General Plan
Water System Improvements

Village of Ashville, Ohio
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REPORT 2023

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Table of Contents

List of Tables

List of Figures

Appendices

Section 1 – Introduction

The Village of Ashville is located in northeast Pickaway County, Ohio. The Village owns, operates, and maintains the existing groundwater treatment plant, originally constructed in 1935. The plant was expanded in 1970 to install additional filters, softeners and a new aerator. The plant serves the Village population of an estimated 4,529 according to the 2020 census. The Village currently does not supply water service or bulk water to any other entity at this time however it does have an emergency connection with South Bloomfield. The Village has started design to connect the distribution system to Earnhart Hills to obtain an additional supply of 130,000 gpd. The Village operates three wells that supply raw water to the Water Treatment Plant (WTP) that typically operates 18-19 hours a day and has a capacity of around 0.6 mgd.

The current plant's treatment process is relatively simple and involves chlorination, aeration, filtration, disinfection and softening. The plant is manually operated. The raw water is pumped to the aerator then into a detention basin. Chlorine is injected prior to aeration to allow for disinfection to take place in the settling tank. Water is then fed to two sets of filters before being softened using ion exchange softening. Finished water is stored in a clearwell before three high service pumps pump the water to the distribution system.

The Village's water system also includes 660,000 gallons of elevated storage tanks across three towers. The distribution system as a whole provides potable water to 1,624 connections and provided fire protection for the Village.

The adequacy of the water plant's design has been evaluated and compared against the Ohio Environmental Protection Agency (Ohio EPA) design criteria for plants treating groundwater supplies. Available test results indicate that the treated water produced by the Village's WTP has recently exceeded the secondary maximum contaminant levels for iron and manganese due to poor filter performance. There have been periodic improvements and equipment replacement, since the existing plant first went on-line in 1935, but the plant is deteriorating. Given the age and state of the plant, the rapidly increasing population and service area, the Village has determined there is a need to construct a new treatment plant.

Distribution storage capacity is also a concern. The sprawling population north of town is in need of additional storage for adequate pressure and fire flow. A new elevated tank at the north end of the Village is also vital to the long term stability of the water system.

Section 2 – Purpose

The purpose of this report is to:

- Discuss existing water system.
- Detail why a new water facility is necessary.
- Investigate future conditions of the water system, specifically pertaining to capacity and present and future regulatory compliance.
- Investigate alternatives for a new treatment plant and other system upgrades.
- Select an alternative based on costs, operations, reliability, and environmental impacts.
- Provide an estimate for selected alternative and associated impact on water rates.
- Investigate environmental impacts associated with the new project.
- Identify funding sources for the project.

Section 3 – Existing Situation

3.1 Raw Water

3.1.1 Water Source

The Village of Ashville owns, operates and maintains the local groundwater treatment plant which supplies water to the community. The community served had a population of approximately 4,529 according to the 2020 census. The Village does not provide bulk water to any other entity via the distribution system.

The WTP currently obtains its raw water supply from three Village owned wells that draw water from underground aquifers. The WTP currently utilizes two on-site wells (Wells 2 and 3) and an off-site well (Well 4). A new well adjacent to Well 4, Well 5 is currently being placed online pending OEPA approval. Wells 4 and 5 are located off Lockbourne Eastern Road. Well 4 is off-site and Well 5 is set to begin operation shortly which will allow for Ashville to abandon their last on-site well. Wells 4 and 5 will have a pumping capacity of 1200gpm and 1400gpm respectively. Wells 2 and 3 will be abandoned when Well 5 is permanently placed online and therefore only Wells 4 and 5 are being considered as viable wells in this report.

3.1.2 Raw Water Quality

The table below summarizes the raw water characteristics for Wells 4 and 5 from samples taken in 2014 and 2022 respectively.

Table 1
Raw Water Quality

Parameter	Well 4	Well 5
Total Alkalinity (as CaCO3 mg/L)	315	288
pH	7.03	7.47
Temperature (°C)	13	
Total Hardness (as CaCO3 mg/L)	346	328
Fluoride (mg/L)	1.04	
Arsenic (ug/L)	8.3	11.6
Iron (mg/L)	1670	1690
Manganese (mg/L)	64	31
Sulfate (ug/L)	54.9	65
Nitrogen, Ammonia	0.6	0.3

ND = Not Detected

3.2 Treated Water

The table below summarizes the treated water characteristics of finished water samples taken in 2021.

Table 2
Treated Water Quality

Parameter	Average
Total Hardness (as CaCO3 mg/L)	292
pH	7.6
Iron (mg/L)	0.17
Manganese (mg/L)	0.03
Arsenic (ug/L)	ND
Chlorine Residual (mg/l)	0.54

3.3 Drinking Water Problems

Iron and Manganese have exceeded their secondary maximum contaminant levels for 20 weeks and four weeks respectively over a five year period. The aerator is not working properly. The blower is not functional and scale and iron build up on the slots do not allow for proper operation. Insufficient aeration does not allow for enough iron and manganese to be oxidized and insoluble. The filters can only remove oxidized iron and manganese and the lack of aeration limits the amount that can be removed. The filter media is also past its useful life and is not properly removing iron and manganese that has been oxidized. The filters were recently cleaned and washed of built-up calcium carbonate to provide better treatment. The ion exchanger softeners are removing very little hardness, indicating the resin is past its useful life. Resin effectiveness has likely been reduced to high levels of chlorine maintained throughout treatment that is necessary for oxidation.

3.4 Existing Service Area and Population Served

The Village of Ashville's water system serves the Village of Ashville and as well as 24 connections outside the city. Ashville has a population of 4,529 according to the 2020 census report.

The Village of Ashville and Pickaway County Population data, along with a breakdown of customer classification, is presented in the tables below.

Table 3
Village of Ashville Population Data

Year	Population (US Census)	Population Change	Percent Change
1970	1,772	N/A	-N/A
1980	2,046	274	15.5%
1990	2,254	208	10.2%
2000	3,174	920	40.8%
2010	4,097	923	29.1%
2020	4,529	432	10.5%

Table 4
Pickaway County Population Data

Year	Population (US Census)	Population Change	Percent Change
1970	40,071	N/A	--
1980	43,662	3,591	9.0%
1990	48,255	4,593	10.5%
2000	52,727	4,472	9.3%
2010	55,698	2,971	5.6%
2020	58,539	2,841	5.1%

Table 5
Customer Classification

Service Area	Category	No. Customers	Percent Customers	Percent Water Usage
Total	Residential	1530	94.2%	66.5%
	Commercial	72	4.4%	3.5%
	Industrial	4	0.2%	19.5%
	Public	18	1.1%	10.5
Total	All	1624	100%	100%

3.5 Existing Water Demand

The existing water demand for the years 2019 to September 2022 is presented in Table 6. This demand represents the water production in million gallons per day (mgd) from the Ashville WTP with the maximum-day, average-day, and minimum-day demands for the given time period. The maximum-day to average-daily flow and minimum-day to average-daily ratios were also calculated. These ratios can be used when estimating future water demands.

