WATER TREATMENT PLANT NO. 5 FEASIBILITY STUDY FOR THE DUBLIN RESERVOIR SITE

FOR

THE CITY OF EDINA

NOVEMBER 2018

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Name: ______________________
Grant L. Meyer, PE

Date: 11/30/18 Registration Number: 43013

Name: ______________________
Aaron Vollmer, PE

Date: 11/30/18 Registration Number: 51398

Prepared By:
Advanced Engineering and Environmental Services, Inc.
Water Tower Place Business Center
6901 East Fish Lake Road, Suite 184
Maple Grove, MN 55369

INTRODUCTION

The City of Edina is committed to advancing plans for design and construction of Water Treatment Plant No. 5 (WTP No. 5) to increase the supply of treated water available to system customers, meet the needs of the growing community, and produce more filtered water to reduce aesthetic concerns throughout the distribution system. The Project team worked through 2017 on the review of four (4) potential sites for WTP No. 5 including the Southdale Site, Yorktown Site, Median Site, and Fred Richards Site. A preliminary design report (PDR) comparing the site alternatives was prepared and published in September of 2017. Based on the findings and recommendations presented in this report, the Southdale Site was initially determined to be the preferred site. A combination of aesthetic integration challenges at the Southdale Site and the opportunity to improve system performance by considering an alternate location led Edina City staff to request that AE2S review one additional site for the potential WTP. The alternate location (Site No. 5) will be the site of the existing Dublin Reservoir, referred to herein as the Dublin Site, located on Dublin Rd. between Dublin Circle and Kerry Rd.

The planned WTP at the Dublin Site will be designed to treat the City's existing raw water source in the area, which is comprised of existing Wells 16, 19, and 20. Analysis within this feasibility study will include consideration of raw water quality, treatment technologies, equipment alternatives, structural integration of the existing Dublin Reservoir and Pumping Station, architectural consideration for the residential neighborhood, mechanical and electrical support systems, evaluation of the raw and finished water piping alternatives, evaluation of non-financial considerations, and financial evaluation of the primary alternatives.

As the City looks to redevelop the Southdale District into higher density and mixed-use development over the next few decades, increased water demand will accompany this change and growth. This southeastern area is primarily served by Wells 5 and 18, which were the wells originally planned to be treated by WTP No. 5. Due to the relatively far proximity of these wells to the Dublin Site, it was determined that treating Wells 16, 19, and 20 at this site and looking at distribution system improvements to distribute finished water to the Southdale District would outweigh the benefits of bringing Wells 5 and 18 to the Dublin Site. Wells 16, 19, and 20 will increase the treated capacity of the system from 13.8 MGD to 18.1 MGD.

The study approach will follow the process consistent with the Water Treatment Plant No. 5 - Preliminary Design Report (September 2017), and will be integrated as an addendum to the original report. Chapter and section headings, where applicable, will follow the same numbering format as the original PDR with the intention that the Dublin Site analysis fits in consecutively as the fifth site alternative. Sections with headings not including numbering are provided to briefly describe the purpose of each numbered section to allow reading this study as a standalone document.

SOURCE WATER EVALUATION

The following sections review the wells to service WTP No. 5 at the Dublin Site, provide general raw water characteristics of these wells, summarize the breakpoint chlorination testing results, and review well performance considerations.

A2.1.4 Wells to Service WTP No. 5 at the Dublin Site

Wells 16, 19, and 20 will provide raw water to the future WTP No. 5 at the Dublin Site. The following sections summarize detailed information regarding conditions and water quality of the three existing wells. Note that some water quality concentrations provided herein may vary from the summary table provided in the original report after additional sampling data was reviewed for these wells as part of this study. The range of concentrations for each contaminant ensures treatment sizing considers the highest historical concentration.

The existing well houses include systems to dose fluoride for public wellness, chlorine for disinfection, and polyphosphates for pipe corrosion inhibition. The wells are currently only used during peak summer demand and emergencies. WTP No. 5 will include treatment technologies to oxidize and filter out the iron in the raw water and radium removal equipment to reduce combined radium and gross alpha from the three blended sources.

A2.1.4.1 Well No. 16

Well No. 16 is located at 6301 Gleason Road, just south of Crosstown Highway 62 on the east side of Gleason Road within Creek Valley Park. The Gleason elevated storage tower also sits within this property. The well shares a building with the park ice rink warming house. Original drilling of the well occurred in 1967 and was last re-built in 2004. The water level during pumping is approximately 112 feet below the surface at a pumping rate of 1,100 gpm. The test pumping completed in 2009 indicated that the well has a specific capacity of approximately 183 gpm/ft.

The existing pump is a 150 horsepower (Hp) vertical turbine pump designed to pump 1,100 gpm at an estimated total dynamic head (TDH) of 343 feet. The TDH value was taken from the 2009 test pumping data sheet. The City typically operates this pump at 1,000 gpm. Use of this well is limited as a seasonal well due to noisy operation, likely caused by electrical frequency, which can be heard even with the building doors closed. This issue is important when considering this well for treatment at WTP No. 5 as the well would operate year-round, when citizens utilize the attached warming house during winter months. The well characteristics for Well No. 16 are provided in Table A2.1.

Table A2.1 Well No. 16 Characteristics

Well Characteristic	Well No. 16
Unique Well No.	203101
Date Reconstructed	2004
Formation	Prairie du Chien - Jordan
Pump Hp	150
Depth (ft.)	381
Open Hole Depth (ft.)	116
Pumping Rate (gpm)	1,100
Static Level (ft.)	106
Pumping Level @ Rate (ft.)	112
Specific Capacity (gpm/ft.)	183

Table A2.2 summarizes the raw water quality available for this well. Well No. 16 has elevated concentrations of iron. Onsite testing by AE2S indicated manganese levels approximately two times the 0.05 mg/L secondary maximum contaminant level (SMCL), however, previous laboratory certified results have indicated historical manganese of less than 0.05 mg/L. The well also has combined radium at approximately 70% of the EPA regulated MCL of 5 pCi/L.

Table A2.2 Well No. 16 Water Quality

Analyte	Concentration Range
Ammonia (mg/L)	0.39 – 0.42
Iron (mg/L)	0.50 – 0.67
Manganese (mg/L)	< 0.05
Nitrate + Nitrite as Nitrogen (mg/L)	<0.05
pH	7.8
Sulfate (mg/L)	13.3
Sodium (mg/L)	12.0
Radium-226 + Radium-228 (pCi/L)	2 – 3.6
Gross Alpha (pCi/L)	4.9 – 6.5

A2.1.4.2 Well No. 19

Well No. 19 is located at 6054 Valleyview Rd, just south of Crosstown Highway 62 and north of Valley View Road within the Valley View Middle School and Edina High School complex. Original drilling of the well occurred in 1989. After installation, during test pumping, water level was approximately 202 feet below the surface at a pumping rate of 1,200 gpm. The test pumping completed as part of the well construction indicated that the well has a specific capacity of approximately 31 gpm/ft.

The existing pump is a 150 horsepower (Hp) vertical turbine pump designed to pump 1,200 gpm at an estimated TDH of 344 feet. The TDH value was taken from the original well record data sheets. The City typically operates this pump at 1,000 gpm. The well characteristics for Well No. 19 are provided in Table A2.3.

Table A2.3 Well No. 19 Characteristics

Well Characteristic	Well No. 19
Unique Well No.	505626
Date Constructed	10/26/1989
Formation	Jordan
Pump Hp	150
Depth (ft.)	520
Open Hole Depth (ft.)	80
Pumping Rate (gpm)	1,200
Static Level (ft.)	163
Pumping Level @ Rate (ft.)	202
Specific Capacity (gpm/ft.)	31

Table A2.4 summarizes the raw water quality available for this well. Well No. 19 has elevated concentrations of iron. Onsite testing by AE2S indicated manganese levels slightly above the 0.05 mg/L SMCL, however, previous laboratory certified results have indicated historical manganese of less than 0.05 mg/L. The well also has combined Radium-226 and Radium-228 just below the EPA regulated MCL of 5 pCi/L and Gross Alpha approximately 73% of the 15 pCi/L MCL.

Table A2.4 Well No. 19 Water Quality

Analyte	Concentration Range
Ammonia (mg/L)	0.39 – 0.44
Iron (mg/L)	0.51 – 0.58
Manganese (mg/L)	< 0.05 – 0.076
Nitrate + Nitrite as Nitrogen (mg/L)	<0.05
pH	7.8
Sulfate (mg/L)	10.2 – 10.4
Sodium (mg/L)	6.8 – 7.1
Radium-226 + Radium-228 (pCi/L)	3 – 4.9
Gross Alpha (pCi/L)	8.9 – 10.9

A2.1.4.3 Well No. 20

Well No. 20 is located just north of Crosstown Highway 62 on the east side of Gleason Road in the southwest corner of Bredesen Park. The well was constructed in 2008. During test pumping, water level was approximately 105 feet below the surface at a pumping rate of 1,200 gpm. The test pumping completed as part of the well construction indicated that the well has a specific capacity of approximately 80 gpm/ft.

The existing pump is a 150 horsepower (Hp) vertical turbine pump designed to pump 1,200 gpm at an estimated TDH of 355 feet. The TDH value was taken from the original well record data sheets. The City typically operates this pump at 1,000 gpm. The well characteristics for Well No. 20 are provided in Table A2.5.

Table A2.5 Well No. 20 Characteristics

Well Characteristic	Well No. 20
Unique Well No.	686286
Date Constructed	6/30/2008
Formation	Prairie du Chien - Jordan
Pump Hp	150
Depth (ft.)	467
Open Hole Depth (ft.)	80
Pumping Rate (gpm)	1,200
Static Level (ft.)	90
Pumping Level @ Rate (ft.)	105
Specific Capacity (gpm/ft.)	80

Table A2.6 summarizes the raw water quality available for this well. Well No. 20 has elevated concentrations of iron. Onsite testing by AE2S indicated manganese levels slightly above the 0.05 mg/L SMCL, however, previous laboratory certified results have indicated historical manganese of less than 0.05 mg/L. The well has relatively low combined radium and Gross Alpha compared to the other wells being investigated.

Table A2.6 Well No. 20 Water Quality

Analyte	Concentration Range
Ammonia (mg/L)	0.23 – 0.26
Iron (mg/L)	0.35 – 0.42
Manganese (mg/L)	< 0.05 – 0.063
pH	7.8
Sulfate (mg/L)	11.1 – 14.6
Sodium (mg/L)	6 – 17.1
Radium-226 + Radium-228 (pCi/L)	< 2.5
Gross Alpha (pCi/L)	4.4 – 5.7

A6.1.8 General Raw Water Characteristics of Dublin Site Wells

Raw water characterization of the investigated wells included analysis of iron, manganese, ammonia, and confirmation of hydrogen sulfide presence by a rotten egg odor. Table A6.1 provides a summary of the data collected for Wells 16, 19, and 20. Iron and manganese concentrations in all wells exceed the SMCLs of 0.3 and 0.05, respectively.

Table A6.1 Well No. 16, 19 and 20 Raw Water Characteristics

	Well No. 16	Well No. 19	Well No. 20
Iron, mg/L	0.67	0.55	0.35
Manganese, mg/L	0.114	0.076	0.063
Ammonia, mg/L as N	0.42	0.39	0.23
Hydrogen Sulfide Odor?	Yes	Yes	Yes, Faint

The raw water ammonia will exert an additional chlorine demand beyond that required for oxidation of iron, hydrogen sulfide, and manganese. Ammonia reacts with chlorine to form monochloramine, exerting a chlorine demand. The ammonia concentrations in all wells are favorable for chloramination disinfection but may require the addition of supplemental ammonia to provide a satisfactory monochloramine residual in the distribution system that matches or boosts the monochloramine residuals from other Edina water treatment facilities and inhibits microbiological growth.

All laboratory certified manganese data from the wells has indicated concentrations below the SMCL, therefore, limitations of field testing accuracy may be a factor in the manganese levels experienced during sampling. At the relatively low levels of manganese present within the source wells, oxidation with chlorine or permanganate may not be effective. It may be difficult to feed permanganate at levels low enough to oxidize the manganese concentrations present, leading to unintentional water discoloration from overfeeding permanganate. For these reasons, it is recommended to include provisions to install permanganate feed systems in the future for the case where water quality changes over time or additional wells with higher manganese concentrations are brought into the facility. AE2S observed a hydrogen sulfide odor while collecting the water samples at all wells during the breakpoint chlorination sampling. Hydrogen sulfide will consume oxidant chemicals and could cause odor and corrosion issues in the WTP facility if not considered in the WTP design.

A6.1.9 Breakpoint Chlorination Curve Development of Dublin Site Wells

AE2S conducted experiments to create breakpoint chlorination curves for the wells that would supply raw water to WTP No. 5 at the Dublin Site on October 23, 2018. The goal was to observe the oxidant demand of the source water and gather water quality information to develop the recommended preliminary treatment train.

AE2S created customized breakpoint chlorination curves for Wells 16, 19, and 20. For this test, jars were filled with 1L of water and dosed with chlorine over a range of 0.3 to 6.6 mg/L. After dosing each jar, a mixing apparatus gently stirred the water for approximately 30 minutes to allow reactions to take place. After the 30-minute reaction time, samples were collected from each jar and analyzed for free chlorine, total chlorine, free ammonia and monochloramine. The results are representative of the water quality from each well on that day. The curve could be slightly different for other well combinations or different days.

A6.1.9.1 Well No. 16 Results

Table A6.2 summarizes the data collected from the jar test experiment and Figure A6.1 depicts the water quality trends for Well No. 16. As indicated by the concentration trends, Well No. 16 should achieve peak chloramination with a dosage of approximately 2.4 mg/l of chlorine and reach breakpoint chlorination with a chlorine dose of approximately 4.4 mg/L. A dose of 6.4 mg/L is estimated to provide a 2.0 mg/L total chlorine residual.

Table A6.2 Well No. 16 Breakpoint Chlorination Results

Jar	Cl_2 Dose (mg/L)	Total Cl_2 (mg/L)	Free Cl_2 (mg/L)	Free NH_3 (mg/L as N)	Mono-chloramine (mg/L)
0	0.0	0.00	0.00	0.42	0.04
1	0.7	0.50	0.00	0.35	0.50
2	1.4	1.18	0.00	0.19	1.12
3	2.1	1.79	0.00	0.02	1.69
4	2.4	1.99	0.00	0.00	1.82
5	2.8	1.78	0.00	0.00	1.60
6	3.6	1.23	0.16	0.00	0.86
7	4.4	0.55	0.35	-	0.19
8	5.4	1.24	1.03	-	0.07
9	6.6	2.16	1.88	-	0.07

Theoretical (stoichiometric) ratios (mg/L chlorine per mg/L ammonia (as N)) to reach peak chloramination are 5:1 chlorine to ammonia, and the oxidant demands of iron and manganese are 0.63 mg/L chlorine per 1 mg/L iron, and 1.3 mg/L chlorine to 1 mg/L manganese. These ratios assume the reactions reach equilibrium. Based on the raw water on the day of testing, the stoichiometric peak chloramination chlorine dose is 2.7 mg/L. This is 0.3 mg/L higher than the experimental results. The difference between theoretical chlorine demand and the experimental demand indicate that the reactions might not have reached equilibrium, and that chlorine was not a strong enough oxidant to oxidize all the parameters that exert chlorine demand in the raw water. Another explanation may be that involuntary aeration caused oxidation of iron during sampling or transportation of the sample for testing, which would reduce the chlorine demand of iron.

Breakpoint chlorination (indicated by the valley in the total chlorine residual curve) theoretically requires a 7.6:1 ratio of chlorine to ammonia. The 0.42 mg/L ammonia concentration of Well No. 5, would require 3.2 mg/L of chlorine to reach breakpoint. Well No. 16 required 4.4 mg/L of chlorine to reach breakpoint. This additional 1.2 mg/L chlorine demand above the ammonia demand is due to other constituents such as iron, a portion of manganese, or unquantified parameters such as organics or hydrogen sulfide.

