American Rescue Plan State Fiscal Recovery Fund Recommendation
Cover Sheet

Please submit this document with any recommendations for funding from Rhode Island's allocation of federal fiscal recovery funds available through the American Rescue Plan Act. This information will be made available to the public along with any detailed documents submitted that describe the proposal. It is encouraged that such documents identify clear goals and objectives and quantifiable metrics.

This is not a formal request for funds, and submission of recommendations does not guarantee a response, public hearing, or appropriation from the General Assembly.

Name of Lead Agency: Prudence Park Water Association

Additional agencies making recommendation (if applicable): ______

Contact Person / Title: Kristin DiPrete, Treasurer Phone: 401-714-6065

Address: 515 Narragansett Pkwy, Warwick RI 02888

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Brief Project Description (attachments should contain details)
Essential rehabilitation of the Prudence Park Water system, a small public water system

Total request: $ 1,250,000

One-time or Recurring Expense? One-time

ARPA Eligibility Category (check all that apply) – See link for further information
https://www.rilegislature.gov/commissions/arpa/commdocs/Treasury%20-%20Quick-Reference-Guide.pdf

- Respond to the public health emergency and its economic impacts ______
- Premium pay to eligible workers______
- Government services/state revenue replacement ______
- Water/sewer/broadband infrastructure Water Infrastructure

November 19, 2021

Senator James A. Seveney
Senate Finance Committee
State of Rhode Island General Assembly
sen-seveney@rilegislature.gov

Dear Senator Seveney and Members of the Finance Committee,

We are writing to you on behalf of the members of the Prudence Park Water Association (PPWA), a non-profit association responsible for the operation and maintenance of a small public water system in Prudence Park, a community on the west side of Prudence Island. As Co-Chair and Treasurer of the Board of the PPWA, we would like to communicate to you a brief summary of the history of the Association and an explanation of the obstacles, both current and anticipated, that our water system faces. In light of the passage of the American Rescue Plan Act and its allocation of funds to the state of Rhode Island, we hope to provide you with information to consider whether the PPWA might be considered for support within the state allocations.

The Prudence Park water system was established in 1947 to provide a reliable water supply seasonally to houses located in the Prudence Park community. Over successive decades, the residents of this community collaboratively developed the system into its present configuration, which supplies water to 23 member households (a mix of year-round, three-season, and summer residences). These houses depend upon the PPWA for potable water and household water supply. The system is maintained and operated by the member households, who provide funding (in an annual connection fee and an annual capital assessment), volunteer labor, and varied technical expertise (two members, for example, are licensed to operate this public water system). The system is governed by the Prudence Park Water Association, a registered non-profit association in which all member households have an equal vote, and is operated under the regulatory oversight of the RI Department of Health as a designated public water system.

Most of the components of the system were installed between 1947 and 1990. These include the well, pumping system, storage tanks, pump house and distribution pipes. Repairs and upgrades have been made as necessary over the years, but the system overall is arriving at the lifespan limit of its components; furthermore, these components no longer meet the current standards of compliance that would be applicable to components installed today.

In 2019, the PPWA worked with the RIDOH and Northeast Water Solutions, Inc. (NWSI) to prepare an evaluation of the system and a recommendation for a capital improvement plan (See attached report). The report drafted by NWSI indicated that the system will require a comprehensive overhaul, with the replacement of all system components, in order to ensure the stability of the water supply and its compliance will all current regulations. The estimated cost of this of this overhaul (accounting for inflation since December 2019) is approximately $1,250,000.

Funding the rehabilitation of our community water system is a daunting challenge. We have been determining the best allocation of our small capital fund. But the costs of this rehabilitation, which we would emphasize is required for the provision of water supply to our community, will necessitate that we secure additional sources of funds.

Thank you for your consideration. We would be happy to provide you with additional information, as and when you need it.

Sincerely,

Timothy Hyde
Co-Chair, Prudence Park Water Association
Prudence Island, Portsmouth RI
thyde@mit.edu

Kristin DiPrete
Treasurer, Prudence Park Water Association
Prudence Island, Portsmouth RI
kris@sdkstructures.com

Attachment: Northeast Water Solutions, Inc. Report on PPWA (2019)

PRUDENCE PARK WATER ASSOCIATION (PPWA)

Key Facts

- The PPWA is a non-profit that operates and maintains a small public water system in the Prudence Park neighborhood on the west side of Prudence Island.

- Prudence Park is roughly the area defined by Atlantic Avenue, Walnut Avenue, Bay Avenue, and Providence Avenue. This area is geographically distant from the other water systems on Prudence Island, and is not connected to them physically or administratively.

- The PPWA provides drinking water and water for household use to 23 member households, some of which are year-round. (There are 11 additional houses in the Prudence Park neighborhood that are not currently connected to the system and that obtain water from individual private wells.)

- The Prudence Park water system was established in 1947 and has been in continuous operation since that time.

- The PPWA is operated and maintained with connection fees paid by member households and with the voluntary labor of those households.

- The PPWA operates as a public water system under the regulatory oversight of the Rhode Island Department of Health.

- The PPWA has been working collaboratively and productively with the Rhode Island Department of Health on a capital improvement plan to ensure future functioning of the water system and access to drinking water for the member households.

- All parts of the water system are contained on land owned by the PPWA, the Town of Portsmouth, or the Prudence Conservancy. The PPWA does not require any special easements for its current operations.

Northeast Water Solutions, Inc.

DRAFT FOR REVIEW ONLY

ENGINEERING EVALUATION
AND
FACILITY CAPITAL IMPROVEMENT PLAN

FOR

PRUDENCE PARK
PUBLIC WATER SYSTEM
PORTSMOUTH, RI

DECEMBER 2019

567 South County Trail, Suite 116, Exeter, RI 02822. Tel. 401-667-7463 Fax. 401-667-7465 www.nwsi.net

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INTRODUCTION

The Prudence Park Water Co-op (PWS-ID #1647514) is a seasonal public water system providing service to approximately 25 residents in the summer and 3 residents year-round. The public water system is located off of Atlantic Ave., and consists of one gravel-packed water supply well, a 6,000 gallon exterior, above-grade atmospheric storage tank, and a pump house with a single booster pump, two (2) hydro-pneumatic storage tanks, controls and related equipment.

NWSI has developed this engineering evaluation and facility improvement plan to assess the public water system needs for a 30-year operating window. This evaluation has included: (1) an inspection of the existing site, facility and water system equipment, (2) a determination of the physical condition and expected effective life of the equipment, (3) an assessment of the available water quality data for the existing water supply well, and (4) an assessment of the needs to assure the continued effective operation of the system and protection of public health. A summary of the investigations, evaluations, findings and recommendations are presented herein.

I. EXISTING SYSTEM DESCRIPTION

1.1 General Description of Existing System

The Prudence Park Water Co-op (PWS-ID #1647514) is described as a seasonal water system; it serves roughly 22 residential service connections in the summertime (June 1 to September 30) and 3 connections in the off-season. During the summer season the service population is believed to be approximately 35, with a lesser population during the weekdays. Water is supplied by a drilled bedrock well, installed approximately 9 ft. north of the Pump House which is located off of Atlantic Ave. near its intersection with Francis Ave. The well has a 6 in. Ø casing with a 4 in. Ø inner sleeve and was reported to be 398 ft. deep when it was drilled in 1946. A 1-HP submersible pump is set at 160 ft. below grade in the well, with a capacity of 12-16 gpm. The Pump House contains two (2) pressure bladder tanks, one (1) small expansion tank, and a booster pump, all of which are used year-round. A 6000-gal. atmospheric storage tank, is installed adjacent to the Pump House to support the additional demands in the peak summer season. There is currently no treatment of the well water.

Drawings M-1 and M-2 (Appendix A) present the Site Plan of the existing system and the Equipment Arrangement Plan inside the Pump House. Drawings P-1 (Appendix A) presents the process and instrumentation drawing of the existing system.

During the summer, Well #1 is controlled (on/off) by the water elevation in the exterior, atmospheric (6,000-gallon) water storage tank. When the water level falls to the “pump on” elevation, the well pump is activated via a float switch relay, pumping until the water level attains the float switch "pump off" elevation, on a rising level. In the off-season, the outdoor atmospheric tank is drained and the two hydro-pneumatic tanks provide the sole storage. A pressure gauge and its set-points control when the well pump turns on to replenish the supply.

The outdoor atmospheric storage tank and hydro-pneumatic tank connect to a copper discharge pipeline, extending through the pump house floor, connecting to the community distribution piping system. The distribution system is has some dead-legs, and a total of 22 service laterals (1" to 2" Ø).

1.2 Field Inspection of Existing System

The Prudence Park Water Co-Op (PWS-ID #1647514) was originally created in 1946 to serve the summertime community. The well and certain other system components and infrastructure are original construction, and consequently demonstrate the effects of more than 70 years of service. Although still in place, the original elevated water storage tank has been removed from service. NWSI personnel conducted a detailed inspection of the Prudence Park Water Co-op on September 19, 2019. Findings of this inspection include the following:

1.2.1 Water Supply Well (Photos #x, #x): The drilled bedrock well (Appendix B) is the single water source for the Prudence Park community, and has been since its installation in 1946. The well is installed approximately 9 ft. north of the Pump House, which is located off of Atlantic Ave. near its intersection with Francis Ave. The well is protected by an above-ground, insulated, wood frame and plywood sheathed enclosure (interior: 33" L by 25" W) with an asphaltic shingle cover. The casing of the well is 23" above the ground surface within the well box (35" deep), which is dug 10" below the actual ground surface. Two (2), incandescent light bulbs inside the well box provides heat. The well was installed to a depth of 398 ft below ground surface (BGS) with a 6" Ø casing that was later re-lined with a 4" Ø carbon steel pipe. A 3 7/8" 1-HP submersible pump is reported to be installed at a depth of approximately 160 ft. BGS, provided with a 1 ¼" polyethylene riser pipe. The well is reported to have a yield of 13 gpm, but this capacity has not been verified since a report from the 1950's.

