater source development;
- An updated safe yield analysis for the Tomhannock Reservoir (a requirement of the Water Withdrawal Permit issued to the City of Troy) and the results of surface water samples collected from this water source for PFAS analysis; and
- A review of PFAS occurrence in NYS drinking supplies and current best available technologies for removing organic contaminants, including PFAS, from drinking water along with examples of PFAS treatment of drinking water in water supplies nationwide.

The Study evaluates the following five alternatives:

- Alternative 1 – Development of a new groundwater source;
- Alternative 2 – Development of a new surface water source;
- Alternative 3 – Interconnection with an existing water supply source;
- Alternative 4 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System[8]; and
- Alternative 5 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System with PFOA Remediation through the McCaffrey Street IRM.

The five alternatives described in this Study were evaluated based on criteria set forth in 6 NYCRR 375-1.8(f), in conjunction with guidance provided for each criterion in subdivisions (b) through (j) of Section 4.2 of DER-10 (Technical Guidance for Site Investigation and Remediation Issued on May 3, 2010). Based on NYSDEC guidelines, this Study considers the remedial action objective to "prevent the ingestion of water with contaminant levels exceeding drinking water standards."

[8] Since the Full Capacity GAC Treatment System is already installed at the Village MWS it serves as the "No Further Action" alternative.

Each of the alternatives is evaluated based on its ability to meet the current maximum day demand (0.71 MGD) and the conceptual future maximum day demand[9] (1.13 MGD). The conceptual future maximum day demand was derived using a conceptual expansion of the Village distribution system, described in the August 2016 *Engineering Report for the Village of Hoosick Falls Water System Expansion* by MRB Group. The conceptual future maximum day demand of 1.13 MGD will be used throughout this report as the design condition that all alternatives will be evaluated against.

[9] In discussion with NYSDEC it was decided that the alternative described in the RI/FS Work Plan titled: "Modification of the Municipal Water System (MWS) – Full Capacity System for possible expanded distribution" would be incorporated into each of the five alternatives considered as part of the Study. Both the current demand and conceptual future maximum day demand were considered for each alternative. Therefore, each of the alternatives will be assessed for their ability to supply the *current* and *future* water demand of the Village, thereby satisfying the RI/FS Work Plan and the requirements of the Order.

3.0 REVIEW OF AVAILABLE DATA

3.1 Documents from NYSDEC

The NYSDEC retained Arcadis to search for a new groundwater supply in parallel with the Companies' work pursuant to the Order. The results of the Arcadis effort were subsequently furnished in a document entitled "Memorandum: Village of Hoosick Falls Alternative Water Supply Study" (Arcadis, July 12, 2016). The memorandum provided documentation of preliminary work, investigations, and analysis that had been completed to date, including assessment work to evaluate a new groundwater source, a new surface water source, and an interconnection with an existing municipal water supply. The information contained in that memorandum was integrated into this Study.

The NYSDEC also furnished a copy of "Groundwater Source Aquifer Evaluation: Hoosick Falls Alternative Water Supply Study" (Arcadis, July 6, 2017), which documented the evaluation of a groundwater source site approximately two miles south of the Village between Route 22 and the Hoosic River (the "Wysocki Farm" property). The results of that report were also integrated into this document.

Further discussion of the Arcadis Memorandum and Report is included in Section 4.1.

3.2 Interim Remedial Measures

Interim remedial measures have been implemented by the Companies in response to the presence of PFOA in the Village drinking water, including:

- Installation of a temporary GAC treatment system at the Village water treatment plant;
- Installation of POETs on eight private drinking water systems in the Village[10]; and
- Installation of a full capacity GAC treatment system at the MWS.

These measures have been approved by NYSDEC and have proven effective at removing PFAS from drinking water in the municipal water supply and the eight private drinking water systems where POETs were installed. One IRM at the McCaffrey Street Site has been completed and is operational; see Section 5.5 for details.

3.2.1 Temporary & Full Capacity GAC Treatment System

The temporary GAC treatment system was installed at the MWS in February 2016 and consisted of two 10-foot diameter vessels piped in a series configuration downstream of the existing microfiltration units. With the approval of the NYSDOH, the full capacity GAC treatment system was completed in late 2016 and replaced the temporary system in February 2017, at which time the temporary system was taken offline. The full capacity GAC system is identical to the temporary system, but the vessels are 12-foot diameter so the system can treat the full

[10] All but one have subsequently been disconnected when the full capacity GAC system was brought online; refer to Section 3.3.2.

permitted capacity of the existing MWS. The GAC discharge is further treated with sodium hypochlorite to disinfect prior to distribution.

The NYSDOH has conducted routine PFAS testing on both the temporary and the full-capacity GAC system commencing in March 2016 and has found the systems are continually effective at reducing site-related and non-site related PFAS to non-detectable levels in the municipal water supply prior to distribution of finished water.

3.2.2 POETs and Private Well Sampling for PFOA

SGPP initially coordinated the installation of eight POETs at selected businesses within the Village, seven of which have connections to the distribution system. All of the POET systems installed at businesses within the Village were disconnected after the full capacity GAC treatment system was operational, with the exception of the TOPS Market, which is served by a private well and continues to utilize a POET. This well is currently monitored by SGPP in accordance with a monitoring plan developed by NYSDEC.

In addition to the remedial measures undertaken to date by the Companies, the NYSDEC and NYSDOH installed whole-house POETs for residents with private wells in the Town of Hoosick, the Village of Hoosick Falls, the Town of White Creek, and the Town of Cambridge. The POETs, which were provided to any resident who requested one, consist of twin vessels filled with GAC to treat the entire plumbing system of a building and are monitored and maintained by the State. The most recent data made available by the NYSDEC (as of April 16, 2019) indicates a total of 857 installed and operational POET systems within the Town of Hoosick, 60 within the Town of White Creek, 29 within the Town of Cambridge, 5 within the Town of Pittstown, 4 within the Town of Jackson, and 1 within the Town of Schaghticoke.

Information on the distribution of PFOA detected in private wells is derived from sampling conducted by both the NYSDOH and the NYSDEC. In particular, the NYSDOH has coordinated the sampling and testing of privately owned drinking water wells. For the purposes of completing this Study, the NYSDEC provided water sampling data pursuant to a confidentiality agreement (last updated in April 2019) from privately owned wells located in the Town of Hoosick and surrounding Towns of White Creek, Cambridge, Jackson, Schaghticoke, and Pittstown.

The results through April 2019 indicate 1,599 wells have been tested for PFOA within the Town of Hoosick and surrounding areas. There were 865 wells (54 percent) with non-detectable[11] levels of PFOA, 539 wells (34 percent) with PFOA concentrations greater than 2 ppt but less than 70 ppt, and 195 wells (12 percent) with concentrations of 70 ppt or higher. Appendix A is a map of the private well sampling results in the Town of Hoosick and surrounding towns where sampling was conducted by NYSDOH.

[11] The NYSDOH recognizes two methods for PFOA analysis in drinking water: USEPA Method 537.1 and ISO 25101. Most labs analyze New York State drinking water samples using ISO 25101 because it currently is the only method that can achieve 2 ppt reporting limits. USEPA Method 537.1 cannot achieve 2 ppt reporting limits unless modified, and those modifications are not allowed under the NYSDOH Environmental Laboratory Approval Program (ELAP). Therefore, for the purposes of this Study, any reference to "non-detect" PFOA levels will mean less than 2 ppt.

3.3 Existing Village Water Supply

3.3.1 Source Water

The Village provides water to the distribution system using three groundwater wells: #3, #6, and #7. Well #6 is currently maintained in reserve for emergency use only due to higher levels of iron and manganese.[12] The capacities of these wells, and the most recently conducted pumping test results provided by Arcadis and the NYSDEC, are provided in Table 3.3.1.

Table 3.3.1 – Summary of Village Groundwater Well Capacities

Well	Rated Pump Capacity	Most Recent Pumping Test (date)
Well #3	1,000 gpm	1080 gpm (2018)[13]
Well #6	300 gpm	431 gpm (2012)
Well #7	1,000 gpm	682 gpm (2012)
Total, All Wells	2,300 gpm	2,193 gpm[14]

3.3.2 Current Village Drinking Water Treatment

In 2006, the Village wells were designated as producing Groundwater Under the Direct Influence of Surface Water (GWUDI) pursuant to NYSDOH regulations. As such, the filtration requirements of the US EPA Surface Water Treatment Rules (SWTRs) became applicable. A new water treatment plant was constructed to treat the water from the Village wells. The water treatment plant is rated for 1.0 million gallons per day (MGD) of treated water capacity. It uses two banks of microfiltration membrane filter units (1.0 MGD each) for redundancy.

Chemicals are added for pre- and post-treatment at the water treatment plant as a part of the treatment process. Sodium hypochlorite and potassium permanganate are added for the pre-treatment oxidation of soluble iron and manganese upstream of the membrane filters. Sodium hypochlorite also is added downstream of the membrane filters for disinfection, and orthophosphates are injected to control water main corrosion throughout the distribution system.

The GAC treatment system was installed at the MWS to remove PFOA in 2016. The GAC system treats water downstream of the filter units and consists of two 12-foot diameter vessels arranged in series. Two finished water pumps convey water into the distribution system; each pump is also rated at 1.0 MGD. The GAC treatment system is sampled regularly at the influent, midpoints, and effluent of each vessel for analysis of 21 PFASs.

3.4 Current Village Water Demands

The information obtained from the Village covering the period from 2010 through April 2019 indicates the average daily demand for the Village's municipal water supply is 0.44 MGD and

[12] NYSDEC rehabilitated Well #3 enabling the NYSDOH to notify the Village in November 2018 that Well #3 was acceptable for use.

[13] Pump test reported estimated value using known relationship between flow rate and pump output capacity.

[14] The pump tests were performed individually; if pumped concurrently, capacities could be lower.

the maximum day demand is 0.71 MGD. Table 3.4.1 is a summary of the Village treated water flows, which were measured at the MWS. For purposes of this report, the five-year demand statistics have been determined based upon the higher water usage from 2010 to 2014.

Table 3.4.1 – Summary of Village MWS Flows

Year	Average Daily Demand (MGD)	Maximum Day Demand (MGD)
2010	0.54	0.69
2011	0.44	0.67
2012	0.40	0.61
2013	0.43	0.82
2014	0.40	0.74
2015	0.33	0.61
2016	0.30	0.73
2017	0.26	0.54
2018	0.26	0.72
2019*	0.26	0.48
Five Year Average (2010 – 2014)	0.44 (306 gpm)	0.71 (493 gpm)

** Demand data through April 2019*

3.5 Conceptual Future Village Water Demands

According to projections from the Capital District Regional Planning Commission, the populations of the Village and Town are forecasted to remain generally constant through 2050, as shown in Table 3.5.1.

Table 3.5.1 – Population Trends and Forecasts, 1990-2050

Year	Village of Hoosick Falls Population	Town of Hoosick Population
1990	3,490	6,696
2000	3,436	6,759
2010	3,501	6,924
2020	3,497	6,979
2030	3,493	7,024
2040	3,489	7,061
2050	3,411	6,939

Source: https://cdrpc.org/data/population/population-projections/capital-district-population-projections

In general, water usage rates per capita tend to diminish with time as water conservation measures become more mainstream and high-efficiency water fixtures are adopted into building regulations. Commercial and industrial users also tend to take steps to reduce their water usages over time. For example, the two SGPP industrial facilities in Hoosick Falls have reduced their water consumption by 85% in the past five years. In 2014, the combined water usage at the SGPP facilities was 0.04 MGD, which amounted to approximately 9% of the Village total. The projected 2018 usage is 0.005 MGD, representing less than 2% of the Village total. Based on the foregoing, it is a reasonable assumption that the water demand in the MWS is expected to remain unchanged or decrease as a result of further conservation measures under the existing customer base.

However, a conceptual expansion of the existing Village municipal water distribution system into surrounding areas of the Town has been explored in a coordinated effort between the two municipalities. This proposal could link new customers to the public water supply and add new demands. The August 2016 *Engineering Report for the Village of Hoosick Falls Water System Expansion* by MRB Group describes a conceptual expansion of the distribution system throughout multiple phases of improvements, including new water mains, tanks, pumps, and other miscellaneous upgrades required to extend the network.

The additional average daily demand associated with the conceptual new customers would be 0.24 MGD, and the additional maximum day demand would be 0.42 MGD. This would result in a conceptual future average daily demand of 0.68 MGD and a conceptual future maximum day demand of 1.13 MGD, or 472 gpm and 785 gpm, respectively. Although there are no current plans to move forward with this described expansion, it provides a suitable benchmark demand target for the purposes of comparing how alternative water supplies could provide the long-term water needs of the Village.

Therefore, for the purposes of this report, the conceptual future maximum day demand for the Village is defined as 1.13 MGD. The conceptual future maximum day demand of 1.13 MGD will be used throughout this report as the design condition that all alternatives will be evaluated against.

3.6 Treatment Methods for Drinking Water

The federal Safe Drinking Water Act (SDWA) of 1974 established a nationwide program that required public drinking water systems to test the water provided to customers. Regulations under the SDWA went into effect in 1976 at which time the US EPA began to establish maximum contaminant levels (MCLs) for various contaminants. Contaminants are classified as disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, microorganisms and radionuclides. The statute has been reauthorized twice, in 1986 and 1996, each time adding further requirements to ensure protection of drinking water.

The SDWA gave the States authority to promulgate enforceable standards for drinking water contaminants that were no less stringent than US EPA standards. The States were authorized under the SDWA to establish standards below the federal MCLs. Authority for implementing the SDWA in New York State was delegated to the NYSDOH. The applicable New York State regulations for public drinking water systems, is set forth in 10 NYCRR Part 5, Subpart 5-1: Public Water Systems.

Public drinking water systems throughout the country use various water treatment methods to provide drinking water for their communities. Today, the most common steps in water treatment used by community water systems include coagulation and flocculation, sedimentation, filtration, and disinfection (CDC, accessed September 2, 2017). As mentioned in Section 3.3, the wells in the MWS are considered to produce groundwater under the direct influence of surface water (i.e., GWUDI designation). In order to meet requirements of the SWTRs and Subpart 5-1: Public Water Systems, the Village water is filtered and disinfected.

When public water systems in New York State are found to contain principal or unspecified organic contaminants[15] in excess of MCLs[16], NYSDOH regulations provide water purveyors the opportunity to seek approval from the NYSDOH to implement one of three best available technologies; Packed Tower Aeration (PTA), Granular Activated Carbon (GAC) or Oxidation (chlorination or ozonation).[17]

Of these three best available technologies, public water suppliers throughout the country, including in New York State, frequently use GAC to meet drinking water MCLs. GAC adsorption systems are most often used in water treatment to remove natural organic matter (Summers, et al., 1995), disinfection byproducts (DBPs) and their precursors (Adams, Clark and Miltner, 1989; Crittenden, et al., 1987; Chiu, Westerhoff and Ghosh, 2012; Saratoga County Water Authority, 2015), synthetic organic compounds (SOCs) (Speth and Miltner, 1990), polychlorinated biphenyls (PCBs) (Pirbazari, et al., 1992), and to improve taste and odor qualities (Graese, Snoeyink and Lee, 1987).

GAC treatment has been used by groundwater-based public water systems (PWS) in various locations in New York State. In these applications, GAC treatment is predominantly relied upon to address impacts from volatile organic compounds (VOCs). Detailed information was compiled in 2017 for 44 PWS on Long Island and is provided in Appendix B. Eighteen (18) of the 44 PWS reported using GAC treatment for drinking water. These PWS serve a total population of approximately 2 million people.

In addition, GAC is also occasionally used to treat drinking water supplies where trihalomethanes (THMs) are formed as a result of disinfecting the raw water with chlorine. For example, the Saratoga County Water Authority (SCWA), whose drinking water source is the upper Hudson River, uses water treatment consisting of GAC with the addition of a coagulant, sodium permanganate and filtration (SCWA, 2015).

3.6.1 PFAS in Drinking Water

Under US EPA's third Unregulated Contaminant Monitoring Rule (UCMR 3)[18] samples were collected from 2013 to 2015 at 4,864 PWSs across the nation.[19] PFOA and PFOS were detected

[15] 10 NYCRR Part 5-1: Public Water Systems, Section 5-1.1 Definitions. Principal Organic Contaminant (POC) is any organic chemical compound belonging to the following classes, except for trichloromethane (chloroform), dibromochloromethane, bromodichloromethane, tribromomethane (bromoform) and any other organic contaminant with a specific MCL listed in section 5-1.52 table 3 of the Subpart. Unspecified Organic Contaminant (UOC) means any organic chemical compound not otherwise specified in the Subpart.