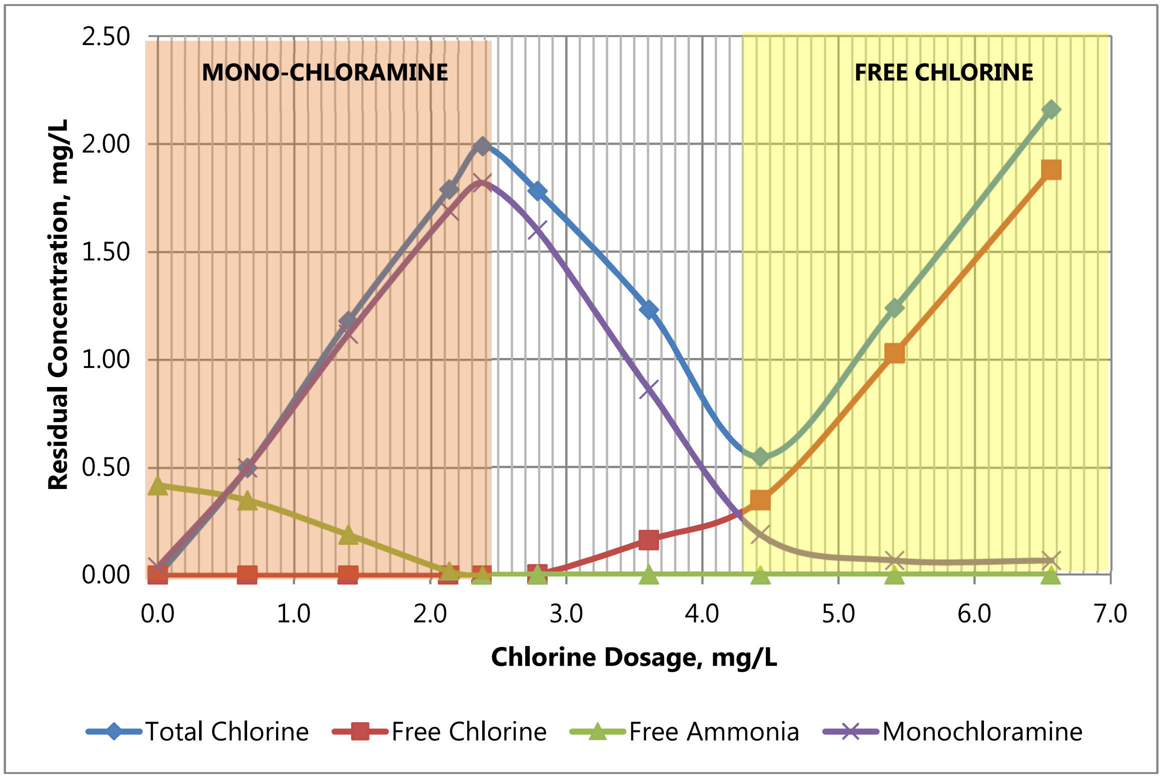


Figure A6.1 Well No. 16 Breakpoint Chlorination Curve

<u>A6.1.9.2 Well No. 19 Results</u>

Table A6.3 summarizes the experimental data and Figure A6.2 depicts the concentration trends for Well No. 19. As shown by the plotted chlorine residuals, Well No. 19 should achieve peak chloramination with a chlorine dose of approximately 2.6 mg/l of chlorine and should reach breakpoint chlorination at a chlorine dose of approximately 4.0 mg/L.

Stoichiometric calculations indicate a peak chloramination dose of 2.4 mg/L, which shows that experimental results are consistent with theoretical results. The slight difference is within the accuracy range of the experimental procedures. For breakpoint chlorination, theoretically Well No. 19 requires 3.0 mg/L to consume the raw water ammonia. Other constituents in the water contribute to the remaining chlorine demand between experimental and theoretical results.

Table A6.3 Well No. 19 Breakpoint Chlorination Results

Jar	Cl_2 Dose (mg/L)	Total Cl_2 (mg/L)	Free Cl_2 (mg/L)	Free NH_3 (mg/L as N)	Mono-chloramine (mg/L)
0	0.0	0.00	0.00	0.39	0.02
1	0.7	0.55	0.00	0.28	0.50
2	1.3	1.16	0.00	0.16	1.02
3	2.0	1.67	0.00	0.03	1.53
4	2.4	1.97	0.00	0.00	1.80
5	2.8	1.96	0.12	0.00	1.55
6	3.6	0.81	0.17	-	0.48
7	4.4	0.72	0.57	-	0.12
8	5.4	1.46	1.36	-	0.08
9	6.6	2.44	2.18	-	0.05

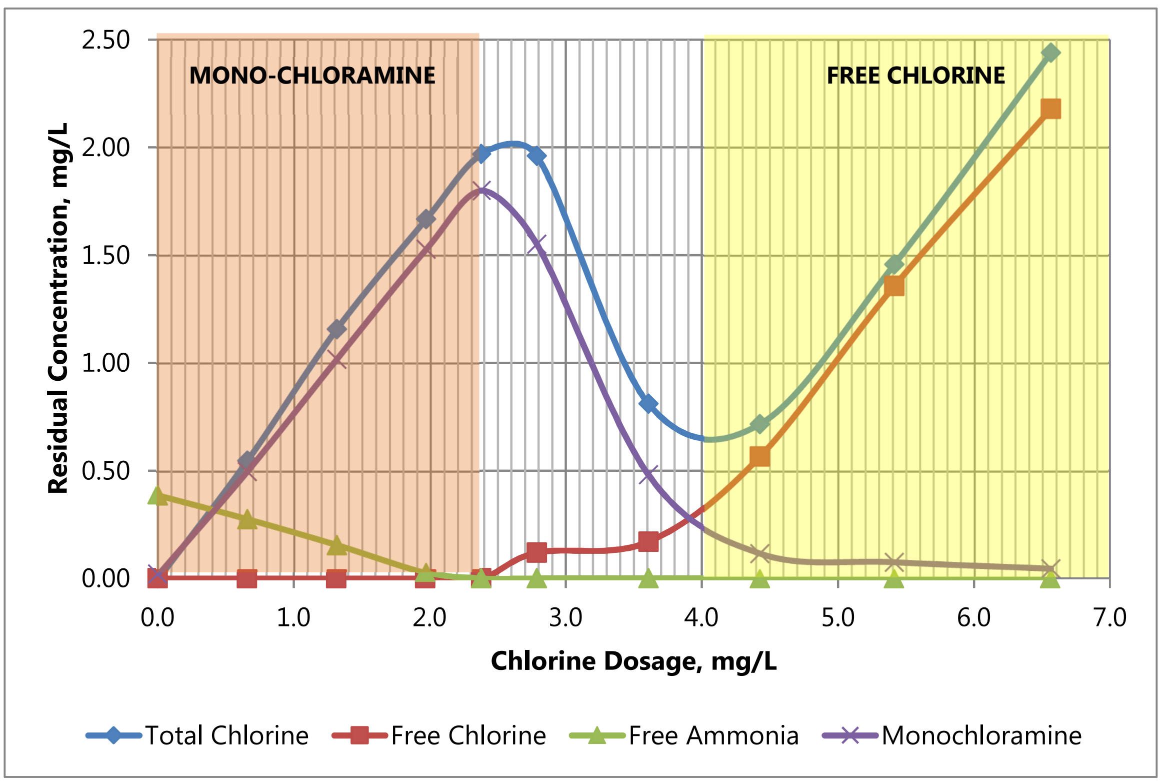


Figure A6.2 Well No. 19 Breakpoint Chlorination Curve

A6.1.9.3 Well No. 20 Results

Table A6.4 summarizes the experimental data and Figure A6.3 depicts the concentration trends for Well No. 20. As shown by the plotted chlorine residuals, Well No. 20 should achieve peak chloramination with a chlorine dose of approximately 1.7 mg/l of chlorine and should reach breakpoint chlorination at a chlorine dose of approximately 2.5 mg/L.

Stoichiometric calculations indicate a peak chloramination dose of 1.5 mg/L, which shows that experimental results are consistent with theoretical results. The slight difference is within the accuracy range of the experimental procedures. For breakpoint chlorination, theoretically Well No. 20 requires 1.7 mg/L to consume the raw water ammonia. Other constituents in the water contribute to the remaining chlorine demand between experimental and theoretical results.

Table A6.4 Well No. 20 Breakpoint Chlorination Results

Jar	Cl_2 Dose (mg/L)	Total Cl_2 (mg/L)	Free Cl_2 (mg/L)	Free NH_3 (mg/L as N)	Mono-chloramine (mg/L)
0	0.0	0.00	0.00	0.23	0.07
1	0.3	0.28	0.00	0.21	0.26
2	0.7	0.58	0.00	0.13	0.57
3	1.0	0.89	0.00	0.04	0.88
4	1.3	1.17	0.03	0.00	1.18
5	1.5	1.32	0.06	0.00	1.24
6	1.6	1.43	0.07	0.00	1.30
7	2.0	1.21	0.10	0.00	0.91
8	2.3	0.64	0.13	0.00	0.41
9	2.6	0.55	0.28	-	0.16
10	3.3	0.90	0.76	-	0.05
11	4.1	1.56	1.39	-	-

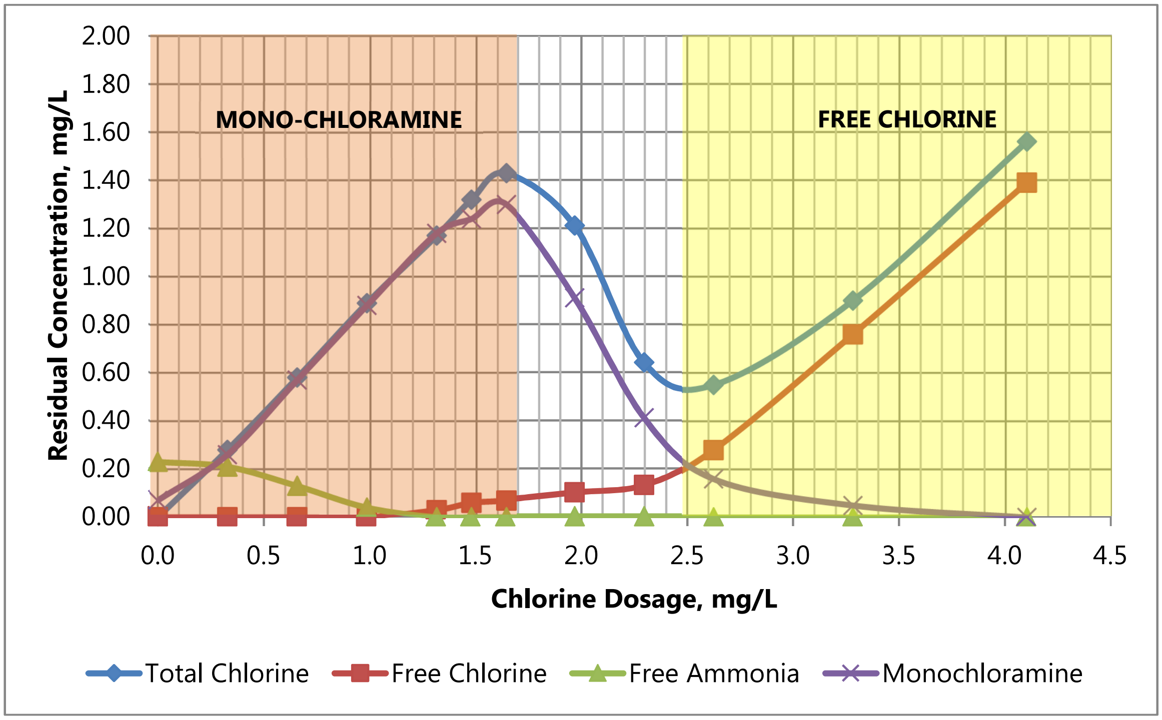


Figure A6.3 Well No. 20 Breakpoint Chlorination Curve

A6.1.10 Well Performance Considerations

As stated in the PDR, performance of each well is a function of many separate variables that can have varying effects. Physical characteristics, proximity to other wells, and general maintenance are all important considerations of optimizing the production of each ground water source.

The decentralized layout of the City's water supply and treatment systems provide for maximum distances between the wells and therefore mitigate any adverse effects of well interference. The three wells planned to supply WTP No. 5 at the Dublin Site are all within a 1.2-mile radius of the Dublin Site. The presence of multiple wells at each WTP provides both redundancy and reliability, as well as operational flexibility. Original installation of wells was at separation distances adequate to reduce interference, but the City should monitor well performance and drawdown over time to ensure continued performance of the wells.

The City's updated Wellhead Protection Plan (WHPP) provides vulnerability assessments for each City well and source water aquifer within the drinking water supply management area (DWSMA). These vulnerability assessments are another important factor to consider when assessing WTP source redundancy and reliability. Vulnerability is determined based on multiple factors. One factor includes the analysis of tritium, a naturally occurring radioactive isotope present in rainwater and aquifer system surface recharge, to estimate the time since recharge to the groundwater system occurred. Another factor is the absence or presence of a confining layer, which presence of one tends to decrease vulnerability. According to Part I of Edina's updated Wellhead Protection Plan (WHPP), Wells 16 and 19 have a very low vulnerability rating due to the presence of a confining layer. These wells have a vulnerable classification based on tritium presence in nearby wells. Well No. 20 is considered vulnerable due to a high DNR geologic sensitivity rating.

The amount of groundwater an individual production well can pump is dependent upon the hydraulic characteristics of the aquifer, the recharge rate of the aquifer, and the well construction itself. Characteristics of the aquifer may not be conducive to providing the desired well capacity objectives. In these situations, the supplier can develop individual wells at reduced capacities or operate the well system on a rotating cycle. Under these scenarios, additional wells may be necessary to meet the water supply objectives.

The efficiency of the well can also limit the yield from a well. The efficiency of the well is largely dependent upon the design and construction of the well. A better-designed and constructed well provides greater well efficiency, or ease of the flow of groundwater from the aquifer into the well. Specific capacity is the basic measure of the performance of a well, with higher values signifying a greater yield capability.

Test pumping data from available well records were used to calculate the individual well specific capacities, which are summarized in Table A6.5. The specific capacity can be monitored over time to help track well performance and be used to prioritize maintenance efforts.

Table A6.5 Well No. 16, 19 and 20 Specific Capacity Summary

	Well No. 16	Well No. 19	Well No. 20
Test Pumping Date	5/18/2009	10/26/1989	6/30/2008
Pumping Rate (gpm)	1,100	1,200	1,200
Drawdown (ft)	6	39	15
Specific Capacity (gpm/ft)	183	31	80

As stated previously, Well No. 16 has unpleasant noise while operating, requiring personal protective equipment in some cases even while standing outside the building. This will not be acceptable during the winter months when the wellhouse shares use as a hockey rink warming house, requiring that upgrades to the well be completed as part of the WTP No. 5 project. Upgrades to the well could result in improved performance and efficiency.

PRELIMINARY TREATMENT TRAIN RECOMMENDATIONS

The following sections revise the treatment target goals of WTP No. 5 at the Dublin Site with the change in source water wells, develop the recommended preliminary treatment train of the facility, and review the treatment processes applicable to the WTP.

A4.4 Dublin Site Treatment Target Goals

Beyond continued compliance with all primary drinking water regulations as identified in the original PDR, the City of Edina, together with AE2S, established additional treatment target goals for the future WTP No. 5 at the Dublin Site. The treatment target goals implement treatment for iron removal, promote compliance with D/DBP regulations, and enhance the stability of the residual disinfectant in the finished water supply.

A treatment target goal for manganese was not established due to the low manganese levels in the three existing wells planned to supply WTP No. 5 at the Dublin Site. Laboratory data indicates that all wells have manganese concentrations below the SMCL. Provisions to install a permanganate feed system to oxidize manganese in the future will be provided to address manganese concentration or water source changes over time. Other future options include, but are not limited to,

The Project Team determined the following treatment target goals to be primary goals for WTP No. 5 at the Dublin Site. In addition to identifying the treatment target goals, the Project Team also developed recommended measurement criteria for each goal.

A4.4.1 Iron Removal

Mitigation of the aesthetic effects of iron from the finished water supply is one of the primary objectives of additional water treatment.

Recommended Measurement Criteria:

- Consistently achieve iron concentrations less than half of the established 0.3 mg/L SMCL. This sets a treatment goal of < 0.15 mg/L.

A4.4.2 Radium Removal

Mitigation of adverse health effects associated with exposure of water system customers to radionuclides is another primary objective for WTP No. 5. The Dublin Site supply wells have never exceeded the MCL for either contaminant but have had results just below in some reported results. A radium removal system will be included in the preliminary treatment train as a conservative measure, accounting for trends of increasing radionuclide concentrations over time with increased pumping.

Recommended Measurement Criteria:

- Consistently achieve combined radium (Radium-226 and Radium-228) and gross alpha emitters concentrations less than half of the established MCL. This sets a treatment goal of < 2.5 pCi/L for Combined Radium and < 7.5 pCi/L for Gross Alpha Emitters.

A4.4.3 Finished Water Stability - Disinfection

To provide a disinfection strategy consistent with the other WTPs, WTP No. 5 will require the addition of chlorine to create chloramines. Currently the system uses a chloramination disinfection strategy. Wells 16, 19, and 20 have favorable raw water ammonia concentrations for creating high concentrations of monochloramine. Raw water ammonia concentrations vary from 0.23 to 0.44 mg/L, with breakpoint chlorination results indicating average total chlorine at peak chloramination of 2.2 mg/L. To address changes in raw ammonia, well source, and other constituents impacting chlorine demand, a supplemental ammonia feed system is recommended to maintain total chlorine residuals leaving the facility. Boosting total chlorine leaving this facility may help increase total chlorine residual in the distribution system when treated water from WTP No. 5 mixes with other finished water. Maintaining this disinfection strategy and ensuring a biologically stable distribution system water quality is another primary objective for the proposed facility.