Table 6
Water Demand (mgd)

Year	Max Flow	Avg Flow	Min Flow	Max Avg Ratio	Min Avg Ratio
2019	0.667	0.531	0.215	1.26	0.40
2020	0.757	0.486	0.255	1.56	0.52
2021	0.711	0.468	0.143	1.52	0.31
2022	0.678	0.536	0.189	1.26	0.35
Average	0.703	0.505	0.201	1.40	0.40

3.6 Existing Facilities

3.6.1 General

The existing WTP was constructed in 1934 and consisted of an aerator, detention basin, and two filters to remove iron from the groundwater. Two wells fed the WTP one pre-existing, and another drilled at the time of construction. A softening system was added in 1948. In 1970 the aerator and detention basin were replaced and added to a new building addition that provided additional lab and office space. An additional set of filters and another softening tank were also a part of these improvements. In 2001, the WTP switched from chlorine gas to sodium hypochlorite, control systems were updated, and a generator was installed along with improvements to the structure. The current treatment system consists of chlorination, aeration, filtration, and softening. Chlorine is fed as sodium hypochlorite prior to aeration and is softened using two sets of ion exchangers. The existing plant is assumed to have a rated capacity of approximately 500 gpm based on the filter capacity. A location map and an existing site plan can be found in Figures 1 and 2 respectively in Appendix A.

The existing building, piping, equipment and electrical systems are all aging and in poor condition. There are structural cracks, rusting pipes, and deteriorating equipment. Many of these issues are beyond repair.

3.6.2 Treatment Process

In Ohio, the design requirements for water treatment processes are established by the Ohio EPA. These requirements are, for the most part, are based on “Ten States Standards” and are tailored by Ohio EPA to Ohio’s specific water supply and treatment conditions and the agency’s policies.

The existing plant provides treatment through aeration to oxidize the well water to help remove iron and manganese. Hypochlorite is fed prior to aeration to allow for sufficient disinfection contact time in the detention basin that is fed by the aerator effluent. The detention basin is 17 feet x 11 feet x 8 feet deep. The water is then gravity fed to four filters arranged in two sets of two that utilize sand as filter media to remove primarily iron and manganese. The filter effluent is then stored in a clearwell located partially underneath the facility and partially on the exterior of the building. The water is then pumped using two high service pumps to the softening system. The softening system consists of four ion exchange softening tanks and feeds from the softeners to the Village’s distribution system.

3.6.3 Wells

There are 4 wells onsite at the WTP with one being abandoned and filled prior to the 1970 improvements and another in the time afterwards. Wells 2 and 3 are currently in use with plans to abandon them once Well 5 is operational. Well 4 is offsite located south of the WTP off Lockbourne Eastern Road. Well 5 is in development and will be located off site with Well 4. Wells 4 and 5 will supply 1200 and 1400 gpm respectively. The raw water supply line runs along Lockbourne Eastern Road before continuing on Station Street and entering the plant from the North. The raw water from the onsite wells has a separate intake line and each line has an isolation valve prior to the riser pipe that feeds the aerator.

3.6.4 Chlorine Feed System

Sodium hypochlorite provides oxidation and disinfection is the only chemical fed at the WTP. Hypochlorite is fed prior to aeration on the riser pipe that feeds to the aerator. This provides disinfection and additional oxidation in the detention basin. Excess hypochlorite is currently being fed to make up for the lack of oxidation caused by aeration. The hypochlorite is stored in 275 gallon tanks in the chlorine room adjacent to the detention basin. There is an eyewash station onsite, however it is not located in close proximity to the chlorine feed room.

Figure 1: Chlorine Storage Room

Figure 2: Chlorine Feed Point

3.6.5 Aeration

The raw water is pumped from the wells and flows through the aerator. The original aerator was installed in 1934 and replaced in 1970 and is still in use today. The aerator in combination with sodium hypochlorite oxidizes the well water to convert ferrous iron into ferric iron to be filtered. The water is then fed to the detention basin below. The aerator does not function properly. The blower does not work, and the aerator slots have scale and iron build up that cause it to not operate properly. Chlorine is injected prior to aeration and has taken on a portion of the oxidation load. Any iron or manganese not oxidized by the aerator or chlorine is unable to be removed by the filters. The aerator is located on top of the existing WTP and its position makes access difficult and a safety concern.

Figure 3: Aerator

3.6.6 Detention Basin

The WTP has a detention basin with dimensions 17 feet x 11 feet x 8 feet deep and holds approximately 11,000 gallons of water. The aerator sits directly on top of the detention basin and allows for the aerated water to flow directly into the basin for oxidation. The detention basin is in poor condition and in need of repair. The basin has several structural issues and is prone to short circuiting. The tank is also undersized for the flow required for the WTP and does not allow for a minimum of 30 minutes of contact time to ensure the oxidation reactions are as complete as possible. The only access to the detention basin for cleaning or inspection is via a side wall entrance. The entrance requires climbing a ladder making it difficult and unsafe to access.

Figure 4: Access to Detention Tank

3.6.7 Filtration

The WTP has four gravity filters in two sets of two filters each. The filters are single media filters consisting of sand above a bed of gravel. The filters operate at 500 gpm with all filters operating at once. This correlates to a total filtration capacity of 3.0 gpm per square foot. The filters have no air scour and cannot backwash at the proper rate or provide proper bed expansion. The first set of filters, Filters 1 and 2 are from the original 1934 plant each with dimensions of 8 feet x 5 feet. The filter media from Filters 1 and 2 were most recently replaced in 2014. Filters 3 and 4 were built in 1970 as a part of the plant expansion. Filters 3 and 4 have dimensions of 8.3 feet x 5.2 feet and filter media was most recently replaced in 1991. The filter media is no longer up to OEPA approved specifications, the effective size of the filter media is above specifications and there is a thick coating of iron and manganese on the filter media due to poor aeration/detention prior to filtration. The analysis of the media from each filter can be seen below.

