

CITY OF STAUNTON

WATER SUPPLY EVALUATION

FINAL REPORT

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1.0 INTRODUCTION

The City of Staunton Department of Public Works has initiated a study of its raw water system. This study includes an evaluation of existing infrastructure and conceptual design alternatives for improvements. The City receives raw water for treatment and distribution from Gardner Spring and from the North River Reservoir system which is comprised of the Elkhorn Reservoir and Staunton Dam. Water from Gardner Spring is pumped from the Gardner Spring Pump Station to the City Water Treatment Plant (WTP) through a dedicated raw water line. Water from the North River Reservoir flows by gravity to the City WTP through a separate raw water line.

The goals of this evaluation are to ensure the system's reliability and capacity to meet the City's current and future drinking water needs. This report was prepared with coordination and input from the City of Staunton Department of Public Works (City), Wiley|Wilson, Emery & Garrett Groundwater Investigations (EGGI), Troutman Sanders, and Resource Environmental Solutions (RES).

This evaluation report provides the City with the following:

- Water supply history
- Projected water demands
- Safe yield and property ownership for Gardner Spring
- Conceptual design of the Gardner Spring Pump Station
- Conceptual designs for the replacement of raw water lines from the North River Reservoir and Gardner Spring Pump Station to the water treatment plant
- Reliability recommendations for the City's raw water system



2.0 WATER SUPPLY OVERVIEW

The City's existing raw water system consists of the Staunton Dam and Elkhorn Reservoir (also known as the North River Reservoir), North River raw water line, Gardner Spring, Middle River intake, Gardner Spring Pump Station, and the Gardner Spring raw water line. Raw water from the City's two primary sources, North River and Gardner Spring, is conveyed via two raw water lines to the City's Water Treatment Plant (WTP) which is permitted for a design capacity of 8 MGD and a treatment capacity of 12 MGD (VDH No. 2790600).



Figure 2.1: Staunton Dam

The City's water system serves the City of Staunton and parts of Augusta County through a water purchase agreement with Augusta County Service Authority (ACSA). This agreement specifies that ACSA will purchase a minimum of 1.0 MGD average annual volume of treated water, and that a total capacity of 3.0 MGD is reserved. The terms of the existing agreement are in place until December 31, 2036.

This section includes a historical overview of the City's raw water supply, description of the existing supply and infrastructure, an updated projection and demand summary, and a description of potential future supply sources.



2.1 HISTORY OF RAW WATER SUPPLY

The earliest known water supply used by the City of Staunton for public consumption was in 1875 when various springs were developed in Gypsy Hill Park. A pump house was later constructed in 1886, with an estimated capacity of 1.25 MGD, to convey flow from the 11 Gypsy Hill Park springs to the City mains. Based on a 1923 letter (see Appendix D), it is also known that Buttermilk Spring and a 2.5 million gallon (MG) reservoir, named Reservoir Hill, were also part of the City's early water supply system. In 1923, the area suffered a water crisis that led to a water supply evaluation. This evaluation resulted in the 1926 construction of the Staunton Dam Impoundment on the Upper North River and the 12-mile cast iron transmission line. At that time the dam had a reported safe yield of 1.2 MGD.^{1,2}

The City experienced water shortages again in the 1940s that led to the development of Gardner Spring and the Gardner Spring Pump Station in 1949. This added a capacity of 1.5 MGD to the system. Between 1950 and 1951, the Gardner Spring Pump Station was upgraded to a capacity of 4.0 MGD. In 1965, the Elkhorn Dam was constructed by the Soil Conservation Service 1.5 miles upstream of the Staunton Dam. This increased the interconnected system's safe yield to 2.4 MGD. Almost ten years later in 1974, the Middle River intake and second wet well were constructed at the Gardner Spring Pump Station site, adding Middle River as another raw water source. Frank's Mill Dam was located downstream from the Gardner Spring Pump Station. The dam was constructed in 1923, but damaged in 1985 and never repaired. The damage to the dam caused the water surface elevation of the Middle River at the Gardner Spring Pump Station site to drop, leading to the 1988 Middle River intake upgrades. No other major upgrades have been made to the City's raw water system since that time. Figure 2.3 includes a timeline of the above listed improvements.^{2,3}



Figure 2.2: Existing Gardner Spring Pump Station



City of Staunton Water Supply History

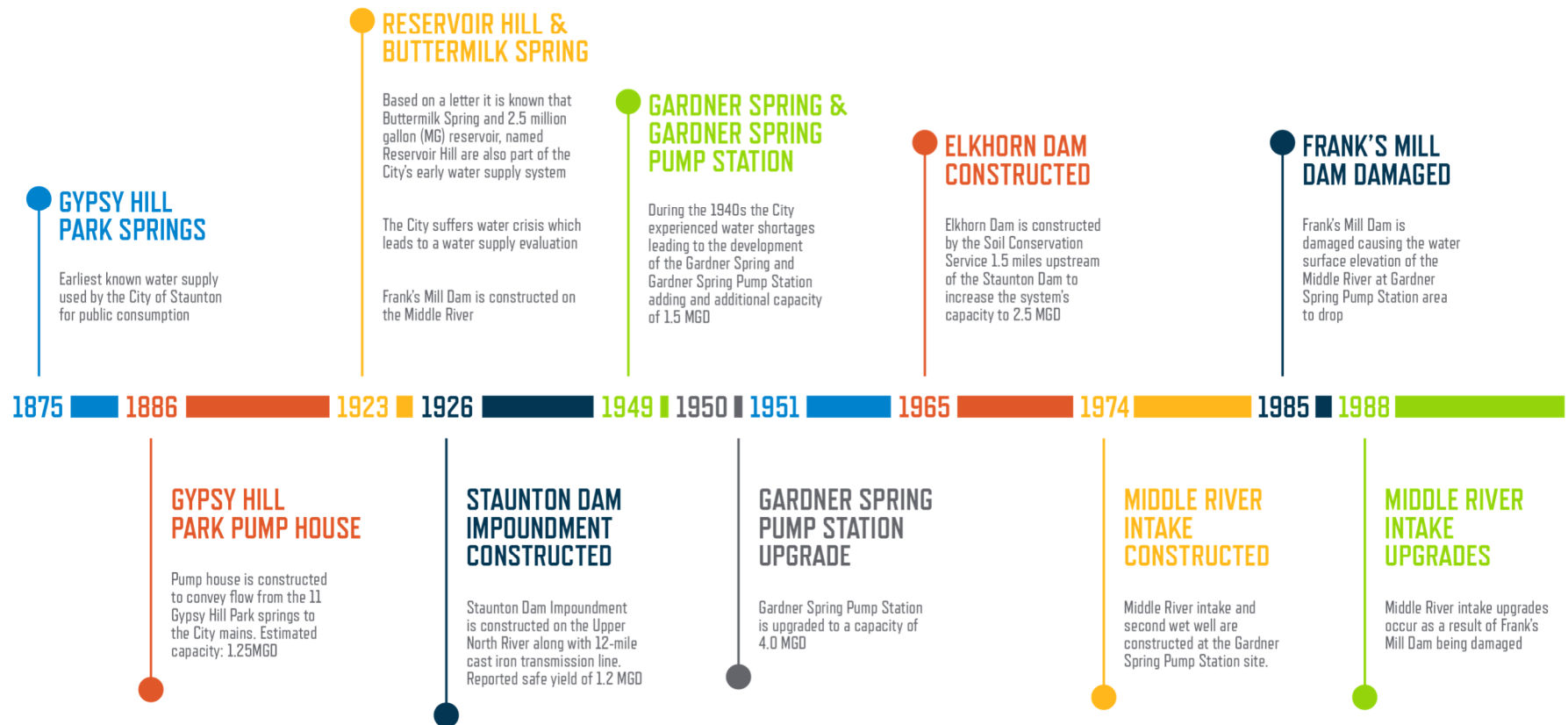


Figure 2.3: Historic Timeline of City's Raw Water Supply^{1,2,3}



2.2 EXISTING WATER SUPPLY SYSTEM

The existing raw water sources and infrastructure include the following:

- Elkhorn Reservoir/Staunton Dam (North River Reservoir) – This system flows by gravity through approximately 12 miles of 20-inch and 16-inch cast iron transmission line to the City's WTP
- Gardner Spring – This system is pumped to the WTP by the 7.08 MGD capacity Gardner Spring Pump Station through approximately 3.5 miles of 16-inch transmission line

Figure 2.4 is a map of the City's existing raw water supply system infrastructure, including the transmission lines and WTP.

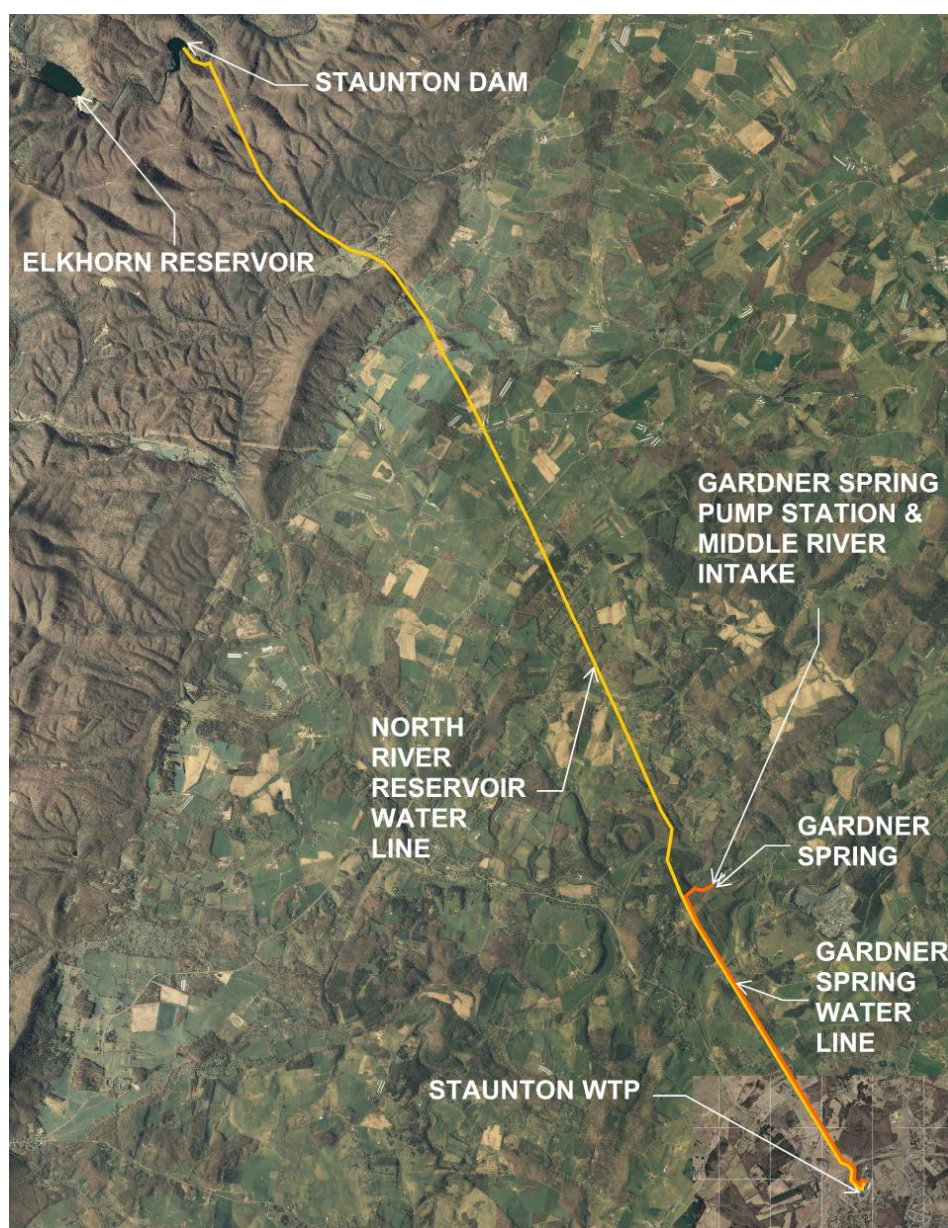


Figure 2.4: City of Staunton Existing Water Supply System (2015 VGIN Aerial)



The North River Reservoir is located approximately 12 miles northwest of the City of Staunton within the North River drainage basin. The North River Reservoir raw water line includes a 5,500 foot long tunnel through Lookout Mountain, as well as crossings of Middle River and Bell Creek, along the waerline alignment. Water flows throught his line by gravity from the North River Reservoir to the City WTP.

The Gardner Spring Pump Station is located approximately 3 miles northwest of the City along the Middle River. The water line from this pump station (Gardner Spring raw water line) follows the west bank of the Middle River, crossing the Middle River before paralleling the North River Reservoir water line to the City WTP. The two lines enter the WTP separately through a common meter vault. Each line is monitored for turbidity and flow rate using magnetic flow meters. The two lines combine in the chemical building where the pH of the blended raw water is measured.

Table 2.1 shows the City's minimum, maximum, and average daily withdrawals from each raw water source over the past 10 years (September 2007-2017). According to City records, the maximum daily withdrawal of 4.85 MGD for the combined North River Reservoir and Gardner Spring system between September 2016 and September 2017 is due to line breaks in the system, not increased consumption.

Table 2.1: Maximum, Minimum, and Average Daily Withdrawal (MGD) for Water Supply Sources between September 2007 and 2017

WATER SUPPLY	2007-2017 MINIMUM DAILY WITHDRAWAL (MGD)	2007-2017 MAXIMUM DAILY WITHDRAWAL (MGD)	2007- 2017 AVERAGE DAILY WITHDRAWAL (MGD)
Gardner Spring/ Middle River	0.98 (Feb 2017)	3.49 (Oct 2007)	1.77
Elkhorn Reservoir/ Staunton Dam	0.75 (Sep 2010)	2.15 ^a (May 2008)	1.88

a. Maximum daily withdrawal rate following pigging of North River Reservoir water line. Maximum daily withdrawal is less than the safe yield of 2.4 MGD due to corrosion within the North River Reservoir water line.

To analyze the system capacity for each of the City's water supply systems, the infrastructure capacity was compared to the safe yield of the supply. The infrastructure capacity reflects the limitations of the water lines and pump station, while the safe yield is what the supply could provide without being limited by the existing pipe and pump infrastructure.



North River Reservoir System Capacity

The North River Reservoir system provides both water supply storage and flood control for the downstream area. The Staunton Dam has 108 million gallons (MG) of live storage between the intake invert and Ogee spillway crest, and the Elkhorn Reservoir has 261 MG of live storage between the invert of the low-level Gate 1 and the spillway crest.³ The 2002 report recommended that the minimum drawdown level in Staunton Dam be elevation 1888.2' to minimize air entrainment in the North River Reservoir water line pipe. This reduces the live storage at Staunton Dam to 107 MG, making the combined live storage of the North River Reservoir system 368 MG. (See Figure 2.5 for other key elevations for the Elkhorn Reservoir and Staunton Dam.)

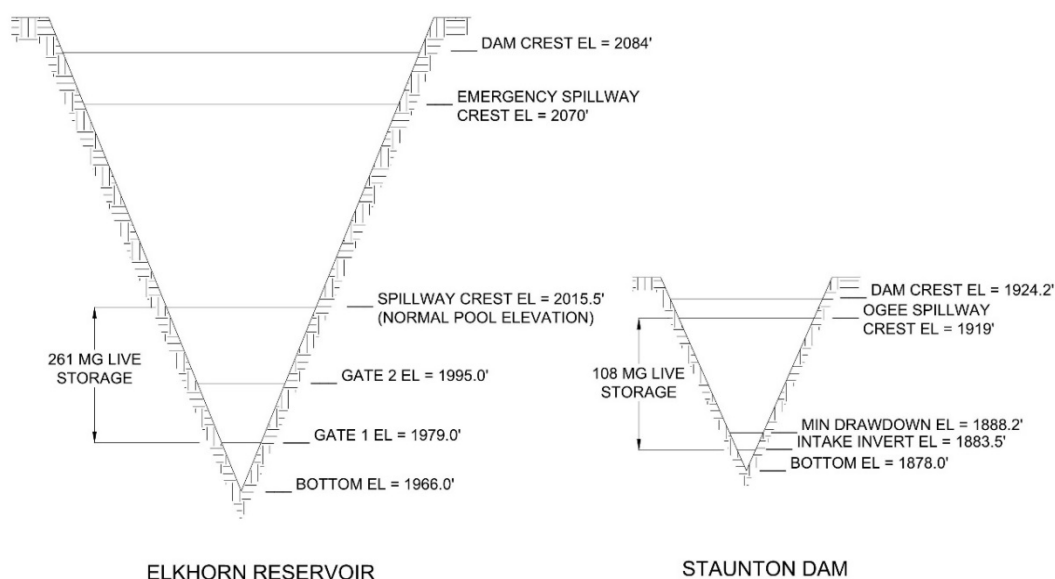


Figure 2.5: Representative Section View the Elkhorn Reservoir and Staunton Dam

Under normal conditions, the City currently operates the North River Reservoir system by opening or closing a valve to control the flow until the water level in the Staunton Dam stabilizes. To illustrate drought conditions, the total amount of live storage for the total North River Reservoir system (368 MG) and for the Elkhorn Reservoir only (261 MG) was analyzed with various withdrawal rates to determine the number of days of storage for each withdrawal scenario (see Figure 2.6). It was assumed that the Elkhorn Reservoir and Staunton Dam both had full live storage at the start of the drought and that the interconnecting valve between the two reservoirs was open or could be opened when needed. No amount of recharge was assumed to replenish the North River Reservoir system during the time of this drought scenario.

As part of a raw water system evaluation performed in 2002, the safe yield of the Elkhorn Reservoir/Staunton Dam and the infrastructure capacity of the raw water line was determined to be 2.4 MGD. However, as shown in Table 2.1, the water line currently conveys an average daily withdrawal of 1.88 MGD. This lower average is due to corrosion and age of the line. The 2002 report recommended that the transmission line be pigged every 3-5 years to maintain capacity.³ The line has been pigged twice, resulting in restoration of some lost capacity to approximately 2.1 MGD. Since the North River



Reservoir water line infrastructure capacity is less than the Elkhorn Reservoir/Staunton Dam safe yield, the system capacity is limited to 2.1 MGD.

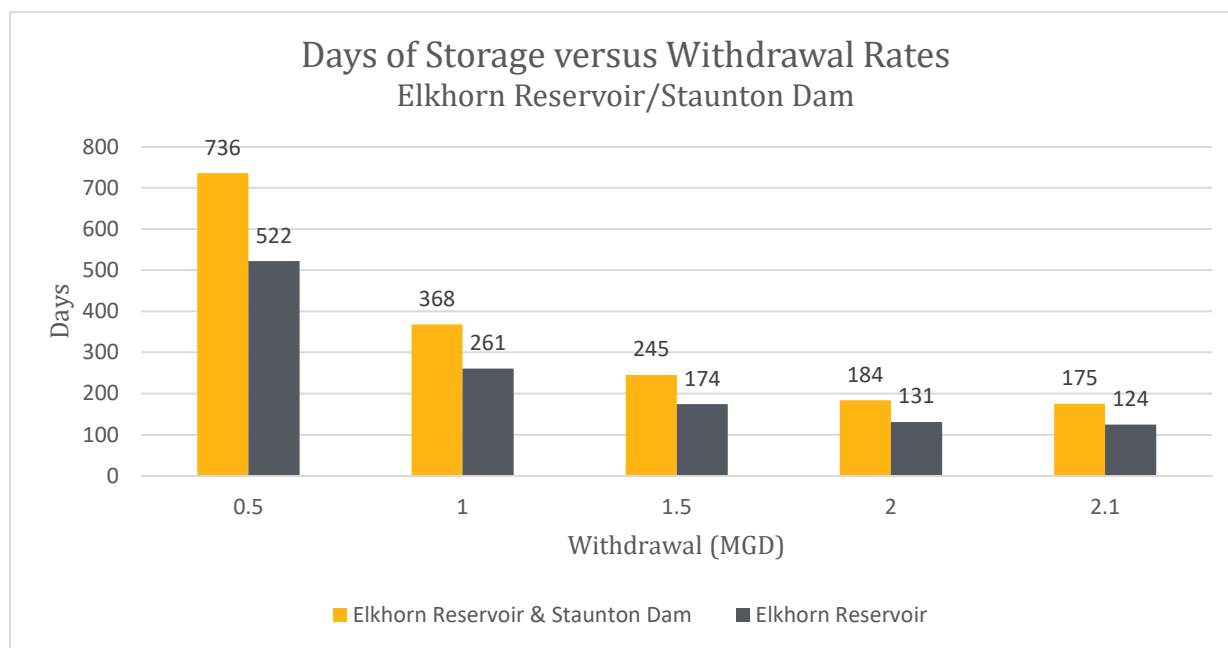


Figure 2.6: Days of Storage vs. Withdrawal Rates for the Elkhorn Reservoir/Staunton Dam System

Gardner Spring & Middle River System Capacity

The City's current water demands are adequately being met by Gardner Spring and the North River Reservoir system, with the Middle River functioning as a standby source. There are limitations to the concurrent use of Middle River and Gardner Spring due to the hydraulic conditions between the river and the pump station wet well. The normal water surface elevation (WSE) of Gardner Spring is higher than that in the Middle River by several feet. This prevents the WSE inside the pump station wet well from dropping to a level that would allow for gravity flow from the Middle River to the wet well. The Middle River intake is approximately located in the center of the river on the riverbed and is connected to the pump station wet well by a 24-inch pipe. Flow from Gardner Spring is conveyed through a 30-inch gravity pipe from the spring box to the Gardner Spring Pump Station wet well. In addition, the Gardner Spring water quality is more stable than Middle River, adding to the City's preference for using the spring.