Recommended Measurement Criteria:

- Consistently provide a total chlorine residual of 2.0 to 2.5 mg/L in the finished water;
- Consistently meet the established chloramine MRDL of 4.0 mg/L;
- Consistently provide stable total chlorine residuals in the City's distribution system; and
- No nitrification in the City's distribution system.

A4.4.4 Radon

Although radon is not a regulated contaminant, high radon levels in the City's existing WTPs prompted conversation to mitigate radon in the proposed facility. The facility will include enhanced ventilation and radon monitors to ensure the safety of the operational staff.

Recommended Measurement Criteria:

- Consistently monitor the air quality of the facility and alert the proper City staff if radon levels are above 2.0 pCi/L.

If the radon is above the recommended criteria, the City can install additional radon mitigation measures.

A5.7 Dublin Site Treatment Process Technology Alternatives

The original PDR went into greater detail reviewing the various treatment technology alternatives available to meet the treatment targets set for WTP No. 5. The following sections summarize the treatment technologies applicable to the developed Dublin Site alternatives.

Based on the review of raw water quality and desired treated water quality, the City will accomplish the following treatment objectives in the water treatment process:

- Iron removal
- Hydrogen sulfide removal

- Radium removal
- Radon removal (optional)
- Ammonia removal and reaction with chlorine to form chloramines
- Fluoridation
- Disinfection and maintaining a disinfectant residual in the distribution system

AE2S evaluated several alternative technologies to accomplish these treatment objectives for the proposed Water Treatment Plant No. 5.

A5.7.1 Pre-Oxidation Processes

Removal of dissolved iron from the raw water will be achieved by oxidizing the soluble forms by chemical addition of chlorine followed by filtration. The proposed facility alternatives include ten minutes of reaction time in a detention tank after oxidation and prior to filtration. The detention tank also provides additional reaction time to promote adherence of radium to hydrous manganese oxide (HMO) particles.

Due to low levels of manganese in the Dublin Site source wells, use of permanganate for pre-oxidation processes is not recommended because it may not be effective. It may be difficult to feed permanganate at levels low enough to oxidize the manganese concentrations present, leading to unintentional water discoloration from overfeeding permanganate. For these reasons, it is recommended to include provisions to install permanganate feed systems in the future for the case where water quality changes over time or additional wells with higher manganese concentrations are brought into the facility.

Aeration was not considered for this site due to the relatively high capital costs of aeration equipment and the additional need for chlorine as a disinfectant. Wells 5 and 18 studied in the original PDR have similar water quality to the quality of Wells 16, 19, and 20. Based on the similar water quality and breakpoint chlorination results indicating minimal chlorine demand by raw water iron for all wells, chlorine for pre-oxidation is recommended over aeration.

Similar to the other sites explored for WTP No. 5, the design of the facility at the Dublin Site will consider and control the impacts of natural draft aeration, which can negatively affect the treatment facility. Negative impacts include, the release of hydrogen sulfide and/or chlorine vapors which can cause significant odor and major equipment damage inside a water treatment facility if not closely managed.

Another pre-oxidation alternative includes using an oxidizing filter media, such as manganese greensand. Manganese coated filter media is a filter media coated with a layer of oxidized manganese. The media oxidizes the iron and manganese in the water passing through and the oxidized iron and manganese precipitates. Either the media catches the precipitate, or it adsorbs to the media. The oxidizing capability of the media diminishes over time, and must be regenerated with another oxidant, typically potassium or sodium permanganate. Chlorine regenerates and maintains the oxidizing nature of the media in certain applications when the filter maintains a free chlorine residual.

A5.7.2 Filtration Processes

The two filtration processes included as alternatives for the Dublin Site WTP No. 5 are gravity and pressure filtration with conventional sand and anthracite media. The filters will capture oxidized iron and HMO particles from the raw water. Water treatment facilities typically use filtration as a polishing step for the removal of suspended solids and particles from water. Based on industry trends, treatment facility footprint considerations, and operator convenience, the Project Team deemed gravity filters and pressure filters most appropriate in the treatment concepts developed for this report.

The gravity filters will be sized to operate at 3.0 gpm/ft^2 under normal operating conditions in accordance with Ten States Standards. Design of the filters will follow Ten States Standards and industry standards in terms of filter structure depth, overflows, underdrains, backwash troughs, and media depth. Appurtenances to measure pressure, flow, and headloss will be provided to monitor filter performance and optimize operation. Filter systems will include the equipment and components necessary for both air and water backwash.

The pressure filters will again be sized to operate at 3.0 gpm/ft^2 under normal operating conditions and be designed to meet all Ten States Standards requirements and recommendations.

Conventional sand and anthracite media is recommended for this facility, with depths following Ten States Standards recommendations of not less than 24 inches and not more than 30 inches. This media selection lends itself to requiring a backwash system capable of producing 3-5 cfm/ft^2 of air wash and up to 15 gpm/ft^2 (and down to 3 gpm/ft^2) of water wash. The backwash shall last at least 15 minutes per filter at the design backwash rate. The larger-sized anthracite settles on top of the smaller-sized sand following backwash. The anthracite traps larger particles and the sand traps smaller particles, enabling filtration throughout the entire filter bed. Dual media filtration has the advantage of higher filtration rates and longer runs between backwash. Water treatment facilities commonly use dual media to remove oxidized iron and manganese following oxidation and detention processes.

As stated previously, manganese greensand media is another media commonly used in iron and manganese removal facilities. If greensand media use is something the City would like to explore more, a media regeneration method must also be provided. This is typically with permanganate or a free chlorine residual. With the current disinfection strategy of chloramination used in Edina, creating a free chlorine residual upstream of the filters is counter-intuitive as the raw water free ammonia would be consumed, requiring additional ammonia feed downstream of the filters. Another consideration of this media is that the HMO used for radium removal is the same chemical as the coating on manganese greensand. This creates the potential for adsorption of radium to the filter media, and as a result, may create a radioactive filter media. The presence of radium in the raw water feeding the proposed facility in Edina makes manganese greensand media an undesirable filter media.

Each filter will be sized to operate at 1,000 gpm. Preliminary filter layouts include three filters, providing 3,000 gpm of filtration capacity (2,000 gpm firm capacity with one filter offline). The preliminary facility layout may be optimized to allow the addition of filters if the City would like to bring more raw water wells into the facility in the future.

A5.7.3 Disinfection Processes

Two common methods of disinfection for municipal water treatment plants include chloramination and breakpoint chlorination. Ammonia in the water reacts with chlorine to form chloramines. As chlorine reactions occur with increased chlorine addition, the free ammonia residual decreases. The type of chlorine residual formed changes with increased ratios of chlorine to ammonia. Once raw water ammonia is fully consumed by chlorine, the breakpoint is reached, and free chlorine exists. Detailed explanation of the applicable disinfection strategies for Edina were provided in the original PDR.

The raw water ammonia present throughout most of the wells in Edina have resulted in the selection of chloramination as the City's disinfection strategy. The three wells feeding WTP No. 5 at the Dublin Site have favorable amounts of raw ammonia, requiring minimal artificial ammonia addition prior to sending finished water into the distribution system. An ammonia feed system is planned for this facility to allow boosting of total chlorine residual and to provide the means for makeup monochloramine if raw water ammonia concentrations change over time.

A5.7.3.1 Chlorine Feed System

Three options for chlorine addition include gaseous chlorination, bulk delivery of sodium hypochlorite, and onsite sodium hypochlorite generation. The original PDR compares the advantages, disadvantages, capital costs, and operation and maintenance costs (O&M) of these three alternatives. Based on the source water characteristics of Wells No. 16, 19, and 20 being comparable to the original PDR Wells No. 5 and 18, gaseous chlorine is still the recommended chlorine alternative for WTP No. 5 at the Dublin Site.

The City currently receives gas chlorine in 150-lb cylinders at all existing facilities. To obtain a preliminary sense for if 150-lb cylinders will be adequate for WTP No. 5 at the Dublin Site, the Project Team used the results of the breakpoint chlorination testing to estimate chlorine feed requirements for the facility. Results of the breakpoint chlorination chlorine demands are summarized in Table A5.1.

Table A5.1 Well No. 16, 19 and 20 Chlorine Demand Summary

	Raw Peak Chloramination (mg/L TCR)*	Required Chlorine to Raw Peak (mg/L)	Non-Ammonia Chlorine Demand (mg/L)
Well No. 16	2.0	2.4	0.4
Well No. 19	2.0	2.6	0.6
Well No. 20	1.4	1.7	0.3
Average	**1.8**	**2.2**	**0.4**

* This is the peak chloramination TCR achieved during jar testing using raw water ammonia for chloramine formation.

With the three wells blended, it is estimated that the raw water ammonia would provide 1.8 mg/L TCR in the finished water with a chlorine dose of 2.2 mg/L, indicating a chlorine demand from other raw water constituents of 0.4 mg/L.

The Dublin Site treatment target goals stated that the disinfection system should provide 2 to 2.5 mg/L TCR leaving the facility. To reach a 2.5 mg/L TCR, an estimated 2.9 to 3.0 mg/L chlorine dose is required.

At 3,000 gpm, a 3.0 mg/L chlorine dose amounts to approximately 108 pounds per day (PPD) of gaseous chlorine consumption. Manifolding four, 150-lb cylinders together would provide approximately 5.5 days of chlorine feed assuming the facility operates at 3,000 gpm, 24 hours a day.

If the City would like less chlorine delivery frequency or treatment capacity above the planned 3,000 gpm at the Dublin Site, 1-ton chlorine cylinders should be considered.

A5.7.3.2 Ammonia Feed System

As stated previously, the TCR goal for treated water leaving WTP No. 5 is 2.0 to 2.5 mg/L. The three wells serving the facility at the Dublin Site have relatively high raw ammonia concentrations, indicating that artificial ammonia feed will be minimal. To ensure that the facility meets this goal, an ammonia feed system is recommended. This system will provide small amounts of make-up ammonia with concentrations based on flow-paced chemical feed and real-time finished water quality monitoring. This system will account for any fluctuations in raw water quality with the increased pumping of the three wells.

In the original PDR, the Project Team evaluated three options for ammonia addition including gaseous anhydrous ammonia, aqua ammonia, and ammonium sulfate in dry/solid or liquid form. Again, based on similar water quality between all wells evaluated for WTP No. 5 and the small amount of ammonia required to meet treatment goals, liquid ammonium sulfate is still the recommended alternative for the Dublin Site ammonia feed system.

The ammonia feed concentration is estimated at approximately 0.1 mg/L to boost TCR to 2.5 mg/L for the finished water. At 3,000 gpm and 24 hour operation, the ammonium sulfate consumption is estimated to be 5 gallons per day (GPD).

A5.7.4 Corrosion Control

Like the recommended approach in the original PDR, corrosion control for the Dublin Site would be a 50/50 blend of orthophosphate and polyphosphate to keep consistency between all existing facilities and finished water characteristics in the distribution system. The intent of this ortho/poly blend system is to inhibit corrosion of iron pipe and other metals in the distribution system and sequester iron and manganese.

A5.7.5 Radium Removal

To again maintain consistency with other existing treatment facilities in Edina, the recommended radium removal technology for WTP No. 5 at the Dublin Site remains HMO addition. The three wells planned for the Dublin Site do not have concentrations of combined radium or gross alpha above the regulated MCLs, unlike Wells No. 5 and 18 originally planned for the treatment facility. The concentrations, however, have increased over time and could continue to increase in the future with the increased pumping of the wells. Installation of an HMO feed system is recommended for this facility as a conservative measure, providing treatment flexibility and proper tools for meeting regulated treatment requirements into the future.

Many treatment technologies exist that the EPA considers Best Available Technologies (BAT) for removal of radium. These include, but are not limited to, ion exchange, reverse osmosis, lime softening, greensand filtration, and addition of preformed hydrous manganese oxide (HMO) followed by filtration. HMO addition is the current method used throughout Edina for wells containing high levels of combined radium or gross alpha.

It is important to note that if the use of manganese greensand filtration media is considered further for this facility, the raw water radionuclide particles may be adsorbed by the media. This may result in media classified as radioactive waste, which becomes a disposal problem when the media has reached its usable lifespan. For this reason, manganese greensand media is not a recommended treatment alternative for radium removal at WTP No. 5.

A5.7.6 Backwash Recovery / Recycle Processes

The backwash water from the gravity of pressure filters can be either routed to the sanitary sewer or a backwash reclaim facility. The City of Edina proactively looks for ways to integrate re-use into their facilities, making backwash reclaim at the WTP a priority, continuing to provide good stewardship of their available water resources.

Backwash reclaim alternatives explored in the original PDR include traditional backwash basins that allow settlement of particles over time and above or below grade plate settlers that increase backwash efficiency in a smaller footprint. Based on the greater available footprint for the WTP on the Dublin Site, traditional backwash reclaim with settling tanks and a pumping system is the recommended alternative.

The use of plate settlers is recommended when the site footprint is tight and if there are concerns about backwash settling time. Above grade plate settlers require additional height on the facility to provide proper hydraulic grade lines. With the Dublin Site situated within a residential area, the site lends itself to below grade backwash reclaim as a more favorable option aesthetically as well. Plate settlers also introduce additional mechanical components, a polymer feed system, and materials that increase O&M complexity.

The backwash reclaim basins will be sized to provide detention volume equaling the amount of water required for a 15-minute backwash at 20 gpm/ft^2 for each filter. Reclaim pumping systems will be sized to handle the maximum allowable reclaim rate of 10% of the maximum WTP flow (300 gpm reclaim rate for 3,000 gpm facility).

If the treated capacity of WTP No. 5 at the Dublin site increases in the future or backwash settling time requirements lead to inefficient reclaim, the City can consider installation of a backwash coagulant system or retrofitting the traditional backwash tanks with below grade plate settlers. Based on the known water quality of Wells No. 16, 19, and 20, extended backwash settling time is not an anticipated issue for WTP No. 5 at the Dublin Site.

A6.5 Recommended Dublin Site Preliminary Treatment Train

The Project Team developed the preliminary treatment train for WTP No. 5 based on preliminary breakpoint chlorination testing, raw water quality review, and discussions with City of Edina staff. The following recommendations detail the system component for each treatment goal:

1. Iron Removal: use chlorine as a pre-oxidant to oxidize iron and hydrogen sulfide followed by detention time prior to filtration. Manganese removal is not targeted at the Dublin Site due to low raw manganese concentrations in Wells 16, 19, and 20.
2. Radium Removal: use HMO followed by the extended detention time for consistent radionuclide removal to half the regulated MCLs. Provide multiple chemical feed locations to allow optimization during full-scale operation.
3. Detention: provide detention to allow additional time for pre-oxidation reactions to take place and offer treatment flexibility in chemical injection locations.
4. Filtration:
    a. Size filters to operate at a 3 gpm/ft^2 loading rate.
    b. Load filters with 18" of silica sand (0.45 – 0.55 mm) and a 12" cap of anthracite (0.8 – 1.0 mm).
    c. Install a sustainable simultaneous air and water backwash system to ensure thorough cleaning of the filter media and reduce backwash waste water. A preliminary backwash sequence includes 10 minutes of simultaneous air and water wash at 3 gpm/ft^2 and 3 cfm/ft^2, a 2 minute air purge at 3 gpm/ft^2 and a 3 minute media restratification at 13 to 15 gpm/ft^2.
    d. Size the backwash reclaim system to provide enough storage for backwashing all filters once and allowing two days of settling before reclaim.
5. Disinfection: provide the chemical feed systems necessary to operate at either peak chloramination or breakpoint chlorination.
    a. Peak chloramination: requires chlorine and supplemental ammonia at doses that provide a recommended 2 to 2.5 mg/L total chlorine leaving the facility.
    b. Breakpoint chlorination: requires chlorine at a dose that provides a recommended 1.0 mg/L free chlorine residual leaving the facility.
    c. Size the chlorine system to feed at least 4.0 mg/L of available chlorine and the ammonia system to feed at least 1.0 mg/L of available ammonia. Actual feed rates will vary based on well operation and chosen disinfection method.
6. Additional chemical feed post-filtration includes fluoride and an ortho/poly blend for corrosion control.

Figure 6.14 shows a process flow diagram for the recommended WTP No. 5 treatment train.

