United Water New York Inc.

Report on the Feasibility of Incremental Water Supply Projects and Conservation Opportunities in Rockland County, New York

June 2015

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IN ASSOCIATION WITH

AKRF

Table of Contents

Tables

Figures

Figures (Cont'd)

Appendices

Executive Summary

S.1 Introduction

The New York State Public Service Commission's (PSC or Commission) Order Addressing Status of Need and Directing Further Study, issued on November 17, 2014 (2014 Order), directed United Water New York Inc. (United Water or UWNY) to report on conservation and supply opportunities in United Water's Rockland County water supply system:

> UWNY shall study what conservation opportunities exist, in collaboration with the Task Force [the Rockland County Task Force on Water Resources Management], with the goal of identifying measures that may reduce demand by 2 million gallons per day (mgd) and shall file a report with the Secretary within six months of the issuance of this order identifying the feasibility, cost and estimated demand reductions associated with each identified measure.
>
> UWNY shall conduct a study and file a report with the Secretary within six months of the issuance of this order describing the feasibility, anticipated cost of development and description of the associated permitting process and processing time for a project or series of projects that could yield an additional 2-3 mgd of water supply. (2014 Order, pp. 66-67)

This report submitted by United Water responds to the directive of the 2014 Order to identify feasible conservation measures to reliably reduce water demand and small-scale incremental water supply projects that may be implemented for United Water's operations in Rockland County, New York.

S.2 Potential Incremental Water Supply Projects

This report considers the feasibility of additional groundwater resources, potential interconnections with other water suppliers, possible redistribution of water from the Ramapo River, and the potential for wastewater reuse.

S.2.1 Additional Groundwater Supply from Wells

United Water evaluated the potential feasibility of incrementally increasing water supply through the development of new wells and redevelopment and/or rehabilitation of existing wells not presently in use. It also discusses purchase of additional wells from private owners.

Numerous conditions factor into decisions regarding the siting of new wells. These include yield, impacts to the aquifer and nearby wells, location in system (proximity to demand need), water quality, and land availability. Localized groundwater levels are affected by new and continuous pumping and peak seasonal demand can create a steep decline in aquifer level, potentially resulting in the need to greatly reduce withdrawal or close certain wells. The presence of approximately 6,000 private wells spaced throughout Rockland County makes the identification of new well sites that will not interfere with existing wells difficult. Beyond the hydrogeological considerations, localized water quality and the potential for contamination from nearby land uses must be considered. Furthermore, available well locations are limited based on the siting requirements mandated by the New York State Department of Health (NYSDOH) regulations for wells that are part of public water supply systems.

A combination of factors will make it difficult and costly to develop new supply wells, to rehabilitate existing wells, or to convert private wells into community supply wells:

- United Water has already developed most of the productive well sites in Rockland County. What generally remain are potential sites with relative small yields and potentially significant siting and other issues. There would likely be some opportunities to develop new wells but United Water anticipates this to be time-consuming and costly with some risk that substantial funds could be expended without accomplishing a significant increase in supply. The cost to develop a small well (i.e., less than 300 gpm or 0.4 mgd) could be as high as $7 million, assuming normal permitting and land acquisition costs.

- Finding new well locations that will not potentially interfere with any number of the approximately 6,000 private wells scattered throughout Rockland County has proven to be difficult and will likely continue to be difficult.

- Nevertheless, there appear to be some opportunities to develop new small supply wells. Using these considerations, United Water has identified 10 potential well sites that may warrant further investigation, as well as a number of others with potential to be suitable as well sites. Additional investigation would be required before the feasibility, potential yield, and cost can be better understood. This would include substantial testing to fully understand capacity potential, water quality issues and impacts on private wells.

S.2.2 Interconnections with Other Water Suppliers

United Water has identified three potential interconnections with adjacent water suppliers, as well as the opportunity to recover water currently being supplied to a small number of accounts in Montvale, New Jersey. While supply from such interconnections may seem plausible, each is likely to have substantial and costly permitting complexity. Each of the identified projects will likely raise concerns over impacts on riparian rights in both New York and New Jersey. A dialogue with regulators in both states is needed to fully understand the ramifications of such projects. In addition, regardless of the legal arrangements made to secure the water transfer, there is a risk for these projects that if demands increase, the water supplier may unilaterally elect to cease providing water to United Water, which of course raises reliability concerns. The four potential projects are as follows:

- ***Village of Suffern:*** The Village of Suffern indicates that it has approximately 1 mgd of additional water supply that could be sold to United Water. The village has four wells along the Ramapo River and the permitted capacity is about 1 mgd higher than the current demand. With construction of a new booster station and certain other infrastructure improvements, United Water could purchase up to 1 mgd of potable supply from the Village of Suffern. However, United Water and the Village of Suffern would have to demonstrate for the New York State Department of Environmental Conservation (NYSDEC) and the Rockland County Department of Health that withdrawal of additional water from these wells would not exacerbate an existing chlorides problem in some of Suffern's wells.

- ***Village of Nyack:*** This project involves the purchase of up to 1 mgd of supply from the Village of Nyack and distribution to United Water's Rockland County system via a new booster station and certain infrastructure improvements. Due to the complex nature of the water supply permits in the Hackensack River, this project is likely to encounter significant regulatory issues. This project would require a clear willingness by the regulators in both New York and New Jersey to move the project forward.

- ***Water from the North Jersey District Water Supply Commission (NJDWSC) via the Blaisdell Interconnection:*** NJDWSC, a regional water supply entity for the State of New Jersey, supplies a large portion of the raw water used by United Water New Jersey (UWNJ) at its Oradell Reservoir. NJDWSC indicates that it has excess allocation that could be sold to another party. This water could be sold to United Water for use in Rockland County, via a transfer of raw water to UWNJ's Oradell Reservoir, where it would be treated at the Haworth Water Treatment Plant and then transferred from UWNJ's system to the Rockland County system through the existing Blaisdell interconnection/ pump station, located on the state line between the two United Water systems. The existing capacity of the station is 3 mgd; a 5 mgd capacity increase was also considered. Due to the large quantity of water that would be input to United Water's Rockland County system, substantial infrastructure improvements would be needed. Infrastructure improvements of about $1.25 to $6 million would also be required within the UWNJ system. However, NJDEP is currently assessing the supply capacity throughout northern New Jersey. This is an ongoing process that will take many years to complete. The transfer of water across state lines is a complex regulatory undertaking that would require the approval of regulators of both states, and would have to consider the water supply needs of other communities in New Jersey.

- ***Return of Water Provided to Montvale, New Jersey:*** The existing Blaisdell interconnection could be used to recover the approximately 0.1 mgd of water that is currently being provided by United Water to UWNJ customers in Montvale, New Jersey, if necessary water supply permits are obtained.

From a capital cost perspective some of these potential projects appear attractive. The unit cost based on capital cost estimates for the three interconnection projects ranges from $1.6 to $9.0 million per mgd of supply. However, operating costs as well as the costs of some other required improvements (e.g., potential upgrade of the Nyack Water Treatment Plant and upgrades to UWNJ's system) were not included in this feasibility study and the cost to purchase water would significantly increase the cost.

S.2.3 Optimizing Supply from Ramapo Aquifer and Ramapo River Watershed

There are a number of potential options to increase the water produced, within existing permit limits, from United Water's Ramapo Valley Well Field (RVWF) by augmenting flows in the Ramapo River. United Water has been able to reliably extract an annual average of about 7 mgd from the RVWF when it can be operated. However, during periods of low flow in the Ramapo River, the well field is not as productive and/or cannot be operated because of limitations set by the RVWF's water supply permit related to maintaining a minimum passing flow in the Ramapo River immediately downstream of the well field. The interaction between the river and the well field is relatively complicated and no modeling tool has been developed to completely understand this system. As a consequence, it is not possible to thoroughly evaluate the potential increases in well field production that may result from a wide range of possible improvements. United Water believes that development of a modeling tool and conducting modeling may identify opportunities for additional water supply from the Ramapo Aquifer. Some potential opportunities that may warrant further study with a surface water/groundwater model include the following:

- Additional augmentation of river flow from various sources (e.g., Potake Pond, Harriman Park Lakes, Lake Tuxedo, etc.).

- Pump back of water from the Ramapo River to Potake Pond during high flow events, for storage before returning to the river to augment supply.

- Additional treated wastewater effluent discharge from the Western Ramapo Advanced Wastewater Treatment Plant (AWTP) into the Ramapo River by an expansion to the AWTP and diversion of flow from other plants or areas in Rockland County.
- Possible additional flow into the Ramapo River from the Harriman Wastewater Treatment Plant resulting from population growth in Orange County.
- Combined management of the Village of Suffern and United Water's systems and their impact on river flow, using a holistic approach to maintain adequate flow for Suffern's interests while maximizing production from the RVWF.

S.2.4 Wastewater Reuse

As part of the development of the Haverstraw Water Supply Project (the Haverstraw Project), United Water conducted an extensive evaluation of wastewater reuse as a possible alternative to development of the Haverstraw Project, which was presented in the Draft Environmental Impact Statement (DEIS) prepared for the Haverstraw Project (completed in January 2012). The analysis concluded that reuse of stormwater or wastewater for non-potable purposes, to free up potable water capacity, would have little potential to increase capacity and would be cost-prohibitive. The reuse of wastewater (i.e., treated wastewater treatment plant effluent) for potable water is feasible and could produce up to 7.5 mgd of potable water, but requires upgrades to the wastewater treatment facility, expansion of the Lake DeForest water treatment plant, and installation of extensive new transmission mains. In total, this alternative was projected to have higher capital costs than the Haverstraw Project and therefore was not advanced.

As noted above, additional treated wastewater effluent discharge from the Western Ramapo Advanced Wastewater Treatment Plant (AWTP) could be discharged into the Ramapo River by an expansion to the AWTP and diversion of flow from other plants or sewering additional areas in the County. This option would require that the Rockland County Sewer District No. 1, which operates the AWTP, plan, design, permit, and construct an expansion to the AWTP, which was designed to allow an expansion up to 5 mgd. It would also require diverting additional wastewater to the plant to be treated, either by sewering additional areas of the county or by diversion of flow from other wastewater treatment plants such as the Rockland County Sewer District No. 1 Wastewater Treatment Plant in Orangeburg. However, the cost of increasing the treatment capacity of this plant and directing additional wastewater flows to the plant would likely be extensive.

S.3 Conservation and Water Recovery

United Water has identified a number of measures that it will take, and others that may be appropriate, to reduce water demand, including demand-side management methods to reduce the amount of water consumed by customers and improved management of the network by United Water.

In terms of conservation by customers, United Water's existing conservation program includes an ongoing customer conservation outreach and education initiative that will be maintained in the future. In addition, United Water has engaged in dialogue with municipal and Rockland County officials, company stakeholders, customers, and partnering utilities to identify additional ways to conserve, as well as to explore synergies between municipal leadership and the business community as well as potential cost sharing with other utilities. Feasible measures were identified that can reduce water demand, including a water audit program, rebate program for installation of water-saving devices, and partnership with local municipalities to implement water restriction regulations and ordinances.

In addition, United Water is planning to take numerous actions to reduce the amount of non-revenue water (NRW) produced, which will decrease the total amount of water produced, equivalent to reducing demand. All water systems have a component of production that is non-revenue water. Non-revenue water consists of water that is produced but not billed, such as water used during the water treatment process, to flush fire hydrants, and for fire-fighting, as well as water lost through leaks in the distribution system and from water main breaks. A certain amount of non-revenue water is normal for any water supply system, and cannot be avoided. United Water has an ongoing program to identify and repair system leaks, including replacement of some of the system's water mains each year. United Water also regularly undertakes a number of other initiatives to control NRW. This includes upgrading meters and identifying theft of service, so as to reduce apparent losses (which will shift some water consumption from NRW to revenue water). To address real losses, United Water's program includes installation of Advanced Metering Infrastructure (AMI), investment in renewal and replacement of water mains and services, leak detection on customer services and throughout the network via soundings, and accelerated leak and main break repairs. Most importantly, United Water anticipates that NRW control and reduction can best be accomplished by division of the four largest pressure districts in the Rockland County service area into smaller zones, referred to as District Metered Areas (DMAs), where leaks will be easier to detect and where there may be opportunities to reduce pressure. United Water affiliates have implemented DMAs in other systems (United Water New Rochelle and United Water Westchester) and two DMAs have already been installed within PD10, the largest pressure district in United Water's Rockland County system. United Water operations and engineering staff have been working on developing budgets and plans that would provide the option to accelerate the implementation of DMAs for United Water's Rockland County system. The estimated cost to complete the creation of DMAs in the four largest pressure districts is approximately $10.5 million and the time frame for the completion is about three years. United Water estimates that altogether, these initiatives may eliminate approximately 0.5 to 1.0 mgd of recoverable NRW within the Rockland County water supply system.

S.4 Conclusion Regarding Short-Term Measures

Based on the information in the report, United Water is confident that if the activities and associated targets identified in the report and summarized below are pursued to address short-term needs, supply and demand will remain in balance for the next 10 years. The report identifies the potential to reduce consumption by as much as 1 mgd total over 10 years through conservation programs and another 1 mgd total through an aggressive program to reduce NRW. In addition, the report identifies several small-scale incremental water supply projects that could be pursued depending upon the effectiveness of conservation and NRW reduction programs, as well as residential and commercial growth trends within Rockland County. Incremental supply of 1 to 3 mgd is likely feasible over a 10-year period. There may be opportunities beyond these targets, but a conservative view is prudent given significant factors that United Water has limited or no ability to control, such as environmental impact review / permitting costs and timing, ratemaking time and uncertainty, and stakeholder buy-in and cooperation.

Please note, however, that planning short-term water supply projects does raise the risk of incurring unnecessary cost for the ratepayers if a long-term project ultimately proves necessary. This point was made by Dr. Daniel M. Miller, the Water Supply Program Manager at the Rockland County Department of Health, in his comments of July 9, 2014 on the DPS's 2014 Staff Report on Need:

> Timing the development of any new water supply project, large or small, carries risks. If a project is built too early, the ratepayers would incur the expense of maintaining a plant

> before it is needed. Worse yet, if demand patterns significantly changed, rate payers would potentially incur the cost of building and maintaining a source that may never be needed. On the other hand, if a project is started too late, there is an increased risk that there will not be enough water to meet future demands.
>
> The latter scenario could lead to a potential public health hazard if demand increased rapidly such that supply capacity was insufficient to maintain pressure in the system, or in a less extreme case, could result in slowing or stopping further expansion of the UWNY system and thus commercial and residential development.
>
> Even postponing development of the desalination plant by developing smaller projects first involves some level of risk. Assuming the desalination plant is ultimately needed, ratepayers would bear not only the cost of the earlier smaller projects, but the cost of the desalination plant as well. The point I make is that all risks and implications need to be considered when long term water supply planning decisions are made. *(Comments of Dr. Daniel M. Miller to the Department of Public Service Staff Report on Need, July 9, 2014, p. 3)*

United Water has provided this report to inform short-term water supply and demand planning and, at the same time, to help inform the decision of the PSC as to whether United Water should continue to pursue the long term water supply project ordered in its 2006 and 2010 Rate Orders.

Section 1
Introduction

In response to the New York State Public Service Commission's (PSC or Commission) Order Addressing Status of Need and Directing Further Study, issued on November 17, 2014, United Water New York Inc. (United Water or UWNY) is providing this report discussing the feasibility of conservation measures to reliably reduce water demand and small-scale incremental water supply projects that may be implemented for United Water's operations in Rockland County, New York.

In response to requests to reexamine the need for an additional source of long-term water supply for Rockland County, on July 19, 2013, the PSC issued an Order Instituting Proceeding in Case 13-W-0303 (2013 Order) in connection with United Water's proposal to build a long-term water supply project in Haverstraw, New York. The 2013 Order required United Water to prepare a report providing "the most recent information relating to projected demand and need" for a long-term water supply project. United Water filed its report (2013 United Water Report) on August 19, 2013 and further supplemented it on November 8, 2013. The 2013 United Water Report responded to the 2013 Order and concluded that the most recent information about water supply and demand in Rockland County confirmed the previous findings by the PSC, other governmental agencies, and United Water: there is a continuing need fora long-term water supply project to satisfy projected water demand in Rockland County.

On May 22, 2014, the New York State Department of Public Service (DPS) Staff submitted a Report on Need (2014 Staff Report) and the PSC issued a Notice Seeking Comments on the Need Report. On November 17, 2014, the PSC issued an Order Addressing Status of Need and Directing Further Study (2014 Order) which concluded that:

> the need for new supply is delayed, but there is still an ongoing need for additional long-term water supply. . . . That said, our overarching concern is that a margin of reserve is maintained between demand and safe yield supply. All efforts should be directed to keeping demand below that level or otherwise securing additional supplies so as to raise that threshold.
>
> Thus, there is a small window of opportunity to further explore whether significant conservation measures can be identified and executed to produce reductions that can be relied upon, and whether smaller increments of supply can be identified to complement conservation measures and ensure adequate supply. We direct UWNY to provide reports on conservation and supply alternatives within six months of the issuance of this order and will require UWNY to submit quarterly reports providing data on actual usage to monitor the gap between supply and demand. We also call upon the Rockland County Task Force on Water Resource Management to report on its plans for adopting feasible conservation options and the demand reductions associated with these measures. (2014 Order, pp. 65-66)

The specific requirements of the 2014 Order related to reports on conservation and supply alternatives were as follows:

> UWNY shall study what conservation opportunities exist, in collaboration with the Task Force [the Rockland County Task Force on Water Resources Management], with the goal of identifying measures that may reduce demand by 2 million gallons per day (mgd) and shall file a report with the Secretary within six months of the issuance of this order identifying the feasibility, cost and estimated demand reductions associated with each identified measure.
>
> UWNY shall conduct a study and file a report with the Secretary within six months of the issuance of this order describing the feasibility, anticipated cost of development and description of the associated permitting process and processing time for a project or series of projects that could yield an additional 2-3 mgd of water supply. (2014 Order, pp. 66-67)

This report submitted by United Water responds to the directive of the 2014 Order related to conservation opportunities and the feasibility of smaller scale, incremental water supply projects.

Regarding conservation, the 2014 Order provides some additional discussion of the PSC's expectations for the report (p. 42):

> Regarding the comments for additional conservation measures, it is urgent for these options to be explored, however, we cannot at this time depend on the results of conservation efforts not yet identified, evaluated or undertaken. We direct UWNY to study what additional conservation opportunities exist, in collaboration with the Task Force, with the goal of identifying measures that may reduce demand by 2 mgd. UWNY shall report back to us within six months of the issuance of this order identifying the feasibility, cost and estimated demand reductions associated with each identified measure. We also are interested in hearing the plans of the Task Force for adopting feasible conservation options and demand reductions associated with those measures. To that end, we request that the Task Force submit its findings to us in six months.

With respect to conservation, this report discusses the measures that United Water plans to implement to reduce water consumption by its customers as well as other programs that may further reduce water consumption, subject to approval by the PSC. The report also discusses measures to reduce "non-revenue water" (also referred to as NRW) and, more specifically, water that is lost due to leakage or other factors that may be corrected. Reduction in non-revenue water is the primary conservation measure that can be implemented by United Water, which, as a private company, does not have the authority to mandate or enforce conservation by its customers.

Regarding incremental water supply projects, the 2014 Order further elaborates on the requirement to assess the feasibility of smaller scale incremental water supply projects (pp. 46-47):

> We instruct UWNY to conduct a new and independent study and report to us the feasibility, anticipated cost of development and description of the associated permitting process and processing time for a project or series of projects that could collectively yield an additional 2-3 mgd of water supply. While Staff recommended an evaluation of the development of groundwater resources, we will require UWNY to broaden its review of potential supply alternatives. For example, UWNY should investigate development of new wells, purchase of additional wells from private owners, redevelopment and/or rehabilitation of existing wells not presently in use,

the appropriate supplier of water to the Montvale community and wastewater reuse. While UWNY is not limited to these options, we expect that it will review them in the context of its study and provide a thorough analysis of each potential new source.

This report considers the feasibility of additional groundwater resources, potential interconnections with other water suppliers, possible redistribution of water from the Ramapo River, and the potential for wastewater reuse. The discussion of each of the incremental water supply projects evaluated in this report includes an opinion of probable cost (see Sections 2.3.3, 3.2.2, 3.3.2, 3.4.2). Included within each probable cost summary is a line item for engineering and permitting (and related expenses). The permitting costs items include environmental impact review, likely under the New York State Environmental Quality Review Act (SEQRA). It is important to note that each of the statements of probable costs set forth in this report assume (without confidence) as part of the permitting process a modest environmental impact review that would ordinarily be expected for a routine water utility project. In the event the environmental impact review (or any other aspect of the permitting process) becomes prolonged or otherwise extensive in terms of scope, timing, expense, or procedural requirements (public meetings, hearings, other administrative processes, litigation, etc.), the actual cost for any project will likely exceed the estimate of probable cost set forth in this report, and potentially by a significant (and currently unquantifiable) margin.

After this introduction, this report includes the following sections:

- Section 2: Additional Groundwater Supply from Wells
- Section 3: Interconnections with other Water Suppliers
- Section 4: Optimizing Supply from Ramapo Aquifer and Ramapo River Watershed
- Section 5: Wastewater Reuse
- Section 6: Conservation and Water Recovery
- Section 7: Conclusion

Section 2

Additional Groundwater Supply from Wells

2.1 Introduction

This section evaluates the potential feasibility of incrementally increasing water supply through the development of new wells and redevelopment and/or rehabilitation of existing wells not presently in use. It also discusses purchase of additional wells from private owners.

United Water currently operates 60 production wells throughout Rockland County. Since 2006, in response to a PSC Order mandating increases to average and peak-period water supply, United Water has added 1.5 mgd to its annual average water supply capacity through introduction of improvements to existing groundwater wells. Most of the well improvement projects have added peak capacity rather than average capacity, and those projects that have increased average capacity have provided a small increase per project, with the largest increase at 0.5 mgd for a single well project.

Previously, the 2014 Staff Report on Need recommended that United Water should "explain whether or not potential exists for further development of groundwater resources as short- and long-term measures to delay the need for a major supply source construction project." (Staff Report, pp. 43-44) The 2014 United Water Report submitted in response to the Staff Report provided a discussion of the reasons that, after extensive analysis, United Water concluded that available groundwater supply sources that would satisfy short- and medium-term demand and meet the state sanitary code requirements are limited.

Numerous conditions factor into decisions regarding the siting of new wells. Localized groundwater levels are affected by new and continuous pumping and peak seasonal demand can create a steep decline in aquifer level, potentially resulting in the need to greatly reduce withdrawal or close certain wells. Expanded use of the bedrock aquifer would rely on small capacity wells (0.25 to 0.5 mgd per well) that are sufficiently spaced to avoid peak interference effects. The presence of approximately 6,000 private wells spaced throughout Rockland County makes the identification of new well sites that will not interfere with existing wells difficult.

Beyond the hydrogeological considerations, localized water quality and the potential for contamination from nearby land uses must be considered. Furthermore, available well locations are limited based on the siting requirements mandated by the New York State Department of Health (NYSDOH) regulations for wells that are part of public water supply systems. NYSDOH's public water supply regulations (10 NYCRR § 5-1, Appendices 5B and 5D) require that the water company possess legal title to lands within 100 feet of the well and control by ownership, lease, easement, or other legally enforceable arrangement the land use activities within 200 feet of the well. Finding available land in a suitable aquifer with an adequate buffer area is difficult in Rockland County.

Using these considerations, United Water has identified 10 potential well sites that may warrant further investigation, as discussed below.

2.2 Identification of Potential Well Sites

This section provides a preliminary list of potential test production well locations and discusses the potential feasibility of each site. This list includes potential new wells, purchase of additional wells from private owners, and redevelopment/rehabilitation of existing wells not in use. United Water developed this initial list using company data from decades of United Water groundwater exploration in Rockland County, along with the 2010 study prepared by the U.S. Geological Survey (USGS) related to Rockland County's groundwater resources[1], and a variety of local, state, and federal databases available from the New York State Department of Environmental Conservation (NYSDEC), Rockland County Planning Department, the Federal Emergency Management Agency (FEMA), and New York State mapping information available from the New York State Geographic Information Systems (GIS) Clearinghouse.

To develop this list, potential sites throughout Rockland County were considered for their ability to meet preliminary evaluation criteria related to yield, impacts to the aquifer and nearby wells, location in system (proximity to demand need), water quality, and land availability, as discussed below. This list identifies a number of possible sites that may be appropriate for further investigation.

The list of potential well sites provided in this report is preliminary, based on an initial phase of investigation. Before a particular well site for a new well or existing well can be selected for development, further investigation is required. For new sites, this includes preliminary drilling and testing to determine the potential production capacity of that site and the quality of the water that may be obtained there. The results of the preliminary drilling and testing may result in the progression of development of a test production well (and further testing), placing the test well on reserve (pending other test well results), or abandonment of the site due to insufficient yield (or other unforeseen factors). In addition, for well sites that appear to have potential for development, additional discussions will be required with property owners regarding their interest in selling the site and, for any sites with a willing seller, environmental review and permits and approvals will be required, as discussed below.

2.2.1 Evaluation Criteria

In the development of the 60 groundwater supply wells it operates in Rockland County, United Water has purchased existing wells and installed over 100 test wells at various sites in the County. Many of the test well sites were developed into some of the 60 production wells, while others were not developed due to water quality and/or quantity (yield) issues. The last new United Water groundwater supply well was installed in 1995 near Rockland Community College. The primary evaluation criteria for the existing groundwater supply wells were yield, location in the system (proximity to demand need), water quality, and land availability. These same criteria remain applicable and were used in evaluating potential new groundwater production sites.

2.2.1.1 Potential Yield

The existing United Water groundwater supply network consists of 60 wells, with production ranging from less than 100 gallons per minute (gpm) to 1,400 gpm, equivalent to 0.14 to 2.02 mgd. Many of United Water's existing wells are high yielding wells located in the more prolific areas of Rockland

[1] Heisig, P.M., 2010, Water resources of Rockland County, New York, 2005–07, with emphasis on the Newark basin bedrock aquifer: U.S. Geological Survey Scientific Investigations Report 2010–5245, 130 p., at http://pubs.usgs.gov/sir/2010/5245/.