The most recent safe yield on record for the Middle River is 10.1 MGD which was calculated by the Virginia State Water Control Board in 1985 using the 1Q30 method. However, Frank's Mill Dam was damaged in 1985. Therefore, it is assumed that the 1985 safe yield did not account for the possible impact of this event. In 2005, the Virginia Department of Health (VDH) updated the safe yield 1Q30 values for several stream intakes in the surrounding region, but not for the Middle River intake at the Gardner Spring Pump Station location. As part of this report, a new safe yield was calculated to be 2.62 MGD and is further discussed in Section 2.4 – Future Supply Options. The safe yield of Gardner Spring was assessed by EGGI to be 4.5 MGD (+/- 0.7 MGD) and is discussed further in Section 3.0 -



Gardner Spring Evaluation. The +/- 0.7 MGD associated with the Gardner Spring safe yield is due to seasonal and climatic fluctuations of the spring. However, for the purposes of this report, 4.5 MGD will be referenced as the safe yield for Gardner Spring. In a 2008 report, the Gardner Spring Pump Station capacity was determined to be 7.08 MGD based on a series of drawdown tests.⁴ Since the Gardner Spring safe yield is less than the Gardner Spring Pump Station infrastructure capacity, the system capacity is limited to 4.5 MGD.

Based on the capacity limitations of each supply, the City has a total raw water system capacity of 6.6 MGD, as shown below in Table 2.2.

Table 2.2: Total Raw Water System Capacity

RAW WATER SUPPLY	INFRASTRUCTURE CAPACITY (MGD)	SAFE YIELD OF WATER SUPPLY (MGD)	SYSTEM CAPACITY (MGD)
Gardner Spring/ Middle River	7.08 ^b	4.5/2.62 ^a	4.5
Elkhorn Reservoir/ Staunton Dam	2.1 ^c	2.4 ^d	2.1
TOTAL	9.18	9.52	6.6

- a. Safe yield as calculated by Wiley/Wilson, see Section 2.4 for further discussion.
- b. The full Gardner Spring Pump Station capacity was assigned to Gardner Spring's Infrastructure Capacity since the current system is not hydraulically capable of accepting simultaneous flows from Gardner Spring and the Middle River. In a 2008 report, the Gardner Spring Pump Station capacity was determined to be 7.08 MGD based on a series of drawdown tests.⁴
- c. The infrastructure capacity for the North River Reservoir water line was determined to be 2.1 MGD based on the historical withdrawal rates from the past ten years (including after the line was pigged).
- d. The safe yield of the Elkhorn Reservoir/Staunton Dam and the infrastructure capacity of the line was determined to be 2.4 MGD as part of the 2002 raw water system evaluation.³

2.3 PROJECTION AND DEMAND SUMMARY

The City of Staunton's most recent water demand projections can be found in the 2011 Upper Shenandoah River Basin Water Supply Plan (WSP). The WSP provides an overview of the City's water sources, average and maximum daily withdrawals, water usage, population, and future demand projections.

According to the WSP, the majority of the City's water in 2006 went to Residential use (62%), with the remaining use being Commercial (20%), Industrial (5%), and Lost and Unaccounted (13%). Table 2.3 summarizes the projected water demands in the WSP along with projected demands calculated as part of this report that extend to 2060. This table also accounts for economic development projections that were evaluated by the City in correspondence with the City's Economic Development department. The total projected water demand for 2060 was calculated to be 8.09 MGD. This demand is based on the following assumptions: a growing residential population would result in a 0.6% annual increase in water usage, ACSA will purchase the maximum contract allotment of 3.0 MGD from the City starting in year 2040, and the total 1.0 MGD economic development allotment will be in full use.

**Table 2.3: Projected Water Demand**

YEAR	CITY DEMAND (MGD)	ACSA DEMAND (MGD) ^b	ECONOMIC DEVELOPMENT (MGD) ^c	TOTAL WATER DEMAND (MGD)	2018 EXISTING SYSTEM CAPACITY (MGD)
2020	3.21	1.0	0.5	4.71	6.6
2030	3.42	2.0	0.5	5.92	
2040	3.64	3.0	1.0	7.64	
2050	3.86 ^a	3.0	1.0	7.86	
2060	4.09 ^a	3.0	1.0	8.09	

- City demand calculated by Wiley|Wilson using 0.6% growth rate (same rate as the 2011 Upper Shenandoah River Basin Water Supply Plan).
- Values are based on the existing City/ACSA contract. This agreement specifies that ACSA has the right to purchase an average annual of 1 MGD from the City with a maximum of 3 MGD.
- Values are an estimation of possible economic growth from the City of Staunton.

Table 2.3 reflects one projected water demand scenario based on ACSA sales assumptions. If ACSA only requires 1.0 MGD from the City for the next 40 years, then the City is projected to have adequate system capacity beyond year 2050. Similarly, if the ACSA contract is revised and the City is required to provide more than 3.0 MGD of water then the existing system capacity may be inadequate earlier than year 2040.

Based on these projections and the current raw water system capacity of 6.6 MGD, future need for the City can be broken down into short-, mid-, and long-term. Short-term projects should occur during the 2018-2028 timeframe and would focus on bolstering the reliability of the existing water supply and infrastructure. It is projected that additional water will be needed by year 2040. Therefore, mid-term supply options would fall between 2028 and 2040. Long-term supply options would be beyond the year 2040. Section 2.4 describes future supply options for the City and the corresponding project term.

2.4 FUTURE SUPPLY OPTIONS

In order to meet the City's projected water demands, it is recommended that the City begin exploring additional supply options. In addition, one of the primary concerns with the City's existing water supply system is its vulnerability if Gardner Springs were to be compromised and unusable. In order to reach 4.71 MGD (the total water demand for the year 2020, see Table 2.3) without Gardner Spring, the City's remaining systems (North River Reservoir and Middle River) would have to be operating at their full system capacities (2.1 MGD for North River Reservoir and potentially up to 2.62 MGD for Middle River). Therefore, it is recommended that an additional source be developed to provide redundancy in the event that Gardner Spring is temporarily or permanently rendered unusable.



Figure 2.7 shows an aerial map highlighting each of the future source options discussed in this section. A summary of the options, the respective project term, and the potential supply capacity can be found in Table 2.4. The existing raw water sources were also evaluated and are recommended for either continued use as is or with future improvements.

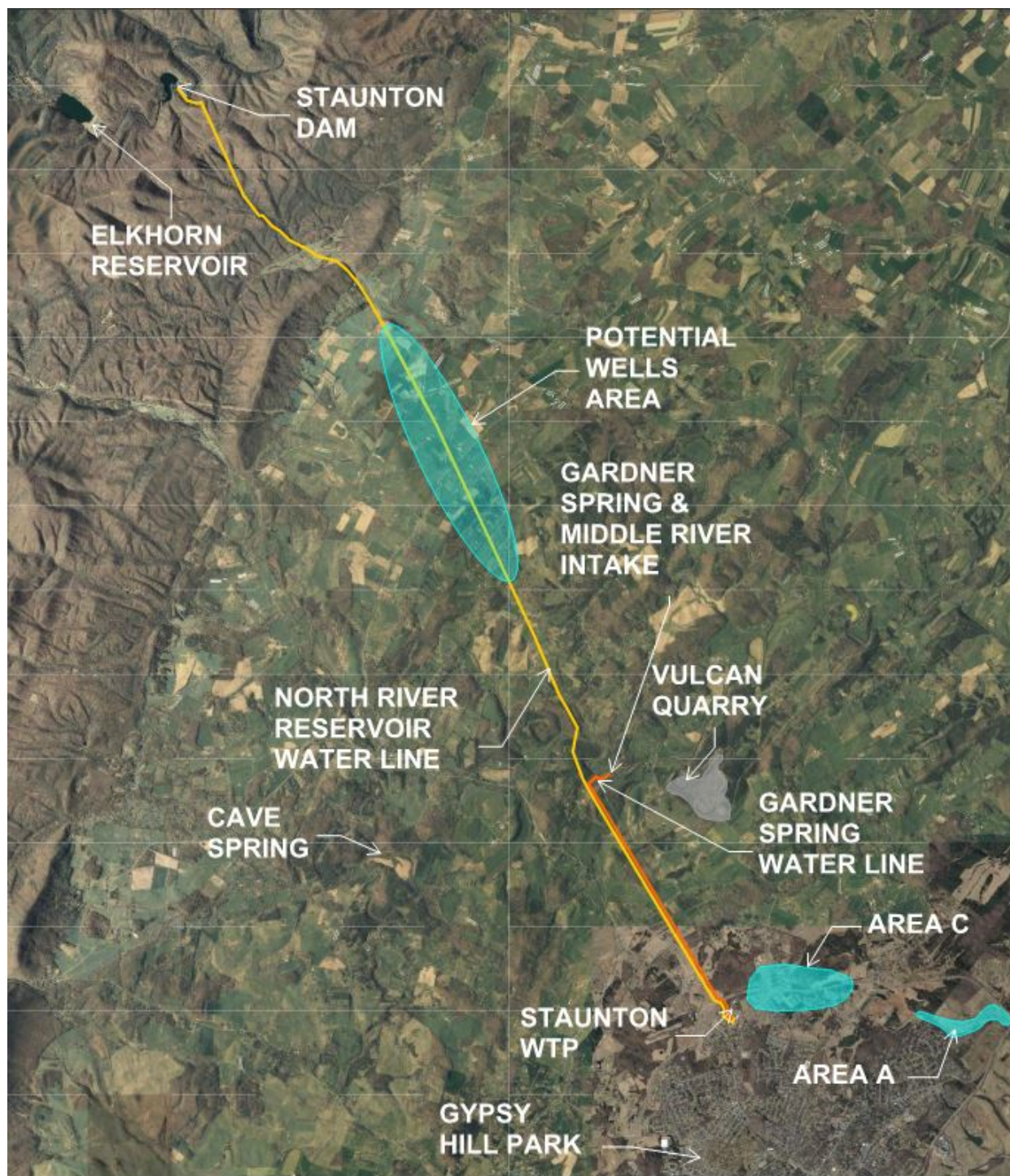


Figure 2.7: Future Supply Options Map (2015 VGIN Aerial)



Table 2.4: Future Supply Options based on Short-, Mid-, and Long-Term Use and Potential Flow

FUTURE SUPPLY OPTION	SHORT-TERM 2018-2025	MID-TERM 2025-2040	LONG-TERM 2040 <	POTENTIAL FLOW SUPPLY/STORAGE
Staunton Dam/ Elkhorn Reservoir (Existing)	X	X	X	2.40 MGD ^a
Gardner Spring (Existing)	X	X	X	4.5 MGD ^b
Groundwater wells near existing water lines		X	X	To be determined
Middle River		X	X	2.62 MGD ^c
Cave Spring			X	1.0 MGD ^b
Raw Water Storage (Vulcan Granite Quarry)			X	Unknown
Gypsy Hill Park Springs		X	X	To be determined
Gypsy Hill Park Groundwater Well		X	X	To be determined
Groundwater wells in Areas A & C ^d		X	X	To be determined

a. Based on safe yield simulation completed by Wiley|Wilson in 2002.

b. Based on EGGI report.

c. Based on 1Q30 calculation performed by Wiley|Wilson and possible withdrawal requirements by DEQ. Achieving 2.62 MGD would require wet well and intake modifications at the Gardner Spring Pump Station.

d. Based on 1994 EGGI Phase I Hydrogeologic Report.



Staunton Dam/Elkhorn Reservoir

The Staunton Dam/Elkhorn Reservoir interconnected system, also referred to as the North River Reservoir system, should remain as one of the City's supply sources for the future. The impoundments provide raw water storage which benefit the City during droughts and have been a reliable water source for the City since the 1920s. System upgrades, such as increasing the transmission line size or dredging out sediment from the impoundments to increase storage volume, could be evaluated as a means to obtain additional capacity. Based on the alternatives for upgrading the transmission line discussed herein, the City may choose to rehabilitate or replace sections of the transmission line to increase reliability and infrastructure capacity. At this time, the Staunton Dam/Elkhorn Reservoir has a safe yield of 2.40 MGD. However, the infrastructure capacity is less due to the age and corrosion within the water line.

Gardner Spring

Gardner Spring has proven to be a reliable and high-quality water source for the City since 1949, and it should continue to be utilized. Part of this report includes alternatives for upgrading the existing Gardner Spring Pump Station to increase system reliability. Based on EGGI's 2018 study, the Gardner Spring has a safe yield of 4.5 MGD.



Figure 2.8: Gardner Spring Box adjacent to the Middle River

In 1930, land owners of Gardner Spring signed a lease agreement with the City of Staunton, allowing the City access and use of the spring for six months (City Deed Book 247, Page 434). The intent of this temporary water supply was to help the City during a severe drought. In 1935, the land owners of Gardner Spring transferred 27 acres of land to the City (Deed Book 270, Page 96). While a description of the property boundary can be found in the deed, there is no sketch or plat of the land. However, there is a plat associated with the deed of exchange that involved the City of Staunton bestowing 13.26 acres of land to others (Deed Book 283, Page 334). This plat, dated May 29, 1936, shows the City of Staunton



owning the property that contains Gardner Spring along the Middle River as indicated by the label, “spring” (see Appendix A).

Groundwater Wells near Existing Water Lines

The City is considering well exploration along the North River Reservoir raw water line route. The goal of those efforts will be to locate ground water wells that can be connected into the existing system. Wells are preferred to be within 8,000 to 10,000 feet of the North River Reservoir /Gardner Spring water line in order to be cost effective and special consideration should be given to electricity and site access potential. Exploration will be outside the recharge area for Gardner Spring and on properties where the City has existing agreements with land owners.

Additional options include Area A-Poague Run and Area C-Shutterlee Mill outlined in the 1994 EGGI Phase I Hydrogeologic Report.

Middle River

The Middle River is currently a standby source at the Gardner Spring Pump Station due to hydraulic limitations. The safe yield at the intake location was calculated to determine the approximate magnitude of the river’s potential supply. DEQ currently accepts the 1Q30 for safe yield determination of a surface water. The 1Q30 is the one-day low flow for a 30-year recurrence interval. This was determined for the City’s Middle River intake by VDH in 1985 to be 10.1 MGD prior to storm damage and subsequent removal of Frank’s Mill Dam.⁶ To obtain the current safe yield of the Middle River at the existing intake location, the Log-Pearson Type III Distribution method was used to calculate the 1Q30. The gage data used in these calculations was from a USGS gage near Grottoes, Virginia (Gage No. 01625000), approximately 14 miles downstream of the Middle River intake. Data from 1929 to 2017 was analyzed to determine the 1Q30 at the gage location, which was then converted to a 1Q30 for the Middle River intake location using a ratio of the drainage areas (see equation below). The 1Q30 for the Grottoes gage was determined to be 75.7 MGD, and the drainage area of 373 square miles was included in the gage description on the USGS website. The drainage area of the Middle River intake, 129 square miles, was generated by the USGS StreamStats online tool. The analysis resulted in a calculated 1Q30 of 26.2 MGD at the Middle River intake.

$$Q_{intake} = Q_{gage} \frac{A_{intake}}{A_{gage}}$$
$$Q_{intake} = 75.7 \text{ MGD} \frac{129 \text{ sq miles}}{373 \text{ sq miles}}$$
$$Q_{intake} = 26.2 \text{ MGD}$$

Although this flow is higher than the 1985 1Q30, it is predicted that the Department of Environmental Quality (DEQ) would likely place a 10% instantaneous flow requirement on the Middle River intake, which would limit the safe yield supply of the Middle River to approximately 2.62 MGD. In order to withdraw 2.62 MGD from the Middle River, the



existing Gardner Spring Pump Station wet well may require modifications to effectively collect the flow, and a new intake would be required to comply with current regulations. These modifications would require permitting from DEQ, Virginia Marine Resources Commission, and the Army Corps of Engineers. The actual safe yield of Middle River at the intake location will be determined by DEQ if the City decides to proceed with a new intake and permitting requirements.



Figure 2.9: Middle River near Existing Intake

Cave Spring

Cave Spring is located northwest of the Middle River and Green Hill Lane (Route 836). The City has owned the 6.38-acre parcel that contains the spring since 1955. This parcel is surrounded by properties used primarily for agricultural purposes owned by James M. Knopp and J. Philip Knopp. The City purchased the land in the interest of using the spring as raw water supply. However, the City did not further develop this source and no infrastructure for source development is present on the property. The safe yield of Cave Spring is currently unknown. Both a safe yield study and feasibility study are recommended before this source is further considered for mid-term or long-term future supply. EGGI has conducted a preliminary evaluation of the spring and determined its potential yield to be approximately 1.0 MGD. Cave Spring is approximately 2.5 miles as a straight line distance, or 3.3 miles via road route, from the existing Gardner Spring and North River Reservoir water lines. See Figure 2.10 for a water line routing option to connect Cave Spring to one of the existing water lines.

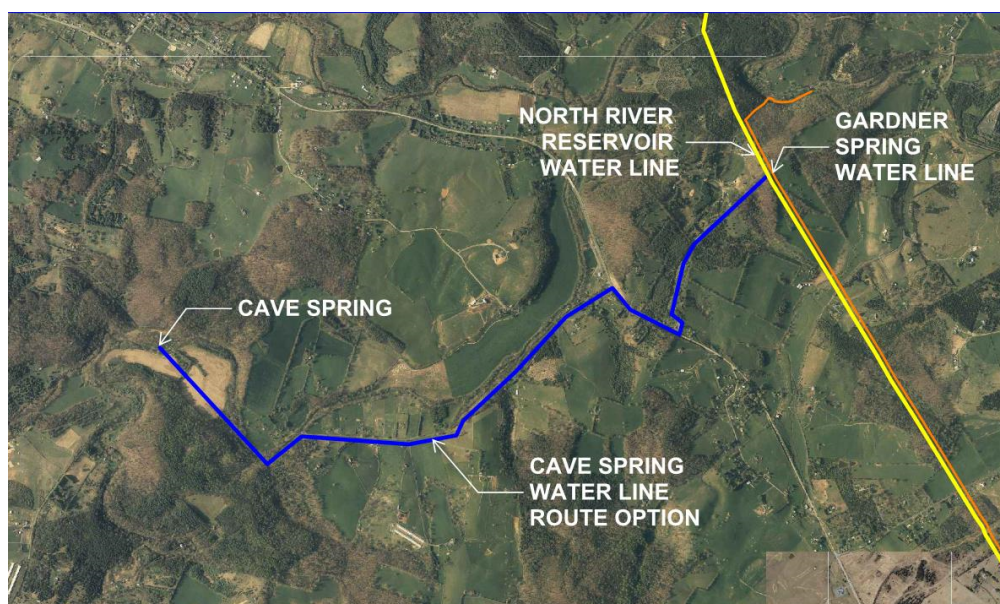


Figure 2.10: Cave Spring Water Line Route Option

Granite Quarry: Raw Water Storage

Using a granite quarry, once abandoned, for raw water storage is another long-term option for the City. This 100-acre site shown in Figure 2.11 is located approximately 1.5 miles from the Gardner Spring Pump Station along Luckstone Road (Route 728) and is currently mined by Vulcan Materials Company. This option is not currently recommended for long-term consideration because of its potential water quality concerns and its continued use by Vulcan. Once the quarry is no longer being mined, the City can initiate hydrogeologic studies and negotiate purchasing the property from Vulcan. Figure 2.11 shows an aerial map with the location of the Vulcan quarry in relation to the Gardner Spring Pump Station. To utilize the quarry as an off-stream storage reservoir, raw water would be pumped from the Middle River.



Figure 2.11: Vulcan Granite Quarry Proximity to Existing City Infrastructure



Gypsy Hill Park Springs

Gypsy Hill Park is located within the western area of the City adjacent to Route 250. There are several springs located within the park that provided the City with raw water in the late 1800s and early 1900s. Historic flows from 1923 indicate seasonal fluctuations ranging from 670 gpm (0.96 MGD) in the spring season to 450 gpm (0.65 MGD) in the fall. Based on EGGI's 1994 Phase I Hydrogeologic Report, the springs at Gypsy Hill Park are capable of yielding 0.50 to 0.65 MGD of flow.⁷ There are two options for future use of the park springs. One option would involve connecting the springs to a central 8-inch gravity line that flows to a pump station on the park grounds (see Figures 2.12 and 2.13). From there water would be pumped to the City WTP through a 10-inch force main. A detailed feasibility study and groundwater analysis would be required prior to the springs being considered as a mid-term or long-term option.



Figure 2.12: Option 1 – Gypsy Hill Park Springs

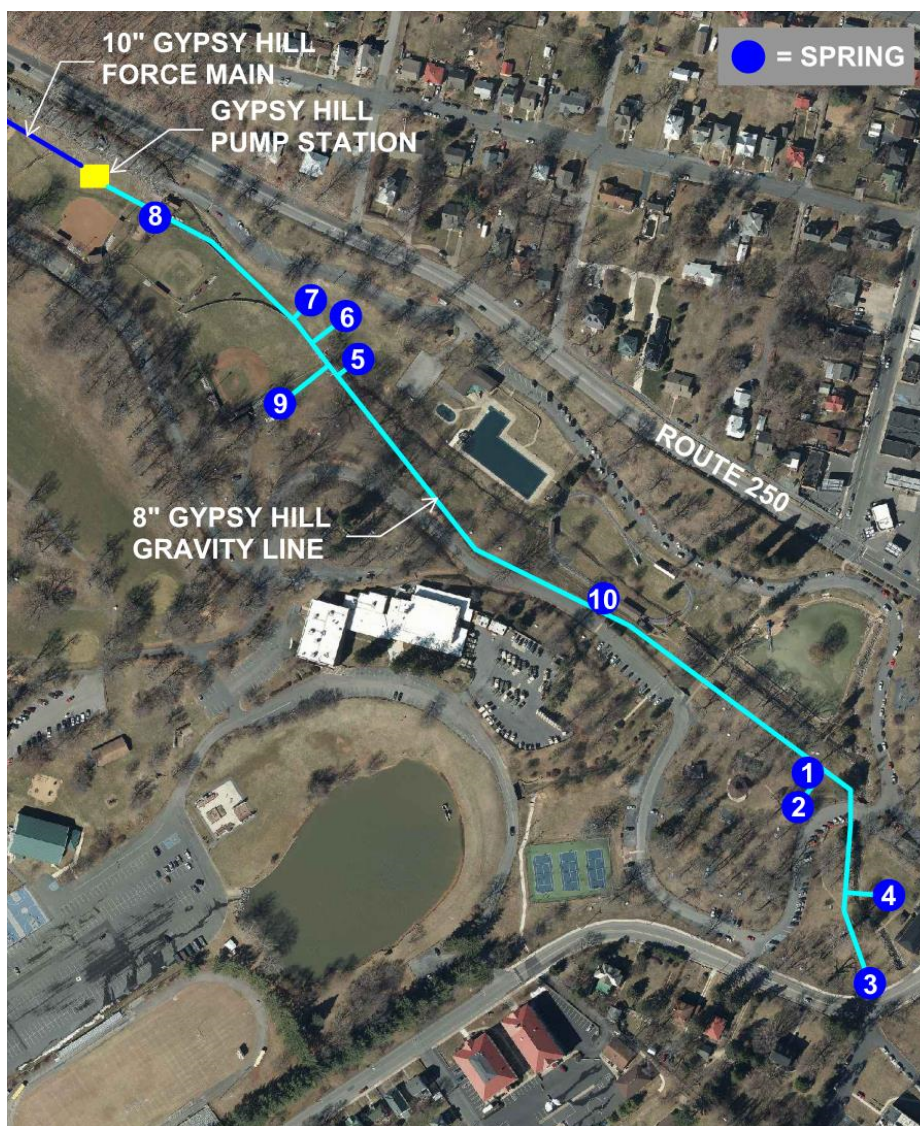


Figure 2.13: Option 1 – Gypsy Hill Park Springs Connection

A second option would be to develop a groundwater well in Gypsy Hill Park and pump raw water to the Staunton WTP following a route similar to that shown above in Figure 2.12. These two options would be further developed as part of the Gypsy Hill springs evaluation.