The installation of the 4" casing liner creates a severe risk of loss of well service because any appreciable corrosion or defect of on the interior face of the liner will prevent the removal of the submersible well pump. It is recommended that a new well be constructed to replace the existing well.

1.2.2 Atmospheric Water Storage Tank (Photos #x, #x, #x): The 6,000-gal. exterior water storage tank is of horizontal, cylindrical design (96" Ø x 197" L), fabricated of welded carbon steel believed to be ¼" to 3/8" thick. Layers of paint suggest that the tank has been repainted many times over the years with corrosion of the substrate steel causing extensive paint delamination. The tank is supported by three (3) steel saddles installed on a concrete pad, with the bottom of the tank approximately 12” above the concrete pad. A 24” Ø access hatch is located on the horizontal tank crown and a level sensor is installed in the tank for control of the well supply.

Table 1-1 Atmospheric Water Storage Tank Design	
Tank Configuration	Horizontal, Cylindrical
Tank Materials	Steel
Tank Volume (nominal)	6,000 gallons
Tank Coatings	Epoxy Paint
Tank Dimensions	96”Ø x 197” S/S Ht.
Top Head Manway	24” Ø
Overflow	2” Ø
Fill Connection	2” Ø
Discharge Connection	2” Ø
Access Ladder	Portable Ladder
Ladder Safety Cage	No
Ladder Access Security	No

The storage tank is provided 2” Ø threaded fill and discharge connections through the east head of the tank, in the 0^o and 180^o positions respectively, and a 2” Ø, threaded, overflow connection in the 0^o position in the west tank head from a penetration at the top sidewall, extending down the tank supported by sidewall offsets, discharging at grade. The tank fill and discharge piping extend from the Pump House, underground, then turning and extending vertically to the respective connections. This piping is unsupported other than by the tank connection and by the underlying soil. The overflow pipe extends horizontally from the tank connection, then turns down to a point approximately 8” above grade. This pipe has no physical support other than the threaded tank connection. The overflow drain is provided a mesh screen. The overflow also serves as the tank vent and is adequately sized relative to the well pump discharge flowrate.

A 1”Ø PVC conduit extends up the sidewall of the tank containing the instrument wiring for the level float switch in the tank that controls the operation of the water supply well pump. The level sensor is installed into a 2” Ø threaded connection in the tank crown, at the west end of the tank.

A portable steel ladder is used to provide access to the top of the tank. This ladder is absent any safety cage or other personnel safety device. Additionally, there is no means to prevent unauthorized access to the top of the tank.

There is **no record of any internal tank inspection** and it is suspected that there is accumulation of corrosion product and other solids within the tank. This tank is in poor physical condition and had exceeded its effective life, and should be replaced.

1.2.3 Hydro-Pneumatic Tanks (Photo #x): The Pump House is provided two (2) hydro-pneumatic (pressure bladder) tanks installed in parallel. The older tank is Amtrol Model WX-304), having a total volume of 317 gallons and rated for 125 psig, installed in 1974. The newer tank Amtrol Model WX-252 with a total volume of 86 gallons and an effective volume of approximately 23 gallons, based upon the system operating pressure. These tanks are in fair condition however, the Model WX-304 is no longer manufactured and should be replaced.

1.2.4 Water Booster Pump (Photo #x): The booster pump is a 1-HP, 3450 rpm, of unknown manufacturer and model. The booster pump has been providing adequate service to the community, but is in poor physical condition. Additionally, the use of a single pump creates a significant risk for loss of water service to the community, in the event of a failure of this pump. Additionally, this pump is not NSF 61 compliant and therefore not appropriate for use in a public drinking water system. This pump should ultimately be replaced with an NSF 61 compliant, duplex pump system.

1.2.5 Instrumentation and Controls: The system is provided an aging, somewhat primitive, yet still effective monitoring/control panel, including status indication for the well and booster pump motors, storage tank fill and level, and low temperature. Field mounted instruments are aging. The monitoring and control system has reached the end of its effective life and should be replaced with a PLC-based monitoring system, with data logging, alarming and new instrumentation.

1.2.6 System Piping: The exposed copper piping (brass valves and fittings) within the Pump House (Photos #x, #x) is in fair to good condition, demonstrating the effect of long-term oxidative exposure to the atmosphere and interative water vapor condensation. Certain brass valves and fittings demonstrate corrosion, although the piping is generally sound. Drawing M-1 (Appendix A) presents the interior mechanical layout of the Pump House.

The distribution system, consisting of 2" Ø polyethylene (120 psig), extends linearly from the point of discharge from the Pump House. Drawing C-1 (appendix A) presents the existing water distribution system, including approximately 4,000 LF of 2" Ø main, with fifteen (15) isolation valves and three (3) flush blow-off connections. Each of the twenty-two (22) residential service connections is provided a curb stop. The pipe has inadequate pressure capacity rating (100 – 120 psig) and additional isolation valves/flush points are necessary for effective operation and maintenance. Additionally, a portion of the system on Park Road is inaccessible due to closing off of access by a property owner. The linear design increases the water age in the system and the risk of a loss of water service, as all service connections are supplied from a single direction.

1.2.7 Emergency Power Supply (Photos #x. #x): An 11-KW generator (Generac Guardian) is located just west of the tank on a concrete pedestal adjacent to the storage shed located immediately west of the water storage tank. Two 100-gal. propane tanks provide fuel via a hard-piped supply to the generator. The automatic transfer switch is installed within the Pump House. The generator system is exercised once per week. The generator is believed to be installed approximately 5 years, and is in very good physical and operating condition.

1.2.8 Pump House Building Structure (Photos #x, #x, #x, #x): The Pump House is a wood frame building of approximately interior dimensions 113” x 111” with 2x4 framing and plywood sheathing, installed on a cast-in-place concrete floor. The building has an interior clear sidewall height of approximately 9 ft. and a pitched roof consisting of asphaltic shingles over plywood sub-roof.

The Pump House is provided a 240 VAC, 3-wire primary power supply, with a 100-Amp main disconnect switch and a sub-distribution panel. Interior lighting and utility receptacles are provided, and the exterior is provided security lighting with motion sensors. Interior, electric heaters provide freeze protection for the piping and equipment. The Pump House is in good overall condition and with appropriate maintenance can continue to provide effective service for the foreseeable future.

II. BASIS OF EVALUATION

2.1 Community Water Use

The existing public water system provides potable water for sanitary use, serving 22 residential housing units. Occupancy is seasonal, roughly 25 residents are present in the summertime (June 1st through September 30th) with only 3 of those residents staying year-round. The summer peak day population has been previously estimated to a maximum of 50 people. The water use of the system is largely unknown because the system is lacking a flow meter. A previous (1973) estimate of water use indicated a maximum of 3,300 gpd. The community water use has been estimated based on populations and duration of occupancy using per capita values for Newport County, RI (USGS National Water Use Information System).

2.1.1 Annual Water Demand Volume (V_{AVG}): According to USGS records of water use in Newport County (which includes Prudence Island), the average person uses 109 gallons of water per day. Because Newport County consists of other cities / towns that are more developed (and more populous) than Prudence Island, the average daily per capita water use for the county may overestimate actual use for Prudence Island. For the three year-round residents and 22 additional summer residents on Prudence Island, this amounts to 411,911 gallons per year.

Table 2.1: Estimated Seasonal Water Use

Water Use Period	Water Users	Water Volume
Summer (6/01 to 9/30)	25	332,450 gallons
Non-Peak Season	3	79,461 gallons
Total:		**411,911 gallons**

2.1.2 Peak Day Water Demand Volume: Average daily demand was determined on a seasonal basis (see Table 2.2) and maximum daily demand was calculated using as 150% of daily demand. Table 2.2 presents a summary of average and maximum day demands and flowrates for both the peak summer season and the non-peak season.

Table 2.2: Estimated Average and Maximum Daily Water Demands

	Summer	Non-Peak Season
Average Demand Day:		
Average Daily System Demand (V_{AVG})	2,725 gallons	327 gallons
Average Daily Flowrate (Q_{AVG-24})	1.9 gpm	0.2 gpm
Peak 4-Hour Demand ($V_{PEAK\ 4-Hr}$)[1]	818 gallons	98 gallons
Peak 4-Hour Demand Flowrate ($Q_{PEAK\ 4-Hr}$)	3.4 gpm	0.4 gpm
Peak 1-Hour Demand ($V_{PEAK\ 1-Hr}$)[2]	311 gallons	37.3 gallons
Peak 1-Hour Demand Flowrate ($Q_{PEAK\ 1-Hr}$)	5.2 gpm	0.6 gpm

Peak Instantaneous Demand Flowrate (Q_{PI})[3]	9.5 gpm	1.1
Maximum Demand Day:		
Maximum Day Demand (V_{PEAK})	4,088 gallons	491 gallons
Maximum Daily Flowrate (Q_{AVG-24})	2.8 gpm	0.34 gpm
Peak 4-Hour Demand ($V_{PEAK\ 1-Hr}$)[1]	1,226 gallons	186 gallons
Peak 4-Hour Demand Flowrate; ($Q_{PEAK\ 4-Hr}$)	5.1 gpm	0.8 gpm
Peak 1-Hour Demand ($V_{PEAK\ 1-Hr}$)[2]	466 gallons	71 gallons
Peak 1-Hour Demand Flowrate; $Q_{PEAK\ 1-Hr}$)	7.8 gpm	1.2 gpm
Peak Instantaneous Demand Flowrate (Q_{PI})[3]	14.0 gpm	1.7 gpm

Note 1: Peak 4-hour demand volume = 30% of Average Day demand volume.
Note 2: Peak 1-hour demand volume = 38% of Peak 4-Hour demand volume.
Note 3: Peak Instantaneous Flowrate = 5.0 x (Q_{AVG-24}).

2.2 Public Water System Planning & Upgrade Criteria

The following criteria have been established for the evaluation and upgrade of the existing public water supply system:

2.2.1 Water Quality:

- The water quality shall conform to all USEPA and RIDOH Primary and Secondary Water Quality Criteria (refer to Appendix D).