[16] 10 NYCRR Part 5, Subpart 5-1: Public Water Systems, Section 5-1.52. Tables, which includes POC and UOC standards

[17] 10 NYCRR Part 5, Subpart 5-1: Public Water Systems, Section 5-1.91 (d)

[18] The SDWA Amendments of 1996 required testing of all drinking water systems serving a population of greater than 10,000 people, as well as representative sampling of drinking water systems serving populations below 10,000 people.

[19] https://news.harvard.edu/gazette/story/2016/08/unsafe-levels-of-toxic-chemicals-found-in-drinking-water-of-33-states/

in approximately 5% of drinking water supplies in New York State that were sampled as part of the UCMR 3.[20] However, the UCMR 3 analyses for PFOA and PFOS used laboratory methods that had detection levels of 20–40 ppt, which is an order of magnitude higher than what laboratories can now reliably test (typically 2 ppt).

Subsequent to the UCMR 3 testing, the NYSDOH undertook an independent state-wide evaluation of the occurrence of PFOA and PFOS in drinking water supplies. This sampling focused on 257 public water supplies which were potentially vulnerable to PFAS contamination, including some of which had known areas of PFOA and PFOS impacts (e.g., Village of Hoosick Falls, Towns of Hoosick and Petersburgh, Southern Washington County, and areas surrounding the Stewart Air National Guard Base in Newburgh) in addition to other areas that were identified as potentially impacted areas based in part on an evaluation of the State's source water assessment program. The NYSDOH testing used lab methods with a lower detection limit of 2 ppt.

The NYSDOH testing indicated that roughly half of the public water supplies that were sampled had PFOA and/or PFOS detections[21] (> 2 ppt). A summary of the NYSDOH follow-up testing is provided in Table 3.6.1.

Table 3.6.1 – Drinking Water Data NYS Summary by Source (January 2018)

PFOA & PFOS Levels	Prevalence in NYS Drinking Water Supplies
ND (<2 ppt)	50% (n = 129)
2 to < 20 ppt	35% (n = 91)
20 to <70 ppt	9% (n = 24)
> 70 ppt	5% (n = 13)

3.6.2 PFAS Treatment for Drinking Water

US EPA has identified the following technologies as effective at removing PFAS from drinking water: GAC, ion exchange resins, nanofiltration and reverse osmosis.[22]

A summary of how these PWS are addressing the occurrence of PFOA and PFOS is provided in Table 3.6.2. In total, 38 PWSs are employing active treatment processes for PFAS – 35 of which use GAC systems. Fourteen (14) of these are located in five Northeast states.[23] Detailed information is provided in Appendix B.

[20] http://www.nysac.org/files/NYS%20Drinking%20Water%20Data%20PFOAs.pdf (Slide 4)

[21] http://www.nysac.org/files/NYS%20Drinking%20Water%20Data%20PFOAs.pdf (Slide 6)

[22] https://www.epa.gov/pfas/treating-pfas-drinking-water

[23] Massachusetts, New Hampshire, New Jersey, New York, and Pennsylvania.

Table 3.6.2 – Treatment Response to PFOA and PFOS in US Public Water Systems

Action	# of PWS	Comment (Appendix B reference)
GAC Treatment	35	31 systems are currently using GAC for removal of PFOA and/or PFOS (A1); 4 systems have proposed the use of GAC treatment (A2)
Ion Exchange Resin Treatment	1	1 system is currently using an ion exchange resin for removal of PFOA and PFOS
Reverse Osmosis Treatment	2	1 system is currently using GAC for treatment, but plans to install a reverse osmosis (RO) system (B1); 1 system is using an existing RO system for treatment but is investigating options for treating other impacted water sources that do not go through the RO system (B2)
Treatment Alternatives	23	2 systems were closed and has begun purchasing water from another system (D); 1 system reduced concentrations by purchasing water from an alternative source and blending with existing water sources for dilution (E); and 20 systems reduced concentrations by either discontinuing the use of impacted source(s) and/or blending water sources for dilution (F)
Treatment Options Under Evaluation	14	14 systems are evaluating options for treating impacted water sources and, at present, have either discontinued the use of impacted water sources and/or are blending existing water sources for dilution (C)
No Action	7	7 systems are currently reporting concentrations below health advisory with no actions taken (G) US EPA
No treatment information	6	No further information on actions taken was found for 6 systems

PFAS are commonly found in public water supplies, especially at low concentrations. There are several treatment processes available for removing PFAS from drinking water, including GAC, which has been proven effective for PFAS treatment at systems across New York State, nationwide, and at the Village WTP. GAC systems are approved for use by the NYSDOH and their effectiveness have been reliably measured through routine laboratory testing.

4.0 SCREENING OF ALTERNATIVE DRINKING WATER SOURCES

This section identifies the potential alternative drinking water sources for the Village of Hoosick Falls for three source types: groundwater source, surface water source, or interconnection with another public water supply. Potential water sources from each of these three source types are screened based on their ability to comply with applicable public health and engineering regulatory standards and meet both the current average maximum day demand of 0.71 MGD and the conceptual future maximum day demand of 1.13 MGD. The alternative in each source type that best meets these screening criteria standards is then advanced for further development and evaluation against the feasibility study criteria set forth in 6 NYCRR 375-1.8(f)[24] and discussed in Section 5.0.

The NYSDOH oversees the approval of all existing and proposed public water systems within the state and enforces the regulations of 10 NYCRR 5-1 *Public Water Systems*. The "Recommended Standards for Water Works" (*Ten States Standards*, GLUMRB, 2012) underpins the NYSDOH public water system regulations and establishes a consistent design methodology. Public water supplies are also subject to rules and regulations established by the US EPA under the SDWA and, if applicable, the SWTRs.

According to Paragraph 3.0 of *Ten States Standards*, new sources of water should provide an adequate quantity of water that will meet the current requirements of NYSDOH with respect to microbiological, physical, chemical, and radiological qualities. It further states that water supplies should take raw water from the "best available source which is economically reasonable and technically possible". Since the construction of transmission mains in any alternative often represents a major component of construction time and resources, the distance between a given source and the Village is an appropriate surrogate for "economically reasonable and technically possible". Water supplies that require longer transmission mains also present greater risk of service interruptions and water quality problems and consume greater amounts of energy for pumping. Therefore, in screening of alternatives, preference is assigned to those sources that can provide adequate quantity of water of sufficient quality while minimizing the distance between the source and the Village. If multiple sources exist that can feasibly supply the Village, the closest source will be advanced for further consideration.

4.1 Groundwater Sources

A groundwater source evaluation was completed as part of this Study to identify one or more areas that would be a potentially suitable location for an alternative groundwater source. The groundwater source analysis evaluated available information and covered an approximately 167-square-mile area, bounded to the west by a line slightly west of the Tomhannock Reservoir, to the south by the southern limits of the Town of Hoosick (extended both east and west of the Town), to the east by a line located east of Bennington, Vermont, and to the north by a corridor centered around the Owl Kill in Washington County extending northward to Cambridge, NY. The groundwater source study area is depicted on Figure 1A (the Study Area).

[24] 6 NYCRR Part 375; Section 1.8(f) – Remedy Selection.

The groundwater source study employed standard methods for screening level assessments including Geographic Information Systems (GIS) mapping resources. GIS shape files were obtained to map various physical parameters from Rensselaer and Washington Counties in New York, and Bennington County in Vermont. The physical attributes mapped included topography, Federal Emergency Management Agency (FEMA) flood zones, surficial geology, and bedrock geology. These physical attributes served as a guide to areas that may be suitable for an alternative groundwater source from a quantity perspective.

To address whether there were areas that would be considered suitable from a quality perspective, mapping included zoning and land use, the location of known wells containing detectable concentrations of PFOA in New York based on data obtained from NYSDEC and NYSDOH, and listed sites from federal and state databases, including sites with known spills or sites that may have the potential to impact a groundwater supply.

4.1.1 Groundwater Quantity Attributes

4.1.1.1 Topography

The topography of the Study Area consists of hills and river valleys. The highest elevation in the Study Area is approximately 500 meters above mean sea level (AMSL), while the lowest elevation is approximately 100 meters AMSL. The topography of the Study Area is provided in Figure 3 (based on United States Geological Survey (USGS), Albany sheet, 1996). As discussed in the following sections, upland areas within the Study Area can generally be excluded as suitable for future groundwater exploration due to a lack of favorable geologic materials.

4.1.1.2 Surface Water, Floodplains, and Aquifers

The surface water bodies in the Study Area with hydrogeologic significance include the Hoosic River (NY), Owl Kill (NY), Walloomsac River (NY/VT), Roaring Branch (VT) and Paran Creek (VT). Figure 4 depicts the rivers and their tributaries, and also depicts the mapped aquifers in the New York portion of the Study Area (USGS Hydrologic Atlas 730, Miller, 2000). The mapped aquifers generally coincide with surficial geologic deposits likely to have high permeability and are typically situated within the aforementioned valleys (see next section).

The flood zone mapping from FEMA is depicted on Figure 5.

4.1.1.3 Surficial Geology

The surficial geology in the Study Area consists primarily of deposits of glacial origin and is depicted on Figure 6 (based on NYS Geological Survey Map & Chart Series Number 40, Hudson Mohawk Sheet, 1987; Stewart, MacClintock and Doll, 1970; and DeSimone, 2017).

The valley regions in the Study Area include areas mapped as outwash sand and gravel, lacustrine sand and silt, lacustrine delta deposits, and to a lesser extent, kame deposits. The outwash sand and gravel deposits tend to be the most productive. The lacustrine delta deposits and kame deposits are usually limited in lateral extent as seen on Figure 6 and therefore are generally not as productive or may not sustain long term yields.

The Village wells are screened in the glacial outwash deposits as mapped by the NYS Geological Survey (1987). Areas north and south of the Village wells are also mapped in these same deposits with the deposits being narrowly confined to the Hoosic River Valley moving southward. There are also two areas of outwash sand and gravel deposits located in the western portion of the Study Area: one along Route 7 and the other located north of the Hoosic River. An additional large area of outwash sand and gravel deposits is located in Washington County centered around Owl Kill, a small tributary to the Hoosic River. Finally, there is one additional area of outwash sand and gravel mapped northwest of Bennington (DeSimone, 2017). There are also Holocene-age Alluvium and Alluvial Fan deposits southeast of Bennington that are characterized as fair to good aquifers if deposits are sufficiently thick.

It is important to note that the available surficial mapping does not reflect subsurface geology and does not show where deeper buried aquifers may exist; however, deeper buried aquifers generally would be more likely to exist in valley areas (Cushman, 1950; Randall, 1995). The importance of deeper buried aquifers is that they may lie beneath a geologic confining layer (strata of lower permeability) generally making them less susceptible to surficial sources of contamination. A test well drilled on the Wysocki Farm property revealed the presence of a confining layer and the well was installed in the buried aquifer beneath the confining layer (Arcadis, July 6, 2017).

4.1.1.4 Upland and Bedrock Geology

The upland portions of the Study Area are generally till or exposed bedrock. The hydrogeologic properties of till and bedrock are not expected to be able to produce sufficient groundwater to meet the required Village supply (Cushman, 1950). Bedrock geology is depicted on Figure 7 (based on NYS Geological Survey Map & Chart Series Number 15, Hudson Mohawk Sheet, 1970; and Ratcliffe et al., 2011). The majority of the rocks are of Cambrian and Ordovician age. Major formations within the Study Area include lower Cambrian through middle Ordovician-age rocks that consist primarily of undifferentiated mudstones in the western portion; the Nassau Formation, which is primarily shale, in the central portion; and the Walloomsac Formation, which is primarily slate, in the eastern portion. This formation underlies the Village of Hoosick Falls and extends eastward into Vermont. The foregoing rock types are not known to produce high yielding groundwater wells in New York (Cushman, 1950), nor in Vermont (Gale et al., 2010), relative to the needs of the Village of Hoosick Falls.

4.1.2 Groundwater Quality Attributes

4.1.2.1 Zoning and Land Use

Land use within the Study Area is depicted on Figure 8. The majority of land within the Study Area is agricultural and residential except within the Villages of Cambridge and Hoosick Falls, and the City of Bennington, which have mixed land uses. The zoning and land use mapping does not exclude any area within the Study Area from consideration as a potential alternative groundwater source area.

4.1.2.2 Sites with Known or Potential Impacts to Groundwater

As discussed in Section 3.2.2, the NYSDOH and the NYSDEC conducted sampling for PFOA in private wells in a portion of the Study Area. The results are shown on a map in Appendix A.

A report was also obtained from Environmental Data Resources Inc. (EDR) to identify sites listed in various state and federal environmental regulatory databases. The EDR search area was centered on the Hoosic River Valley through Rensselaer County, extending northward through a portion of Washington County up to Cambridge, NY.

The EDR report included many sites identified on various federal, state and local, tribal and EDR proprietary databases. A number of sites in the database were determined, through professional judgement, to have little to no potential for adverse impacts on potential new sites for groundwater development. Specifically, these were:

- Sites with a satisfactory regulatory status (e.g., sites listed as closed or meeting cleanup standards);
- Sites with a minimal release or a release confined to the release site (e.g., a fuel oil spill within a concrete basement, or a traffic accident releasing a small amount of material to pavement); and
- RCRA generators that had no history of violations.

The remaining sites that could potentially pose a risk to a new groundwater source, based on identification as a hazardous waste site, solid waste landfill, or a listed spill (referred to as listed sites) are mapped on Figure 9.

4.1.3 Study Findings

The Study Area evaluation identified target areas to the south of the Village with the most potential to satisfy the current and future demands of the Village water system as a new groundwater source. These target areas are located within the larger mapped outwash sand and gravel deposits, lacustrine sand, or kame deposits. Since the target areas are proximal to the Village and have greater potential to provide a high producing well, the screening criteria described in Section 3.0 indicates that no further investigation is warranted in other, more remote areas, including the area east into Vermont.

Further hydrogeologic study has been conducted in the areas south of the Village to evaluate groundwater as a supply source. This work is described in the following sections.

4.1.4 Work Completed to Date

4.1.4.1 Groundwater Supply Development – Wysocki Property

Preliminary work on Alternative 1 to evaluate the feasibility of a new groundwater source was undertaken by Arcadis under contract with the NYSDEC. This included an initial screening study and preliminary field investigations of some potential areas where a new groundwater

source might be located. The results of the Arcadis screening study were summarized in a memorandum (Arcadis, July 12, 2016). This memorandum reported investigation results on two properties south of the Village; one identified as the Browns Brook property; and the other identified as the Wysocki Farm property. Due to the lack of favorable geological deposits, the Browns Brook property was eliminated from further consideration by Arcadis. The investigation on the Wysocki Farm property included boring results that indicated a layer of coarse-grained sediments approximately 20 feet thick. This layer was encountered at depths ranging from 85 to 105 feet below grade, beneath a clay layer approximately 60 feet to 100 feet thick. This unit exhibited characteristics of a buried aquifer, although geophysical data collected in this area suggests the aquifer thins westward, toward the valley margin. When a buried aquifer is located beneath a continuous confining layer, the aquifer is protected from nearby surface contamination to the degree that the confining layer remains continuous.

Based on these findings, a test well and observation wells were installed on the Wysocki Farm property for a more detailed evaluation of water supply potential and water quality in this area. The results of this work were summarized in the "Groundwater Source Aquifer Evaluation" (Arcadis, July 6, 2017). Arcadis reported that the aquifer has a recharge boundary, indicating it is not entirely confined[25]. The maximum long-term yield of the test well was approximately 300 gpm based on a 72-hour pumping test. Further analysis of the Wysocki pumping test performed by the USGS (Williams and Heisig, 2018) provided additional interpretation regarding potential aquifer boundaries and sources of recharge. The 300 gpm yield is approximately equal to the current Village average daily demand, but below the conceptual future maximum day demand of 785 gpm. The investigation also indicated the geological framework is complex, preventing assessment of whether multiple pumping wells could be installed in this hydrogeologic unit to sustain a higher pumping capacity. Arcadis recommended that additional investigations should be conducted "north and east" of the Wysocki Farm property to determine the extent of the semi-confined aquifer.