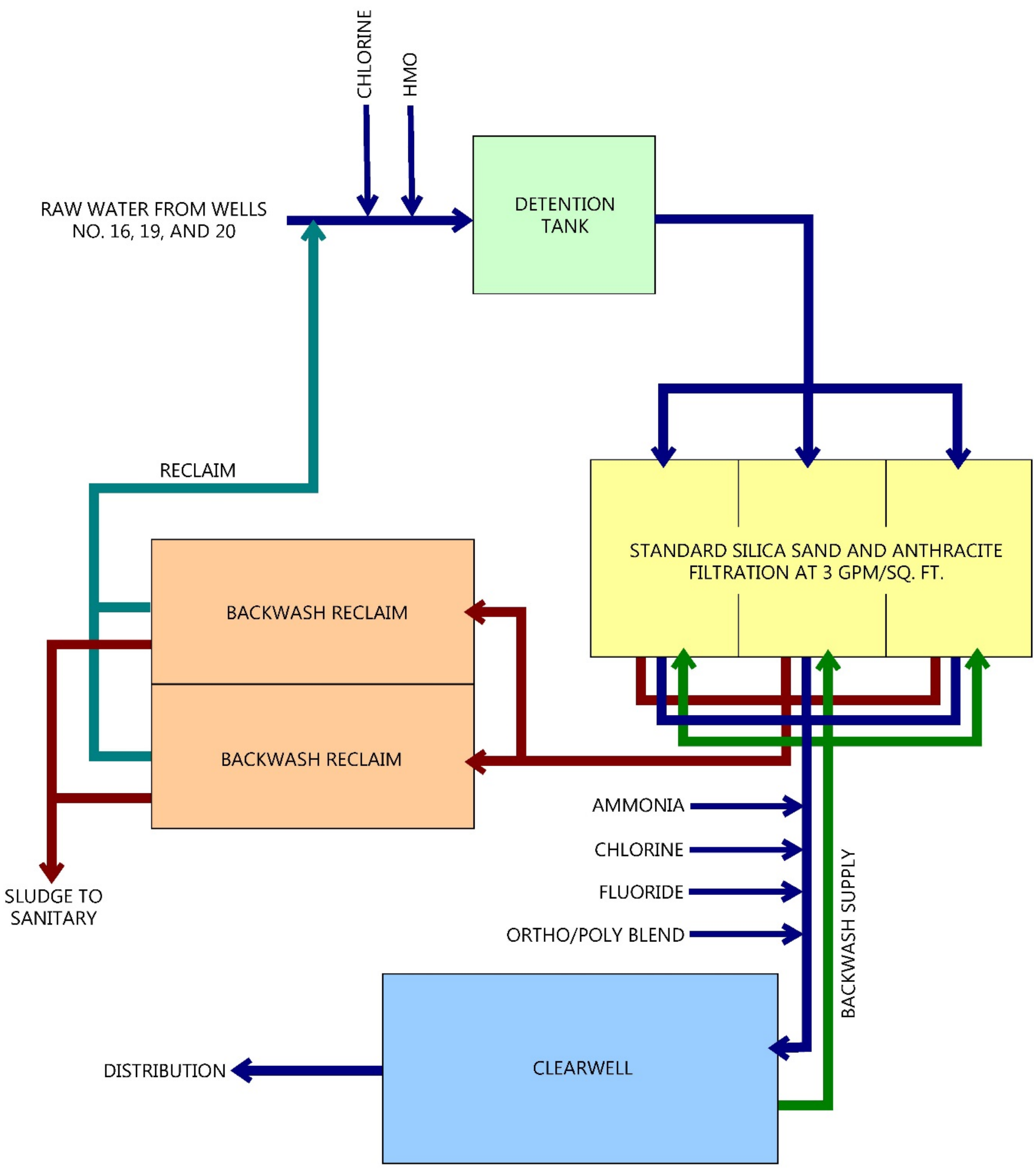


Figure A6.4 Preliminary Recommended Treatment Train Diagram for the Dublin Site

REVIEW OF SITE ALTERNATIVES

The original PDR included the evaluation of four site alternatives including the Southdale Site, Median Site, Yorktown Site, and Fred Richards Site. Upon completion of the PDR, the Southdale Site was selected as the preferred WTP No. 5 location based on many factors including facility integration into the existing water system, non-financial site accommodations, and financial considerations. Preliminary and final design of the WTP No. 5 at the Southdale Site was completed throughout 2017, but ultimately design was stopped due to aesthetic integration challenges at this location and the opportunity to improve overall water system performance by placing the facility at the Dublin Site. This system performance advantage was determined by the City's water system modeler in conjunction with updated water supply plan efforts.

Recall that the first four site alternatives assumed raw water supply from Wells No. 5, 18, and a future Well No. 21. Due to the closer proximity of other currently untreated wells the raw water supply at the Dublin Site was assumed to be from Wells No. 16, 19, and 20.

The following sections describe the facility layout alternatives considered for the Dublin Site, also referred to herein as Option 5.

A8.6 Option 5 – Dublin Site

The City identified the Dublin Site as a feasible location for WTP No. 5 after analysis completed by Edina's water modeling consultant indicated the potential for improved water system performance with addition of a treatment facility at this site. The Dublin Site is located south of Highway 62 and east of Highway 169 in a residential neighborhood near the Edina High School and Valley View Middle School complex.

Figure A8.1 provides an overview of the existing water system surrounding the Dublin Site. The proposed facility would be located within the Dublin Reservoir Site with Wells No. 16, 19, and 20 planned for supplying the 3,000 gpm treatment capacity. The firm capacity of the plant is technically 2,000 gpm, or equal to the plant's capacity with one (1) filter offline or in backwash. This site includes a gravity and pressure filter option.

The Dublin Site uniquely has an existing 4 MG below grade reservoir and associated booster pump station present. Conversations with City staff have indicated current operation of the reservoir is to maintain an approximately 10-foot level, utilizing about half of the available storage (18-foot depth to overflow). WTP No. 5 at the Dublin Site would eliminate approximately half of the reservoir, with the new facility built on the demolished side of the site. Preliminary layouts have assumed the east half used for the facility, however, optimization of this layout would be completed in future phases of the project as necessary. These options assume the demolition of the existing pump station and replacement with high service pumping within the facility.

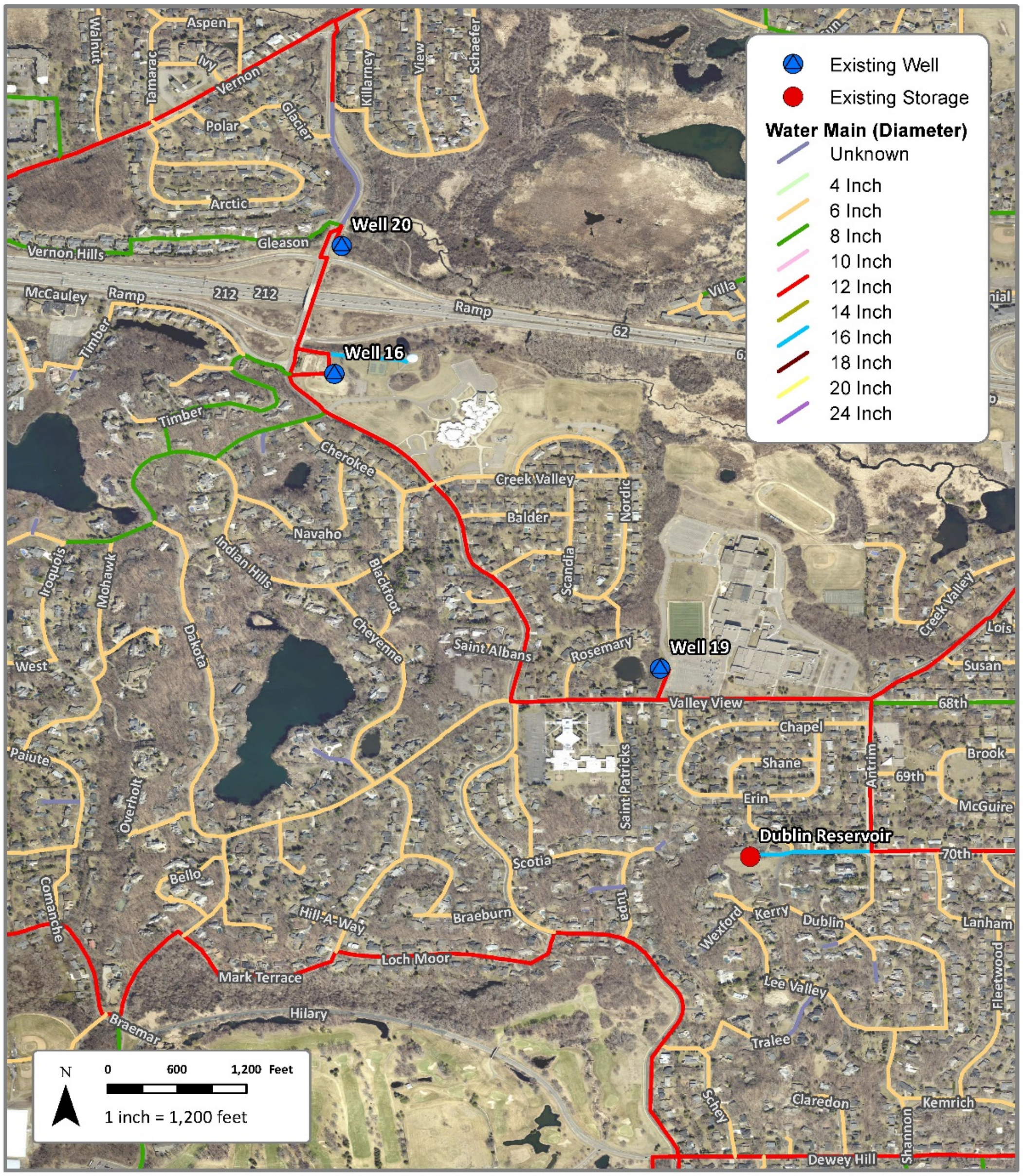


Figure A8.1 – Existing Water System near Dublin Site

A8.6.1 Option 5A

Option 5A is the Dublin Site with gravity filters. ***Appendix A.E*** provides a preliminary site layout and plan views of the upper and lower levels of the facility. Figure A8.2 depicts the general site requirements for Option 5A.

Below grade components include two backwash reclaim tanks each sized to hold a backwash from each of the three gravity filters, a pipe gallery, and a 2 MG clearwell to store finished water prior to pumping into the distribution system. A clearwell bypass from the filters into the high service pumping chamber is provided if the clearwell is taken offline for maintenance or other circumstances.

Main level components include chemical feed rooms, high service and backwash supply pumps, office and lab space, a pipe gallery, chemical unloading garage, indoor generator room, and electrical and mechanical equipment rooms. The main level extends upward for extra detention tank depth that provides 10 minutes of detention at the 3,000 gpm plant capacity, which flows by gravity into the three, 1,000 gpm filters. The upper level overlooks the pipe gallery, provides overhead views of the filters, and provides additional mechanical equipment space including the backwash air blower.

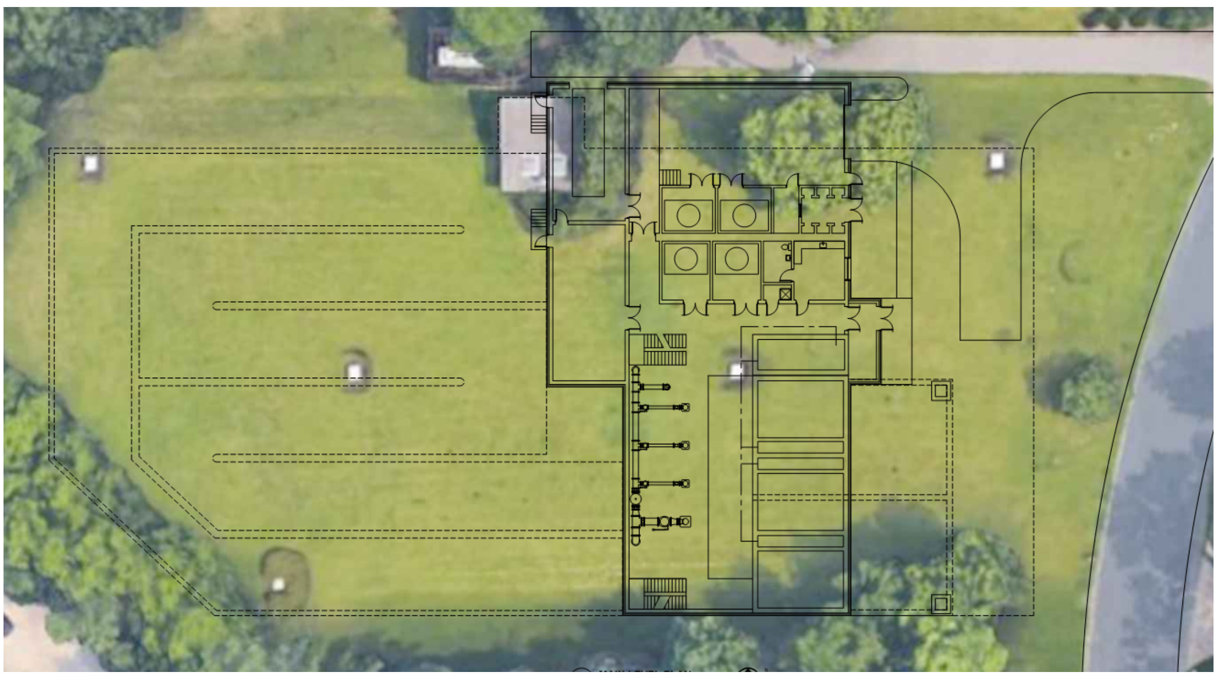


Figure A8.2 Option 5A – Dublin Site with Gravity Filters

A8.6.2 Option 5B

Option 5B is the Dublin Site with pressure filters. ***Appendix A.F*** provides a preliminary site layout and plan views of the upper and lower levels of the facility. Figure A8.3 depicts the general site requirements for Option 5B.

Below grade components include two backwash reclaim tanks each sized to hold a backwash from each of the three pressure filters, a pipe gallery to house backwash reclaim system and mechanical equipment, and a 2 MG clearwell to store finished water prior to pumping into the distribution system. A clearwell bypass from the filters into the high service pumping chamber is provided if the clearwell is taken offline for maintenance or other circumstances.

Main level components include chemical feed and storage rooms, a pressurized detention vessel, three, 1,000 gpm pressure filters, office, lab, and lavatory space, an electrical room, a mechanical room, a chemical delivery garage, and an indoor generator room. This option does not require an upper level for any of the currently proposed treatment technologies.

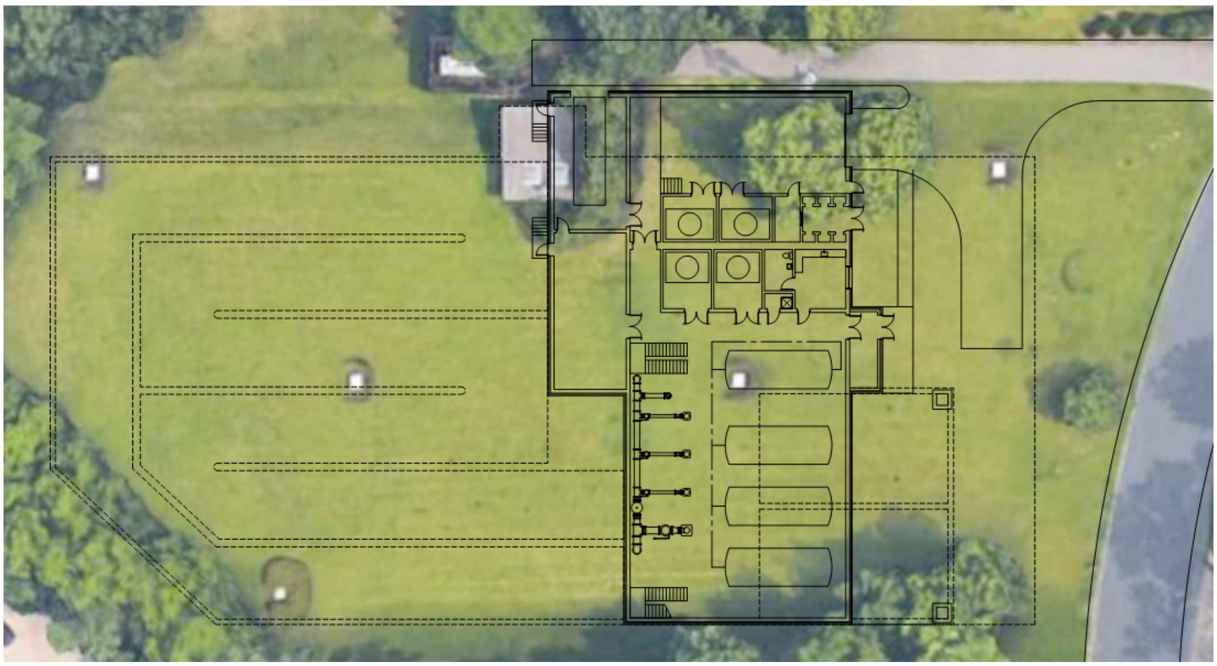


Figure A8.3 Option 5B – Dublin Site with Pressure Filters

A8.6.3 Option 1C

Initial discussions included an Option 5C for the Dublin Site with gravity filters and an above ground plate settler backwash reclaim system. After review of the site footprint availability and the residential surroundings of the site, it was determined that a below grade backwash reclaim system is more appropriate for the Dublin Site. The above grade plate settler system would increase the overall height of the facility and add operational and maintenance complexity to the backwash reclaim system. Since there is adequate space available for traditional backwash reclaim technology, further exploration of an above grade plate settler system at the Dublin Site is not recommended. This option can be reviewed in more detail if deemed necessary in the future.