County's bedrock and sand and gravel aquifers. Thus, these more prolific sections of the aquifers are already developed with wells, and there is limited potential for new wells in the same areas without adverse effects on production at existing wells as a result of interference. As noted in the 2010 USGS study related to Rockland County water supply, "A few large-capacity wells with yields on the order of hundreds of gallons per minute are possible in the most productive areas of the aquifer, but these possibilities are limited by existing domestic wells, water quality, lack of land area, and potential interference with existing supply wells."[1]

Since the more prolific sand and gravel aquifers have already largely been developed with wells by United Water, any new supply wells will be developed from the bedrock aquifer. As a result, United Water estimates the yield of new groundwater supply wells in the bedrock aquifer will be approximately 300 gpm or less, equivalent to 0.4 mgd or less. Historically, United Water has not pursued development of a well site unless it could yield a minimum of 150 gpm, and United Water is initially using this same potential yield rate in its current evaluation. This yield criterion recognizes the high cost of developing smaller wells and the greater energy demand of operating smaller wells, in comparison to larger wells. To reach a total of 2 to 3 mgd of new supply, as directed in the 2014 Order, would require 7 to 14 new wells, assuming the range in yields of 150 to 300 gpm.

Since most of the sites currently being evaluated have no wells on them, the potential yield data is largely inferred from known aquifer characteristics and historic well yields in the vicinity. Potentially suitable sites will require test wells, which will provide the necessary yield and aquifer characteristic data to determine the viability of developing a production well at a particular site.

United Water and Rockland County are currently using the USGS's groundwater model to consider resiliency of supply during a recurrence of the drought of record. RCDOH and UWNY have retained CDM Smith to utilize the existing Rockland County bedrock aquifer groundwater model developed by USGS staff[2] which was a companion to the Rockland County bedrock aquifer resource study conducted by USGS. The groundwater model is being utilized to evaluate the potential impacts of the 1960s drought of record on the bedrock aquifer. Groundwater model runs to date are assuming current groundwater production capacity and documenting theoretical declines in the groundwater levels during the drought of record. Currently, the groundwater level declines are being evaluated relative to potential production capacity losses and also the potential for locating new groundwater supplies in areas of lesser drought impacts. The results of this study, which will provide information on which areas of the aquifer are least impacted by drought, could be another factor to be considered in the selection of potential wells sites for testing.

2.2.1.2 Interference with Other Wells

In addition to United Water's 60 production wells, Rockland County's bedrock, sand, and gravel aquifers also support approximately 6,000 private wells. At any given well site, localized groundwater levels are affected by new and continuous pumping, which can result in an aquifer level that adversely affects nearby wells. This effect can be particularly pronounced during peak seasonal demand. Potential interference with any number of the approximately 6,000 private wells scattered throughout the County has proven to be difficult and will likely continue to be difficult.

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[2] Yager, R.M. and Ratcliffe, N.M., 2010, Hydrogeology and simulation of groundwater flow in fractured rock in the Newark basin, Rockland County, New York: U.S. Geological Survey Scientific Investigations Report 2010–5250, 137 p., at http://pubs.usgs.gov/sir/2010/5250/.

The NYSDEC regulates and requires a permit for any groundwater withdrawal of 100,000 gallons per day (69 gpm) or greater. Requirements of the permit include a 3- to 5-day pumping test, nearby well interference testing, analysis of well and aquifer yield and consideration of potential surface water impacts. Thus, for any potential well sites identified where a test well indicates potential yield and water quality may be suitable for development of a supply well, United Water will have to complete rigorous pumping tests required by the NYSDEC to determine the sustainable yield of the well tapping the aquifer (under drought and average capacity withdrawal rates); determine potential impacts on nearby groundwater users and also any potential effects on surface water resources (e.g., wetlands and streams). For any negative effects on nearby wells identified, mitigation will need to be implemented for those adversely affected wells. For example, this may involve lowering the pump of the affected well, drilling new deeper wells with a deeper pump settings (at a cost of approximately $25,000 per well), or connecting the well owner to the community supply. Any negative impacts to nearby groundwater users and/or surface water resources that cannot be mitigated may result in the denial by NYSDEC of a water supply permit.

2.2.1.3 System Location

Proximity to need (demand) is a criterion in developing additional groundwater supply wells in United Water's Rockland County network. United Water's system is divided into pressure districts (PDs), and the demand for water varies within these districts. The highest area of growth in the County is located in the Town of Ramapo and the Town of Haverstraw. The Town of Ramapo is already developed with the system's higher capacity wells, making identification of new well sites there challenging. If well sites cannot be identified in the pressure districts where demand is located, infrastructure improvements will be required to allow such transmission of water between pressure districts, which adds to the cost of well development. The eastern portion of the County (or PD10), where United Water's main surface water source, Lake DeForest is located, is considered "water rich" so that any additional groundwater supplies developed there would likely need to be transmitted westward to more "water deficient" pressure districts, adding to the cost associated with these new wells.

2.2.1.4 Land Availability

Public community supply wells in New York are regulated by the NYSDOH to ensure the quality of the water supplied to consumers meets applicable health standards. One component of the maintenance of water quality for groundwater supply wells is to obtain and maintain an area around a groundwater supply well that is relatively free of existing or potential future contaminants. To this end, the NYSDOH requires ownership of a 100-foot radius around a public community supply well, and a pollution easement (or ownership) of the area extending 200 feet from a well. The radius of 200 feet from a well occupies 2.9 acres of land. Finding sites in the center of almost 3 acres of undeveloped land is difficult in Rockland County, given the existing development patterns across much of the County. In addition, any suitably large undeveloped sites must have owners willing to work with United Water in developing a groundwater supply well – allowing test wells to be installed, and ultimately selling the well site if it is found to be suitable for a production well.

2.2.1.5 Water Quality

In addition to the NYSDOH land ownership and easement requirements, the existing quality of the groundwater at a given site must be considered in potentially developing a well. Groundwater can be affected by some naturally occurring contaminants, such as arsenic, radiological constituents, iron, manganese and sulfate. Groundwater can also be affected by contamination resulting from current or past activities near the well site. For example, groundwater can be affected by contamination related

to underground fuel storage tanks, such as at gasoline stations. To protect public health, the NYSDOH has set maximum contaminant levels (MCLs) for potential groundwater pollutants.

Contamination can be removed from groundwater so that it meets all applicable MCLs, but this requires additional capital expenditures and long-term operation, maintenance and monitoring expenses in comparison to wells with no contamination. Installation of a test well at a specific site is the only way to determine site-specific water quality characteristics. Thus, in selecting potential well sites, preference is generally given to potentially non-groundwater-contaminated areas based on known historical groundwater contamination through review of potential pollution source databases such as those provided by the NYSDEC.

Groundwater from supply wells also has the potential to be negatively influenced from nearby surface water quality. This is referred to as "Groundwater Under the Direct Influence" of surface water (or "GWUDI"). Wells too close to surface water bodies may not have sufficient natural filtration between the well and surface water bodies to remove pathogens and as such may require treatment that would normally be required for surface water sources. As such, the distance to surface water bodies (including flood zones) is a significant factor in the evaluation of potential well sites. Wells located too close to surface water bodies will have to undergo testing for GWUDI.

In addition, the NYSDOH has rigorous construction and installation requirements for "community supply" wells to help protect the well intake area from migrating surface contaminants such as pathogenic bacteria. Many, if not most, of the existing non-community supply wells in Rockland County do not meet these strict community supply well construction standards. Therefore, most existing wells are unlikely to be able to be used for community supply wells, requiring the installation of an appropriately constructed community supply well.

2.2.2 Potential Well Sites Identified

2.2.2.1 Initial List of Potential Sites

Using the evaluation criteria outlined above, United Water sought to identify potential well sites that may warrant further evaluation and installation of test wells. Given the time constraints imposed by the filing deadline for this report, the investigation was limited primarily to sites that have been investigated in the past (e.g., former United Water test wells) or that were identified by others; have sufficient open area for ownership and easements; have good estimated yield potential; and have a willing property owner as a partner in the investigation. As part of this initial phase of the investigation, United Water met with each of the Rockland County town supervisors and/or representatives regarding the potential use of any town-owned parcels in the groundwater investigation and for recommendations on other private parcels. United Water also initiated discussions with Rockland County, the Palisades Interstate Park Commission, and some private landowners regarding potential use of their parcels. United Water also met with the Groundwater Subcommittee of the Rockland County Task Force on Water Resources Management (Task Force) regarding potential well sites. As a result of these discussions, potential well sites have been identified for this preliminary list. In addition, potential well sites identified by the Paul Heisig of the USGS were included when they appeared to meet evaluation criteria.

Based on evaluations conducted thus far, United Water has identified an initial 10 sites for possible further investigation regarding their potential suitability for development of groundwater production wells (see **Table 2-1** and **Figure 2-1**). Based on preliminary information, the estimated potential yield at the initial sites totals approximately 2.2 mgd, which would need to be verified through site-specific

investigations. United Water has reviewed these sites relative to the evaluation criteria discussed above based on available information. For any sites ultimately selected for consideration, additional site-specific investigations, including drilling and subsequent preliminary quality and quantity testing, will be required. With more detailed information, some sites may be determined not to be suitable, and with additional information, other sites may be identified for further investigation.

Four of the 10 sites are existing United Water test wells/production wells. In addition, United Water has evaluated the use of two former test wells/production wells that were either not put into production or are no longer in production, these well sites are not in service because of their low yield and groundwater contamination. For these reasons, United Water believes that they are not good candidates to serve as production wells. For other wells, United Water has increased/optimized existing production wells during the short-term water supply program implemented between 2006 and 2015 by increasing peak and average capacities where possible. There may be some additional minor average increases possible (peaking would be limited) and these are under consideration.

2.2.2.2 Other Potential Sites that Do Not Warrant Further Investigation

In addition to the 10 sites that may warrant further investigation, United Water also identified four other sites that appear to meet the initial siting criteria, but for which property owners consulted indicated that they are not interested in pursuing a well site investigation at this time. These sites are also listed in **Table 2-1**, but are not considered to warrant further investigation without property owner interest and consent.

In addition to the sites discussed above, a well site at the Pfizer facility in Pearl River, formerly known as Lederle or Wyeth, has been suggested by staff at the USGS and Task Force members as having potential for a community supply source. United Water had investigated this location in the past as a potential community supply source. The property is developed with many buildings and few open spaces, and includes approximately 25 wells that have been used to produce reported volumes of up to 2 to 3 mgd to operate the campus's heating, ventilation, and air conditioning (HVAC) systems. If the current groundwater supply at Pfizer was utilized for a community potable supply, a separate (unknown) source of water for the HVAC systems would need to be acquired or the HVAC systems modified to not use the local groundwater resources, not an insignificant issue. With respect to yield, some pumping tests have been completed at the site in the past; however the actual aggregate sustainable drought yield from the wells tapping the local bedrock aquifer can only be estimated at this time as approximately between 1 and 2 mgd. However, most of the wells at the Pfizer site do not have the required area around them to meet NYSDOH buffer/easement requirements. Moreover, in the past there have been issues of groundwater contamination on the site that would require further investigation and could be difficult to address. Finally, and potentially most importantly, the current owner of the property is not interested in participating in test well investigations or community well development at this time.

2.2.2.3 Additional Sites that May Be Suitable

In addition to the initial 10 sites identified, almost 100 additional sites were identified that have either been investigated in the past or are newer sites recently identified. These sites are listed in **Table 2-2**. Given the very preliminary nature of the site investigation, little information is available about these additional sites.

Table 2-1 - Initial Test Well Site Investigation

Map Site ID	Town	PD	USGS Site [1]	Potential Yield	Existing UWNY Test Well	100-Ft Radius	200-Ft Radius	USGS Aquifer Zone	NYSDEC Remedial or Other Potential Contamination (w/in 2,500 ft)	NYSDEC Bulk Storage Facility (w/in 500 ft)	Potential Natural Contamination Issues	Potential UWNY Production Interference	NYSDEC Water Withdrawal Pt Rank	Private Wells Within 1,500 ft	School Property	Park Alienation	GWUDI Review	Wetlands Present	Flood Potential	Comments
Willing property owner																				
A	Haverstraw	20/21		150		Yes	Yes	D	No	No*		Yes	Yes	2	Yes	Yes	Yes	Yes	?	DPW contamination?
B	Clarkstown	10	x	200		Yes	No	C	No	No		Yes	Yes	13	Yes	Yes	Yes	Yes	Yes	Minimal land area
C	Clarkstown	10		150		Yes	Yes	C	No	No		No	Yes	0	Yes	No	Yes	Yes	Yes	Large open area
D	Clarkstown	10		150	Yes	Yes	No	D	No	No	Sulfate / Fe/ Mn / As	Yes	Yes	5	Yes	Yes	Yes	Yes	No	Easement, natural contaminants
E	Ramapo	20	x	100	Yes	Yes	Yes	B	No	No		No	Yes	11	Yes	Yes	No	No	Yes	Wetlands
F	Clarkstown	95	x	200		Yes	Yes	C	No	No		No	Yes	2	No	Yes	Yes	Yes	Yes	
G	Clarkstown	10		150		Yes	Yes	D	Yes	No*		Yes	Yes	4	Yes	Yes	Yes	Yes	Yes	PIP salt contamination?
H	Clarkstown	10		150	Yes	No	No	D	No	No	Sulfate / Fe/ Mn / As	No	Yes	48	Yes	Yes	No	No	Yes	NYSDEC permitted, NYSDOH easement issue
I	Clarkstown	10		300	Yes	Yes	Yes	D/C?	Yes	No	As	Yes	Yes	60	Yes	Yes	No	No	Yes	Arsenic, Fe/Mn fron LDF
J	Haverstraw	40		150		Yes	Yes	D	No	No		Yes	Yes	15	Yes	?	Yes	Yes	Yes	Potential interference with Hospital wells
				2.9MGD																
Owner not interested at this time																				
M	Ramapo	20		200		Yes	Yes	A/B?	No			Yes	Yes	0	Yes	Yes	Yes	Yes	Yes	
N	Ramapo	95		250		Yes	Yes	C	Yes			Yes	Yes	17	Yes	Yes	Yes	Yes	Yes	
O	Haverstraw	20/21		150		Yes	Yes	D/F	No			No	Yes	1	Yes	Yes	Yes	Yes	Yes	Unwilling to sell
P	Clarkstown/ Orangetown	95/10	x	1400		No	No	C	Yes			Yes	No	?	Yes	Yes	Yes	Yes	Yes	Many wells to consider, most a problem with easements, interference, onsite landfills

Note: 1. USGS Reference: Heisig, 2010.

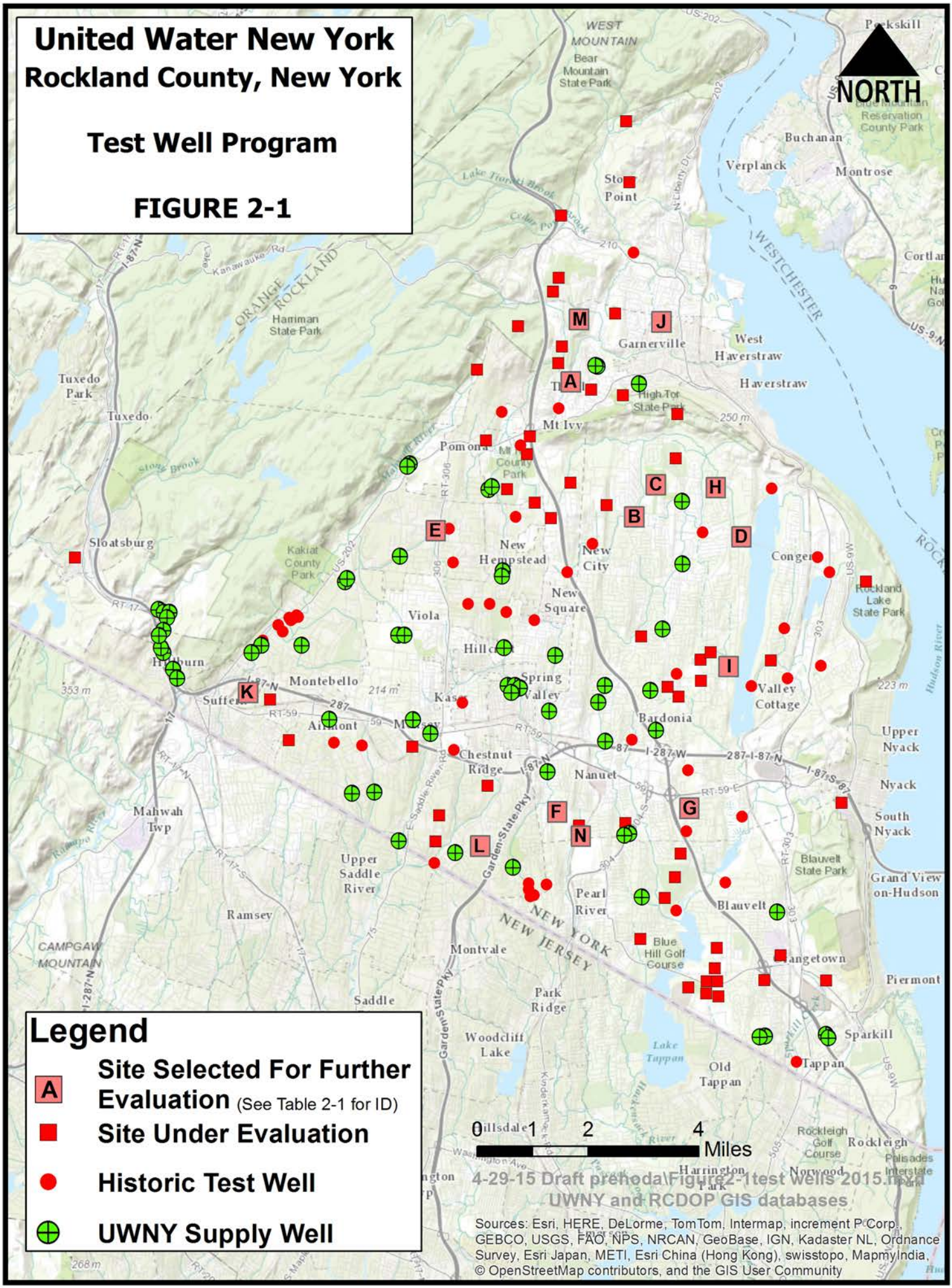

United Water New York
Rockland County, New York
Test Well Program
FIGURE 2-1
NORTH
Legend
Site Selected For Further Evaluation (See Table 2-1 for ID)
Site Under Evaluation
Historic Test Well
UWNY Supply Well
0 1 2 4 Miles
4-29-15 Draft preh oda\Figure 2-1test wells 2015.mxd
UWNY and RCDOP GIS databases
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
WEST MOUNTAIN
Bear Mountain State Park
Peekskill
Buchanan
Verplanck
Montrose
Stony Point
WESTCHESTER
ORANGE ROCKLAND
Harriman State Park
Tuxedo Park
Tuxedo
Garnerville
West Haverstraw
Haverstraw
High Tor State Park
Mt Ivy
Pomona
New Hempstead
New City
New Square
Viola
Sloatsburg
Kakiat County Park
Congers
Rockland Lake State Park
Hillcrest
Spring Valley
Valley Cottage
Montebello
Suffern
Hillburn
Airmont
Monsey
Bardonia
Upper Nyack
Nyack
South Nyack
Chestnut Ridge
Nanuet
Blauvelt State Park
Grand View on-Hudson
Mahwah Twp
Upper Saddle River
Ramsey
Pearl River
Blauvelt
CAMPGAW MOUNTAIN
Montvale
NEW YORK
NEW JERSEY
Blue Hill Golf Course
Piermont
Saddle River
Park Ridge
Woodcliff Lake
Lake Tappan
Old Tappan
Sparkill
Tappan
Rockleigh Golf Course
Rockleigh
Palisades Interstate Park
Norwood
Harrington Park
Garden State Pkwy
I-87-N
I-287-W
I-287-I-87-N
I-87-S
RT-59
RT-17
RT-306
US-202
US-9W
RT-303
RT-304
RT-505
A
B
C
D
E
F
G
H
I
J
K
L
M
N

Table 2-2 - Additional Potential Well Sites

Additional Well Sites under Consideration as of 5/15/15	Town	PD
Animal Shelter Pomona	Clarkstown	20
Cropsey Farm	Clarkstown	10
Germonds Park	Clarkstown	10
Smith Farm	Clarkstown	20/10
Heaton	Clarkstown	10
Tree Farm	Clarkstown	10
Clarkstown Lederle parcel	Clarkstown	95/10
BOCES	Clarkstown	10
St. Frances	Clarkstown	10
Clarkstown High School North, Clarkstown	Clarkstown	10
Albertus Magnus School	Clarkstown	10
Clarkstown Schools	Clarkstown	10/95
Rockland Lake St Park	Clarkstown	10
High Tor State Park	Clarkstown	10
Dellwood/Paramount GC	Clarkstown	10
Pearl River Elks	Clarkstown	10
Legion Site, Leo Lader	Haverstraw	20
Rosman Park	Haverstraw	20/21
Phil Rotella Golf Course	Haverstraw	20/22
Cheesecote Park	Haverstraw	20
Marion Shrine Don Bosco	Haverstraw	20/40
Blue Hill Golf Course and South of Co. Rt 20 to NJ	Orangetown	10
Forested Area around Blue Hill Plaza, Orangetown	Orangetown	10
1 Town parcels by PIP 74.09-2-40, 74.14-1-3	Orangetown	10
3 Town parcels by PIP 64.19-1-44, 69.07-1-7, 69.19-1-26	Orangetown	10
Orangetown RPC Well 3	Orangetown	10
Orangetown RPC Well 9	Orangetown	10
Orangetown RPC Well 10	Orangetown	10
Orangetown RPC Well 12	Orangetown	10
Town of Orangetown 73.16-2-41	Orangetown	10
Town of Orangetown 73.06-1-1	Orangetown	10
Nyack College	Orangetown	10
Dominican College	Orangetown	10
St. Thomas Aquinas College	Orangetown	10
The Gaelic Athletic Association property at RPC	Orangetown	10
Henry Kaufmann Campgrounds – Pearl River	Orangetown	10
Manhattan Woods Golf Course – Pearl River	Orangetown	10
Novartis	Ramapo	20
Reese Benedetto	Ramapo	95
Raymour & Flanagan	Ramapo	20

Table 2-2 - Additional Potential Well Sites (cont'd)

Additional Well Sites under Consideration as of 5/15/15	Town	Pressure District
Schwarz Nature Park	Ramapo	20
Minisceongo Golf Course	Ramapo	20
Village of Sloatsburg properties	Ramapo	61
Platzl Brau Haus	Ramapo	20
Town properties	Ramapo	20
Patrick Farm Property, Ramapo	Ramapo	20
Edwin Gould Academy	Ramapo	20/95
Gracepoint Gospel	Ramapo	20
Town of Ramapo 55.14-2-1	Ramapo	20
Town of Ramapo 62.15-1-18	Ramapo	20/95
Town of Ramapo 62.19-1-16	Ramapo	95
Town of Ramapo 33.15-1-10	Ramapo	20
Town of Ramapo 33.18-1-23	Ramapo	20
Town of Ramapo 42.07-3-1	Ramapo	20
Town of Ramapo 33.05-2-3	Ramapo	20
Patriot Hills GC	Stony Point	20
Town Ball fields by Patriot Hills GC	Stony Point	20
PIP parcel/202	Stony Point	20
Camp Venture	Stony Point	20
Girl Scout Camp	Stony Point	outside 32
Boy Scout Camp	Stony Point	outside 33
Marvello Country Club	Stony Point	outside 20

Former UWNY Test Sites (Abandoned or no longer owned)	Town
Lake DeForest TW-2, Long Clove 81, Congers	Clarkstown
Poplar Street TW-1-75, Bardonia	Clarkstown
Balter Road TW-1-75, New City	Clarkstown
Clarksville TW-1, St. Regis	Clarkstown
Clarksville Partridge TW-1	Clarkstown
Clarkstown TW-1-77, Continental Drive	Clarkstown
Fifth Ave TW-1, Blauvelt	Clarkstown
Gate Way TW-1, Congers	Clarkstown
Germonds TW	Clarkstown
Long Street TW-1, Congers	Clarkstown
O&R Valley Cottage TW-1	Clarkstown
Ridge Rd TW-1, Lowerre Pl., Valley Cottage	Clarkstown
Sheridan Avenue, Congers	Clarkstown
Erie-Lackawanna TW-3-83, Mount Ivy	Haverstraw
Nauraushaun TW-1, Orangeburg	Orangetown
Oak Tree Road, Tappan	Orangetown

Table 2-2 - Additional Potential Well Sites (cont'd)

Former UWNY Test Sites (Abandoned or no longer owned) – cont'd	Town
Caville Drive TW-1-76, Monsey	Ramapo
Monsey Boulevard TW-1-75	Ramapo
Ramapo TW-A (&PW-3), Montebello	Ramapo
Blossom Road TW-2-76, Tallman	Ramapo
Erie-Lackawanna TW-1-82, Pomona	Ramapo
Erie-Lackawanna TW-2-82, New Hempstead	Ramapo
Haller Court TW-1, Chestnut Ridge	Ramapo
Hillside Estates, Pomona	Ramapo
Lorna Lane TW-1, Airmont	Ramapo
Merriman TW-1 & TW-2, Montebello	Ramapo
O&R New Hempstead (TW-1/No.2)	Ramapo
Quaker Road TW-1, Mt. Ivy	Ramapo
Schecter Property TW-1, Mt. Ivy	Ramapo
Skylark Drive TW-1, New Hempstead	Ramapo
Snowdrop TW-1-82, New City	Ramapo
Spring Rock Country Club, New Hempstead	Ramapo
Sunny Ridge Road TW-1-74, Hillcrest	Ramapo
Viola & Route 202 TW 1-5, Montebello	Ramapo
Woodside Dairy, New Hempstead	Ramapo
Pearl River TW 1-5, Pascack Road	Ramapo/ Orangetown
Stony Point TW-1	Stony Point
Stony Point TW-2	Stony Point

2.3 Well Site Infrastructure Summary

The following sections discuss the recommended infrastructure that would be needed at each potential well site if additional testing and investigation indicated that it was suitable for use as a production well. This is the basis for the cost estimates that follow and does not imply that United Water has plans to develop any specific wells.