From a water quality standpoint, multiple samples were collected from both the test well and nearby observation wells over several months. The test well and nearby observation wells had detections of NYSDEC-listed hazardous substances:

- PFOA was detected at a concentration of 2.5 ppt, and Perfluoroheptanoic acid (PFHpA, another PFAS) was detected in three observation wells (Arcadis indicated that an apparent source of the PFOA was not evident);
- Toluene (a volatile organic compound) was detected in the test well after the pumping test at a concentration of 9.2 µg/L, exceeding the New York State Part 5 maximum contaminant level (MCL) of 5 µg/L (Arcadis indicated that since toluene was not detected in any of the other Site wells during this or other sampling events, the toluene detected in the test well sample is likely anomalous, potentially a laboratory contaminant);
- The pesticides Alpha-BHC, Gamma-BHC, and Endrin Aldehyde were detected in two observation wells below their respective Part 5 MCLs; and

[25] Confined aquifers have impermeable material (e.g., clay) both above and below the aquifer.

- Manganese, iron, and arsenic were detected in multiple observation wells in concentrations exceeding their respective Part 5 MCLs.

Review of private well analytical data collected by the NYSDOH indicates the closest sampling conducted to the Wysocki Farm property was along Route 22 to the west of the property. There were some detections of PFAS from wells immediately to the west-northwest of the Wysocki Farm, but since depth and construction details are not available for these wells, it is unclear if the detections are from the same aquifer.

The observation and test well water quality results did not exclude this location as a potential new groundwater source; but the aquifer test results suggested that the maximum withdrawal rate at this location would be insufficient to supply the water needs of the Village as a single source.

4.1.4.2 Groundwater Supply Development – LaCroix Property

A supplemental investigation for a new groundwater source was completed south of the Village by the Companies on a parcel referred to as the LaCroix property. A complete Hydrogeologic Investigation Report is included in Appendix C. The work performed included:

- Surface geophysical surveys in areas where the stratigraphy suggests sufficient saturated thickness to meet the water yield target. The surface geophysical surveys were used to determine the lateral and vertical extent of the water-bearing unit(s).
- Test borings installed through the unconsolidated deposits at locations selected based on the geophysical survey results. Stratigraphic information was collected in the field, from surface grade to bedrock. Monitoring wells were installed at these test boring locations.
- Preliminary groundwater samples collected from these monitoring wells and analyzed for a variety of analytes.
- Installation of one 10-inch diameter test well (the LaCroix well) at the location with the highest potential to supply the required water quantity at acceptable water quality.
- A step-drawdown pumping test and a constant rate pumping (72-hour) test to determine the yield of the aquifer and other aquifer parameters.
- Collection of groundwater quality samples from both the test well and the surrounding monitoring wells pre- and post-72-hour pumping test to establish groundwater quality.
- An evaluation to determine whether groundwater extracted from the test well can be considered under the direct influence of surface water.
- An evaluation of the potential long-term yield of the contributing zones to the test was performed.

The results of the investigation found that the new test well on the LaCroix property produced at least 450 gpm (0.65 MGD) with less than 6 feet of drawdown and likely could produce at an even higher rate. The test also found that the geologic unit in which the test well was screened behaves as a “semi-confined” (or “leaky artesian”) aquifer. This aquifer is also a buried valley aquifer bounded on two sides by valley walls composed of lower-permeability soil or rock. The

transmissivity and storativity of the aquifer were determined to be 9,880 ft^2/day and 1.8 x 10^{-4}, respectively.

Water levels were monitored in observation wells throughout the Village prior to, during, and following the 72-hour aquifer test. As reported in the Hydrogeologic Investigation Report (Appendix C), water levels in observation wells (near the Village wellfield and to the north of the Village) prior to the test showed a response as a result of the cyclical pumping of Village Well #7. In contrast, water levels in monitoring wells near the LaCroix well showed no fluctuations during Well #7 pump cycles. Furthermore, there was no drawdown observed in the nearest monitoring well toward the north (GW-2), located more than 3,500 feet north of the LaCroix test well in the Village wellfield. This indicates that the pumping influence of the LaCroix test well did not extend that far to the north.

Based on the micro-particulate analysis (MPA) and water quality data, the LaCroix well would not be considered groundwater under the direct influence (GWUDI) of surface water; however, the NYSDOH is responsible for making the final determination. Water quality testing indicated that only sodium and manganese marginally exceeded groundwater standards in the test well (See Table 4 in Hydrogeologic Investigation Report - Appendix C). The presence of sodium and manganese in the groundwater does not preclude the LaCroix well from being used as a drinking water supply. There were low concentration detections of PFAS in monitoring wells nearby, including one instance of PFOA at 38 ppt and Sodium 1H,1H,2H,2H-Perfluorooctane Sulfonate (6:2) at 41 ppt. PFAS was not detected in the LaCroix test well.

A projected 180-day drawdown was determined for both the Wysocki well and the LaCroix well with both wells pumping concurrently at their respective tested rates (300 and 450 gpm). Under this scenario, the Wysocki well has greater than 18 feet of additional available drawdown and the LaCroix well has almost 34 feet of additional available drawdown.

Finally, a first order estimate of potential recharge to the semi-confined aquifer was performed to ascertain the rate at which groundwater could likely be extracted from the aquifer. The evaluation concluded that even under conservative assumptions there is 1.7 times more aquifer recharge than the conceptual future maximum day demand of 1.13 MGD.

4.2 New Surface Water Sources

The Study identified the following surface water bodies that could potentially provide the Village with an alternate water supply within a reasonable distance: the Hoosic River, the Walloomsac River, the Tomhannock Reservoir, the Hudson River, and Broad Brook. These surface water bodies are described below and depicted on Figure 2. The closest source to the Village that can provide adequate water quality and quantity was selected for further evaluation.

4.2.1 Hoosic River

The Hoosic River originates at the outflow of the Cheshire Reservoir in Berkshire County, Massachusetts, flows through the Village, and discharges into the Hudson River near Mechanicville, New York. Based on FEMA profiles, the Hoosic River varies from less than five-feet deep to slightly more than 20-feet deep. There are several dams located along its

length, including one in the Village for a hydroelectric power station. Based on available USGS data, the 7Q10 flow (lowest seven-day average flow that occurs approximately once every 10 years) in the Hoosic River is 105 cubic feet per second (CFS). Although a low-profile intake structure could be feasible in sections of the Hoosic River, surface water bodies of this depth are generally not acceptable for raw water supplies due to the potential for sediment clogging. The NYSDEC has classified the Hoosic River in New York State as a Class B or C fresh surface waterbody per 6 NYCRR 701. Class B and C fresh surface waters generally are suitable for fishing, as well as primary and secondary contact recreation, but are not protected as sources for drinking water supplies. In certain circumstances, the NYSDOH will approve Class B or C waterbodies as sources for drinking water, but generally Class AA and A waterbodies are preferred for drinking water uses.

PCBs and organochlorine pesticides have been detected in aquatic life in the Hoosic River[26]; any source of PCBs to aquatic life potentially is assumed to be from an upstream source and is not related to the PFAS sites in Hoosick Falls. The NYSDEC also has conducted surface water sampling of the Hoosic River in the Village in July 2016 and found PFOA and PFOS concentrations up to 17 and 4.4 ppt, respectively.

4.2.2 Walloomsac River

The Walloomsac River originates at the confluence of Jewett Brook and Barney Brook, south of the Village of Bennington, Vermont. It flows northwest through Bennington and is joined by the Roaring Branch just north of Bennington. The river continues flowing northwest into New York, where it ultimately discharges into the Hoosic River, downstream of Hoosick Falls. There are several small dams and natural cascades along the river's length. Based on FEMA profiles, the Walloomsac River varies from less than five-feet deep at the Roaring Branch confluence to slightly more than 15-feet deep at the New York–Vermont border. The 7Q10 flow in the Walloomsac River is 33 CFS, as measured at the USGS monitoring gauge near North Bennington. Although a low-profile intake structure could be feasible in sections of the Walloomsac River, surface water bodies of this depth are generally not acceptable for raw water supplies due to the potential for sediment clogging.

The NYSDEC has classified the Walloomsac River in New York State as a Class C (T) fresh surface waterbody per 6 NYCRR 701. As discussed earlier, the NYSDOH may approve Class B or C waterbodies as sources for drinking water, but generally Class AA and A waterbodies are preferred for drinking water uses. The (T) designation indicates the river receives seasonal stocking of trout. The overall water quality of the river is considered "non-impacted" based on a 2003 Biological Assessment Survey. The VTDEC conducted surface water sampling of the Walloomsac River in March 2016 and found PFOA concentrations of 8.6 ppt near North Bennington. In August and September of 2016, the NYSDEC conducted sampling of the Walloomsac River and found PFOA concentrations up to 23 ppt near North Hoosick.

[26] NYSDEC Upper Hudson River Waterbody Inventory / Priority Waterbodies List, Hoosic River Watershed (2006)

4.2.3 Tomhannock Reservoir

The Tomhannock Reservoir is located approximately 13 miles west-southwest of the Village and is the drinking water source for the City of Troy, New York. Troy sells water to nine nearby municipalities. The Tomhannock Reservoir holds 12.3 billion gallons when full and is controlled by a dam on the northwest side, and ultimately discharges to the Hoosic River. The depth of the reservoir varies from less than 10 feet at the southeast end to approximately 50 feet toward the northwest end.

The published City of Troy Annual Drinking Water Quality Reports (2018 and prior) describe the Source Water Assessment for the Tomhannock Reservoir. The assessment identified an elevated susceptibility to contamination due to agricultural runoff, mines, and closed landfills, in addition to an elevated sensitivity to sources of phosphorus and microbial contamination. The State of New York maintains a protection program for the Tomhannock Reservoir watershed. The Annual Drinking Water Quality Reports list the reservoir water quality as good to excellent.

The City of Troy has tested their raw and finished water supply for PFAS. The most recent samples obtained in April 2019 showed non-detect results for PFOA and PFOS. NYSDOH also performed testing of the Tomhannock Reservoir in June 2018 and found no detections of PFAS compounds in the Reservoir or the City of Troy finished water system. NYSDEC independently tested surface water and sediment samples from the reservoir for 21 PFAS compounds in April 2019. Discrete surface water samples were collected from zones five feet below the surface and five feet above the sediment bed. Concentrations of PFOA up to 2.5 ppt were detected in four samples at various depths. Other PFAS detections included:

- Perfluorododecanoic acid (PFDoA) at 9.0 ppt;
- Perfluorotridecanoic acid (PFTriA) at 7.3 ppt;
- Perfluorononanoic acid (PFNA) at 5.9 ppt;
- Perfluoroundecanoic acid (FPUnA) at 5.7 ppt; and
- Perfluorodecanoic acid (PFDA) at 3.5 ppt.

The concentrations listed above are below current regulatory standards and do not require treatment. Appendix D contains the water quality testing results.

The City of Troy was issued a Water Withdrawal Permit in November 2017 that has an approved limit of 30.5 MGD. The terms of the permit required Troy to submit an updated analysis of the reservoir safe yield, defined as the highest rate of average demand that can be met continuously during the most severe drought of record. Because of the available storage volume within the reservoir, short-term withdrawal rates can sometimes exceed the safe yield value without adverse impacts, provided the long-term annual average withdrawal rate does not trend beyond the safe yield. Therefore, the excess capacity in a given surface water source should be determined by comparing the average day demand to the safe yield value.

The safe yield of the reservoir was calculated at 36.3 MGD in the August 2018 *Tomhannock Reservoir Safe Yield Study* by CDM Smith. It is anticipated that the City of Troy's withdrawal limit in the Water Withdrawal Permit will be updated to reflect this value.

Table 4.2.1 is a summary of the past five years of water usage data for the City of Troy's water system based on the *Safe Yield Study*. Based on the historical trends, there is sufficient capacity to supply the current and future needs of the Village water system while still providing room for growth in the City of Troy and the surrounding communities that connect to the water system.

Table 4.2.1 – Summary of Troy Water System Usage

Year	Average Daily Demand (MGD)	Maximum Day Demand (MGD)
2013	19.06	32.89
2014	19.58	33.57
2015	20.32	33.31
2016	20.13	32.15
2017	19.24	30.10

4.2.4 Hudson River

The Hudson River originates in the Adirondack Mountains and discharges into Upper New York Bay, running approximately 315 miles through eastern New York. The Lower Hudson River has tidal influence from New York City to the Federal Dam in Troy. The closest section of the Hudson to the Village is located approximately 24 miles away in northern Troy, near the confluence of the Mohawk River. The depth of the river in this area is approximately 30 feet.

According to the stream gauge data collected from the Hudson River at Green Island by USGS, the maximum flow recorded was 67,500 CFS, while the minimum flow was 2,010 CFS, and the average flow was 22,182 CFS. The Hudson River would have ample quantity to supply the Village drinking water needs.

The NYSDEC has classified the Hudson River near the confluence with the Mohawk River as a Class C fresh surface waterbody (6 NYCRR 858-4, Table 1). As discussed earlier, the NYSDOH may approve Class C waterbodies as sources for drinking water with suitable treatment methods, but generally Class AA and A waterbodies are preferred for drinking water uses.

The communities of Halfmoon and Waterford historically used the Hudson River as a raw water source for their treatment plants; however, these communities began obtaining water from the City of Troy during the cleanup of the PCB-contaminated sediment in the river and continue to use Troy water to this date. Long-term monitoring and evaluation of the river water quality with respect to PCBs is ongoing following Phase 2 of the Hudson River dredging effort[27].

4.2.5 Broad Brook

Broad Brook is a tributary to the Hoosic River that originates in southern Vermont and flows through Williamstown, Massachusetts. The brook itself is shallow for most of its length, but a dam and intake structure exist on the Brook near where White Oaks Road crosses the Vermont–Massachusetts state line. The dam and intake structure are located approximately 18 miles from

[27] https://www3.epa.gov/hudson/cleanup.html

the Village of Hoosick Falls. The dam and intake structure were formerly used for the City of North Adams (MA) water supply.

Per information provided by the NYSDEC, Broad Brook was last utilized as a drinking water source for North Adams in 2000; it was taken offline due to high levels of fecal coliform[28] in the raw water supply. In addition, the dam reportedly was in need of repair, and renovations would have made the source too costly. Broad Brook was officially abandoned as a water supply source for North Adams in 2005.

The flow through Broad Brook is not well defined; the USGS does not maintain any stream gauges, no safe yield studies are known to exist, and detailed water withdrawal data from North Adams was not available. North Adams has reported that they could use up to 1.0 MGD from the brook except during drought conditions.

Any connection to Broad Brook to serve the Village would require coordination from parties in multiple communities and states. The Brook originates in Vermont, but the dam and intake structure are still owned by the City of North Adams. The most direct transmission main route to Hoosick Falls would pass through the communities of Williamstown, MA, Pownal, VT, and North Petersburg, NY. Interstate water transfers would further complicate this option.

4.2.6 Summary of Potential Alternative Surface Water Sources

The Hoosic River was eliminated from further consideration as an alternate surface water supply due to the shallow depth, which presents the potential for sediment clogging, and the presence of contaminants, including concentrations of PFAS, PCBs, organochlorine pesticides and other compounds. This conclusion is consistent with the Arcadis Memorandum (Arcadis, July 12, 2016). The Walloomsac River was removed from further consideration for the same reasons. Broad Brook was also removed from further consideration as an alternate surface water supply because of the remote location, aging dam and intake in need or rehabilitation, uncertain water quality and quantity, and administrative challenges.

The Tomhannock Reservoir and Hudson River can supply adequate quantities of water to serve the needs of the Village, but the distance from the Hudson to the Village is almost twice the distance from the Tomhannock. The water quality of the Tomhannock is suitable for a drinking water source with appropriate filtration, and treatment. For these reasons, the Tomhannock Reservoir was selected as the surface water alternative for further evaluation in this Study. The Tomhannock Reservoir is described further as the new surface water source alternative in Section 5.2.

4.3 Interconnection with an Existing Water Supply Source

The closest existing public water supplies that could feasibly provide the Village with an alternate water supply were considered. Many of the communities surrounding Hoosick Falls do

[28] Coliform bacteria are often referred to as "indicator organisms" because they indicate the potential presence of disease-causing bacteria in water. However, the presence of coliform bacteria in water does not guarantee that drinking the water will cause an illness.

not have public water distribution systems. In total, 14 public water supplies were identified (Table 4.3.1), reaching west to the Hudson River and east to the nearest moderate-sized communities in Vermont and Massachusetts. Most of the identified public water supplies are too small to serve the water needs of the Village.

Based on the information available for neighboring water systems, the nearest public water supply that best meets the screening criteria with sufficient capacity for the current and future needs of the Village water system is the City of Troy. This conclusion is consistent with the Arcadis Memorandum from July 2016 (refer to Section 3.1).

The water source for the City of Troy is the Tomhannock Reservoir. As discussed earlier, the safe yield of the reservoir is 36.3 MGD, and the maximum day withdrawal during the past five years was 33.57 MGD. This leaves sufficient volume available for the current and future needs of the Village water system. The raw water is treated by the Troy water treatment plant for compliance with state and federal regulations. The capacity of the Troy water treatment plant is 45.8 MGD, which would not pose any limitations beyond the safe yield of the reservoir.