A8.6.4 Building Code Review

Review of the existing City code was completed to ensure that the preliminary site layouts meet minimum setback and maximum building height requirements based on the lot zoning designation. According to the City's zoning map, the Dublin Site parcel is classified as a Single Dwelling Unit (R-1).

The requirements as set forth in Section 36-438 are summarized and compared to the preliminary layouts for Option 5A and 5B in Table A8.1.

Table A8.1 Review of Preliminary Dublin Layouts Compared to City Code

Requirement Description	Section 36-438 Code Requirement	Current Layouts Provide the Following	
		Option 5A	Option 5B
Minimum Front Street Setback	30′	>60′	>60′
Minimum Side Street Setback	15′	NA	NA
Minimum Interior Side Yard Setback	10′	>20′	>20′
Minimum Rear Yard Setback	25′	>120′	>120′
Maximum Building Height	40′	32′ + Pitched Roof*	18′ + Pitched Roof*

* Required for process equipment operational height, pitched roof height can be adjusted to accommodate code maximum building height.

The lot width is approximately 220 ft based on existing as-builts for the Dublin Reservoir. The maximum height to the ridge line is 35 ft, with the maximum height increased by one inch for each foot that the lot exceeds 75 feet. The maximum height cannot exceed 40 ft. With the 220 ft width, the code limits height to ridge line at 35 ft and maximum height to 40 ft.

According to code, the preliminary layouts could be optimized to reduce the front street setback and allow for more of the existing reservoir capacity to remain. This would minimize the impact that the Dublin Site has on overall finished water storage volume for the City.

FACILITY INTEGRATION

Integration with the existing infrastructure is a critical part of this preliminary design process. Using the existing infrastructure that is functioning well will help to conserve costs and allow the City of Edina to spend money on infrastructure that brings long term value to its Utility. Currently, the City has three raw water wells that will provide water to WTP No. 5 at the Dublin Site. In addition to these wells, the new WTP will need to operate seamlessly with the distribution system. The Project Team must consider the impact to adjacent infrastructure such as the Dublin Reservoir, adjacent roads, and adjacent buildings.

A9.8 Wells 16, 19, and 20

The proposed WTP will require 1,000 gpm of water from each of the three wells planned to supply the Dublin Site. Currently, Well No. 16, 19, and 20 each produce 1,000 gpm and pump directly into the distribution system. The distribution system pressure at the wellhouses in these areas operates between 80 and 100 psi. Like the calculations for well integration completed for Well No. 5 and 18 in the original PDR, the following tables provide the analysis for Well No. 16, 19, and 20 for Option 5A and 5B to determine if well modifications are necessary.

Table A9.1 indicates the ground, pump setting, and pumping water elevations at each well supplying the Dublin Site.

Table A9.1 Well Site Elevations

Well	Site Elevation (ft.)	Setting Elevation (ft.)	Pumping Water Elevation (ft.)
Well No. 16	891	Unknown	779
Well No. 19	948	692	746
Well No. 20	885	694	780

Each WTP configuration will require different pumping requirements from the supply wells. Table A9.2, Table A9.3, and Table A9.4 illustrate these head loss variations for Well No. 16, 19, and 20, respectively. Note that these calculations are only estimates to gauge whether well sizing adjustments must be made as part of the Dublin Site options.

The WTP hydraulic grade line (HGL) elevation is equal to the assumed detention basin normal water level for the gravity option and the clearwell normal water level for the pressure option. The filtration pressure is estimated at 5 psi for the pressure filter options to push through the detention vessel and filter components before entering the clearwell. The abbreviation TDH stands for total dynamic head, which is the summation of the static head, well pipe and pump losses, filtration pressure converted to feet of water (multiply psi by 2.31 to obtain feet), and pipeline losses.

Table A9.2 Well No. 16 Hydraulic Analysis

WTP Site	Site Elevation (ft.)	WTP HGL Elevation (ft.)	Static Head (ft.)	Well Pipe and Pump Losses (ft.)	Filtration Pressure (ft of water)	Pipeline Losses (ft.)	TDH Requirements
Dublin Gravity Filtration w/ Detention	1006	1019	240	10	0	50 (16"HDPE, 2,000gpm, 4300ft) + (20" HDPE, 3,000 gpm, 3400ft)	302
Dublin Pressure Filtration w/ Detention	1006	1001	222	10	12	50 (16"HDPE, 2,000gpm, 4300ft) + (20" HDPE, 3,000 gpm, 3400ft)	296

Table A9.3 Well No. 19 Hydraulic Analysis

WTP Site	Site Elevation (ft.)	WTP HGL Elevation (ft.)	Static Head (ft.)	Well Pipe and Pump Losses (ft.)	Filtration Pressure (ft of water)	Pipeline Losses (ft.)	TDH Requirements
Dublin Gravity Filtration w/ Detention	1006	1019	273	10	0	18 (20" HDPE, 3,000 gpm, 3400ft)	301
Dublin Pressure Filtration w/ Detention	1006	1001	255	10	12	18 (20" HDPE, 3,000 gpm, 3400ft)	295

Table A9.4 Well No. 20 Hydraulic Analysis

WTP Site	Site Elevation (ft.)	WTP HGL Elevation (ft.)	Static Head (ft.)	Well Pipe and Pump Losses (ft.)	Filtration Pressure (ft of water)	Pipeline Losses (ft.)	TDH Requirements
Dublin Gravity Filtration w/ Detention	1006	1019	239	10	0	59 (12"HDPE, 1,000gpm, 1400ft) + (16"HDPE, 2,000gpm, 4300ft) + (20" HDPE, 3,000 gpm, 3400ft)	309
Dublin Pressure Filtration w/ Detention	1006	1001	221	10	12	59 (12"HDPE, 1,000gpm, 1400ft) + (16"HDPE, 2,000gpm, 4300ft) + (20" HDPE, 3,000 gpm, 3400ft)	303

Based on preliminary calculations, the existing wells, motors, and pumps should have adequate brake horsepower (BHP) to pump to the Dublin Site. Note that each well may experience a decrease in the observed efficiency and flow due to the change in pumping conditions. Table A9.5 examines the current motors installed in each well to verify their operating characteristics under the new pumping conditions should the hydraulic grade line increase or decrease. Typically, calculations for all motors on VFD's include a 1.15 service factor. The 1.15 service factor provides a 15% factor of safety on the motor size, which helps to protect possible overload of the motor.

Table A9.5 Well Motor Capacity Analysis

Well	Current Motor Hp	Current Design Point BHP	New Design Point BHP	Recommended Motor Hp (*With 1.15 Service Factor*)
Well No. 16	150	108		
Dublin Gravity			95	125
Dublin Pressure			93	125
Well No. 19	150	109		
Dublin Gravity			95	125
Dublin Pressure			93	125
Well No. 20	150	112		
Dublin Gravity			97	125
Dublin Pressure			95	125

Based on the results shown above, the motor sizes would only decrease slightly for all wells. The City's 2017-2021 Capital Improvements Plan (CIP) has allocated $120,000 for Well No. 16 rehabilitation in 2019 and $120,000 for Well No. 19 rehabilitation in 2020. These rehabilitation costs would cover a new pump, motor, VFD, and electrical wiring to meet the new, slightly lower design point. Well No. 20 may operate with slightly less efficiency, however, re-building the pump to accommodate the new facility is not required in either facility alternative. When the pump is up for rehabilitation, the City can re-assess the pump efficiency and determine whether reduced motor size is recommendation. Approximate budgetary costs to complete the Well No. 20 modification would be $120,000.

A9.9 Dublin Reservoir and Pump Station

The addition of WTP No. 5 at the Dublin Site will require that half of the existing 4 MG underground storage reservoir be demolished, and the void area be used for the lower level of the facility, including backwash reclaim tanks and systems, a pipe and mechanical equipment area, and a high service pumping chamber. The remaining reservoir would be used as a clearwell for the facility prior to being pumped into the distribution system. To help facilitate proper turnover of the clearwell and reduce impacts of short-circuiting on water age, the Project Team recommends the addition of baffling between the existing reservoir columns to create a serpentine flow path from clearwell influent to effluent. Anticipated costs for adding approximately 550 feet of FRP baffling are $410,000 including materials and installation. Optimization of the FRP baffling arrangement may be completed during future design phases to reduce costs while still providing reduced short-circuiting impacts.

The three proposed high service pumps downstream of the clearwell will be sized to provide half the treatment capacity (1,500 gpm). This would provide 3,000 gpm of firm high service pumping capacity. Additional pumping capacity could be included to use the clearwell to meet a maximum hour demand (MHD), which was estimated at 4,800 gpm by the City's water system model consultant. This would likely require a larger pump in addition to the high service pumps to operate the pumps within the limitations of the pump curves. Additional analysis to determine the most efficient arrangement and selection of pumps would be conducted in future phases of the design. Costs to provide pumps capable of producing MHD are not included in the financial evaluation for the Dublin Site at this time.

Refer to section A9.10 for a structural evaluation of the Dublin Reservoir transformation into a WTP facility and clearwell.

Operation of Water Towers and Distribution System

At the request of the Project Team, the City's water distribution system consultant completed an analysis on the impacts of the proposed WTP No. 5 at the Dublin Site under multiple scenarios. The analysis determined the impacts of the facility during average day and peak demands and identified concerns related to existing infrastructure size and operation. The following sections briefly describe scenarios analyzed and the major takeaways for each. ***Appendix A.G*** provides a copy of the water distribution system analysis report.

A9.3.6 Dublin Site

The first scenario assumed addition of 3,000 gpm at the Dublin Site entry point into the distribution system. The second scenario assumed 5,000 gpm of total plant capacity, which comes from 5, 1,000 gpm wells including Well No. 16, 19, and 20 plus additional future wells.

Analysis included an Extended Period Simulation (EPS) for water tower operation comparison over a three-consecutive day run with average July water demand. This analysis assumed continuous operation of WTP No. 5, other treatment plants operating based on water tower levels, and initial tower levels set to 10-feet below overflow. In addition, the evaluation looked at a maximum day demand simulation to determine the impacts on the distribution system and identify infrastructure improvement needs.

A9.3.6.1 Scenario 1 – 3,000 gpm WTP at Dublin Site

The first scenario indicates favorable results in terms of the ability to push the 3,000 gpm of treatment capacity into the existing 16-inch water main with limited increases on average day discharge pressure. For the maximum day simulation, results indicate that the Southdale Tower may lag during periods of high demand due to inefficient delivery of water from the Dublin Site to the Southdale Area. In this simulation pressures were limited to current system pressures, which led to a maximum day flow capacity of only 2,800 gpm (not 3,000 gpm as designed) pushed into the system. The tower lag and reduced flow capacity provide evidence that upsizing the east-west water main between the Dublin Site and Southdale Area would alleviate these impacts in the future. Based on these findings, no substantial finished water distribution upgrades were assumed for the 3,000 gpm Dublin Site analysis.

A9.3.6.2 Scenario 2 – 5,000 gpm WTP at Dublin Site

The second scenario assuming a 5,000 gpm treatment capacity indicated that portions of trunk water main upgrades would be required to get the water out into the system efficiently, with minimized pipe headloss and limited pressure increases. These upgrades include upsizing the facility discharge piping to the Antrim Road and W 70th St intersection to a 24" pipe and the trunk water main from this intersection to Metro Boulevard along W 70th St to a 16" pipe. This scenario results in all tanks trending together during the average summer day EPS simulation, aside from some lag in the Southdale Tower.

A9.3.6.3 Additional Major Takeaways

An interesting takeaway to note for both scenarios is that existing system pressures in the area are relatively low, so increases in discharge pressure from this facility may be considered a benefit. Analysis of the existing Dublin Reservoir has indicated that the filling cycle is the limiting factor in being able to utilize the full 4 MG capacity of the tank. Overall, the addition of a WTP at this location would eliminate the current fill limitations of the existing Dublin Reservoir, ultimately benefiting system wide water age.

A9.3.6.4 Water Storage Impacts

The water modeling consultant also reported on the impacts of reducing the 4 MG storage reservoir down to the approximate 2 MG capacity with the proposed Dublin Site facility. Previous analysis completed for the City's updated 2018 Water Supply Plan indicated the usable volume of 2.88 MG for the Dublin Reservoir. Recommendations in this plan also included a 2040 storage shortfall of 0.5 MG. Taking into consideration the reduced volume associated with the WTP No. 5 at the Dublin Site, an updated storage recommendation for the City is an additional 1.5 MG of water storage. Site optimization to minimize the reservoir storage volume reduction would be completed in future design phases.

Raw Water Transmission

A9.4.5 Dublin Site Raw Water Transmission

Raw water supply to the Dublin Site requires significant piping installations. To minimize the installation of new piping, the Project Team recommends installation of one common trunk raw water transmission line that increases in size as wells are intersected along the proposed alignment. The assumed alignment for estimating purposes is shown in Figure A9.1.

The pipeline would begin as a 12-inch HDPE pipe from Well No. 20 for 1400 ft to Well No. 16, increase to a 16-inch HDPE for 4,300 ft from Well No. 16 to Well No. 19, then increase to a 20-inch HDPE pipe for 3,400 ft from Well No. 19 to the Dublin Site. This is a suggested trunk main based on current projected flows, maintaining velocities in an acceptable range, and limiting head loss across the pipeline. If the City would like to increase diameter to accommodate additional flows in the future, that can be considered in future design phases. The proposed alignment assumes that no substantial utilities or structures will cause significant impacts to the water main construction. The new HDPE pipeline length is approximately 9,100-feet long. Anticipated costs for this pipeline are $2,800,000.Finished Water Transmission

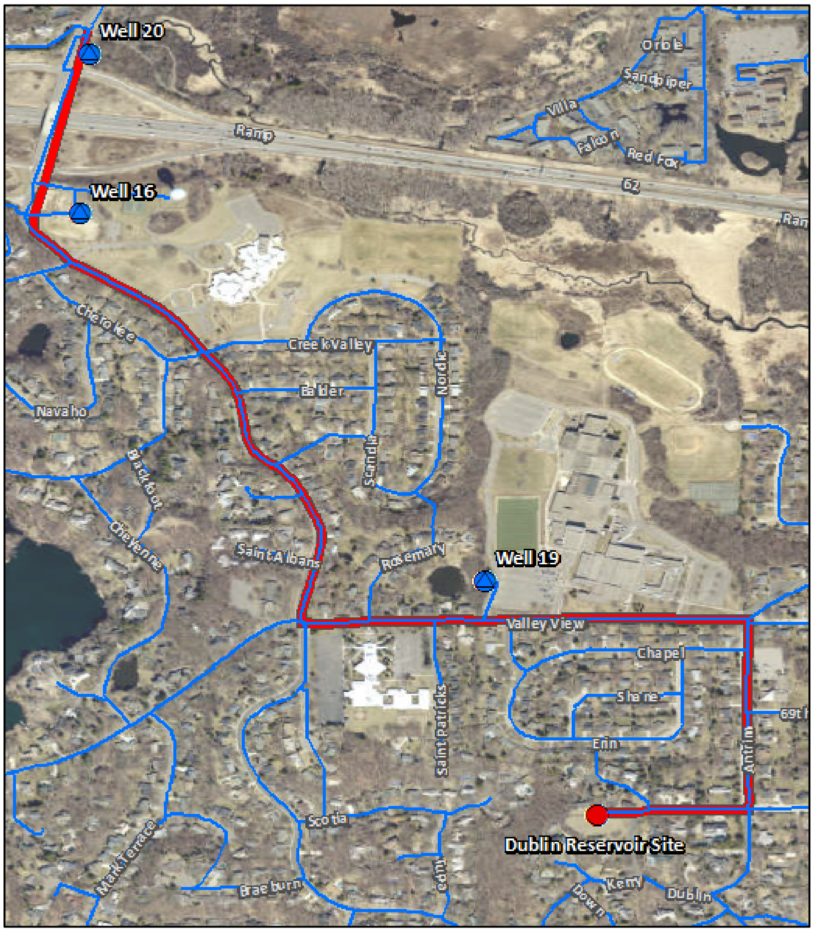


Figure A9.1 Dublin Site Raw Water Transmission

A9.5.5 Dublin Site Finished Water Transmission

The Dublin Reservoir has an existing 16" ductile iron pipe (DIP) that connects into water main at the intersection of Dublin Road (turns into W 70th St) and Antrim Road. At this intersection, there is a 12" main that travels north along Antrim Road, a 12" main traveling east along W 70th St, and a 6" lateral traveling south along Antrim Road. Figure A9.2 depicts the existing water main near the Dublin Site.

Figure A9.2 Dublin Site Finished Water Transmission

The connection of the finished water into the distribution system is a relatively straight forward installation. Site piping required to make this connection will include approximately 150 ft of 16" DIP tied into the existing 16" DIP at the northeast corner of the property. Anticipated costs for this pipeline are $50,000.