2.3.1 Required Well Site Infrastructure

For planning purposes, it is assumed that each production well would be equipped with a vertical turbine well pump and installed within a new brick and block style standard well house (see **Figure 2-2**). Each new standard well house would also include sodium hypochlorite (for disinfection and chlorine residual) and Seaquest® (an orthophosphate for corrosion control) storage and chemical feed equipment. Based on the anticipated flow rates for each well at 300 gpm or less, each well would include 100-ft, 24-inch water main for chlorine contact time (CT) and the connection to the distribution system would be an 8-inch ductile water main. Access to the new wells would be provided by a new gravel access road with a vehicle control gate at the access location along with an 8-ft high chain-link type fence around the well house (assumed approximately 30-ft around all sides of well house).

2.3.2 Potential Well Treatment Requirements

Based on the planning level information provided by United Water during the identification of potential well sites, the following potential well sites have been identified as having potential water quality concerns, which would require additional treatment:

- Well D – Groundwater Under the Direct Influence of Surface Water (or GWUDI)
- Well F – Volatile Organic Compounds (VOCs)
- Well H – GWUDI
- Well I – Arsenic

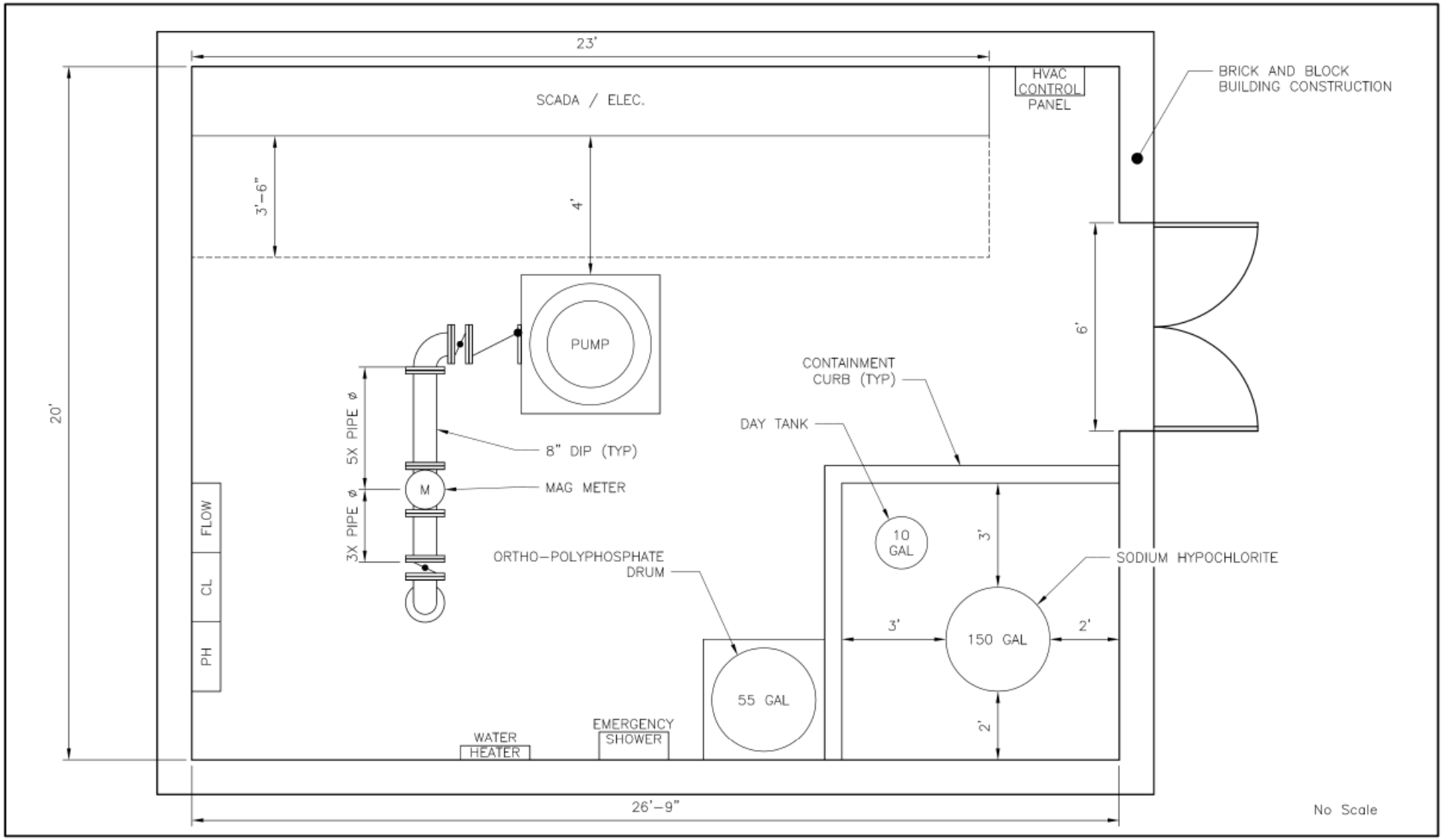
These contaminants are not intended to be exhaustive of the types that may be present. Some examples of other types of contaminants include naturally occurring radionuclides, radon (standard pending), sulfate, and other organic compounds. It should also be noted that future regulations could add other contaminants to the list of those that need to be considered – these are not considered for this preliminary analysis. In addition, some of United Water's wells contain entrained air, which is not a health standard but rather an aesthetic issue. This was also not considered as there is no specific information on air entrainment at the wells considered.

2.3.2.1 GWUDI Treatment Addition

For planning level purposes, to treat well water under the influence of surface water or GWUDI, it is assumed that the standard well house would need to be enlarged by approximately 140 square feet (sf) to accommodate the addition 1-micron cartridge filters along with ultraviolet light disinfection.

2.3.2.2 VOCs Treatment Addition

For planning level purposes, to treat well water with low amounts of volatile organic compounds (VOCs) such as might occur with contamination from gasoline, it is assumed that the standard well house would need to be enlarged approximately 740 sf to accommodate the air stripping units.



CDM Smith

Standard Well House Layout
United Water New York
Figure 2-2

2.3.2.3 Arsenic Treatment Addition

Similarly, for planning level purposes, to treat well water with elevated levels of naturally occurring arsenic, it is assumed that the standard well house would need to be enlarged approximately 450 sf to accommodate pressurized adsorption vessels with ferric oxide based arsenic removal media.

2.3.3 Well Supply Opinion of Probable Cost

An Opinion of Probable Cost was developed for each well site (see **Table 2-3**) based on the required well site infrastructure identified in Section 2.3.1 along with potential well treatment requirements identified in Section 2.3.2. The Opinion of Probable Cost for each well site also includes an allowance for the test well program (as provided by United Water) along with land acquisition allowance, engineering, and United Water overhead costs. The cost estimates assume basic permitting based on United Water's experience with previous wells.

An important factor to consider is that development of most new wells in Rockland County is likely to have some impact on private wells. No cost was included for any required mitigation to nearby wells, since the mitigation requirements are site-specific.

Table 2-3 - Well Supply Opinion of Probable Cost

Map ID	Type of Site	Pressure DIstrict	Potential Well Yield	Potential Water Quality Issues	Test Well Program Allowance	Well Supply Infrastruc-ture Cost	Engineering, Permitting, Land Acquisition Allowance, UW Overhead Project Cost	Total
A	Former UWNY test well	PD20/21	150 gpm	Unknown	$550,000	$1,037,000	$1,442,000	**$3,030,000**
B	Private school	PD10	200 gpm	Unknown	$550,000	$848,000	$1,360,000	**$2,760,000**
C	County Park	PD10	150 gpm	Unknown	$550,000	$1,225,000	$1,467,000	**$3,240,000**
D	Former UWNY test well	PD10	150 gpm	GWUDI	$550,000	$1,333,000	$824,000	**$2,710,000**
E	UWNY test well	PD20	100 gpm	Unknown	$550,000	$743,000	$565,000	**$1,860,000**
F	School Environmental Center	PD95	200 gpm	VOCs	$550,000	$2,217,000	$1,901,000	**$4,670,000**
G	Former UWNY test well	PD10	150 gpm	Salt (no treatment)	$550,000	$1,019,000	$1,376,000	**$2,950,000**
H	UWNY test well	PD10	150 gpm	GWUDI	$550,000	$1,333,000	$824,000	**$2,710,000**
I	UWNY Test Well	PD10	300 gpm	Arsenic	$550,000	$1,420,000	$862,000	**$2,830,000**
J	Open parcel	PD40	150 gpm	Unknown	$550,000	$866,000	$1,367,000	**$2,780,000**

Note: Costs are as of May 2015

2.4 Potential Permit Requirements and Regulatory Issues

Development of new wells will require permits and approvals from local and state agencies, and some wells may require federal approvals as well. All wells would require permits from the NYSDEC and NYSDOH, noted above, and approvals from the Rockland County Department of Health. All wells would also require local site plan approval and building department approval from the local municipality where the well site is located. Other permits, approvals, and reviews would depend on site-specific conditions and cannot be fully determined without additional investigation. For purposes of this report, an initial list of potential permits, approvals, and consultations was developed based on a review of online mapping and other online available resources and is subject to change as more information becomes available. The potential approvals for each of the 10 initially identified potential well sites are provided in **Table 2-4**.

The primary agencies that are anticipated to have jurisdiction over the well supply program evaluated in this report include the following:

- United States Army Corps of Engineers (USACE): For wells or associated water mains that would affect wetlands or other water bodies under federal jurisdiction.
- New York State Department of Environmental Conservation (NYSDEC): For public water supply; also for wells or associated water mains that would affect water bodies under state jurisdiction; construction activities that disturb more than one acre.
- New York State Department of Health (NYSDOH): For public water supply.
- New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP): For activities within state parkland; also consultation for state or federal agencies regarding effects to historic resources.
- New York State Department of Transportation (NYSDOT): For installation of mains within a state roadway or right-of-way.
- Rockland County Department of Health (RCDOH): For public water supply.
- Rockland County Drainage Agency (RCDA): Review of stormwater management plans and erosion and sediment control plans.
- Rockland County Highway Department (RCHD): For installation of mains within a County roadway or right-of-way.
- Site Plan Approval (SPA) – Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point.
- Building Permit - Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point.
- Local Highway Permit - Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point.

Appendix A describes the potential permits and approvals in more detail.

Table 2-4 Well Supply Permit Summary

Well Map ID	USACE	NYSDEC (Freshwater wetland/ Protection of Waters/ 401 WQ Cert	Rare, Threatened/ Endangered	NYSOPRHP Consultation	NYSDOT/NYSTA	NYSDOH/RCDOH	RC Drainage Agency	RC Highway Dept	Local Site Plan Approval	Local Building Permit	Local Highway Department (WM install)
A	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
B	No	No	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes
C	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
D	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No
E	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
F	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No
G	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes
H	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
I	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No
J	No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No

Notes:
1. For more information on each permit, please see Appendix A.
2. Storage of water treatment chemical at any of the new well locations will be below the regulatory trigger for registration under the NYS Bulk Storage requirements.
3. No onsite permanent power generation.
4. Land ownership/access agreements not reflected on table.
5. Office of Parks, Recreation and Historic Preservation (NYSOPRHP) Consultation triggered by Federal Permit and/or coverage under NYS GP-0-15-002.

Section 3

Interconnections with Other Water Suppliers

3.1 Introduction

United Water has been exploring the possibilities of purchasing water from adjacent water supply systems to meet future demands. Four potential options have been evaluated:

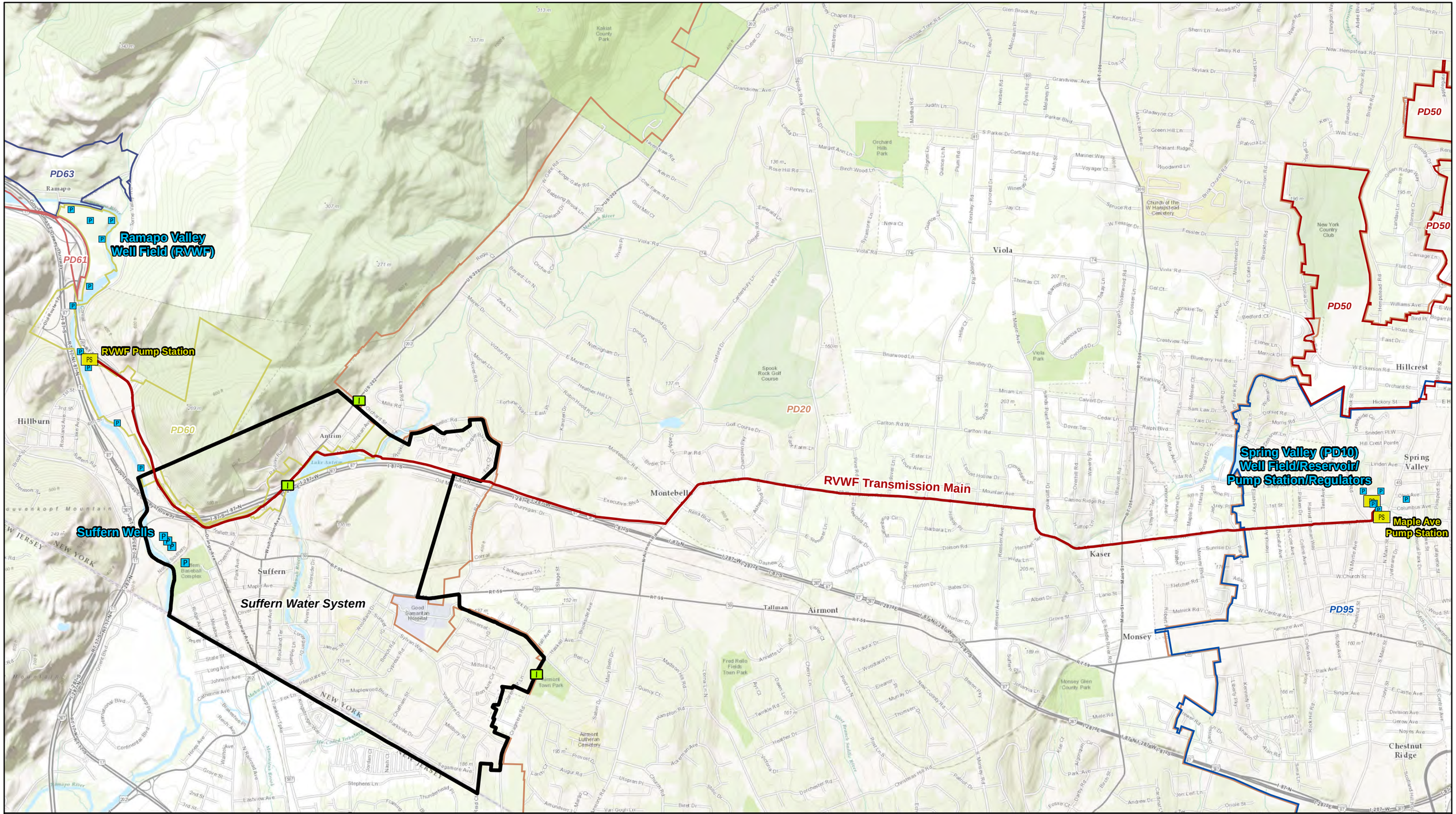
- ***Suffern***: The Village of Suffern indicates that it has approximately 1 mgd of additional water supply that could be sold to United Water. The village has four wells along the Ramapo River and the permitted capacity is about 1 mgd higher than the current demand.
- ***Nyack***: The Village of Nyack has a permit to withdraw up to 3 mgd from the Hackensack River, about one mile below the Lake DeForest dam. The village is currently using less than 2 mgd and therefore the possibility exists to sell approximately 1 mgd to United Water.
- ***North Jersey District Water Supply Commission (NJDWSC) to United Water New Jersey (UWNJ) to United Water New York***: NJDWSC, a regional water supply entity for the State of New Jersey, indicates that it currently has excess supply allocation. This water could be sold to United Water for use in Rockland County, via a transfer of raw water to UWNJ's Haworth Water Treatment Plant and then a transfer from UWNJ's system to the Rockland County system through the existing Blaisdell interconnection/pump station, located on the state line between the two United Water systems. NJDWSC may have 3 to 5 mgd of raw water available.
- ***Montvale***: United Water supplies an average of 0.1 mgd of potable water to a small area in the Borough of Montvale in Bergen County, New Jersey. The quantity of water supplied to UWNJ could be recovered from UWNJ via the existing Blaisdell Road Pump Station/Interconnection.

This section describes the infrastructure improvements and potentially complex regulatory reviews and permitting requirements that would be required to facilitate transfer of water from these sources to United Water's Rockland County system. Both near-term and long-term infrastructure improvements are described, to address changes that would be appropriate to meet near-term needs and those that may be appropriate if water demands increase substantially.

3.2 Suffern Interconnection

As shown in **Figure 3-1**, the Village of Suffern is located next to United Water's Pressure District (PD) 20 and just south of United Water's Ramapo Valley Well Field (RVWF). The RVWF has its own pressure district, PD60, which is also adjacent to the Village of Suffern. In addition to the area around RVWF, this pressure district includes a 30-inch transmission main that extends to the Spring Valley Well Field (SVWF) and the Maple Avenue Pump Station (MAPS), which pumps water from PD10 (the district that contains Lake DeForest) to PD20.

Suffern has proposed selling up to 1 mgd of excess supply to United Water. The Suffern Village Well Field consists of four wells (Wells 1-4) that are installed within the same sand and gravel aquifer as United Water's RVWF. The Suffern wells are approximately 100 feet deep and are located south of RVWF Well No. 100, and south of the regulatory weir on the Ramapo River. **Figure 3-2** provides an aerial photo showing the RVWF pump station, the 10 RVWF wells, and the four Suffern wells.



N

- Production Well
- Pump Station
- Transmission Main
- Pressure District (PD)
- UWNY/Suffern Existing Interconnections

United Water, NY

1 inch = 2,250 feet

0 1,000 2,000 4,000 Feet

Suffern Interconnection Supply Option

Figure 3-1

CDM Smith

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USGS Gauge
01387400
RVWF Pump Station
PS
Ramapo River
USGS Gauge
01387420
Suffern Well No. 4
Suffern Well No. 1
Suffern Well No. 2
Suffern Well No. 3
I-87 S
I-87 N
RT-17
Gov Thomas E Dewey Thruway
Tonne Valley Rd
RT-59
I-87 N I-87 S
RT-17 S
Old Route 17
Boulder Ave
6th St
Mountain Ave
1st St
3rd St
4th St
5th St
Rockland Ave
Lake Ave
Suffern Rd
Brook St
Denison St
Pine Hill Rd
Split Rock Rd
Geiger Rd
I-287 W I-87 S
I-287 E
Memorial Dr
Wayne Ave
Pavilion Rd
Washington Ave
Hall Pl
Suffern Pl
Tillotson Rd
Orange Ave
Park Ave
Antrim Ave
Clinton Pl
Riverside Dr
Oakdale Mnr
W Park Pl
E Maple Ave
W Maitbie Ave
Meadow Ave
Ramapo Ave
Prairie Ave
Brook St
Jersey Ave
1st St
State St
Rockland Ter
Prospect Pl
RT-17 N I-287 N
RT-17 S I-87 S
N
USGS Gauge
Pump Station
Suffern Wells
Ramapo Valley Wells
United Water, NY
0 1,000 2,000
Feet
1 inch = 1,500 feet
Suffern Interconnection
Supply Option
Figure 3-2
CDM Smith
NEWELLJD F:\United_Water_Westchester\DATA\MXD\Fig3-2_Suffern_Wells.mxd 5/4/2015

The original Suffern water supply permit for its wells, WSA 709 (1932), lists Wells 1 and 2 as having a combined capacity of 1,200 gallons per minute (gpm), equivalent to approximately 1.7 million gallons per day (mgd). A permit for a third well, WSA 6060, was obtained in 1971. This permit indicates the addition of Well 3 at 1,050 gpm (1.5 mgd), modified in April 1974 to 1,500 gpm. A fourth well (Well 4) was added to ensure well field yield with the largest well (Well 3) out of service. Well 4 was approved by the New York State Department of Environmental Conservation (NYSDEC) in WSA 6437, dated May 10, 1974. No yield was provided for Well 4 in WSA 6437 and the combined yield of Wells 1-3 was noted as 4.3 mgd. The individual well capacities do not add up to the combined yield listed in WSA 6437 for Wells 1-3 and United Water does not have further information on these wells at this time.

A site visit to the well field was conducted by United Water and Village of Suffern personnel on January 23, 2015, and the following data was provided to United Water about the well field:

- Average day demand: 1.5 mgd
- Normal peak demand (consistent year to year): 2.3 mgd
- Peak capacity: 4 mgd
- Miles of water main: 25 to 30
- One generator, located at Well 3
- Pump Capacities:
  - Well 1 – 725 gpm
  - Well 2 – 650 gpm
  - Well 3 – 1,600 gpm originally/downsized to 1,100 gpm
  - Well 4 – 1,200 gpm

The current total pump capacity for Wells 1 through 3 is 3.6 mgd (i.e., the total capacity with the largest well, Well 4, out of service), and the current total pump capacity for Wells 1, 2, and 4 (i.e., the total capacity with Well 3 out of service) is 3.7 mgd. In both scenarios, the current total pump capacities are below the permitted capacity of 4.3 mgd and more than 1 mgd greater than the reported annual peak demand of 2.3 mgd. Therefore, the Village of Suffern is offering the sale of approximately 1 mgd of water to United Water.

There are three existing interconnections between United Water and the Village of Suffern, as shown on **Figure 3-1**. Suffern has larger transmission piping leading to the existing Wayne Avenue interconnection site. This site is already interconnected with the RVWF district (i.e., into the 30-inch transmission pipe) and is located approximately 3,000 feet from PD20. However, Suffern's hydraulic gradient is lower than that of United Water's system, so a pump station would be required to move water from Suffern to the United Water system. To facilitate the transfer of water, a pump station would need to be installed that can pump water into PD20 through a transmission main on Wayne Avenue (i.e., direct option) or indirectly through the RVWF transmission main and the existing MAPS (i.e., indirect option). In addition, some improvements would be required within the Village of Suffern, including some electrical work and raising some wells above the floodplain.

3.2.1 Suffern Interconnection Hydraulic Model Analysis Summary

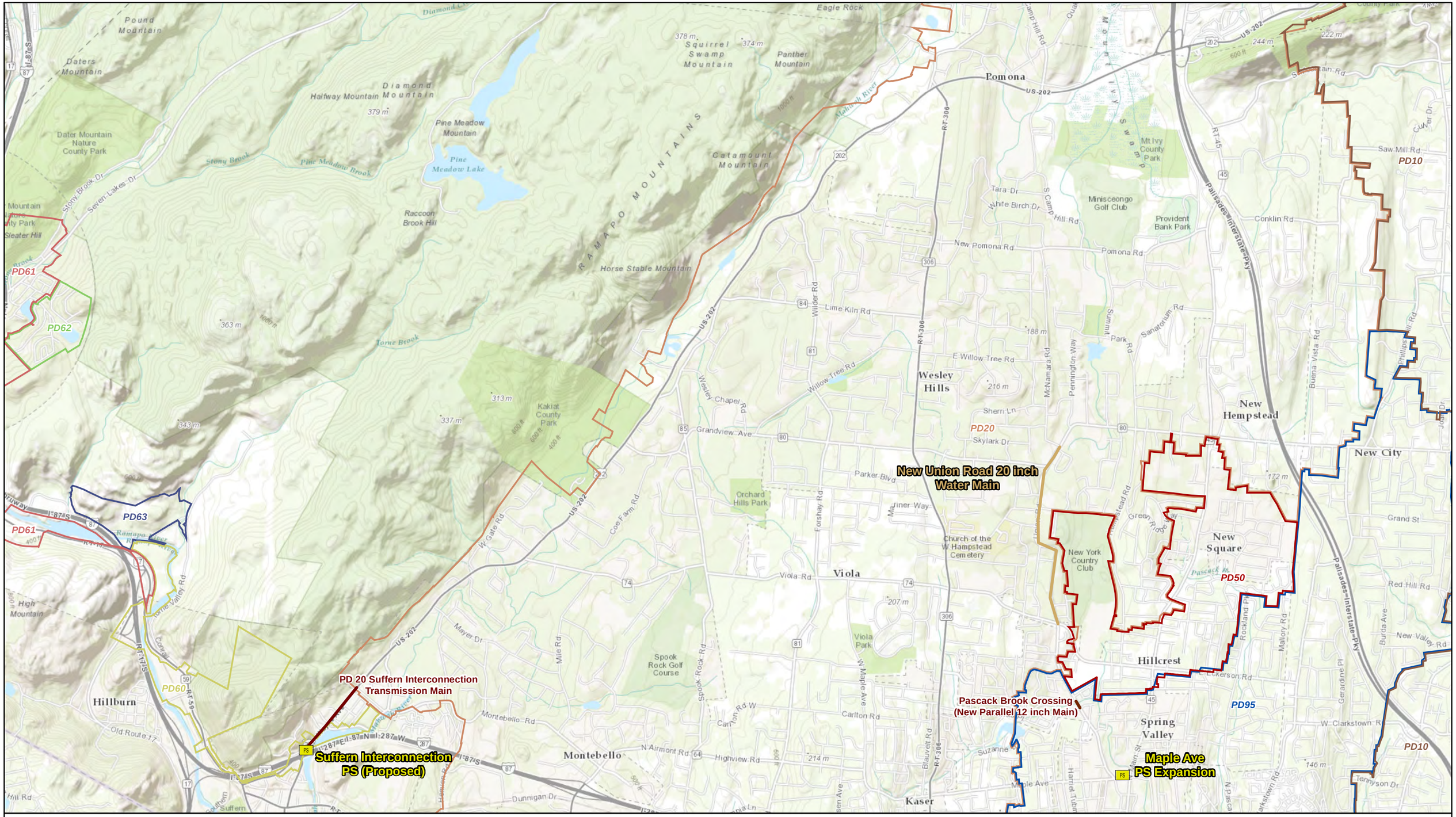
CDM Smith utilized the existing United Water hydraulic computer model to evaluate obtaining 1 mgd from the Village of Suffern's water system through a connection to the 16-inch Suffern water main and a new below-grade pump station located on Wayne Avenue just north of the New York State Thruway (see **Figure 3-1**). For purposes of this report, the pump station is referred to as the Suffern Interconnection Pump Station (SIPS). CDM Smith then evaluated both direct and indirect supply options:

- Supply 1 mgd from Suffern directly to PD20 (i.e., direct option)
- Supply 1 mgd from Suffern to PD20 through the RVWF transmission main and MAPS (i.e., indirect option)

The model was also used to investigate various improvements to allow for the efficient transfer of water from Suffern into PD20, which is discussed in more detail in Appendix B. The hydraulic model used to evaluate system upgrade needs was based on a future peak day of approximately 52 mgd. If future peak day demands are lower, the recommended infrastructure improvements for the Suffern Interconnection supply option may be different.