Table 7
Filter Media Analysis Data

Filter	Fe in mg/kg	Mn in mg/kg	Uniformity Coefficient	Effective Size	Freeport
Sand 1	4,462	103	1.37	0.65	23
Sand 2	4,075	111	1.31	0.68	19.5
Sand 3	18,538	1,116	1.31	0.65	26
Sand 4	16,775	1,012	1.33	0.54	24

The Village opted to rehabilitate their filter media by cleaning them which was completed in November of 2022. Cleaning the media should extend the lifespan of the filters until a new WTP is built or another long term solution is enacted. Initial results after cleaning have been positive and SCML's for iron and manganese were met. However, media will be prone to calcify again given the current state of operations.

Figure 5: Filters 1 & 2

Figure 6: Filters 3 & 4

3.6.8 Clearwell and High Service Pumps

The filter effluent is stored in the clearwell before being sent to the softeners. The top of the clearwell is exposed to the outside and regularly leaks. A membrane type roofing material was placed over the top of the clearwell however the leaks continue. The clearwell is in poor structural condition and cannot be taken out of service for proper cleaning.

Three high service pumps, pump filtered water from the clearwells to the softeners and out to the distribution system. Most of the water is fed through the softeners with 9-13% bypassing the softeners. The high service pumps are vertical turbine pumps and are capable of pumping at normal plant processing rates although the true capacity is unknown.

Figure 7: Clearwell

Figure 8: High Service Pumps

3.6.9 Softeners

The WTP has two sets of ion exchange softeners. The first set from 1948 and the second set was installed in 1970 along with the additional set of filters. The softener is currently only softening to 250 to 300 mg/L ($CaCO_3$) due to the resin's age and condition. Increased chlorine residuals in the water have also likely shortened the lifespan of the softener's resin. Resin should typically not see a residual higher than 0.5 mg/L and the current softener influent has a chlorine residual of 1.5 mg/L. The softeners valves also do not function properly and leak onto the floor during use. Replacement parts for the valves and other mechanisms are not readily available and have been difficult for the Village to find when parts are needed. The softeners age is largely to blame for the lack of accessible replacement parts and will likely get worse as they continue to age. For brine, the WTP receives loads of 24 tons of salt at a time and are stored in a partially underground storage tank. Brine often spills through the overflow and onto the adjacent grass during the deliveries.

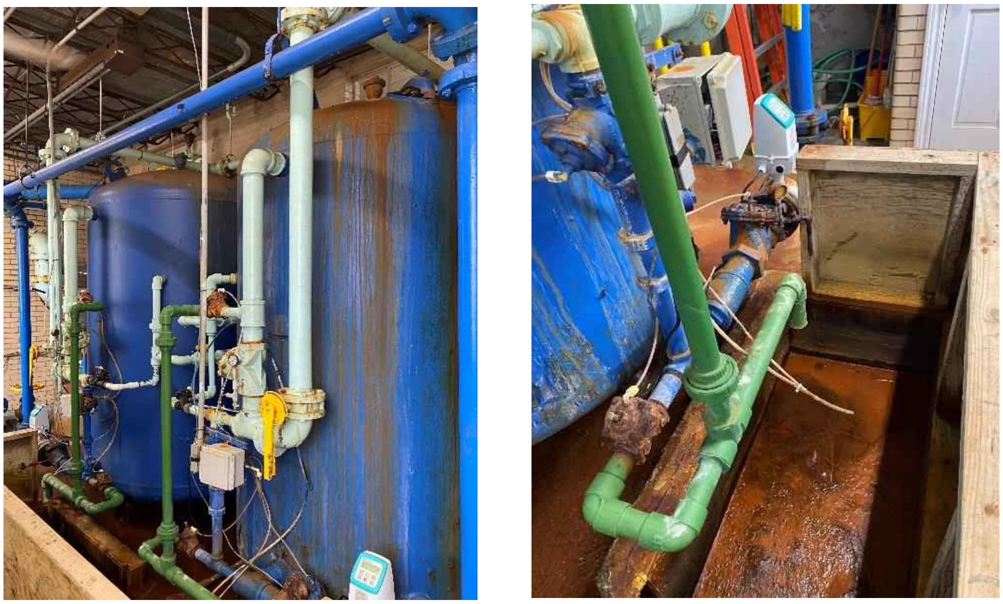


Figure 9: Softeners from 1948

Figure 10: Softeners from 1970

3.6.10 Electrical Power and Control

The electricity is fed to a control panel next to the detention basin and is then routed throughout the building. Backup power can be supplied by a 300 amp generator on-site that has been repurposed and brought over from the wastewater treatment plant. The generator has an automatic transfer switch in case auxiliary power is needed. The automatic transfer switch appears to have been replaced recently and is in good condition.

There is currently no SCADA system, and the plant is manually operated/controlled. The WTP also runs for 18-19 hours a day making it very difficult for one person to operate the plant on their own.

Figure 11: Generator and Electrical Control Panel

3.6.11 Current Building Conditions

The building itself is in poor condition. The original building was built in 1934 of brick and the addition was built of CMU in 1970. Both are in poor structural condition and have cracks forming. The storage tank for the softening brine and the clearwell are also in poor structural condition. Leaks from the softeners have also caused water damage throughout the building.

The WTP property also has a utility garage on the southeast corner and is in good structural condition. It has no utilities connected aside from electricity.

Figure 12: Building Conditions

Section 4 – Future Conditions

4.1 Future Major Construction Projects.

Ashville is set for growth in the next 5-10 years. Five residential developments are scheduled to be constructed that include houses, apartments and duplexes. A logistics company also plans on building a development in Ashville and is scheduled to be completed in 2027. This growth is accelerating the already increasing population of Ashville.

4.2 Projected Service Area and Population

The projected population was compiled by first using the planned developments to project the populations for 2025 and 2030. The populations in 2025 and 2030 are projected to be 7,115 and 9,350 respectively. Historical data and projected additional growth was then used to project the remaining years and was determined to increase 10% every 5 years.