A9.10 Dublin Site Structural Evaluation

The Dublin Site offers a unique opportunity to transform an existing 4 MG reservoir into a combination WTP facility and clearwell that would improve the overall water system performance for the City. The following sections review the existing Dublin Reservoir construction, outline preliminary options for construction integration of the WTP with the existing reservoir, and highlight additional structural construction considerations.

A9.10.1 Existing Dublin Reservoir Construction

The existing Dublin Reservoir was constructed of conventionally reinforced cast-in-place (CIP) concrete. The cover slab is a two-way concrete slab with dropped panels and column capitals, which is a common method of elevated concrete slab construction. The 18" diameter columns are also CIP and supported by isolated spread footings below the 8" concrete slab that serves as the base or bottom of the reservoir. The exterior walls are 16" reinforced CIP supported by continuous concrete strip footings.

Figure A9.3 details the typical column and footing of the existing reservoir. This detail was taken from the reservoir as-built drawings prepared in October 1958 by Banister Engineering Co.

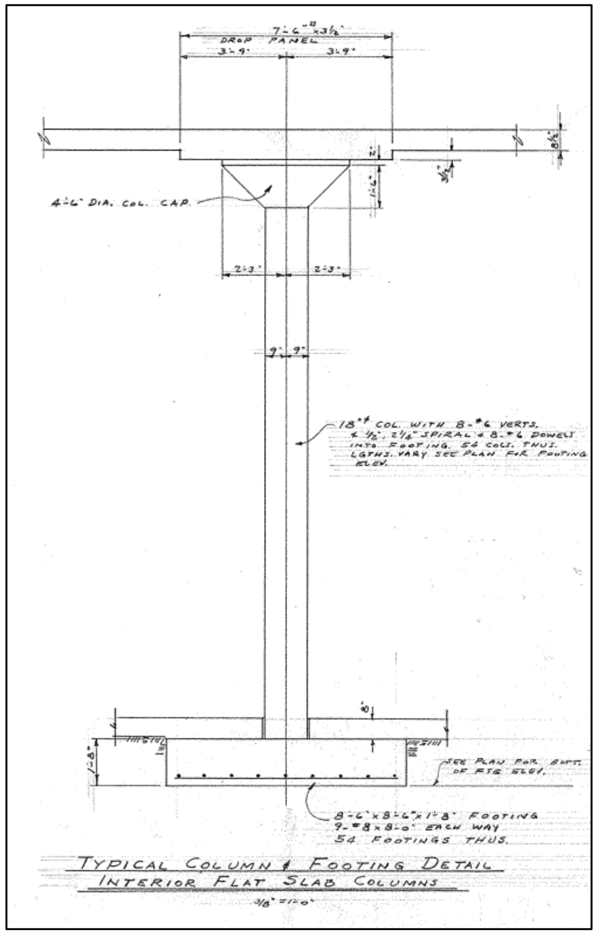


Figure A9.3 Existing Dublin Reservoir Typical Column and Footing Detail

Source: Dublin Reservoir As-Builts

A9.10.1.1 Existing Reservoir Structural Loading

The 8" base slab-on-grade for the existing reservoir is designed to support the water depth that is contained within the reservoir. This amounts to a water load of approximately 1,120 pounds per square foot (psf) based on a maximum water depth in the reservoir of 18 feet. It is important to note that removal of the water load does not necessarily increase or allow the repurposing of the load to a new WTP structure because most of this load is supported by the thin slab on grade. This note introduces a limitation of using the existing reservoir to structurally support the new facility.

The existing reservoir lid was designed to support 2 feet of soil, or approximately 220 psf. Removal of this soil load makes it available as a new construction dead load, however, this amount of load is much less than that which would be required to support a new WTP. This also introduces a limitation of using the existing reservoir for structural support of the new facility.

One other important consideration of the existing reservoir is the age of the structure. Typically, well maintained concrete has a 100-year design life. With this structure already 60 years old, it has already exceeded upwards of 60% of its useful life. Thorough evaluation of the concrete condition should be completed as part of the preliminary design phase. This condition assessment will impose complications because it is buried and filled with water.

A9.10.2 Options for New Facility Construction

Options for construction of the new WTP facility at the Dublin Site included demolishing half of the existing reservoir to build the facility within the available open half or reinforcing and constructing the facility above the existing reservoir. Both options present unique challenges that must be considered before providing a recommendation for new structural construction.

A9.10.2.1 Independent Reservoir and WTP Structure Option

The first option includes eliminating half the existing 4 MG reservoir and building the WTP in the open half of the site. Preliminary layouts have depicted the front, east half of the site be used for the WTP and the back, west half for an approximate remaining 2 MG reservoir. Important items to consider when determining the location and extent of demolition include:

- Modification, including partial demolition of the existing reservoir, would cause a redistribution of stresses within the concrete cover slab. A complete analysis of the existing slab system would be required during a preliminary design phase to determine if there is any overstressing in the slab.
- The cover slab dropped panels are 7′-6″ square and the column capitals are 4′-6″ in diameter, both centered at each column. These components will limit the extent of demolition and where the remaining reservoir edge is located.

For the portion of the existing reservoir remaining, demolition will need to be completed carefully to ensure structural integrity is not impacted. The demolition edge or extent will create a void during construction, which may require additional structural support and bracing. Installation of a new exterior wall within this void will be required and water tightness of the modified reservoir will become an important consideration. Additional slab patching may also be required to complete the reduced reservoir construction. Overall, the reuse of the existing reservoir as a reduced capacity reservoir (or WTP clearwell) is acceptable, keeping in mind these considerations.

In this option, the WTP would be built adjacent to, but separate from, the reduced capacity reservoir. Due to the high potential risk for differential settlements between the existing reservoir and new facility construction, there are added design considerations. These include the potential for deep foundations, inclusion of expansion or movement joints, and addition of flexible pipe connections. Pipe connections between the existing and new construction would be limited to two pipes; one into the clearwell from the filters and one from the clearwell into the high service pumping chamber.

The high service pumping chamber planned for the WTP eliminates the need for the existing pump station situated at the center of the north side of the existing reservoir. Demolition of the pump station introduces a logical edge of demolition for the reservoir. This edge was used in preliminary site layouts presented previously for the Dublin Site.

For the purposes of this feasibility study, structural design assumptions for the WTP assume a concrete foundation slab at a similar depth as the reservoir for the base of the facility, below grade exterior and interior CIP walls supported by continuous concrete strip footings, above grade concrete slabs at various levels, above grade interior walls as either CIP or concrete masonry unit (CMU), and precast concrete wall panels as the building shell. The high roof framing system is assumed to be precast hollowcore plank.

A9.10.2.2 Construction of WTP Above Existing Reservoir

The second option investigated with this feasibility study is the construction of the WTP above the existing reservoir. Initial review of the reservoir has indicated that this option would not be acceptable due to the following limitations:

- The existing structural system of the reservoir was not designed to support the required dead load of the WTP facility. The additional loading would require increased foundation support capacity, which would be costly to achieve.
- The existing framing and methods of construction are not easily modifiable, meaning that shoring and reinforcing would be costly.
- Selective demolition to provide a more robust structural system for the existing reservoir would occur at a higher or premium cost compared to complete demolition of a larger area.
- Repurposing and modification of the existing reservoir to house below grade WTP components such as the backwash reclaim system, required pipe galleries, and other typical equipment would come at a higher cost than new construction of an optimized layout.

For these reasons, this option was deemed unfeasible for WTP No. 5 at the Dublin Site. Further investigation of this option was not completed by the Project Team.

A9.10.3 Additional Cost Considerations

A few additional cost considerations were kept in mind when assessing the WTP options for the Dublin Site. These include, but are not limited to, the added noise and access disturbance likely during demolition and construction within the residential neighborhood and the limited area available for construction staging, offices, and parking. The noise disturbance may limit the working hours of the construction crew, requiring elongated periods to complete project tasks. Parking of vehicles or material storage will not be allowed on the top of the remaining reservoir, limiting the amount of space available to the contractor during construction.

SITE ACCOMMODATIONS EVALUATION

The original PDR included an analysis to evaluate each site's ability to accommodate various non-financial criterion related to treatment performance, security and safety, site architecture, constructability, and additional infrastructure considerations.

The following sections evaluate the Dublin Site for the same criterion and provide summary tables for all site options for comparison. Explanation of the evaluation criteria and discussion for the other sites was not included in this feasibility study. Refer to the original PDR for these details. The table below summarizes the evaluation symbols and descriptions used throughout this evaluation.

Evaluation Description	Very Unfavorable	Unfavorable	Neutral	Favorable	Very Favorable
Evaluation Symbol	OO	O	_	X	XX

Treatment Performance

A10.2.5 Dublin Site Evaluation

A10.2.5.1 Performance Objectives

The gravity and pressure filter options for the Dublin Site accommodate the required treatment technologies for meeting all MDH standards, primary drinking water regulations, and established treatment goals. This includes chlorine for pre-oxidation and disinfection, HMO for radium adsorption, filters for iron and radium removal, ammonia for supplemental chloramine formation, fluoride for dental hygiene, and an ortho/poly blend for corrosion inhibition. Also included is a clearwell for storing finished water prior to pumping into the system with high service pumps.

The Dublin Site alternatives also include redundancy for chemical feed, high service pumping, and backwash reclaim. High service pumps are sized to pump the full 3,000 gpm plant capacity with only two (2) of the three (3) pumps online, allowing cycling of online pumps and a back-up during maintenance or emergencies. The plant maintains a 2,000 gpm firm capacity during filter backwash.

The two options proposed for the Dublin Site include a detention basin within the design, but detention time provided is limited. Detention time will aid in pre-oxidation and radium adsorption. Table A10.1 summarizes the evaluation of each site related to meeting performance objectives and treatment target goals.

Table A10.1 Performance Objectives Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	XX	XX	XX	O	XX	X

A10.2.5.2 Operational Complexity

The only new chemical feed technology at the Dublin Site is an ammonium sulfate system. All other systems are used in other facilities throughout the City. Plant operator responsibility will be limited to general maintenance of the system and optimization of chemical feed rates. The facility will include instrumentation and controls for automatic adjustment of chemical dose using flow-paced chemical feed and residual concentration monitoring.

The gravity filters are a new technology for the City of Edina, but some staff have operated gravity filters in the past. No other existing facilities have a detention tank, but O&M of the tank is minimal and like traditional backwash reclaim tanks. The Dublin Site also proposes traditional backwash reclaim, eliminating the complexity of an above grade plate settler. Table A10.2 summarizes each sites evaluation related to operational complexity.

Table A10.2 Operational Complexity Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	—	—	—	X	—	X

A10.2.5.3 Operational Flexibility

Sizing of chemical feed systems for all site alternatives accommodates operation at a wide range of feed rates with changes in raw water quality. Chlorine in 150-lb cylinders is planned for the Dublin Site. There is potential for requiring 1-ton cylinders in the future with changing water characteristics or if treatment capacity is added to the facility. Selecting 150 lb cylinders will inevitably increase delivery frequency of chlorine compared to storing ton cylinders. Online instrumentation will monitor residual concentrations and adjust chemical feed as required. Wells will operate on a variable frequency drive (VFD) for adjustment of plant production based on system demand. The Dublin Site has the flexibility to expand in the future with either additional treatment technologies or increased treatment capacity. With extensive upgrades to the distribution system, additional wells could be routed to this site. Table A10.3 summarizes the evaluation of each site related to treatment expandability and flexibility.

Table A10.3 Operational Flexibility Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	—	O	XX	OO	X	XX

Security and Safety

A10.3.4 Dublin Site Evaluation

A10.3.4.1 Operator Security and Safety

With proper risk management plans established and chemical handling procedures followed, operator safety is not a concern for any of the proposed chemicals or equipment. The Dublin Site will incorporate emergency systems to ensure operator safety. This site also has adequate parking and space onsite for operator and chemical delivery truck access. Table A10.4 summarizes each site evaluation related to operator security and safety.

Table A10.4 Operator Security and Safety Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	XX	X	XX	OO	XX	XX

A10.3.4.2 Public Security and Safety

Again, none of the proposed site alternatives incorporate equipment or technology that creates an unsafe environment for the public. This evaluation criterion relates to the public's perception of the safety of the site. The Dublin Site is located within a residential neighborhood, which in some cases may raise concerns about delivery of chemicals to the facility. For this reason, a chemical unloading garage is planned for the site. Pedestrian traffic is minimal at this site. Table A10.5 summarizes the evaluation of each site related to public security and safety.

Table A10.5 Public Security and Safety Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	—	O	X	OO	X	XX

Site Architecture

A10.4.6 Dublin Site Evaluation

A10.4.6.1 Architectural Value

The Dublin Site is located within a residential neighborhood with limited vehicular access. The existing building stock surrounding the site is single-family residential with no plans for future development in the vicinity. The site in existing conditions is an open green space with a below grade storage reservoir. Development of the site would be visible to the neighborhood residents, making architectural concepts that blend the facility into the residential surroundings important. An initial architectural rendering for the facility is presented in ***Appendix A.H*** that was developed based on the preliminary site layout for Option 5A. There are potential architectural benefits for the Dublin Site dependent on what features are included that would provide beneficial use to the public, such as walking paths or park space in front of the proposed facility. Table A10.6 summarizes the evaluation of each site related to architectural value.

Table A10.6 Architectural Value Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	X	XX	—	O	X	—

A10.4.6.2 Sustainability / Resiliency

There are no known limiting factors preventing the integration of sustainable building features at the Dublin Site. The site has good south exposure for passive or active solar system addition. The level of sustainable building features includes for this site would be determined in future design phases. Table A10.7 summarizes the evaluation of each site related to sustainability / resiliency.

Table A10.7 Sustainability/Resiliency Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	—	—	X	O	X	X

A10.4.6.3 Shared-Use Benefit

The shared-use benefit of the Dublin Site includes the possible addition of park and green space for the neighborhood residents to use, but aside from this, shared-use options are limited. Pedestrian traffic is limited to those in the neighborhood, making addition of public art or a trailhead unfavorable.

Table A10.8 summarizes the evaluation of each site related to sustainability / resiliency.

Table A10.8 Shared-Use Benefit Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	—	XX	—	OO	X	O

A10.4.6.4 Land Use

The Future Land Use Plan, developed as part of the City's 2008 Comprehensive Plan Update, indicated that the Dublin Site is within the Open Space character category. The City's zoning map identifies the site as a Single Dwelling Unit (R-1). Placement of the water treatment facility at the Dublin Site changes the parcel to a public/semi-public land use category, but likely maintains the single dwelling unit zoning classification. Table A10.9 summarizes the evaluation of each site related to land use.

Table A10.9 Land Use Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	O	X	—	—	—	—

Constructability

A10.5.5 Dublin Site Evaluation

A10.5.5.1 Initial Construction

The Dublin Site construction limitations relate to the limited road access to the site in the residential neighborhood. The adjacent street is only a 30' wide road, with any construction equipment limiting full use of the corridor to residents. Periodic lane closures may be a nuisance but should not limit passage through the neighborhood. Noise constraints are also likely for this site with the residential presence. Space available for stockpiling and equipment or material storage is limited because the existing below grade reservoir restricts construction to foot traffic and minor weight-bearing activities such as rebar tying. Once demolition of the portion of the reservoir being removed is complete, construction footprint will not be as limited. The contractor will need to exercise care in demolition, staging, and storage to minimize impacts on the existing reservoir structural system. Dublin Rd. is scheduled for street reconstruction in 2020. Coordination of the projects should be considered to minimize construction disturbance. Table A10.10 summarizes the evaluation of each site related to initial construction.

Table A10.10 Initial Construction Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	O	X	O	OO	XX	—

A10.5.5.2 Construction Staging / Sequencing

The Dublin Site is less favorable in terms of construction staging and sequencing due to the presence of the existing reservoir that limits construction activities in areas above the structure. The area left behind for the facility after demolition will be larger than the proposed 3,000 gpm facility, providing some additional staging area during parts of construction. Table A10.11 summarizes the evaluation of each site related to construction staging and sequencing.

Table A10.11 Construction Staging and Sequencing Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	OO	X	X	OO	XX	—

A10.5.5.3 Future Maintenance

The Dublin Site provides favorable access to the proposed facility for future maintenance, depending on the final placement of the facility on the site. If the facility is placed on the back, western half of the site with the reservoir remaining at the front half, maintenance activities would not be allowed on top of the reservoir. Access to the site for major equipment maintenance could be interfered with in this scenario. For the purposes of this evaluation, the facility was assumed to be located on the front, east side of the site, which should provide adequate access for future maintenance. Table A10.12 summarizes the evaluation of each site related to future maintenance of the facility.