2.2.2 Risk Minimization:

- Because this system has only a single water supply well, it shall have a minimum effective water storage capacity of 1-day peak demand season volume. If a new well is constructed Well #1 may remain in service as a backup water supply well.
- The water supply system shall have the capacity to meet the peak community demand requirements with a single well pump in operation.
- The water supply well shall be capable of meeting the community demand requirements under worst-case conditions of 180-day, zero recharge.
- All critical equipment shall be provided 100% redundant capacity. The water supply system shall have two (2) distribution booster pumps to assure continuous service in the event of a loss of one (1) pump, for any reason.
- The emergency generator system shall be provided preventative maintenance and regular exercising to assure effective service during loss of primary power supply.
- System inspection and maintenance protocols shall be upgraded to include internal tank inspections on a minimum 5-year frequency.

2.2.3 System Operation:

- The water supply and distribution system shall be designed for fully automatic operation with manual override.
- The system shall maintain 40-50 psig at the Pump House and a minimum 30 psig pressure at all service connections (e.g: street connections).
- The system shall operate with part-time certified operator attention and maintenance.
- The system will be provided monitoring instrumentation for key operating, performance and water quality parameters, with data logging, trend analysis, alert and alarm notifications, etc.

2.2.4 System Infrastructure & Maintenance:

- System infrastructure shall be upgraded to provide a minimum 30-year projected effective life for tanks, buildings, pump house infrastructure and a 50-year projected life for the water distribution system.
- A formal maintenance program including preventative and predictive maintenance shall be developed implemented.
- Accurate As-Built drawings of the water supply, storage, treatment and distribution system shall be developed.
- To facilitate distribution system maintenance and sanitization, appropriate flush connections shall be installed.

2.2.5 System Administration:

- A comprehensive electronic and hard-copy record of water quality monitoring and operational data shall be maintained by the system Certified Operator;
- A formal customer call-in and complaint log program shall be developed;
- A Public Works Committee shall provide community management and oversight of the Public Water System.

2.3 Identification of System Deficiencies and Needs

The following system deficiencies and needs were identified during the system inspection and evaluation:

2.3.1 Water Supply Well & Well Capacity:

- Permit and install a new water supply well (Well #2). It is recommended that this well be located NE of the Pump House.

  - The well installation shall conform to RIDOH and AWWA requirements.
  - Installation of Well #2 should include a stilling tube to permit the future installation of a pressure transducer to monitor the well water level.
- Upon installation of Well #2, conduct a formal pump test (step test and minimum 24-hour constant rate test) to establish the effective yield of the well.
- During the Well #2 constant rate pump test, obtain water samples and conduct comprehensive water quality monitoring.
- If Well #1 is to remain in use, during the Well #2 pumping test monitor the static water level in Well #1 to assess potential hydraulic connectivity between the wells.

2.3.2 Atmospheric Water Storage Tank: The existing 6000-gal. atmospheric storage is in poor physical condition, has exceeded its effective life, and should be replaced with a new, atmospheric water storage tank. It is further recommended that any new water storage tank be constructed of FRP materials to minimize the potential for corrosion in this coastal, sea-air environment.

2.3.3 Hydro-Pneumatic Tank 1: The existing WX-304 pressure tank has exceeded its life expectancy and should be replaced with a new tank.

2.3.4 Water Booster/Distribution Pump System: The single existing booster pump poses a significant security risk in the system. This pump is in poor physical condition, is not NSF 61 compliant and the loss of this single pump will result in the loss of water service during the peak demand season. Implement a new, duplex distribution booster pump system with an alternating (lead/lag) pump controller and variable frequency drives, to operate on the basis of system pressure, to maintain a more consistent pressure and capacity in the distribution system.

2.3.5 Instrumentation & Controls: The existing system has minimal monitoring instrumentation resulting in limited information with which to operate the system. At a minimum, the following monitoring and control should be provided:

- Water Supply Well – Stilling tubes & pressure (level) transducers;
- Well Water – pH, Flow meter;
- Atmospheric Water Storage Tank – Ultrasonic or pressure transducer – level monitoring (replace existing unit) and data logging;
- Distribution System:
  - Pressure transducer monitor and record pipeline pressure;
  - Flowmeter to monitor and record flowrates and volume of water used per day

2.3.6 Water Distribution Piping System: Based upon the system age and inspection of a pipeline specimen, it is assumed that the entire distribution piping system is nearing the end of its effective life and should be replaced. The piping is made of low pressure PVC (designed for pressures less than 100 psi), and is not NSF-61 compliant. Replacement with compliant piping of similar dimension is recommended, with the inclusion of flush connections, valve boxes and new service connections. Additionally, accurate As-Built drawings of the installed piping, valves and service connections is needed.

2.3.7 System Operations and Maintenance: The Prudence Park PWS needs to upgrade the system operational documentation, record keeping and preventative maintenance. The needs for system maintenance programs includes the following:

- Records and Reporting Forms:
  - Water Use
  - Water Quality Monitoring Data
  - Instrument Calibrations
  - Routine Operating Data
- As-Built Record Drawings of the Existing Distribution System (including isolation valves and curb stops)
- Water Supply Well Log and Pump Test Report
- Tank Inspection Reports
- Operation & Maintenance Manual
- Manufacturer Data Sheets & Specifications for all Equipment and System Components
- Preventative Maintenance Schedule
  - Scheduled inspections and calibrations
  - Valve ID and Exercising Schedule
  - Pump and Motor Inspections, Lubrication & Testing
  - Leak Detection Surveys
  - Tank Inspection Schedule
  - Emergency Generator Exercising and Maintenance Schedule
- Inventory of Spare Parts
- Public Water System Operating License, License Application, Operator Certificates
- List of Materials & Equipment Suppliers, Vendors, Service Support, etc.

2.3.8 Remove Unused, Potentially Hazardous Components of Old System: The Prudence Park PWS was originally supplied by an elevated storage tank, which is no longer in use. This steel frame-supported tank, has been out of service for decades and is slowly degrading. The potential for its collapse represents a threat to the existing pump house. We recommend that this hazard be deconstructed to eliminate any potential problems.

However, we recognize that this suggestion may be contentious given that an osprey nest is situated at the top of the elevated storage tank. Our recommendations are based solely on the questionable structural integrity of the elevated storage tank and the potential damage its collapse may cause, not on the osprey.

III. WATER QUALITY EVALUATION

NWSI conducted an evaluation of the water quality monitoring data from 1990 to present (Appendix B), augmented with additional analysis of water samples obtained during the September 19, 2019 site visit. A review of this data resulted in the following summary assessment;

3.1 Physical and Inorganic Water Quality Monitoring (Table 3-1):

3.1.1 pH: Only two (2) pH measurements were included in the RIDOH database, 7.1 s.u. in July 1991 and 6.5 s.u. in July 1992. Field monitoring on September 19, 2019 determined pH values of 6.87 su in the well source and 7.03 su at the point-of-entry (POE) to the water distribution system. These measurements fall within the range of the RIDOH and USEPA Secondary Drinking Water Limits (6.5 to 8.5 su).

3.1.2 Turbidity: The RIDOH database determine the turbidity of the well water was measured only once (July 1988), at 0.1 NTU. Similarly, the distribution water turbidity was also measured only once (July 1990), at 0.1 NTU. Both measurements are below the RIDOH and USEPA Primary Limit (1 NTU). Monitoring on September 19, 2019 determined a well water turbidity of <1.0 NTU and a point-of-entry (POE) turbidity of 16.3 NTU. The significantly elevated turbidity at the POE is consistent with the observation of solids in the sample and the elevated iron and zinc concentrations (see below).

3.1.3 Total Dissolved Solids (TDS) and Specific Conductance: In the July 1988 and 1990 monitoring events the TDS of the well water was 95 mg/l and the distribution water was 72 mg/l, respectively. Monitoring on September 19, 2019 determined a well water TDS of 102 mg/l and a point-of-entry (POE) TDS of 92 mg/l. Specific Conductance, a measure of the ability of water to conduct electric current, is also used as an indirect indicator of TDS (conductivity increases with increasing concentration of ions). Concurrent monitoring (11/19/19) of specific conductance indicated values of 138 umhos/cm and 135 umhos/cm, respectively.

The water characterization is relatively consistent across the noted monitoring events, with the TDS principally consisting of: calcium (12.9 to 14.2 mg/l), sodium (5.5 to 9.2 mg/l), alkalinity (24 to 28 mg/l as $CaCO_3$), chloride (8.2 to 11.9 mg/l), sulfate (11.6 to 14.0 mg/l) and silica (13.6 to 14.0 mg/l), with lesser amounts of magnesium (0.8 to 1.0 mg/l), nitrate (0.2 to 0.54 mg/l) and potassium (0.46 to 0.68 mg/l). The September 19, 2019 POE sample also demonstrated significantly elevated iron (9.01 mg/l), copper (2.11 mg/l), lead (3.11 mg/l) and zinc (1.66 mg/l) that is indicative of corrosion occurring within the water storage tanks and interconnecting piping. All other inorganic constituents are non-detectable or present at trace concentrations.

3.1.4 Alkalinity: The July 1988 and 1990 monitoring events demonstrated the well water with moderately low alkalinity at 27 mg/l (as $CaCO_3$) and the distribution water similar at 28 mg/l (as $CaCO_3$). The September 19, 2019 monitoring demonstrated similar results for the well water (27 mg/l, as $CaCO_3$) and distribution water (24 mg/l, as $CaCO_3$). Based upon the field pH measurements (6.87 & 7.03 su) approximately 75–80% of the inorganic carbon in the water is present as bicarbonate alkalinity (HCO_3) with the balance present as carbonic acid (H_2CO_3) or carbon dioxide (CO_2).

3.1.5 Chloride and Sulfate: All water quality monitoring results demonstrate low levels of both chloride (8.2 to 11.9 mg/l) and sulfate (11.6 to 14.0 mg/l). Chlorides in particular can be a particular driver of corrosion, however the well water concentrations are comparatively low and not believed to be a significant factor.