For the reasons set forth in this subsection, an interconnection with the City of Troy water supply is the alternative that will be carried forward for further evaluation in Section 5.3.

Table 4.3.1 – Summary of Neighboring Municipal Water Supplies

Location	Feasible?	Distance from Hoosick Falls	Maximum Day Demand	System Capacity	Population or Connections	Notes
Greenwich, NY	**No**, insufficient spare capacity	18 miles	0.4 MGD	0.8 MGD	1777 connections	Supply from 3 wells
Cambridge, NY	**No**, insufficient spare capacity, community is too small	10 miles	0.16 MGD	0.58 MGD	483 connections	Supply from 2 wells
Town of Schaghticoke, NY (Water District #1)	**No**, supply limited via Troy	16 miles	0.35 MGD	Purchases from Troy	1,208 connections	-
Town of Schaghticoke, NY (Water District #2)	**No**, supply limited by Mechanicville, which will obtain water from SCWA in future. Total transit distance >50 miles	16 miles	0.56 MGD*	Purchases from Mechanicville	188 connections	-
Town of Schaghticoke, NY (Water District #3)	**No**, supply limited by Troy	16 miles	0.11 MGD*	Purchases from Troy	366 connections	-
Village of Schaghticoke, NY	**No**, insufficient spare capacity, community is too small	16 miles	0.21 MGD	0.3 MGD	700 residents	-
Petersburg, NY	**No**, insufficient spare capacity, community is too small	12 miles	0.01 MGD	0.09 MGD	80 residents	-
Bennington, VT	**No**, insufficient spare capacity; discussions with Bennington indicate any further system expansion would consume remaining capacity buffer and would require upgrades to sources and treatment capacity	10 miles	3.0 MGD	3.9 MGD	6,900 connections	Extensions to water system in progress (Preliminary Engineering Report - Bennington Water Distribution System Expansion; MSK, July 2016). Would require interstate agreement for water sale.
North Bennington, VT	**No**, insufficient spare capacity	8 miles	0.474 MGD	0.688 MGD	675 connections	North Bennington has moratorium on new connections outside Village limits.
Pownal, VT (Fire District 2)	**No**, insufficient spare capacity, community is too small	12 miles	0.03 MGD	0.14 MGD	61 connections	Supply from 1 well, currently being treated for PFAS
Pownal, VT (Fire District 3)	**No**, supply limited by Williamstown	12 miles	0.03 MGD*	Purchases water from Williamstown	30 connections	-
Williamstown, MA	**No**, based on size of community	17 miles	Avg: 0.65 MGD Max: 1.2 MGD[29]	1.09 MGD (water withdrawal permit)	7,324 residents	Supplies water to Pownal FD3 and Williams College
North Adams, MA	**No**, insufficient spare capacity limited by safe yield	22 miles	1.7 MGD (average – max unknown)	2.1 MGD (safe yield)	13,700 residents	Obtains water from two surface water sources. Maximum demand water usage not available, but average daily demand is within 0.4 MGD of safe yield
Troy, NY	**Yes**, based on 2018 safe yield analysis	18 miles	33.57 MGD	30.5 MGD (2017 Water Withdrawal Permit) 36.3 MGD (Safe yield evaluation 2018)	50,000+ residents, plus wholesale customers	Sells water to Rensselaer, Menands, East Greenbush, North Greenbush, Brunswick, Schaghticoke, Poestenkill, Waterford, and Halfmoon.

* Estimated value using 300 gpd per connection

[29] According to Williamstown, this was due to two hydrants left open overnight.

5.0 DESCRIPTION OF ALTERNATIVES

This section describes potential alternative drinking water sources for Hoosick Falls and identifies the basic requirements for implementing each, along with order of magnitude cost estimates, schedule, and other pertinent details. Potential combinations of one or more sources were considered during the development of this study; however, none were selected for advancement because an independent option for each source type was identified.

5.1 Alternative 1: Development of a New Groundwater Source

Alternative 1 (Development of a New Groundwater Source) describes the development of two new groundwater wells to replace the existing wellfield as the primary Village water source. The existing Village wells, microfiltration membranes, and full capacity GAC system would be maintained under this alternative in order to meet maximum day demand with the largest of the new wells out of service[30], but the new wells would be assigned priority. Periodic O&M of Village Well 7 through the microfiltration units and GAC media is included in this alternative as it would be necessary maintain both in readily usable condition.

For this alternative, the LaCroix and Wysocki test wells located south of the Village would be converted to permanent production wells. The LaCroix well would be considered the primary source, with the Wysocki and Village Well #7 as backup sources[31]. The LaCroix test well produced a yield of 450 gpm and the Wysocki test well yielded 300 gpm for a combined capacity of 750 gpm (or 1.08 MGD). However, higher levels of production are considered achievable (especially in the LaCroix well) to attain the conceptual future maximum day demand of 1.13 MGD. As presented in Section 4.1.4.2, the projected 180-day drawdown for the Wysocki and LaCroix wells under concurrent pumping conditions substantiates the ability of these two wells to meet the 1.13 MGD objective. However, additional testing may be necessary to permit these wells for permanent use.

The aquifer tests, micro-particulate analysis (MPA), and water quality data for the new wells indicate that they would not be classified as groundwater under the direct influence of surface water (GWUDI); however, the NYSDOH is responsible for making the final determination. The test data and MPA analysis are provided as part of Appendix C. Assuming the new wells are not GWUDI, filtration would not be required to satisfy state and federal drinking water regulations. Under this alternative, the microfiltration system at the WTP would be bypassed for the LaCroix and Wysocki wells but remain intact for operation of Village Well #7.

Water quality sampling from the LaCroix well showed levels of manganese and sodium slightly above the MCL. The existing Village wells have similar concentrations of manganese, which is removed through oxidation and settling in a detention tank. The observed sodium concentration requires the Village to notify individuals who may be on severely restricted diets, but no further

[30] Required for public water supplies under NYSDOH regulations.

[31] Other groundwater supply sources may exist instead of Well #7 that would require further study. For example, these could include proving additional production capacity in the Wysocki and/or LaCroix wells, or installation of another productive well.

treatment is required under state or federal drinking water regulations. As discussed in Section 4.1.4, other constituents were detected in groundwater in the vicinity of the new wells.[32] Therefore, groundwater quality evaluations and monitoring are included as part of this alternative to assess the potential for PFAS (or any other contaminants) migration during operation of the new wells.

Water from the proposed wells would be pumped to the WTP for manganese removal using existing equipment. The WTP would also be used to disinfect the water supply with chlorine and to transmit water to the distribution system. Because the concentrations of PFAS were below any regulatory standard, the full capacity GAC system would not be needed for the LaCroix and Wysocki wells; however, it would remain and be periodically operated together with Village Well #7.

Each well would be outfitted with a new sanitary cap, submersible pump and motor, and discharge pipe. Variable frequency drive controllers would be installed to adjust pump speed to match well withdrawal rates with current demand. New electric services would be required for each well. Similar to the existing Village wells, the Wysocki well location is within a FEMA flood zone, so the casing will be extended sufficiently high enough to prevent inundation.

There is a privately owned property separating the LaCroix and Wysocki properties; therefore, individual 8-inch water mains would be extended from the wells to the public right-of-way on Route 22 before joining into a single 12-inch main. The 12-inch main would head north along NYS-22 and River Street, cross the Hoosic River on the bridge, turn south, and follow Fiske Street and Water Works Road to the WTP. The entirety of the alignment would be within the public right-of-way, with the exception of the well discharge mains on the LaCroix and Wysocki properties. Permanent easements would be required from these landowners. The total length of main is approximately 2.7 miles.

The 8-inch well discharge pipes and 12-inch common raw water main were selected based on reasonable hydraulic losses for the pumping distances required under maximum day demand conditions. The topography of the raw water main route is relatively flat, varying less than 50 feet in elevation. Based on surficial geology, the proposed raw water main would be installed in primarily sand and gravel soils. Surface rock is not present according to record mapping, although small quantities may be encountered. Refer to Figure 10 for a map showing the conceptual infrastructure for Alternative 1.

The location of the LaCroix test well is approximately 70 feet from the western bank of the Hoosic River. A review of available aerial imagery for the site indicates that the river has shifted approximately 100 feet to the west in the vicinity of the well between 2000 and 2017. As it is expected that this meander trend will continue in the future, Alternative 1 includes mitigation measures to prevent further erosion. Based on the characteristics of bed and banks on this reach of the Hoosic River, it is anticipated that bendway weirs can be utilized to redirect the thalweg away from the western bank. Alternative 1 will also include hard armoring at the toe of slope, regrading, and revegetation of the eroded bank for approximately 500 feet.

[32] Toluene and arsenic were detected in observation wells above the MCL; the toluene sample was a presumed anomaly. Further sampling would be necessary during detailed design to confirm concentrations.

Alternative 1 would require several administrative reviews and approvals from agencies and municipalities. At a minimum, coordination would be necessary with the NYSDEC, NYSDOH, NYSDOT, the Town of Hoosick, and the Village of Hoosick Falls. Easements would be required from private landowners for the proposed water main route. The water main alignment crosses an agricultural district, so a notice of intent would be required with the NYS Department of Agriculture and Markets. Alternative 1 would require a full design review from the US Army Corps of Engineers (USACE) and the NYSDEC for the construction of the bendway weirs and associated bank protection.

The site of both wells is currently agricultural and has already been cleared. The remainder of the required infrastructure would require temporary disturbance along paved and unpaved shoulders of existing roads, and privately owned property.

As described above, Alternative 1 proposes to utilize some existing equipment at the WTP. As the WTP is rated to produce a maximum of 1.0 MGD, the finished water pumps would need to be expanded to supply the conceptual future maximum day demand of 1.13 MGD. This would not be necessary until the completion of a distribution system infrastructure associated with any future expansion.

The estimated direct construction cost for Alternative 1 is $4.0 million. The estimated indirect costs (engineering, permitting, construction administration and legal fees) are $1.1 million. In present dollars, the total estimated O&M cost over a 30-year period is $1.9 million. The overall present cost of the alternative is estimated to be $6.9 million. Refer to Appendix E for further detail on the cost estimates.

It is estimated that the design, permitting, and construction of Alternative 1 would take approximately two to three years to complete. The full capacity GAC system would remove PFOA from the current source of supply in the interim while the new wells are constructed.

5.2 Alternative 2: Development of a New Surface Water Source

Based on the screening evaluation in Section 4.2, the Tomhannock Reservoir is the closest surface water source to the Village with adequate quantity and quality. Therefore, Alternative 2 explores the use of the Tomhannock Reservoir as a new surface water source.

To consider the Tomhannock Reservoir as a new surface water source for the Village, several key pieces of new infrastructure would be required, including a raw-water intake, a raw-water pump station and pre-disinfection station, and a raw-water transmission main connecting the pump station to the Village WTP. Depending on the chemistry of the raw water, the addition of orthophosphates at the proposed pump station may also be required to prevent corrosion inside the transmission mains.

Preliminary investigations by Arcadis identified locations for a raw-water intake and pump station on the east side of the reservoir, near the intersection of Reservoir Lake Road and Ashcroft Road. Based on NYSDEC depth charts for the reservoir, an intake and pump station located farther north would draw from deeper waters and provide better water quality and intake

performance. The conceptual raw-water intake would be located approximately 1,200 feet northwest of the intersection of Reservoir Lake Road and Croll Road. An evaluation of properties available for a pump station was not included as part of this Study.

The pump station would be designed using variable speed pumps that can satisfy the current average maximum day demand of 0.71 MGD as well as the conceptual future maximum day demand of 1.13 MGD. The raw water transmission main would be sized for the future capacity since it would be impractical to upgrade the size after it has been installed. Based on preliminary calculations, the required size of the main is 16-inch diameter.

The most direct route for a raw-water transmission main generally extends east from the reservoir along Croll Road, Quaker Street, and Lower Pine Valley Road before following the existing electric utility right-of-way to the Village. Although much of the new transmission main would be installed within the public right of way, some easements would be required from the City of Troy for the pump station on the east shore of the Tomhannock Reservoir, as well as from National Grid to construct a water main within its corridor. Easements from private property owners would also be needed, which would add cost and possible delay in the implementation of this alternative.

Following the conceptual alignment, the total length of new water main from the raw-water pump station at the reservoir to the existing Village water treatment plant is approximately 13.4 miles. Refer to Figure 11 for a map showing the conceptual infrastructure for Alternative 2.

Surface geology data along the conceptual alignment shows variable soil textures, ranging from silts and clays to coarse gravels. Some areas of surface bedrock are identified from available data, but soil borings as part of a detailed design will better identify areas of potential construction obstacles. The transmission main alignment crosses several streams along its length, so horizontal directional drilling (HDD) methods would be used in these areas. The alignment also is adjacent to several wetlands which could be impacted by the construction. The elevation along the raw-water main alignment changes from approximately 395 feet at the reservoir, 1,110 feet at the high point, and 435 feet at the Village water treatment plant. Multiple pressure reducing stations would be required to prevent damage to the transmission main.

The raw-water transmission main would connect to the upstream side of the existing Village water treatment plant for treatment consisting of microfiltration and disinfection to comply with drinking water standards. Because the concentrations of PFAS were below any regulatory standard, the full capacity GAC system would not be needed. However, under this alternative it would undergo be periodic O&M involving cycling of potable water through the GAC system to maintain the integrity of the media in the event it was needed in the future. Once treated at the WTP, water would be pumped into the distribution system using the existing finished water pumps.

The water from the Tomhannock Reservoir may have different characteristics than the current groundwater source (which is deemed to be under the direct influence of surface water) that the Village WTP currently treats. Direct microfiltration of surface waters has precedent, but additional pretreatment may be required to prevent natural organic matter and other constituents

in the reservoir from fouling the microfiltration membranes. A review of Tomhannock raw water quality records (provided by the City of Troy) indicates seasonal fluctuations in reservoir turbidity, ranging from less than 1 NTU to more than 50 NTU; therefore, the addition of a coagulant upstream of the filtration units may be required. If necessary, the existing 26,000-gallon pre-treatment storage tank could be repurposed for contact time of the coagulant polymer. A pilot study would be necessary to demonstrate the microfiltration units can successfully treat the Tomhannock raw water without requiring excessive cleaning cycles; the associated costs are included in this alternative.

Alternative 2 would require extensive administrative reviews and approvals/permits from state and federal agencies as well as local municipalities. At a minimum, coordination would be necessary with the NYSDEC, NYSDOH, NYSDOT, National Grid, the City of Troy, the Town of Hoosick, and the Village of Hoosick Falls. The transmission main alignment crosses an agricultural district for the majority of its length, so a notice of intent would be required with the NYS Department of Agriculture and Markets. Alternative 2 is also anticipated to require a review of wetlands impact from the US Army Corps of Engineers and Full Environmental Assessment under the State Environmental Quality Review Act (SEQR). Highway work permits with the NYSDOT would be required to construct within public right of ways and a water withdrawal permit would need to be filed with the NYSDEC. Approvals from the NYSDOH would be required before changing the raw-water source of the existing Village water treatment plant.

The site of the conceptual pump station would require clearing and permanent land development. The remainder of the required infrastructure would require temporary disturbance along unpaved shoulders of existing roads, cleared utility easements, and privately-owned property. Potential risks associated with Alternative 2 include source water contamination of the Tomhannock Reservoir, severe drought, or damage to the extensive length of raw-water transmission main.

The existing WTP equipment is rated to produce a maximum of 1.0 MGD; however, as described further in Section 5.4, the filtration equipment and finished water pumps can be expanded to supply 1.15 MGD. This will be sufficient for the conceptual future maximum day demand condition of 1.13 MGD. The expansion of the WTP equipment would not be necessary until the completion of extensive distribution system infrastructure.

The estimated direct construction cost for Alternative 2 is $24.7 million. The estimated indirect costs (engineering, permitting, construction administration and legal fees) are $6.7 million. The total estimated O&M cost, in present dollars over a 30-year period, is $3.5 million. The overall present cost of the alternative is estimated to be $34.4 million. Refer to Appendix E for further detail on the cost estimates.

It is estimated that the design, permitting, and construction of the raw water intake, pump station and pre-disinfection station, and transmission main would take approximately four to five years to complete. The full capacity GAC system would remove PFOA from the current source of supply in the interim while the raw-water infrastructure is being constructed.