Table A10.12 Future Maintenance Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	O	X	X	OO	X	X

Additional Site Considerations

A10.6.5 Dublin Site Evaluation

A10.6.5.1 Distribution System Operation

The water distribution system analysis indicated that with minimal transmission piping additions and connections, the Dublin Site provides a favorable distribution system operation in terms of water tower balance, handling the planned 3,000 gpm capacity, minimizing increases in system pressure, and reducing impacts of water age that exist with current operation of the reservoir. Some lagging at the Southdale Tower occurs with this alternative, which is expected to be an existing occurrence. With future transmission piping upsizing, additional benefits of more efficiently serving the Southdale Area with the Dublin Site facility may be realized. Table A10.13 summarizes the evaluation of each site related to distribution system operation.

Table A10.13 Distribution System Operation Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	XX	XX	O	—	OO	X

A10.6.5.2 Raw Water Transmission Pipeline

The raw water transmission pipeline requirements associated with the Dublin Site are extensive because the piping currently does not exist. The wells are situated nicely in that a single raw water alignment could be installed that would add wells supplying the facility at this site along the way from north to southeast, adjacent to the existing trunk water main. Bringing these wells to the site requires approximately 9,300 feet of additional water main installation. With this length of pipe comes maintenance of the pipeline and its associated valves and appurtenances. Table A10.14 summarizes the evaluation of each site related to additional raw water transmission pipeline considerations.

Table A10.14 Raw Water Transmission Pipeline Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	X	X	XX	XX	OO	OO

A10.6.5.3 Finished Water Transmission Pipeline

The finished water transmission pipeline requirements associated with the Dublin Site are minimal because the Dublin Reservoir has an adequately sized 16-inch water main connection into the distribution system. The system capacity analysis indicated that this water main is adequate to handle the proposed 3,000 gpm plant capacity. Table A10.15 summarizes the evaluation of each site related to additional finished water transmission pipeline considerations.

Table A10.15 Finished Water Transmission Pipeline Evaluation for All Site Alternatives

Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Performance Objectives	X	X	O	—	OO	XX

Site Accommodations Evaluation Summary

A10.7.1 Dublin Site Evaluation Summary

Evaluation of the site accommodations provides a thorough review of non-financial factors considered in the selection of the preferred site alternative for future WTP No. 5.

The Dublin site meets the treatment performance objectives, with a slightly less favorable evaluation than other sites due to the limited detention time provided. The treatment goals at this site differ from those of the other four due to the supply source adjustment, so operational complexity lessens without requiring permanganate addition for manganese at this site. This site also provides the opportunity for treatment expandability in the future.

Operator and public safety is very favorable for this site as it is not located in a high-profile area like it is for other sites.

This site does not offer exceptional architectural value or shared-use benefit but does have room for addition of public use features depending on how the site layout develops over time. The Dublin Site is currently viewed as an open space, so conversion of the site into public infrastructure will require specific architectural components. Initial architectural concepts have unveiled a facility resembling a residential dwelling, allowing better blending of the facility into the existing residential neighborhood.

Construction related criterion pose some challenges for the Dublin Site, especially during early stages when demolition of the existing reservoir would take place. The location of the site may have limited impacts to the public overall, but impacts related to access and noise disturbance must be accounted for.

Finally, additional considerations related to distribution system operation and finished water transmission piping are favorable for the Dublin Site. The water system analysis completed for the site indicated that placement of the facility at this site would ultimately benefit the water distribution and promote reduced system water age. The extensive raw water transmission piping required to supply the site is undesirable compared to other sites.

Table A10.16 summarizes all criterion evaluated in the site accommodations analysis. Evaluation descriptions and symbols are provided again for reference below Table A10.16.

Table A10.16 Summary of WTP No. 5 Site Accommodations Evaluation

Evaluation Criteria	Standalone Southdale	Integrated Southdale	Yorktown	Median	Fred Richards	Dublin
Treatment Performance						
Performance Objectives	XX	XX	XX	O	XX	X
Operational Complexity	_	_	_	X	_	X
Operational Flexibility	_	O	XX	OO	X	XX
Security and Safety						
Operator Security and Safety	XX	X	XX	OO	XX	XX
Public Security and Safety	_	O	X	OO	X	XX
Site Architecture						
Architectural Value	X	XX	_	O	X	_
Sustainability / Resiliency	_	_	X	O	X	X
Shared-Use Feasibility	_	XX	_	OO	X	O
Land Use	O	X	_	_	_	_
Constructability						
Initial Construction	O	X	O	OO	XX	_
Staging / Sequencing	OO	X	X	OO	XX	_
Future Maintenance	O	X	X	OO	X	X
Additional Site Considerations						
Distribution System Operation	XX	XX	O	_	OO	X
Raw Water Pipeline	X	X	XX	XX	OO	OO
Finished Water Pipeline	X	X	O	_	OO	XX

Evaluation Description	Very Unfavorable	Unfavorable	Neutral	Favorable	Very Favorable
Evaluation Symbol	OO	O	_	X	XX

FINANCIAL CONSIDERATION EVALUATION

This chapter provides a financial evaluation of the estimated total project cost for the Dublin Site that includes the capital cost of constructing WTP No. 5 and integrating the facility into the City of Edina's existing water distribution system.

A11.7 Option 5 – Dublin Site

The fifth site evaluated is the Dublin Site with two different base facility options. These include Option 5A and Option 5B previously introduced in section A8.6.

A11.7.1 Option 5A – Dublin Site with Gravity Filters

Option 5A consists of gravity filtration with a traditional backwash reclamation system. ***Appendix A.E*** provides a preliminary site layout and plan views of the upper and lower levels of the facility. The building is approximately 80-feet east to west by 140-feet north to south, with the buried backwash tanks extending the building an additional 30-feet east. Building height will be approximately 32-feet high to accommodate the gravity filters and an upper level process area. Additional building height of approximately 8-10' is proposed for the false peaked roof provided that would screen the mechanical equipment required at the roof level. The structural and architectural estimate incorporates architectural features to ensure the facility is aesthetically similar to residential buildings adjacent to the site.

The gravity filters provide a dual purpose: major process equipment and exterior walls for the building. This filter type requires higher concrete costs but reduced process equipment costs. The existing reservoir presents unique excavation savings for the facility, limiting the amount of stockpiling and haul-off required for the facility.

Costs for integrating the facility into the City's existing distribution system are significant for Option 5A due to the extensive raw water transmission piping upgrades required to tie the three planned wells into the facility and the demolition/repurposing work required on the Dublin Reservoir. This includes approximately 9,100 feet of new HDPE water main piping and careful reservoir demolition to reduce the capacity of the tank approximately in half. Integration costs for well rehabilitation were not included because two wells are up for rehab as part of the City's CIP and the third is relatively new and could be downsized as part of future rehabilitation if necessary. The higher elevation of the facility compared to the well houses results in similar pump design points as compared to existing operation. The addition of FRP Baffling within the Dublin Reservoir was included as a premium cost.

Table A11.1 provides a combined summary of the facility construction and integration costs. This summary also includes 15-percent contingencies and 15-percent for engineering design and construction phase services. ***Appendix A.I*** provides a detailed opinion of probable total construction cost for Option 5A.

Table A11.1 Option 5A Construction Cost Summary

Facility Construction Cost		
1	General Requirements	$ 746,000
2	Structural / Architectural	$ 3,462,000
3	Mechanical	$ 490,000
4	Electrical	$ 1,525,000
5	Site Work	$ 660,000
6	Process Equipment and Integration	$ 1,524,000
	Facility Construction Subtotal	**$ 8,407,000**
Facility Integration Cost		
1	Raw Water Pipeline – Gleason Road Alignment	$ 2,800,000
2	Finished Water Pipeline	$ 50,000
3	Dublin Reservoir Reduction	$ 285,000
	Facility Integration Subtotal	**$ 3,135,000**
	Construction Cost Subtotal	**$ 11,542,000**
	Contingencies (15%)	$ 1,731,000
	Preliminary Opinion of Probable Total Construction Costs	**$ 13,273,000**
	Professional Services to Date	$ 1,043,300
	Engineering Design Phase Services (10%)	$ 1,372,000
	Construction Phase Services (5%)	$ 686,000
	Total Project Costs	**$ 16,307,300**

Table A11.2 summarizes the optional premium costs of components feasible for inclusion in Option 5A. Premium costs for this site are limited to FRP Baffling within the remaining Dublin Reservoir to promote a serpentine like flow through the basin to reduce effects of short-circuiting and lessen water age impacts. The costs do not include the contingencies, engineering design phase services, or construction phase service fees.

Table A11.2 Optional Premium Costs for Option 5A

Facility Construction Cost		
1	FRP Baffling in the Dublin Reservoir	$ 410,000

A11.7.2 Option 5B – Dublin Site with Pressure Filters

Option 5B consists of pressure filtration with a traditional backwash reclamation system. ***Appendix A.F*** provides a preliminary site layout and plan views of the upper and lower levels of the facility. The building is approximately 80-feet east to west by 140-feet north to south, with the buried backwash tanks extending the building an additional 30-feet east. Building height will be approximately 18-feet high to accommodate the pressure filters. Additional building height of approximately 8-10' is proposed for the false peaked roof that would screen the mechanical equipment required at the roof level. The structural and architectural estimate incorporates architectural features to ensure the facility is aesthetically similar to residential buildings adjacent to the site.

The use of pressure filters allows sliding of the backwash reclaim tanks below the main operating level, reducing concrete costs associated with the cover slab of the reclaim tank. The overall smaller size of the facility also decreases the structural and architectural related costs. This option requires the same excavation costs for below grade components. The pressure filters elevate the process equipment and integration costs compared to gravity filter options.

Facility integration costs are the same between Option 5A and 5B. The addition of FRP Baffling within the Dublin Reservoir was included as a premium cost.

Table A11.3 provides a combined summary of the facility construction and integration costs. This summary also includes 15-percent contingencies and 15-percent for engineering design and construction phase services. ***Appendix A.J*** provides a detailed opinion of probable total construction cost for Option 5B.

Table A11.3 Option 5B Construction Cost Summary

Facility Construction Cost		
1	General Requirements	$ 772,000
2	Structural / Architectural	$ 2,827,000
3	Mechanical	$ 490,000
4	Electrical	$ 1,521,000
5	Site Work	$ 660,000
6	Process Equipment and Integration	$ 2,601,000
	Facility Construction Subtotal	**$ 8,871,000**
Facility Integration Cost		
1	Raw Water Pipeline – Gleason Road Alignment	$ 2,800,000
2	Finished Water Pipeline	$ 50,000
3	Dublin Reservoir Reduction	$ 285,000
	Facility Integration Subtotal	**$ 3,135,000**
	Construction Cost Subtotal	**$ 12,006,000**
	Contingencies (15%)	$ 1,801,000
	Preliminary Opinion of Probable Total Construction Costs	**$ 13,807,000**
	Professional Services to Date	$ 1,043,300
	Engineering Design Phase Services (10%)	$ 1,381,000
	Construction Phase Services (5%)	$ 690,000
	Total Project Costs	**$ 16,921,300**

Table A11.4 summarizes the optional premium costs of components feasible for inclusion in Option 5B. Premium costs for this site are limited to FRP Baffling within the remaining Dublin Reservoir to promote a serpentine like flow through the basin to reduce effects of short-circuiting and lessen water age impacts. The costs do not include the contingencies, engineering design phase services, or construction phase service fees.

Table A11.4 Optional Premium Costs for Option 5B

Facility Construction Cost		
1	FRP Baffling in the Dublin Reservoir	$ 410,000

A11.8 Dublin Site Capital Cost Evaluation Summary

This chapter presented the base facility options for the two Dublin site alternatives for WTP No. 5. Refer to the Technical Memorandum titled WTP No. 5 Alternatives – Comparison of Opinions of Probable Cost for a summary of all alternatives considered for WTP No. 5. This document provides a side-by-side comparison of all twelve alternatives developed to date for WTP No. 5.

These two options present conceptual design of base facilities that adequately accomplish the facility treatment goals. Table A11.6 summarizes the total construction costs of each option.

Table11.6 Summary of Opinion of Total Construction Costs for WTP No. 5 at Dublin Site

Site	Option	Facility Construction	Facility Integration	Contingencies	Engineering & Construction Phases*	Total Construction Cost
Dublin	Option 5A	$ 8,407,000	$ 3,135,000	$ 1,731,000	$ 3,101,300	**$ 16,307,300**
	Option 5B	$ 8,871,000	$ 3,135,000	$ 1,801,000	$ 3,114,300	**$ 16,921,300**

* Engineering & Construction Phases include $1,043,300 for professional services to date for both options.

The integration of the facility into the City of Edina's existing distribution system is the largest differentiator in the alternative selection. The extensive raw water transmission main required and costs associated with Dublin Reservoir capacity reduction make this site less cost effective than the Southdale Site.

CONCLUSIONS AND RECOMMENDATIONS FOR IMPLEMENTATION

The following sections summarize the evaluation completed for the Dublin Site to ultimately determine whether it is a feasible location for WTP No. 5.

A13.7 Dublin Site Evaluation

A13.7.1 Treatment Technology Evaluation

The addition of the Dublin Site required re-evaluation of the treatment technology used for WTP No. 5 at that plant because the raw source shifted from Wells No. 5, 18, and future Well No. 21 to treating Wells No. 16, 19, and 20. Breakpoint chlorination testing and review of available raw water quality for these new wells indicated similar water quality to the original wells. Differences in treatment technology between the Dublin Site and other evaluated sites include the elimination of manganese treatment due to low raw manganese concentrations and proceeding with traditional backwash reclaim tanks and systems with the additional available facility footprint. Raw water radionuclide concentrations have not yet exceeded the MCL for these wells, however, results have increased over time. For this reason, and to provide treatment flexibility as water quality changes in the future, a radium removal system is included for the Dublin Site base facilities.

Chemical alternatives selected for the Dublin Site include gaseous chlorine, liquid ammonium sulfate, HMO, fluoride and an ortho / poly blend. Life cycle analysis completed as part of the original PDR resulted in selection of gaseous chlorine and liquid ammonium sulfate. With the relatively similar water chemistries present between all evaluated wells, these selections were carried through for the Dublin Site. Artificial ammonia addition may be limited due to higher raw ammonia concentrations; however, the system is proposed to ensure maintenance of a high chloramine residual leaving the facility.

A13.7.2 Facility Integration Evaluation

Integration with the existing infrastructure is a critical part of the PDR process. The new WTP must operate seamlessly with the existing distribution system and the Project Team must consider the facility's impacts on existing infrastructure.

Rehabilitation of Well No. 16 is necessary due to noise disturbance caused by the unit during operation. Well 16 and 19 have allocated funds in the City's CIP for rehabilitation, so additional rehab costs were not included as part of this analysis. Well No. 20 may be downsized at a later date with other schedule rehabilitation. With the higher elevation of the Dublin Reservoir compared to the wellhouses, operating points to get the raw water to the plant are only slightly reduced from existing conditions. This is even true for the pressure filter option because both filter types will lead directly into the reduced Dublin Reservoir before being pumped into the system by the high service pumps.

The major facility integration components of the Dublin Site include extensive (9,100 ft) raw water transmission piping installation to get the raw water to the facility and select demolition and rehabilitation of the Dublin Reservoir to reduce its capacity and open half of the site for the WTP.

The City's water distribution system consultant completed an analysis on the impacts of the proposed WTP No. 5 at the Dublin Site under multiple scenarios. The first analysis determined that overall, the Dublin Site at 3,000 gpm capacity would eliminate the current fill issues experienced at the Dublin Reservoir, would have minimal impacts on system pressures, and would not require significant distribution system improvements to function properly. The Southdale Area would benefit from this scenario if the main from Antrim Rd to Metro Blvd were upsized, however, this is not necessary at this time.

The second analysis with a 5,000 gpm assumption concluded that to push this much water out into the system, upsizing of both the finished water main from the facility to the Antrim Rd and W 70th St intersection and the water main from Antrim Rd to Metro Blvd is required. This scenario resulted in minimal pressure increases and water tower tanks mostly trending together.

The water model analysis also looked at available water storage for the City with the reduction of capacity at the Dublin Site. Previous analysis completed for the City's updated 2018 Water Supply Plan indicated the usable volume of 2.88 MG for the Dublin Reservoir. Recommendations in this plan also included a 2040 storage shortfall of 0.5 MG. Taking into consideration the reduced volume associated with the WTP No. 5 at the Dublin Site, an updated storage recommendation for the City is an additional 1.5 MG of water storage.

With all infrastructure integration components considered, the Southdale Site is still the most favorable option for future WTP No. 5. The Dublin Site does provide a unique opportunity to optimize use of the existing reservoir and reduce water age because of these changes.

A13.7.3 Site Accommodations Evaluation

The Dublin site meets the treatment performance objectives, with a slightly less favorable evaluation than other sites due to the limited detention time provided. The treatment goals at this site differ from those of the other four due to the supply source adjustment, so operational complexity lessens without requiring permanganate addition for manganese at this site. This site also provides the opportunity for treatment expandability in the future.

Operator and public safety is very favorable for this site as it is not located in a high-profile area like it is for other sites.