A brief summary of the main points of the assessment is provided below.

- **Direct connection to PD20:** To supply PD20 directly from the new SIPS, a new 3,000-foot–long, 16-inch transmission main is required from the SIPS that would be located on Wayne Avenue, north of the New York State Thruway, to the intersection of Wayne Avenue and Orchard Street (see **Figure 3-3**). However, PD20 already has relatively high pressures at the direct interconnection area. The transfer of additional water into PD20 in the area of Wayne Avenue and Orchard Street would further increase pressure by approximately 10 pounds per square inch (psi). This is not considered prudent, as it would likely result in increased water losses and an increase in pipe breaks. Nevertheless, since the potential SIPS location is in close proximity to PD20, a direct connection would be useful, particularly during emergencies. Investigations were made into methods to mitigate the higher pressures, but no feasible methods were identified. Therefore this direct connection option is not considered appropriate as a near-term project, but rather may be appropriate in the long-term to further augment supply capability, particularly during emergencies or to offset temporary deficiencies due to restrictions at existing wells within PD20 (e.g., mechanical failures or water quality issues).
- **Indirect connection to PD20:** As discussed above, the Village of Suffern water system is already interconnected to United Water's RVWF 30-inch transmission main at Wayne Avenue just north of the New York State Thruway overpass. A booster station would be required to pump water from the Village of Suffern water system into United Water's 30-inch transmission main. To then supply PD20 through the RVWF transmission main, expansion of the MAPS would be required, along with a 16-inch water main connection from the RVWF transmission main to the MAPS expansion. According to the model results, the pressure in the vicinity of the MAPS discharge transmission main connection to PD20 (at the intersection of Union Road and Viola Road) would increase by approximately 10 psi due to the increased supply from the MAPS. System improvements were evaluated and it was determined that the installation of 6,800 feet of 20-inch water main along Union Road is required to keep the predicted pressure increases below 5 psi in the vicinity of the MAPS discharge transmission main connection. This improvement along with the installation of a parallel 12-inch water main on Union Road at the



United Water, NY

Suffern Interconnection Supply Option

Figure 3-3

CDM Smith

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Pascack Brook is required to allow the existing MAPS to operate at its design condition. See **Figure 3-3**.

3.2.2 Suffern Interconnection Opinion of Probable Cost

The Total Opinion of Probable Costs for the Suffern Interconnection based on the interconnection improvements outlined above is shown in **Tables 3-1 and 3-2**. The cost information in this section is separated into near-term (i.e., the indirect connection to PD20) and long-term (i.e., the direct connection). It is important to note that this does not include the cost for improvements to the Village of Suffern water system, which is estimated at approximately $0.2 million according to United Water.

Table 3-1 Suffern Interconnection Indirect Supply Option – Near-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
1	Suffern Interconnection Booster Station (Prefabricated Below Grade Station) [2]	1	EA	$950,000	$950,000
2	Expansion of MAPS	1	LS	$975,000	$975,000
3	Suction improvements to expanded MAPS [3]	1	LS	$75,000	$75,000
4	Union Road/Pascack Brook Crossing (second 12-inch water main)	1	LS	$75,000	$75,000
5	New 20-inch DIP main - Union Road	6,800	LF	$240	$1,632,000
				SUBTOTAL	**$3,707,000**
				Contingency	$927,000
				SUBTOTAL	**$4,634,000**
				Engineering, Permitting & Inspection	$1,159,000
				SUBTOTAL	**$5,793,000**
				United Water Overhead Project Cost	$869,000
				TOTAL OPINION OF PROBABLE COST	**$6,662,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to Suffern water system
3. Includes 250 feet of 16" main plus tap of existing PCCP pipe.

Table 3-2 Suffern Interconnection Direct Supply Option – Long-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
6	New 16-inch DIP water main - Suffern PS to PD 20	3,000	LF	$200	$600,000
				SUBTOTAL	**$600,000**
				Contingency	$150,000
				SUBTOTAL	**$750,000**
				Engineering, Permitting & Inspection	$188,000
				SUBTOTAL	**$938,000**
				United Water Overhead Project Cost	$141,000
				TOTAL OPINION OF PROBABLE COST	**$1,079,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to Suffern water system

3.2.3 Suffern Interconnection Potential Permit Requirements and Regulatory Issues

Based on a review of the potential Suffern Interconnection infrastructure listed above, the permits that are anticipated to be required to construct a booster station and associated piping are summarized in **Table 3-3**. More information on the individual permits is provided in Appendix A of the report.

Table 3-3 Suffern Interconnection Permit Summary

USACE	NYSDEC (Freshwater wetland/ Protection of Waters/ 401 WQ Cert	Rare, Threatened/ Endangered	NYSOPRHP Consultation	NYSDOT/NYSTA	NYSDOH/RCDOH	RC Drainage Agency	RC Highway Dept	Local Site Plan Approval	Local Building Permit	Local Highway Department (WM install)
Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Some issues related to permitting and approvals include the following:

- In recent conversations with United Water, the NYSDEC indicated that the Village of Suffern would not be required to obtain a water supply permit to sell water to United Water, since the transfer would occur within the same watershed, the major watershed basin for the Passaic-Hackensack River system, and would not cross watershed basins. An official determination from the NYSDEC will need to be obtained prior to proceeding with this project.
- Withdrawing of additional water from the Village of Suffern's wells could affect the flow of water in the Ramapo River, which may be of concern to the New Jersey Department of Environmental Protection (NJDEP) and/or to downstream water purveyors (e.g., the Villages of Mahwah and Ramsey, the NJDWSC).
- Prior to authorizing the sale of water to United Water, the Village of Suffern would need to make a determination in accordance with the New York State Environmental Quality Review Act (SEQRA).
- Suffern's Wells 1 and 4 have historically been impacted by chlorides, which are subject to a secondary health standard. United Water and the Village of Suffern would work to assure the New York State Department of Environmental Conservation and the Rockland County Department of Health that withdrawal of additional water from these wells would not exacerbate the problem or negatively impact the customers of either system.
- Regardless of the legal arrangements made between the Village of Suffern and United Water, this interconnection option poses a risk that in the future, Suffern may see an increased demand and may unilaterally elect to cease providing water to United Water.

In light of the reasonable possibility of riparian rights issues being raised by downstream water users, a prudent approach may be to perform further hydrological and hydrogeological studies within the Ramapo River watershed to better understand this project's effects on flows in the Ramapo River.

3.3 Nyack Interconnection

The Village of Nyack withdraws water from the Hackensack River approximately one mile downstream of the Lake DeForest dam. United Water's water supply permit for Lake DeForest (WSA 2189) requires that United Water maintain a daily average flow of 9.75 mgd in the river just above the Nyack intake. Of that 9.75 mgd, WSA 2189 states that "at least 2 mgd" is reserved for the Village of Nyack and the rest (7.75 mgd) flows to reservoirs downstream operated by UWNJ. Nyack's permit (WSA 3431, 1958) allows for an annual average withdrawal of 3.0 mgd. For the last four years, Nyack has used approximately 1.7 mgd on average.

Nyack is permitted to withdraw up to an annual average of 3 mgd with the following provisions based on a 1972 settlement agreement with UWNJ:

- Nyack can take withdraw to 2 mgd from the Hackensack River without payment to UWNJ.
- Nyack can withdraw up to an additional 0.5 mgd (i.e., up to a total of 2.5 mgd) without payment to UWNJ to accommodate an increase in population in Nyack's service area (using an assumed water demand rate of 125 gallons per person per day); Nyack is required to provide documentation to UWNJ related to the population increase.
- For usage greater than 2.5 mgd, payments are due to UWNJ.

Since the Village of Nyack is permitted to withdraw up to 3 mgd, but is currently using less than 2 mgd, the excess capacity of approximately 1 mgd may be available for sale to United Water. United Water would be responsible for payments to UWNJ for withdrawals of water in accordance with the terms of Nyack's settlement agreement with UWNJ.

Potable water (i.e., water that has already been treated at the Village of Nyack's Water Treatment Plant) would be transferred through a direct pipe connection between the Nyack's water system and United Water's system. There are six interconnections between the Village of Nyack and United Water; United Water's hydraulic gradient is higher than Nyack's for five of these interconnections. For the other interconnection, water could flow by gravity from Nyack to a small United Water pressure district, PD13. On average, PD13 uses 0.1 mgd, so there is limited opportunity for an interconnection at this site. Using any of the other five interconnections would require a booster station. The interconnection located at Route 303 and adjacent to the Palisades Mall is the most favorable location for a booster station, since Nyack has substantial hydraulic pipe capacity leading to it and United Water has hydraulic pipe capacity leading from it at this location. A booster station at this location would transfer water into the water-rich PD10 district, which includes the Lake DeForest Water Treatment Plant. Water from Nyack would then need to be transferred through PD10 into PD20.

On March 23, 2015, United Water personnel met with Village of Nyack personnel and their consultant to review the technical feasibility of transferring water to United Water's system. It was generally agreed that there is sufficient hydraulic piping capacity to supply United Water's system but a limiting factor may be the capacity of the Nyack Water Treatment Plant. Further study would be required to understand the maximum practical capacity of Nyack's Water Treatment Plant. Currently, the plant operates for 15 hours per day and the off-time is used to perform necessary maintenance. For purposes of this analysis, it is assumed that 1 mgd could be transferred to United Water's Rockland County system. However, the scope/cost of work to upgrade Nyack's Water Treatment Plant, if necessary, has not been evaluated.

Figure 3-4 shows the location of the Nyack Water Treatment Plant relative to the Lake DeForest Water Treatment Plant. There are several ways that additional water could be provided from Nyack. These are briefly discussed below:

- **Nyack increases its withdrawal of water from the Hackensack River up to 3 mgd and the additional capacity (i.e., approximately 1 mgd) is sold to United Water**. As mentioned above, there may be constraints with regard to Nyack's Water Treatment Plant capacity. This option may require costly plant improvements and would likely require additional personnel to operate the plant for more than 15 hours each day. A booster station would be required.

- **Nyack takes raw water from Lake DeForest reservoir.** This option would require that a pipeline be built from the Lake DeForest reservoir to Nyack's Water Treatment Plant, so that Nyack can withdraw water directly from the reservoir instead of from the river. Such a project would be beneficial to Nyack because their current run-of-river intake is impacted by salt runoff from the NYS Thruway, which is located upstream from the Nyack intake and downstream from Lake DeForest. This project would require a modification to United Water's permit for Lake DeForest, WSA 2189, to modify the amount of water that must be maintained in the Hackensack River, since Nyack would no longer be withdrawing from the river. With elimination of the need to release 2 mgd for Nyack, United Water could withdraw the additional water that Nyack is not using from the reservoir for use by Rockland County customers (i.e., if Nyack uses 1.7 mgd, the remaining 0.3 mgd that was previously released for Nyack would be available). This project would also require modification to United Water's permit for the Lake DeForest Water Treatment Plant permit to increase its peaking capacity.

  In terms of cost, in 2009, Nyack applied for a grant to extend an intake pipeline to upstream of the Thruway, although not as far as into Lake DeForest. The estimated cost of this intake pipeline extension was approximately $2 million in 2009. Nyack did not receive the grant, and this pipeline extension was not built.

- **United Water reduces flows to the Hackensack River and uses Nyack's allotment.** In this option, United Water would withdraw an additional 0.3 mgd from the Lake DeForest reservoir (the amount not needed by Nyack) and would reduce its minimum release by that same 0.3 mgd. This would require a modification to United Water's permit for Lake DeForest, WSA 2189, to modify the amount of water that must be maintained in the Hackensack River. Like the option above, this project would also require modification to United Water's permit for the Lake DeForest Water Treatment Plant permit to increase its peaking capacity.

3.3.1 Nyack Interconnection Hydraulic Model Analysis Summary

CDM Smith utilized United Water's existing hydraulic computer model to evaluate obtaining 1 mgd from the Village of Nyack water system into PD10 through the existing interconnection and a new above-grade booster pump station located on Route 303, just south of the Palisades Center Drive (see **Figure 3-5**). To be conservative, the analysis assumed for purposes of the hydraulic assessment that three new PD10 groundwater wells (totaling approximately 600 gpm) were online.

Modifications to PD10 infrastructure would be required in order to move the additional water from PD10 into other districts where future need would likely materialize (i.e., PD20). The hydraulic model was used to investigate various improvements to allow for the efficient transfer of water from Nyack into PD10 and then into PD20, which is discussed in more detail in Appendix B. The hydraulic model used to evaluate system upgrade needs was based on a future peak day demand of approximately 52

N

WTP Water Treatment Plant

USGS Gauge

PS Pump Station

United Water, NY

0 1,000 2,000 Feet

1 inch = 1,000 feet

Nyack Interconnection
Supply Option
Figure 3-4

CDM Smith

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New 12" New Hempstead Road PS Water Main

New Hempstead PS (Proposed - General Location)

New Union Rd 20 inch Water Main

Pascack Brook Crossing (New Parallel 12 inch Main)

Maple Ave PS (Expansion)

Nyack Interconnection PS (Proposed)

PD10 PD11 PD20 PD50 PD95

Improvement 5

Other Improvement

Pump Station

Pressure Districts (PD)

United Water, NY

1 inch = 2,400 feet

0 1,000 2,000 4,000 Feet

Nyack Interconnection Supply Option

Figure 3-5

CDM Smith

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mgd. If future peak day demands are lower, the recommended infrastructure improvements for the Nyack Interconnection supply option may be different.

A brief summary of the conclusion of the assessment is as follows:

- Under current demand conditions (i.e., in the near-term), the minimum improvements are a new 1 mgd Nyack Interconnection Booster Station to move water from the Village of Nyack's water system to United Water's system, along with the same water main improvements to Union Road as discussed for the near-term Suffern alternative.
- If demand increases and the full amount of water from the Nyack Interconnection is needed, then the improvements would involve expansion to MAPS as well as the construction of a second booster station and associated piping within PD10 to move water to PD20.
- As discussed above, upgrades to the Nyack Water Treatment Plant may also be necessary but these have not been assessed yet. A separate study would be required to evaluate the scope/cost of the upgrades. In addition, Nyack employees indicate that additional treatment plant operators would be needed to run the plant for more than its current operation of 15 hours a day.

3.3.2 Nyack Interconnection Opinion of Probable Cost

The Total Opinion of Probable Costs for the Nyack Interconnection based on the interconnection improvements outlined above is shown in **Tables 3-4 and 3-5**. It is important to note that this does not include any cost for improvements to the Village of Nyack water system.

Table 3-4 Nyack Interconnection – Near-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
1	New Nyack PS (1.0-mgd prefabricated, above grade PS)	1	LS	$750,000	$750,000
2	Union Road/Pascack Brook Crossing (second 12-inch water main)	1	LS	$75,000	$75,000
3	New 20-inch DIP main - Union Road	6,800	LF	$240	$1,632,000
				SUBTOTAL	**$2,457,000**
				Contingency	$615,000
				SUBTOTAL	**$3,072,000**
				Engineering, Permitting & Inspection	$768,000
				SUBTOTAL	**$3,840,000**
				United Water Overhead Project Cost	$576,000
				TOTAL OPINION OF PROBABLE COST	**$4,416,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to Nyack water system

Table 3-5 Nyack Interconnection – Long-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
4	Expansion of MAPS	1	LS	$975,000	$975,000
5	Suction improvements to expanded MAPS	1	LS	$75,000	$75,000
6	New New Hempstead Road PS (1.0-mgd prefabricated, below grade PS)	1	LS	$800,000	$800,000
7	New 12-inch DIP main - New Hempstead Road	4,000	LF	$180	$720,000
				SUBTOTAL	**$2,570,000**
				Contingency	$643,000
				SUBTOTAL	**$3,213,000**
				Engineering, Permitting & Inspection	$804,000
				SUBTOTAL	**$4,017,000**
				United Water Overhead Project Cost	$603,000
				TOTAL OPINION OF PROBABLE COST	**$4,620,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to Nyack water system

3.3.3 Nyack Interconnection Potential Permit Requirements and Regulatory Issues

Based on a review of the potential Nyack Interconnection infrastructure listed above, the permits that are anticipated to be required to implement the above construction projects are summarized in **Table 3-6**. For more information on the individual permits, see Appendix A of the report.

Table 3-6 Nyack Interconnection Permit Summary

USACE	NYSDEC (Freshwater wetland/ Protection of Waters/ 401 WQ Cert	Rare, Threatened/ Endangered	NYSOPRHP Consultation	NYSDOT/NYSTA	NYSDOH/RCDOH	RC Drainage Agency	RC Highway Dept	Local Site Plan Approval	Local Building Permit	Local Highway Department (WM install)
No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Due to the complex nature of the water supply permits in the Hackensack River, this project is likely to encounter significant regulatory issues. This project would require a clear willingness by the regulators in both New York and New Jersey to move the project forward. Some issues related to permitting and approvals include the following:

- Similar to the Suffern Interconnection, the Village of Nyack would have to make a SEQRA determination prior to selling water to United Water.
- Any taking of additional water by United Water via Nyack's permit would result in less flow in the Hackensack River to downstream reservoirs operated by UWNJ. This would be of concern to UWNJ and NJDEP and may result in questions concerning the existing permits that control

releases from Lake DeForest to UWNJ. It is anticipated that issues of riparian rights would be raised by both NJDEP and UWNJ.

- Based on preliminary discussions, both the NYSDEC and the NJDEP noted that permitting for this project could be complex given bi-state riparian rights concerns.
- Regardless of the legal arrangements made between the Village of Nyack and United Water, this interconnection option poses a risk that in the future, Nyack may see an increased demand and may unilaterally elect to cease providing water to United Water.

3.4 Water from NJDWSC via Blaisdell Interconnection

NJDWSC is a regional water supply entity for the State of New Jersey. The NJDWSC was established in 1916 to develop, acquire, and operate a water supply system for use by any municipality in the 12 northernmost counties of New Jersey. Today, the NJDWSC operates two major reservoirs (the Wanaque and Monksville reservoirs), two river-diversion pumping stations, and a 210 mgd water filtration plant located in the Passaic/Pompton River watersheds. NJDWSC supplies water to a number of contracting municipalities within its service territory, including Newark, Paterson, Kearny, Bayonne, Passaic and others. In total, the safe yield of NJDWSC's system is 190 mgd.

UWNJ and NJDWSC established a public private partnership to provide raw water to UWNJ. This is accomplished by pumping water approximately 18 miles through the Oradell aqueduct to UWNJ's Oradell reservoir. As this is a partnership, UWNJ has ownership rights for this water. UWNJ receives a large portion of its raw water supply from NJDWSC. UWNJ's allocation of safe yield from NJDWSC is 48 mgd.

NJDWSC indicates that it currently has additional unused allocation of supply of approximately 3 to 5 mgd. United Water and NJDWSC have met to discuss the possibility of providing this additional allocation to UWNJ in the form of raw water, transferred to the Oradell reservoir through the existing aqueduct. This additional water would be treated at the Haworth Water Treatment Plant and then pumped through UWNJ's existing network to an existing interconnection to United Water's Rockland County system, at the Blaisdell Pump Station interconnection. This interconnection is an existing 3 mgd pump station/interconnection with UWNJ located on Blaisdell Road in Orangeburg, New York (see **Figure 3-6**).

It should be noted that if 3 to 5 mgd is transferred from NJDWSC's system to UWNJ's system, this may not result in an increase in capacity within the UWNJ system of that same amount. This is because the ultimate determination on additional yield also depends on the condition of UWNJ's reservoirs, to comply with the rule curve provisions of UWNJ's permits for its reservoirs. For purposes of this analysis, United Water assumes the full 3 to 5 mgd will be available for transfer to Rockland County, but the final feasible amount would need to be determined by using a mathematical model of the reservoir system. UWNJ currently has such a model, but this analysis will not be performed unless regulatory agencies indicate that such a transfer is allowable.

3.4.1 Blaisdell Interconnection Hydraulic Model Analysis Summary

The following section discusses the hydraulic analysis to provide 3 to 5 mgd from UWNJ's system into PD10 through the Blaisdell Interconnection Pump Station (BIPS). Similar to the Nyack Interconnection, the BIPS is located in PD10 and therefore improvements would be needed to transfer water from this water-rich district into PD20. However, the improvements are more substantial than

New 20 inch Union Rd Water Main

New 16 inch New Hempstead Road Water Main

New Hempstead PS (Proposed -General Location)

Pascack Brook Crossing (New Parallel 12-Inch Main)

Maple Ave PS (Expansion)

Clausland Mountain Tank Improvement

Blaisdell Interconnection PS (Existing)

PD20

PD50

PD95

PD10

PD11

PD13

New Hempstead

New Square

Hillcrest

Valley

Chestnut Ridge

Nanuet

Bardonia

West Nyack

Congers

Blauvelt

Pearl River

Orangeburg

Tappan

Woodcliff Lake

Montvale

NEW JERSEY

NEW YORK

- Improvement 5
- Improvement 12
- Other Improvement
- Storage Tank
- Pump Station
- Pressure Districts (PD)

United Water, NY

0 2,500 5,000 Feet

1 inch = 3,500 feet

Blaisdell Interconnection
3 MGD Supply Option
Figure 3-6

CDM Smith

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for the Nyack Interconnection due to the larger flow rate that is being considered. CDM Smith utilized United Water's existing hydraulic computer model to evaluate obtaining 3 to 5 mgd from UWNJ via the BIPS, which is discussed in more detail in Appendix B. The hydraulic model used to evaluate system upgrade needs was based on a future peak day of approximately 54 mgd for the 3 mgd supply option and approximately 56 mgd for the 5 mgd supply option. If future peak day demands are lower, the recommended infrastructure improvements may be different.

United Water also engaged the assistance of the consultant, Buck Seifert and Jost, Inc. (BS&J) to consider improvements that could be required to transmit 3 to 5 mgd of supply within UWNJ's system as well as the estimated cost to upgrade the BIPS from 3 to 5 mgd.

The recommended infrastructure improvements for the Blaisdell Interconnection are broken down into three categories: 3 mgd near-term, 3 mgd long-term and 5 mgd long-term. A brief summary of the main points of the assessment is provided below:

- **3 mgd Scenario – Near-Term:** Under current demand conditions (i.e., in the near-term), water main improvements to Union Road (downstream of the MAPS) are required, as discussed with the Suffern and Nyack alternatives, as well as improvements to one of United Water's existing large distribution tanks. UWNJ's system would not require improvements under this scenario.
- **3 mgd Scenario – Long-Term:** If demand increases and the full amount of water from the BIPS is needed, then more substantial improvements will be required. The improvements needed consist of expansion to MAPS and the construction of a second booster station within PD10 to move water to PD20 and associated piping additions. In addition, UWNJ would require the installation of a booster station within their system
- **Upgrade to 5 mgd Scenario – Long-Term:** If the demand increases and additional supply from the BIPS is needed, then fairly extensive infrastructure improvements in both systems are needed (see **Figure 3-7**). In addition to the improvements listed above, United Water would require additional booster station expansions and pipeline improvements. UWNJ would require substantial piping improvements.

3.4.2 Blaisdell Interconnection Opinion of Probable Cost

The Total Opinion of Probable Costs for the Blaisdell Interconnection based on the interconnection improvements outlined above is shown in **Tables 3-7 through 3-9**. This does not include the estimated cost for improvements to the UWNJ system. For the 3 mgd long-term scenario, required improvements for UWNJ includes a booster station at one of UWNJ's tank sites for an estimated cost of $1.25 million; however, during peak day, supply to United Water will likely need to be reduced to 1.5 mgd, according to information from UWNJ's hydraulic model. For the 5 mgd long-term scenario, UWNJ would require about $6 million of pipeline improvements, according to work done by BS&J.