3.1.6 Nitrate-N & Nitrite-N: Nitrate-N samples were collected on 27 occasions between July 1988 and July 2019 in the distribution system and at the well. The raw well water demonstrates low nitrate-N (0.19 to 0.49 mg/l, as N) and non-detectable nitrite (<0.02 mg/l, as N). The nitrate-N concentrations for samples collected in the distribution system were comparable (0.1 mg/L to 0.4 mg/l), with no detections of nitrite. The September 19, 2019 monitoring event demonstrated nitrate-N at 0.547 mg/l (well water) and 0.514 mg/l (distribution POE), reasonably consistent with historical findings. Nitrite-N was non-detectable (<0.010 mg/l) in the well, with a trace detection (0.013 mg/l) at the distribution POE. In all cases the well water nitrate and nitrite concentrations are substantially less than the respective RIDOH and USEPA Primary Drinking Water Limits (10.0 mg/l and 1.0 mg/l, respectively), and consistent with typical “background” groundwater concentrations in Rhode Island.

3.1.7 Fluoride: The fluoride concentration of the raw well water (sampled July 1988) and distribution water (sampled July 1990) was non-detectable (<0.02 mg/l). The September 19, 2019 monitoring demonstrated fluoride concentrations of 0.062 mg/l (well water) and 0.053 (distribution POE). In all cases the results are substantially less than the RIDOH and USEPA Primary Drinking Water Limit (4.0 mg/l) and the USEPA Secondary Drinking Water Limit (2.0 mg/l).

3.1.8 Iron: In July 1988, iron in the distribution water was not detectable (<0.02 mg/L). In July 1990, iron in the well water was measured as 0.04 mg/L. The September 19, 2019 monitoring determined an iron concentration of 0.0597 mg/l in the well water, consistent with previous results, substantially less than the RIDOH and USEPA Secondary Drinking Water Limit (0.3 mg/l).

The distribution POE sample demonstrated a massive iron concentration of 9.01 mg/l, that coincided with significantly elevated copper (2.11 mg/l), lead (3.11 mg/l) and zinc (1.66 mg/l). The sample also demonstrated discoloration believed principally due to iron precipitation. The results of this sample, obtained at the POE to the distribution system indicate that corrosion is occurring within the water storage tank(s) and interconnecting piping, with an accumulation of corrosion product solids. The principle source of the copper and zinc is believed to be from brass valves and fittings, the lead from soldered pipe joints and brass valves and fittings. The iron is sourced from the well casing, and the carbon steel water storage tank and the WX-304 pressure tank.

3.1.9 Manganese: The manganese concentration of the raw well water (sampled July 1988) and distribution water (sampled July 1990) was non-detectable (<0.02 mg/l). The September 19, 2019 monitoring demonstrated non-detectable (<0.020 mg/l) manganese in the well water and 0.041 at the distribution POE. In all cases the monitoring results are below the RIDOH/USEPA Secondary Water Quality Limit for manganese (0.05 mg/l).

3.1.10 Hardness: The raw well water demonstrates low total hardness (calcium & magnesium, as $CaCO_3$) at 38 mg/l (July 1988) and the concentration in the distribution system (July 1990) was comparable at 32.6 mg/L as $CaCO_3$. The September 19, 2019 monitoring demonstrated the well water with total hardness of 37.5 mg/l (as $CaCO_3$) and distribution POE total hardness of 39.6 mg/l (as $CaCO_3$).

3.1.11 Silica: Silica was not included in the historical water quality monitoring program. The September 19, 2019 monitoring demonstrated silica concentrations of 13.6 mg/l (well water) and 14.0 mg/l (distribution POE).

3.1.12 Other Inorganic Constituents: All other inorganic parameters were either non-detectable or present at trace concentrations, well below their respective USEPA and RIDOH Drinking Water Limits.

Table 3-1
Well Water & Distribution System Characterization

	Well #1 Historical		Well #1 09/19/19	Distribution POE 09/19/19
Parameter	**Qty**	**Average**	-----	-----
Temperature - Field	-----	-----	19.4ºC	19.5ºC
pH	2	6.8 su	6.87 su	7.03 su
Turbidity	2	0.1 NTU	<1.0 NTU	16.3 NTU
Sp. Conductivity	-----	-----	138 umhos/cm	135 umhos/cm
Total Dissolved Solids	2	83.5 mg/l	102 mg/l	92 mg/l
Alkalinity ($CaCO_3$)	2	27.5 mg/l	27 mg/l	24 mg/l
Chloride	2	8.5 mg/l	11.8 mg/l	11.9 mg/l
Fluoride	2	<0.2 mg/l	0.062 mg/l	0.053 mg/l

Nitrate – N	27	0.211 mg/l	0.547 mg/l	0.514 mg/l
Nitrite - N	27	<0.02 mg/l	<0.010	0.013 mg/l
Sulfate	2	11.8 mg/l	14.0 mg/l	13.4 mg/l
Barium	2	<0.02 mg/l	<0.02 mg/l	<0.02 mg/l
Calcium	2	13.4 mg/l	13.5 mg/l	14.2 mg/l
Copper	2	<0.02 mg/l	<0.02 mg/l	2.11 mg/l
Iron	2	0.03 mg/l	0.0597 mg/l	9.01 mg/l
Lead	2	<0.003 mg/l	0.0004 mg/l	3.11 mg/l
Manganese	2	<0.02 mg/l	<0.020 mg/l	0.0407 mg/l
Mercury	2	<0.001 mg/l	-----	-----
Nickel	2	<0.01 mg/l	-----	-----
Potassium	2	0.51 mg/l	0.638 mg/l	0.68 mg/l
Selenium	2	<0.005 mg/l	-----	-----
Silica	-----	-----	13.6 mg/l	14.0 mg/l
Sodium	2	8.35 mg/l	6.77 mg/l	5.48 mg/l
Zinc	2	<0.02 mg/l	<0.050 mg/l	1.66 mg/l
T. Hardness (CaCO3)	2	36.8 mg/l	37.48 mg/l	39.6 mg/l
Water Qual. Indices:				
LSI – 50ºF	-----	-2.58	-2.51	-2.38
LSI – 130ºF	-----	-1.74	-1.65	-1.55
Larson-Skold Index	-----	0.88	1.16	1.28
CSMR	-----	0.72	0.84	0.89
Alk./Chloride Ratio	-----	3.23	2.29	2.02

3.2 Bacterial Monitoring:

Monitoring for total coliform has been conducted from 1991 to present (29 years), a total of 82 sampling events. Coliform was detected in six of the samples, collected on June 16, 2010, June 18, 2010, June 28, 2010, September 6, 2011, June 5, 2018 and June 6, 2018. In all cases, follow-up monitoring determined “absent” results. Monitoring for E.coli has been conducted from 2005 to present, a total of 47 sampling events, with all results demonstrating “Absent”.

3.3 Volatile Organic Compounds

A single monitoring event (July 18, 1988) determined all VOC’s to be non-detectable, excepting Trichlorofluoro Methane, detected at a concentration of 2 ug/l. This organic chemical was principally used at a refrigerant (R-11) in low pressure mechanical systems. Production of this chemical in the United States ended in 1996 due to its potential for ozone depletion and other possible adverse environmental effects.

3.4 Radionuclides

A single monitoring event (7/17/90) determined non-detectable Radium 226 and Radium 228 with a concentration of 0.23 pCi/l. These results are substantial less than the combined Ra 226/228 RIDOH and USEPA Primary Drinking Water Limit (5 pCi/l).

3.5 Lead & Copper Monitoring & Corrosion Evaluation:

3.5.1 Lead & Copper Source Monitoring:

Well #1 and the distribution system POE both demonstrated non-detectable copper (<0.02 mg/l) and lead (<0.003 mg/l) in a single round of monitoring in July 1990. The monitoring conducted on September 19, 2019 demonstrated non-detectable copper (<0.02 mg/l) and low lead (0.004 mg/l) in the well discharge. However, the distribution POE demonstrated significantly elevated copper (2.11 mg/l) and lead (3.11 mg/l), in addition to zinc (1.66 mg/l) and iron (9.01 mg/l), indicating that corrosion is occurring in the water storage tanks and interconnecting piping.

3.5.2 Lead & Copper Distribution System Monitoring:

No lead and copper monitoring of the water distribution system or points of use, is reported.

3.5.3 Corrosion Potential

Using the water quality characterizations presented in Table 3-1 for Well #1 and the water distribution system, an evaluation of the corrosion potential of water was conducted using the following methods: (a) Langelier Saturation Index; (b) Larson-Skold Index and (c) Chloride/Sulfate Mass Ratio (CSMR) and (d) Alkalinity-to-Chloride Ratio.

Langelier Saturation Index (LSI)

This methodology identifies the tendency of calcium carbonate to either dissolve (or remain soluble) or precipitate as a scale. The calculation relates pH, calcium, total alkalinity, total dissolved solids and temperature, to calcium carbonate solubility in water. The Langelier Saturation Index is the difference between the actual pH of the water (pH_a) and the calcium carbonate saturation pH (pH_s):

$$Langelier\ Saturation\ Index = pH_s - pH_a$$

Where the terms are as follows:

- pH_s = the calcium carbonate saturation pH
- pH_a = the actual pH of the water

There are two accepted formulae for calculating the pH_s value. The first option uses pK values, as follows:

$$pH_s = (pK_2 - pK_s) - \log(Ca^{+2}) - \log(Alk)$$

Where the terms are as follows:

- K_2 = the acidity constant for the dissociation of bicarbonate (the pH at which water with a given calcium content and alkalinity is in equilibrium with calcium carbonate; temperature dependent)
- K_s = the solubility product constant for calcium carbonate (temperature dependent)
- Ca^{+2} = calcium concentration (moles/L)
- Alk = alkalinity concentration (moles/L)

The second option uses the total dissolved solids concentration of the water and the temperature as follows:

$$pH_s = (A + B) - \log(Ca^{+2}) - \log(Alk)$$

Where the terms are as follows:

- A = constant related to the temperature of the water
- B = constant related to the dissolved solids concentration of the water
- Ca^{+2} = calcium concentration (mg/L as $CaCO_3$)
- Alk = alkalinity concentration (mg/L as $CaCO_3$)

Values of A and B can be obtained from the U.S. EPA Corrosion Manual for Internal Corrosion of Water Distribution Systems (EPA Number 570984001, April 1984).