Table 8
Ashville Projected Service Area Population

Year	Population	Increase/Decrease	Change
2020	4529	432	10.5%
2025*	7115	2586	57.1%
2030*	9350	2235	31.4%
2035*	10285	935	10%
2040*	11314	1029	10%
2045*	12445	1131	10%
2050*	13689	1244	10%
2055*	15058	1369	10%
2060*	16564	1506	10%
*Projected			

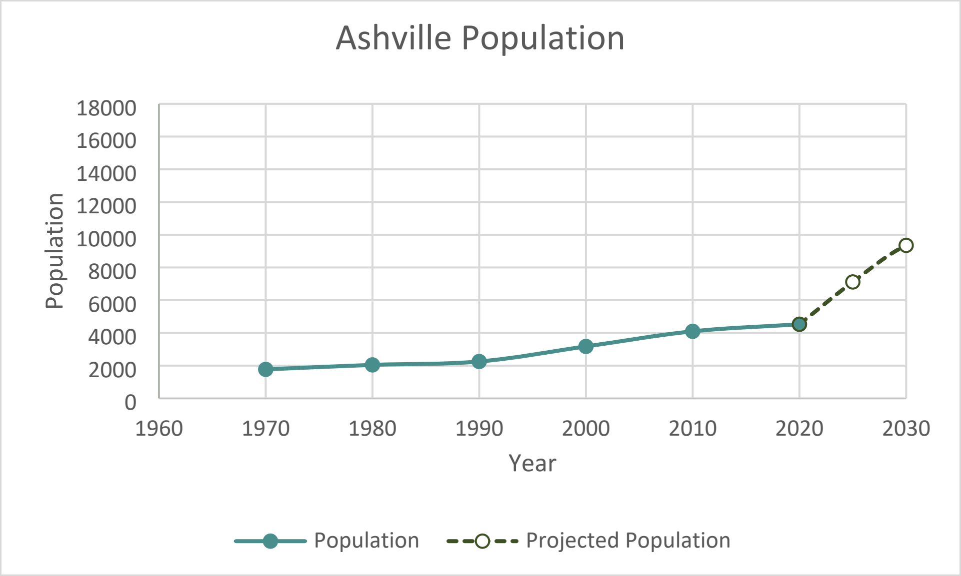


Figure 13: Ashville Population Projection

4.3 Projected Water Demand

Projected future water demands have been estimated to the year 2060. The majority of the water demand in Ashville water system is from residential use. Commercial demand is to increase slightly with the installation of a logistics facility within the Village. Water demand for 2025 and 2030 was estimated by using the expected water demand from the developments scheduled through 2030. The remaining projection was determined by calculating a per capita water demand of 112 gallons per day from existing water data and multiplying it times the projection population to determine the average water demand from 2035 -2060. The maximum water demand was determined by finding an average to maximum ratio of 1.4 from existing data and using that ratio to project the maximum water demand from the projected average water demand.

Table 9 below shows historical and projected water demands.

Table 9
Water Projections and Projections

Year	Max Day	Avg Day
2019	0.667	0.531
2020	0.757	0.486
2021	0.711	0.468
2022	0.678	0.537
2025*	1.168	0.835
2030*	1.508	1.078
2035*	1.718	1.228
2040*	1.878	1.343
2045*	2.055	1.469
2050*	2.249	1.608
2055*	2.463	1.761
2060*	2.698	1.929

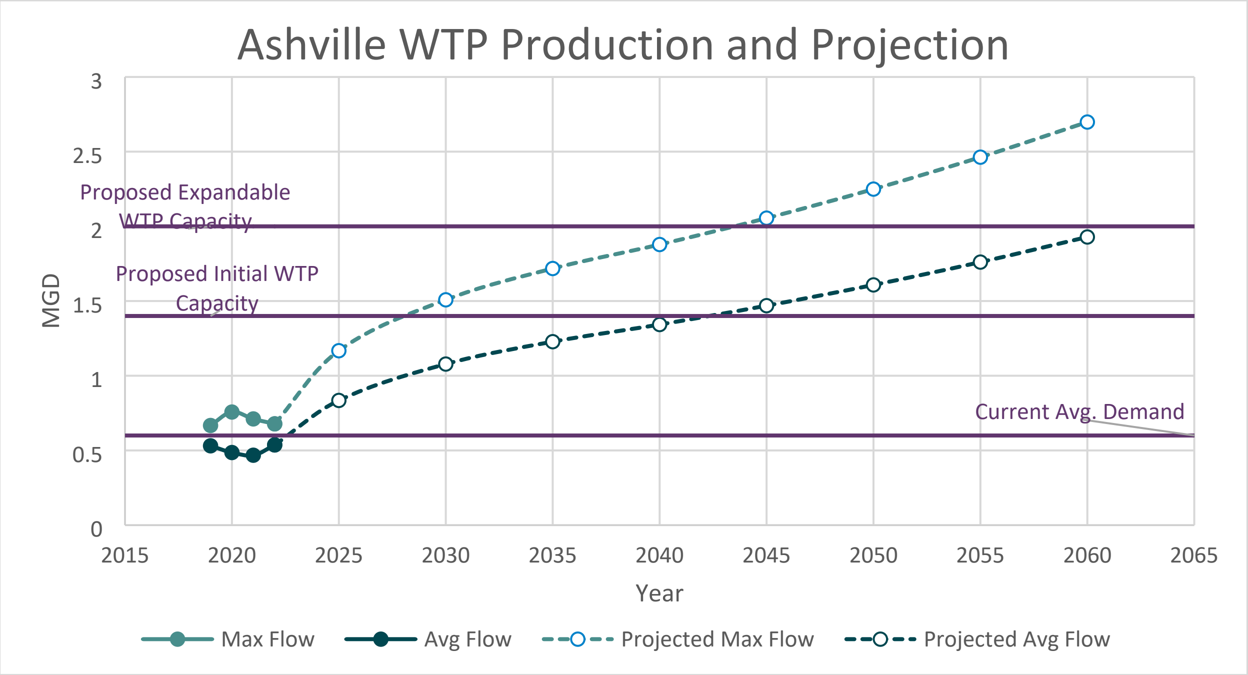


Figure 14: Historical Production and Future Projections

The proposed new plant will have an initial maximum capacity of 1.4 mgd at the time of completion. Additional space will be included in the design and construction for the addition of more filtration and softening capacity to allow the plant to easily expand to 2.0 mgd in the future. The projected maximum for 2060 is 2.698 mgd. There is adequate space on site to expand the plant in future if these projections hold true. Plant capacity may need to increase faster than expected as a large user is considering locating to the area. This could mean a potential increase of an additional 0.5 mgd.

The capacity of the wells is 1200 gpm with the largest out of service. As more plant capacity is required additional well capacity will be needed in the future by adding an additional well or expanding capacity of the existing wells.

Section 5 – Alternatives Considered

Several options were considered to address the issues and concerns of the Village of Ashville WTP. These alternatives include connecting to an existing water system, constructing a new filtration and softening plant, and rehabbing the existing facilities. Doing nothing to the existing system is not an alternative that can be considered given the current state of infrastructure and increasing water demand in the system.