3.0 GARDNER SPRING EVALUATION

Emery & Garrett Groundwater Investigations (EGGI) completed a study to determine the safe yield of Gardner Spring and identify a recommended groundwater protection zone, or Source Water Protection Area (SWPA). The study involved the following scope:

- Inventory of existing wells
- Bedrock mapping and inventory of sinkholes and springs
- Observation of surface water flow
- Water chemistry monitoring
- Ambient groundwater monitoring and withdrawal testing of Gardner Spring
- Production of a water table map and delineation of a SWPA
- Sanitary survey

The EGGI study estimated the long term annual average safe yield of Gardner Spring to be 4.5 MGD (+/- 0.7 MGD). During long periods of drought, this safe yield may be diminished; however, historic pumping records indicate that even during the 2001-2002 drought, a minimum of 2 MGD was available from Gardner Spring.

From the preliminary study results, EGGI identified a 16.8-square mile area as a SWPA. This area represents the estimated recharge contribution area for the spring and should not be considered for well development. A 5-square mile subset was also identified as “most critical” for groundwater protection of the spring. The detailed report from EGGI dated January 2018 has been provided to the City as a separate document.

EGGI Report Summary

The following recommendations are summarized from the EGGI study report:

1. The City should develop a Drought Monitoring Plan to determine groundwater behavior during a drought.
2. The City should explore developing wells along the North River Reservoir water line that can be connected to the existing water line. These wells should be outside of the Gardner Spring SWPA.
3. The City should prepare a SWPA plan to educate land owners within the spring SWPA of its significance to the City’s raw water supply. The plan would also include a suggested list of activities to avoid in order to better protect the spring from contamination.
4. The City should consider replacing the existing Gardner Spring box weir.



4.0 REGULATORY STATUS OF EXISTING SUPPLY

The development of the City's current water supply sources date back to 1926 for the North River Reservoir, the 1940s for Gardner Spring/Middle River, and 1965 for the Elkhorn Reservoir. The development of these water sources predates the current Department of Environmental Quality (DEQ) permitting requirements, the Virginia Water Protection (VWP) permit. The VWP program is focused on ensuring that a water withdrawal does not adversely impact instream or off-stream existing beneficial uses. It also provides some protection from other water users and creates a record that DEQ will utilize in future permitting activities to protect that withdrawal.

Since the City's water sources predate the DEQ program, there are no current VWP permits for Gardner Spring, Middle River, or the North River Reservoir systems. Therefore, the sources fall under the "grandfathering" concept. Withdrawals that were in place prior to July 1, 1989 are considered exempt or "grandfathered" from the DEQ VWP permitting program. In 2007, DEQ began requiring withdrawals from grandfathered sources to be documented along with the capacity of the intake as of July 1, 1989. Currently, the City provides an annual report to DEQ of the actual water withdrawals from each source. Even though Gardner Spring is a spring, it is still considered a surface water withdrawal by DEQ. The annual withdrawals submitted by the City may be used in the future to establish the permitted withdrawals, if permitting under the current program is triggered. In addition, the capacity of existing intakes may be used to determine the permitted withdrawals.

Under the current Commonwealth of Virginia Regulations, the City will retain the grandfathering status. The only item that may trigger the permitting process under the current regulations would be the requirement for a 401/404 Certification from the U.S. Army Corp of Engineers. The 401/404 Certification process would be required if there were repairs or modifications to the existing intakes, impacts to waterways, or increases in capacity/withdrawals to existing facilities. If a 401/404 Certification is required, DEQ could review all of the City's water sources collectively to determine the overall water supply need of the City. This could have a negative impact on the total permitted withdrawal from all the existing sources. In addition, the VWP process is a public process. There is the potential for comments or challenges that could impact the permitted withdrawals. Once a VWP permit is granted, it is only valid for 15 years and will be re-evaluated by DEQ to address the City's water supply needs when the permit is renewed.

If the City desires to maintain the "grandfathering" status, any proposed improvement or project should be evaluated to determine if a 401/404 Certification is required and how it could impact the current withdrawal rates.



The following actions would require new permitting that would impact the City's current "grandfather" status:

- Middle River Intake Improvements
- Improvmenets/modifications to Spring Box
- Cave Spring Development as a New Source

The following additional actions may potentially impact the City's current "grandfather" status:

- Groundwater Well Development along North River Reservoir Water Line, and Areas A and C outlined in the 1994 EGGI Phase I Hydrogeologic Report
- Gypsy Hill Park Springs Development
- Gypsy Hill Park Groundwater Well Development

If/when the City is contemplating a project that will require a 401/404 Certification, the City should begin a conversation with DEQ to develop an overall water supply strategy that will meet DEQ's requirements and minimizes the impact to the City's existing water sources. This report provides the basis for developing the overall water supply strategy.



5.0 GARDNER SPRING PUMP STATION

5.1 PUMP STATION DESCRIPTION

Property Description

The Gardner Spring Pump Station is located approximately 2.5 miles east of Churchville, Virginia, and bounded by approximately 200 linear feet of the Middle River (to the south) and Hundley Distillery Road (Route 728, to the north). As part of this report, the parcel was surveyed by EGS & Associates, Inc. to confirm the property boundary and right-of-way of the adjacent Domion Energy power transmission lines. The site is 0.743 acres and is bounded to the east and west by private land owners. The City has a 30-foot easement for the Gardner Spring intake line on the adjacent property east of the pump station site. The parcel across the Middle River is owned by the City of Staunton. The Gardner Spring Pump Station was originally built in 1949 and was upgraded in 1950, 1951, and also in 1974 when the Middle River intake and second wet well were added. The Middle River intake was upgraded in 1988 in order to increase withdrawals from the river. See Figure 5.1 for the Gardner Spring Pump Station property parcel map.



Figure 5.1: Gardner Spring Pump Station Parcel Map

Flood Concerns

In 1985 and 1996, the City pump building was flooded with water up to approximate elevations 1361.5' and 1364', respectively. The pumps were unusable during both of these events. Figure 5.2 shows the approximate water level in relation to the pump building and other equipment. Table 5.1 summarizes flood elevations at the pump station. According to the FEMA Flood Insurance Rate Map (Map Number 51015C0330D), the Gardner Spring Pump Station site is located within the 100-year floodplain of the Middle River at approximate elevation 1360' (see Figure 5.3). The observed flood events, which are above the 100-year floodplain, raised concerns regarding the reliability of the pump station.

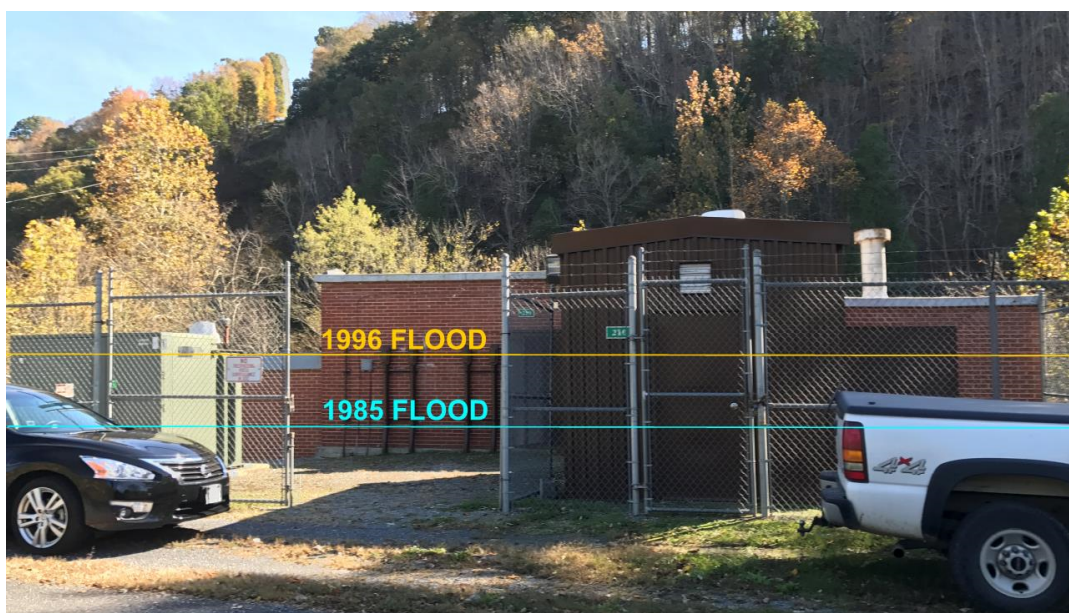


Figure 5.2: Existing Gardner Spring Pump Station with Approximate Flood Elevations

Table 5.1: Key Elevations for Gardner Spring Pump Station Property

DESCRIPTION	ELEVATION
100-Year Flood Zone	1360'
1985 Observed Flood	1361.5'
1996 Observed Flood	1364'

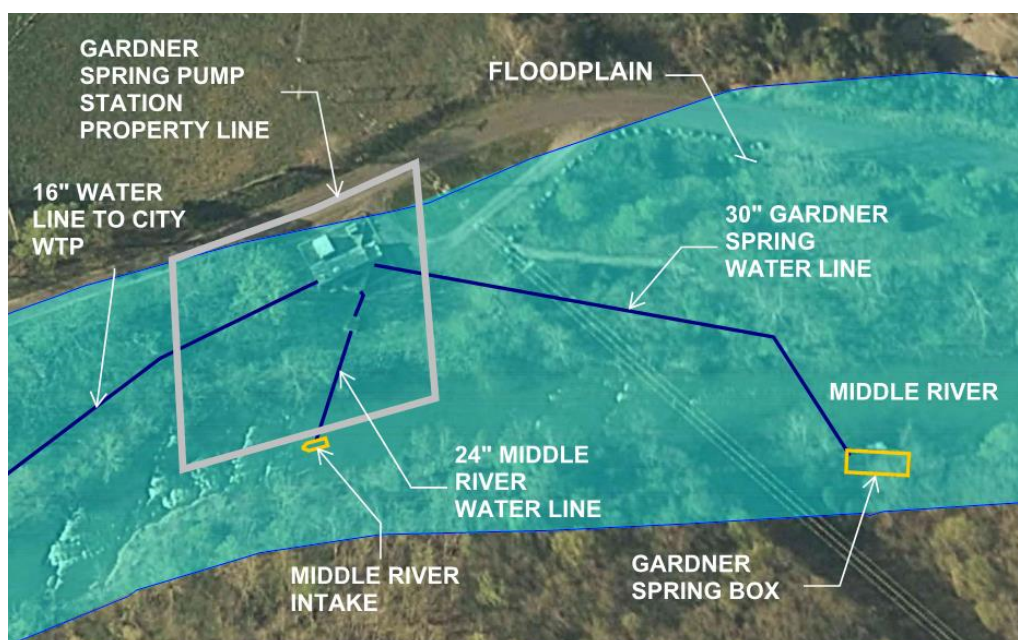


Figure 5.3: Existing Site Plan of Gardner Spring Pump Station (2015 VGIN Aerial)



Pump Station Equipment

The Gardner Spring Pump Station site includes the Middle River intake structure, Middle River and Gardner Spring intake lines, concrete valve vault, two wet wells, pump building, motor control center building, and transformer. There is a gravel driveway to the pump station from Hundley Distillery Road for site access. All buildings and equipment are enclosed in a chain-link fence with the exception of the west side of the pump building. The west side does not provide access into the building or to equipment.



Figure 5.4: Existing Gardner Spring Pump Station Site

The pump building currently houses four 8-stage, 10-inch vertical turbine pumps. The motors for these pumps were rebuilt between 2005 and 2012. See Table 5.2 and Figure 5.5 for existing pump information and site photos.

Table 5.2: Existing Gardner Spring Pump Station Pump Information

PARAMETER	DETAIL
Number of Pumps	4 (3 operating, 1 spare)
Model	Worthington Pump Corporation 14M135
Rated Capacity per Pump	2.02 MGD
Head Capacity	713 feet
Motor Size	350 HP; 3-Phase, 1775 RPM



Figure 5.5: Existing Vertical Turbine Pumps and Discharge Piping

Gardner Spring Box

The Gardner Spring box is located approximately 400 feet downstream from the Gardner Spring Pump Station on the south (opposite) riverbank. The concrete spring box has control boards and an overflow weir which allows water to flow into the Middle River. Water from the spring is conveyed by gravity through a 30-inch concrete pipe into the original wet well below the pumps. The Middle River intake structure rests on the riverbed approximately 100 feet upstream of the Gardner Spring Pump Station. The 1988 intake upgrades added a side entry for raw water and sealed the top of the structure with a concrete cap. A 24-inch cast iron pipe extends from the intake structure into the second wet well that was built as part of the 1974 upgrades. The second wet well has five (5) 16-inch gate valves connecting into the original wet well. Both raw water intake lines enter either the original or second wet well at the same invert elevation of 1355.5' according to the 1978 record drawings of the Gardner Spring Pump Station.

Middle River Intake

The Middle River intake is normally closed because the water surface elevation at the river is lower than the hydraulic gradient of Gardner Spring. Wiley|Wilson conducted a survey of the Gardner Spring Pump Station site between October 11 and 13, 2016. On those dates, the water surface elevations (WSEs) of the Gardner Spring and Middle River were 1343.73' and 1340.90', respectively. This is an elevation difference of over 2.5 feet. With the pump station operating at a normal wet well level of 1343.3' (according to the 1978 revised record drawings of the Gardner Spring Pump Station) it is not possible for withdrawals from the river to enter the wet well unless the WSE of Gardner Spring, and subsequently the wet well, fall below the Middle River WSE. To ensure efficient use of the Middle River, modifications to the wet well design are recommended as part of Alternative 2 discussed below. See Figure 5.6 below for a graphic of the existing elevation differences between the structures and WSEs at the Gardner Spring Pump Station site.

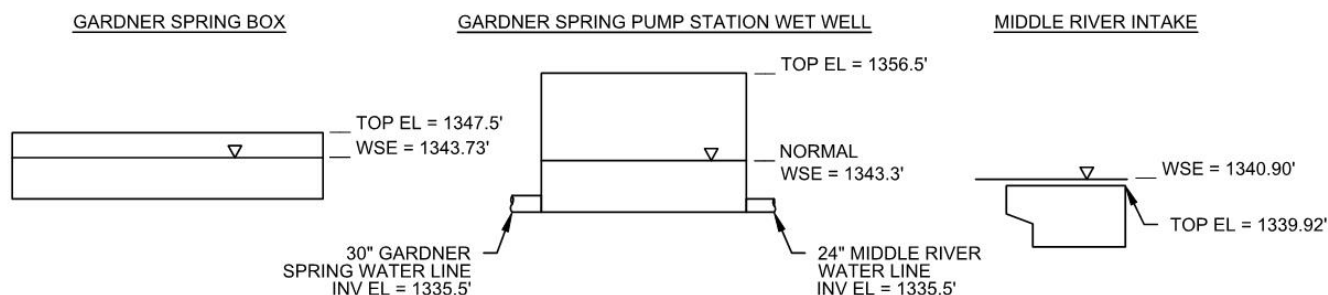


Figure 5.6: Elevations of Existing Structures and WSEs at Gardner Spring Pump Station

Based on the existing conditions and reliability concerns at the Gardner Spring Pump Station site, the City has outlined the following four goals for the Gardner Spring Pump Station upgrade alternatives:

1. Increased Reliability
2. Standby Power
3. Efficiency of Operations and Maintenance
4. Flood Proof – All equipment located two feet above the 1996 observed flood elevation.

5.2 PUMP STATION ALTERNATIVES

The main concerns with the existing Gardner Spring Pump Station are the Middle River 100-year floodplain (elevation 1360'), the age of the existing pumps, the lack of standby power, and the inability to effectively utilize the Middle River source if Gardner Spring were compromised. Two Gardner Spring Pump Station improvement alternatives were developed to eliminate or minimize these concerns in addition to meeting the City's goals listed above in Section 5.1. Alternative 1 would retrofit the existing pump station and Alternative 2 would construct a new pump station and wet well adjacent to the existing Gardner Spring Pump Station. The finished floor elevation in either alternative will be at or above 1366' so that all equipment is two feet above the observed 1996 flood elevation. In addition, both alternatives would include the following equipment:

- Multi-stage vertical turbine pumps with variable frequency drive (VFD) controllers
- Diesel-fueled generator for standby power (meeting Tier 4 emissions standards)
- Electrical room or building serving as the Motor Control Center (MCC)
- Diesel tank
- Pad mounted utility-owned transformer



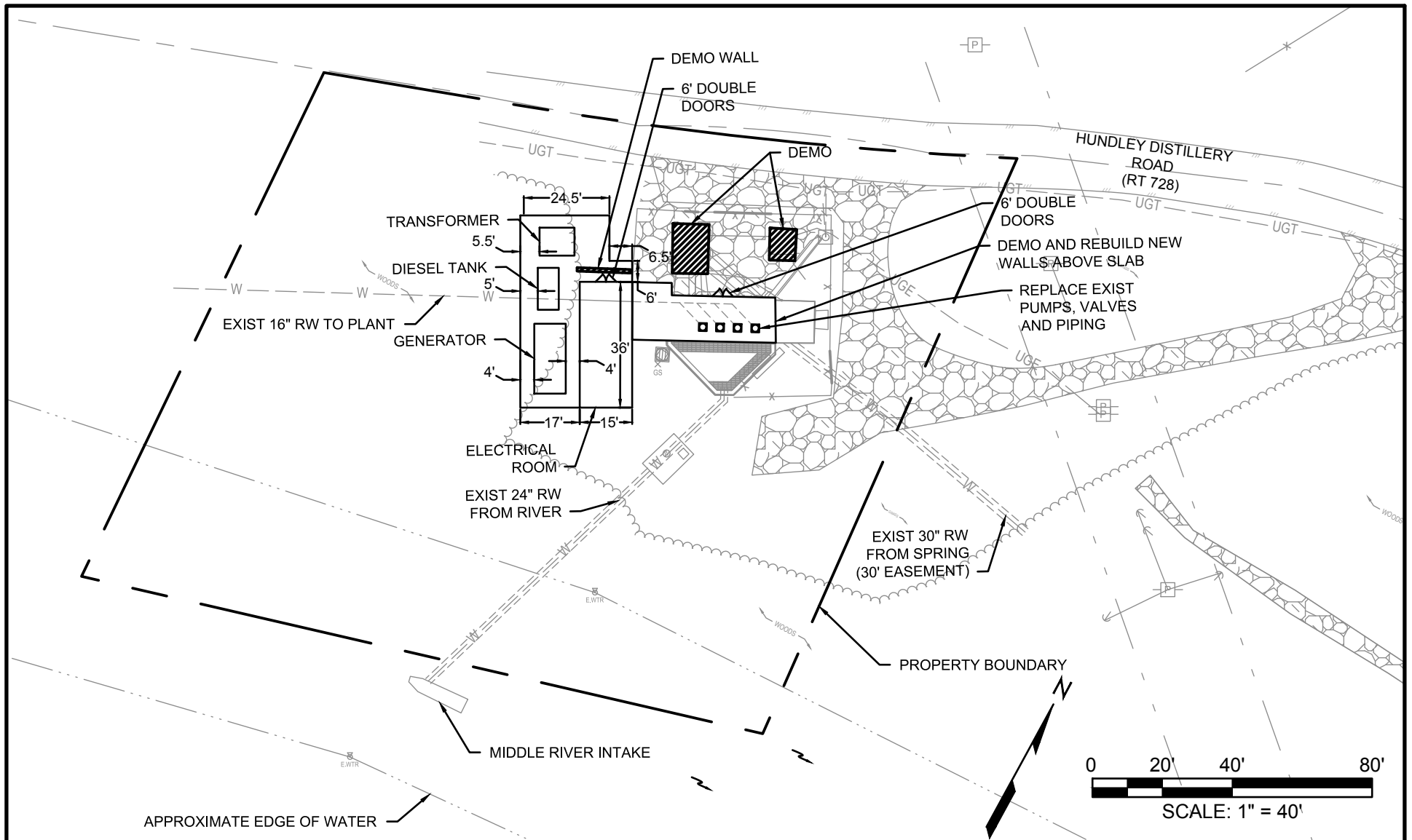
Both alternatives would also involve deep excavation into possible bedrock. Froehling & Robertson, Inc. completed a preliminary geotechnical investigation at the Gardner Spring Pump Station site (see Appendix E). The investigation included two test borings conducted on February 19, 2018. The borings found evidence of rock 6 to 7 feet below the ground surface. These findings were used to calculate excavation depths for each alternative and were factored into the Opinions of Probable Project Cost.