5.3 Alternative 3: Interconnection with an Existing Water Supply Source

Based on the screening evaluation in Section 4.3, the City of Troy water system presents the closest public water supply source with sufficient quantity and quality to support the Village as a wholesale customer. Alternative 3 describes an interconnection with the City of Troy water system to provide an alternative water source for the Village.

The City of Troy owns and operates a public water system that provides water to its 50,000 residents as well as several neighboring communities. These communities include the City of Rensselaer, the Village of Menands, portions of the Towns of East Greenbush, North Greenbush, Brunswick, Schaghticoke, and Poestenkill. The Village of Waterford and the Town of Halfmoon also obtain water from the City of Troy system.

The water source for the City of Troy is the Tomhannock Reservoir, which is the surface water source proposed under Alternative 2. Alternative 3 would also use the Tomhannock Reservoir water source through a purchase agreement of treated water by the City of Troy water treatment facility.

The City of Troy pre-disinfects water from the Tomhannock Reservoir with chlorine dioxide, and seasonally treats it with potassium permanganate. Raw water flows by gravity to the water treatment plant, which uses conventional treatment processes (coagulation, flocculation, sedimentation, and filtration). Chlorine and fluoride are added to the treated water before it is pumped into the distribution system. The City of Troy does not currently utilize treatment processes for PFAS removal; should PFAS treatment be required at some point in the future, these processes would be implemented at the City of Troy water treatment plant for the entire customer base, including the Village.

The closest connection to drinking water from the City of Troy distribution system is a 16-inch diameter main located along Route 278 (Brick Church Road) in Cropseyville, within the Town of Brunswick. Conversations with the City indicate sufficient pressure would be available in the existing water main for a new interconnection. A booster pump station and wholesale water meter would be installed at the new connection. Depending on the chemistry of the Troy finished water, the addition of orthophosphates as a corrosion inhibitor may also be required.

The pump station would be designed using variable speed pumps that can satisfy the current average maximum day demand of 0.71 MGD as well as the conceptual future maximum day demand of 1.13 MGD. The raw water transmission main would be sized for the future capacity since it would be impractical to upgrade the size after it has been installed. Based on preliminary calculations, the required size of the main is 16-inch diameter.

The conceptual route for a drinking water transmission main from the City of Troy water system to the Village would travel northeast from the connection point along Tamarac Road, east along Route 7, and northeast along the existing National Grid electric utility corridor until the Village limits. Although much of the new water transmission main will be installed within public right-of-way corridors, some easements will be required for the pump station in the Town of Brunswick and for the transmission main within the National Grid right-of-way corridor. The

transmission main would deliver water to the Village WTP, where it would be re-chlorinated and pumped into the distribution system using the finished water pumps. Further design would be required to evaluate the potential for DBP formation during the extended transit time from Troy and appropriate treatment options.

In total, the transmission main length is approximately 18 miles. Easements from private property owners will be needed, which will add cost and possible delay in the implementation of this alternative. Refer to Figure 12 for a map showing the conceptual infrastructure for Alternative 3.

Based on surficial geology, the proposed water transmission main would be installed through rock along Tamarac Road south of Storm Hill Road for approximately 0.7 miles. The remainder of the transmission main would be installed in variable soil textures, ranging from silts and clays to coarse gravels. The transmission main alignment crosses several streams and wetland areas along its length, so HDD methods would be used in these areas to avoid impacts. The elevation along the water transmission main alignment changes from approximately 505 feet at the connection point, to 1,110 feet at the high point, and 435 feet at the existing water treatment plant. Multiple pressure reducing stations would be required to prevent damage to the water transmission main.

Alternative 3 would require extensive administrative reviews and approvals from agencies and municipalities. At a minimum, coordination would be necessary with the NYSDEC, NYSDOH, NYSDOT, National Grid, the City of Troy, the Town of Brunswick, the Town of Hoosick, and the Village of Hoosick Falls. The transmission main alignment transits an agricultural district for the majority of its length, so a notice of intent would be required with the NYS Department of Agriculture and Markets. Alternative 3 is also anticipated to require a review of wetlands impact from the US Army Corps of Engineers and a Full Environmental Assessment under SEQR.

The site of the conceptual booster pump station would require clearing and permanent land development. The remainder of the required infrastructure would require temporary disturbance along unpaved shoulders of existing roads, previously cleared utility easements, and privately owned property.

Potential risks associated with Alternative 3 include future source water contamination of the Tomhannock Reservoir (from surface runoff or other unknown sources); the potential for damage to the extensive amount of water main needed to transport water from Troy to the Village; and formation of DBPs due to the transit time inherent with pumping water over long distances. Areas of surface or near-surface bedrock not identified during the study of available information may also complicate construction and add cost.

Although Alternative 3 purchases treated water from Troy, it still proposes to utilize some existing equipment at the WTP, including the chlorination equipment and finished water pumps. As the WTP is rated to produce a maximum of 1.0 MGD, the finished water pumps would need to be expanded as to supply the conceptual future maximum day demand of 1.13 MGD. This would not be necessary until the completion of distribution system infrastructure. The existing

full capacity GAC system would not be used under this alternative after the interconnection is active.

The estimated direct construction cost for Alternative 3 is $30.7 million. The estimated indirect costs (engineering, permitting, construction administration and legal fees) are $8.3 million. In present dollars, the total estimated O&M cost over a 30-year period is $10.1 million, which is significantly higher than Alternative 2 due to the need to purchase water from Troy at a wholesale rate. The overall present cost of the alternative is estimated to be $48.5 million. Refer to Appendix E for further detail on the cost estimates.

It is estimated that the design, permitting, and construction of the interconnection, booster pump station, and water transmission main would take approximately five to six years to complete. The full capacity GAC system would remove PFOA from the current source of supply in the interim while the new interconnection is constructed.

5.4 Alternative 4: Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System

This alternative involves using the full-capacity GAC treatment system already in operation at the existing Village water treatment facility for the removal of PFOA[33]. The system outlined in this alternative was approved by the NYSDOH, constructed, and became operational in February 2017. The full capacity GAC treatment system was designed to match the production rate of the existing water treatment plant (1.0 MGD) and was installed downstream of the existing microfiltration units. The GAC water discharge is subsequently treated with sodium hypochlorite to disinfect prior to distribution.

The full capacity GAC treatment system consists of two 12-foot diameter vessels installed within the existing water treatment plant property; no additional easements are required for this alternative. Each vessel is loaded with 40,000 pounds of virgin coal-based GAC. As discussed in Section 3.6, GAC is a proven effective technology for removing PFOA from drinking water. GAC has been used for decades on municipal water supplies, across NYS, throughout the United States and internationally, for a wide variety of water treatment purposes, including for the treatment of PFOA and other PFAS substances.

The vessels are arranged in a lead-lag series configuration, where the lead vessel will remove all of the PFOA and the lag vessel serves as a backup barrier from the lead vessel. Regular water quality monitoring at the system influent, midpoint (i.e., between vessels) and effluent is performed monthly for 21 PFAS compounds. When there is a detection of PFAS at the midpoint, the sampling frequency increases to every two weeks. In addition, samples are tested from three locations along the height of each vessel; this allows the operators to determine how far the PFAS compounds have traveled through the GAC media. When there is a detection of PFAS halfway through the lag vessel, the lead GAC vessel is refilled with clean GAC media.

[33] Pursuant to the "Final Remedial Investigation/Feasibility Study Work Plan, Saint-Gobain Performance Plastics Site 14 McCaffrey Street, Village of Hoosick Falls, Rensselaer County, New York", (Revised August 30, 2016), the full capacity GAC treatment system, which is effectively removing PFOA from the water supply and has been approved by NYSDOH, is an IRM that also represents the no further action alternative as described in DER-10.

The vessel containing clean GAC will be reassigned to the lag position, and the former lag vessel is placed in the lead position.

Regular testing since March 2016 has been performed by the NYSDOH at the GAC system's influent, midpoint, and effluent sampling points and the system has proved effective for the past three years at removing PFAS as verified by sampling data. As of March 2017, ongoing sampling is being performed by the Companies and results are reported to the NYSDOH. The type of GAC used in the full capacity system has been approved by the NYSDOH, which has concluded the system enables the "use of the water for any and all uses, including drinking and cooking" (*NYSDOH letter to Mayor Borge, March 30, 2016*). Moreover, as the PFAS analyte list has expanded since installation of the full capacity GAC system, removal of all PFAS from the municipal water supply continues to be demonstrated.

The MWS is limited to a capacity of 1.0 MGD. Upgrades to the WTP would be required to supply the future maximum day water demand of 1.13 MGD. The following paragraphs detail to what extent the WTP equipment can be modified to supply additional water.

Wells

As described in Section 3.3.1, the Village has three production wells: #3, #6, and #7. When the highest capacity well (#7) is out of service, the capacity of the remaining wells is 1,300 gpm (1.87 MGD), sufficient to meet the future maximum daily demand. Well #6 is currently maintained in reserve for emergency use only due to higher levels of iron and manganese.

Pre-Treatment and Filtration Equipment

The existing WTP uses a chemical oxidation system for iron and manganese pretreatment in a 26,000-gallon detention tank, which creates insoluble forms of the metals for removal in the filtration units. The detention tank would be able to provide the recommended 30-minute chemical contact time for flows up to 1.24 MGD. If Well #6 is regularly used, the additional iron and manganese loading may increase the required cleaning frequency of the microfiltration units. Further bench scale and pilot testing would be required to determine the impact to the operational efficiency.

Each microfiltration rack unit in the existing WTP uses 26 membrane modules to produce 1.0 MGD of treated water. The original design allows for an additional four membrane modules per rack (30 total), so the microfiltration plant can be upgraded to a 1.15 MGD capacity. Space is not available for additional filtration racks. Upgrades to the microfiltration feed pumps would also be required to achieve the higher system throughput. The microfiltration system manufacturer also indicated that the plant could successfully operate at higher flux (i.e., filtration rate per membrane unit area), but a higher flux may decrease the run time of the membranes between cleaning cycles. The design flux is based on NYSDOH standards, so a pilot test would also be necessary to approve such an increase. Further evaluation would be required to confirm the potential capacity increase.

Full Capacity GAC System

A preliminary review of the full-capacity GAC system indicates an expansion to this system would not be required to treat flows to match the upgraded filtration capacity of 1.15 MGD described above. Even at the higher flow rate, the contact time between the water and the GAC media is sufficient to support PFAS removal. It is expected that the higher flow through the vessels will result in an additional 2-3 psi of pressure loss. As a result, the GAC media will need more frequent replacement when operating at higher flow rates. Further testing would be required to estimate the impact to the GAC media replacement frequency under the future demand.

Miscellaneous WTP Equipment

Additional upgrades at the WTP would be required to supply the conceptual future maximum day demand, including replacing the finished water pumps and increasing the dosing and storage capacity of chemical injection and disinfection systems. Miscellaneous piping and mechanical improvements would be required to complete the upgrades.

Based on the limitations of expanding the treatment process components, the Village water treatment plant could potentially be upgraded to supply a maximum of 1.15 MGD. This assumes that all further evaluation and testing indicates the upgrade would be successful. With these assumptions, the existing treatment processes can meet the conceptual future maximum day demand of 1.13 MGD.

The future demands would not be realized until distribution system infrastructure (water mains, storage tanks, etc.) has been constructed and new customers connected to the public water supply. Given the scope of the conceptual improvements as described in the August 2016 *Engineering Report for the Village of Hoosick Falls Water System Expansion* by MRB Group, it is anticipated a conceptual future maximum day demand of 1.13 MGD would not be completed for at least five to ten years. It is appropriate for any water treatment plant improvements to be performed concurrently with the distribution upgrades; however, the costs of such improvements are considered as part of this alternative for evaluation. Costs for the expanded distribution system infrastructure are not included as part of this Alternative.

The direct construction cost for the full capacity GAC system was $1.5 million, based on public bids received May 4, 2016. These costs have already been spent, as the system is currently operational. The estimated construction cost to expand the treatment system to meet a future demand of 1.13 MGD is $0.4 million. The estimated indirect costs (engineering, permitting, construction administration and legal fees) are $0.5 million. In present dollars, the total O&M cost over a 30-year period is estimated at $3.9 million. The overall present cost of the alternative is $6.3 million, and includes direct construction costs, indirect costs, and O&M costs. Refer to Appendix E for further detail on the cost estimates.

5.5 Alternative 5: Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System and PFOA Remediation through the McCaffrey Street IRM

This alternative involves all the components of Alternative 4, plus measures to control offsite migration of groundwater toward the Village wellfield and reduce the volume of PFAS in the subsurface. Specifically, this alternative combines Alternative 4 with the McCaffrey Street IRM. The McCaffrey Street IRM was approved by NYSDEC on April 4, 2019, and is constructed and operating.

The McCaffrey Street facility is located northwest of the MWS, and portions of the McCaffrey Street facility are upgradient of the MWS. Ongoing investigations at this facility have identified the presence of PFOA in soil and groundwater. The approved IRM will intercept groundwater with the potential to migrate southeast from the McCaffrey Street Site.

The IRM pumps groundwater from two extraction wells in the southeastern portion of the McCaffrey site, treats the water with GAC, and discharges the treated water to the Hoosic River. The IRM work plan (C.T. Male, 2019) presents design details for the groundwater extraction and treatment systems, and the process for installing and implementing the system. The IRM is intended to:

- Capture groundwater containing PFAS within the eastern and southern portions of the McCaffrey site;
- Pose no impact on the yield of the MWS and its ability to provide sufficient water to serve the needs of the Village; and
- Not compromise the structural integrity of buildings on the McCaffrey site.

Consistent with DER-10, the IRM was selected without an extensive economic evaluation, but costs are included for purposes of comparison with the other alternatives. The cost estimate for Alternative 5 encompasses all elements included in Alternative 4, construction of the McCaffrey IRM, and the operation, maintenance and monitoring of the McCaffrey IRM for 30 years. Because the IRM will reduce concentrations of PFAS in the Village wellfield, the full capacity GAC system will run more efficiently and require less frequent media replacement[34].

The estimated direct construction cost for Alternative 5 is $2.5 million, which includes the construction costs for the full capacity GAC system (already incurred), the costs to upgrade the WTP in the future, and the IRM construction costs. The estimated indirect costs (engineering, permitting, construction administration and legal fees) are $0.6 million. In present dollars, the total estimated O&M cost over a 30-year period is $7.0 million. The overall present cost of the alternative is estimated to be $10.1 million, of which $1.5 million has already been spent. Refer to Appendix E for further detail on the cost estimates.

[34] PFOA influent concentrations were assumed to decline from an average of 496 ppt to 40 ppt over a period of 22 years. This was based on the current understanding of the aquifer setting, parameters affecting PFOA transport, and application of standard hydrogeologic methods.

6.0 CRITERIA DISCUSSION

Potential alternative water supplies are discussed in the following sections with respect to each of the following remedy selection criteria established in 6 NYCRR 375-1.8(f) and in conjunction with subparts *b* through *i* of DER-10, Section 4.2:

i. Overall protectiveness of the public health[35];
ii. Compliance with applicable standards, criteria, and guidance (SCGs);
iii. Long-term effectiveness and permanence;
iv. Reduction of toxicity, mobility, or volume of site contamination through treatment;
v. Short-term impact and effectiveness;
vi. Implementability;
vii. Cost effectiveness (capital and O&M costs);
viii. Land use; and
ix. Community Acceptance.

The first two evaluation criteria are "threshold" criteria that must be satisfied for an alternative to be considered for selection. The remaining criteria are "balancing" criteria. The balancing criteria are used to establish a preference of one alternative over another, based on the relative importance of each evaluative criterion in the context of this Report.

The last remedy selection criterion in DER-10, "Community Acceptance", will be evaluated by the NYSDEC after the close of a public comment period following issuance of this Report.

Alternatives 1, 2, and 3 each represent options to replace the existing Village water supply. Alternative 4 uses the full capacity GAC treatment system currently in operation. Alternative 5 considers the McCaffrey Street IRM operating in tandem with the full capacity GAC system. The IRM is anticipated to reduce the influent concentrations of PFOA and associated PFAS reaching the Village wellfield over time, and therefore improve the operation of the full capacity GAC process. Therefore, with respect to all criteria except for reduction of toxicity, mobility and volume through treatment and cost effectiveness, Alternative 5 would mirror Alternative 4. Since the IRM portion of Alternative 5 has been constructed and is operating, it is independent of the alternative chosen.

Table 6.0.1 contains summarizes some key features of each alternatives as relates to the criteria.

[35] Since this Report focuses on alternatives to supply potable water, they must meet the standard of being protective of human health and associated applicable regulatory criteria.