5.1 Regionalization – Connecting to Existing Nearby Water System

One alternative is to purchase bulk treated water from a neighboring municipality. Ashville is currently in the process of connecting to Earnhart Hills for an additional supply of water of 130,00 gpd. This connection would not be enough to supply the Village entirely given the growth expected. The two other nearby possible sources are South Bloomfield and Commercial Point. Both of these sources would not have sufficient capacity to meet Ashville's demand especially given the expected growth for future. There are no other viable sources for regionalization.

5.2 New Water Treatment Plant

Another alternative is to construct a new facility with all new equipment. The proposed new treatment plant would be built on the same site as the existing WTP adjacent to the existing plant to allow for operation while the new plant is being constructed. The new WTP would utilize the existing wells as the water source. The new treatment plant would include: aeration/oxidation, detention/stabilization, transfer pumps, filtration, softening, clearwell storage, high service pumping and a chemical feed systems for sodium hypochlorite and caustic soda. Alternatives for each treatment process are compared below. Several configurations of new site plans with the different options discussed below can be found in Appendix B.

5.2.1 Aeration/Detention

Oxidation of iron will be achieved via aeration. Two options to incorporate aeration are a traditional induced draft aerator and an aerator injection system. The existing plant incorporates induced draft aeration as do many groundwater plants across the state. An injected aeration system can be supplied by Mazzei. The Mazzei system is a skid-mounted booster pump that draws a sidestream from the mainline and pumps it through the skid-mounted Venturi Injector where atmospheric air is aspirated into the sidestream. The water/gas mixture is then blended back into the mainline through a flash reactor. The Mazzei system would be indoors making maintenance ideal. However, building footprint would be expanded, the system is more expansive, and it would not provide redundancy should the system need maintenance. There are very few installations in the country of these systems and it is recommended to install the traditional induced draft aerators.

The detention tank will provide a minimum detention time of 30 mins at maximum plant flow to enable raw water time to oxidize and provide settlement of any non-suspended particles. The tanks would be enclosed but on the exterior of the building. Because these are not pressurized tanks, transfer pumps to supply water to the filters, and softeners would be required to pump water through the system.

5.2.2 Filtration

Vertical and horizontal pressure filters are being considered for filtration. Manganese greensand and anthracite would be utilized as filter media for either filtration system. This media adsorbs and catalyzes the oxidation of iron and manganese. Chlorine will be fed prior to filtration to promote oxidation of iron and manganese. Chlorine is also used to regenerate greensand media to retain its adsorption and catalytic oxidation capabilities. The iron:arsenic concentration ratio (minimum 20:1) is such that co-precipitation of arsenic can be achieved with the removal of iron.

Regardless of filter style, the filters will be rated for a loading capacity of 3.0 gpm/sf with one filter out of service. Groundwater plants can be rated for higher loading capacities. However, the presence of arsenic above the MCL in raw water will require a 3.0 gpm/sf rating by OEPA standards.

5.2.2.a Vertical Pressure Filters

An option being considered for filtration are vertical pressure filter units. Four units would be installed, each with a 12-foot diameter. Space for an additional filter will be included if a fifth filter is required in the future.

5.2.2.b Horizontal Pressure Filters

Alternatively to vertical filters, horizontal filters may also be utilized for the filtration process. Only two filters would be required for proper filtration and space for a third if water demand requires it in the future. Horizontal filters can also have independent cells in each filter to allow for operation with one cell out of service for maintenance. Utilizing horizontal filters rather than vertical filters will save on equipment costs but add building footprint. Overall costs will be similar to vertical filters.

5.2.2 Softening

There are generally four alternatives for softening water at municipal water plants. These include lime/soda ash precipitation, pellet precipitation, ion exchange and membrane filtration. Only ion exchange (IX) and reverse osmosis (RO) softening are being considered for the WTP's softening system. Lime/soda ash softening would require significant capital costs, land for lime sludge lagoons, and possibly a residual handling facility. Pellet precipitation can only remove calcium hardness and still requires residuals handling facilities for spent pellet sand. Each precipitation process utilizes pH adjustment for hardness removal and would change the pH of the current finished water significantly. For these reasons, lime/soda and pellet softening were eliminated as alternatives.

Currently the WTP utilizes four ion exchange softeners that are softening to approximately 250mg/L. Due to aging softening equipment and resign, the existing softeners are not capable of softening to the finished hardness goal. The goal for softening in the new WTP would be 150mg/L ($CaCO_3$) of hardness.

5.2.2.a Ion Exchange Softening

Ion exchange (IX) is capable of removing divalent and multivalent ions from the water including calcium, magnesium, iron and manganese. These systems typically use salt (sodium chloride) to regenerate resins. This creates an exchange process of multivalent ions for sodium on the resin, removing the hardness ions and replacing with sodium in the finished water. After the sodium in the resin is exhausted it will be regenerated by passing a concentrated solution of brine through the bed to replenish it and remove the cations. Periodic replacement of the resin is required as the system ages. Using IX requires a brine holding tank as well as a waste tank. Three softening tanks with 8ft or 9 ft diameter would be used for IX softeningfor adequate softening levels with one unit out of service. To achieve a finished water hardness of 150 mg/L, approximately 56% of flow will need to be passed through ion exchangers and bypassing the remainder of the flow.

These systems are relatively simple to operate and the Village is familiar with this process. Ion exchange can be negatively impacted by iron in the water and it is important adequate iron removal is achieved before the softening process. The downside to the system is the addition of sodium to the finished water and the addition of chlorides and total dissolved solids (TDS) to the wastewater. The chlorides and TDS can put a burden on the wastewater treatment plant operations. Raw water entering the water treatment plant has a TDS concentration of approximately 430 mg/L. It was noted from wastewater treatment plant (wwtp) staff that wwtp effluent has a concentration of between 800 – 1100 mg/L. This indicates and has been expressed by the Village that there are a significant number of home softening systems being utilized in the distribution system. Currently around 90% of treated water flow is sent through the existing ion exchange softeners and regeneration of the resin is required frequently further adding to the TDS at the wwtp effluent. Total Dissolved solids levels at the wwtp effluent are expected to remain consistent with today operations if ion exchange is installed at the new water treatment plant.

5.2.2.b Reverse Osmosis Softening

Membrane softening such as nanofiltration (NF) or reverse osmosis (RO) is capable of removing ions from the water including calcium, magnesium, iron and manganese. Membrane treatment operates by using water pressure to force water through a semipermeable membrane that is capable of removing the ions that contribute to water hardness.