It should be noted that the Langelier Saturation Index is qualitative only in its ability to predict the tendency of calcium carbonate to remain in solution or precipitate. A positive LSI value indicates the tendency for scale formation, while a negative LSI value indicates that calcium carbonate will either dissolve or remain in solution. A zero LSI value indicates that the water is in equilibrium. As summarized in Table 3-1 the calculated values for the LSI indicate a moderate corrosion potential (-2.38 to -2.58) at ambient temperature (50^{o}F) and a low to moderately low corrosion potential (-1.55 to -1.74) at the elevated temperature (130^{o}F) typical of residential hot water systems. The well water has a slightly acidic to neutral pH, moderately low alkalinity, in conjunction with a low chloride content, that limits the corrosion potential. The system demonstrates consistent compliance with USEPA lead and copper water quality requirements.

Larson-Skold Index

The Larson-Skold Index describes the corrosivity of water towards mild steel and was developed based on in-situ measurements of corrosion in steel pipelines. Although developed for carbon steel, this index has value for assessing the corrosion potential relative to copper and copper alloy piping materials, particularly due to the impact of chlorides. The index is a ratio of the concentration of chloride and sulfate ions to the concentration of bicarbonate and carbonate ions, with all concentrations expressed in equivalents per million (or meq/L), as follows:

$$Larson - Skold\ Index = \frac{(Cl^{-} + SO_4^{-2})}{(HCO_3^{-} + CO_3^{-2})}$$

Values for calculation of this index are presented in Table 3-1. Based on low pH values, the alkalinity was determined to be all in the bicarbonate (HCO_3^{-}) form, with no carbonate (CO_3^{-2}). **The Larson-Skold Index value range of 0.88 to 1.28 indicate a moderate potential for interference with the formation of protective films on the wetted interior surface of the pipe, valves and fittings, that could promote galvanic and pitting corrosion of copper, zinc and lead.**

Chloride-to-Sulfate Mass Ratio (CSMR)

The more recently developed CSMR is intended to assess the impact of the relative concentrations of chloride and sulfate upon lead materials (tin-lead solder, brass alloys, lead pipe, etc.) in the premise distribution piping in direct contact with the water. Research has indicted the tendency of lead, when galvanically connected to copper, to react with sulfate to form relatively insoluble lead sulfate compounds or to react with chloride to form soluble lead (Pb II). Sulfates reduce the galvanic current while chlorides increase the galvanic current and inhibit the formation of protective scale layers on the material surface.

If the galvanic current is sufficiently high, conditions at the lead/water interface can "decouple" from the bulk water chemistry, resulting in elevated chloride and/or sulfate and a low pH (2-5 su). Acidic conditions result in the dissolution of lead in the thin film of water at the lead/water interface. The presence of alkalinity in the water can serve to buffer pH changes.

The CSMR is the concentration ratio of chloride and sulfate in the water. CSMR values <0.58 are believed to indicate no adverse impact upon lead pipe materials galvanically coupled with copper. Alternatively, CMSR values >0.58 could result in an increase in the evolution of soluble lead and reactions to form lead chloride. It should be noted that additional research had indicated CSMR values >0.77 are needed to create conditions that accelerate the evolution of soluble lead (Nguyen *et al.*, 2011). Research and practical experience have further demonstrated that the potentially adverse impacts of high chloride concentrations can be aggravated by stagnant conditions, and conversely can be mitigated by elevated alkalinity (>40-50 mg/L as $CaCO_3$).

As summarized in Table 3-1 the well water demonstrates low CSMR values of 0.72 to 0.89, due to the **very low chloride concentration (8.5 to 11.9 mg/l) relative to the sulfate (11.6 to 14.0 mg/l) content in the water.**

Alkalinity-to-Chloride Ratio:

The relationship of alkalinity and chloride is a significant factor in evaluating a water characterization relative to corrosion potential. Experience has demonstrated that bicarbonate alkalinity (HCO_3) concentrations of 50 – 60 mg/l (as $CaCO_3$) are often favorable to mitigate corrosion, however the relationship of alkalinity to chloride (and sulfate) must also be considered. As noted in Table 3-1 despite the well water containing moderately low (24 to 28 mg/l, as $CaCO_3$), the **alkalinity-to-chloride ratio (2.02 to 3.23) is favorable**, due to the low chloride content (8.5 to 11.9 mg/l), relative to buffering of acid formation in the water. **However, the consistently low alkalinity content does limit buffering capacity and localized areas could experience corrosion** the at the thin film interface with metallic (brass, copper) components in the water supply system. It should be noted however that the buffering capacity of the water (resistance to pH change) is a function of the alkalinity, dissolved inorganic carbon (DIC) and pH. Based upon a pH range of 6.8 to 7.3 su and an alkalinity range of 24 to 28 mg/l (as $CaCO_3$) the DIC content in the water is low, within a range from 6.0 to 8.0 mg C/l. Figure 3-1 presents standard curves for "buffer capacity" as a function of DIC and pH. The water characterization range experienced in the Prudence Park system demonstrates low buffering capacity, and the water is highly susceptible to local changes in pH due to corrosion chemical reactions, temperature change, and other factors.

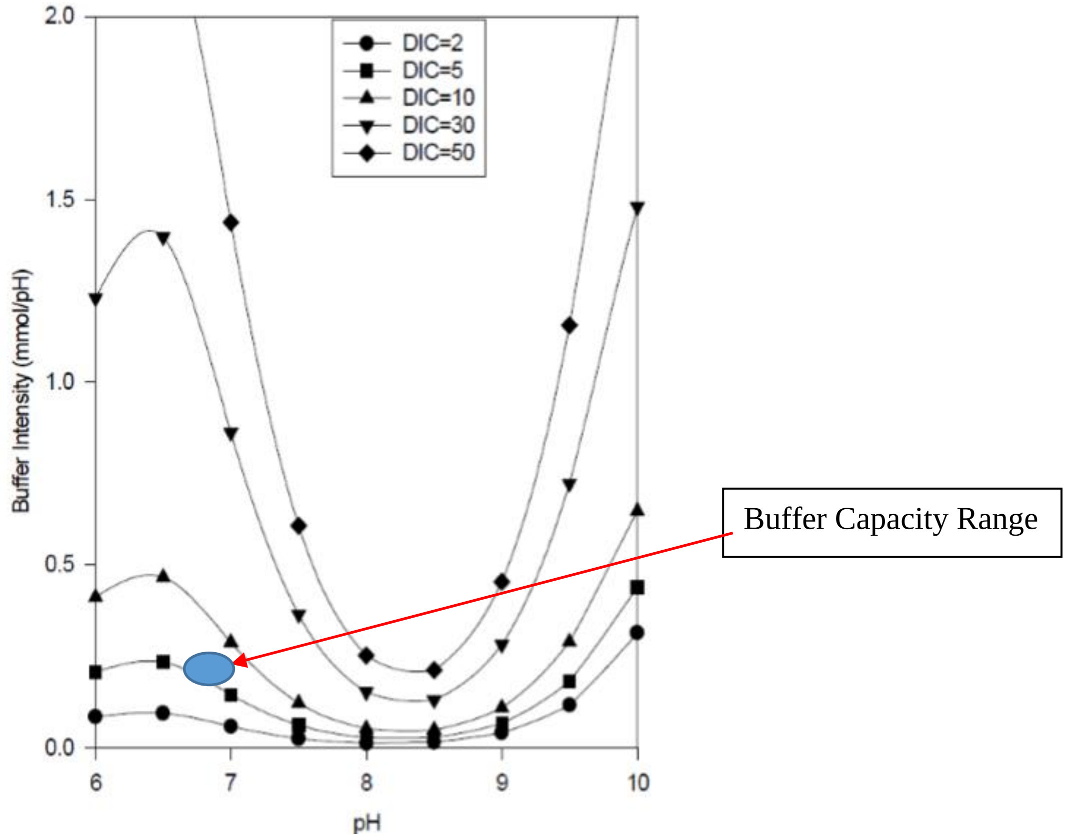

Figure 3-1: Buffer Capacity as a Function of pH & DIC (from USEPA 816-B-16-003)

3.6 Summary of Water Quality Monitoring:

Based upon a comprehensive review of the water quality monitoring data, the following conclusions have been developed:

1. The water produced by Well #1 demonstrates near neutral pH, moderately low TDS, alkalinity and total hardness, and low chlorides, sulfates, iron and manganese.

2. The well water has a generally low corrosion potential however, the low buffering capacity can render the system susceptible to localized corrosion, particularly under low flow or stagnant conditions. This is evidenced by the slug of iron, zinc and lead that occurred in the distribution POE sample obtained on September 19, 2019.

3. The well water demonstrates low nitrate-N content, consistent with the levels naturally occurring in soils in Rhode Island. This indicates the well is not adversely impacted from sanitary wastewater conveyance and treatment systems.