New 16 inch New Hempstead Road Water Main

New 20 inch Union Rd Water Main

New Hempstead PS (Proposed -General Location)

Pascack Brook Crossing (New Parallel 12-Inch Main)

Maple Ave PS (Expansion)

Clausland Mountain Tank Improvement

New Parallel 16 inch Water Main

Blaisdell Interconnection PS (Expansion)

PD20 PD50 PD95 PD10 PD11 PD13

New Hempstead New Square Hillcrest Valley Chestnut Ridge Nanuet Bardonia West Nyack Pearl River Blauvelt Congers Orangeburg Tappan Woodcliff Lake Montvale

NEW JERSEY NEW YORK

- Improvement 5
- Improvement 11
- Improvement 12
- Other Improvement
- Pressure Districts (PD)
- Storage Tank
- PS Pump Station

United Water, NY

0 2,500 5,000 Feet

1 inch = 3,500 feet

Blaisdell Interconnection
5 MGD Supply Option
Figure 3-7

CDM Smith

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Table 3-7 Blaisdell Interconnection – 3 mgd Near-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
1	Union Road/Pascack Brook Crossing (Second 12-inch Water Main)	1	LS	$75,000	$75,000
2	New 20-inch DIP main - Union Road	6,800	LF	$240	$1,632,000
3	Clauseland Tank Improvements	1	LS	$950,000	$950,000
				SUBTOTAL	**$2,657,000**
				Contingency	$665,000
				SUBTOTAL	**$3,322,000**
				Engineering, Permitting & Inspection	$831,000
				SUBTOTAL	**$4,153,000**
				United Water Overhead Project Cost	$623,000
				TOTAL OPINION OF PROBABLE COST	**$4,776,000**

Note: 1. All costs are in 2015 Dollars as of May 2015
2. Cost excludes improvements to UWNJ water system

Table 3-8 Blaisdell Interconnection – 3 mgd Long-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
4	Expansion of MAPS - 2 mgd to 4 mgd	1	LS	$1,000,000	$1,000,000
5	Suction improvements to expanded MAPS	1	LS	$75,000	$75,000
6	New New Hempstead Road PS (2.0-mgd prefabricated, below grade PS)	1	LS	$1,100,000	$1,100,000
7	New 16-inch DIP main - New Hempstead Road	18,500	LF	$200	$3,700,000
8	Stream Crossings (each 100 feet J&B)	3	EA	$100,000	$300,000
				SUBTOTAL	**$6,175,000**
				Contingency	$1,544,000
				SUBTOTAL	**$7,719,000**
				Engineering, Permitting & Inspection	$1,930,000
				SUBTOTAL	**$9,649,000**
				United Water Overhead Project Cost	$1,448,000
				TOTAL OPINION OF PROBABLE COST	**$11,097,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to UWNJ water system

Table 3-9 Blaisdell Interconnection – Upgrade to 5 mgd Long-Term Improvements Opinion of Probable Cost Summary

Item	Description	Estimated Qty	Unit	Unit Price	Total Price
9	Modifications to Existing Blaisdell Int. Booster Station	1	LS	$650,000	$650,000
10	New 16-inch DIP main - Blaisdell and Hunt Roads	3,500	LF	$200	$700,000
11	Upgrade of MAPS - 4 mgd to 6 mgd	1	LS	$550,000	$550,000
12	Upgrade New Hempstead Road PS – 2 mgd to 3 mgd	1	LS	$150,000	$150,000
13	New 16-inch DIP main - New Hempstead Road	5,500	LF	$200	$1,100,000
14	Stream Crossings (each 100 feet J&B)	1	EA	$100,000	$100,000
				SUBTOTAL	**$3,250,000**
				Contingency	$813,000
				SUBTOTAL	**$4,063,000**
				Engineering, Permitting & Inspection	$1,016,000
				SUBTOTAL	**$5,079,000**
				United Water Overhead Project Cost	$762,000
				TOTAL OPINION OF PROBABLE COST	**$5,841,000**

Note: 1. All costs are in 2015 dollars as of May 2015
2. Cost excludes improvements to UWNJ water system
2. Assumes 3 mgd Long Term Improvements performed

3.4.3 Blaisdell Interconnection Potential Permit Requirements and Regulatory Issues

Based on a review of the potential Blaisdell Interconnection infrastructure listed above, the permits that are anticipated to be required to implement the necessary construction projects are summarized in **Table 3-10**.

Table 3-10 Blaisdell Interconnection Permit Summary

USACE	NYSDEC (Freshwater wetland/ Protection of Waters/ 401 WQ Cert	Rare, Threatened/ Endangered	NYSOPRHP Consultation	NYSDOT	NYSDOH/RCDOH	RC Drainage Agency	RC Highway Dept	Local Site Plan Approval	Local Building Permit	Local Highway Department (WM install)
Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

Some issues related to permitting and approvals include the following:

- Currently, NJDEP is assessing the supply capacity throughout northern New Jersey. This is an ongoing process that will take many years to complete. The transfer of water across state lines is complex regulatory undertaking that would require the approval of regulators of both states, and would have to consider the water supply needs of other communities in New Jersey.

- Regardless of the legal arrangements made between NJDWSC, UWNJ, and United Water, this interconnection option poses a risk that in the future, NJDWSC may see an increased demand and may unilaterally elect to cease providing water to United Water.

3.5 Return of Water Provided to Montvale, New Jersey to United Water

Since the early 1960s, United Water has served a small portion of UWNJ's service area in Montvale, New Jersey because the area is at an elevation that could not be served by UWNJ without a booster station. The average usage of this system for the last three years has been about 0.1 mgd. Over the past several years, UWNJ has investigated the possibility of installing the necessary booster station to serve this area. However, fire flow needs in the system caused the costs to be excessive. For this reason, UWNJ has decided to not pursue this option.

As discussed in the previous section, the BIPS already exists and it would be feasible to use this station to recover the water provided to UWNJ. No new infrastructure would be required to accomplish this. The only requirement is to obtain the necessary water supply permits from NJDEP and NYSDEC and to establish an appropriate agreement between UWNJ and United Water.

Section 4

Optimizing Supply from Ramapo Aquifer and Ramapo River Watershed

4.1 Introduction

This section discusses the potential for United Water to draw additional water, within existing permit limits, from the Ramapo Aquifer or Ramapo River watershed through United Water's existing Ramapo Valley Well Field (RVWF).

4.2 Ramapo Valley Well Field Existing Operations

The RVWF consists of 10 shallow wells that draw groundwater from the Ramapo Aquifer on the eastern bank of the Ramapo River, immediately upstream of the New Jersey border in the Village of Hillburn and Town of Ramapo in Rockland County. The RVWF was developed and implemented by the Spring Valley Water Company through the 1970s, with the last well coming on line in 1981. Water from the 10 wells in the RVWF is pumped to a central pump station, where the water is treated to remove volatile organic compounds and chlorinated. The RVWF component of United Water's system also includes a related surface water source, Potake Pond, which is used to augment flow in the Ramapo River to support operation of the well field. The RVWF provides approximately 25 percent of the average daily water supply in the United Water system in Rockland County on an annual basis, but less during the summer peak when this source can be adversely affected by low precipitation, which can affect the groundwater and flow in the Ramapo River.

The Ramapo Aquifer is hydraulically connected to surface water flows in the adjacent Ramapo River (i.e., water flows back and forth between the two depending on the relative water levels of each); the well field's water is drawn in part by infiltration from the river through permeable sand and gravel to the wells.

Withdrawal of water from the RVWF is governed by the water supply permit issued in 1967 by the New York State Department of Environmental Conservation (NYSDEC) for the RVWF, WSA 6507; a Modifying Decision for this permit was issued in 1982. The permit was developed in accordance with terms of stipulations with the Village of Hillburn and with the New Jersey Department of Environmental Protection (NJDEP). The permit conditions are intended to maintain the ecological health of the Ramapo River and the riparian rights of downstream communities, including the Village of Suffern and communities in New Jersey that also use the Ramapo River for drinking water or other purposes.

WSA 6507 permits a total of 14 mgd to be withdrawn from the RVWF on any given day, but the total amount of water pumped in any given month may not exceed an average of 10 mgd. That condition is permitted as long as flow in the Ramapo River at a U.S. Geological Service (USGS) gauge downstream of the well field, in Suffern, is greater than 10 mgd. When flow in the river is less than 10 mgd at the Suffern gauge, permitted withdrawals are lower:

- When flow in the Ramapo River at the Suffern gauge is lower than 10 mgd but greater than 8 mgd, maximum withdrawal of 8 to 10 mgd is permitted.

- When flow in the Ramapo River at the Suffern gauge is at or below 8 mgd, no withdrawal is permitted.

United Water has been able to reliably extract an annual average of about 7 mgd from the RVWF when it can be operated. However, during periods of low flow in the Ramapo River, the well field is not as productive and/or cannot be operated because of limitations set by its water supply permit related to the minimum passing flow in the Ramapo River immediately downstream of the well field. During peak summer conditions when Ramapo River flows are low, the sustainable withdrawal rate from the RVWF is about 4 mgd on average.

This sustainable rate is possible because of the augmentation of river flow by releases from Potake Pond. United Water uses water stored in Potake Pond, a reservoir that straddles the New York–New Jersey border, to supplement the flow of water in the Ramapo River so that the well field can remain operational when flows in the river would otherwise be too low. Water is withdrawn from Potake Pond through an intake structure and carried by pipe to a brook that feeds the Ramapo River. Prior to 2003, United Water had a lease agreement to take water from Potake Pond and another nearby water body, Cranberry Pond, to augment flow in the Ramapo River. In 2003, United Water purchased Potake Pond, constructed a pipeline from the pond to Nakoma Brook (a tributary of the Ramapo River), and consolidated the water supply permit to withdraw 190 million gallons from Potake Pond, which has a total volume of approximately 700 million gallons.

Use of Potake Pond is allowed by NYSDEC permit No. 3-3926-00207/0003-0, issued in 1993 and later modified by WSA 8620, issued in 2002. WSA 8620 permits release of water from Potake Pond for augmentation of the Ramapo River at a rate of 10 mgd or less per day, with maximum drawdown not to exceed usage of the upper 7 feet of the pond (and 190 million gallons). These releases shall occur only when necessary and effective in enabling use of the RVWF by raising the flow of the Ramapo River to at least 8 mgd when measured at the Suffern gauge. This permit does not require a minimum release to a water body downstream of Potake and Cranberry Ponds.

During dry periods, if water released from Potake Pond is not sufficient, United Water sometimes pumps water from the RVWF to the Ramapo River (in accordance with a State Pollutant Discharge Elimination System, or SPDES, permit issued by the NYSDEC) to maintain the required flows in the river.

4.3 Potential to Optimize Withdrawal from the RVWF

It may be possible to increase production from the RVWF, within the limits of the well field's existing permit, by augmenting flows in the Ramapo River or by augmenting storage in Potake Pond for later release to the river. However, the interaction between the river and the well field is relatively complicated and no detailed modeling tool has been developed to completely understand this system. As a consequence it is not possible to thoroughly evaluate the improvement in well field production that may result from a wide range of possible improvements. United Water believes that development of a modeling tool and conducting modeling may identify opportunities for additional water supply from the Ramapo Aquifer.

Some potential opportunities that may warrant further study include the following:

- Additional augmentation of Ramapo River flow from various sources (e.g., Potake Pond, Harriman Park Lakes, Tuxedo Lake, etc.). Currently, the water supply permit for Potake Pond

permits United Water to use the upper 7 feet of Potake Pond, but the possibility exists to use an additional 4 feet (an additional 110 million gallons), for a total of 300 million gallons.

- Pump back of water from the Ramapo River to Potake Pond. This would involve enhancing the supply capability in Potake Pond by pumping water during high flow events from the Ramapo River back to Potake Pond when it is not full.
- Additional treated wastewater effluent discharge from the Western Ramapo Advanced Wastewater Treatment Plant (AWTP) into the Ramapo River. The Western Ramapo AWTP currently treats wastewater to tertiary treatment standards, resulting in effluent that is close to drinking water standards. The plant discharges treated wastewater into the Ramapo River, with a permitted capacity of up to 1.5 mgd of discharge. If this plant's capacity was expanded, and the amount of treated effluent it discharges were increased, this could add to the flows in the Ramapo River. This option would require that the Rockland County Sewer District No. 1, which operates the AWTP, plan, design, permit, and construct an expansion to the AWTP, which was designed to allow an expansion up to 5 mgd. It would also require diverting additional wastewater to the plant to be treated by diversion of flow from other wastewater treatment plants such as the Rockland County Sewer District No. 1 Wastewater Treatment Plant in Orangeburg, or other areas in Rockland County.
- Possible additional flow into the Ramapo River resulting from growth in Orange County. As population grows in Orange County, the amount of treated wastewater effluent discharged to the Ramapo River from the Harriman Wastewater Treatment Plant (Orange County Sewer District No. 1) may increase.
- Combined management of the Village of Suffern and United Water's systems and their impact on river flow. As discussed in Section 3 (Interconnections with Other Water Suppliers), the Village of Suffern also withdraws water via wells from the Ramapo Aquifer. Both the Village of Suffern and United Water have unused allocation of supply in their permits for wells that use the Ramapo Aquifer. As discussed above, United Water is not always able to withdraw the full amount allowed in the RVWF's permit, because of the need to maintain a passing flow in the Ramapo River. This passing flow requirement is partly based on Suffern's concern over sufficient dilution flow being available in the river for the Suffern wastewater plant effluent discharge. It is possible that a holistic approach to operating these systems would allow additional production capacity from the RVWF.
- Optimization of existing operations. A surface water/groundwater model of the Ramapo River system could be used to determine whether there are better ways to operate RVWF to increase production.

For these reasons, it may be productive to begin a thorough study of the hydrological and hydrogeological capabilities of the Ramapo Aquifer and Ramapo watershed. United Water has already begun to develop a scope of work for this study, outlining two phases of study. The first phase would consist of data collection and a full definition of the scope; the second phase would be development and application of the modeling tool. The timeframe for such a study is still to be determined but at a minimum would be 2 to 3 years.

Many, if not all, of the above-mentioned projects will have substantial permitting issues. Nevertheless, as United Water already has invested in much of the necessary infrastructure to make additional use of water from this area, further study to identify the real possibilities may be warranted.

4.4 Other Ramapo River Flow Augmentation: Pine Meadow Lake via Torne Brook

One other option for augmenting the Ramapo River flow has been previously evaluated. This option, the use of Pine Meadow Lake in Harriman State Park through a siphon to Torne Brook, is not a feasible option, for the reasons discussed below.

In the past, United Water has occasionally received the assistance from the Palisades Interstate Park Commission (PIPC) to release water to the Ramapo River for flow augmentation. Releases were made from Lake Sebago in Harriman State Park into Stony Brook, which flows to the Ramapo River, as well as from Pine Meadow Lake which also flows to the Ramapo River via Stony Brook. While useful, the natural flow path of these releases via Stony Brook did not result in substantial gains in the Ramapo River, as much of the water was absorbed by the relatively dry creek bed.

However, one project that was not fully explored previously was the diversion of water from Pine Meadow Lake to Torne Brook, which flows directly into the Ramapo River directly above the RVWF. While this project could be investigated more thoroughly with the previously mentioned surface water/groundwater model study, a preliminary investigation on whether such a diversion was practical was conducted for this feasibility report. United Water developed a basic water supply model of this Pine Meadow Lake in order to evaluate the drawdown resulting from various release scenarios. As Pine Meadow Lake is not one of Harriman State Park's primary recreational lakes, it offered the possibility of some drawdown for augmentation of the river without interfering with the park's primary recreational objective. To this end, CDM Smith evaluated the possibility of installing a siphon to Torne Brook to achieve this objective. A siphon was selected as the drawdown method because there is no power in the vicinity of the lake for electric pumps.

Pine Meadow Lake has a reported volume of approximately 290 million gallons and a small drainage area of about 1.4 square miles. Spillage from Lake Wanoksink also flows into Pine Meadow Lake. **Figure 4-1** shows the location of the lake relative to the RVWF and Torne Brook as well as the conceptual plan for the siphon.

As shown in **Figure 4-2**, a 1 mgd release during the early 1960s (i.e., drought of record) during the August-October period resulted in a lake drawdown of about 3 feet below spillway. This analysis used 2 mgd to evaluate siphon capacity.

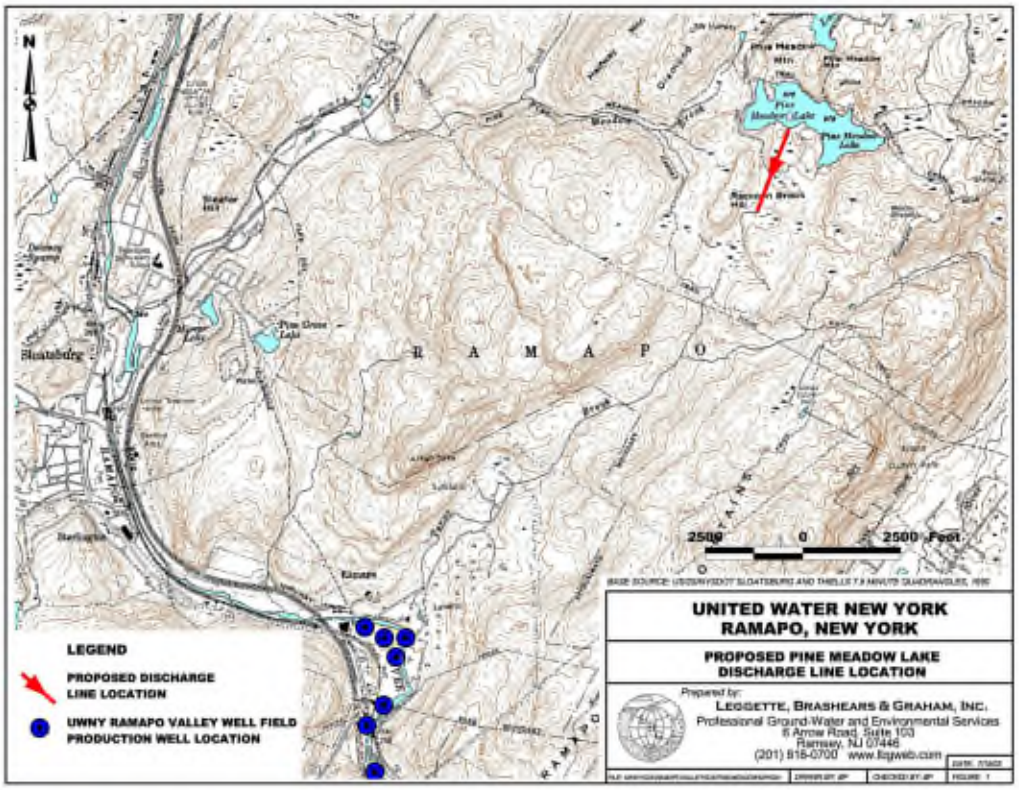


Figure 4-1
Ramapo River Flow Augmentation Conceptual Plan
(Source: Leggette, Brashears & Graham, Inc. July 15, 2003)

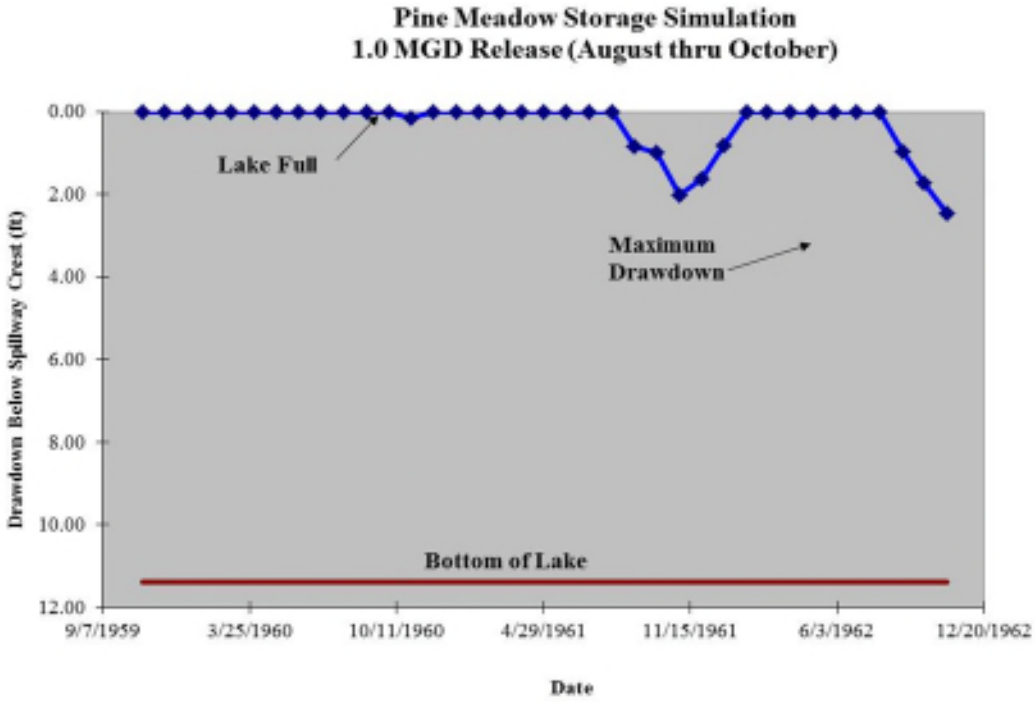


Figure 4-2
Pine Meadow Lake Water Level Simulation
(Source: United Water September 23, 2014)

4.4.1 Ramapo River Flow Augmentation – Pine Meadow Lake via Torne Brook Feasibility Evaluation

The design criteria used for the analysis were as follows:

- 2 mgd Siphon System
- Portable Vacuum Priming System
- Overland Piping

4.4.1.1 Siphon Main Sizing

CDM Smith calculated the velocity and headloss within 8-inch, 12-inch, and 16-inch siphon mains under 2 mgd flow conditions to determine the siphon main size (see **Table 4-1**). Based on the information summarized in **Table 4-1**, a 16-inch pipe is recommended in order to minimize the headloss between the siphon inlet and high point.

Table 4-1 Siphon Main Sizing

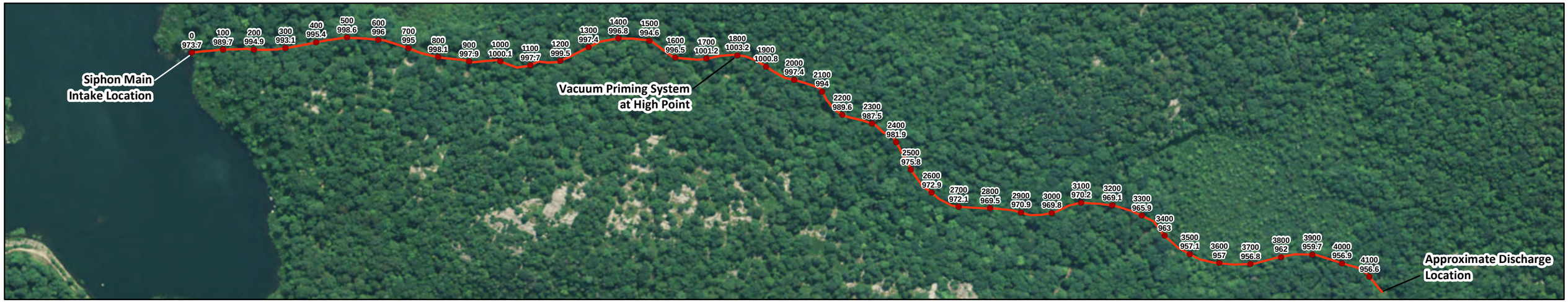
	8-inch Siphon Main	12-inch Siphon Main	16-inch Siphon Main
Velocity	8.9 fps	3.9 fps	2.2 fps
Headloss	39.1 ft/1,000 ft	5.4 ft/1,000 ft	1.3 ft/1,000 ft

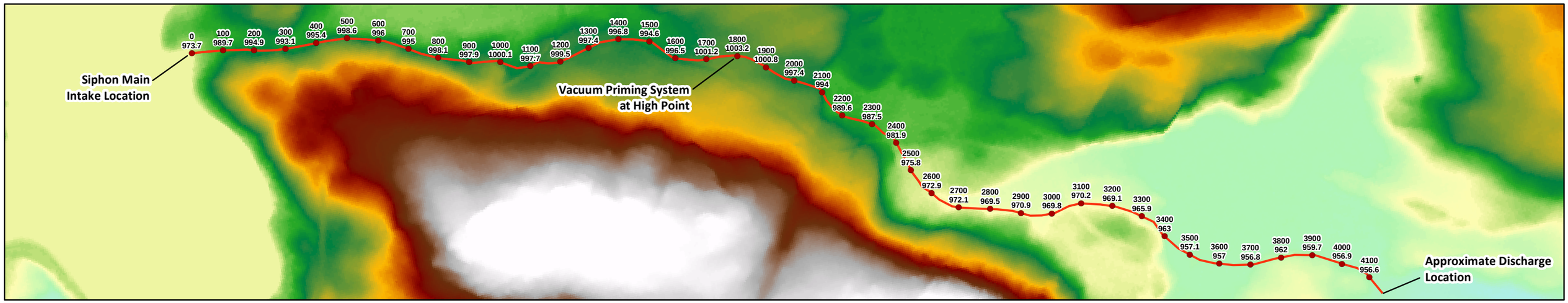
4.4.1.2 Siphon Main Profile

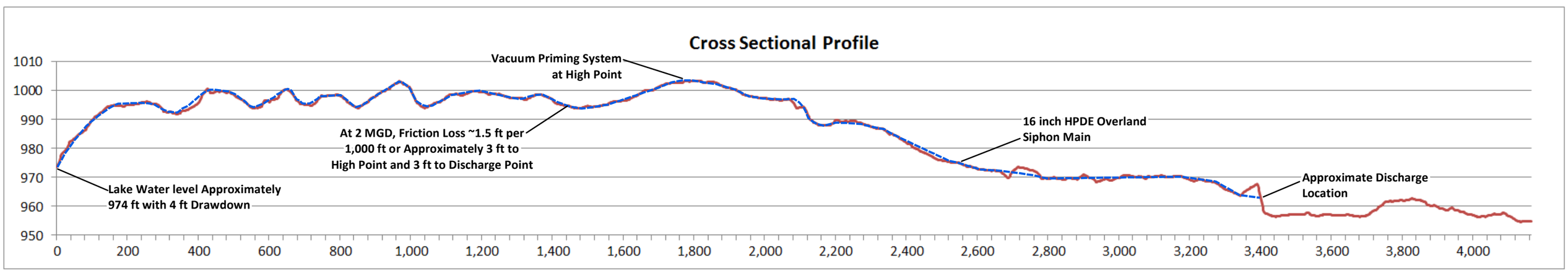
Based on the Pine Meadow Lake water surface elevation as shown in **Figure 4-1** and the estimated maximum drawdown water level within Pine Meadow Lake as shown in **Figure 4-2**, the estimated low water level is 974 feet (or 978 feet minus 4-foot drawdown).

CDM Smith initially reviewed the overland siphon main route based on a USGS topographic map with 20-foot contours, which showed the overland siphon main crossing the 1,000-ft elevation contour. This would result in a static water lift of 26 feet.

To better define the route and its contours, CDM Smith developed an overland siphon main profile using Lidar elevation data (see **Figure 4-3**) in an effort to locate the proposed overland siphon at the lowest possible elevation location. The profile confirmed that the overland siphon main would be above 1,000 feet or 26 feet above the Pine Meadow Lake low water level. Based on preliminary discussions with the company Q-Vac (vacuum system supplier), this 26-foot water level lift would exceed the reasonable capability of a vacuum priming system. For a vacuum priming assisted siphon system, Q-Vac recommends that the water level lift should be less than 14 feet, which would therefore require the siphon main to be at least 12 feet below grade in an area with shallow bedrock. This option would still require a custom-built portable vacuum priming skid system with a diesel-powered generator, since there is no power in the area and access is difficult. To avoid the use of vacuum priming system and the associated maintenance of the diesel-powered system located over four miles into Harriman State Park, United Water could construct a diversion structure and a rock tunnel to divert water from Pine Meadow Lake to the Torne Brook via gravity. However, this would be extremely expensive for a part-time flow augmentation system.