For this, membranes are arranged into trains that are grouped in two or three phases. A typical setup for a system such as Ashville's would require two first stage membrane trains followed a one second stage treating concentrate from the first two stages. This is referred to as a 2 to 1 array. A feed pump pressurizes the water to approximately 150 psi to force the water through the membrane. Chemical needs for the system would be clean-in-place (CIP) chemicals, antiscalants, sodium bisulfite for dichlorination, sulfuric acid for pH adjustment prior to membrane treatment, caustic soda to increase pH after treatment.

Membrane softening removes nearly all hardness in the water it treats so a bypass is often utilized to blend the softened water with still hard water that was not sent through reverse osmosis softening. To reach the desired hardness of 150 mg/L, approximately 67% of flow will need to pass through the membrane system. Approximately 20 percent of the influent stream to the membranes is wasted in a concentrate stream that is high in TDS. Concentrate TDS levels would be approximately 3,000 mg/L but membrane permeate levels would be near zero, lowering the wwtp effluent TDS from today's levels. Given the high volume of water wasted (180 gpm at future plant flow of 2.0 mgd), a direct line may be required for these wastes to pumped to the wwtp or a receiving stream. If the waste is pumped to a receiving stream a new NPDES permit and outfall would be required. With nearly 9% of filtered water going to directly to waste, this much additional raw water supply is required to be treated prior to softening, reducing the true capacity of the wells, aerators and filters.

Iron and manganese can foul the filter if build up is allowed to occur on the membrane. The filters prior to the RO should remove sufficient iron and manganese, however a cartridge filter and descalant can be used to help remove these constituents. If these foulants are not addressed properly prior to membrane softening, this can lead to permanent damage and frequent membrane fouling.

5.2.2.c Softening Cost Comparison

A comparison of capital and operation/maintenance (O&M) costs is presented in the table below. These values are based on a future treatment flow of 1.4 mgd. Additional costs may be incurred in the wastewater collection system or for installing a new force main to discharge the high volume of waste associated with the membrane system. Additional building costs were based on the additional building footprint and costs for the additional structural, architectural, electrical, HVAC/mechanical, and plumbing associated with the larger building space and chemical feed rooms. Maintenance/replacement costs are based yearly maintenance for each system, replacing IX resin every 7 years, and replacing membrane elements every 5 years.

Table 10
IX vs. RO Cost Summary

Capital Costs	Ion Exchange	Membrane
Softening Equipment/Piping	$900,000	$1,200,000
Additional Building Costs		$600,000
Additional Design Costs		$75,000
O&M Costs	**Ion Exchange**	**Membrane**
Additional Electricity		$30,000
Chemicals	$134,000	$40,000
Maintenance/Replacements	$40,000	$50,000

Even by excluding sanitary sewer upgrades likely required for the membrane system, capital costs are higher by approximately $975,000. The salt required for ion exchange is the largest contributor for O&M costs associated with IX system, making these costs $54,400/year more than the membrane system.

5.2.3 Clearwells

Treated water storage is provided in the water treatment plant clearwells. The clearwells should be sized to relieve equipment and pumps from having to follow daily fluctuations in water usage. Clearwell storage also provides a buffer for delivery to the distribution system should there be an interruption in plant production. Clearwell sizing commonly is based on the amount of distribution storage, firefighting needs, and engineering judgement. It is common for a system of the size of Ashville's to have clearwell capacity of 15-25% of the design capacity.

Two identical clearwells totaling 400,000 gallons are included to provide disinfection contact time, chemical concentration equalization, reserve supply for peak hourly flows and firefighting, and a place to store treated water so the plant does not have to process water 24/7. The clearwells will be baffled and typically receive a 0.5 effective volume factor from OEPA for the CT calculation, should this type of calculation be required in the future. To minimize costs, piping would be provided only for parallel flow to the clearwells.

5.2.4 Chlorination

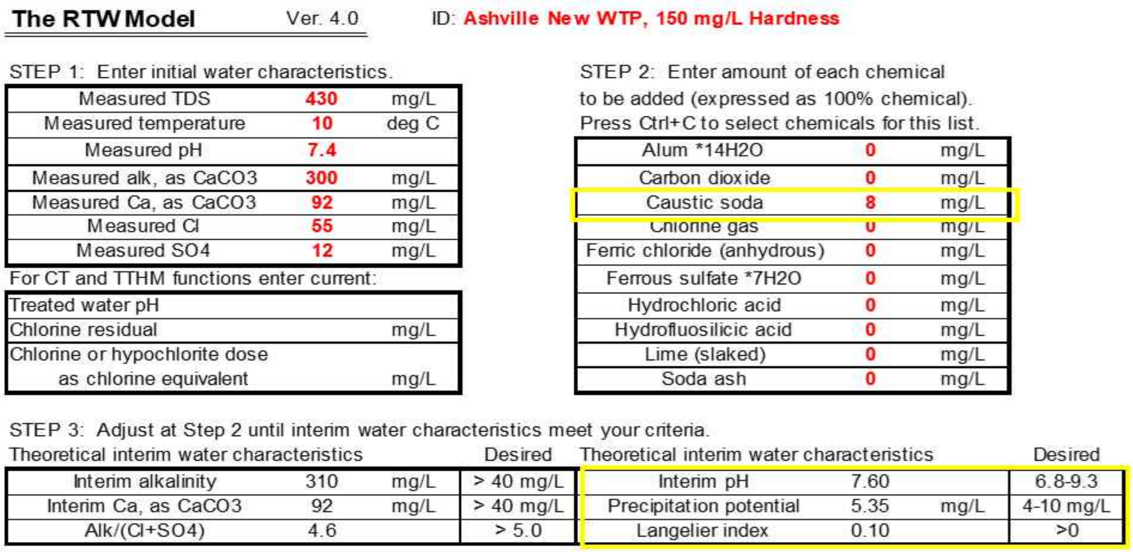
Chlorine will continue to be fed for two purposes – oxidation and regeneration of greensand filter media; and disinfection. Sodium hypochlorite will be utilized as it is the safer chemical and plant staff is familiar with the product. Equipment will consist of bulk storage, a day tank for prefilter feeding, a day tank for post filter feeding, and metering pumps. There will be feed points post aeration, prefilter, pre-clearwell, and high service pump suction as an emergency point.

5.2.5 High Service Pumps

High service pumps convey treated water to the distribution system. In the new plant, at least two pumps will be required for operational purposes and plant capacity needs to be met with the largest pump out of service. Horizontal split case or vertical turbine pumps with motors equipped with VFDs will be used. This will provide operational flexibility and reduce power costs. Because the clearwells will be above grade, pump suction will be positive head negating the need for a vacuum priming system.