IV. ENGINEERING EVALUATION OF WATER SUPPLY SYSTEM

4.1 <u>Water Supply Well</u>

The existing well at Prudence Park has a 6" Ø casing with a 4" Ø sleeve and a 3 7/8" Ø submersible pump inside of it. Because of these tight dimensions, the submersible pump is at risk of entrapment in the well; any accumulation of corrosion on its exterior may increase the pump's diameter, making it impossible to remove. A loss of the pump would, at least temporarily, render the well unusable. By developing a new water supply well, the community can be assured a reliable, continuous water service with the ability to include a level transducer in the well and to readily perform well servicing. Development of a new well source will require the following tasks:

- Preparation and submittal to RIDOH of an Application for Source Approval for a new water supply well (Well #2).
- Following receipt of approval from RIDOH, construction of a 6"Ø exploratory well. During the well installation detailed inspection of the bedrock material and water discharged from the borehole would be performed. The well installation would include grouting of the casing, and provision of a submersible well pump and riser, power cable, stilling tube, and vented sanitary cap. The new well would be installed to a similar depth as the existing well, roughly 400 ft.
- Pump Test Program – Phase 1: The initial phase of the pump test program to assess the effective well capacity is a step-pumping test conducted using incremental flowrates (5, 10, 15, 20 gpm, etc.). Each step phase of the test is conducted for 1- hour or until log stabilization of the water level in the well is attained. During this phase of the test, a transducer installed in the well provides continuous monitoring and logging the water column pressure, temperature and level readings.
- Pump Test Program – Phase 2: The well performance data developed from the step-pumping test would be used to determine the flowrate for the Phase 2 constant rate pumping test. This test would be conducted over a 48-hour period, depending upon achievement of minimum 12-hour stabilization, at the specified flowrate. The transducer would provide continuous monitoring of the during the test phase, as well as during the recovery phase following shut down of the well pump. During the pumping phase, field monitoring of certain water quality parameters would be conducted (pH, TDS, conductivity, temperature, odor, color).
- Safe Yield Assessment: The data generated by the well pumping test would be used to develop a safe yield projection for the well. This would include a projection of the well water drawdown using a 180-day, no recharge extrapolation scenario, to assess whether the well would be able to continue to produce water at a specific rate under conditions of long-term aquifer stress.
- Water Quality Monitoring: During the constant rate pump test water samples would be obtained to execute a comprehensive water quality evaluation including; inorganic contaminants, VOC's, SOC's, and radionuclides.

The budget for implementation of a new water supply well, inclusive of the necessary engineering, drilling, testing and validation is summarized in Table 4-1.

Table 4-1: **Conceptual Capital Implementation Budget** **New Public Water Supply Well**	
Well Installation – 6”Ø Drilled Well:	
Drill Rig Mobilization	$ 2,000
Casing, Drive Shoe, Grout & Pitless Adapter	$ 1,000
Drilling (400 vlf @ $14/lf)	$ 5,600
Riser, Transmission Main & Stilling Tube	$ 1,200
Power Cable, Junction Box	$ 1,100
Well Pump (motor & wet end)	$ 3,200
Well Installation Sub-Total:	**$ 14,100**
Well Development (if needed)[3]	**$ 7,500**
Engineering Services:	
Final Design & RIDOH Permitting[1]	**$ 3,800**
Pumping Test Program	**$ 6,500**
Analytical Validation – 4 Quarters[2]	**$ 8,400**
Project Sub-Total	**$ 40,300**
Project Contingency – 10%	**$ 4,030**
Total Project Implementation Budget	**$ 44,330**

NOTES:
1. Includes bacteria, IOC, VOC, SOC & Radionuclide monitoring.
2. RIDOH permitting/approval.
3. Hydro-fracturing with double packer rig, 60 ft. c-c spacing, 8 sets.

4.2 Atmospheric Water Storage Tank

4.2.1 Water Storage Tank Capacity Evaluation:

Water storage capacity must be provided to meet the sustained peak potable water demand requirements of the community, previously determined to be approximately 2,725 gpd. This value represents summertime peak demand when the occupancy on the island is highest. The necessary effective storage tank capacity is calculated using the following criteria:

- The storage tank must provide hydraulic equalization to handle the peak 4-hour and 1-hour demands during the maximum demand day;
- The water storage tank shall have a minimum effective volume equivalent to the maximum demand day volume (4,088 gallons);
- The water supply well will have a minimum effective yield of 5 gpm.

Table 4-2 presents a summary of the storage tank capacity calculations based upon a minimum effective well yield of 5 gpm. (In 1950, the well was reported to have a capacity of 13 gpm). Due to the relatively low demands of the community, the required equalization volume is minimal, at 166 gallons, with an effective well yield of 5 gpm. Therefore, the storage tank volume is determined by the need to provide a minimum of a 1-day maximum demand volume (4,088 gallons).

Table 4-2 **Potable Water Storage Tank Capacity Evaluation**		
	Summer - ADD	**Summer - MDD**
Average Demand Day:		
Daily System Demand (V_{AVG})	2,725 gallons	4,088 gallons
Average Daily Flowrate (Q_{AVG-24})	1.9 gpm	2.8 gpm
Peak 4-Hour Demand ($V_{PEAK\ 4\text{-}Hr}$)[1]	818 gallons	1,226 gallons
Peak 4-Hour Demand Flowrate ($Q_{PEAK\ 4\text{-}Hr}$)	3.4 gpm	5.1 gpm
4-Hour Well Yield[1]	1,200 gallons	1,200 gallons
Required Equalization Capacity	0 gallons	**26 gallons**
Peak 1-Hour Demand ($V_{PEAK\ 1\text{-}Hr}$)[2]	311 gallons	466 gallons
Peak 1-Hour Demand Flowrate ($Q_{PEAK\ 1\text{-}Hr}$)	5.2 gpm	7.8 gpm
1-Hour Well Yield[1]	300 gallons	300 gallons
Required Equalization Capacity	**11 gallons**	**166 gallons**

4.2.2 Tank Replacement:

The existing atmospheric storage tank is in poor physical condition and has exceeded its effective life and should be replaced with a new tank. The new water storage tank would be installed adjacent to the existing Pump House on a reinforced concrete foundation pad. The tank would be provided with insulation and freeze protection, a flanged sidewall access manway and flanged connections for fill, vent, pump suction, monitoring instruments (tank level, temperature), overflow and drain. The operation (on/off) of the electronic tank fill valve would be controlled by liquid level (pressure transducer) monitoring in the storage tank. To minimize corrosion potential the tank would be fabricated of FRP materials and be fabricated with an NSF 61 compliant resin. A gravity pipeline would provide supply from the water storage tank to the new, duplex distribution pumps installed within the Pump House. The design criteria of the water storage tank is presented in Table 4-3 and the conceptual capital implementation budget is presented in Table 4-4.

Table 4-3: **Potable Water Storage Tank Design Criteria**	
Tank Configuration	**Horizontal, Cylindrical**
Contents	Potable Water
Tank Operating Pressure	Atmospheric
Tank Design Pressure	Max. 10 psig @ Bottom of Tank
Nominal Volume	6,000 gallons
Tank Materials	FRP, NSF 61 Compliant Resin
Tank Dimensions	
Tank Specifications	AWWA D-103, UL-142, NSF-61
Tank Construction	Single Wall, Centrifugally Cast
Tank Shell Thickness	¼" (minimum)

Tank Head Thickness	¼" (minimum)
Tank Insulation	2" Thk. Spray-on Polyurethane Foam
Exterior Finish	100 mil FRP Overlay Coating
Level Monitoring	Continuous – Pressure Tranducer
Tank Supports	Tank Saddles (2) – Carbon Steel
Tank Access	24" Bolted Manway
Tank Fill Connection	2" Flange
Tank Drain (Pump Suction) Connection	3" Flange
Tank Vent Connection	3" Flange
Tank Level Sensor Connection	1" Flange
Spare Connections	2 (minimum)

Table 4-4:
Conceptual Capital Implementation Budget
Potable Water Storage Tank

Equipment:	
Water Storage Tank[1]	$ 48,800
Tank Level Transducer	$ 800
Civil, Mechanical, Electrical Installation:	
Site Preparation & Erosion Control	$ 900
Excavation & Materials Compaction	$ 1,800
Tank Foundation Pads[2]	$ 11,000
Tank Rigging w/Crew	$ 2,400
Mechanical Piping – Labor & Materials	$ 5,600
Electrical & Inst. Wiring – Labor & Mat'ls	$ 3,200
Exterior Heat Tracing & Insulation (Piping)	$ 1,700
Field Instrumentation, Programming & Start-up	$ 2,200
Security Fencing	$ 1,500
Final Flushing & Hydrostatic Testing	$ 750
Decommissioning of Existing Tank	$ 8,000
Equipment & Installation Sub-Total:	**$ 87,650**
Contractor O&P (15%):	**$ 13,148**
Contractor General Conditions (8%):	**$ 7,012**
Engineering Services:	
Final Design & Permitting[4]	**$ 12,000**
Construction Management	**$ 7,500**
Final Sanitization & Analytical Validation[3]	**$ 1,100**
Freight Budget	**$ 5,000**
Project Sub-Total	**$ 133,410**
Project Contingency – 10%	**$ 13,340**
Total Project Implementation Budget	**$ 146,750**

NOTES:
1.Horizontal, cylindrical tank, FRP, w/insulation, freeze protection heaters, lift lugs, anchors, pipe connection fittings, etc., NSF-61 Compliant.
2. Two (2) reinforced concrete pads; 5' x 10' x 12" Tk., over engineered fill.
3. Includes bacteria &, VOC monitoring (2 rounds)..
4. Final Design, RIDOH permitting/approval.

4.3 Water Treatment Requirements

The water has not been treated historically and the amount of water quality data collected over the years is relatively sparse. This evaluation has determined that there is some corrosion occurring within the storage system, however it may be due to the extended off-season when the system is stagnant or near-stagnant for long periods of time. This can be substantially mitigated by the use of an FRP water storage tank and replacement of the unlined pressure tank (WX-304). No corrosion control or other treatment is warranted, at this time to ensure the safety of the water and maintain conformance with the USEPA and RIDOH Primary and Secondary Water Quality Limits.

4.4 Water Distribution System – Distribution Pumps and Controls

4.4.1 Water Distribution Pump System:

The single existing booster pump is in poor physical condition and poses a significant operational security risk in the system during the peak summer demand period because the loss of this single pump will result in the loss of water service. Additionally, the existing distribution pump is not NSF 61 compliant. It is recommended that the system be upgraded with a duplex distribution pump system and replacement of the aging, WX-304 pressure tank.

The duplex distribution pumps would discharge into the distribution force main, controlled by the discharge pipeline pressure. Two (2) pressure bladder tanks (1 existing, 1 new) would be installed on the discharge main to handle small, short-term demands with the distribution pumps activated on the basis of pressure control. Similar to the existing operation, the pressure bladder tanks would provide sufficient storage capacity during the non-peak season, when demands are minimal. The distribution pumps would be designed for single pump operation, with the second pump providing 100% standby capacity, and would be designed to maintain the system operating pressure at 45-50 psig at the point of discharge. The distribution system would be provided with a pressure transducer to monitor the line pressure and provide high/low pressure alert and alarm notification.