Legend

- Station Points (Station, Elevation)
- Potential Overland Route
- Siphon Main

Ramapo River Flow Augmentation

1 inch = 300 feet

0 300 600 Feet

Siphon Main

Figure 4-3

CDM Smith

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4.4.2 Ramapo River Flow Augmentation – Pine Meadow Lake via Torne Brook Conclusion

Based on the inability of the overland siphon to work with a priming system and the extremely high cost of the rock tunnel alternative, the option of using a siphon from Pine Meadow Lake to Torne Brook to augment the flows in the Ramapo River is not being further pursued.

Section 5
Wastewater Reuse

5.1 Introduction

As part of the development of the Haverstraw Water Supply Project (the Haverstraw Project), United Water conducted an extensive evaluation of alternatives and combinations of alternatives to that project, which were presented in the Draft Environmental Impact Statement (DEIS) prepared for the Haverstraw Project and completed in January 2012. A number of different methods of wastewater reuse were evaluated in the DEIS's alternatives chapters. Specifically, Chapter 18A of the DEIS, "Process and Operational Alternatives," included an extensive discussion of wastewater and stormwater reuse alternatives in Section 18A.5.2 (beginning on p. 18A-39), and one specific wastewater reuse alternative that used treated wastewater to supplement the capacity of Lake DeForest was evaluated in detail in Chapter 18D of the DEIS, "Wastewater Reuse Alternative."[1] These analyses are summarized below. In addition, another option is to use treated wastewater discharge from the Western Ramapo Advanced Wastewater Treatment Plant (AWTP) to augment flow to the Ramapo River, as discussed in Section 4 (Optimizing Supply from Ramapo River and Ramapo River Aquifer) and summarized again below.

5.2 Wastewater Reuse for Non-Potable Purposes

The analysis in Chapter 18A considered the potential to use stormwater or wastewater treatment plant effluent for non-potable purposes, such as irrigation or industrial uses, as a substitute for using potable water. This would free up potable water capacity to meet a portion of future water demands. The analysis concluded that the amount of increased capacity would be minimal, and the costs of this alternative would be prohibitive.

5.3 Wastewater Reuse for Potable Purposes

The analysis in Chapter 18A of the DEIS also considered the potential to collect stormwater or wastewater to be pumped into groundwater aquifers to recharge the aquifer. It concluded that the assemblage and acquisition of suitable land areas for stormwater infiltration basins or soil-aquifer recharge areas near Rockland County's sand and gravel aquifers (in western Ramapo) is not likely to be economically feasible. Moreover, stormwater is not a reliable water source in the event of drought conditions. Reuse of wastewater treatment plant effluent to recharge the aquifer is possible, and would require the same treatment and conveyance infrastructure as the Wastewater Reuse Alternative that would introduce treated effluent to Lake DeForest, described below.

The analysis in Chapter 18D of the DEIS presented and analyzed an alternative to the Haverstraw Project that involves diverting treated sewage effluent from the Rockland County Sewer District No. 1 Wastewater Treatment Plant (RCSD1 WWTP) in the Town of Orangeburg for further treatment so that it can be released into the Lake DeForest Reservoir, or, alternatively, into the Hackensack River downstream of the Lake DeForest dam. This could be used to increase the safe yield of the Lake DeForest reservoir for United Water's Rockland County customers by as much as 7.5 mgd, the same safe yield as the Haverstraw Project would provide.

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[1] http://haverstrawwatersupplyproject.com/draft-environmental-impact-study-deis.html.

Under this alternative, treated wastewater effluent from the RCSD1 WWTP in Orangeburg would be pumped to United Water's Lake DeForest property via a new buried effluent transmission main (force main) approximately 5.6 miles long, originating at the wastewater treatment plant. To accomplish this, a new connection to either the RCSD1 WWTP's existing chlorine contact chamber or existing effluent outfall pipe would be created and a new effluent pumping station would be constructed. At Lake DeForest, a new Advanced Wastewater Treatment Plant (AWTP) would provide tertiary treatment to the treated wastewater effluent, so that the resulting processed water would be similar to the quality of the water in Lake DeForest and meet regulatory standards for discharge to Lake DeForest or the Hackensack River. The water would then be discharged by one of the following methods:

- The treated wastewater would be pumped to the north end (head) of Lake DeForest via a new pump station located at the AWTP and 3.9-mile-long transmission main beneath Strawtown Road (on the west side of Lake DeForest). The treated wastewater would supplement and mix with the existing reservoir water, and be detained in the reservoir as the water travels southward to the dam. The addition of this water would increase the amount of raw water that could be withdrawn from Lake DeForest for use by Rockland County by 7.8 mgd, resulting in 7.5 mgd of additional potable water for Rockland County. United Water's existing obligations for discharges from the reservoir to meet the needs of downstream users in the Village of Nyack and reservoirs in New Jersey would be unchanged.

- Alternatively, the treated wastewater would be discharged at the base of the Lake DeForest dam into the Hackensack River. In addition, the Village of Nyack's water intake would be relocated from the Hackensack River downstream of the dam to instead draw directly from Lake DeForest. In this River Discharge Option, the treated wastewater would serve to meet the flow requirements in the Hackensack River for downstream users in New Jersey. Eliminating United Water's requirement to discharge a minimum flow from the reservoir to meet that obligation would increase the amount of raw water that could be withdrawn from Lake DeForest for use by Rockland County by 7.8 mgd, resulting in 7.5 mgd of additional potable water for Rockland County.

In either scenario, the existing Lake DeForest Water Treatment Plant would be expanded and upgraded to increase its current capacity for daily intake of raw water by 7.8 mgd. The potable water produced at the expanded treatment plant would be distributed through United Water's existing water distribution system. Some improvements to the distribution system, particularly near Lake DeForest, may be required with this alternative.

Like the Haverstraw Project, the Wastewater Reuse Alternative could be implemented in three phases, based on growth in water demand as Rockland County's population increases. Phase 1 would enable the Lake DeForest Water Treatment Plant to produce an additional 2.5 mgd of potable water, Phase 2 would increase production capacity to 5 mgd of potable water, and Phase 3 would increase the plant's capacity to produce 7.5 mgd of potable water. However, with the River Discharge Option, the alternative would not be phased, and the full capacity would be provided when the alternative begins operation.

Like the Haverstraw Project, the Wastewater Reuse Alternative would create a new long-term water supply source capable of providing 7.5 mgd of potable water as a supplement to United Water's existing water supply sources. However, this alternative would have higher capital costs than the Haverstraw Project and would therefore be less able to meet the public need and benefit of being cost-effective. The analysis presented in the DEIS also concluded that in terms of system redundancy, this

alternative would also be less successful than the Haverstraw Project. Whereas the Haverstraw Project would add an entirely new water supply source that would operate independently of the other sources in United Water's Rockland County system, the Wastewater Reuse Alternative would increase the system's dependence on one existing water supply element, the Lake DeForest Water Treatment Plant. With this alternative, approximately 45 percent of the water produced by United Water for Rockland County would be produced at the Lake DeForest Water Treatment Plant. In the event that the plant must be shut down for maintenance or because of an unforeseen emergency, the entire system would be more vulnerable to unreliability. The Wastewater Reuse Alternative also has the potential to result in increased flooding in the Hackensack River downstream of Lake DeForest (with the River Discharge Option having a greater potential for increased flooding than the option that discharges treated wastewater to the head of the reservoir).

5.4 Western Ramapo Advanced Wastewater Treatment Plant

As discussed in Section 4, additional treated wastewater effluent could be discharged from the Western Ramapo AWTP into the Ramapo River to augment flows in the river, so as to optimize use of the Ramapo Valley Well Field (RVWF). The Western Ramapo AWTP currently treats wastewater to tertiary treatment standards, resulting in effluent that is close to drinking water standards. The plant discharges treated wastewater into the Ramapo River, with a permitted capacity of up to 1.5 mgd of discharge. The discharge is just above the regulatory weir in the river where the RVWF permit requires that flows be maintained at 8 mgd. As discussed in Section 4, during some periods of low flow in the Ramapo River, the RVWF cannot be operated because of limitations set by its water supply permit related to the minimum passing flow in the Ramapo River immediately downstream of the well field. During peak summer conditions when Ramapo River flows are low, the sustainable withdrawal rate from the RVWF is about 4 mgd on average, in comparison to the maximum withdrawal of 14 mgd when river flows are not constrained. If this plant's capacity were expanded, and the amount of treated effluent it discharges were increased, this could add to the flows in the Ramapo River, which could result in an increase in the RVWF's capacity.

This option would require that the Rockland County Sewer District No. 1, which operates the AWTP, plan, design, permit, and construct an expansion to the AWTP, which was designed to allow an expansion up to 5 mgd. It would also require diverting additional wastewater to the plant to be treated by diversion of flow from other wastewater treatment plants such as the Rockland County Sewer District No. 1 Wastewater Treatment Plant in Orangeburg, or from other areas in Rockland County. The cost of increasing the treatment capacity of this plant and directing additional wastewater flows to the plant would likely be expensive.

Section 6
Conservation and Water Recovery

6.1 Introduction

The PSC's November 17, 2014 Order Addressing Status of Need and Directing Further Study (2014 Order) requires that "UWNY shall study what conservation opportunities exist, in collaboration with the Task Force [the Rockland County Task Force on Water Resources Management], with the goal of identifying measures that may reduce demand by 2 million gallons per day (mgd) and shall file a report with the Secretary within six months of the issuance of this order identifying the feasibility, cost and estimated demand reductions associated with each identified measure." (2014 Order, pp. 66-67)

United Water continuously adjusts its internal processes and controls in an effort to improve system efficiency, reduce the cost of service through water loss reduction, and ensure sustainability of critical water supplies. Water conservation also helps conserve energy and reduce chemical usage, which in turn may result in a cost savings for customers. This section describes several actions that United Water can take to reduce demand, including demand-side management methods to reduce the amount of water consumed by customers and improved management of the network by United Water.

6.2 Conservation

This section of the report outlines feasible conservation measures that can be implemented in United Water's Rockland County service area to reduce water demand by United Water's customers. It includes the continuation of programs that have been in place for decades as well as innovative and effective water conservation measures that can be taken.

6.2.1 Outreach and Education to Promote Conservation by Customers

United Water's existing conservation program includes an ongoing customer conservation outreach and education initiative that will be maintained in the future. United Water has provided information on conservation through a variety of media and venues:

- A *Water Conservation Guide*, produced and distributed annually, which provides information for saving water indoors and outdoors. In previous years, this communication was an insert in the local newspaper, the *Journal News*. As part of a green initiative, the *Water Conservation Guide* is now posted on United Water's website and promoted via Facebook, digital ads, and other social media. Select pages continue to be printed and distributed at community events, school presentations and the company's customer service center.
- The ET (EvapoTranspiration) lawn watering program, which uses weather information to determine how much water a lawn needs on a given day. The ET number is published daily on the company website (https://www.unitedwater.com/newyork/et-lawn-water.aspx) during the gardening season. General information is offered in a bill insert. United Water has launched a social media campaign promoting ET and will continue to use these tools.
- Information on xeriscape gardening. United Water has provided information on xeriscape (conservation) gardening for many years and recently has committed to funding a conservation

garden at the Rockland County Courthouse. This type of garden uses native plants, drought tolerant plants and waterwise landscaping techniques. Information on conservation gardening is available on the company website (https://www.unitedwater.com/newyork/xeriscape.aspx), in the *Water Conservation Guide* published annually, and in bill inserts.

- Promotion of the use of water-efficient irrigation products such as rain sensors, rain barrels, and drip irrigation systems. Information on these products was previously available in the *Water Conservation Guide*; in the future, these products will be promoted through bill inserts and social media.
- Discounts on water-saving devices. This information was previously available in the *Water Conservation Guide* and through the company's website. This program was discontinued in 2015 due to low volume of responses but will be reevaluated.
- Promoting the use of water efficient appliances and plumbing fixtures with the United States Environmental Protection Agency (EPA) WaterSense label. United Water is a partner in this EPA program, which is referenced in the company's annual *Water Conservation Guide*, on its website, in bill inserts, and through social media campaigns.
- Educational outreach to customers about the need to use water wisely, especially in summer months. This has been accomplished through press releases, bill inserts, cable TV spots, local radio, social media campaigns, and videos available on the company's website.
- Educational outreach to customers about non-revenue water (theft of service, illegal use of fire hydrants, etc.) and how these actions impact water availability and rates. Bill inserts, meetings with municipal officials, and discussions with United Water's Customer Advisory Panel have been used to accomplish this.
- Outreach in local schools. Company representatives actively make presentations in Rockland County schools, using the Project WET (Water Education for Teachers) curriculum. This includes specific lesson plans tailored by grade level on conservation, the water cycle, and how to protect water resources.

6.2.2 Conservation Rate Structure

In 1981, United Water implemented a summer–winter water rate structure, in which higher water rates are charged from May 1 to September 30 each year in order to encourage conservation during the period of peak demand. Initially, the rate structure was 3:1, so that summer rates were three times higher than non-summer rates. In response to strong customer opposition, during the following summer the PSC reduced the differential to 1.5:1, which has remained since its adoption in 1982.

In 2014, United Water introduced monthly billing. This enables customers to more closely monitor water usage and to detect household leaks at an early stage.

6.2.3 Future Conservation Pilot Program

To ensure the success of the company's conservation program and broaden its impact, United Water has engaged in dialogue with municipal and Rockland County officials, company stakeholders, customers, and partnering utilities. The goal of these discussions has been to identify additional ways to conserve, as well as to explore synergies between municipal leadership and the business community as well as potential cost sharing with other utilities. Feasible conservation measures that

have been identified are outlined below. It should be noted that a number of these strategies would require input from the PSC as well as funding mechanisms through the regulatory process.

- Work with municipal officials. United Water will work collaboratively with officials who wish to consider updating local ordinances to require the use of conservation apparatus for construction of new homes and businesses.
- Implement watering restrictions. Work with Rockland County officials to determine the feasibility of amending the sanitary code to reflect odd/even day watering and time-of-day restrictions to relieve peak day demand.
- Utility partnerships. Explore opportunities with partnering utilities such as Orange & Rockland (O&R) that would result in mutually beneficial savings related to energy and water. For example, this might include the following shared outreach efforts:
  - Customer mailings with shared messaging on conservation.
  - Customer conservation kits with information on conservation of electricity, gas, and water.
  - Radio outreach, with O&R representatives as guests on United Water-sponsored radio shows in Rockland County.
  - Shared social media outreach. Conservation information could be distributed through O&R and United Water social media channels (e.g., Facebook, Twitter).
- Water audit program: Water use audits can provide water companies and their customers with information about how water is used and can help to identify potential conservation strategies. United Water is currently developing a pilot program to measure current water usage practices in specific Rockland County buildings and identify ways to improve water efficiency and conserve water.
- WaterSense rebate program. A rebate program for customers who install water-saving devices, appliances, or irrigation products may provide an incentive for conservation by customers. While further information would be needed to estimate realistic savings from implementing fixture/appliance rebate programs, some potential savings can be estimated. For example, if 10,000 toilets and 10,000 washing machines (of the estimated 85,000 households within United Water's Rockland County service area) are replaced with more efficient types, there is the potential to save approximately 0.5 mgd. Other fixture/appliance renewals (e.g., showers, dishwashers) as well as irrigation control devices could provide water savings as well. Prior to proceeding with such a program, a cost-benefit analysis would need to be done and, if deemed cost-effective, approval of a funding mechanism by the PSC would be needed.

Preliminary evaluations indicate that strategic implementation of these measures will reduce water consumption by United Water's customers by as much as a total of 1 mgd over a 10-year period. This estimate accounts for declining trends in per capital residential consumption as well as anticipated population growth over that same time period. While residential water consumption per capita is

expected to continue to decline, it is assumed that it will not be lower than the EPA's guideline rate of 45 gallons per day per capita for indoor water usage for a water-efficient home.[1]

Conservation measures outlined above can be implemented strategically to reduce water consumption by United Water's customers. Most of these programs will require funding mechanisms, as well as partnerships with municipalities and other utilities.

6.3 Water Recovery

As a private company, United Water does not have the authority to mandate or enforce conservation by its customers. However, it does have the ability to implement its own conservation measures, primarily through the careful control of the amount of "non-revenue water" (or NRW) produced. All water systems have a component of production that is non-revenue water. Non-revenue water consists of water that is produced but not billed, such as water used during the water treatment process, to flush fire hydrants, and for fire-fighting, as well as water lost through leaks in the distribution system and from water main breaks. A certain amount of non-revenue water is normal for any water supply system, and cannot be avoided. Addressing NRW losses is a constant concern to any water company and part of the ongoing investment in infrastructure and management practices. United Water has an ongoing program to identify and repair system leaks, including replacement of some of the system's water mains each year. United Water invests annually in this program at a level approved by the PSC as part of previous rate orders. United Water also regularly undertakes a number of other initiatives to control NRW. This section of the report describes recent initiatives related to reduction in NRW.

6.3.1 Overview of NRW Components

Non-revenue water consists of the water that is produced but that is not sold to customers. It includes three main categories of water: unbilled, authorized consumption; apparent losses; and real losses. Reductions in real losses can be targeted to reduce the amount of water produced, as discussed below. However, a certain amount of non-revenue water, including real losses, is normal for any water supply system and cannot be avoided.

The three broad categories of NRW are as follows:

- Unbilled, authorized consumption. This includes water used within the water treatment processes and water used for critical public safety functions (i.e., firefighting and hydrant flushing). This water usage is not billed and, therefore, does not generate revenue for the water utility. Nonetheless, this element of NRW cannot be reduced and is unavoidable.
- Apparent losses. This is water used by customers that is not billed correctly, such as unauthorized consumption (theft), water that is not metered or is metered inaccurately, and data errors. This water is used by customers but does not produce revenue for the water utility. This element of NRW can be addressed by identifying and correcting the errors (i.e., corrections to the meters). This will not reduce the amount of water produced; it will instead shift water from NRW into revenue water but the water will nonetheless be consumed. Certain apparent losses, such as standard customer metering inaccuracy, are unavoidable but are minimized through proper management of the aged-meter replacement policy as required by the PSC.

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[1] U.S. Environmental Protection Agency, *Water Conservation Plan Guidelines,* August 6, 1998, Table B-1. http://www.epa.gov/WaterSense/pubs/guide.html.

- Real losses. This is water lost through system leakage, including water main breaks, leakage on mains, leakage and overflows at storage tanks, and leakage at service connections. Some real losses (i.e., some kinds of leaks) cannot be practically reduced. These are called unavoidable real losses. Essentially, each pipe segment in the 1,000+ miles of distribution mains has some small level of leakage, and when summed, these unavoidable real losses can account for a significant component of the NRW. All water supply systems include some leakage of this type, and those that operate at relatively high pressure (like the system in Rockland County) have higher leakage rates than those operating at lower pressures. Other real losses (i.e., other types of leaks and breaks) can be practically reduced. These types of leaks can include those that are visible and quickly repaired as well as those that cannot be seen from the surface. Real losses represent the only element of NRW that can be controlled to some extent by the water utility so as to reduce the amount of water produced (since the other elements of NRW – unbilled, authorized consumption and apparent losses – both constitute water that is needed for legitimate purposes). Real losses can be primarily addressed through programs to more efficiently identify and repair non-reported leaks.

6.3.2 Plans to Reduce NRW

In recent years, NRW has constituted approximately 20 to 21 percent of the total water produced by United Water in Rockland County. To reduce the component of production that is NRW to the extent practicable, United Water has taken numerous actions to date, in accordance with the company's ongoing NRW reduction strategy and process. These are described in United Water's NRW reduction plans submitted to the PSC, which include the following:

- United Water New York Non-Revenue Water Cost Benefit Analysis for Potential New Programs (September 2014) – submitted to PSC as directed in Case #13-W-0295.
- 2013 and 2014 NRW Reduction Plans submitted to PSC.

As discussed in the plans and summarized below, United Water is planning to take numerous actions to reduce NRW, which will decrease the total amount of water produced, equivalent to reducing demand. These include measures to reduce apparent losses and measures to address and reduce real losses (i.e., leaks and breaks) that can be practically reduced. These measures will also provide information to allow a better understanding of each type of loss within the category of NRW.

6.3.2.1 Measures to Reduce Apparent Losses

To reduce "apparent" losses, in which water is produced but not billed to customers due to errors or theft, United Water will address metering inaccuracies and theft:

- Metering inaccuracies – A meter is not a perfect device and as such does not measure consumption with 100 percent accuracy. From the thousands of meter accuracy tests performed by United Water, the deterioration in meter accuracy with age is well-established. Continual investment in meter replacement/renewals in order to replace aging meters before meter accuracy deteriorates will prevent substantial "under-registration" of consumption (i.e., incorrectly under-registering water usage). This means that the water consumed but not registered is NRW. Addressing this issue will not result in less production; rather, it will result in a better understanding of NRW and an increase in revenue, which can contribute towards proper investments in the water system.

- Theft of service – United Water has already identified numerous theft of service issues. Typically, these involve tampering with a meter or tapping a service prior to the meter. United Water will increase its efforts to detect and correct theft of service issues. Some evidence exists that this could be a significant component of NRW. Substantial analysis and manpower will be needed to address this issue. Where theft exists, there is no financial incentive to limit water use. Therefore, it is expected that successful correction of theft issues will have real impact on actual water consumption. Another form of theft is the unlawful use of water from unmetered hydrants. Although control of this problem will be difficult, identifying it will help to deter use from hydrants and will also will allow a better understanding of losses.

6.3.2.2 Metering and Billing Initiatives

United Water has already implemented monthly meter reading and billing cycles to better correlate system consumption and production data. Going forward, meter reading cycles will be revised to focus on individual pressure zone regions (and district metered areas, or DMAs, as discussed below) in sequence, which will allow for high-accuracy mass balance and water audit calculations to be performed on a zone-specific basis.

All metered customer accounts were geocoded and mapped within the Geographic Information System (GIS), and all service points were reconciled with their corresponding record within the Customer Information System (CIS) to ensure consistency with customer metering records. As part of this process, all customer metering points were assigned a DMA/pressure zone identifier to allocate metered consumption to specific zones within the system.

6.3.2.3 Installation of Advanced Metering Infrastructure (AMI)

Currently United Water's metering system is one that uses drive-by readings. A vehicle drives down a street and picks up meter signals from customers. Recently, meter reading frequency was changed to monthly for the entire system. This more detailed information allows for a better alignment of production vs. consumption, allowing for higher resolution water audits. United Water is moving forward with AMI, which will allow more frequent reading of customer meters. Such a system, when coupled with the division of large pressure districts into smaller DMAs, discussed below, will allow NRW to be monitored more frequently than the current situation (e.g., daily instead of monthly). AMI will also allow United Water to notify customers of leaks that occur after their meter.

United Water estimates that approximately 10 fixed AMI Gateways (receivers) will be required to provide complete coverage of the Rockland County service area. The estimated costs associated with both the fixed AMI Gateways and the replacement of customer meter data transmitters with improved technology is approximately $14.5 million over five years.

6.3.2.4 Investment in Renewal/Replacement of Water Mains and Services

United Water currently replaces water mains on a regular basis, as part of the company's Underground Infrastructure Renewal Program (UIRP), which was established and approved by the PSC in prior rate order proceedings. Those rate orders established the average capital expense ($5.5 million per year) that United Water could spend on this program as well as a maximum per year ($6.0 million), and required United Water to file with the PSC each year a list of the projects to be included in the UIRP for that rate year. Since 2007, the company has replaced approximately 23 miles of mains as part of the UIRP program. This represents approximately 0.28 percent of the system on average per year during this time. A more aggressive program of replacement/renewal will promote sustainability of efficient water loss levels, once achieved. A reasonable target would be to reach a renewal rate of 0.7 percent by 2020, which is equivalent to replacing the network every 140 years and more in-line

with typical life spans of water main material. This will require an investment of approximately $10.5 million in 2020. United Water is working toward this goal with a planned steady increase in main replacement investment in the future to reach 0.7 percent in 2020.

6.3.2.5 Leak Detection on Customer Services

United Water owns the portion of the service lines between the main and curb. Customers are responsible for service lines from the curb into homes and places of business. As most meters are located inside the home or business, service lines can leak without the customer being aware. These types of "smaller" service line leaks will become more apparent as DMAs are installed. Once such a leak is detected, customers need to be compelled to take action to fix the leak within a reasonable time frame.

6.3.2.6 Leak Detection via Soundings

United Water has an ongoing process whereby, as company personnel come into contact with components of the network as part of routine maintenance activity, these system components are inspected for leaks using acoustical listening equipment. This encompasses every valve, hydrant, curb stop, and meter that is inspected, changed, or repaired – which results in leak survey of more than 50 percent of the service territory each year. So far, in 2015, United Water personnel have made over 9,000 such soundings, covering a wide range of the distribution system. United Water believes that this current program is adequate but that greater attention should be paid to detecting leaks on customer services, as discussed above.

6.3.2.7 Accelerated Leak and Main Break Repairs

Leak and main break "find-to-fix" times, or the time between when United Water becomes aware of a leak and when it is repaired, have been minimized by repair policies prioritized by leak magnitude and resulting system impacts. United Water repairs most leaks within hours of discovery and will continue this practice. Dedicated leak correlation personnel have been assigned and trained on the various equipment and methods used under best-practice techniques. Additionally, the planned DMA system implementation will greatly improve the efficiency with which non-surfacing leaks are identified and resolved.

6.3.2.8 Separation of Large Pressure Districts into Smaller District Metered Areas (DMAs)

One typical and effective means of detecting leaks is to evaluate system usage late at night and very early in the morning when most customers are not using water. A small amount of usage is always present, but leaks may become obvious when normal background trends increase. In large pressure zones, only a very large leak can be detected by routine desktop system monitoring. Therefore, smaller leaks that do not cause issues with water pressure or quality and do not surface to cause damage must be located via leak detection. Most of the pressure districts in United Water's Rockland County water supply system are large and therefore have this issue. Breaking the distribution system into smaller zones increases the precision with which anomalies in the amount of water delivered to a zone can be detected by routine desktop analysis. This information can then be used to deploy the appropriate resources to investigate the issue. This approach has already been proven out in the industry in general and specifically in one of United Water's systems in New Rochelle. United Water has begun to implement division of its Rockland County system pressure districts into DMAs and will continue this work until the system is subdivided into districts that are more manageably sized.