Alternative 1: Retrofit Existing Pump Station

This alternative would include major modifications to the existing pump station, while continuing to use some of the existing infrastructure, such as the raw water intakes and piping, wet well, and sections of the pump building. The conceptual design includes the following new equipment: pumps, pump motors, valves, electrical room (MCC), generator, diesel tank, and transformer. Modifications would be evaluated to allow use of the Middle River and Gardner Spring sources simultaneously. The hydraulics would be evaluated during design to determine the feasibility of the required wet well modifications. To ensure the pump motors are above the floodplain, the first floor elevation would be raised to 1366' with a new roof and walls to enclose the new equipment. An electrical room to house the MCC would be constructed adjacent to the west side of the existing pump building. A 1,000-kilowatt generator, 3,500-gallon diesel tank, and transformer would also be located to the west of the existing building on an elevated platform and walkway. The diesel tank would be able to provide approximately two days of fuel for the generator. See sketches CSK-01 and CSK-01A on the following pages for the Alternative 1 proposed site layout and section view.

Pump Options

Alternative 1 would replace the existing pumps with four new vertical turbine pumps – three pumps for normal operation and one as a spare. This alternative also includes one spare bay for a future pump to allow for expansion. This matches the existing pump station configuration with a total of five pump bays. Each pump would be rated for 2.0 MGD capacity. See Table 5.3 for additional pump details. Figure 5.7 shows the system curve for the design as well as pump curves for when one to four pumps are running. The final pump selection will be made during the detailed design phase.



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PROJECT

CITY OF STAUNTON GARDNER SPRING PUMP STATION

TITLE

ALTERNATIVE 1 - RENOVATE
EXIST PUMP STATION

COMM. NO.

216183

DRAWN

CES

CHECKED

AST

SKETCH NO.

CSK-01

DWG. REFERENCE NO.

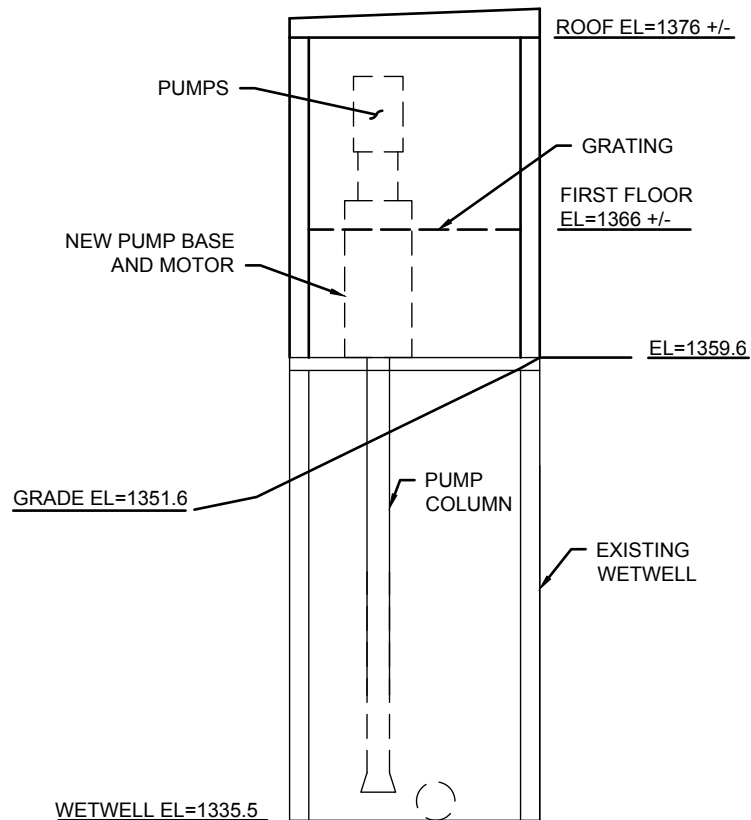
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03/22/2017

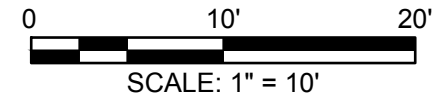
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NOTE:
GENERATOR, TRANSFORMER, ELECTRICAL ROOM,
AND DIESEL FUEL TANK NOT SHOWN, BUT WILL ALSO
BE ABOVE THE FLOODPLAIN AT ELEVATION 1366' +/-.

GARDNER SPRING NORMAL WSE EL = 1343'
MIDDLE RIVER NORMAL WSE EL = 1340'



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PROJECT **CITY OF STAUNTON**
GARDNER SPRING PUMP STATION

TITLE **ALTERNATIVE 1 - SECTION**

COMM. NO.
216183

DRAWN
CES

CHECKED
AST

SKETCH NO.
CSK-01A

DWG. REFERENCE NO.
216183A16CSK01A.DWG

DATE:
03/22/2017

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Table 5.3: Pump Information for Alternatives 1 & 2

PARAMETER	PUMP INFORMATION
No. of Pumps	4 (3 operating, 1 spare)
Stages	5
Model	Pentair 14_TURB_2130_1800_SS Rev 170804
Rated Capacity per Pump	2.00 MGD
Discharge Line Size	10 in
Impeller Diameter	9.67 in
Motor Size	250 HP; 60 Hz, 1785 RPM
Motor Efficiency	80.82%
TDH at 6 MGD	460 ft

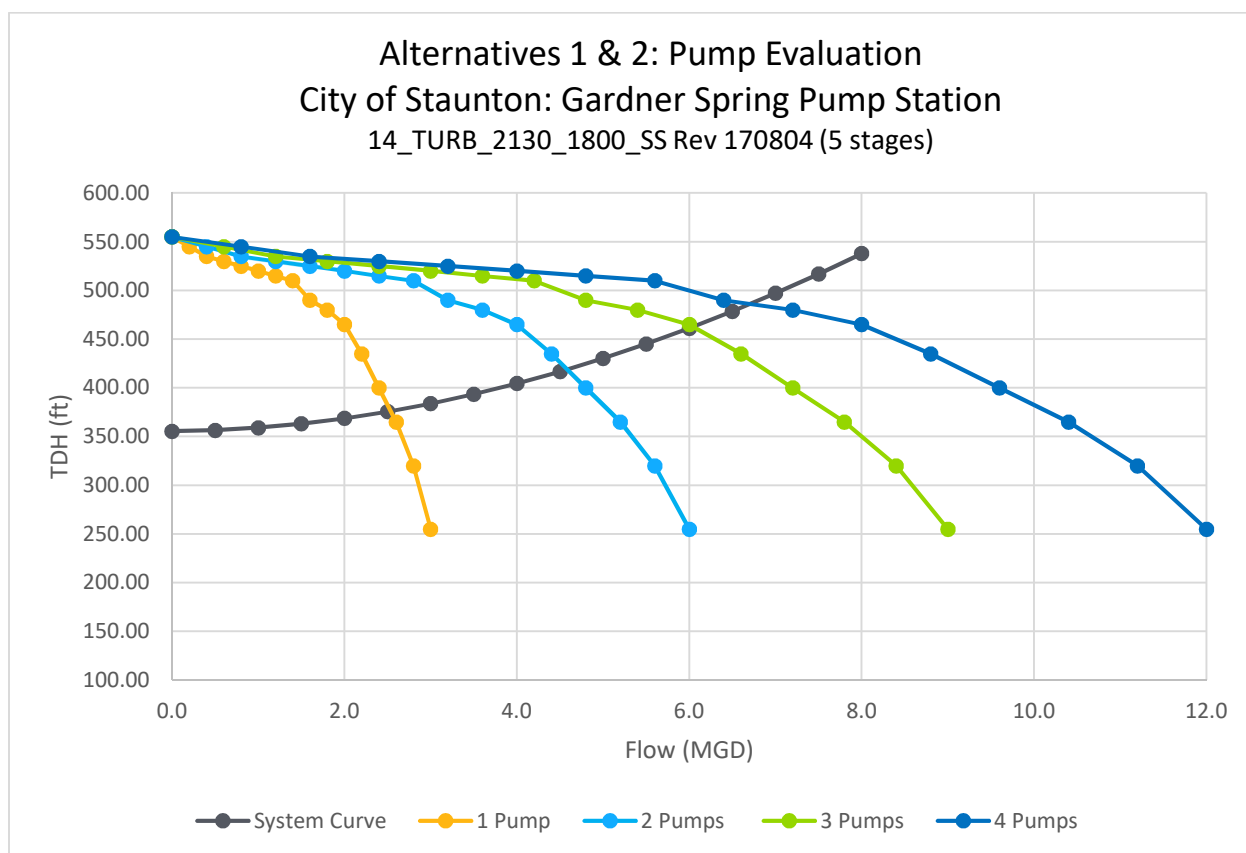


Figure 5.7: Pump Curve for Alternatives 1 & 2



Sequence of Construction

A sample sequence of construction for Alternative 1 is described below. This sequence of construction will be further developed during detailed design.

1. Build supporting structure on the west side of the existing Gardner Spring Pump Station for the new electrical room, generator, transformer, and diesel tank.
2. Build/install new electrical room, generator, transformer, and diesel tank.
3. Provide temporary supports for power feed for Pumps 1 and 2 located on the east side of the existing Gardner Spring Pump Station.
4. Demolish the roof and roof supports of the existing Gardner Spring Pump Station and provide temporary weather protection for the east side of the Gardner Spring Pump Station.
5. Temporarily relocate SCADA/communications panel, or install a temporary panel for Pumps 1 and 2.
6. Demolish the west side of the Gardner Spring Pump Station walls and electrical gear to Pumps 3 and 4. Demolish diesel pump room brick and block walls down to the concrete walls. Fill this space with gravel and pour a new concrete floor to match the existing base.
7. Build a new concrete wall up from 1359.6' to elevation 1366' on the west side of the existing Gardner Spring Pump Station.
8. Modify exterior wet well for simultaneous withdraw from Middle River & Gardner Spring. Raise concrete wall of exterior wet well by 7 feet.
9. Replace Pumps 3 and 4, including the installation of new pump bases.
10. Build new reinforced block and brick walls up from 1366' on the west side to approximately 1376'. Install new disconnects for Pumps 1 through 4 in the new room which is above the existing diesel pump room. (The existing disconnects located in front of the pumps do not appear to meet the 42-inch spacing code requirement.)
11. Provide a temporary roof over the west side of the new building.
12. Test and start-up Pumps 3 and 4, and put new electrical service online.
13. Take old electrical service for Pumps 1 and 2 offline.
14. Demolish Pumps 1 and 2. Demolish east side wall of the existing Gardner Spring Pump Station.
15. Demolish existing electrical building.
16. Build a new concrete wall up from 1359.6' to 1366' on the east side of the existing Gardner Spring Pump Station.
17. Replace Pumps 1 and 2, including the installation of new pump bases.
18. Build new reinforced block wall up from 1366' to approximately 1376' on the east side of the Gardner Spring Pump Station.



19. Install elevated grating floor at 1366' inside the Gardner Spring Pump Station.
20. Test and start-up Pumps 1 and 2.
21. Install permanent roof for the whole Gardner Spring Pump Station.

Alternative 2: New Adjacent Pump Station

Alternative 2 includes a new pump station constructed on the west side of the existing pump building. The electrical room would be adjoined to the pump building on the northwest side and accessible directly from the pump building or from the outside. The transformer would be constructed to the northwest of the electrical room on an elevated platform and walkway. The 1,000-kilowatt generator and 3,500-gallon diesel tank would be installed on an elevated platform above the existing pump building. The diesel tank would be able to provide approximately two days of fuel for the generator. The two intake lines from Gardner Spring and the Middle River would be rerouted into the new pump station wet well. The new wet well would be designed to allow use of both the Middle River and Gardner Spring sources simultaneously. The hydraulics would need to be evaluated during design to determine the wet well configuration. See sketches CSK-02 and CSK-02A on the following pages for the Alternative 2 proposed site layout and section view.

Pump Options

The new pump building would include five (5) pump bays with one pump bay left open for future use. Each pump would be rated for 2.0 MGD capacity. See Table 5.3 for additional pump details. Figure 5.7 shows the system curve for the design as well as pump curves for when one to four pumps are running. The final pump selection will be made during the detailed design phase.

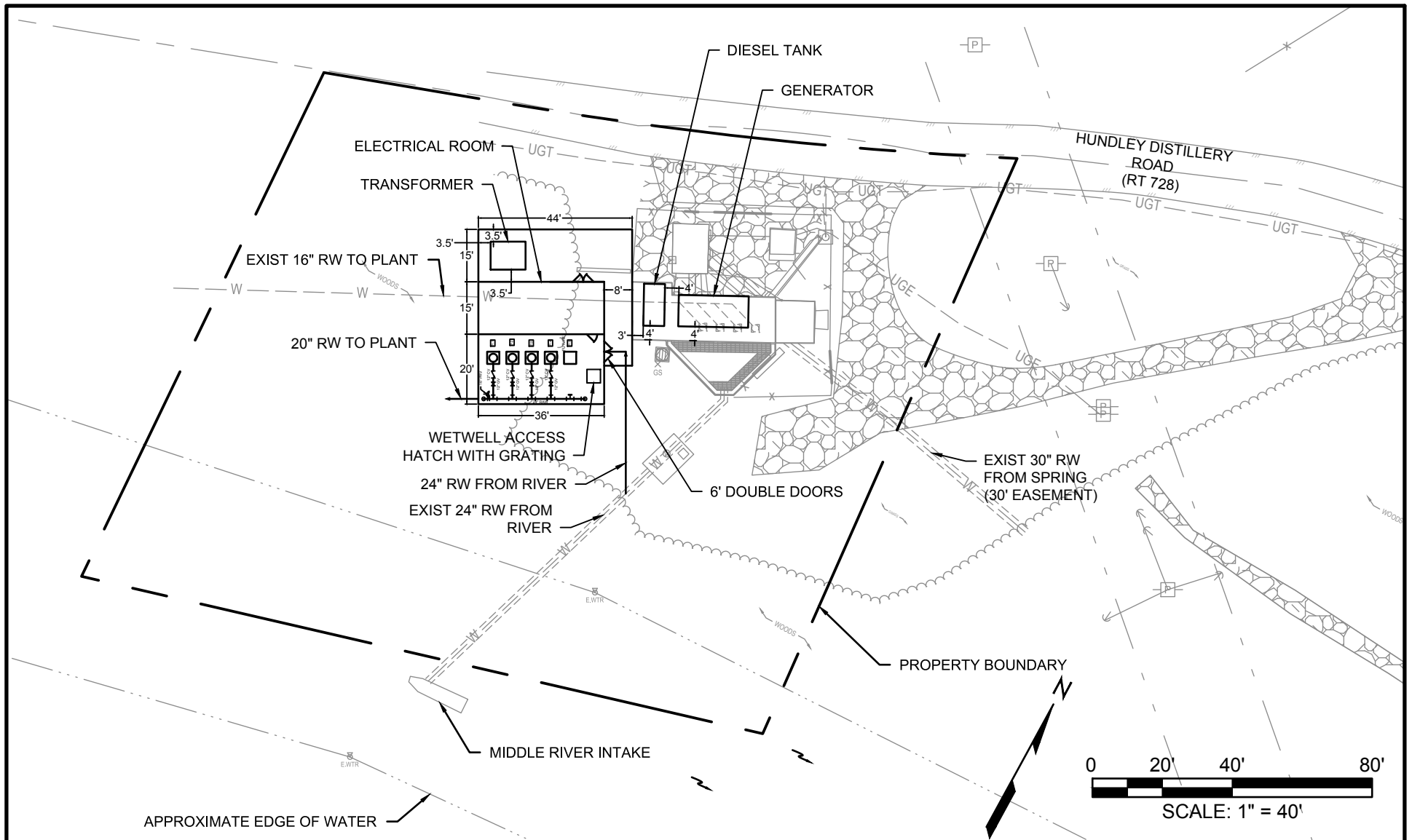
Wet Well Conceptual Design

Due to the WSE differences between Gardner Spring and the Middle River, the proposed wet well in Alternative 2 would need to be modified from the existing wet well design. The pump wet well operating level is currently set to 1343.3' which only allows for gravity flow from Gardner Spring. To allow for river inflows, the pump wet well operating level would have to be lowered, which would also result in deepening the wet well. Valves or gates with actuators could be used to control the flow from either source into the wet well.

Sequence of Construction

A sample sequence of construction for Alternative 2 is described below. This sequence of construction will be further developed during detailed design.

1. Excavation for the proposed wet well and site.
2. Construct the pump building and electrical room.
3. Construct the electrical room with MCC equipment and transformer.
4. Install all pumps and associated valves/piping.
5. Reroute 24-inch Middle River intake and 30-inch Gardner Spring lines to the new wet well.



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PROJECT

CITY OF STAUNTON GARDNER SPRING PUMP STATION

TITLE

ALTERNATIVE 2 - NEW
WETWELL ON EXIST SITE

COMM. NO.

216183

DRAWN

MCT

CHECKED

AST

SKETCH NO.

CSK-02

DWG. REFERENCE NO.

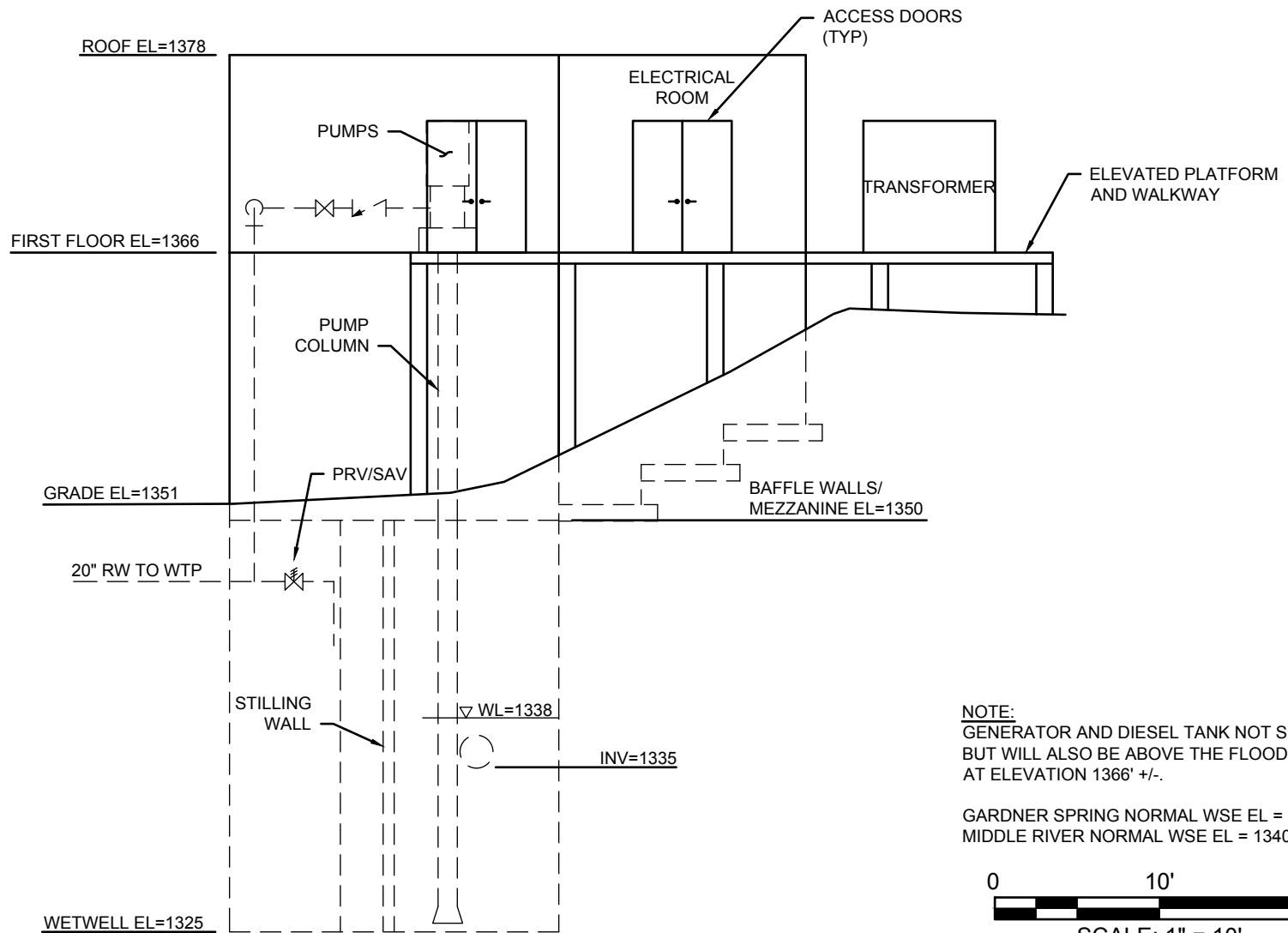
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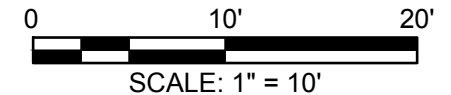
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NOTE:
GENERATOR AND DIESEL TANK NOT SHOWN,
BUT WILL ALSO BE ABOVE THE FLOODPLAIN
AT ELEVATION 1366' +/-.

GARDNER SPRING NORMAL WSE EL = 1343'
MIDDLE RIVER NORMAL WSE EL = 1340'



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PROJECT **CITY OF STAUNTON**
GARDNER SPRING PUMP STATION

TITLE **ALTERNATIVE 2 - SECTION**

COMM. NO.
216183

DRAWN
MCT

CHECKED
AST

SKETCH NO.
CSK-02A

DWG. REFERENCE NO.
216183A16CSK02A.DWG

DATE:
03/22/2017

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6. Test and start-up pumps.
7. Install generator and diesel tank.

Operations and Controls

Variable frequency drives (VFD) are proposed for the pumps in both alternatives. VFDs control flow without the use of a throttling valve. Therefore, the system curve is not affected by another flow restrictive appurtenance. Pumps with VFD controllers will provide the operators with flexibility in running the pump station. The pump station will be connected to the City SCADA system allowing remote viewing and operation of the pumps. An operator will be able to remotely adjust the pump VFD setting to obtain the desired flow rate.

Opinion of Probable Project Costs

The following table summarizes the opinions of probable project cost for each pump station alternative. An itemized cost breakdown for each can be found in Appendix B. Costs are based on the year 2018.

Table 5.4: Opinion of Probable Project Cost for Gardner Spring Pump Station Alternatives 1 and 2

GARDNER SPRING PUMP STATION ALTERNATIVE	OPINION OF PROBABLE PROJECT COSTS(\$2018) ^a
Alternative 1: Retrofit Existing Pump Station	\$5,097,600
Alternative 2: New Adjacent Pump Station	\$5,187,000

- a. Opinion of probable costs includes costs for construction, easements, surveying, engineering design, permitting, geotechnical, inspection, modifier for renovation (if applicable) and construction administration.