Table 6.0.1 – Summary of Alternatives

Evaluation Criteria	Alternative 1 – New Groundwater Source	Alternative 2 – New Surface Water Source	Alternative 3 – Interconnection with Existing Public Water Supply	Alternative 4 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System	Alternative 5 – Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC Treatment System and PFOA Remediation through the McCaffrey Street IRM
Description	Development of two new groundwater wells (LaCroix and Wysocki properties) as the primary Village water source. Maintain the existing Village Well #7 to meet redundancy requirements. Existing filtration and GAC systems to be bypassed for new wells but remain for use of Well #7. Requires water main to connect new wellfield to existing WTP for manganese removal, disinfection, and distribution.	New water intake and pump station at Tomhannock Reservoir. Requires 13.4 miles of raw water transmission main and pressure reducing stations. Existing Village WTP will filter and disinfect raw water. Maintenance of full capacity GAC system is included during construction of alternative, then bypassed. GAC would be periodically maintained for future use.	New connection with Troy system in Cropseyville. Requires booster pump station, 18 miles of transmission main, and pressure reducing stations. Existing Village WTP will only be used for disinfection and distribution pumping. Maintenance of full capacity GAC system is included during construction of alternative, then bypassed.	Uses proven GAC adsorption technology as a secondary treatment process at the existing Village WTP for PFOA removal.	Alternative would capture and contain groundwater at the McCaffrey Street Site that could migrate to the Village wellfield. The IRM uses two recovery wells. Groundwater is pumped through GAC to remove PFOA. Requires continued operation of full capacity GAC system to remove PFOA that has already impacted the Village wellfield. The IRM is expected to reduce PFOA concentrations reaching the Village wellfield over time, extending the media life of the full capacity GAC treatment system.
Overall Protectiveness of public health and environment	All alternatives would be protective of public health. The water supply in each alternative would be monitored for PFOA and other constituents to ensure levels are within acceptable limits.				
Compliance with SCGs	All alternatives would conform to applicable standards, criteria, and guidance.				
Long-term effectiveness and permanence	Effective and permanent in the long term. Long-term reliability of new groundwater source could be affected by movement of unknown contaminants (PFAS or other) in aquifers over time. Well monitoring between the Village MWS and the proposed wells is included. Other drilled wells in the future may cause interference with new groundwater source. Long-term O&M requirements on par with existing Village water system. Periodic O&M of the Village Well #7 and the full-capacity GAC system.	Effective and permanent in the long term. Transmission main does not offer redundant water supply in case of damage. Long-term risks include drought or contamination of the Tomhannock. Long-term O&M of raw water intake, pump station, and water main is required. Operation of filtration processes at existing WTP required. Additional pre-treatment using coagulant polymer needed seasonally to prevent filter fouling. Periodic O&M of the full-capacity GAC system in the event treatment is required in the future.	Effective and permanent in the long term. Transmission main does not offer redundant water supply in case of damage. Long-term risks include drought or contamination of the Tomhannock Reservoir. Filtration system and full capacity GAC treatment system will be bypassed.	Effective and permanent in the long term. System already built, operational, and determined effective. PFOA in the Village MWS is removed using GAC system in series operation to ensure breakthrough will not occur. Maintenance centralized at existing WTP. GAC media widely used in water treatment applications and is commercially available. Consistent sampling is necessary to ensure long-term reliability of GAC system.	Effective and permanent in the long term. PFOA in the Village MWS is removed using GAC system in series operation to ensure breakthrough will not occur. Maintenance centralized at existing WTP. GAC media widely used in water treatment applications and is commercially available. Consistent sampling is necessary to ensure long-term reliability of GAC system. McCaffrey Street IRM requires routine maintenance. IRM is expected to improve efficiency of the GAC system.
Reduction of toxicity, mobility, or volume of site contamination through treatment	Criterion not evaluated in detail in this report. All of the alternatives are designed to provide drinking water that has been treated effectively.				Criterion not evaluated in detail in this report. All of the alternatives are designed to provide drinking water that has been treated effectively. Groundwater from the McCaffrey Street Site would be contained, captured, and treated, thereby reducing toxicity, mobility, and volume of PFOA.
Short-term impact and effectiveness	Effective in the short term because full capacity GAC system operates during design and construction. Disturbance of 2-3 miles for water main installation. Localized short term impacts during conversion of test wells and water main installation (noise, temporary traffic closures). Stormwater pollution prevention methods would be used. The design, permitting, and construction will take approximately 2-3 years to complete.	Effective in the short term because full capacity GAC system operates during design and construction. Disturbance of 13-14 miles for transmission main installation. Localized short term impacts during construction of intake, pump station, and transmission main (noise, temporary traffic closures). Stormwater pollution prevention methods would be used. Design, permitting, and construction will take approximately 4-5 years to complete.	Effective in the short term because full capacity GAC system operates during design and construction. Disturbance of 18 miles for transmission main installation. Localized short term impacts during construction of pump station and transmission main (noise, temporary traffic closures). Stormwater pollution prevention methods would be used. Design, permitting, and construction will take approximately 5-6 years to complete.	GAC system already online. No further short term impacts for this alternative.	GAC system already online. The McCaffrey Street IRM has been approved by NYSDEC, has been constructed, and is operating. No further short term impacts for this alternative.
Implementability	New wells and transmission main are technically feasible. Coordination required with NYSDEC, NYSDOH, and NYSDOT, NYS Agriculture districts, USACE, among others. Easements required from private landowners.	Intake, raw water pump station, and transmission main are technically feasible. Coordination required with NYSDOT, NYSDEC, NYSDOH, Rensselaer County, City of Troy, NYS Agriculture districts, USACE, among others. Easements required from private landowners & National Grid.	Pump station and transmission main are technically feasible. Coordination required with NYSDOT, NYSDEC, NYSDOH, Rensselaer County, City of Troy, NYS Agriculture districts, USACE, among others. Easements required from private landowners & National Grid.	Full Capacity GAC system already online and proven effective based on routine sampling.	Full Capacity GAC system already online. McCaffrey Street IRM has been implemented and is operating. Coordination required with NYSDEC for IRM approval and issuance if a discharge permit (has already been completed).
Cost Effectiveness (present value)	Direct: $ 4.0 M Indirect: $ 1.1 M O&M: $ 1.9 M **Total: $ 6.9 M**	Direct: $ 24.7 M Indirect: $ 6.7 M O&M: $ 3.5 M **Total: $ 34.4 M**	Direct: $ 30.7 M Indirect: $ 8.3 M O&M: $ 10.1 M **Total: $ 48.5 M**	Direct: $ 1.9 M Indirect: $ 0.5 M O&M: $ 3.9 M **Total: $ 6.3 M**[36]	Direct: $ 2.5 M Indirect: $ 0.6 M O&M: $ 7.0 M **Total: $ 10.1 M**[36]
Land use	Alternative is anticipated to be consistent with current and future land uses.	No land use restrictions are anticipated. Alternative is consistent with current and future land uses.	No land use restrictions are anticipated. Alternative is consistent with current and future land uses.	Alternative is built and consistent with current and future land uses.	Alternative is built and consistent with current and future land uses.

[36] Construction costs (direct and indirect) for the Full Capacity GAC System under Alternatives 4 and 5 have already been paid.

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6.1 Overall Protectiveness of Public Health

This criterion investigates how each alternative would eliminate, reduce, or control any existing or potential human exposure or environmental impact. Since this study evaluates potential drinking water supplies for the Village, this criterion was used to consider how each alternative would provide potable water that is protective of human health. This criterion draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness and compliance with SCGs.

Alternative 1 would convert the two test wells south of the Village to full production wells, and install a raw water main to connect them to the Village WTP. Groundwater would be treated at the WTP for manganese removal and disinfection. The existing microfiltration units and full capacity GAC system would remain in order to utilize Well #7 to satisfy redundancy requirements. Alternative 1 would meet the overall protectiveness of public health criterion since the finished water would meet SCGs at the Village WTP.

Alternative 2 would include a raw water intake at the Tomhannock Reservoir and the construction of a pumping station and transmission main from the reservoir to the Village WTP for treatment consisting of filtration and disinfection. The full capacity GAC system would be bypassed but remain available by periodic operation to maintain the integrity of the media should the need for the system arise in the future. Alternative 2 would meet the overall protectiveness of public health criterion since the raw water from the Tomhannock Reservoir will be treated to meet SCGs at the Village WTP.

Alternative 3 would consist of connecting to the City of Troy water distribution system in Cropseyville and the construction of a booster pump station and transmission main to connect to the Village WTP. Drinking water under Alternative 3 would be re-chlorinated to provide secondary disinfection; additional treatment may be needed to eliminate disinfection byproducts. Alternative 3 would meet the overall protectiveness of public health criterion since Troy's water distribution system is appropriately treated to meet SCGs, and upon delivery would be re-disinfected at the Village WTP.

Alternative 4 proposes the continued use of the existing full capacity GAC treatment system. Regular testing has been performed at the GAC system's influent, midpoint, and effluent, and the system has proved effective at removing PFOA and other PFAS as verified by sampling data. Since Alternative 4 includes the treatment of constituents to SCGs, it meets the overall protectiveness of public health criterion.

Alternative 5 includes the implementation of the McCaffrey Street IRM. This IRM captures and treats PFOA-contaminated groundwater and discharges it, after treatment, to the Hoosic River, to control offsite migration of groundwater toward the Village wellfield. This alternative also assumes that the Village would continue to operate the full capacity GAC treatment system at the Village WTP to treat PFOA, thus meeting the criterion of overall protectiveness of public health related to delivery of potable water.

6.2 Compliance with SCGs

This criterion assesses whether an alternative conforms to official standards, criteria, and guidance that are directly applicable or that are relevant and appropriate.

Alternative 1 would convert new groundwater wells to full production wells. Manganese removal and chlorination would be performed at the existing Village WTP. The treatment methods would be in accordance with state and federal regulations, including *Recommended Standards for Water Works* ("Ten States Standards"), NYSDOH Part 5-1 *Public Water Systems*, and US EPA Drinking Water Rules. Routine water quality sampling of the raw and finished water would be conducted according to the regulations. Alternative 1 would comply with SCGs.

Alternative 2 would include a raw water intake at the Tomhannock Reservoir. The water would be treated appropriately using filtration and disinfection processes at the Village WTP. The water treatment methods would be in accordance with state and federal regulations. Routine water quality sampling of the raw and finished water would be conducted according to the regulations. Alternative 2 would comply with SCGs.

Alternative 3 would consist of connecting to the City of Troy water distribution system in Cropseyville and the construction of a booster pump station and transmission main to connect to the Village WTP. The water received from Troy would already have been treated and would be re-disinfected as necessary upon delivery to the Village WTP. Routine water quality sampling of the raw and finished water would be conducted according to the regulations. Alternative 3 would comply with SCGs.

Alternative 4 proposes the continued use of the existing full capacity GAC treatment system. Regular testing has been performed at the GAC system's influent, midpoint, and effluent, and the system has proved effective at removing PFOA and other PFAS as verified by sampling data. Routine water quality sampling of the raw and finished water would continue to be conducted according to the regulations. Alternative 4 would comply with SCGs.

Alternative 5 includes the implementation of the McCaffrey Street IRM. This IRM contains and treats PFAS in groundwater, and controls offsite migration of groundwater toward the Village wellfield. The full capacity GAC system removes PFAS according to the regulations. Alternative 5 would comply with SCGs.

6.3 Long-term Effectiveness & Permanence

This criterion evaluates the long-term effectiveness and permanence of an alternative after implementation. In a typical DER-10 feasibility study, this is evaluated in relation to how effectively the alternative eliminates site contamination and how any residual contamination can be controlled to prevent human exposure or environmental impact. Since this Report primarily assesses alternative sources of water for the Village MWS, this criterion is used here to evaluate how effectively an alternative can provide a water supply to the Village over the long term. This assessment contemplates the full-capacity GAC system remaining in place to provide potable water during the design and construction of all the alternatives.

All of the alternatives considered would provide a permanent drinking water supply; however, there are differences between the alternatives in their long-term maintenance needs and future risk mitigation considerations. All of the alternatives would be capable of supplying both the current and conceptual future maximum day water demands.

Alternative 1 would convert the two test wells to full production wells. The long-term reliability of a new groundwater source could be affected by movement of unknown contaminants (PFAS or other) in aquifers over time. PFAS was detected at low concentrations in monitoring wells and domestic supply wells near the LaCroix property. Sentinel well monitoring at key locations is included under this alternative. The long-term operation and maintenance requirements of the proposed groundwater well source and treatment strategy are similar to the existing wellfield.

Alternative 2 would require extensive amounts of new water main, which increases the risk of water supply interruption in case of damage. In addition, long-term reliability could be affected by drought or contamination (including chemical or biological) of the Tomhannock Reservoir, as with any surface water supply. The presence of PFAS at low concentrations has recently been detected in the Tomhannock Reservoir. For Alternative 2, long-term operation and maintenance of the raw water intake, pump station, and water main is required, along with continued operation of the filtration processes at the existing WTP. Additional pre-treatment at the existing WTP will be required with the transition from a groundwater source to a surface water source. Although it is anticipated that the existing GAC system would not be required to meet the applicable drinking water standards, this alternative maintains the integrity of the existing GAC media should it be needed in the future.

Like Alternative 2, Alternative 3 requires long-term operation and maintenance of the pump station and water main. The existing microfiltration units and GAC system would not be required to meet the applicable drinking water standards.

Alternative 4 provides drinking water to the Village via use of the GAC treatment system, which is already operational and effectively removes PFAS from the water supply. The full capacity GAC system requires regular maintenance, similar to the existing filtration plant. GAC systems have been used to reliably treat drinking water for decades in New York State (for PFAS and other constituent removal), throughout the United States and internationally, and GAC will be readily available for the foreseeable future.

The long-term effectiveness of Alternative 5 in terms of providing safe drinking water to the Village is the same as that of Alternative 4. The IRM is expected to be effective in the long-term by maintaining hydraulic control of groundwater migrating toward the Village well field from the McCaffrey Street Site, capturing and treating the PFAS impacted groundwater, and reducing concentrations of PFAS in the aquifer over time. The IRM is expected to improve the operations of the full capacity GAC system over time, reducing the frequency of GAC media replacement.

6.4 Reduction of Toxicity, Mobility, or Volume of Site Contamination through Treatment

This criterion, as described in DER-10, is typically used to evaluate environmental remediation projects that are designed to reduce the toxicity, mobility, or volume of contamination at a contaminated site. This criterion is not evaluated in detail in this report. All the alternatives are designed to provide drinking water that has been treated effectively.

However, Alternative 5 includes an IRM that is designed to reduce the toxicity, mobility, or volume of PFOA in groundwater at the McCaffrey Street Site. The IRM discussed in Alternative 5 has been constructed to reduce PFOA mobility via hydraulic control and PFOA volume through removal by a pump and treat system. The IRM is expected to reduce migration of PFOA (and other associated PFAS) in groundwater moving from the McCaffrey Street Site toward the Village well field. The outcome estimated for purposes of this evaluation, which is subject to large uncertainty, is that PFOA concentrations at the wellfield decrease over time until a minimum value of 40 ppt is achieved after approximately 22 years. This minimum value is assumed to remain constant into the future. Note, the IRM has been implemented and is operating, independent of the alternative chosen.

6.5 Short-term Impacts and Effectiveness

This criterion evaluates the potential short-term adverse environmental impacts and human exposures during the implementation of an alternative. As noted above, this assessment contemplates the full-capacity GAC system remaining in place to provide potable water during the design and construction of Alternatives 1, 2 and 3.

Alternative 1 would require the conversion of the test wells to production wells and the construction of a transmission main, which is estimated to take between two and three years to complete. Alternative 1 would require land disturbance for the conversion of the new wells and for the water transmission main, for a total of two to three miles. Construction would have minor short-term impacts to the community, such as noise and traffic disruptions, and would temporarily require construction of weirs and bank stabilization within the Hoosic River. Stormwater pollution during construction would be mitigated using standard erosion and sediment controls.

Alternative 2 would include a raw water intake at the Tomhannock Reservoir and the construction of a pumping station and transmission main from the Reservoir to the Village WTP. Alternative 2 is estimated to require four to five years before construction could be completed and drinking water could be available to allow for coordinating the project among many state and local agencies. The installation of the surface water intake and raw water pump station at the Tomhannock Reservoir would require earthwork and land disturbance on the eastern shore. The raw water transmission main would disturb approximately 13.4 miles of land during installation along public right of ways and existing electric easements. Construction would have short-term impacts throughout the project, including noise and traffic disruptions in the vicinity of work areas. Stormwater pollution during construction would be mitigated using standard erosion and sediment controls.