United Water operations and engineering staff have been working on developing budgets and plans that would provide the option to accelerate the implementation of DMAs for United Water's Rockland County system. Five DMA metering sites (and two DMA zones) have already been established within

Pressure District (PD) 10, the largest pressure district in the system, and the cost basis for this project was used to estimate costs for the entire system. Based on industry-wide standards, the optimal size for a DMA is to serve approximately 3,000 connections, so this is the approximate size that has been assumed for each DMA in United Water's Rockland County system, where practical. Four pressure districts are targeted for DMA development: the two largest, PD10 and PD20, as well as the third and fourth largest, PD40 and PD95. The remaining districts are already small enough that additional DMAs are not required.

To create DMAs, underground meters, together with electrical and communications equipment, are installed that measure the flow into and out of each DMA. Each DMA would require several of these underground equipment locations, or DMA metering sites. Depending on the specific characteristics of the pressure district, other modifications to underground infrastructure could also be required.

Table 6-1 summarizes the breakdown of DMAs for each of the major pressure districts.

Table 6-1 Proposed DMAs

Pressure District	Total No. of Connections in Pressure District	Proposed No. of DMA Zones	Average No. Services per DMA Zone	No. of DMA Metering Sites Required
PD10	29,451	8[1]	3,681	29
PD95	11,644	5	2,328	7
PD20	15,659	8	1,957	21
PD40	6,226	2	3,113	4
			TOTAL:	**61**

Note: 1. Including the 2 DMA zones already created in PD10.

The estimated cost to develop these DMAs is approximately $10.5 million and the time-frame to design, construct, and place all of the approximately 56 additional metering sites into service is about two to three years in total. Since the work involved is routine underground utility work, the permitting requirements associated with creation of DMAs should be minor.

As part of the DMA program implementation, United Water will also evaluate pressure reduction opportunities to reduce the level of real losses associated with unavoidable background leakage.

At this time, it is not possible to accurately predict how much real and apparent loss will be recovered via this program; however, United Water's sister companies have seen significant reductions in avoidable leakage in Westchester County through implementation of DMAs.

6.3.3 Conclusions Related to Water Recovery

United Water estimates that between 0.5 and 1.0 mgd of recoverable NRW exists within the Rockland County water supply system, based on a study done for United Water New Rochelle, which has similar service characteristics to the Rockland County system. The United Water New Rochelle study concluded that 60 percent of that system's NRW was due to real losses. The recoverable quantity consists of the real losses minus estimated leakage that is not possible to recover (i.e., the unavoidable annual real loss or UARL).

Section 7
Conclusion

7.1 Introduction

In response to the New York State Public Service Commission's (PSC or Commission) Order Addressing Status of Need and Directing Further Study, issued on November 17, 2014 (2014 Order), this report identifies a number of feasible conservation measures to reliably reduce water demand and small-scale incremental water supply projects that may be implemented for United Water's operations in Rockland County, New York.

7.2 Potential Incremental Water Supply Projects

7.2.1 Additional Groundwater Supply from Wells

A combination of factors will make it difficult and costly to develop new supply wells, to rehabilitate existing wells, or to convert private wells into community supply wells:

- United Water has already developed most of the productive well sites in Rockland County. What generally remain are potential sites with relative small yields and potentially significant siting and other issues. There would likely be some opportunities to develop new wells but United Water anticipates this to be time-consuming and costly with some risk that substantial funds could be expended without accomplishing a significant increase in supply. The cost to develop a small well (i.e., less than 300 gpm or 0.4 mgd) could be as high as $7 million, assuming normal permitting and land acquisition costs.
- Finding new well locations that will not potentially interfere with any number of the approximately 6,000 private wells scattered throughout Rockland County has proven to be difficult and will likely continue to be difficult.
- Nevertheless, there appear to be some opportunities to develop new small supply wells. Additional investigation would be required before the feasibility, potential yield, and cost can be better understood. This would include substantial testing to fully understand capacity potential, water quality issues and impacts on private wells.

7.2.2 Interconnections with Other Water Suppliers

United Water has identified three potential interconnections with adjacent water suppliers, as well as the opportunity to recover water currently being supplied to a small number of accounts in Montvale, New Jersey. From a capital cost perspective some of these potential projects appear attractive. The unit cost based on capital cost estimates for the three interconnection projects ranges from $1.6 to $9.0 million per mgd of supply. However, operating costs as well as the costs of some other required improvements (e.g., potential upgrade of the Nyack Water Treatment Plant and upgrades to United Water New Jersey's (UWNJ) system) were not included in this feasibility study and the cost to purchase water would significantly increase the cost.

While supply from such interconnections may seem plausible, each is likely to have substantial and costly permitting complexity. Each of the identified projects will likely raise concerns over impacts on riparian rights in both New York and New Jersey. A dialogue with regulators in both states is needed

to fully understand the ramifications of such projects. In addition, regardless of the legal arrangements made to secure the water transfer, there is a risk for these projects that if demands increase, the water supplier may unilaterally elect to cease providing water to United Water, which of course raises reliability concerns.

A brief summary is provided:

- ***Village of Suffern:*** This potential project involves the purchase of up to 1 mgd of potable supply from the Village of Suffern and distribution to United Water via a new booster station and certain infrastructure improvements. United Water and the Village of Suffern would work to assure the New York State Department of Environmental Conservation and the Rockland County Department of Health that withdrawal of additional water from these wells would not exacerbate an existing chlorides problem in some of Suffern's wells or negatively impact the customers of either system.

- ***Village of Nyack:*** This project involves the purchase of up to 1 mgd of supply from the Village of Nyack and distribution to United Water's Rockland County system via a new booster station and certain infrastructure improvements. Due to the complex nature of the water supply permits in the Hackensack River, this project is likely to encounter significant regulatory issues. This project would require a clear willingness by the regulators in both New York and New Jersey to move the project forward.

- ***Water from the North Jersey District Water Supply Commission (NJDWSC) via the Blaisdell Interconnection:*** NJDWSC, a regional water supply entity for the State of New Jersey, supplies a large portion of the raw water used by UWNJ at its Oradell Reservoir. NJDWSC indicates that it has excess allocation that could be sold to another party. This water could be sold to United Water for use in Rockland County, via a transfer of raw water to UWNJ's Oradell Reservoir, where it would be treated at the Haworth Water Treatment Plant and then transferred from UWNJ's system to the Rockland County system through the existing Blaisdell interconnection/ pump station, located on the state line between the two United Water systems. The existing capacity of the station is 3 mgd; a 5 mgd capacity increase was also considered. Due to the large quantity of water that would be input to United Water's Rockland County system, substantial infrastructure improvements would be needed. Infrastructure improvements of about $1.25 to $6 million would also be required within the UWNJ system. However, NJDEP is currently assessing the supply capacity throughout northern New Jersey. This is an ongoing process that will take many years to complete. The transfer of water across state lines is a complex regulatory undertaking that would require the approval of regulators of both states, and would have to consider the water supply needs of other communities in New Jersey.

- ***Return of Water Provided to Montvale, New Jersey:*** The existing Blaisdell interconnection could be used to recover the approximately 0.1 mgd of water that is currently being provided by United Water to UWNJ customers in Montvale, New Jersey, if necessary water supply permits are obtained.

7.2.3 Optimizing Supply from Ramapo Aquifer and Ramapo River Watershed

There are a number of potential options to increase the water produced, within existing permit limits, from the Ramapo Valley Well Field (RVWF) by augmenting flows in the Ramapo River. United Water has been able to reliably extract an annual average of about 7 mgd from the RVWF when it can be operated. However, during periods of low flow in the Ramapo River, the well field is not as productive

and/or cannot be operated because of limitations set by the RVWF's water supply permit related to maintaining a minimum passing flow in the Ramapo River immediately downstream of the well field. The interaction between the river and the well field is relatively complicated and no modeling tool has been developed to completely understand this system. As a consequence, it is not possible to thoroughly evaluate the potential increases in well field production that may result from a wide range of possible improvements. United Water believes that development of a modeling tool and conducting modeling may identify opportunities for additional water supply from the Ramapo Aquifer. Some potential opportunities that may warrant further study with a surface water/groundwater model include the following:

- Additional augmentation of river flow from various sources (e.g., Potake Pond, Harriman Park Lakes, Lake Tuxedo, etc.).
- Pump back of water from the Ramapo River to Potake Pond during high flow events, for storage before returning to the river to augment supply.
- Additional treated wastewater effluent discharge from the Western Ramapo Advanced Wastewater Treatment Plant (AWTP) into the Ramapo River by an expansion to the AWTP and diversion of flow from other plants or additional areas in Rockland County.
- Possible additional flow into the Ramapo River from the Harriman Wastewater Treatment Plant resulting from population growth in Orange County.
- Combined management of the Village of Suffern and United Water's systems and their impact on river flow, using a holistic approach to maintain adequate flow for Suffern's interests while maximizing production from the RVWF.

7.2.4 Wastewater Reuse

As part of the development of the Haverstraw Water Supply Project (the Haverstraw Project), United Water conducted an extensive evaluation of wastewater reuse as a possible alternative to development of the Haverstraw Project, which was presented in the Draft Environmental Impact Statement (DEIS) prepared for the Haverstraw Project (completed in January 2012). The analysis concluded that reuse of stormwater or wastewater for non-potable purposes, to free up potable water capacity, would have little potential to increase capacity and would be cost-prohibitive. The reuse of wastewater (i.e., treated wastewater treatment plant effluent) for potable water is feasible and could produce up to 7.5 mgd of potable water, but requires upgrades to the wastewater treatment facility, expansion of the Lake DeForest water treatment plant, and installation of extensive new transmission mains. In total, this alternative was projected to have higher capital costs than the Haverstraw Project and therefore was not advanced.

7.2.5 Potential Cost per Yield

Table 7-1 presents a summary of the per million gallon cost range for the incremental water supply projects evaluated as part of this report.

Table 7-1 Incremental Water Supply Projects
Opinion of Probable Cost per Million Gallons (MG)

Water Supply Project	Cost per MG
Well Supply	$6.6M to $16.2M per MG
Suffern Interconnection	$6.7M to $7.7M per MG
Nyack Interconnection	$4.4M to $9.0M per MG
Blaisdell Interconnection	$1.6M to $5.3M per MG

Note: 1. Cost in May 2015 dollars
2. Does not include cost for interconnection supply side system improvements

These unit costs assume as part of the permitting process a modest environmental impact review and permitting process that would ordinarily be expected for a routine water utility project. Furthermore, operating costs have not been factored into the above assessments. Each interconnection would involve payments for water purchased and operations of new pumps and wells will have inherent operating costs. These are not included as sufficient information is not yet available to include these accurately. Based on preliminary discussions with some of the interconnection providers, it is anticipated that the price for wholesale water would be approximately $2,500 per MG and pricing would be similar to United Water's tariff rate for the sale of treated water on a wholesale basis.

7.3 Conservation and Water Recovery

United Water has identified a number of measures that it will take, and others that may be appropriate, to reduce water demand, including demand-side management methods to reduce the amount of water consumed by customers and improved management of the network by United Water.

In terms of conservation by customers, United Water's existing conservation program includes an ongoing customer conservation outreach and education initiative that will be maintained in the future. In addition, United Water has engaged in dialogue with municipal and Rockland County officials, company stakeholders, customers, and partnering utilities to identify additional ways to conserve, as well as to explore synergies between municipal leadership and the business community as well as potential cost sharing with other utilities. Feasible measures were identified that can reduce water demand, including a water audit program, rebate program for installation of water-saving devices, and partnership with local municipalities to implement water restriction regulations and ordinances.

In addition, United Water is planning to take numerous actions to reduce the amount of non-revenue water (NRW) produced, which will decrease the total amount of water produced, equivalent to reducing demand. All water systems have a component of production that is non-revenue water. Non-revenue water consists of water that is produced but not billed, such as water used during the water treatment process, to flush fire hydrants, and for fire-fighting, as well as water lost through leaks in the distribution system and from water main breaks. A certain amount of non-revenue water is normal for any water supply system, and cannot be avoided. United Water has an ongoing program to identify and repair system leaks, including replacement of some of the system's water mains each year. United Water also regularly undertakes a number of other initiatives to control NRW. This includes upgrading meters and identifying theft of service, so as to reduce apparent losses (which will shift some water consumption from NRW to revenue water). To address real losses, United Water's program includes installation of Advanced Metering Infrastructure (AMI), investment in renewal and replacement of water mains and services, leak detection on customer services and throughout the network via soundings, and accelerated leak and main break repairs. Most importantly, United Water

anticipates that NRW control and reduction can best be accomplished by division of the four largest pressure districts in the Rockland County service area into smaller zones, referred to as District Metered Areas (DMAs), where leaks will be easier to detect and where there may be opportunities to reduce pressure. United Water affiliates have implemented DMAs in other systems (United Water New Rochelle and United Water Westchester) and two DMAs have already been installed within PD10, the largest pressure district in United Water's Rockland County system. United Water operations and engineering staff have been working on developing budgets and plans that would provide the option to accelerate the implementation of DMAs for United Water's Rockland County system. The estimated cost to complete the creation of DMAs in the four largest pressure districts is approximately $10.5 million and the time frame for the completion is about three years. United Water estimates that altogether, these initiatives may eliminate approximately 0.5 to 1.0 mgd of recoverable NRW within the Rockland County water supply system.

7.4 Conclusion Regarding Short-Term Measures

Based on the information in the report, United Water is confident that if the activities and associated targets identified in the report and summarized below are pursued to address short-term needs, supply and demand will remain in balance for the next 10 years. The report identifies the potential to reduce consumption by as much as 1 mgd total over 10 years through conservation programs and another 1 mgd total through an aggressive program to reduce NRW. In addition, the report identifies several small-scale incremental water supply projects that could be pursued depending upon the effectiveness of conservation and NRW reduction programs, as well as residential and commercial growth trends within Rockland County. Incremental supply of 1 to 3 mgd is likely feasible over a 10-year period. There may be opportunities beyond these targets, but a conservative view is prudent given significant factors that United Water has limited or no ability to control, such as environmental impact review / permitting costs and timing, ratemaking time and uncertainty, and stakeholder buy-in and cooperation.

Please note, however, that planning short-term water supply projects does raise the risk of incurring unnecessary cost for the ratepayers if a long-term project ultimately proves necessary. This point was made by Dr. Daniel M. Miller, the Water Supply Program Manager at the Rockland County Department of Health, in his comments of July 9, 2014 on the DPS's 2014 Staff Report on Need:

> Timing the development of any new water supply project, large or small, carries risks. If a project is built too early, the ratepayers would incur the expense of maintaining a plant before it is needed. Worse yet, if demand patterns significantly changed, rate payers would potentially incur the cost of building and maintaining a source that may never be needed. On the other hand, if a project is started too late, there is an increased risk that there will not be enough water to meet future demands.
>
> The latter scenario could lead to a potential public health hazard if demand increased rapidly such that supply capacity was insufficient to maintain pressure in the system, or in a less extreme case, could result in slowing or stopping further expansion of the UWNY system and thus commercial and residential development.
>
> Even postponing development of the desalination plant by developing smaller projects first involves some level of risk. Assuming the desalination plant is ultimately needed, ratepayers would bear not only the cost of the earlier smaller projects, but the cost of the desalination plant as well. The point I make is that all risks and implications need to be

> considered when long term water supply planning decisions are made. *(Comments of Dr. Daniel M. Miller to the Department of Public Service Staff Report on Need, July 9, 2014, p. 3)*

United Water has provided this report to inform short-term water supply and demand planning and, at the same time, to help inform the decision of the PSC as to whether United Water should continue to pursue the long term water supply project ordered in its 2006 and 2010 Rate Orders.

Appendix A

Permitting Requirement Summary

The following is a discussion of the permits, approvals, and consultations that are anticipated to be required for the implementation of the incremental water supply projects described in this report.

A.1 Permitting Introduction

The permits, approvals, and consultations included in this appendix have been determined based on a review of online available resources. A summary listing of permits/approvals required by potential project is included in the main body of the report. As the design of any individual project progresses and a greater level of detail is developed, the applicability of the permits and approvals listed (along with their specific requirements) may change.

The primary agencies that are anticipated to have jurisdiction over the incremental water supply projects evaluated in this report include the following:

- United States Army Corps of Engineers (USACE)
- New York State Department of Environmental Conservation (NYSDEC)
- New York State Department of Health (NYSDOH)
- New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP)
- New York State Department of State (NYSDOS)
- New York State Department of Transportation (NYSDOT)
- Rockland County Department of Health (RCDOH)
- Rockland County Drainage Agency (RCDA)
- Rockland County Highway Department (RCHD)
- Site Plan Approval (SPA) – Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point
- Building Permit - Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point
- Local Highway Permit - Orangetown, Haverstraw, Clarkstown, Ramapo, Stony Point

For each permit type and/or approval presented, the lead review agency is identified along with the jurisdictional and regulatory basis. It is important to note that several agencies may have advisory roles in the permitting process without having a formal permit requirement.

A.2 Federal Permits

A.2.1 United States Army Corps of Engineers (USACE)

As proposed wells may be located within federal wetlands and connecting water mains could traverse these regulated features, permits from the USACE could be required.

A.2.1.1 Nationwide Permit 12 – Utility Line Activities

Coverage under this permit is applied for projects that include activities associated with utility lines or associated facilities (such as maintenance or repair) within or affecting a jurisdictional water body. Under this permit, a "utility line" is defined as any pipe or pipeline for the transportation of any gaseous, liquid, liquefiable, or slurry substance, for any purpose. Applications require the use of the Joint Application for Permit form, project description, site photographs, relevant plans/specifications and the completion of an Environmental Questionnaire. Application for several NWPs may be applied for under a single application. USACE strives to log in each application within a 30 day period and provide a written determination within an additional 30 days after a complete application has been received.

A.2.1.2 Nationwide Permit 33 – Temporary Construction, Access, and Dewatering

Project actions that include construction of temporary structures, work, and/or stormwater/ groundwater discharges necessary for USACE-approved construction activities, access fills, or dewatering of construction sites within or affecting a jurisdictional water body can fall under the requirements of a Nationwide Permit 33. Applications require the use of the Joint Application for Permit form, project description, site photographs, relevant plans/specifications and the completion of an Environmental Questionnaire. Application for several NWPs may be applied for under a single application. USACE strives to log in each application within a 30 day period and provide a written determination within an additional 30 days after a complete application has been received.

A.3 New York State Permits

A.3.1 New York State Department of Environmental Conservation (NYSDEC)

NYSDEC administers the environmental permitting program within the state. This includes, but not limited to, actions within or adjacent to regulated waterbodies, wetlands, sources of air pollution, temporary actions that can result in a discharge to water of the state. For example, all well sites considered in this report involve permanently installed systems that provide piped water to the public for drinking and other potable purposes. In addition, three potential well locations could involve work in or adjacent to waters of the State of New York. Force mains/water main construction may need to cross a regulated stream or require construction in an area where endangered/threatened species have been documented. Consequently, this work is likely to be subject to NYSDEC review and approval.

A.3.1.1 State Pollutant Discharge Elimination System (SPDES) – General Permit for Stormwater Discharge from Construction Activity GP-0-15-002

SPDES requirements include a General Permit (GP) under the Municipal Separate Storm Sewer System (MS4) program for temporary Sediment and Erosion Control for construction activities that disturb one or more acre of soil. The purpose of this regulation is to safeguard persons, protect property, and prevent damage to the environment from erosion and sedimentation during any activity that disturbs or breaks the topsoil or results in the movement of earth on land.

A Notice of Intent (NOI) will be required for the specific construction activities and should include a schedule of proposed construction activities. The erosion control measures and post-construction (if required) stormwater management elements will be defined.

The local MS4 program, as designated by the NYSDEC, will review and approve the construction Stormwater Pollution Prevention Plan (SWPPP) that is required prior to appling for coverage under this General Permit.

A.3.1.2 Protection of Waters Permit – 401 Water Quality Certification

Section 401 of the Clean Water Act requires a Water Quality Certification for all discharge activities within the waters of the United States. Under Section 401 any applicant for a federal permit or license to conduct any activity, including the construction or operation of facilities that may result in any discharge into navigable waters must first receive certification from the state or states in which the action will be undertaken. Further, the action must not violate the water quality standards set by the state for the body of water or wetlands affected by the project (Title 33 U.S.C. 1341 and 6 NYCRR Part 608.9).

This permit is required if a project includes placement of fill, for activities that result in a discharge to a jurisdictional water body. Work directly in or that may result in a discharge to waters of the United States are required to apply for and obtain a Water Quality Certification. Actions requiring an individual permit from the USACE trigger the need to obtain a 401 Water Quality Certification. At this time it appears the individual program components will not trip this trigger.

USACE Nationwide Permits are often covered by a correspondingly issued blanket statewide Water Quality Certification issued by NYSDEC. The Joint Application for Permit form and supporting material submitted to USACE for coverage under a NWP would therefore be sent to NYSDEC for concurrence. NYSDEC technical support material requirements are similar to those listed for USACE. NYSDEC does require its SEQR review form be included as an attachment. NYSDEC strives to determine completeness within 30 days and issuance of minor permits within an additional 30 to 60 days. Major permits can take six to 12 months to be issued.

A.3.1.3 Protection of Waters Permit – Stream Disturbance (Bed and Banks)

Based on the NYSDEC classification of the stream (CT or higher), this permit will be required for activities within or adjacent to the regulated water body. Activities include placement of structures (such as bridges, culverts or pipelines); fill for bank stabilization or to isolate a work area (such as rip-rap or cofferdams); excavation for gravel removal; part of a construction activity; lowering stream banks to establish a stream crossing; or using equipment in a stream to remove debris or to assist in construction. Application for this permit is also made using the Joint Application for Permit form. Review times and requirements are the same as noted above.

A.3.1.4 Public Water Supply Permit

The public water supply program established in 1905, contributes to the protection and conservation of available water supplies by ensuring equitable and wise use for domestic, municipal, and other purposes. The public water supply program regulates activities that involve permanently installed systems providing piped water to the public for drinking and other potable purposes (6 NYCRR Part 601).

This permit may be required for any project that connects to a water supply system. Actions that will trigger the need to apply for a public water supply permit include:

- Use of permanent systems providing piped water to public for drinking or other potable purposes; or
- Construction of new water supplies or any projects in connection to water supply systems; or
- Construction of any extension of water supply mains which will extend the boundaries of a water supply district; or
- Supplying water for the use by another person or public corporation in any municipality or civil division of New York State ; or
- Entering into a contract for water supply; or
- Transportation of more than 10,000 gallons per day of water by a vessel.

Application is made using the Joint Application for Permit form and the required Supplement form. Technical attachments include an Engineer's Report, pump test report, plans/specs, statement of need, and ownership documentation. Review and approval time for this permit can take up to 12 months.

A.3.2 New York State Department of Health (NYSDOH)

All wells involve permanently installed systems that provide piped treated water to the public for drinking and other potable purposes. Consequently, this is likely to be subject to NYSDOH review and approval. A coordinated review by Rockland County Department of Health (RCDOH) is also anticipated. Water mains and force mains would fall under the jurisdiction of the RCDOH.

A.3.2.1 Division of Water, Bureau of Public Water Supply Protection - Approval of Plans for Public Water Supply Improvements

An approval is required for projects that include connection, construction or installation of a public water supply system or any addition, deletion or modification of a public water supply system. NYSDOH and Rockland County DOH will need to review and approve/endorse the design documents for this project. A submittal of these design documents (plans and specifications) and Engineer's Design Report is expected to be made at the 90% design stage of the project for this purpose. Once construction is complete and testing has been accepted, an Approval of Completed Works can be issued.

A.3.2.2 Division of Water, Bureau of Public Water Supply Protection - Backflow Prevention Device Approval and Report on Test and Maintenance of Backflow Prevention Device

This approval is required for projects that include connection to public water supply system. The intent of this approval is to protect the public water supply from the possibility of contamination caused by backflow from private distribution or water supply systems.

Private users have the primary responsibility of preventing contaminants from entering the public water supply and distribution system by installing, testing, operating, maintaining and keeping adequate maintenance and repair records for every backflow prevention device installed to provide containment.

A.3.3 New York State Department of Transportation (NYSDOT)

Work within a New York State roadway or its right-of-way requires a Utility Work Permit from NYSDOT. Applications include the application form, plans detailing the proposed that conform to the requirements of the NYSDOT, as well as traffic/pedestrian safety plans. Applications are made to the Regional office and are typically issued in 30 to 60 days after all required information is provided.

A.3.4 Office of Parks, Recreation and Historic Preservation (NYSOPRHP)

The NYSOPRHP regulates state parkland and activities within the state parks. In addition, the State Historic Preservation Office at NYSOPRHP identifies structures within the State of New York of specific historic importance and reviews project plans and identifies concerns involving historic structures.

It should be noted that NYSOPRHP consultation is required for coverage under NYSDEC GP-0-15-002 as well as USACE NWPs. Consequently, NYSOPRHP review and statement of 'No Impact' is anticipated to be required for all strategy components.

A.4 Rockland County Permits and Approvals

In addition to requirements of the State of New York, the incremental water supply projects must also obtain several approvals on the County level. Erosion and sediment control plans and SWPPPs must also be reviewed and approved by the Rockland County Drainage Agency. These same documents are also reviewed by the local towns. The multi-level governmental review can be time consuming.

A.4.1 Rockland County Department of Health (RCDOH)

The RCDOH is the agent of NYSDOH in enforcing the State Sanitary Code. A coordinated review of the entire project between the NYSDOH and RCDOH will be required for each new proposed well and associated treatment process.

A.4.2 Rockland County Highway Department (RCHD)

The RCHD is responsible for County roadways as well as the placement of utilities within the roadway easement. Application to the RCHD is required where new water mains are proposed to be installed. Consistency with the requirements of the department for the protection and safety of vehicles and pedestrians and for road restoration is required.

A.4.3 Rockland County Drainage Agency (RCDA)

The Rockland County Drainage Agency is responsible for the review and approval of stormwater management plans, and erosion and sediment control plans for activities within the County. This a coordinated review with the local towns and villages.

A.5 Town Permits and Approvals

Water supply projects would require several approvals from the local town in which the proposed construction would take place. In addition to Site Plan approval requirements—for example for the construction of a well house or pump station—local town permitting authority often 'duplicates' that of the State. For example, it is not unusual for local towns to require freshwater wetland permits and water crossing permits even if permits have been secured from USACE and/or NYSDEC. Erosion and sediment control plans and SWPPPs must also be reviewed and approved by the local municipality. RCDA also reviews these same project elements. The multi-level governmental review of various project elements can be time consuming.