5.3 RECOMMENDED ALTERNATIVE

The two alternatives described in Section 5.2 were compared using the evaluation criteria listed below in Table 5.5. Scoring is based on 0 being the least preferred and 5 being the most preferred.

Table 5.5: Comparative Analysis of Gardner Spring Pump Station Alternatives 1 and 2

EVALUATION CRITERIA	ALTERNATIVE 1	ALTERNATIVE 2
Magnitude of Overall Project Costs	5	3
Depth of Excavation	5	2
Sequence of Construction	1	4
Reliability	3	5
Flood Proofing	5	5
Standby Power	5	5
Future Middle River Intake Use	1	5
Future Flow Capacity	4	5
Risk During Construction	3	5
TOTAL	32	39

Based on the total scores of the comparative evaluation, Alternative 2 was selected as the recommended alternative. While the overall project costs are expected to be higher for Alternative 2 due to excavation depth and construction costs. Alternative 1 would result in a more complex sequence of construction because the existing pump station would need to remain in service as it is being renovated. Also, the Alternative 1 renovation project has a lower reliability score due to the remaining aging infrastructure. Additionally, the deeper wet well in Alternative 2 would be beneficial in using the Middle River source. Both alternatives compare equally in standby power and flood proofing since both include a generator and diesel fuel tank, and all equipment is out of the 100-year floodplain. Therefore, Alternative 2 meets all of the City's goals discussed in Section 5.1.

The future flow capacity relates to the maximum capacity of the pump station alternatives if all pump bays were occupied and all pumps running. For Alternative 1, there are only four existing pump bays, which limits the future flow capacity to 8 MGD, whereas Alternative 2 is designed with five pump bays for a total of 10 MGD. Neither alternative was evaluated for the visual aesthetics of the structures and equipment, which would be addressed in the detailed design phase.



6.0 RAW WATER LINE OVERVIEW

6.1 RAW WATER LINE DESCRIPTIONS

The North River Reservoir water line conveys raw water by gravity from the Staunton Dam to the City WTP through approximately 12.7 miles of 16 and 20-inch diameter pipe. The water line is 20-inch pipe from the dam to the east (downstream) portal of the tunnel through Lookout Mountain (7,000 feet). The tunnel itself includes 5,500 feet of 20-inch water line. The water line reduces in size from 20-inch to 16-inch on the east side of the tunnel and extends approximately 60,000 feet southeast cross-country to the City WTP. The tunnel through Lookout Mountain was not investigated as part of this study. It is recommended a tunnel investigation be completed in order to determine rehabilitation costs of both the tunnel and water main. The tunnel varies in size throughout its length, but is approximately 5 feet wide and 7 feet high. There are no roof supports and there are reported to have been several collapses over the years.

The North River Reservoir water line route includes Bell Creek and Middle River crossings. Blow-offs, line valves, and air release valves are located along the water line. The blow-offs and air release valves were determined to be in fair to poor condition during preparation of the 2002 study, and were subsequently replaced when the water line was pigged in 2007. Four permanent pigging stations were also constructed as part of the 2007 project to facilitate access for future pigging operations. Prior to the 2007 pigging project there was only one line valve located between the dam meter vault and the WTP. Additional line valves were added at each pigging station location. An insertion magnetic flow meter was also installed in a valve vault located at the base of the dam as part of the 2007 project. Prior to 2007, the only meter located on the line was at the WTP.

The Gardner Spring water line is 18,700 feet of 16-inch steel pipe that extends southeast from the Gardner Spring Pump Station to the City WTP. The route includes a crossing of the Middle River. Two short sections of the line have been replaced with either cast or ductile iron pipe. The original pipe was coated with an exterior asphaltic coating and it is unknown whether the pipe has an interior protective lining.

See Figure 6.1 for a conceptual overview of the two existing water lines. According to the City, the two existing 16-inch lines are only 5 to 6 feet apart when their routes begin to run parallel. The existing easement for these lines is 30 feet wide.

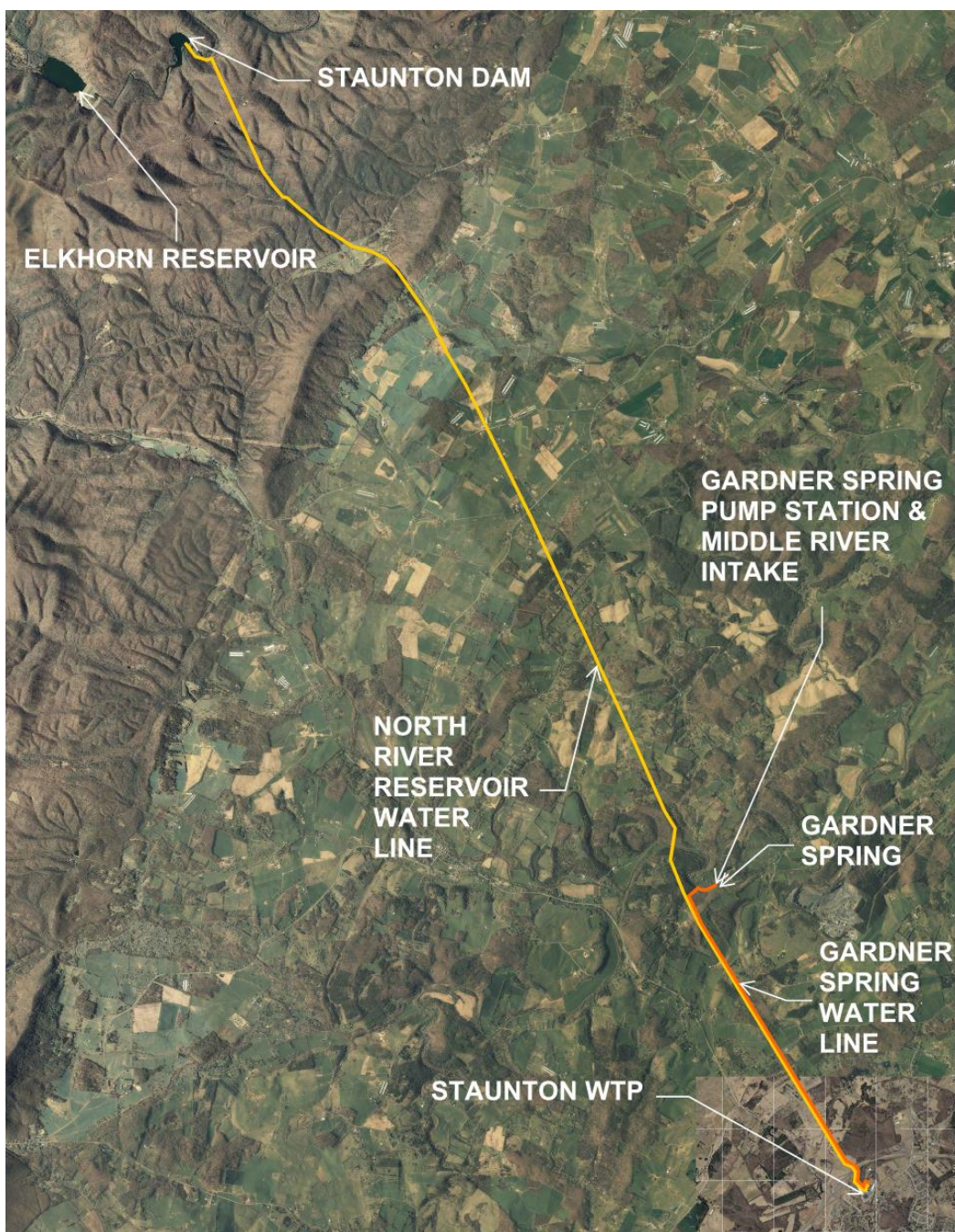


Figure 6.1: North River and Gardner Spring Raw Water Lines (2015 VGIN Aerial)



6.2 WATER LINE ALTERNATIVES

The main concern with the North River water line is its age and condition. The water line was constructed in the late 1920s, and is nearly 100 years old. Sections of the water line were installed with very little cover, making the line susceptible to potential damage. It has also been observed that there are significant internal corrosion issues with this line that limit the infrastructure capacity of the entire North River system. Even when the North River water line was pigged within the last ten years, the withdrawal rate did not reach the expected capacity of 2.4 MGD. More aggressive cleaning/pigging of the line may restore a higher flow rate, but also may strain the line too much, leading to potential breaks or leaks. A corrosion evaluation of the existing line was performed in 2004-05 by Russell Corrosion Consultants, Inc. Similarly, the Gardner Spring water line was installed in the late 1940s which also raises potential reliability concerns. Both water line routes cross Middle River, which would require environmental permitting if replaced.

In-situ rehabilitation methods were considered for the water lines. However, these methods in most cases were determined not to be cost effective compared to direct water line replacement. In-situ rehabilitation of the Gardner Spring line would present operational challenges since Gardner Spring is the City's primary source. A new water line could be constructed while the existing Gardner Spring line remains in service.

A field walk of the Gardner Spring water line was completed on April 5th, 2017 prior to the development of alternatives to assess the current condition of the line route.



Figure 6.2: Air Relief Valve Along Water Line Route



Gardner Spring Water Line

A new Gardner Spring water line would be constructed in conjunction with the renovation or replacement of the existing Gardner Spring Pump Station. This would involve the design and installation of a new 20-inch ductile iron pipe parallel to the existing water line. The alignment would likely require excavation through rock for a significant portion of the water line. Rock excavation can be accomplished by blasting, drilling, or a combination of the two. Preliminary considerations based on other pipeline projects in the valley recommend at least 15 feet or greater separation from existing utilities to minimize impacts from blasting. A detailed geotechnical evaluation would need to be performed during design to determine the construction methods and recommended separation for the new water line. It is likely the construction methods will put the new water line outside of the City's existing 30-foot easement, requiring additional easements for the entire proposed water line. The new installation would not include replacing the 500-foot Middle River crossing section. However, this section of 16-inch pipe could be rehabilitated with pigging or replaced in-situ. In-situ pipe replacement would reduce the interior diameter of the pipe at the river crossing, and would need to be further evaluated and modeled to ensure this does not adversely impact the capacity of the entire transmission line.

North River Alternative 1

This alternative includes replacing the existing 16-inch North River line with 20-inch ductile iron pipe, starting at the southeast side of the tunnel and extending approximately 53,000 linear feet to the WTP. Replacing pipe from the Staunton Dam up through the tunnel is recommended as a future project or part of phasing since this construction would also likely include major repairs to the tunnel itself.

North River Alternative 2

Alternative 2 would involve pigging the existing 16-inch and 20-inch pipeline as necessary, instead of replacing the water line. This is considered a short-term measure for the City, with the recommendation that replacing the entire North River Reservoir be considered for the future. This is discussed further in Section 8 of this report.

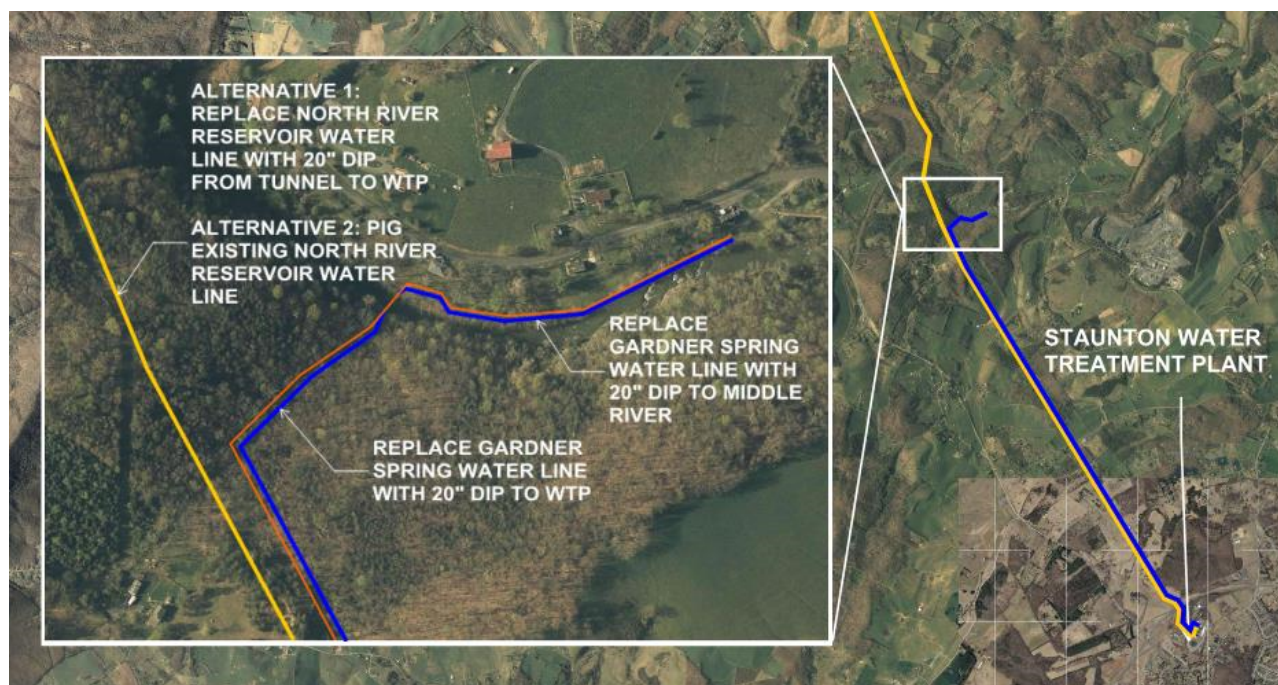


Figure 6.3: Overview of Water Line Alternatives

Hydraulic Model

A hydraulic model of the proposed raw water system, including the Gardner Spring Pump Station alternatives discussed in the previous section, was created using WaterCAD. This model was used to verify proposed water line sizes and the design of interconnections between the Gardner Spring and North River lines. The model was also used to check the effects of leaving a short section of existing 16-inch steel pipe at the Middle River crossing on the Gardner Spring line.

The following assumptions were made when modelling each of these scenarios:

- The Hazen-Williams coefficient used for the existing Gardner Spring and North River lines were 100 and 71, respectively, and 120 for the proposed Gardner Spring pipe sections. The low coefficient used for the North River line is based on the historical withdrawal rates which indicate interior corrosion.
- The inside diameter used for the 16-inch steel pipe across the Middle River on the Gardner Spring line was 15.25 inches.

Pipe Sizing

The pipe sizes evaluated for the Gardner Spring line were 16-inch, 18-inch, 20-inch, and 24-inch ductile iron pipe. Table 6.1 indicates the velocities of the evaluated pipe sizes at various flow rates (2.0 MGD, 4.5 MGD, 6.0 MGD, and 8.0 MGD). The ideal velocity range for a raw water line is between 2 and 5 feet per second (ft/s). In this range, the water would be moving fast enough to prevent stagnation and sediment build-up, but not so fast that scouring occurs. The velocity ranges from 1.42 ft/s to 5.67 ft/s for the 20-inch pipe over the range of flow rates analyzed.



Table 6.1: Gardner Spring Water Line Velocity and Pipe Size Evaluation

LINE SIZE (IN)	VELOCITY (FT/S)			
	2.0 MGD	4.5 MGD	6.0 MGD	8.0 MGD
16	2.22	4.99	6.65	8.87
18	1.75	3.94	5.25	7.00
20	1.42	3.19	4.26	5.67
24	0.99	2.22	2.96	3.94

Interconnection between North River and Gardner Spring Waterlines

Interconnecting the three water lines (2 existing and 1 new) would allow for raw water from the North River system to flow into either the existing or new Gardner Spring lines and vice versa. This would increase system reliability by adding an alternative route for the raw water in case a section of the southern (parallel) portion of North River or Gardner Spring lines is compromised or under repair. The interconnection point would be developed where the North River and Gardner Spring lines begin to run parallel toward the City WTP. At this location, a series of tees and manual gate valves could be installed to redirect flow as needed. While this design would add redundancy to the overall raw water system, it would also require maintenance and routine exercising of the valves by the City staff. Figure 6.4 provides a conceptual sketch of the interconnection design.

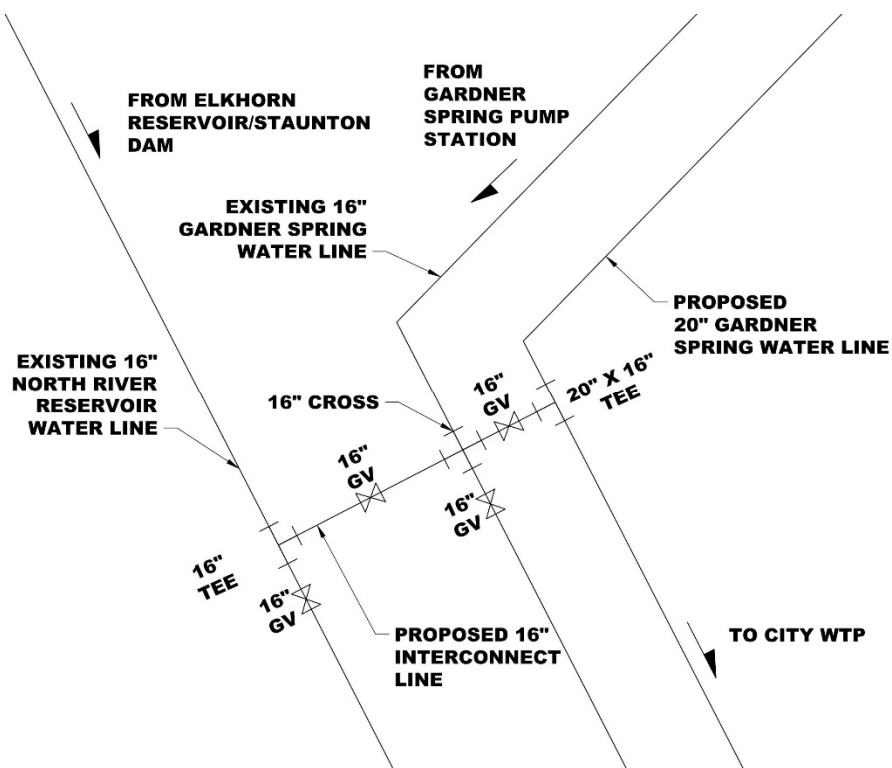


Figure 6.4: North River and Gardner Spring Interconnection Concept



Middle River Crossing

WaterCAD was used to model the effects of keeping a section of existing 16-inch diameter pipe in place across the Middle River if the remainder of the pipeline is replaced and upsized to 20-inch diameter. This would relieve the City from environmental permitting for a new river crossing, such as the 401/404 permitting process through DEQ. The proposed 20-inch line would include fitting on both sides of the Middle River to connect to the existing 16-inch river crossing. In-situ rehabilitation of the existing river crossing will be evaluated during the design phase. Results for the initial water modeling efforts indicate that this conceptual design would not have a significant impact on the capacity of the Gardner Spring system to deliver water to the City WTP. Future consideration will be made for replacing the water main, either by standard construction methods or directional drilling.

Construction

Construction permits that may be required for either alternative include blasting permits and an Erosion and Sediment Control plan as discussed in Section 7 of this report. Additional easements may be required as well. Based on information regarding the original construction of the North River and Gardner Spring water lines, it is known that significant rock is present along these water line routes. In order to construct the proposed 20-inch Gardner Spring line while protecting the existing lines, a customized blasting program may need to be implemented. A research paper titled “Extremely Controlled Rock Blasting near Critical Pipes where Mechanical Excavation is Not Practical” analyzed two case studies that featured blasting near existing pipes. The research suggests developing a blasting program using the following procedure:

1. Investigate specific site conditions,
2. Identify real risks to pipes and other structures,
3. Develop appropriate controls and measurements to assure the work is successful.⁹

It is recommended that the City review this research and implement this methodology into the design/construction process of constructing any new pipelines along the routes of the existing lines.

Opinion of Probable Project Costs

The following table presents the opinions of probable project costs for each raw water line alternative. Costs are based on the year 2018. An itemized cost breakdown can be found in Appendix B.



Table 6.2: Opinions of Probable Water Line Project Costs

RAW WATER LINE ALTERNATIVES	OPINIONS OF PROBABLE PROJECT COSTS (\$2018) ^a
Gardner Spring Water Line	\$7,572,000
North River Water Line – Alternative 1	\$19,534,000
North River Water Line – Alternative 2	\$150,000

- a. Opinion of probable costs includes costs for construction, easements, surveying, engineering design, permitting, geotechnical, inspection, and construction administration.

6.3 RECOMMENDED ALTERNATIVE

It is recommended that a new Gardner Spring water line be constructed to replace the existing water line. The recommendation for the North River water line includes a combination of Alternative 1 and 2 with phasing for the replacement of the water line over several years. The first priority is to improve the reliability of the Gardner Spring raw water system. Therefore, the priority construction of the two water lines would include construction of the new Gardner Spring line as three phases. The first phase would include replacing the existing 16-inch Gardner Spring line with a 20-inch line from the Gardner Spring Pump Station to the Middle River crossing. The remaining Gardner Spring line would be installed in two phases from the Middle River crossing to the WTP. The next phases would include replacing the entire North River line in segment lengths and times as determined by the City. Until the North River waterline is fully replaced, the remaining sections of existing waterline would continue to be pigged approximately every 10 years.

Although not related to the water line alternatives discussed herein, it is recommended that City staff exercise the valve connecting the Elkhorn Reservoir to the Staunton Dam at least once per year to better ensure ongoing North River system reliability.



7.0 PERMITTING AND ENVIRONMENTAL

A preliminary Waters of the U.S. (WOUS) investigation was completed for both Gardner Spring Pump Station alternative designs. The investigation was completed by Resource Environmental Solutions (RES) on January 11, 2018 (see Appendix C). The only jurisdictional feature for WOUS on the project site is the Middle River. The Middle River is under the jurisdiction of the U.S. Army Corps of Engineers (Corps) and the Virginia Marine Resources Commission (VMRC). The two alternative pump station designs, discussed in further detail in Section 5 include retrofitting the existing pump station or constructing a new pump station adjacent to the existing structure. Since neither of these alternatives involves water withdrawal from the river, or construction within, over, or under the Middle River, RES determined that neither project “would not impact any jurisdictional streams or wetlands.” Therefore, based on this preliminary evaluation, it is not anticipated that Gardner Spring Pump Station construction would require a permit from the Corps, VMRC, or the VDEQ (401/404 permitting). However, the project may require coordination with the Federal Emergency Management Agency (FEMA) since the project site is located in the 100-year floodplain of the Middle River. Other requirements may include an Erosion and Sediment Control Plan as well as County/City approval.