Alternative 3 would consist of connecting to the City of Troy water distribution system in Cropseyville and the construction of a booster pump station and transmission main to connect to the Village WTP. Alternative 3 is estimated to require five to six years before the connection to the Troy water system could be completed to allow for coordinating the project among many state and local agencies. The installation of the pump station in Cropseyville would require earthwork and land disturbance, and the water transmission main would disturb approximately 18 miles along public right of ways and existing electric easements. Construction would have short-term impacts throughout the project, including noise and traffic disruptions in the vicinity of work areas. Stormwater pollution during construction would be mitigated using standard erosion and sediment controls.

Alternative 4 has already been implemented and is providing potable drinking water to the Village; therefore, it has no short-term impacts.

Alternative 5 includes the implementation of the IRM for the McCaffrey Street Site. As previously noted, the IRM Work Plan has been approved by NYSDEC, construction is completed, and the system is operating. Short-term impacts during construction of the IRM were negligible.

6.6 Implementability

This criterion evaluates the technical and administrative feasibility of implementing an alternative. This includes assessing the technology involved in the alternative, construction challenges during implementation, and the level of permitting and approvals required for the alternative.

Alternative 1 converts test wells to production wells and 2.7 miles of water main as a replacement source of water for the Village. Alternative 1 requires approvals from private property owners, NYSDEC, NYSDOH, USACE, NYS Department of Agriculture and Markets, and NYSDOT. The technical feasibility of this alternative is known and involves standard protocols to install well pump components, conduct pump tests, test for constituents, and install a transmission main.

Alternative 2 would include a raw water intake at the Tomhannock Reservoir, the construction of a pumping station, and over 13 miles transmission main from the reservoir to the Village WTP. Alternative 2 requires extensive and significant administrative approvals and levels of design, which is estimated to require four to five years before the new source is online. The new infrastructure proposed for this alternative is technically feasible but necessitates large amounts of construction. Alternative 2 requires approvals from property owners, NYSDEC, NYSDOH, NYSDOT, National Grid, NYS Department of Ag and Markets, Rensselaer County, the City of Troy, and the Town of Brunswick. It is possible that the review and approval process associated with Alternative 2 could lead to additional delays in implementation.

Alternative 3 would include a new pump station and 18 miles of transmission main. Like Alternative 2, it would require extensive and significant levels of permitting, design and construction. Alternative 3 is estimated to take five to six years to complete. The new

infrastructure proposed for this alternative is technically feasible but necessitates the most construction. Alternative 3 also requires approvals from property owners, NYSDEC, NYSDOH, NYSDOT, National Grid, NYS Department of Ag and Markets, Rensselaer County, the City of Troy, and the Town of Brunswick. It is possible that the review and approval process associated with Alternative 3 could lead to additional delays in implementation.

Alternative 4 entails continued use of the existing full capacity GAC treatment system that was previously approved by the NYSDOH and has been effectively removing PFOA from the MWS since February 2017. Alternative 4 is already implemented and requires no additional administrative approvals.

Alternative 5 continues the IRM at the McCaffrey Street Site coupled with the continuation of the full capacity GAC treatment system. The IRM is intended to control offsite migration of groundwater toward the Village well field, and the full capacity GAC treatment system at the Village MWS would treat residual PFOA and other PFAS already within the aquifer system. Alternative 5 is implementable as both the full capacity GAC treatment system and IRM are in place and operational.

6.7 Cost Effectiveness

This criterion examines the cost effectiveness of each alternative to determine if the costs are proportional to the overall effectiveness. As stated in the National Contingency Plan (NCP), overall effectiveness is a balance between three of the criteria (long-term effectiveness, reduction in toxicity, mobility or volume and short-term effectiveness). It should be noted that cost effectiveness is based on the total cost for each alternative; however, it is important to understand the direct, indirect, and O&M costs for each as they vary significantly between alternatives. A summary of the estimated costs for each alternative is presented[37] in Table 6.7.1.

[37] The cost estimates for each of the alternatives do not consider potential impacts to consumer water bills, which will continue to be issued after the alternative is implemented.

Table 6.7.1 – Alternative Costs

	Direct Construction Costs	Indirect Costs	O&M Costs (30-year)	**Total Cost (30-year)**
Alternative 1 *New Groundwater Source*	$ 4.0 M	$ 1.1 M	$ 1.9 M	**$ 6.9 M**
Alternative 2 *New Surface Water Source*	$ 24.7 M	$ 6.7 M	$ 3.5 M	**$ 34.4 M**
Alternative 3 *Interconnection with Existing Public Water Supply*	$ 30.7 M	$ 8.3 M	$ 10.1 M	**$ 48.5 M**
Alternative 4 *Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System*	$ 1.9 M	$ 0.5 M	$ 3.9 M	**$ 6.3 M**
Alternative 5 *Continued Use of Public Supply Wells #3 and #7 with Treatment through Full Capacity GAC System and PFOA Remediation through the McCaffrey Street IRM*	$ 2.5 M	$ 0.6 M	$ 7.0 M	**$ 10.1 M**

Note: Construction cost for the Full Capacity GAC System, which will continued to be relied on under of these alternatives, is not included in the estimates. Construction costs for the Full Capacity GAC System under Alternatives 4 and 5 and the IRM under Alternative 5 are included in the above estimates but have already been expended.

Although Alternative 1 has the second lowest estimated total cost, it is essentially the same as total estimated costs of Alternative 4. However, since direct construction and indirect costs ($1.5M) for Alternative 4 have already been expended, Alternative 1 would remain the second highest future cost.

Alternative 2 has the second highest total costs. This is due to the significant infrastructure necessary to pump surface water from the Tomhannock Reservoir to the Village WTP.

Alternative 3 has the highest estimated total cost. The O&M costs for Alternative 3 are substantially higher than Alternative 2 primarily because of the need to purchase water at a wholesale rate from the City of Troy.

Alternative 4 achieves the objective of providing drinking water for the lowest total cost. It has the lowest direct and indirect costs, but the third lowest O&M cost. The $1.5 million of direct construction costs (and associated indirect costs) for the full-capacity system included in the above estimate has already been expended.

Alternative 5 has total costs that are approximately 50% higher than the total cost for Alternative 4 due to the design and construction of the IRM. Although the IRM would reduce the long-term O&M costs at the full capacity GAC system over time, the IRM has its own O&M costs and ultimately requires additional resources. Since this alternative satisfies the additional goal of remediation, its costs are not directly comparable to the other four alternatives.

6.8 Land Use

This criterion evaluates if an alternative is consistent with current and future land uses in the areas it is implemented. For the purposes of this Report, it also evaluates property access requirements for each alternative.

The conversion of test wells and a water transmission main under Alternative 1 would be consistent with current and future land uses. The infrastructure needed above the surface for a new well is small and would not disrupt neighboring properties. The new wells are private land, for which permanent easements or property acquisition would be required. The water main would be installed primarily in the public right of way.

Alternative 2 would construct a new surface water intake, raw water pump station, and raw water transmission main from the Tomhannock Reservoir to the Village WTP. The alternative is anticipated to be consistent with current and future land uses; the intake and pump station would require coordination with the City of Troy and Town of Brunswick for property access on the eastern shore of the reservoir, but the land is zoned for water supply. The majority of the raw water transmission main would be installed in the public right of way or share existing electric utility easements. The raw water main corridor must transit a NYS Agriculture District to connect to the Village. While this is typically discouraged to prevent development of farmlands, the raw water main would not transmit water suitable for drinking, so no future water connections would occur. Therefore, no land use restrictions are anticipated.

Alternative 3 would construct a new pump station and potable water transmission main to deliver water from the Troy water system in Cropseyville to the Village WTP. The pump station would require permanent easements or property acquisition to build. The majority of the potable water transmission main would be installed in the public right of way or share existing electric utility easements. The potable water main corridor must transit a NYS Agriculture District to connect to the Village. This is typically discouraged to prevent development of farmlands; therefore, moratoriums on water taps to the transmission line would be expected during permitting if this alternative is selected.

Alternative 4 is already constructed within the existing Village WTP property, which carries a "Water Supply" property class. This alternative is consistent with current and future land uses of that site.

The amount of land necessary to implement Alternative 5 is limited to property associated with the McCaffrey Street Site. The land needed to implement Alternative 5 is consistent with current and planned future land use.

The last remedy selection criterion in DER-10, "Community Acceptance", will be evaluated by the NYSDEC after the close of a public comment period following issuance of this Report.

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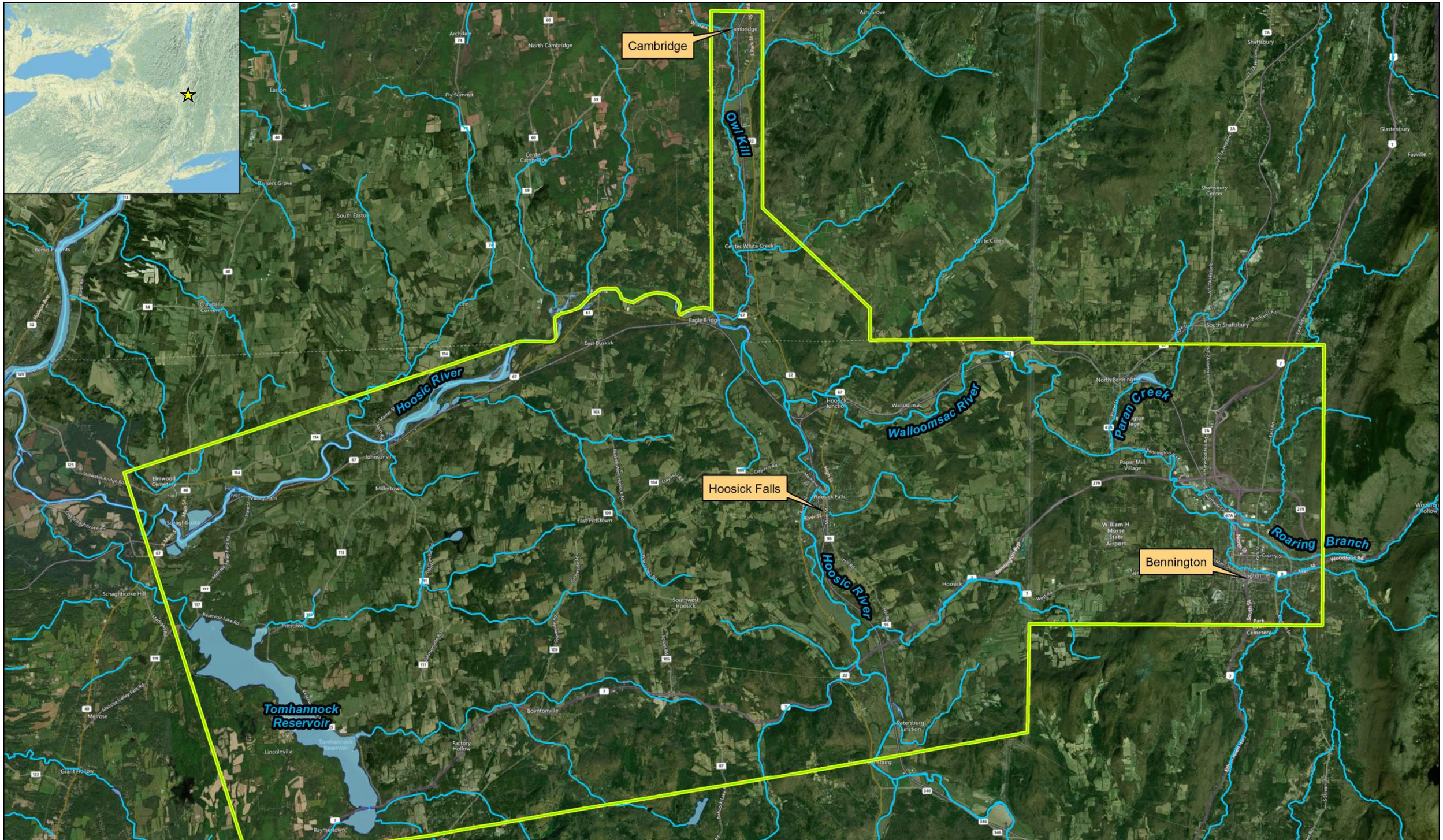
Figures



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Main: (518)453-4500 • www.cloughharbour.com

Figure 1

Groundwater Study Area

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

Hudson River

Walloomsac River

Hoosick Falls

Hoosic River

20 Mile Radius

10 Mile Radius

Tomhannock Reservoir

Broad Brook

Figure 2

Surface Water Source Study Area

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

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N W E S

1 inch = 12,500 feet

Project No. : 32091

Date : August 2019

0 6,000 12,000 Feet

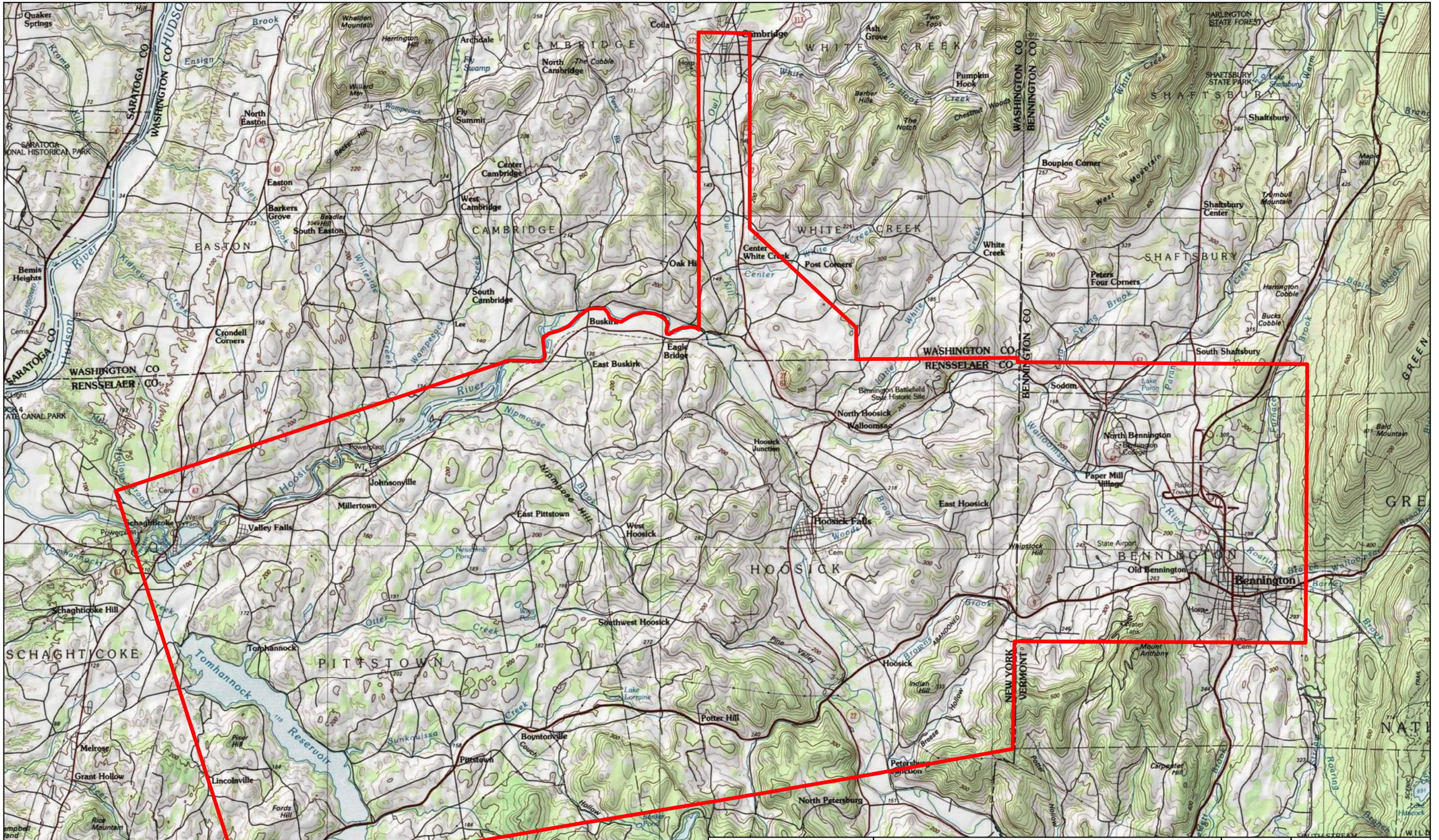

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Figure 3

Groundwater Study Area Topography

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

Map Credit:USGS 1:100,000 scale Quad courtesy of the United States Geologic Survey