5.2.6 Caustic Soda

The additional calcium and hardness removal from the current finished water can result in decrease pH, stability, and precipitation potential on the new finished water quality. These can lead to corrosion issues in the distribution system. To combat these, adding caustic soda (NaOH) to the finished water to increase pH will be necessary. Caustic soda is typically delivered as 50% solution strength and typically diluted to 25% strength due to the high freezing point of the 50% solution (approximately 50 deg. F). Exact feed rates will need to be determined during design and once the new plant is online. It can be expected to feed approximately 32 mg/L of 25% caustic soda solution or 35 gal/day of solution at a plant flow rate of 1.4 mgd. The new equipment would include a bulk storage tank, day tank, and metering pumps. The model below shows the expected corrosion control results expected from softening to 150 mg/L and using caustic soda for pH adjustment.



The RTW Model Ver. 4.0 ID: **Ashville New WTP, 150 mg/L Hardness**

STEP 1: Enter initial water characteristics.

Measured TDS	430	mg/L
Measured temperature	10	deg C
Measured pH	7.4	
Measured alk, as CaCO3	300	mg/L
Measured Ca, as CaCO3	92	mg/L
Measured Cl	55	mg/L
Measured SO4	12	mg/L

For CT and TTHM functions enter current:

Treated water pH	
Chlorine residual	mg/L
Chlorine or hypochlorite dose as chlorine equivalent	mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	8	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Soda ash	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired
Interim alkalinity	310	mg/L	> 40 mg/L
Interim Ca, as CaCO3	92	mg/L	> 40 mg/L
Alk/(Cl+SO4)	4.6		> 5.0

Theoretical interim water characteristics			Desired
Interim pH	7.60		6.8-9.3
Precipitation potential	5.35	mg/L	4-10 mg/L
Langelier index	0.10		>0

5.2.7 Phosphate

The need to add a phosphate compound to the finished water should be discussed with Ohio EPA during the design phase. Provisions will be accounted for in the building footprint for a spare or phosphate feed area. Phosphate compounds aid in corrosion control by helping control lead and copper release from distribution system piping. During design, a pipe loop study or benchtop study to evaluate optimal water quality parameters may be required. At minimum, Ohio EPA will require a year long testing and monitoring period for corrosion control parameters and lead and copper testing after the new plant is online. Protocol for determining the phosphate compound required would follow Ohio EPA guidelines and USEPA document *Optimal Corrosion Control Treatment Evaluation Technical Recommendations for Primary Agencies and Public Water Systems*. Ohio EPA will likely require a Corrosion Control Treatment Evaluation be completed during the design phase and into initial plant operations.

5.2.8 Standby Generator

A generator will be required to provide enough standby power to keep the entire plant operational during a power outage. Ten State Standards requires enough backup power so water may be treated and pumped to the distribution system to meet average day demands. The generator will likely be in an outdoor enclosure. We would recommend that the generator have a base mounted double walled tank with level sensing and leak detection. The generator automatic transfer switch should be installed indoors adjacent to the motor control center to incorporate overall reliability and longevity into the design.

5.3 Rehab Existing Facility

As the existing plant utilizes a similar treatment process as the proposed new facility, there was consideration given to upgrade the existing plant with new equipment. However, several factors make upgrading the existing plant not feasible. The size and condition of the existing structure make it incompatible with the projected growth of Ashville. The existing structure is in such bad condition, that it would be difficult and expensive to properly repair them. Even so, once repaired the reliability and longevity of those repairs could not reasonably be expected to last past the short term before additional repairs would again be needed. Extensive repairs, expansions and upgrades of the existing structure would not be cost effective and would not provide an ideal layout or lifespan of a new facility. For these reasons, this is not a reasonable alternative.

Section 6 – Alternative Selection

The alternative selected was based on a number of factors including financial, technical, operational, maintenance, and public opinion. Environmental impacts will be minimal regardless of the alternative chosen. Given the age and condition of the existing plant's equipment and buildings, a new plant and all new equipment is the best alternative. The new plant's treatment process will be similar to the existing process, with an addition of a caustic soda feed and some additional upgrades to reliability and redundancy. The plant will draw water from two wells and aerated with two aerators then stored in two detention basins. The water will then be pumped through the filters then the softeners before being fed caustic soda and stored in a clearwell. The finished water will then be pumped to distribution using two high service pumps. The new process flow diagram can be found in Appendix C. The new plant will have an initial capacity of 1.4 mgd with space available to expand to 2.0 mgd.

The new WTP will have separate storage rooms for sodium hypochlorite and caustic soda along with storage tanks for salt for and a backwash holding tank for the filter and softener backwash. The building will also include an electrical room, mechanical room, office, lab, meeting area, and restrooms. The site will also include a new driveway and pavement for employees, deliveries, and maintenance access to the plant.

With the increased water demand and growing population of the Village, additional storage is required in the distribution system. A new elevated tank is proposed at the Village owned property east of Dowling Ave. and Princeton St. See location in Appendix A. The proposed new tank would have a capacity of approximately 400,000 gallons.

Section 7 – Basis of Design

Water Quality

Target contaminant levels for treated water effluent are based on Ohio EPA regulations. The goal for the new treatment plant is to produce treated water with contaminant levels below the limits listed below:

	Primary MCL	Secondary MCL	Raw Water Quality	Finished Water Goals
Arsenic	0.010 mg/L			<0.010 mg/L
Iron		0.3 mg/L	1.67 – 1.69 mg/L	<0.05 mg/L
Manganese		0.05 mg/L	0.03 – 0.06 mg/L	ND
Hardness (as $CaCO_3$)			328 – 346 mg/L	150 mg/L
Calcium (as $CaCO_3$)			210 -215 mg/L	95 mg/L
Magnesium (as $CaCO_3$)			118 – 131 mg/L	55 mg/L
Total Alkalinity (as $CaCO_3$)			288 – 315 mg/L	300 mg/L
Total Dissolved Solids		500 mg/L	424- 436 mg/L	430 mg/L
Temperature			45 – 55 (F)	
pH		6.5 – 8.5	7.0 – 7.5	7.6

Design Capacity

Rated Capacity	1.4 mgd
Current Average Day Demand	0.51 mgd
Current Maximum Day Demand	0.76 mgd
Expected Process Rate	1.0 mgd
Projected 20-year Average Day Demand	1.2 mgd
Projected 20-year Maximum Day Demand	1.7 mgd
Future Capacity	2.0 mgd