Alternatives for improvements to the North River and Gardner Spring water lines include pipeline replacement and/or rehabilitation. The replacement of the Gardner Spring water line would not involve replacing the Middle River crossing section. Therefore, 401/404 permitting is not anticipated. However, this work would require additional easements, an Erosion and Sediment Control Plan, and possibly blasting permits. During a field walkthrough of the Gardner Spring water line, an area along the route was observed as a possible wetland area. Prior to construction, this area would be further investigated and may require additional permitting. One water line option calls for the pigging the North River water line, which would require an Erosion and Sediment Control Plan for the land disturbance areas of the project.



8.0 RECOMMENDATIONS & PRIORITIES

8.1 WATER SUPPLY

According to the projected water demands, the City's raw water supply, including Gardner Spring and the North River Reservoir systems, has adequate capacity to meet demands until 2050.

Reliability

It is recommended that the City focus on increasing system reliability in order to maintain water supply from its existing sources. The initial focus should be to improve the Gardner Spring Pump Station and water line since this is the primary water source for the City.

To ensure the reliability of short-term and mid-term needs, the City should:

- *Initial Focus*
 - Improve the reliability of the Gardner Spring Pump Station
 - Improve the reliability of the Gardner Spring water line
 - Confirm the City's water rights to Gardner Spring
 - Develop a Groundwater Monitoring Program
 - Develop a Source Water Protection Area plan for Gardner Spring
- *Secondary Focus*
 - Evaluate the existing condition of the tunnel and water line through Lookout Mountain
 - Increase reliability of North River water line
 - Install a new weir at the Gardner Spring box to provide more accurate flow measurements to further monitor the spring

Future Water supply

The following options should be part of the City's long-term water supply strategy as demands begin to reach the capacity of the existing raw water supply:

- *Initial Focus*
 - Review the 2018 and 2023 Upper Shenandoah River Basin Water Supply Plans to determine potential impacts and timing for future water supply projects
 - Confirm the long-term water demands for the ACSA from the City's water system



- *Secondary Focus*
 - Improvements to the Middle River intake for more efficient use of this source
 - Development of groundwater source along the existing North River raw water pipelines outside of the Gardner Spring recharge zone
 - Development of groundwater source in Area A-Poague Run and Area C-Shutterlee Mill outlined in the 1994 EGGI Report.
 - Development of the existing springs/groundwater at the Gypsy Hill Park
 - Development of Cave Spring

8.2 WATER SOURCE RELIABILITY

The City's current water sources, North River Reservoir and Gardner Spring, have adequate capacity to serve the projected needs of the City beyond 2050. The safe yield of Gardner Spring is 4.5 MGD and North River Reservoir is 2.4 MGD. The North River Reservoir source is limited to approximately 2.1 MGD due to pipe line capacity.

Gardner Spring can meet the current water supply demands if the North River Reservoir source is unavailable. However, the North River Reservoir source cannot meet the current water demands if the Gardner Spring source is off-line. The City should consider evaluating options for water supply in addition to North River Reservoir and Gardner Spring. It is recommended that any evaluated options be totally independent of the existing sources. Improvements to the Middle River intake have not been considered due to the potential impacts to Gardner Spring. The recommended options to be evaluated are:

- Gypsy Hill Park new groundwater source
- Cave Spring
- Potential groundwater along the North River Reservoir pipe line outside of the Gardner Spring recharge zone
- Potential groundwater in Area A-Poague Run and Area C-Shutterlee Mill as outlined in the 1994 EGGI Report.

The opinions of costs associated with the evaluation of the potential sources is shown in the Recommended Project Priority Table (Table 8.1). Assuming that Gardner Spring is unavailable, the new source(s) capacity should be 2 to 3 MGD. Providing additional water supply capacity will allow the City to meet the water supply demands if either of the existing sources (North River Reservoir or Gardner Spring) become unavailable.

8.3 SYSTEM RELIABILITY PROJECTS

The following projects are recommended to increase the reliability of the existing water supply system for the short and mid-terms. These projects are reliability-related, not capacity-related. Table 8.1 shows the projected opinions of costs and timeframes for completing these projects.



Gardner Spring Pump Station

A new pump station is recommended to replace the existing Gardner Spring Pump Station. The new station will be constructed adjacent to the existing facility. The new pump station will increase reliability by including standby power and flood protection, while also increasing the efficiency and ease of maintenance and operations. The section of water line from the pump station to the Middle River would be replaced as part of this project.

Gardner Spring Raw Water Line

It is recommended that the existing 16-inch Gardner Spring water line be replaced with a 20-inch water line from the Middle River to the water treatment plant. The water line project should be completed in the short-term since the City's top priority is to increase the reliability of the Gardner Spring raw water system. This replacement will connect to the initial water line replacement constructed as part of the pump station project. For planning purposes, the water line from the Middle River to the water treatment plant has been shown to be constructed in three phases.

North River Reservoir Raw Water Line

It is recommended that the North River Reservoir line be replaced after completion of the Gardner Spring pump station and water line projects. While the Gardner Spring water line is being designed and constructed, the existing North River Reservoir line should be pigged as needed and the City should investigate the condition of the tunnel through Lookout Mountain. The next steps would involve replacing the entire North River Reservoir line with new 20-inch diameter pipe in segment lengths and times that accommodate the City's budget. The 20-inch pipe will provide adequate conveyance capacity to utilize the 2.4 MGD safe yield of the Elkhorn Reservoir/Staunton Dam. The replacement of the line through Lookout Mountain depends on the result of the tunnel investigation. The route and costs for the North River Reservoir replacement line may be impacted by the feasibility of reusing the existing tunnel. The replacement of the North River Reservoir line has been shown beyond FY2028 in the Recommended Project Priority Table.

8.4 RECOMMENDED PROJECT PRIORITY TABLE

The following Recommended Project Priority Table (Table 8.1) outlines the timeframe and costs associated with the implementation of the recommended projects from fiscal year 2020 (FY2020) through FY2028 and projects beyond FY2028. The initial projects are related to the replacement of the Gardner Spring pump station and raw water line. The second priority includes investigations to determine the potential for a new reliable water source. The table shows the implementation of one new water supply option in FY2024-25. Only one of the potential new water sources is recommended to be implemented in the short term. This has been recommended not to provide additional capacity, but to provide backup capacity for the existing supply sources.



Table 8.1: Recommendations & Priorities by Fiscal Year^a

ITEM NO.	ACTION ITEMS	TOTAL PROJECT COSTS	FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028	FUTURE PROJECTS (FY>2028)
1	Develop SWPA	NA	NA									
2	Confirm Water Rights at Gardner Spring	NA	NA									
3	Gardner Spring Pump Station PER and Design	\$400,000	\$150,000	\$250,000								
4	Gardner Spring Pump Station Construction	\$5,360,000			\$2,680,000	\$2,680,000						
5	Gardner Spring Water Line Design/Construction	\$7,500,000				\$600,000	\$2,300,000	\$2,300,000	\$2,300,000			
6	Potential Groundwater Evaluation ^b	\$604,500	\$244,500		\$135,000	\$225,000						
7	Groundwater Monitoring Program	\$418,000					\$110,000	\$44,000	\$44,000	\$44,000	\$44,000	\$132,000
8	New Water Supply Source Implementation	\$4,000,000					\$2,000,000	\$2,000,000				
10 YEAR SUBTOTAL		\$18,282,500										
9	North River Reservoir Water Line Pigging	\$150,000										\$150,000
10	North River Reservoir Water Line Design/Replacement	\$24,000,000										\$24,000,000
11	Middle River Intake	\$1,500,000										\$1,500,000
> 10 YEAR SUBTOTAL		\$25,650,000										
TOTAL		\$43,932,500	\$394,500	\$250,000	\$2,815,000	\$3,505,000	\$4,410,000	\$4,434,000	\$2,344,000	\$44,000	\$44,000	\$25,782,000

^a All costs are based on 2018 estimates and do not include construction administration or inspection fees.
^b Evaluation will include options along the existing North River Reservoir water line, Gypsy Hill Park, and areas A-Poague Run and C-Shutterlee Mill Road from the 1994 EGGI report.

to agree upon the amount of such damages, the same shall be arbitrated in the usual manner. This deed contains all agreements between the parties hereto relative to said right-of-way, to the compensation for the use thereof, and to the damages, if any, resulting from the use of the same. The COMPANY may inspect, maintain, patrol and keep in repair all poles, wires, fixtures, and appliances connected therewith on said land, and may remove the same from said premises whenever it may elect to do so. The party of the first part covenants that it has the right to convey said right-of-way and that it will warrant and defend the same from the claims of all persons whomsoever. IN TESTIMONY WHEREOF the said Rose Cliff Company, Inc., has caused its name to be signed hereto by Frank Parker, Jr., its Vice President and its corporate seal to be hereto affixed and attested by Marion M. Parker, its Asst. Secretary, they both being thereunto duly authorized; all upon the day and year first above written.

(CORPORATE SEAL)

Attest:

Marion M. Parker,
Asst. Secretary.

ROSE CLIFF COMPANY, INC.,

By, F. T. Parker, Jr.,
Vice President.

STATE OF VIRGINIA,

COUNTY OF AUGUSTA, To-wit:

I, E. I. Carruthers, Jr., a Notary Public in and for the County and State aforesaid, do certify that F. T. Parker, Jr., whose name as Vice President of the Rose Cliff Co., Inc., a corporation, is signed to the foregoing writing bearing date on the 28 day of Sept., 1937, personally appeared before me this day in my said County and in the name and on behalf of the said Rose Cliff Co., Inc., acknowledged the said writing as the act and deed of the said corporation and made oath that he is Vice President of the said corporation and that the seal affixed to said writing is the true corporate seal of said corporation and that it has been affixed thereto by due authority. My commission expires on the 23 day of August, 1939. Given under my hand this 25th day of October, 1937.

E. I. Carruthers, Jr.,
Notary Public.

VIRGINIA - In the Clerk's Office of the Circuit Court for Augusta County. Nov. 1, 1937 4 P. M. The foregoing Deed from Rose Cliff Company, Inc., to Virginia Public Service Company was this day presented in the office aforesaid, the State Tax of 12-cents being paid thereon, it is with the certificate of acknowledgement annexed, admitted to record.

TESTE Harry Burnett Clerk.

Exam'd

(57429) THIS DEED OF EXCHANGE made this 20th day of August, in the year 1937, between the City of Staunton, Virginia, a municipal corporation, party of the first part, and William Arthur Dudley and Edna R. Dudley, his wife, of Augusta County, Virginia, parties of the second part, WITNESSETH: That for and in consideration of the rights of way and easements hereinafter mentioned to be granted and conveyed in exchange by the said parties of the second part to the said party of the first part, and for and in consideration of the sum of One Dollar (\$1.00) cash in hand paid by the said parties of the second part to the said party of the first part, the receipt whereof is

hereby acknowledged, the said City of Staunton, Virginia, a municipal corporation, doth hereby grant, exchange and convey, with general warranty of title, unto the said William Arthur Dudley, party of the second part, that certain tract or parcel of land, situate in Pastures District, Augusta County, Virginia, adjoining the lands of the said William Arthur Dudley, Wanger and others, containing 13.26 acres, more or less, according to a plat by C. G. Irvine, Registered Surveyor, dated May 29, 1936, attached hereto and made a part of this deed, together with a right of way as shown on said plat as appurtenant to said tract of land hereby conveyed extending from said land over and across the other lands of the City of Staunton to Middle River as a passageway for watering stock of the grantee, his heirs and assigns, and for no other purpose; excepting and reserving unto the said party of the first part and its assigns a perpetual right of way Thirty (30) feet wide located according to the city's survey, running in, over and across said tract of land hereby conveyed, together with the perpetual right to install, lay, maintain, inspect, repair, re-lay and remove pipe line or lines, with convenient appliances, for taking water across and through said tract of land as appurtenant to the lands of said City of Staunton in Augusta County and Staunton in connection with its water supply, as fully set forth and contained in the deed from T. N. Wilson and wife to the City of Staunton, dated August 24, 1926, of record in the clerk's office of Augusta County in D. B. 227, p. 317, and further reserving and excepting unto the said City of Staunton a perpetual right of way Thirty (30) feet wide to be located according to the city's survey at the most convenient point to be determined by the City of Staunton in over and across said tract of land hereby conveyed, in which aforesaid right of way the City of Staunton reserves and excepts a perpetual right to install, lay, maintain, inspect, repair, re-lay, and remove a pipe line or lines, with convenient appliances, for taking water across and through said tract of land from its spring located on the tract of land adjoining the tract hereby conveyed and of which this tract of land was a part to the city's present North River pipe line, as set forth on said plat; and also a right of way for an electric power line, with the necessary poles, guy wires and appliances, in over and across said tract of land at its most convenient point to be determined by the city in connection with pumping water from its aforesaid spring to its said North River pipe line; it being understood and agreed that the city by its agents and employees, or companies contracting with the city, shall have the right to build, construct, complete, operate, maintain, repair, relay and remove said water pipe or pipe lines or electric power line in and across said lands, with right of ingress and egress for said purposes; said pipe line or lines to be laid so as not to interfere with the ordinary cultivation of the land and said power line to be located along the fence line where possible. The above tract of land is part of a tract of about 27 acres which was conveyed to the City of Staunton by S. H. Gardner and wife and Nettie B. Cook and husband by deed dated May 14, 1935, and duly of record in said clerk's office in D. B. 270, p. 96. And this deed further WITNESSETH that for and in consideration of the said lot or parcel of land being so granted and conveyed unto the said William Arthur Dudley and in consideration of the sum of One Dollar (\$1.00) cash in hand paid to the said parties of the second part by the said party of the first part, the receipt whereof is hereby acknowledged, the said William Arthur Dudley and Edna R. Dudley, his wife, do hereby grant, exchange and convey, with general warranty of title, unto the said City of Staunton a perpetual right

of way thirty (30) feet wide located according to the city's survey at the most convenient point to be determined by the city, the approximate location of which is shown on the above-mentioned plat hereto attached, and running a distance of approximately Seven Hundred and Twenty-seven (727) feet in, over and across all of that certain tract or parcel of land, situate in Beverley Manor District, Augusta County, Virginia, on the south side of Middle River, adjoining the above-described tract belonging to the City of Staunton, Wanger and others, containing 139-1/4 acres, more or less, and being the same land conveyed to the said William Arthur Dudley by Frank T. Dunlap and Davis L. Dunlap by deed dated October 30, 1926, and of record in said clerk's office in D. B. 228, p. 45; in the aforesaid right of way the city shall have the right to install, lay, maintain, inspect, repair, re-lay and remove a pipe line or lines, with convenient appliances, for taking water across and through said tract of land from the spring on the above-mentioned tract belonging to the City of Staunton and continuing over the adjoining tract of land belonging to Joseph and Louis Wanger to connect with the water line belonging to the city running from its North River dam to the city's reservoir, and said right of way and pipe lines shall be appurtenant to the lands of the said City of Staunton in Augusta County and Staunton and in connection with its water supply. In consideration of the above premises the said William Arthur Dudley and Edna R. Dudley, his wife, do further grant and convey to the City of Staunton as appurtenant to the lands of said City of Staunton in Augusta County and Staunton and in connection with its water supply a perpetual right to erect, maintain, inspect and repair an electric power line, with the necessary poles, guy wires and appliances, in, over and across said tract of land. It is understood and agreed that the city by its agents and employees, or companies contracting with the city, shall have the right to build, construct, complete, operate, maintain, repair, re-lay and remove said water pipe or pipe lines or electric power line in and across said land, with right of ingress and egress for said purposes, said pipe line or lines to be laid so as not to interfere with the ordinary cultivation of the land and said power line to be located along the fence line where possible.

WITNESS the signature of the City of Staunton, Virginia, by Curry Carter, its Mayor, and its corporate seal hereto annexed, attested by C. V. Herndon, Clerk of the Council, and the following signatures and seals, all on the day and year first above written.

(CORPORATE SEAL)

Attest:

C. V. Herndon,
Clerk of the Council

CITY OF STAUNTON, VIRGINIA

By, Curry Carter,
Its Mayor

William Arthur Dudley (SEAL)

Edna R. Dudley (SEAL)

COUNTY OF AUGUSTA, To-wit:

I, Duncan Curry, a notary public for the county aforesaid, in the State of Virginia, do hereby certify that Curry Carter, Mayor of the City of Staunton, Virginia, whose name is signed to the above writing, bearing date on the 20th day of August, 1937, has acknowledged the same before me in my county aforesaid. My commission expires Mar. 14, 1939. Given under my hand this 18th day of Sept., 1937.

Duncan Curry,
Notary Public.

57429

Pipe Line Right of Way

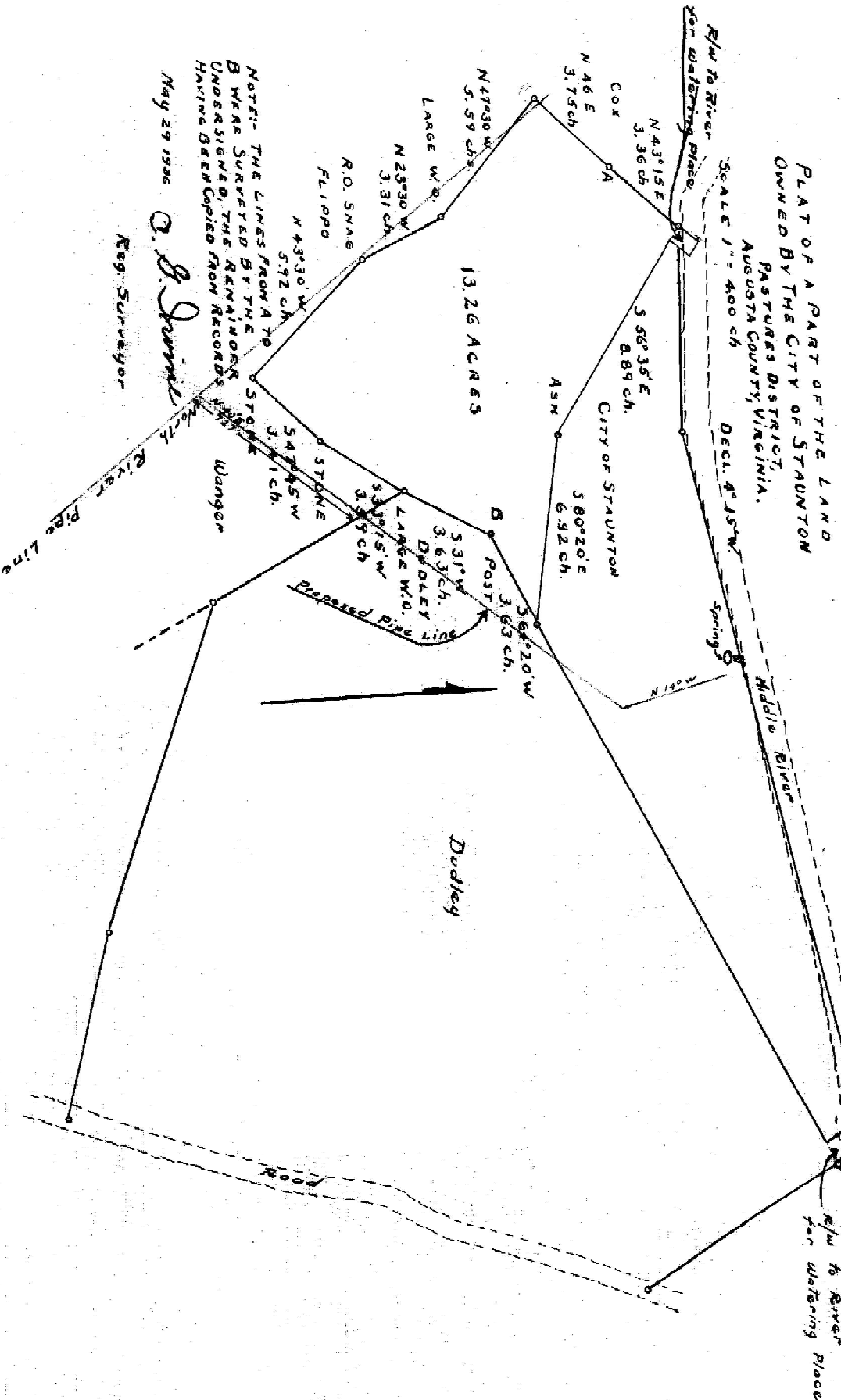




Table B1: Opinion of Probable Project Costs for Gardner Spring Pump Station Alternative 1

OPINION OF PROBABLE PROJECT COSTS GARDNER SRING PUMP STATION ALTERANTIVE 1: RETROFIT EXISTING PUMP STATION		
Civil	Miscellaneous Site Work (Grading, gravel parking area, site restoration, etc.)	\$15,000
	Rock Excavation	\$30,000
	Structural support structure for New Electrical Building, Generator, Transformer	\$150,000
	Block Wall for Fuel Tank Protection	\$15,000
	Fence	\$20,000
Pump Station	Wetwell Modifications	\$160,000
	New Electrical Building	\$95,000
	Raise Exterior of Wetwell	\$70,000
	Demo West Half of PS Walls, Roof, Electrical	\$18,000
	Temporary Protection for Motors 1 & 2	\$2,000
	Install New Concrete Wall West Side to Elev. 1367'	\$26,000
	16" Check Valves (2)	\$60,000
	16" Gate Valves (2)	\$44,000
	16" Wyes (2)	\$30,000
	16" Tees (2)	\$30,000
	16" Dismantling Joint (2)	\$20,000
	Piping	\$10,000
	Install New Pumps 3 & 4	\$280,000
	Build New Brick/Block Wall on West Side	\$30,000
	Temporary Protection for Motors 3 & 4	\$2,000
	Demo East Half of PS Walls, Roof, Electrical	\$15,000
	Install New Concrete Wall East Side to Elev. 1367'	\$22,000
	Build New Brick/Block Wall on East Side	\$20,000
	16" Check Valves (2)	\$60,000
	16" Gate Valves (2)	\$44,000
	16" Wyes (2)	\$30,000