Site Plan Applications are typically required for the construction of above-grade structures (i.e. buildings) as noted in the town's Code. Applications require the preparation of plans as required by the individual town. A preliminary submittal and final submittal are required. Presentation before the town's planning board and/or Town Board is required. Typical time frame for Site Plan approvals is one year.

A.6 Non-Agency Permits and Approvals - Utility Consultation

Consultation with the various existing utility owners in the area of work will be required prior to any excavation.

Appendix B

Interconnection Hydraulic Model Evaluation

The following is a discussion of the hydraulic model analysis performed as part of the interconnection supply option evaluations discussed in Section 3.

B.1 Suffern Interconnection Hydraulic Model Analysis

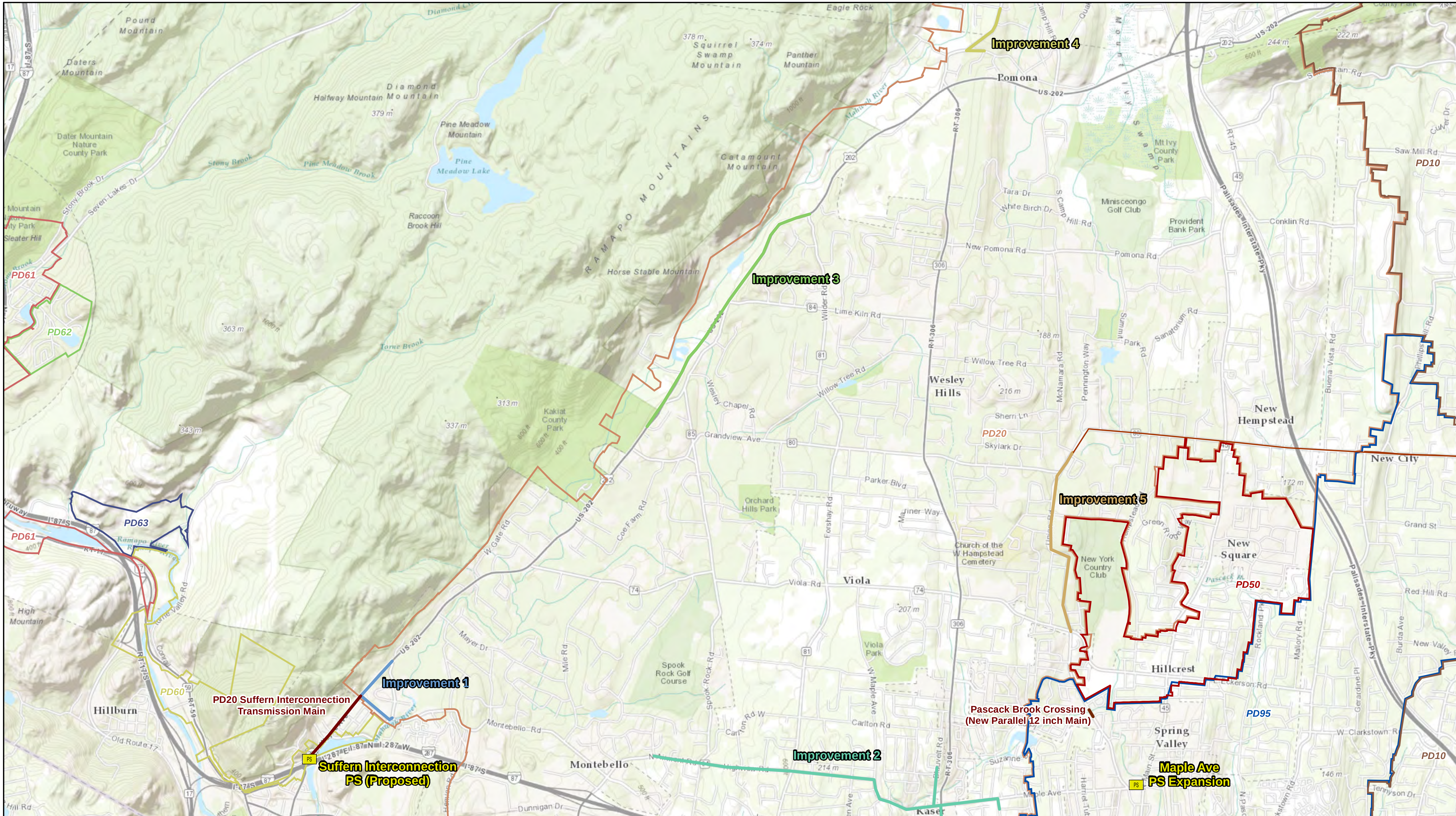
As discussed in Section 3, CDM Smith utilized the existing United Water hydraulic computer model to evaluated obtaining 1 mgd from the Village of Suffern water system through a connection to the 16-inch Suffern water main and a new below grade pump station located on Wayne Avenue, just north of the NYS Thruway (see **Figure B-1**). CDM Smith then evaluated both direct and indirect supply options:

- Supply 1 mgd from Suffern directly to PD20 (i.e., direct option)
- Supply 1 mgd from Suffern to PD20 through the RVWF Transmission Main and the Maple Avenue Pump Station (MAPS) (i.e., indirect option)

B.1.1 Suffern Interconnection Water Main Improvements Selected for Evaluation

As part of the Suffern Interconnection supply analysis for both the direct and indirect options, the following water system improvements were selected for evaluation (see **Figure B-1**):

- Improvement No. 1 – New 16-inch DIP Main:
    - Haverstraw Road (Rt 202) from Orchard Street to Lake Road (approx. 1,600-ft)
    - Orchard Street from Haverstraw Road (Rt 202) to Monte Belle Road (approx. 1,500-ft)
- Improvement No. 2 – New 16-inch DIP main:
    - Airmont Road (Rt 64) from Champion Parkway to Spook Rock Road (approx. 1,600-ft)
    - Highview Road (Rt 64) from Spook Rock Road to Maple Ave (approx. 6,000-ft)
    - Maple Avenue (Rt 64) from Highview Road to Monsey Blvd (approx. 4,800-ft)
    - Blauvelt Road from Maple Avenue (Rt 64) to Manor Drive (approx. 1,400-ft)
    - Main Street from Maple Avenue (Rt 64) to Maple Leaf Road (approx. 500-ft)
    - Monsey Blvd from Maple Avenue (Rt 64) to Sunrise Drive (approx. 400-ft)
- Improvement No. 3 – New 16-inch DIP main – Haverstraw Road (Rt 202) from Cutler Court to Wilder Road (approx. 9,300-ft)
- Improvement No. 4 – New 16-inch DIP main:
    - Old Haverstraw Road from Jade Court to Call Hollow Road (Rt 75) (approx. 500-ft)



N

Improvement 1
Improvement 2
Improvement 3
Improvement 4
Improvement 5
Other Improvement
Pump Station
Pressure Districts (PD)

United Water, NY

1 inch = 3,000 feet

0 1,000 2,000 4,000 Feet

Suffern Interconnection
Supply Option
Figure B-1

CDM Smith

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  - Call Hollow Road (Rt 75) from Old Haverstraw Road to Oakridge Road (approx. 2,000-ft)

- Improvement No. 5 – New 20-inch DIP main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft)

B.1.2 Suffern Interconnection Supply to PD20 Evaluation Results – Direct Option

To supply PD20 directly from the Suffern Interconnection Booster Pump Station, a new 3,000-foot-long 16-inch transmission main is required from the Suffern Interconnection Booster Pump Station located on Wayne Ave, north of the NYS Thruway, to the intersection of Wayne Avenue and Orchard Street (see **Figure B-1**).

According to the model results without any of the system improvements incorporated, the pressure within the southwestern area of PD20 will increase by approximately 10 psi when supplying PD20 directly from the Suffern Interconnection Booster Pump Station. This is a concern because pre-existing pressure already exceed 200 psi in this area and increased pressure could lead to pipe breakage and/or increased leakage.

System Improvements Nos. 1 through 4, as listed in Section B.1.1, were then systematically evaluated with the hydraulic model in an attempt to reduce the resultant pressure increase. Overall, even with System Improvements Nos. 1 through 4, the pressure within the southwestern area of PD20 is still predicted to increase by approximately 7 psi.

Based on the results and discussions with United Water, supplying PD20 directly is not the recommended supply option hydraulically due to the increase in system pressure as a result of the Suffern Interconnection Supply. However, in the future, United Water may want to consider this as a back-up connection to PD20 from the Suffern Interconnection Booster Pump Station in the event that Ramapo Well 29A is offline and the RVWF Transmission Main is at capacity.

B.1.3 Suffern Interconnection Supply to PD20 Evaluation Results – Indirect Option

To supply PD20 through the RVWF Transmission Main and MAPS, expansion of the MAPS would be required along with a 16-inch water main connection from the RVWF Transmission Main and the MAPS Expansion.

According to the model results, the pressure in the vicinity of the MAPS discharge transmission main connection to PD20 (at the intersection of Union Road and Viola Road) will increase by approximately 10 psi due to the increased supply from the MAPS. Therefore, System Improvement No. 5, as listed in Section B.1.1, was evaluated and the model predicted the pressure increase in the vicinity of the MAPS discharge transmission main connection to PD20 (at the intersection of Union Road and Viola Road) to be reduced to less than 5 psi. This improvement along with the installation of a parallel 12-inch water main on Union Road at the Pascack Brook would allow the existing MAPS to operate at its design condition.

Based on the hydraulic model results and discussions with United Water, supplying PD20 indirectly through the RVWF Transmission Main and MAPS is a viable supply option hydraulically.

B.1.4 Suffern Interconnection Supply Recommended Infrastructure Summary

In summary, to supply United Water with 1 mgd from the Village of Suffern water system through the RVWF Transmission Main and MAPS (i.e., the indirect option), the following water system infrastructure improvements are required:

- New 1 mgd Below Grade Interconnection Booster Pump Station (sized to supply either PD20 directly or the Ramapo Valley Wellfield Transmission Main)
- Expansion of the MAPS (for new pumps sized to supply water from the RVWF Transmission Main to PD20)
- New 16-inch suction main from the RVWF Transmission Main and the MAPS Expansion (approx. 250-ft)
- New parallel 12-inch Pascack Brook water main crossing on Union Road
- Improvement No. 5 – New 20-inch DIP Main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft) (to mitigate system pressure as a result of the increased supply from the MAPS)

As discussed above, if in the future, United Water determines that a back-up connection to PD20 from the Suffern Interconnection Booster Pump Station is desired, the following water system infrastructure would be required:

- New 16-inch transmission main from the Suffern Booster Pump Station to PD20 (approx. 3,000-ft)

B.2 Nyack Interconnection Hydraulic Model Analysis

CDM Smith utilized the existing hydraulic computer model to evaluate obtaining 1 mgd from the Village of Nyack water system into PD10 through the existing interconnection and a new above grade booster pump station located on Rt 303, just south of the Palisades Center Drive (see **Figure B-2**). For a conservative analysis, it was assumed that three new PD10 groundwater wells (totaling approximately 600 gpm) were online, as instructed by United Water for the purposes of this hydraulic assessment.

B.2.1 Nyack Interconnection Water Main Improvements Selected for Evaluation

As part of the Nyack Interconnection supply analysis, the following water system improvements were considered (see **Figure B-2**):

- Improvement No. 5 - New 20-inch DIP main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft)
- Improvement No. 6 – New 16-inch DIP main – West Nyack Road from NYS 59 to Strawtown Road (approx. 3,100-ft)
- Improvement No. 7 – New 12-inch DIP main – Kings Highway from Five Oaks Lane to Bluebird Drive (approx. 1,600-ft)

New 12" New Hempstead Road PS Water Main

New Hempstead PS (Proposed - General Location)

Improvement 5

Improvement 7

Pascack Brook Crossing (New Parallel 12 inch Main)

Maple Ave PS (Expansion)

Nyack Interconnection PS (Proposed)

Improvement 6

PD10

PD11

PD20

PD50

PD95

Improvement 5
Improvement 6
Improvement 7
Other Improvement
PS Pump Station
Pressure Districts (PD)

United Water, NY

1 inch = 2,400 feet

0 1,000 2,000 4,000 Feet

Nyack Interconnection Supply Option

Figure B-2

CDM Smith

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B.2.2 Nyack Interconnection Supply Evaluation Results

With the additional PD10 interconnection supply and the additional PD10 groundwater wells during average day demand condition, the model predicts that the storage tanks within PD10 would remain full while the storage tank within PD20 would run very low. Therefore, additional supply/transfer of water is needed from PD10 to PD20 in order to maintain the water level within the PD20 storage tank. To accomplish the additional transfer of water, CDM Smith utilized the second pump within the MAPS in order to increase the supply from PD10 from 2 mgd to 4 mgd.

However, during maximum day demand condition, pumping 4 mgd from PD10 to PD20 through the MAPS impacts the water level within the Spring Valley Reservoir. Therefore, reducing the flow to PD20 from the MAPS to 3 mgd but building a new 1 mgd below ground pump station along New Hempstead Road (near Patricia Drive) would shift the supply to PD20 from PD10 closer to the new PD10 wells and shift the draw from PD10 towards the Valley Cottage Tank.

In terms of impact to system pressure as a result of the new PD10 interconnection supply and the additional PD10 groundwater wells, according to the model results, the pressure within PD10 at the Nyack Interconnection area will increase by approximately 5 psi. System Improvements Nos. 6 and 7, as listed in Section B.2.1, where systematically evaluated with the hydraulic model. However, System Improvements Nos. 6 and 7 did not significantly mitigate the predicted pressure increase Nyack Interconnection area and are therefore not recommended.

However, according to the model results, the pressure in the vicinity of the MAPS discharge transmission main connection to PD20 (at the intersection of Union Road and Viola Road) will increase by approximately 10 psi due to the increased supply from the MAPS. Therefore, System Improvements No. 5, as listed in Section B.2.1, is recommended to reduce the pressure increase at the MAPS discharge transmission main connection to less than 5 psi. This improvement along with the installation of a parallel 12-inch water main on Union Road at the Pascack Brook would allow the MAPS to operate at its design condition.

B.2.3 Nyack Interconnection Supply Recommended Infrastructure Summary

To obtain 1 mgd from the Village of Nyack Water System along with an additional 600 gpm from three new groundwater wells in PD10, the following near-term water system infrastructure improvements, which is defined as improvements needed initially to obtain water from the Nyack Interconnection under intermediate operation, are required:

- New 1 mgd Above Grade Interconnection Booster Pump Station (to supply PD10 from the Nyack water system)
- New parallel 12-inch Pascack Brook water main crossing on Union Road
- Improvement No. 5 – New 20-inch DIP Main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft) (to mitigate system pressure as a result of the increased supply from the MAPS)

As system demands increase over time, the following additional long-term water system infrastructure improvements, which are defined as improvements needed to obtain the full amount of water from the Nyack Interconnection under consistent operation, are recommended:

- Expansion of the MAPS (for the installation of a third pump for proper system reliability of 4 mgd)

- New 1 mgd New Hempstead Road Pump Station (to pump water from PD10 to PD20 and located near Patricia Drive)
- New 12-inch DIP New Hempstead Road Pump Station Supply and Discharge main (needed to bridge a short section of PD95 on New Hempstead Road) – New Hempstead Road from Havermill Road to W. Clarkstown Road (approx. 4,000-ft)

B.3 Blaisdell Interconnection Hydraulic Model Analysis

The following section discuss the analysis to provide 3 to 5 mgd from UWNJ into PD10 through the Blaisdell Interconnection Pump Station. For a conservative analysis, it was assumed that three new PD10 groundwater wells (totally approximately 600 gpm) were online, as instructed by United Water for the purposes of this hydraulic assessment.

B.3.1 Blaisdell Interconnection Water Main Improvements Selected for Evaluation

As part of the Blaisdell 3 to 5 mgd Interconnection supply analysis, the following water system improvements were considered (see **Figure B-3**):

- Improvement No. 5 - New 20-inch DIP main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft)
- Improvement No. 8 – New 16 DIP main:
    - Hunt Road from Blaisdell Road (Rt 17) to existing 16-inch on Hunt Road (approx. 300-ft)
    - Blue Hill Road from Veterans Memorial Drive to Sickletown Road (approx. 4,100-ft)
    - Sickletown Road from Blue Hill Road to Blauvett Road (approx. 2,400-ft)
    - Blauvelt Road from Guterl Terr to Ehrhard Road (approx. 1,200-ft)
- Improvement No. 9 – New 16 DIP main:
    - Blauvelt Road from Townline Road to Church Street (approx. 4,300-ft)
    - Church Street from Blauvelt Road to S. Middletown Road (Rt 33) (approx. 1,900-ft)
- Improvement No. 10 – New 16 DIP main:
    - Convent Road (Rt 46) from Old Middletown Road to Grandview Ave (approx. 2,500-ft)
    - Grandview Ave from Convent Road (Rt 46) to NYS RT 59 (approx. 5,000-ft)
- Improvement No. 11 – New 16 DIP main:
    - Blaisdell Road (Rt 17) from Blaisdell PS to Hunt Road (approx., 2,700-ft)
    - Hunt Road from Blaisdell Road (Rt 17) to existing 16-inch on Hunt Road (approx. 300-ft)

Improvement 13

Improvement 12

New Hempstead PS
(Proposed -General Location)

Improvement 5

PD20

PD50

Pascack Brook Crossing
(New Parallel 12-Inch Main)

Maple Ave
PS (Expansion)

PD95

Improvement 10

Improvement 9

Improvement 8

Improvement 11

Blaisdell Interconnection
PS (Existing)

PD10

PD11

PD13

Clausland Mountain
Tank Improvement

New Hempstead
New Square
Hillcrest
Valley
Chestnut Ridge
Nanuet
Bardonia
West Nyack
Congers
Pearl River
Orangeburg
Tappan
Woodcliff Lake
Montvale

NEW JERSEY
NEW YORK

N

- Improvement 5
- Improvement 8
- Improvement 9
- Improvement 10
- Improvement 11
- Improvement 12
- Improvement 13
- Other Improvement
- Storage Tank
- Pump Station
- Pressure Districts (PD)

United Water, NY

0 2,500 5,000 Feet

1 inch = 3,500 feet

Blaisdell Interconnection Option

Figure B-3

CDM Smith

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- Improvement No. 12 – New 16-inch DIP main:
    - Brewery Road from 3rd Street to Congers Road (approx. 2,100-ft)
    - Congers Road from Brewery Road to S. Main Street (County Rt 29) (approx. 3,600-ft)
    - S. Main Street (County Rt 29) from Congers Road to New Hempstead Road (approx.. 300-ft)
    - New Hempstead Road from N. Main Street (County Rt 29) to N. Main Street (NYS Rt 45) (approx. 12,500-ft)
- Improvement No. 13 – New 16-inch DIP main - New Hempstead Road from N. Main Street (NYS Rt 45) to McNamara Road (approx. 5,500-ft)

B.3.2 Blaisdell 3 mgd Interconnection Supply Evaluation Results

Similar to the Nyack Interconnection evaluation, the additional PD10 interconnection supply from the Blaisdell Interconnection Pump Station and the additional PD10 groundwater wells will cause the PD10 storage tank to remain full while the PD20 storage tank will empty under average day demand conditions. Therefore, additional supply/transfer of water is needed from PD10 to PD20 in order to maintain the water level with the PD20 storage tank. To accomplish this, the second pump at the MAPS would have to operate to increase the supply from PD10 from 2 mgd to 4 mgd under average day demand conditions.

During maximum day demand condition, an additional 2 mgd of pumping from PD10 to PD20 is required to fully utilize the 3 mgd supply from the Blaisdell Interconnection Pump Station and increase the supply from PD10 to PD20 through MAPS. This is not recommended due to the impact to the water level within the Spring Valley Reservoir. Therefore, increasing flow to PD20 by constructing a new 2 mgd below ground pump station along New Hempstead Road (near Patricia Drive) would shift the supply to PD20 from PD10 closer to the new PD10 wells and shift the draw from PD10 towards the Valley Cottage Tank.

It is important to note that the existing Clauseland Mountain Tank is approximately 13-ft lower than the Spring Valley Reservoirs and due to the close proximity of the Blaisdell Interconnection Pump Station to the Clauseland Mountain Tank, the Clauseland Mountain Tank will remain full. Therefore, the Clauseland Mountain Tank will need to be either raised or have a pitless-type booster station installed to utilize its water.

In terms of impact to system pressure, according to the model results, the pressure within PD10 at the Blaisdell Interconnection area will increase by approximately 10 psi. Since existing system pressure within PD10 at the Blaisdell Interconnection area already exceeds 160 psi, System Improvements Nos. 8 through 10, as listed in Section B.3.1, where systematically evaluated with the hydraulic model in an attempt to reduce the increase system pressure. However, these system improvements did not significantly mitigate the predicted pressure increase within the Blaisdell Interconnection area. Upon further review of the resultant hydraulic grade line (HGL) required to reverse flow and supply water from the Blaisdell Interconnection to the Spring Valley Reservoir, it was confirmed that there is very little that can be done to reduce the resultant pressure increase. Therefore, System improvement Nos. 8 through 10 are not recommended.

However, according to the model results, the pressure in the vicinity of the Maple Avenue Pump Station discharge transmission main connection to PD20 (at the intersection of Union Road and Viola Road) will increase by approximately 10 psi due to the increased supply from the Maple Avenue Pump Station. Therefore, System Improvements No. 5, as listed in Section B.3.1, could be implemented to reduce the pressure increase at the Maple Avenue Pump Station discharge transmission main connection to less than 5 psi. This improvement along with the installation of a parallel 12-inch water main on Union Road at the Pascack Brook will also help insure that 4 mgd can be supplied from the MAPS into PD20.

Similarly, according to the model results, to mitigate the suction side and discharge side pressure impact of the proposed 2 mgd New Hempstead Road Sump Station, approximately 18,500-ft of new 16-inch water main will be required, see Improvements No. 12 as listed in Section B.3.1.

B.3.3 Blaisdell 5 mgd Interconnection Supply Evaluation Results

As water system demands increase, to increase the supply from the Blaisdell Interconnection Pump Station from 3 mgd to 5 mgd, additional transfer of water from PD10 to PD20 is required by increasing the Maple Ave Pump Station supply from PD10 up to 6 mgd and the proposed New Hempstead Road Pump Station up to 3 mgd.

As with the Blaisdell 3 mgd Interconnection Supply option, the Clauseland Mountain Tank will remain full under the Blaisdell 5 mgd Interconnection Supply option without improvements. Therefore, the Clauseland Mountain Tank will need to be either raised or have a pitless-type booster station installed to utilize the water in the Clauseland Mountain Tank.

In terms of impact to system pressure as a result of increasing the Blaisdell Interconnection Pump Station from 3 mgd to 5 mgd, CDM Smith recommends Improvement No. 11, as listed in Section B.3.1, in order to reduce the velocity of the water in the water main along Blaisdell Road. System Improvements No. 5, as listed in Section B.3.1, is still recommended to reduce the pressure increase at the Maple Ave Pump Station discharge transmission main connection. This improvement along with the installation of a parallel 12-inch water main on Union Road at the Pascack Brook would allow the MAPS to operate at its design condition.

To mitigate the discharge side pressure impact of increasing the proposed New Hempstead Road Sump Station to 3 mgd, approximately 5,500-ft of new 16-inch water main will be required, see Improvement No. 13 as listed in Section B.3.1.

B.3.4 Blaisdell Interconnection Supply Recommended Infrastructure Summary

To obtain 3 mgd from UWNJ along with an assumed additional 600 gpm from three new groundwater wells in PD10 (included in the analysis to be conservative), the following near-term water system infrastructure improvements are required (near-term improvements are defined as improvements needed initially to obtain water from the Blaisdell Interconnection under intermediate operation):

- New parallel 12-inch Pascack Brook water main crossing on Union Road
- Improvement No. 5 - New 20-inch DIP Main - Union Road from Viola Road to McNamara Road (approx. 6,800-ft) (to mitigate system pressure as a result of the increased supply from the MAPS)
- Raise the Clauseland Mountain Tank approximately 18-ft (note: the existing Clauseland Mountain Tank is approximately 13-ft lower than the Spring Valley Reservoirs and due to the

close proximity of the Blaisdell Underground Interconnection PS to the Clauseland Mountain Tank, the Clauseland Mountain Tank will remain full)

As system demands increase over time, the following additional long-term water system infrastructure improvements (defined as improvements needed to obtain the full 3 mgd amount of water from the Blaisdell Interconnection under consistent operation), are recommended:

- Expansion of the MAPS (for the installation of a third pump for proper system reliability of 4 mgd)
- New 2 mgd New Hempstead Road Pump Station (to pump water from PD10 to PD20 and located near Patricia Drive)
- Improvement No. 12 - New 16-inch DIP New Hempstead Road Pump Station Supply and Discharge main (approximately 18,500-ft) (need to bridge the section of PD95 on New Hempstead Road along with reducing the impact of the new pump station)

As system demands continue to increase over time and should United Water decide to increase the supply from 3 mgd to 5 mgd, the following additional long-term water system infrastructure improvements are needed to obtain 5 mgd amount of water from the Blaisdell Interconnection:

- Upgrade Blaisdell Road Interconnection Pump Station from 3 mgd to 5 mgd.
- Improvement No. 11 - New 16 DIP Main - Blaisdell Road (Rt 17) from Blaisdell Road Pump Station to existing 16-inch water main on Hunt Road (approx., 2,700-ft) (to reduce the velocity of the water within the water main on Blaisdell Road as a result of the increased supply from UWNJ)
- Upgrade the MAPS from 4 mgd to 6 mgd
- Upgrade the New Hempstead Road Pump Station from 2 mgd to 3 mgd
- Improvement No. 13 – New 16-inch DIP main - New Hempstead Road from N. Main Street (NYS Rt 45) to McNamara Road (approx. 5,500-ft) (to further mitigate the impact of the new pump station)

B.4 Interconnection Hydraulic Model Analysis Conclusion

Based on the hydraulic model evaluation of the interconnection options and the required infrastructure improvements, opinion of probable costs were developed and a review of the required projects permits was performed as discussed in Section 3 of the report.