Processes

Components		**Unit Capacity**
Wells		1200 gpm (1.73 mgd)
Number	2	
Well 4	1200 gpm	
Well 5	1400 gpm	
Aerators		1400 gpm (2 mgd)
Number	2	
Aerator Loading	23 gpm/sf; 66-in square	
Blower Capacity	2,269 cfm	

Capacity of Each	700 gpm	

Detention Basins		1400 gpm (2 mgd)
Number	1, two-celled	
Capacity	5,586 ft^3 required for 30 mins detention time @ 2 mgd total capacity	

Transfer Pumps		980 gpm (1.4 mgd)
Number	2 (1 future)	
Capacity	980 gpm (1.4 mgd) each	

Filters		Rating with One Filter Out of Service: 1018 gpm (1.47 mgd) Future: 1357 gpm (1.96 mgd)
Number	4 (1 future)	
Dimensions	12-feet diameter	
Filtration Rate	3 gpm/sf	
Backwash Rate	12 gpm/sf Supply from in service filters or distribution system	
Media	Greensandplus - 18-inches Anthracite cap – 12-inches	
Capacity of Each Filter	339 gpm (113.1 sf x 3 gpm/sf)	

Ion Exchange Softeners		1050 gpm (1.5 mgd)
Number	3	
Dimensions	8-feet diameter	
Softening Rate	<7 gpm/sf	
Resin	Purolite – 36-inches	
ing goal	~56% water softened; 150 mg/L	

Treated Water Storage		6,600 gpm 9.5 mgd
Number	2	
Required Detention Time	Min 30 Minutes, at 2 mgd each	
Capacity	200,000 gallons each	
Detention Time at 2 mgd	142 minutes	

High Service Pumps		980 gpm 1.4 mgd
Number	2 (1 future)	
Capacity	980 gpm (1.4 mgd) each	

Chemicals

Sodium Hypochlorite	
Purpose	Disinfection
Storage	5,000 gallon bulk storage tank
Feeder Type/Capacity	Metering Pumps, feed up to 4 mg/L

Sodium Hydroxide (Caustic Soda)	
Purpose	Disinfection
Storage	5,000 gallon bulk storage tank
Feeder Type/Capacity	Metering Pumps, feed up to 35 mg/L

Residuals Handline

Residuals Holding Tank	
Number	1
Purpose	Store filter backwash waste and Softener waste
Capacity	70,000 gallons (2 filter backwashes and 1 softener regeneration)
Dimensions	50’ x 25’ x 8’
Pumps	100 gpm; Pump to sanitary system; size to pump out 1 filter backwash and 1 regen in 6 hours

Section 8 – Preliminary Estimates

8.1 New Water Treatment Plant Capital Costs

Table 11
New Water Treatment Plant Capital Costs

Description	Costs
Mobilization, Bonding, Insurance, Overhead	$750,000
Demo/Removals	$250,000
Site Work	$1,000,000
Building and Concrete	$2,500,000
Piping, Plumbing, HVAC	$1,100,000
Process Equipment	$3,300,000
Pumps	$400,000
Chemical Feed Systems	$250,000
Clearwells	$1,000,000
Misc. Equipment, Lab, Office, Restroom	$500,000
Generator, Electrical, Controls	$1,500,000
Contingency (30%)	$3,765,000
Construction Total	**$16,315,000**
Engineering Design, Permits, etc.	$1,200,000
Geotechnical Services, Survey	$75,000
Engineering Construction Services, O&M Manual, RPR	$750,000
Non-Construction Total	**$2,025,000**
Total Project Cost	**$18,340,00**

8.2 New Water Tower Capital Costs

Table 12
New Water Tower Capital Costs

Description	Costs
Mobilization, Bonding, Insurance, Overhead	$100,000
Site Work and Piping	$400,000
Tank Construction*	$2,000,000
Electrical/SCADA	$250,000
Contingency (15%)	$412,500
Construction Total	**$3,162,500**
Engineering Design, Permits, etc.	$75,000
Geotechnical Services, Survey	$36,850
Engineering Construction Services, O&M Manual, RPR	$100,000
Non-Construction Total	**$211,850**
Total Project Cost	**$3,374,350**

*Tank construction assumed a shallow spread foundation system. If rock excavation or deep piles are required costs could increase by an additional $350,000.

8.3 User Rates and Funding

The Village is anticipating utilizing a Water Supply Revolving Loan Account (WSRLA) through the Ohio EPA Division of Environmental and Financial Assistance (DEFA). To assist paying for this loan it is expected user rates will increase. Completing a General Plan is the first step in the loan nomination process. User rate information will be included in the final General Plan submitted for loan nomination.

Section 9 – Public Participation

The Village of Ashville, through Council meetings, social media, and local newspaper articles should keep the water users abreast of the state of the current water system and any improvements. Users will be able to voice any comments and concerns at future Council meetings and will be encouraged to do so. Preliminary construction plans and documents will be made available for public viewing.

Section 10 – Environmental Issues

10.1 Water Treatment Plant

The new WTP will be located on Village-owned property. These areas have been previously disturbed by construction and environmental, historical, and archeological reviews should not be required. The new building will be out of the floodplain. Site design and storm water runoff will be limited but will comply with Village regulations.

Backwash wastes from the filter system will be discharged into the existing sanitary sewer system. Flow back to the sanitary system will be regulated by pump or control valve to ensure sanitary piping can hydraulically handle the flows.

Best management practices will be used to address noise, dust, erosion, and sediment runoff. Temporary seeding and mulching will be implemented in areas that will be inactive for twenty-one days or more. All disturbed and eroded earth will be seeded within seven days. Silt fences will be installed along the perimeter of all construction activity to prevent sediment from storm water runoff.

10.2 Water Tower

The new water tower will be located on Village Property obtained from Teays Valley Local School District. An environmental assessment of the site was completed in 2007 by BBC & M Engineering. The assessment determined that wetlands were found on the site. Stone Environmental completed a preliminary jurisdictional wetland/waters delineation report in 2023 to further investigate where the wetlands are located. The new tower and site work will be located to the south of the property in the area not designated as wetlands.

Best management practices will be used to address noise, dust, erosion, and sediment runoff. Temporary seeding and mulching will be implemented in areas that will be inactive for twenty-one days or more. All disturbed and eroded earth will be seeded within seven days. Silt fences will be installed along the perimeter of all construction activity to prevent sediment from storm water runoff.

Please direct any questions
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Engineers