	16" Tees (2)	\$30,000
	16" Dismantling Joint (2)	\$20,000
	Piping	\$8,000
	Install New Pumps 1 & 2	\$280,000
	Install Elevated Fiberglass Platform at Elev. 1367'	\$25,000
	Beam & Hoist	\$10,000
	Install Roof	\$30,000
	Demo Existing Electrical Building	\$12,000
	Demo Existing Transformer	\$3,000
	Install Exterior Stairs for New PS at Elev. 1367'	\$4,000
	New HVAC	\$30,000
	Coordination	\$200,000
	Painting	\$20,000
Electrical and I&C	Generator	\$350,000
	Fuel Tank	\$40,000
	Electrical (MCC, ATC, Panelboards, Conduit & Wiring, Disconnects, Lighting)	\$500,000
	Utility Costs (Transformer, New Service)	\$50,000
	New SCADA Panel & Controls	\$40,000
Subtotal		\$2,950,000
Mobilization (3%)		\$88,500
General Conditions (5%)		\$147,500
Subtotal		\$3,186,000
Construction Contingency (20%)		\$637,200
Contingency – Easements, Surveying, Design, Permitting, Geotechnical, Inspection, Modifier for Renovation, and Construction Administration (40%)		\$1,274,400
TOTAL		\$5,097,600



Table B2: Opinion of Probable Project Costs for Gardner Spring Pump Station Alternative 2

OPINION OF PROBABLE PROJECT COSTS GARDNER SPRING PUMP STATION ALTERNATIVE 2: NEW PUMP STATION		
Civil	Miscellaneous Site Work (Grading, gravel parking area, site restoration, etc.)	\$25,000
	Rock Excavation	\$320,000
	Structural support structure for New Electrical Building, Generator, Transformer	\$110,000
	Block Wall for Fuel Tank Protection	\$15,000
	Fence	\$25,000
Pump Station	Wetwell	\$150,000
	Pump Station Structure	\$700,000
	Wetwell Gates with Actuators	\$100,000
	16" Check Valves (4)	\$120,000
	16" Gate Valves (4)	\$88,000
	16" Wyes (4)	\$30,000
	16" Tees (4)	\$30,000
	16" Dismantling Joint (4)	\$20,000
	Piping Inside Pump Station & Valve Room	\$16,000
	Pumps 1 through 4	\$560,000
	Beam & Hoist	\$10,000
	HVAC	\$30,000
	Demo Existing PS to Concrete Slab Elev. 1360'	\$12,000
	Demo Existing Electrical Building	\$12,000
	Demo Existing Transformer	\$3,000
	Demo Existing Pumps	\$6,000
	Concrete Fill for Existing Pump Shaft Holes in Slab	\$10,000
	Demo & Abandon Existing Valve Room	\$8,000
	Abandon Existing Wetwell	\$5,000
	Connect to Middle River Intake Line	\$10,000
	Connect to GS Intake Line	\$15,000
	Painting	\$20,000



Electrical and I&C	Generator	\$350,000
	Fuel Tank	\$40,000
	Electrical (MCC, ATC, Panelboards, Conduit & Wiring, Disconnects, Lighting)	\$500,000
	Utility Costs (Transformer, New Service)	\$50,000
	New SCADA Panel & Controls	\$40,000
Subtotal		\$3,430,000
Mobilization (3%)		\$102,900
General Conditions (5%)		\$171,500
Subtotal		\$3,704,400
Construction Contingency (20%)		\$740,880
Contingency – Easements, Surveying, Design, Permitting, Geotechnical, Inspection, and Construction Administration (20%)		\$740,880
TOTAL		\$5,187,000



Table B3: Opinion of Probable Project Costs for Gardner Spring Waterline from Gardner Spring Pump Station to Middle River

ITEM NO	ITEM	UNIT	UNIT PRICE	QUANTITY	COST
1	20" Waterline	LF	\$160	1000	\$160,000
2	20" Waterline Bends	EA	\$8,000	4	\$32,000
3	Air Release Valve Assembly	EA	\$30,000	1	\$30,000
4	20" Gate Valve	EA	\$20,000	1	\$20,000
5	20"X16" Reducer	EA	\$5,000	1	\$5,000
6	16"X16" Tee	EA	\$3,500	1	\$3,500
7	16" Gate Valve	EA	\$15,000	1	\$15,000
8	Tie into Middle River 16"	LS	\$25,000	1	\$25,000
9	Rock Excavation (Hoe Ram)	CY	\$250	65	\$16,204
10	Rock Excavation (Blasting)	CY	\$150	97	\$14,583
11	Aggregate Backfill	TN	\$28	50	\$1,400
12	Select Backfill	CY	\$35	81	\$2,836
13	Clearing & Grubbing	AC	\$10,000	0.5	\$5,000
14	Gravel Road Replacement	LF	\$25	80	\$2,000
15	Permanent Easement	AC	\$15,000	0.40	\$6,000
16	Temporary Easement	AC	\$10,000	0.40	\$4,000
17	Drainage Crossing	LF	\$100	50	\$5,000
18	Silt Fence	LF	\$3	1,000	\$3,000
19	Seeding/Restoration	LS	\$1.25	1,000	\$1,250
	Subtotal				\$351,773
	Mobilization (3%)				\$10,553
	General Conditions (5%)				\$17,589
	Construction Contingency (20%)				\$70,355
	Contingency –Surveying, Design, Permitting, Geotechnical, Inspection, and Construction Administration (20%)				\$70,355
	TOTAL				\$520,624



Table B4: Opinion of Probable Project Costs for Gardner Spring Waterline from Middle River to City Water Treatment Plant

ITEM NO	ITEM	UNIT	UNIT PRICE	QUANTITY	COST
1	20" Waterline	LF	\$160	17,500	\$2,800,000
2	20" Waterline Bends	EA	\$8,000	12	\$96,000
3	Air Release Valve Assembly	EA	\$30,000	16	\$480,000
4	20" Gate Valve	EA	\$20,000	2	\$40,000
5	20"X16" Tee	EA	\$5,000	1	\$5,000
6	16"X16" Tee	EA	\$3,500	1	\$3,500
7	16" Gate Valve	EA	\$15,000	2	\$30,000
8	20"X16"X16" Tie In	LS	\$40,000	1	\$40,000
9	Tie into Middle River 16"	LS	\$25,000	1	\$25,000
10	32" Jack & Bore	LF	\$850	350	\$297,500
11	Rock Excavation (Hoe Ram)	CY	\$250	1,134	\$283,565
12	Rock Excavation (Blasting)	CY	\$150	1,701	\$255,208
13	Aggregate Backfill	TN	\$28	2,500	\$70,000
14	Select Backfill	CY	\$35	1,418	\$49,624
15	Clearing & Grubbing	AC	\$10,000	4.0	\$40,000
16	Gravel Road Replacement	LF	\$25	80	\$2,000
17	Asphalt Replacement	LS	\$20,000	1	\$20,000
18	Permanent Easement	AC	\$15,000	4.00	\$60,000
19	Temporary Easement	AC	\$10,000	5.75	\$57,500
20	Drainage Crossing	LF	\$100	50	\$5,000
21	Stream Crossing	LF	\$250	40	\$10,000
22	Silt Fence	LF	\$3	17,500	\$52,500
23	Seeding/Restoration	LS	\$1.25	17,500	\$21,875
24	Traffic Control Allowance	LS	\$20,000	1	\$20,000
	Subtotal				\$4,764,272
	Mobilization (3%)				\$142,928
	General Conditions (5%)				\$238,214
	Construction Contingency (20%)				\$952,854
	Contingency –Surveying, Design, Permitting, Geotechnical, Inspection, and Construction Administration (20%)				\$952,854
	TOTAL				\$7,051,123



Table B5: Opinion of Probable Project Costs for North River Raw Waterline Alternative 1

ITEM NO	ITEM	UNIT	UNIT PRICE	QUANTITY	COST
1	16" Waterline	LF	\$150	52,000	\$7,800,000
2	20" Waterline	LF	\$160	17,500	\$2,800,000
3	Waterline Bends	EA	\$8,000	16	\$128,000
4	Air Release Valve Assembly	EA	\$30,000	36	\$1,080,000
5	20" Gate Valve	EA	\$20,000	2	\$40,000
6	20"X16" Tee	EA	\$5,000	1	\$5,000
7	16"X16" Tee	EA	\$3,500	10	\$35,000
8	16" Gate Valve	EA	\$15,000	6	\$90,000
9	20"X16"X16" Tie In	LS	\$40,000	1	\$40,000
10	Tie into Middle River 16"	LS	\$25,000	1	\$25,000
11	32" Jack & Bore	LF	\$850	350	\$297,500
12	Rock Excavation (Hoe Ram)	CY	\$250	284	\$70,891
13	Rock Excavation (Blasting)	CY	\$150	337	\$50,556
14	Aggregate Backfill	TN	\$28	5,000	\$140,000
15	Select Backfill	CY	\$35	3,000	\$105,000
16	Clearing & Grubbing	AC	\$10,000	6.0	\$60,000
17	Gravel Road Replacement	LF	\$25	250	\$6,250
18	Asphalt Replacement	LS	\$20,000	1	\$20,000
19	Permanent Easement	AC	\$15,000	1.00	\$15,000
20	Temporary Easement	AC	\$10,000	6.00	\$60,000
21	Drainage Crossing	LF	\$100	50	\$5,000
22	Stream Crossing	LF	\$250	100	\$25,000
23	Silt Fence	LF	\$3	69,500	\$173,500
24	Seeding/Restoration	LS	\$1.25	69,500	\$86,875
25	Traffic Control Allowance	LS	\$40,000	1	\$40,000
	Subtotal				\$13,198,822
	Mobilization (3%)				\$395,965
	General Conditions (5%)				\$659,941
	Construction Contingency (20%)				\$2,639,764
	Contingency – Surveying, Design, Permitting, Geotechnical, Inspection, and Construction Administration (20%)				\$2,639,764
	TOTAL				\$19,534,256



Table B6: Opinion of Probable Project Costs for North River Raw Waterline Alternative 2

ITEM NO	ITEM	UNIT	UNIT PRICE	QUANTITY	COST
1	Pigging Water Main	LF	\$4	58,000	\$232,000
2	Pigging Station Access/Restoration	EA	\$15,000	4	\$60,000
	Subtotal				\$292,000
	General Conditions, Mobilization (10%)				\$29,200
	Construction Contingency (20%)				\$64,240
	Markup (20%)				\$77,088
	TOTAL				\$462,528



1408 B Roseneath Road
Richmond, VA 23230

Corporate Headquarters
5020 Montrose Blvd. Suite 650
Houston, TX 77006
Main: 713.520.5400

January 12, 2018

Frederick T.M. Pribble, PE
Wiley|Wilson
6606 West Broad Street, Suite 500
Richmond, Virginia 23230

**Re: Staunton—Gardner Springs Pump Station
Summary of Findings and Permitting Memo**

Dear Mr. Pribble,

RES completed a preliminary Waters of the U.S. (WOUS) investigation for the above referenced project on January 11, 2018 in accordance with the *Corps of Engineers' Wetlands Delineation Manual* (U.S. Army Corps of Engineers, 1987) as well as the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0)* to identify resources that would potentially fall under jurisdiction of the U.S. Army Corps of Engineers (Corps). This method uses a three-parameter approach including indicators of vegetation, soils, and hydrology that must be present for an area to be identified as jurisdictional.

The project area is located approximately 2.53 miles east of Churchville, Virginia, north of the Middle River, and south of Hundley Distillery Road (Route 728), and can be accessed from a gravel lot adjacent to the project area (Appendix A). The project area consists of an existing pump station and its associated lot, and an approximate 200-foot section of the Middle River and its associated floodplain. The Middle River does fall under the jurisdiction of both the Corps and the Virginia Marine Resources Commission (VMRC). Based on the on-site field investigation of the approximately 0.74-acre project area, RES did not identify the presence of any additional WOUS, including wetlands, inside the project area. Detailed data sheets are attached for review (Appendix B).

These findings are consistent with the review of desktop resources, including the USGS topographical map for Staunton, Virginia which indicated that the project area is in the floodplain of the Middle River. Similarly, a review of the National Wetlands Inventory (NWI) did not indicate the presence of any additional WOUS inside the project area. According to the NRCS Web Soil Survey, the site is primarily underlain with Frederick-Christian gravelly silt loams, soils listed as non-hydric in Augusta County, Virginia (Appendix C). Soils observed on-site did not meet hydric soil indicators as defined in the EMP regional supplement (7.5YR 4/3 with no redox concentrations). Please see the attached Preliminary Waters of the U.S Investigation map located in Appendix D.

The preliminary WOUS investigation identified the Middle River as the only jurisdictional feature within the project area. VMRC would also take jurisdiction over the Middle River because it has a drainage area greater than five square miles. It appears that the project as currently proposed, including upgrades to the existing pump station or the construction of a new pump station directly adjacent to the existing station, would not impact any jurisdictional streams or wetlands.



Therefore, we do not anticipate that the project will require a permit from the Corps, VMRC, or the Virginia Department of Environmental Quality (401/404 permitting). The project may require an E&S plan, County/City approval, and coordination with FEMA for land disturbance and work in the 100-year floodplain. If the scope of the project changes including an increase in the amount of water withdrawn or any work within, over, or under the Middle River, then permits will likely be required from one or more of the above listed agencies. If you have any questions concerning this correspondence or the project in general, please feel free to contact me at your convenience.

Best Regards,

Michael Molnar
Field Ecologist
804-729-8988

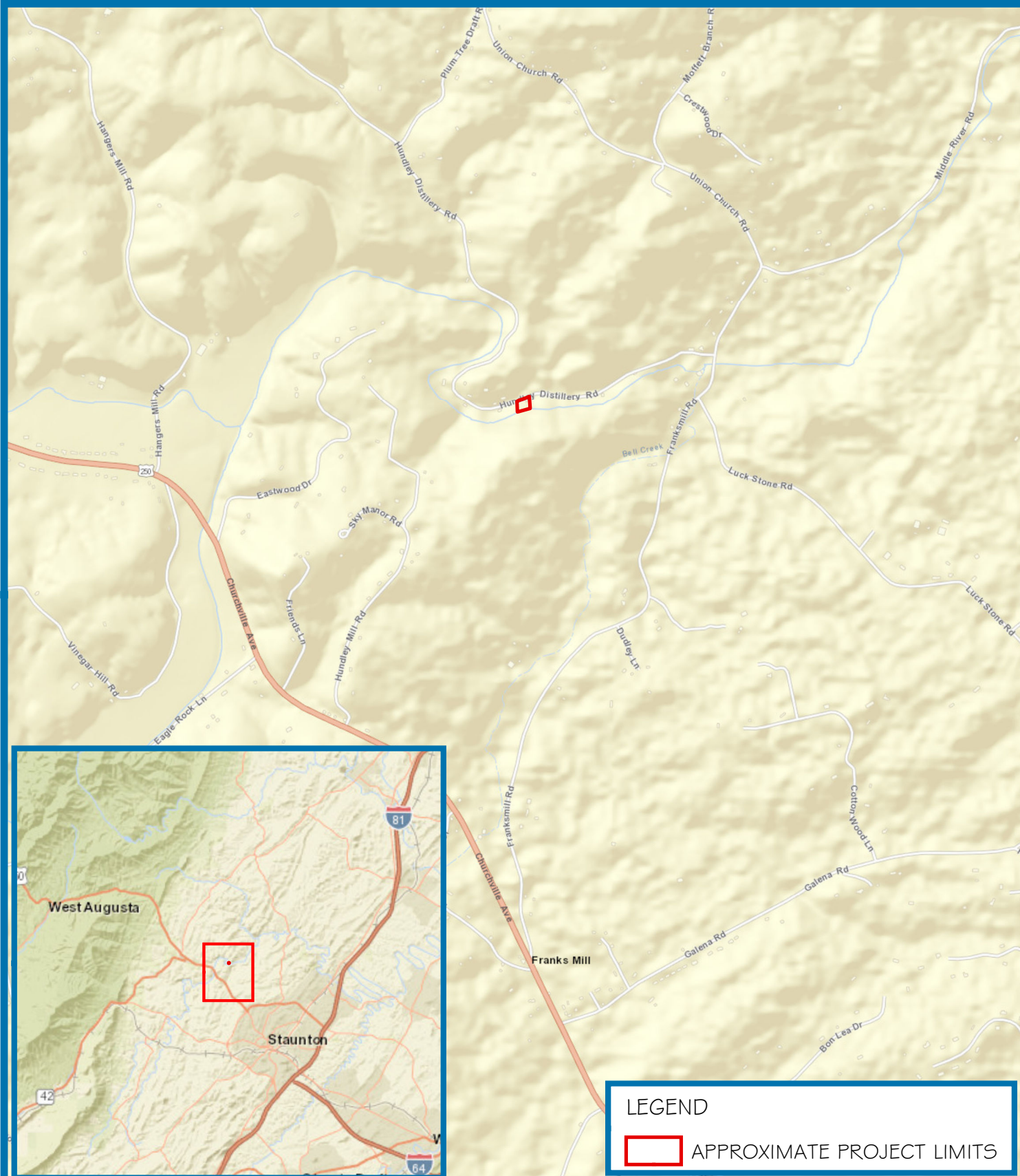
Anna Stuart Lambert
Project Manager
804-729-8984

Attachments:

- Appendix A – Project Location and Vicinity Maps
- Appendix B – Wetland Delineation Data Sheet
- Appendix C – NWI and Soils Maps
- Appendix D – Preliminary WOUS Investigation Map



Appendix A – Project Location and Vicinity Maps



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VICINITY MAP

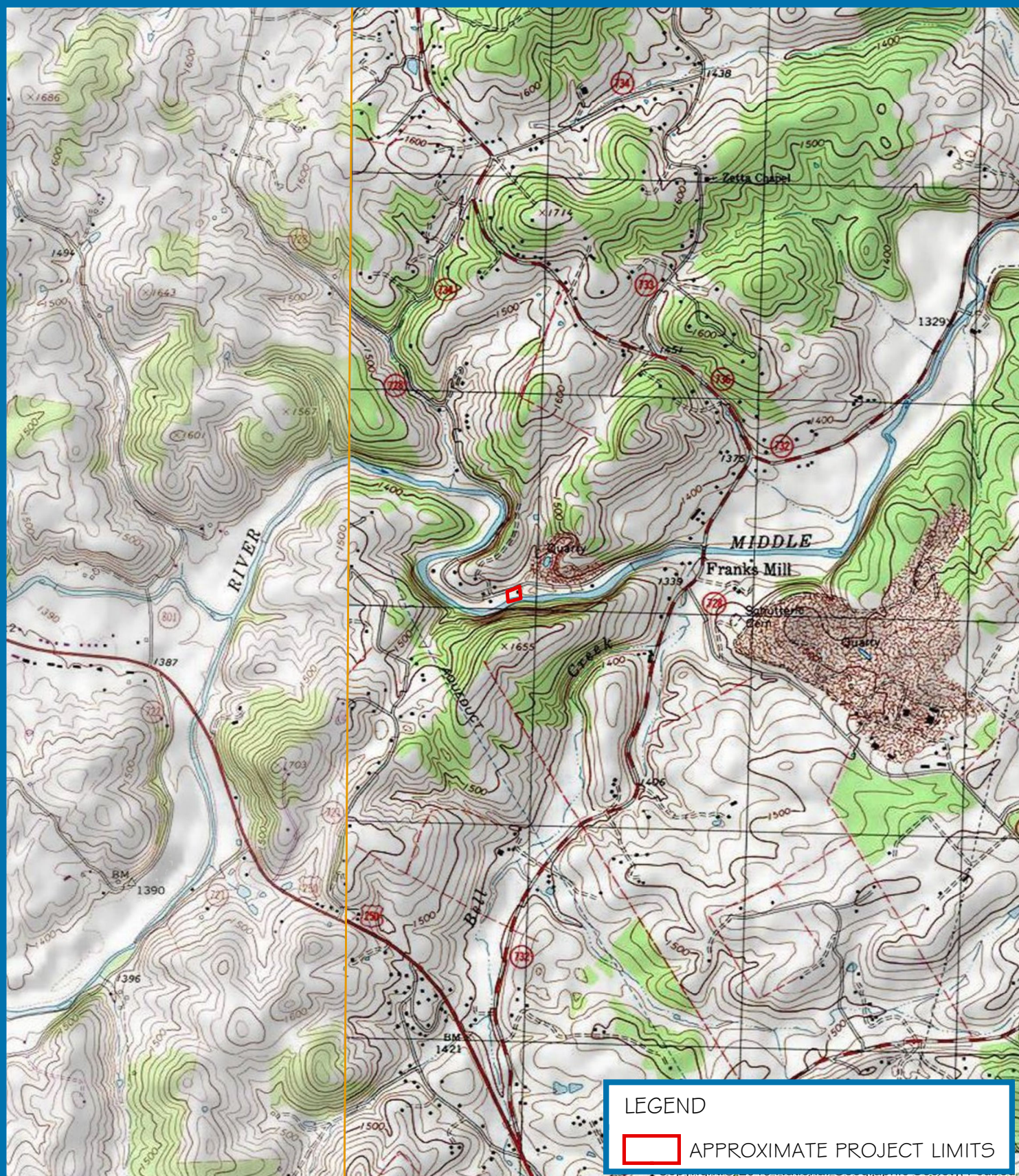
STAUNTON PUMP STATION

AUGUSTA COUNTY, VIRGINIA

Street Map Source:
World Street Map
ESRI ArcGIS Online



1 inch = 2,000 feet



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PROJECT LOCATION MAP

STAUNTON PUMP STATION

AUGUSTA COUNTY, VIRGINIA

USGS Topo Quads: Staunton

Latitude: 38.2215

Longitude: -79.1162

Approx. Project Area: 0.74 acres

Elevation: 1346 - 1362 feet

Scale: 1 inch = 2,000 feet

Source: <http://resources.arcgis.com/>

USA Topo Maps





Appendix B – Wetland Delineation Data Sheet

WETLAND DETERMINATION DATA FORM - Eastern Mountains and Piedmont Region

Project/Site: Staunton-Gardner Pump Station **City/County:** Augusta County **Sampling Date:** 11-Jan-18
Applicant/Owner: Wiley|Wilson **State:** VA **Sampling Point:** 1
Investigator(s): M. Molnar **Section, Township, Range:** S T R
Landform (hillslope, terrace, etc.): Floodplain **Local relief (concave, convex, none):** flat **Slope:** 0.0% / 0.0 °
Subregion (LRR or MLRA): LRR P **Lat.:** 38.2215 **Long.:** -79.1162 **Datum:** NAD83
Soil Map Unit Name: 42E2-Frederick Christian gravelly silt loam **NWI classification:** Upland

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐ , **Soil** ☐ , **or Hydrology** ☐ **significantly disturbed?** **Are "Normal Circumstances" present?** Yes ☒ No ☐

Are Vegetation ☐ , **Soil** ☐ , **or Hydrology** ☐ **naturally problematic?** (If needed, explain any answers in Remarks.)