Legend

- Groundwater Study Area
- 50ft Contours
- Linear Waterbodies
- Waterbodies
- New York Regional Aquifers (Data not available for Vermont Project Area)
- Aquifers of Aluvial Glacial Origin

Cambridge
Owl Kill
Hoosic River
Walloomsac River
Paran Creek
Hoosick Falls
Hoosic River
Roaring Branch
Bennington
Tomhannock Reservoir
bing

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Figure 4

Surface Water Bodies and Aquifer Extents

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

Map Credit: Image Courtesy of Earthstar Geographics LLC SIO © 2016 Microsoft Corporation © Photo Date: 5/7/2015. Waterbodies & Regional Aquifers courtesy of the New York State Department of Environmental Conservation, Glacial Alluval Aquifers courtesy of the USGS. Topography courtesy of the NYS GIS Clearinghouse

Legend

Groundwater Study Area

FEMA Flood Zones

Zone A - Areas subject to inundation by the 1-percent-annual chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AE - Areas subject to inundation by the 1-percent-annual chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Cambridge

Owl Kill

Hoosic River

Walloomsac River

Paran Creek

Roaring Branch

Hoosick Falls

Bennington

Tomhannock Reservoir

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Figure 5

FEMA Flood Zones

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

Legend

Groundwater Study Area

Surficial Geology of Bennington Area VT (2017)

- HPft - Fluvial Terrace
- Haf - Alluvial Fan
- Hal - Alluvium
- Hmp - Muck-Peat
- Pgm - Ground Moraine
- Pif - Inwash Fan
- Pk - Kame
- Pkm - Kame Moraine
- Pkt - Kame Terrace
- Plc - Lake Clay-Silt
- Pm - Moraine
- Pow - Outwash
- Pt - Till
- Ptt - Thin Till
- R - Bedrock
- ar - Artificial Fill

Surficial Geology - New York

- al - Recent Alluvium
- k - Kame Deposits
- km - Kame Moraine
- ld - Lacustrine Delta
- ls - Lacustrine Sand
- lsc - Lacustrine Silt and Clay
- og - Outwash Sand and Gravel
- r - Bedrock
- t - Till

Cambridge

Outwash Sand and Gravel Deposit

Owl Kill

Outwash Sand and Gravel Deposit

Hoosic River

Outwash Sand and Gravel Deposit

Walloomsac River

Outwash Sand and Gravel Deposit

Hoosick Falls

Hoosic River

Outwash Sand and Gravel Deposit

Tomhannock Reservoir

Paran Creek

Bennington

Roaring Branch

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Figure 6

Surficial Geology

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

An error made during the conversion from map to GIS shapefile has been corrected within this document, where Outwash Sand Gravel has been corrected to Till, west of the Kame deposit in Hooksick Falls.

Legend

Groundwater Study Area

Bedrock Geology - Vermont

- CZnm - Bull Formation and Nassau Formation
- Cc - Cheshire Quartzite
- Cdu - Dunham Dolostone
- Cm - Monkton Quartzite
- Csp - Clarendon Springs Formation
- Cw - Winooski Dolostone
- Ob - Bascom Formation
- Os - Shelburne Marble
- Ow, Owbl, Owl, Oww, Owwu - Walloomsac Formation

Bedrock Geology - New York

- Ca - Austerlitz Phyllite
- Cg - Germantown Formation
- Cm - Mettawee Formation
- Cn - Nassau Formation
- Cpw - Poultney Formation
- Cr - Rensselaer Graywacke
- OCs - Taconic Melange
- OCst - Stockbridge Marble
- OCu - Undivided Ordovician and Cambrian pelite
- Oag - Austin Glen Formation
- Obk - Beekmantown Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation
- Osf - Stuyvesant Falls Formation
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Owl - Walloomsac Formation
- Q - Glacial and Alluvial Deposits
- h20 - Water

Cambridge
Hoosick Falls
Bennington
Owl Kill
Hoosic River
Walloomsac River
Tomhannock Reservoir
Paran Creek
Roaring Branch

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Figure 7

Bedrock Geology

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

Legend

Groundwater Study Area

Village of Hoosick Falls
- C-1: Commercial-Industrial
- DC: Downtown Commercial
- I: Industrial
- R-1: Residential - 1
- R-2: Residential - 2
- R-3: Residential - 3

Pittstown Zoning
- HAMLET (HAM)
- RA

Town of Schaghticoke Zoning
- HC - Highway Commercial
- R40 - Residential
- RA - Residential
- Village of Schaghticoke
- Village of Valley Falls

Town of Bennington, Vermont
No Data Available

Town of Hoosick Zoning
- Agricultural / Residential (AR/R)
- Conservation Resource Managment (CRM)
- Daily Mine Zone (MINE)
- Flood Fringe (FF)
- Hamlet (HAM)
- Historic Overlay (H)
- Light Inductrial Commercial (LI)
- Rural Residential (RR)

Town of White Creek and Cambridge & Village of Cambridge Property Classes
- Agriculture
- Residential
- Vacant Lands
- Commercial
- Recreation & Entertainment
- Community Services
- Industrial
- Public Services

Town of Shaftsbury, Vermont
No Data Available

Village of Cambridge
Town of Cambridge
Town of White Creek
Town of Shaftsbury
Town of Bennington
Town of Hoosick
Village of Hoosick Falls
Town of Schaghticoke
Village of Schaghticoke
Village of Valley Falls
Town of Pittstown

RR RR RR HAM RR
FF LI AR/R H H
RR HAM HAM LI LI
LI LI RR
R-2 DC RR R-1 I R-2
R-3 R-1 RR
AR/R RR LI RR AR/R MINE HAM
RR CRM
LI HAM
LI FF RR
CRM RR FF
RA HAM HC HC R40 HAM HAM HAM RA HAM

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Figure 8

Zoning & Land Use

Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 8,600 feet

Project No. : 32091

Date : August 2019

0 4,400 8,800 Feet

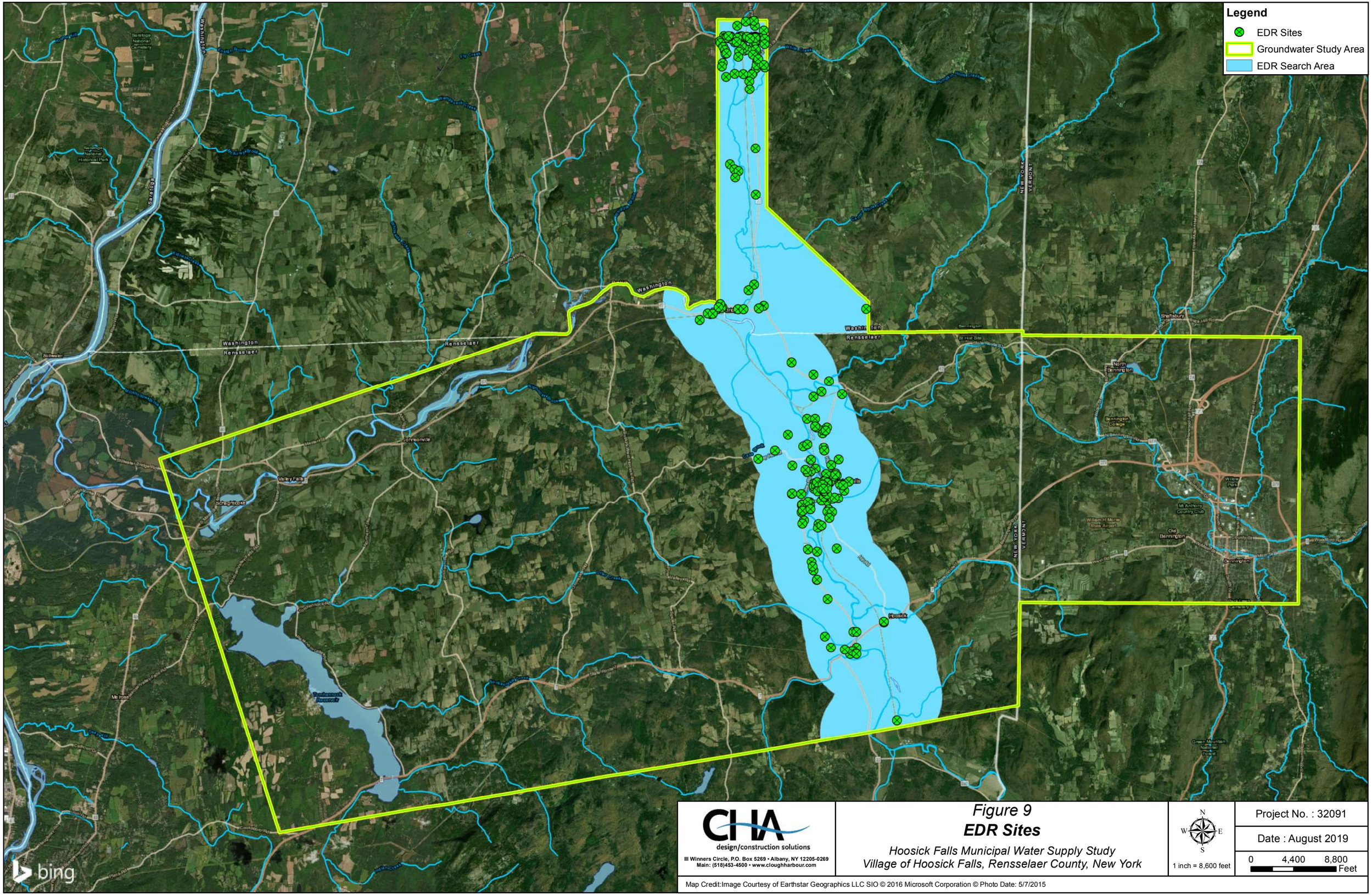

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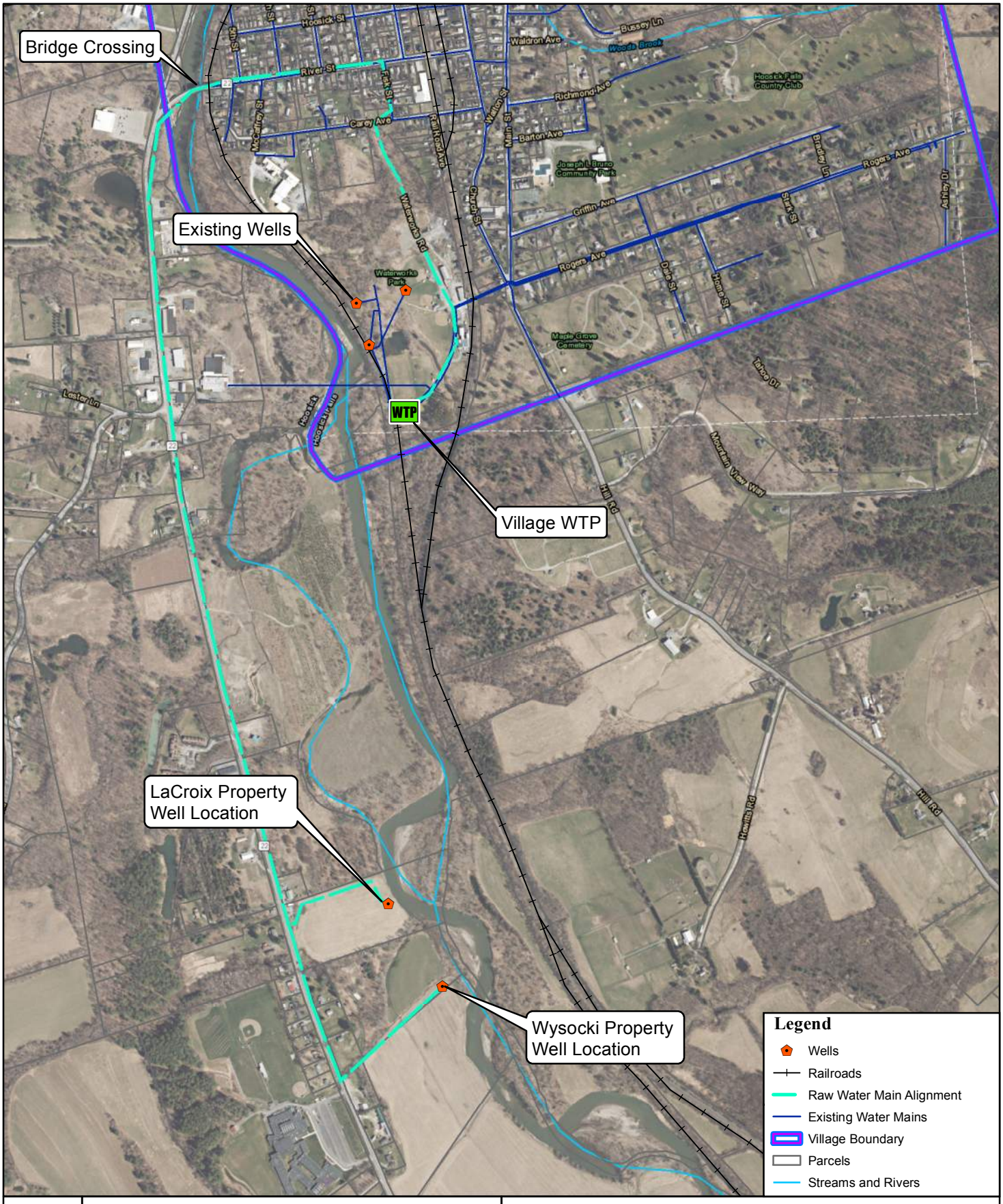
Figure 9
EDR Sites
Hoosick Falls Municipal Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S
1 inch = 8,600 feet

Project No. : 32091
Date : August 2019
0 4,400 8,800 Feet

Map Credit:Image Courtesy of Earthstar Geographics LLC SIO © 2016 Microsoft Corporation © Photo Date: 5/7/2015



N

CHA design/construction solutions

Scale 1" = 1,000'

CHA Project No. 32091

August 2019

Figure 10

Alternative 1 - New Groundwater Source

Hoosick Falls Alternative Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

Map Credit: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Location of Conceptual Raw Water Intake and Pump Station

Pine Valley Road

Quaker Street

Croll Road

Conceptual Raw Water Transmission Main Alignment

Alignment Follows Exisiting Electric Easement

Existing Village Water Treatment Plant

Village of Hoosick Falls

50'

40'

30'

20'

10'

A

C(T)

C

Legend

- Stream Crossings
- Stream
- Freshwater Regulatory Wetlands (DEC)
- Flood Hazards (FEMA)
- Tomhanock Reservoir Depth Contours
- Bedrock
- Waterbody
- Agricultural Districts
- Village of Hoosick Falls Boundary
- Town Boundaries

Alternative Water Supply Alignments

- Proposed Raw Water Main Alignment (13.4 miles)

Natural Heritage (DEC)

- Significant Natural Communities
- Rare Animals
- Rare Plants

Stream Classification

A Water source for drinking, culinary or food processing purposes; primary and seconday contact recreation and fishing

C Water source for fishing

NOTES:
- * = Stream is unprotected
- (T) = Stream designated as Trout waters
- (TS) = Stream suitable for Trout spawning

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Figure 11

Alternative 2 - New Surface Water Source

Hoosick Falls Alternative Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S

1 inch = 5,280 feet

Project No. : 32091

Date: August 2019

0 3,000 6,000 Feet

Alignment Follows Exisiting Electric Easement

Village of Hoosick Falls

Existing Village Water Treatment Plant

Area of known surface bedrock

Tamarac Road

Conceptual Transmission Main Alignment

Conceptual Interconnection with City of Troy distribution system and Pump Station

Existing City of Troy Water Main

50'

40'

30'

20'

10'

A

A-(TS)

C

C(T)

Legend

- Stream Crossings
- Stream
- Cropseyville Water Main

Stream Classification

Alternative Water Supply Alignment

- Proposed Potable Water Main Alignment (18.0 miles)
- Town Boundaries
- Rare Animals
- Rare Plants

Natural Heritage (DEC)

- Significant Natural Communities
- Freshwater Regulatory Wetlands (DEC)
- Bedrock
- Village of Hoosick Falls Boundary
- Waterbody
- Flood Hazards (FEMA)
- Agricultural Districts

A Water source for drinking, culinary or food processing purposes; primary and seconday contact recreation and fishing

C Water source for fishing

NOTES:
- * = Stream is unprotected
- (T) = Stream designated as Trout waters
- (TS) = Stream suitable for Trout spawning

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Figure 12
Alternative 3 - Interconnection with Existing Water Supply
Hoosick Falls Alternative Water Supply Study
Village of Hoosick Falls, Rensselaer County, New York

N W E S
1 inch = 6,667 feet

Project No. : 32091

Date: August 2019

0 3,000 6,000 Feet