The pump system would be skid-mounted, including two (2) centrifugal booster pumps, suction manifold with isolation valves, discharge manifold with isolation and check valves, pressure gages, frame mounted controls, two (2) variable frequency drives, accessories and appurtenances. The pumps would be of close-coupled design with casings of cast 316SS, concentric volute type, fitted with Class 150 flanged stainless steel suction and discharge connections. Each pump would be provided a dedicated microprocessor-based, variable speed pump controller (VFD) and a local, fused disconnect switch at the pump skid. The VFD's shall accept a proportional output signal from the distribution service pressure monitor and control the pump speed to maintain the discharge line pressure within a pre-set range (50 psig +/- 5 psig). The nominal distribution pump design criteria for this application are presented in Table 4-5 (note: duplex, vertical centrifugal pumps can be substituted for the horizontal pumps).

Table 4-5: Water Distribution Pump - Design and Operating Criteria	
Quantity:	Two (2)
Type	Horizontal, Centrifugal, Flooded Suction
Size:	1 x 1-1/4 – 6
Casing Material:	316 SS
Drive:	Direct Drive/VFD
Speed:	3500 rpm
Motor:	2 HP TEFC
Pump Capacity @ 3500 rpm	10 gpm @ 127 ft. TDH 20 gpm @ 119 ft. TDH 30 gpm @ 108 ft. TDH

4.4.2 Pump House Improvements & Controls:

Additional improvements to be incorporated with the upgrade of the distribution pumps and new pressure bladder tank(s) include the following:

- Re-pipe the pump house to replace, reconfigure and simplify the existing piping. This includes provision of a well master meter and sample tap, new water supply and return from the water storage tank, etc. The piping would include the use of Schedule 80 PVC piping to minimize corrosion potential, low-lead alloy water meter and new sample taps.

- Provide a water meter/totalizer, pressure monitoring system and sample tap for the discharge into the water distribution system;

- Provide a new PLC control panel to provide monitoring of critical system variables including well water level, water storage tank level, distribution system pressure and pump house interior temperature, and pump operating status. The panel would include data logging and alarm notifications and would have capability for remote monitoring communications.

- Upgrade the existing interior heating system with two (2) new, electric space heaters to provide freeze protection, upgraded lighting, and minor improvements and repairs to the building structure.

Table 4-6 presents the conceptual capital implementation budget for the recommended pump house improvements, duplex distribution pump system and controls.

Table 4-6: Conceptual Capital Implementation Budget Pump House Improvements & Distribution Pump System	
Equipment:	
Booster Pump System & VFD Controls	$ 21,000
Pressure Bladder Tank (1)	$ 1,650
Monitoring, Control & Alarm Panel	$ 12,600
Field Instrumentation	$ 4,200
Civil, Mechanical, Electrical Installation:	
Pump House Modifications - Allowance	$ 4,000
Rigging	$ 1,200
Mechanical Installation – Labor & Materials	$ 8,800
Electrical Installation – Labor & Materials	$ 7,450
System Testing & Flushing	$ 1,400
Equipment & Installation Sub-Total:	**$ 62,300**
Contractor O&P (15%):	**$ 9,345**
Contractor General Conditions (8%):	**$ 4,985**
Engineering Services:	
Engineering Design & Permitting	**$ 7,500**
Construction Phase Eng. & Management	**$ 8,500**
System Sanitization & Validation	**$ 850**
As-Built Drawings	**$ 1,100**
O&M Manual	**$ 3,200**
Freight	**$ 4,000**
Project Sub-Total	**$ 101,780**
Project Contingency – 10%	**$ 10,180**
Total Project Implementation Budget	**$ 111,960**

4.5 Water Distribution Piping System

Based upon the age of the distribution piping (>50 years), its low, pressure rating (100 psi), and the apparent physical condition, NWSI recommends that the entire distribution system is replaced. Two (2) alternatives have been identified for replacement of the existing system;

- Alternative #1: Replacement of the existing, linear piping system, with selected improvements including additional flush blow-offs. The scope of work includes approximately 4,000 LF of 2” Ø main, fifteen (15) isolation valves and six (6) flush blow-off connections. Each of the twenty-two (22) residential service connections is provided a curb stop (refer to Dwg. C-1, Appendix A).

- Alternative #2: Replacement of the existing system with a “looped” piping system, with appropriate isolation valves and blow-offs, to improve the overall system hydraulics, pressure and minimize risk of loss of service. The scope of work includes approximately 5,888 LF of 2” Ø main, eighteen (18) isolation valves and seven (7) flush blow-off connections. Each of the twenty-two (22) residential service connections is provided a curb stop (refer to Dwg. C-2 – Appendix C).

Table 4-7 presents the conceptual capital implementation cost for each improvement alternative. The basis for these estimates includes the following:

- Pipeline Materials: Polyethylene distribution service piping shall be shall be Schedule 80 seamless type conforming to ASTM F-714 and AWWA-C901 for potable water service. Flanges shall be suitable for mating with Standard ANSI 150 lb. flanges. Flanges shall be furnished with full faced, 1/8" thick gaskets or EPDM or approved equal. Flange bolts, nuts, and washers shall be of Type 304 stainless steel. Fittings shall conform to ASTM D 3261;

- Pipeline Installation: Pipelines shall be installed 48" below ground surface using open trench cut methods. Pipe shall be bedded with minimum 6" sand under pipe and sand backfill to 6" over top of pipe and provided an ID tape, overlain with common backfill. It is assumed that some cobbles and debris may be encountered in the excavation, but no ledge material;

- All isolation valves to be provided valve boxes and riser stems to grade;

- Flush Connections shall be 2" Ø with a tee connection, 2" isolation valve and quick-disconnect fitting;

- House Connections shall include a 3/4" PE service, meter w/meter box, corporation stop, isolation valve, connected to the existing service to each residence. Individual lateral and house connections shall be made sequentially, to minimize service disruption. Each service connection shall undergo flushing, pressure testing, sanitization, re-flushing and validation testing prior to placing into service;

- Pavement Restoration: The existing roads are compacted gravel. Road restoration assumes and 8 ft. wide restoration along the pipeline alignment, trench backfill with existing common fill (removed from the excavation), and installation of a new, 6" top course of compacted stone dust/gravel;

- The new distribution piping system shall be installed in parallel with the existing system, to maintain service to users during the construction phase. Following installation, the new piping shall be flushed and pressure tested, then backfilled;

- After backfilling, the new distribution piping main shall undergo sanitization, flushing and validation testing (microbiological and VOC's) prior to placing into service;

- A topographic survey of the existing system and site area will be performed to support the final design of the upgraded distribution system;

4.6 System Upgrade Prioritization

The prioritization of the upgrades is based upon the combination of need and risk minimization regarding operating security and protection of public health. Recognizing that the system upgrade will likely be a multi-phase project implemented over a number of years, the recommended priority sequence of implementation is the following:

- New Water Supply Well (Well #2) Implementation – 2020;
- New Water Storage Tank/Pump House Improvements – 2020;
- Design of Water Distribution System Improvements – 2020/2021;
- Water Distribution System Replacement – 2022/2025;

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Capital Implementation Budget - Replacement of Water Distribution System				
	Alternative #1		Alternative #2	
Water Distribution System:	**Qty**	**Cost**	**Qty**	**Cost**
Mobilization/De-Mobilization	LS	$ 8,000	LS	$ 8,000
Site Preparation, Erosion Control	LS	$ 3,500	LS	$ 5,000
2" Ø HDPE Distribution Pipe[1]	4,000 LF	$ 300,000	5,888 LF	$ 441,600
2" Isolation Gate Valves & Valve Boxes[2]	15	$ 18,000	18	$ 21,600
Fittings & Thrust Blocks	Allowance	$ 4,500	Allowance	$ 6,000
2" Flush Connections[3]	6	$ 10,800	7	$ 12,600
House Connections[4]	22	$ 36,300	22	$ 36,300
Hydrostatic Testing & Disinfection[5,6]	LS	$ 3,400	LS	$ 4,000
Traffic Control/Safety	LS	$ 2,000	LS	$ 3,000
Road Restoration – Processed Stone[7]	3,555 SY	$ 29,650	5,235 SY	$ 43,600
Loam & Seed Restoration - Allowance	Allowance	$ 2,500	Allowance	$ 3,500
Construction Sub-Total:	-----	**$ 418,650**	-----	**$ 585,200**
Contractor O&P (15%):	-----	**$ 62,798**	-----	**$ 87,780**
Contractor General Conditions (8%)	-----	**$ 33,492**	-----	**$ 46,815**
Transportation (Ferry) Allowance	-----	**$ 12,485**	-----	**$ 17,555**
Engineering Services:				
Field Survey	-----	**$ 6,000**	-----	$ 6,000
Design Engineering/Permitting	-----	**$ 18,000**	-----	$ 20,000
Construction Phase Eng. & Management	-----	**$ 18,500**	-----	$ 18,500
As-Built Drawings	-----	**$ 1,500**	-----	$ 1,500
O&M Manual	-----	**$ 3,200**	-----	$ 3,200
Project Sub-Total	-----	**$ 574,125**	-----	**$ 786,550**
Project Contingency – 10%	-----	**$ 57,410**	-----	**$ 78,655**
Total Project Implementation Budget	-----	**$ 631,535**	-----	**$ 865,205**

NOTES:

1. Includes: field layout, excavation, bedding material, pipe materials, backfill, compaction, general site restoration ($75/lf).
2. Includes: valves, valve boxes, operators ($1,200/ea.).
3. Includes tee, isolation valve w/box, flush fitting ($1,800/ea.).
4. Includes: service tee, curbstop with box, 15 ft. of lateral pipe (3/4"Ø) and tie-in to existing house connection ($1,650/ea.).
5. Phased flushing and pressure testing of piping as work is completed.
6. Phased validation including bacteria and VOC monitoring, as pipeline segments are completed.
7. Includes stone materials, placement, grading, compaction, to restore existing processed stone surface. Assumes 6" thickness of new process stone material, imported from off-island.