Summary of Findings - Attach site map showing sampling point locations, transects, important features, etc

Hydrophytic Vegetation Present? Yes ☒ No ☐ Hydric Soil Present? Yes ☐ No ☒ Wetland Hydrology Present? Yes ☐ No ☒	Is the Sampled Area within a Wetland? Yes ☐ No ☒
Remarks:	

Hydrology

Wetland Hydrology Indicators:		<u>Secondary Indicators (minimum of two required)</u>	
<u>Primary Indicators (minimum of one required; check all that apply)</u>			
☐ Surface Water (A1)	☐ True Aquatic Plants (B14)	☐ Surface Soil Cracks (B6)	
☐ High Water Table (A2)	☐ Hydrogen Sulfide Odor (C1)	☐ Sparsely Vegetated Concave Surface (B8)	
☐ Saturation (A3)	☐ Oxidized Rhizospheres along Living Roots (C3)	☐ Drainage Patterns (B10)	
☐ Water Marks (B1)	☐ Presence of Reduced Iron (C4)	☐ Moss Trim Lines (B16)	
☐ Sediment Deposits (B2)	☐ Recent Iron Reduction in Tilled Soils (C6)	☐ Dry Season Water Table (C2)	
☐ Drift deposits (B3)	☐ Thin Muck Surface (C7)	☐ Crayfish Burrows (C8)	
☐ Algal Mat or Crust (B4)	☐ Other (Explain in Remarks)	☐ Saturation Visible on Aerial Imagery (C9)	
☐ Iron Deposits (B5)		☐ Stunted or Stressed Plants (D1)	
☐ Inundation Visible on Aerial Imagery (B7)		☐ Geomorphic Position (D2)	
☐ Water-Stained Leaves (B9)		☐ Shallow Aquitard (D3)	
☐ Aquatic Fauna (B13)		☐ Microtopographic Relief (D4)	
		☐ FAC-neutral Test (D5)	
Field Observations:			
Surface Water Present?	Yes ☐ No ☒	Depth (inches):	
Water Table Present?	Yes ☐ No ☒	Depth (inches):	
Saturation Present? (includes capillary fringe)	Yes ☐ No ☒	Depth (inches):	
		Wetland Hydrology Present?	Yes ☐ No ☒
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:			
Remarks:			

VEGETATION (Five/Four Strata)- Use scientific names of plants.

Sampling Point: 1

		Absolute % Cover	Dominant Species? Rel.Strat. Cover	Indicator Status		
Tree Stratum (Plot size: <u>30'</u>)						
1.	<u>Quercus rubra</u>	25	☒	62.5%	FACU	
2.	<u>Platanus occidentalis</u>	10	☒	25.0%	FACW	
3.	<u>Quercus rubra</u>	5	☐	12.5%	FACU	
4.		0	☐	0.0%		
5.		0	☐	0.0%		
6.		0	☐	0.0%		
7.		0	☐	0.0%		
8.		0	☐	0.0%		
		40	= Total Cover			
Sapling-Sapling/Shrub Stratum (Plot size: <u>15'</u>)						
1.	<u>Acer negundo</u>	5	☒	100.0%	FAC	
2.		0	☐	0.0%		
3.		0	☐	0.0%		
4.		0	☐	0.0%		
5.		0	☐	0.0%		
6.		0	☐	0.0%		
7.		0	☐	0.0%		
8.		0	☐	0.0%		
9.		0	☐	0.0%		
10.		0	☐	0.0%		
		5	= Total Cover			
Shrub Stratum (Plot size: <u> </u>)						
1.	<u>Ligustrum sinense</u>	5	☒	100.0%	FACU	
2.		0	☐	0.0%		
3.		0	☐	0.0%		
4.		0	☐	0.0%		
5.		0	☐	0.0%		
6.		0	☐	0.0%		
7.		0	☐	0.0%		
		5	= Total Cover			
Herb Stratum (Plot size: <u>5'</u>)						
1.	<u>Verbesina alternifolia</u>	15	☒	25.0%	FAC	
2.	<u>Plantago major</u>	5	☐	8.3%	FACU	
3.	<u>Elymus virginicus</u>	10	☒	16.7%	FACW	
4.	<u>Stellaria media</u>	10	☒	16.7%	UPL	
5.	<u>Microstegium vimineum</u>	10	☒	16.7%	FAC	
6.	<u>Allium vineale</u>	5	☐	8.3%	FACU	
7.	<u>Solidago altissima</u>	5	☐	8.3%	FACU	
8.		0	☐	0.0%		
9.		0	☐	0.0%		
10.		0	☐	0.0%		
11.		0	☐	0.0%		
12.		0	☐	0.0%		
		60	= Total Cover			
Woody Vine Stratum (Plot size: <u>30'</u>)						
1.	<u>Lonicera japonica</u>	20	☒	100.0%	FACU	
2.		0	☐	0.0%		
3.		0	☐	0.0%		
4.		0	☐	0.0%		
5.		0	☐	0.0%		
6.		0	☐	0.0%		
		20	= Total Cover			
Remarks: (Include photo numbers here or on a separate sheet.)						

Dominance Test worksheet:

Number of Dominant Species That are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of dominant Species That Are OBL, FACW, or FAC: 55.6% (A/B)

Prevalence Index worksheet:

Total % Cover of: Multiply by:

OBL species 0 x **1** = 0

FACW species 20 x **2** = 40

FAC species 30 x **3** = 90

FACU species 70 x **4** = 280

UPL species 10 x **5** = 50

Column Totals: 130 (A) 460 (B)

Prevalence Index = B/A = 3.538

Hydrophytic Vegetation Indicators:

☐ Rapid Test for Hydrophytic Vegetation

☒ Dominance Test is > 50%

☐ Prevalence Index is ≤3.0 ¹

☐ Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation ¹. (Explain)

¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definition of Vegetation Strata:

Four Vegetation Strata:

Tree stratum – Consists of woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub stratum – Consists of woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb stratum – Consists of all herbaceous (non-woody) plants, regardless of size, and all other plants less than 3.28 ft tall.

Woody vines – Consists of all woody vines greater than 3.28 ft in height.

Five Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling stratum – Consists of woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub stratum – Consists of woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb stratum – Consists of all herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody species, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vines – Consists of all woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☒ No ☐

*Indicator suffix = National status or professional decision assigned because Regional status not defined by FWS.

Sampling Point: 1

US Army Corps of Engineers Eastern Mountains and Piedmont - Version 2.0

Plot ID:

1

Photo Path: C:\Wetform\6932 Gardner Pump Station\photos\



Photo File: **P1010343.JPG**

Orientation:

-facing

Lat/Long or UTM: Long/Easting: **-79.1162**

Lat/Northing: **38.2215**

Description: Soil



Photo File: **P1010344.JPG**

Orientation:

-facing

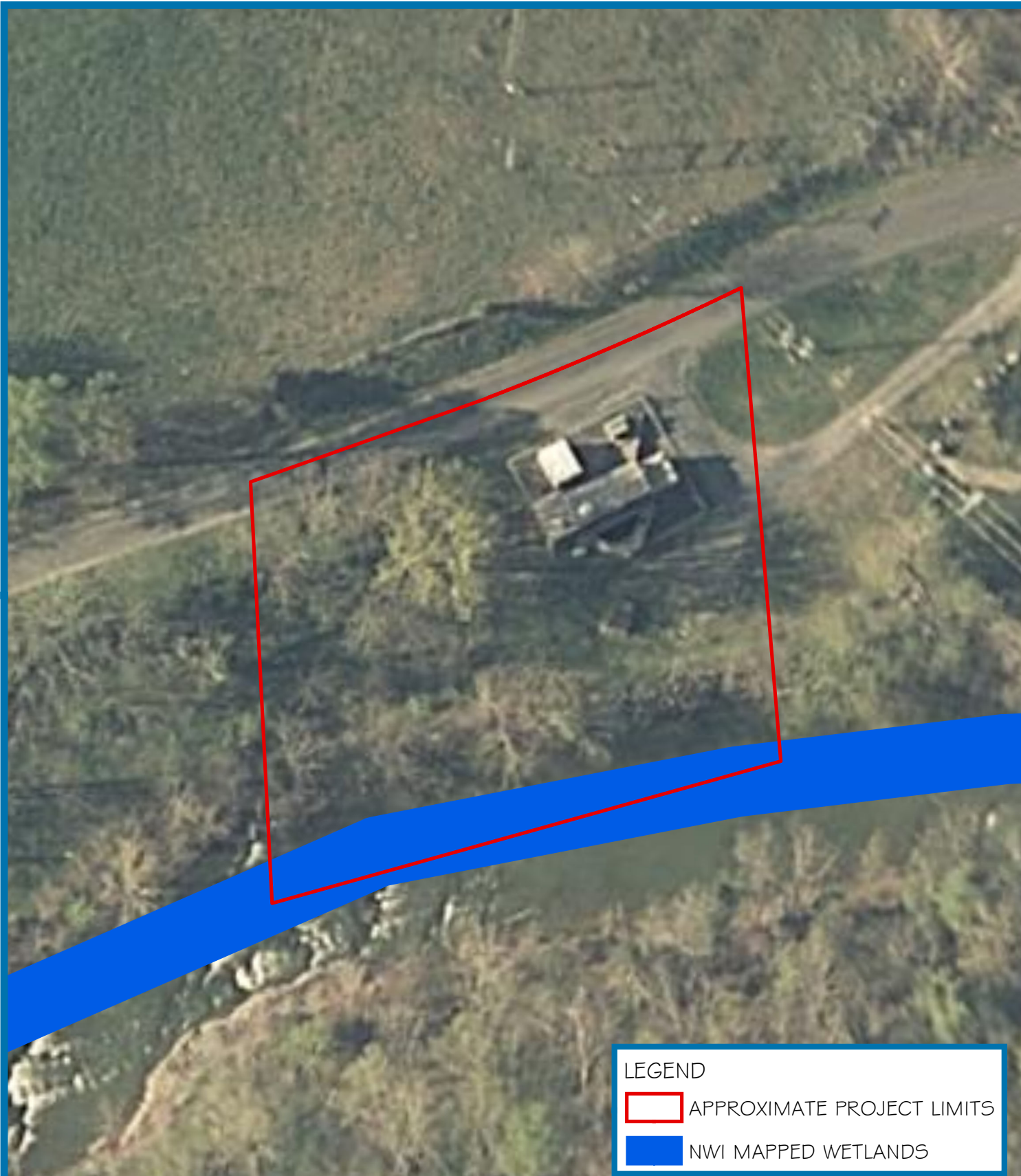
Lat/Long or UTM: Long/Easting: **0**

Lat/Northing: **0**

Description: Vicinity



Appendix C – NWI and Soils Maps



LEGEND

 APPROXIMATE PROJECT LIMITS

 NWI MAPPED WETLANDS



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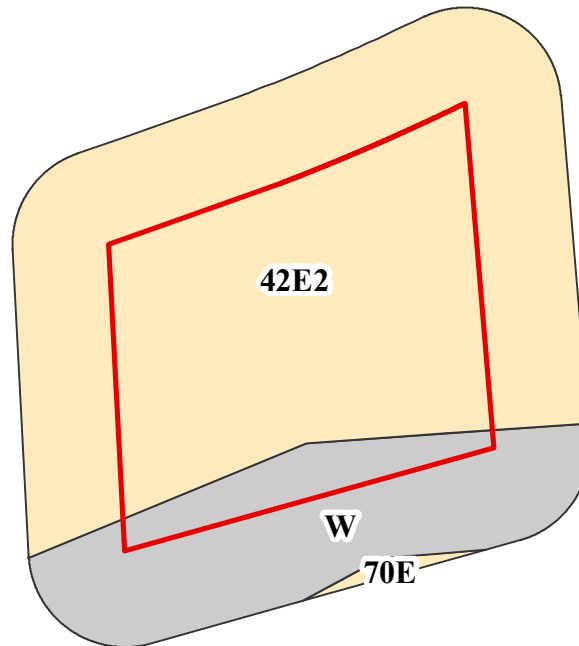
NATIONAL WETLANDS
INVENTORY MAP

STAUNTON PUMP STATION
AUGUSTA COUNTY, VIRGINIA

Digital Ortho Photo Source:
VBMP Most Recent Imagery
Virginia Lambert (VGIN)
National Inventory Wetlands (NWI)
Source
<http://www.fws.gov/>

1 inch = 50 feet





Hydric Soils:
NONE

Soils with Hydric Inclusions:
NONE

Non-hydric Soils:
42E2 - Frederick-Christian gravelly silt loams

Unknown Soil Type:
W Water

LEGEND

- APPROXIMATE PROJECT LIMITS
- HYDRIC SOIL
- SOIL WITH HYDRIC INCLUSIONS
- NON-HYDRIC SOIL
- UNKNOWN SOIL



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SOILS MAP

STAUNTON PUMP STATION

AUGUSTA COUNTY, VIRGINIA

Source:
U.S. Department of Agriculture
Natural Resources
Conservation Service
Soil Survey Geographic
(SSURGO)

1 inch = 100 feet





Appendix D – Preliminary WOUS Investigation Map



WETLANDS

TOTAL PEM = 0.00 +/- AC

TOTAL PFO = 0.00 +/- AC

TOTAL PSS = 0.00 +/- AC

TOTAL WETLANDS = 0.00 +/- AC

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STAUNTON PUMP STATION

PRELIMINARY WATERS OF THE U.S.
INVESTIGATION

AUGUSTA COUNTY, VIRGINIA

PROJECT MANAGER:	TL
DRAWN:	TD
JOB NUMBER:	6932
REVISIONS:	NONE



FROEHLING & ROBERTSON, INC.

Engineering Stability Since 1881

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Crozet, Virginia 22932
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F&R Record No. 71V0232

February 26, 2018

Mr. Aaron Tice, P.E.
Wiley Wilson
127 Nationwide Drive
Lynchburg, VA 24502

Subject: Staunton Pump Station
Augusta County, Virginia

Dear Mr. Tice:

Froehling and Robertson, Inc. (F&R) is pleased to submit the results of our subsurface exploration at the subject site. The purpose of our involvement on the project was to conduct the subsurface exploration program consisting of two (2) test borings designated B-1 and B-2, which was performed on February 19, 2018, at the locations determined by Wiley Wilson, visually classify soil samples, and prepare computer generated boring logs.

The test boring was performed in accordance with generally accepted practices using a track mounted CME-55 rotary drill rig. Hollow-stem augers were advanced to pre-selected depths, the center plug was removed, and representative soil samples were recovered with a standard split-spoon sampler (1 3/8 in. ID, 2 in. OD) in general accordance with ASTM D 1586, the Standard Penetration Test (SPT). Utilizing an automatic hammer, the split-spoon sampler was driven into the soil by freely dropping a weight of 140 pounds from a height of 30 inches. The number of blows required to drive the split-spoon sampler three consecutive 6-inch increments is recorded, and the blows of the last two increments are summed to obtain the Standard Penetration Resistance (N-value). The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils.

The test borings were advanced through the soil overburden to auger refusal depths of 6.7 feet and 6 feet. Subsurface water level readings were taken in the boring, during drilling and immediately upon completion of the drilling process. Upon completion of drilling, the boreholes were backfilled with auger cuttings (soil) prior to demobilization. Periodic observation of the boreholes should be performed to monitor subsidence at the ground surface, as the boreholes backfill could settle over time.



Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory. In the laboratory, the soil samples were evaluated by a member of our professional staff in general accordance with techniques outlined in the visual-manual identification procedure (ASTM D 2488) and the Unified Soil Classification System (USCS). The soil descriptions and classifications discussed in this report and shown on the attached boring log are based on visual observation and should be considered approximate. A copy of the boring logs are provided, and classification procedures are further explained in the attachments.

The transitions between different soil strata are usually less distinct than those shown on the boring logs. Sometimes the relatively small sample obtained in the field is insufficient to definitely describe the origin of the subsurface material. In these cases, we qualify our origin descriptions with "possible" before the word describing the material's origin (i.e. possible fill, etc.). Although individual test borings are representative of the subsurface conditions at the boring location on the date shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific test borings are shown on the attached boring logs.

Split-spoon soil samples recovered on this project will be stored at F&R's office for a period of sixty days. After sixty days, the samples will be discarded unless prior notification is provided to us in writing.

Froehling & Robertson, Inc., appreciates the opportunity to work with you on this project. If there are any questions or if we may be of further service, please contact either of the undersigned.

Very truly yours,

FROEHLING & ROBERTSON, INC.

Matthew Hospodar, G.I.T.
Geotechnical Project Manager

Clyde A. Simmons III, P.E.
Senior Geotechnical Engineer

Enclosures: Unified Soil Classification System
 Key to Boring Log Soil Classification
 Boring Logs



UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 Sieve), coarse-grained soils are classified as follows: Less than 5 per cent More than 12 per cent 5 to 12 per cent GW, GP, SW, SP GM, GC, SM, SC Borderline cases requiring dual symbols	C_u = D_{60}/D_{10} greater than 4; C_c =(D_{30}) ² /(D_{10} × D_{60}) between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below “A” line or PI less than 4	Above “A” line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below “A” line or PI greater than 7	
	Sands (More than half of coarse fraction is smaller than No.4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		C_u = D_{60}/D_{10} greater than 6; C_c =(D_{30}) ² /(D_{10} × D_{60}) between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits above “A” line or PI less than 4	Above “A” line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above “A” line or PI greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	Plasticity Chart			
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays				
		OL	Organic silts and organic silty clays of low plasticity				
	Silts and clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
		CH	Inorganic clays of high plasticity, fat clays				
		OH	Organic clays of medium to high plasticity				
	Highly organic soils	Pt	Peat and other highly organic soils				



KEY TO BORING LOG SOIL CLASSIFICATION

Particle Size and Proportion

Verbal descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size		Proportion		
Descriptive Terms		Descriptive Terms		
Soil Component	Particle Size	Component	Term	Percentage
Boulder	> 12 inch	Major	Uppercase Letters (e.g., SAND, CLAY)	>50%
Cobble	3 – 12 inch	Secondary	Adjective (e.g. sandy, clayey)	20%-50%
Gravel-Coarse	¾ - 3 inch			
-Fine	#4 – ¾ inch			
Sand-Coarse	#10 - #4	Minor	Some Little Trace	15%-25%
-Medium	#40 - #10			
-Fine	#200 - #40			
Silt (non-cohesive)	< #200			
Clay (cohesive)	< #200			5%-15%
				0%-5%

Notes:

1. Particle size is designated by U.S. Standard Sieve Sizes
2. Because of the small size of the split spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.

Density or Consistency

The standard penetration resistance values (N-values are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

DENSITY		CONSISTENCY	
Term	N-Value	Term	N-Value
Very Loose	0 – 4	Very Soft	0 – 1
Loose	5 – 10	Soft	2 – 4
Medium-Dense	11 – 30	Medium Stiff	5 – 8
Dense	31 – 50	Stiff	9 – 15
Very Dense	> 50	Very Stiff	16 – 30
		Hard	>30

Notes:

1. The N-value is the number of blows of a 140 lb. hammer freely falling 30 inches required to drive a standard split-spoon sampler (2.0 in. O.D., 1-3/8 in. I.D.) 12 inches into the soil after properly seating the sampler 6 inches.
2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.



Froehling & Robertson, Inc.

BORING LOG

Boring: B-1 (1 of 1)

Project No: 71V0232

Client: Wiley / Wilson

Project: Staunton Pump Station

City/State: Staunton, Virginia

Elevation: 1351 ±

Total Depth: 6.7'

Boring Location: See Boring Location Plan

Drilling Method: HSA

Hammer Type: Automatic

Date Drilled: 2/19/18

Driller: S. Martin

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1350.9	0.1	Surficial Organics	2-2-8	0.0	10	
		Brown, Moist, Loose, Fine to Coarse, Silty SAND (SM), Little Gravel		1.5		
1348.5	2.5	FILL	5-5-4	2.5	9	
		Brown, Moist, Loose, Fine to Medium, Silty SAND (SM), Trace Gravel		4.0		
1346.0	5.0	ALLUVIUM	32-19-26	5.0	45	
		Gray, Wet, Dense, Fine to Coarse, Well Graded GRAVEL (GP)		6.5		
1344.3	6.7	RESIDUUM				
		Auger Refusal at 6.7 Feet				

BORING LOG (LONG NAME) 71V0232.GPJ F&R.GDT 2/21/18

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N-Value.



Froehling & Robertson, Inc.

BORING LOG

Boring: B-2 (1 of 1)

Project No: 71V0232

Client: Wiley / Wilson

Project: Staunton Pump Station

City/State: Staunton, Virginia

Elevation: 1351 ±

Total Depth: 6.0'

Boring Location: See Boring Location Plan

Drilling Method: HSA

Hammer Type: Automatic

Date Drilled: 2/19/18

Driller: S. Martin

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1350.5	0.5	Surficial Organics	woh-2-2	0.0	4	
		Brown, Moist, Loose, Fine to Medium, Silty SAND (SM)		1.5		
		ALLUVIUM	2-3-3	2.5	6	
				4.0		
1346.0	5.0	Brown, Moist, Soft, Sandy SILT (ML), Trace Gravel	1-50/5	5.0	100+	
1345.0	6.0	ALLUVIUM		5.9		
		Auger Refusal at 6 Feet				

BORING LOG (LONG NAME) 71V0232.GPJ F&R.GDT 2/21/18

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N-Value.

CONSTANT PROGRESS