V. FINANCIAL EVALUATION

5.1 Basis of Capital Implementation Cost Estimate

The following assumptions and criteria were used as the basis for developing the cost estimate for implementation of the recommended scope of improvements to the Prudence Park Public Water System:

- The work shall be divided into the following discrete projects, based upon prioritization.
  - New Water Supply Well (Well #2) Implementation – 2020;
  - New Water Storage Tank/Pump House Improvements – 2020/2021;
  - Design of Water Distribution System Improvements – 2020/2021;
  - Water Distribution System Replacement – 2022/2025;
- The implementation of a new water supply well is optimally completed prior to the 2020 peak water demand season. This will require submittal of the Application for Approval in early 2020, following by the well drilling/installation at the earliest time, based upon availability of transportation to Prudence Island and weather. Following installation, the well must undergo the requisite pumping test and validation of water quality, prior to final approval for use in the public water system.
- The replacement of the water storage tank and the distribution pump and other Pump House improvements is a priority for 2020/2021. These improvements can be designed concurrent with the new water supply well, to facilitate construction during the Fall of 2020, to minimize impact upon the peak water demand (Summer) season.
- The replacement of the water distribution system requires long-term planning, financing and scheduling. Excepting necessary corrective/emergency repairs, all other recommended improvements should occur prior to implementation of the distribution upgrade.
- The replacement of the water distribution system is recommended to occur following the replacement of the water storage tank and implementation of the new distribution pumping system and controls. It is recommended that this work be performed during the non-peak water demand season, to minimize impact upon residents, after the 2022 season. Monitoring of the system during the 2020 to 2022 seasons (water demands, distribution system pressure, well operation and drawdown, etc.) would be used to validate the benefits of the improvements and provide critical information for design of the distribution system.

5.2 Capital Implementation Cost Estimate

Table 5-1 presents a summary of the projected capital implementation cost allocation

Table 5-1
Recommended Capital Budget Allocation – 2020/2022

	2020	**2021**	**2022**
Water Supply Well #2	$ 44,330	-----	-----
Water Storage Tank Replacement	$ 146,750	-----	-----
Distribution Pumps & Pump House Improvements	-----	$111,960	-----
Engineering Design – Water Distribution System	-----	$ 26,000	-----
Distribution System Improvements	-----	-----	$631,535 to $865,205
TOTAL	**191,080**	**$137,960**	**$631,535 to $865,205**

5.3 Long-Term Facility Improvement Budget

The Prudence Park Public Water System funds maintenance projects from the annual operating budget and would fund any major capital project from project specific financing sources, grants or appropriations. In addition to the noted system improvements, it is necessary that the System have sufficient funding to meet long-term capital needs for anticipated long-term system improvements. Table 5-2 presents the long-term financial needs assuming the appropriate implementation of the noted capital projects within the recommended schedule (Table 5-1). The projected replacement cost assumes an average 2.5% per year inflation rate. The recommended reserve funding to allow the System to effectively finance the public water system is $15,516 per year, not including the cost for replacement of the water distribution piping system.

Table 5-2
Financial Assessment - Long Term Capital Improvement[1]

Asset Name/Description	Qty.	Total Life (yrs)	Age (yrs)	Eff. Life (yrs)	Present Replacement Cost	Projected Replacement Cost[2]	Annual Reserve
Well #2[1]	1	50	0	50	$ 18,400	$ 63,112	$ 1,262
Well #2 Submersible Pump	1	20	0	15	$ 3,200	$ 5,245	$ 350
Water Storage Tank[1]	1	50	0	30	$ 45,000	$ 94,500	$ 3,150
Water Distribution Pumps[1]	2	30	0	20	$ 21,000	$ 34,419	$ 2,868
PLC Panel & Instrumentation[1]	LS	10	0	10	$ 16,800	$ 21,504	$ 2,150
Interior Mechanical Installation	-----	50+	Vary	35	$ 20,000	$ 47,400	$ 1,354
Electrical/Controls Installation	-----	40+	Vary	25	$ 15,000	$ 31,500	$ 1,050
Emergency Generator	1	30	5	30	$ 28,000	$ 58,800	$ 1,960
Pump House Building[1]	1	50+	0	50+	$ 20,000	$ 68,606	$ 1,372
TOTAL					**$281,670**		**$ 15,516**

NOTES:

1: The Capital Improvement Plan assumes the System will implement the new Well #2, Water Storage Tank, Distribution Pumps, Pump House Improvements, Controls, Instrumentation, etc.

2. Projected Replacement Cost assumes an average 2.5% per year inflation rate.

3. Assumes construction of new distribution system 2021 to 2025.

VI. CONCLUSIONS & RECOMMENDATIONS

6.1 Summary Conclusions

The following conclusions have been developed from the engineering evaluation, summarized herein;

1. The Prudence Park public water system supplies 22 residences, with a calculated average demand of approximately 2,725 gallons per day (gpd) during the peak summer demand season extending from June to September. During the non-peak season, typically with only 3 active residences, the community water demands decline greatly to approximately 327 gpd. The system does not have a master water meter and there is no documentation of the community water use.

2. The community operates with one (1), drilled-bedrock well (Well #1) supplying water to the community. Well #1 has been in service since 1946, with a reported yield up to 13 gpm. While functional, the well casing is in poor condition and was stabilized with the installation of a 4" carbon steel sleeve within the original 6" Ø casing. The resultant opening dimension is barely sufficient to allow the submersible well pump to be installed into the well.

3. Well #1 directly supports the entire community water demand during the non-peak season, pumping directly into the distribution system, with "storage" provided by two (2) pressure tanks. During the peak demand season Well #1 pumps into a 6,000-gallon atmospheric water storage tank, which supplies a single booster pump that discharges to the distribution system.

   The atmospheric water storage tank is in poor physical condition, has reached the end of its effective life, and should be replaced. The larger pressure tank (WX-304) has been in service approximately 45 years and also is at the end of its effective life. Additionally, the single booster pump is in poor condition and is not NSF 61 compliant and not appropriate for use in a public water system. The water system controls and monitoring components are functional, but beyond their effective life. All of the noted system components should be replaced.

4. The Pump House building structure is in generally good physical condition, and is provided interior lighting and heat for freeze protection. The exposed water service piping is in fair to good condition and the electrical service is in good condition. The building structure is in generally good condition, and with proper maintenance this building can be expected to provide effective service for another 30 years.

5. A gas-fired, 11-KW generator (Generac Guardian) is installed on a concrete pedestal adjacent to the water storage tank. Two 100-gal. propane tanks provide fuel via a hard-piped supply to the generator. The automatic transfer switch is installed within the Pump House. The generator is believed to be installed approximately 5 years, and is in very good physical and operating condition.

6. Water Quality: The water produced by Well #1 demonstrates near neutral pH, moderately low TDS, alkalinity and total hardness, and low chlorides, sulfates, iron and manganese. The well water has a generally low corrosion potential however, the low buffering capacity can render the system susceptible to localized corrosion, particularly under low flow or stagnant conditions. This is evidenced by the slug of iron, zinc and lead that occurred in the distribution POE sample obtained on September 19, 2019. The well water also demonstrates low nitrate-N content indicating the well is not adversely impacted from sanitary wastewater conveyance and treatment systems.

7. Water Distribution Piping System: There are no record drawings available for the water distribution piping system (approx. 4,000 LF). The piping materials are believed to be principally 2” Ø polyethylene that is rated for 100 psig pressure. The distribution system is linear, with 15 isolation valves and three (3) flush blow-offs. Although functional, the configuration of the distribution system results in extended water age, and has an elevated level of loss of service risk, due to each residence being served from a single direction.

8. System Maintenance & Administration: The system has operated effectively since at least 1946, with periodic repairs, maintenance and improvements, as-needed. However, there is no comprehensive Operation and Maintenance Manual, no regular preventative maintenance plan, nor any formal log of the system operation. Additionally, there are no drawings or documentation of the system.

6.2 Recommendations for Implementation:

The following recommendations are presented for consideration by Prudence Park to provide the necessary system maintenance and improvements, minimize the risk of service loss and assure an additional effective 30-year life for the public water supply system. The prioritization and schedule of implementation is presented in Sections IV and V, above.

1. Install a new, 6” Ø, drilled bedrock well, drilled to a depth of 400 ft. BGS. This will require submittal of a RIDOH Application for Approval and will optimally be installed prior to the 2020 peak water demand season. Following installation, the well must undergo the requisite pumping test and validation of water quality, prior to final approval for use in the public water system.

2. Design and install a new, 6,000-gallon, atmospheric water storage tank to replace the existing tank.

3. Design and install a new duplex water distribution pump system, pressure bladder tank and controls. Optimally, this will occur concurrent with the implementation of the new water storage tank, and will further include a re-configuration of the Pump House piping and provision of additional instrumentation including a master water meter, pressure monitoring system. The replacement of the water storage tank and the distribution pump and other Pump House improvements is a priority for 2020/2021. These improvements can be designed concurrent with the new water supply well, to facilitate construction during the Fall of 2020, to minimize impact upon the peak water demand (Summer) season.

4. Initiate the long-term planning process for a new water distribution system, anticipating that construction will occur between 2022 and 2025. The replacement of the water distribution system is recommended to occur following the replacement of the water storage tank and implementation of the new distribution pumping system and controls. It is recommended that this work be performed during the non-peak water demand season, to minimize impact upon residents. Monitoring of the system during the 2020 - 2022 seasons (water demands, distribution system pressure, well operation and drawdown, etc.) would be used to validate the benefits of the improvements and provide critical information for design of the distribution system.

5. Prepare a system Operation & Maintenance Manual and a formal Preventative and Predictive Maintenance Program including description of operations, regulatory compliance requirements, operating protocols, emergency response protocols, maintenance schedules, operating and maintenance logs, etc. This program should be updated, as the system improvements are designed and implemented.