This site does not offer exceptional architectural value or shared-use benefit but does have room for addition of public use features depending on how the site layout develops over time. The Dublin Site is currently viewed as an open space, so conversion of the site into public infrastructure will require specific architectural components. Initial architectural concepts have unveiled a facility resembling a residential dwelling, allowing better blending of the facility into the existing residential neighborhood.

Construction related criterion pose some challenges for the Dublin Site, especially during early stages when demolition of the reservoir would take place. The location of the site may have limited impacts to the public overall, but impacts related to access and noise disturbance must be accounted for.

Finally, additional considerations related to distribution system operation and finished water transmission piping are favorable for the Dublin Site. The water system analysis completed for the site indicated that placement of the facility at this site would ultimately benefit the water distribution and promote reduced system water age. The extensive raw water transmission piping required to supply the site is undesirable compared to other sites.

A13.7.4 Financial Consideration Evaluation

The Project Team estimates a cost between $16.3M and $16.8M (2018 dollars) for WTP No. 5 at the Dublin Site, including facility construction, facility integration into the distribution system, 15-percent contingencies and 15-percent for engineering design and construction phase services. Option 5A with gravity filters would be more cost effective than Option 5B with pressure filters based on these preliminary cost estimates.

A13.7.5 Recommended Alternative

Option 5A of the Dublin Site meets all desired treatment objectives and goals set by the Project Team for WTP No. 5. Distribution system modeling expects selection of this site produces minimal increases in pressure in the system and helps optimize the water system use of the existing Dublin Reservoir. The slight pressure increases may be a benefit in this location due to the low pressures existing near the site. When comparing the two Dublin Site alternatives, Option 5A provides the lower overall opinion of probable construction cost.

The site may present some challenges with constructability due to the need for careful demolition and construction activities near the existing reservoir and the lack of staging or stockpiling area. The site also lacks a substantial shared-use benefit aside from potential park space due to its relatively hidden location within a residential neighborhood.

While analysis related to increasing the facility capacity to 5,000 gpm was not conducted as part of this Feasibility Study, the City may have interest in doing so to eliminate the need for an additional facility in the 2040 planning period currently being reviewed. This would require additional infrastructure improvements to get the additional 2,000 gpm of raw water to and from the Dublin Site.

A13.8 Dublin Site Evaluation Conclusions

The City of Edina should consider the following items for preparing for implementation of the planned WTP No. 5:

- The City should carefully consider the remaining alternatives for WTP No. 5 including the Southdale Site with various levels of architectural enhancements and the Dublin Site.
- The existing reservoir will need condition assessments completed prior to proceeding with the option to demolish half of the reservoir and build the proposed WTP in the open area. Cost increases may be endured if condition of the reservoir is unfavorable and either full or additional select demolition is required.
- The existing water supply wells to supply the Dublin Site will not need improvements in association with the planned WTP project. Rehabilitation of Well No. 16 is recommended to eliminate the noise disturbance present when the well operates. The City's current CIP includes rehabilitation costs for Well No. 16 in 2019 and Well No. 19 in 2020. Downsizing of pumps and

motors may increase well operating efficiency at the new design point but is not necessary for function.

- The preliminary design phase should consider investigation of gaseous chlorine cylinder size optimization.
- The base facility currently assumes initial construction of the plant designed at the full 3,000 gpm capacity. The City could consider increasing treatment capacity of the facility to 5,000 gpm. This increase would result in additional costs associated with facility upsizing, raw water transmission, and finished water transmission. The goal of a facility of this size would be to eliminate the need for another treatment facility in the future.
- Additional optimization in overall facility implementation could be realized in terms of future planned water main upgrades in the vicinity, scheduled street reconstruction projects, and plans for fiber optic installation to the site.
- As identified by the water model analysis, the volume reduction of the reservoir increases the storage recommendations recently identified in the 2018 Water Supply Plan to 1.5 MG of additional storage. This should be considered while planning future water system infrastructure needs. Site optimization in future design phases should be considered to minimize lost storage.

This Feasibility Study is provided as an amendment to the original WTP PDR to investigate a fifth site alternative for location of WTP No. 5. Throughout the planning period and project implementation process, Edina should expect uncertainties and changes, which can best be managed through the continuation of the proactive planning process present between City staff and the Project Team.

Appendix A.A

Well No. 16 Information

TURBINE PUMP
(MOTOR, PUMP, PERFORMANCE RECORD)

(AS INSTALLED) DATE: May 18, 2009

GENERAL INFO:

Customer/Owner: City of Edina Well/Pump 16

Address/Location: 6301 Gleason Road

Persons on Job Site: Pete & Steve

MOTOR INFO: Name Plate

Horsepower 150 Stand Still Volts 460 Running Volt: Varied

Manufacturer US R.P.M 1785 Full Load Amps 170 S.F.Amps

BOWL DESIGN: G.P.M. 1500 T.D.H. 280' Megger Reading

PERFORMANCE TEST: Static Water Level 106' Well Diameter 24" Well Depth 381'

Test #1: HZ 58.5	AMPS 141	G.P.M. 1100	Water Level 112'	P.S.I.	Gauge Broke Est. 100	T.D.H. 343'
Test #2: HZ	AMPS	G.P.M.	Water Level	P.S.I.		T.D.H.
Test #3: HZ	AMPS	G.P.M.	Water Level	P.S.I.		T.D.H.

T.D.H. = Pumping Water Level in Feet + (P.S.I. reading x 2.31) + Friction Loss In Column + Fittings

Example: Information Given: 1000 G.P.M., 150' Water Level, 50 P.S.I.,3.5' Friction Loss

Therefore: 150' + (50# x 2.31 or 115.5') + 3.5' = 269' T.G.H.

OR

The pump is producing 1000 G.P.M. at 269' T.D.H.

Does Well Pump Sand? Yes / NO If So, How Much?

Test #1 " in Gallon Jar

Test #2 " in Gallon Jar

Test #3 " in Gallon Jar

Closed Valve Test: P.S.I. Reading Water Level

Vibration Record: Vibration in Mils:

A	2.2	90* from Discharge
B	2.8	In Line with Discharge
C	0.7	90* from Discharge
D	0.9	In Line with Discharge

Tested By: Jiim K, Dave M.

Problems/Comments: Groute around base all cracked.

Customer/Owner Comment:

Minnesota Unique Well Number

203101

County Hennepin
Quad Hopkins
Quad ID 104B

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date 08/24/1991
Update Date 03/10/2014
Received Date

Well Name	Township	Range	Dir Section	Subsection
EDINA 16	116	21	W 6	ABDCCC

Elevation 895 ft. **Elev. Method** 7.5 minute topographic map (+/- 5 feet)

Address

Contact 4801 50TH ST W EDINA MN 55424
Well 1001 GLEASON RD EDINA MN 55439

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
NO RECORD	0	45		
ROCKS, GRAVEL	45	115		
ST. PETER	115	175		
SHALE	175	184	BLUE	
SHALE, SAND	184	215	GRAY	
SHALE	215	255	GRAY	
ROCK-SHAKOPEE	255	380		
JORDAN SANDSTONE	380	381		

Remarks
M.G.S. NO. 435.

Well Depth	Depth Completed	Date Well Completed
381 ft.	381 ft.	11/10/1967

Drill Method Cable Tool **Drill Fluid**

Use community supply(municipal) **Status** Active

Well Hydrofractured? **Yes** ☐ **No** ☐ **From** **To**

Casing Type Step down **Joint**
Drive Shoe? **Yes** ☐ **No** ☐ **Above/Below** 1 ft.

Casing Diameter **Weight** **Hole Diameter**
20 in. To 265 ft. lbs./ft. 30 in. To 381 ft.
30 in. To 215 ft. lbs./ft.

Open Hole From 265 ft. To 381 ft.
Screen? ☐ **Type** **Make**

Static Water Level
66 ft. land surface Measure 11/10/1967

Pumping Level (below land surface)

Wellhead Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
neat cement		ft.	ft.

Nearest Known Source of Contamination
feet Direction Type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name
Model Number HP 0 Volt
Length of drop pipe ft Capacity g.p. Typ

Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance
Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Miscellaneous
First Bedrock St.Peter Sandstone Aquifer Prairie Du Chien-
Last Strat Jordan Sandstone Depth to Bedrock 115 ft
Located by Minnesota Department of Health
Locate Method GPS Differentially Corrected
System UTM - NAD83, Zone 15, Meters X 469482 Y 4970571
Unique Number Verification Input Date 07/21/1995

Angled Drill Hole

Well Contractor

Licensee Business	Lic. or Reg. No.	Name of Driller
Layne Well Co.	27010	DRECHSEL, B.

Appendix A.B

Well No. 19 Information

WATER WELL RECORD
Minnesota Statutes 156A.01-.08

MINNESOTA UNIQUE WELL NO. for Water Sample: 005626

County Name				
Hennepin				
Township Name	Township Number	Range Number	Section No.	Fraction
Edina	116 N	21 W	5	SW SW SW

Numerical Street Address and City of Well Location or Distance from Road Intersection.

6054 Valleyview Rd. Edina

Show exact location of well in section grid with "X." — Sketch map of well location.

Addition Name — Block Number — Lot Number

Valleyview

4. WELL DEPTH (completed): 520 ft. — Date of Completion: 10-26-89

5. DRILLING METHOD: ☒ Cable Tool ☐ Reverse ☐ Driven ☐ Dug ☐ Hollow Rod ☐ Air ☐ Bored ☐ ☐ Rotary ☐ Jetted ☐ Power Auger 28-L

6. DRILLING FLUID: Water

7. USE: ☐ Domestic ☐ Monitoring ☐ Heat Pump ☐ Irrigation ☐ Public ☐ Industry ☐ Test Well ☒ Municipal ☐ Commercial ☐ Air Conditioning ☐

2. PROPERTY OWNER'S NAME: City of Edina

Mailing Address if different than property address indicated above: 4801 W. 50th Street, Edina, MN 55424

8. CASING: ☒ Black ☐ Threaded ☐ Galv. ☒ Welded ☐ Plastic ☐ — HEIGHT: Above/Below Surface 2 ft. Drive Shoe? Yes X No — HOLE DIAM.

Diameter	Depth	Weight
30 in.	to 30 ft.	118.65 lbs./ft.
24 in.	to 242.75 ft.	94.62 lbs./ft.
18 in.	to 440.25 ft.	70.59 lbs./ft.

3. FORMATION LOG

FORMATION LOG	COLOR	HARDNESS OF FORMATION	FROM	TO
Clay	Yellow		00	52
Clay	Blueish		52	70
Clay & Gravel	Brown		70	182
St. Peter	Tan		182	195
St. Peter	White		195	207
St. Peter	Tan		207	228
Shale & St. Peter	Lt. Blue		228	240
St. Peter	Tan		240	260
St. Peter & Shale	Blueish		260	302
Shakopee Dolomite	Tan		302	428
Jordon Sandstone	White		428	521

Use a second sheet, if needed

9. SCREEN: Make NONE — Or open hole from 440 ft. to 520 ft.
Type ___ Diam. ___ Slot/Gauze ___ Length ___ Set between ___ ft. and ___ ft. FITTINGS:

10. STATIC WATER LEVEL: 163 ft. ☒ below ☐ above land surface — Date Measured 10-26-89

11. PUMPING LEVEL (below land surface): 39 ft. after 3 hrs. pumping 1200 g.p.m.

12. HEAD WELL COMPLETION: ☐ Pitless adapter manufacturer ___ Model ___ ☐ Basement offset ☒ At least 12" above ground ☐ Plastic casing protection

13. WELL GROUTED? ☒ Yes ☐ No — ☒ Neat Cement ☐ Bentonite ☐
Grout material Neat Cement from 242 to suff ft. cu. yds. 6
440 surf 63

14. NEAREST SOURCES OF POSSIBLE CONTAMINATION: ___ feet ___ direction ___ type
Well disinfected upon completion? ☒ Yes ☐ No

15. PUMP: Date installed ___ ☒ Not installed
Manufacturer's name ___ Model number ___ HP ___ Volts ___ Length of drop pipe ___ ft. Capacity ___ g.p.m. Material of drop pipe ___
Type: ☐ Submersible ☒ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ Centrifugal ☐

16. ABANDONED WELLS: Unused well on property? ☐ Yes ☒ No — Sealed ☐ Permanent ☐ Temporary ☐ Not sealed

17. REMARKS, ELEVATION, SOURCE OF DATA, etc.
Mapcode B-309
Elevation 893+10
Quad 104B
Well #19

NOV 1989 RECEIVED GWQ

18. WATER WELL CONTRACTOR CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

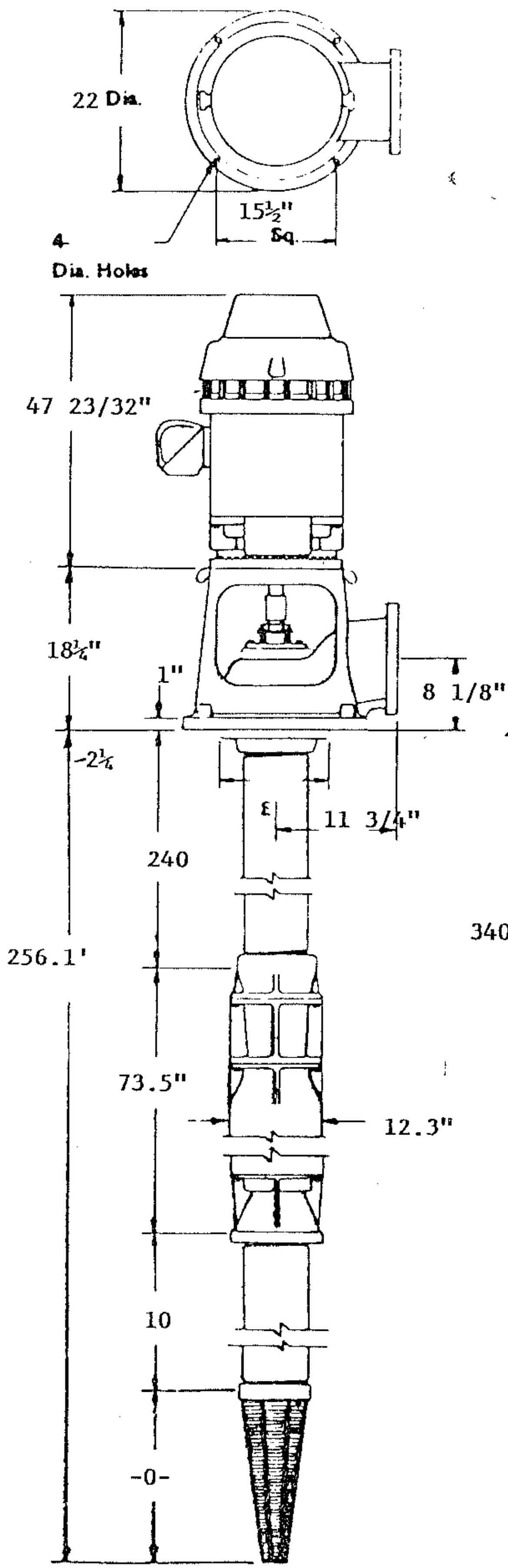
E.H. Renner & Sons, Inc. — Licensee Business Name — 71015 License No.
Address 15688 Jarvis St. Elk River, MN 55330
Signed ___ Authorized Representative — Date 10-30-89
Budd Leubeter — Name of Driller — Date 10-26-89

MINN. DEPT. ... 005626

HE-01205-03 (Rev. 9/88) 5/74 30M 7/76 30M 7/78 30M

E. H. Renner & Sons
INCORPORATED

WELL DRILLING FOR FOUR GENERATIONS
15688 JARVIS STREET N.W. / ELK RIVER, MN 55330 / (612) 427-6100



VERTICAL TURBINE PUMP

CUSTOMER CITY OF EDINA

ADDRESS ~~EAST~~ WEST OF VALLEY VIEW JR. HIGH SCHOOL

DATE ________ WELL # 19

MOTOR

150 H.P. 3 PHASE 60 CYCLE 460 VOLTS 1780 RPM

MFG US MODEL B-412 CPLG MIN BX 1.6875 "

CD CPLG HGT 42 21/32" FRAME 444TP AMPS 176

TYPE RUE N.R.R. WP-I

#7895-9 KLIXON TEMPERATURE SENSORS *

DISCHARGE HEAD

* Normally Closed

AT60 DISCHARGE HEAD BY AMERICAN

MOTOR BASE DIA. 16.5 " DISCH SIZE 10 "

COLUMN SIZE 10 " DISCHARGE HGT 8.125 "

BASE PLATE CAST IRON 24" X 24" X 1

COLUMN & SHAFT

(2) 10 " X 4ft-11¼ " COLUMN PIPE .365 "wall

(23) 10 " X 9ft-11¼ " COLUMN PIPE .365 "wall

(2) 1 11/16" X 5ft C1045 SHAFTING 10 TPI

23 (~~12~~) 1 11/16" X 10ft C1045 SHAFTING 10 TPI

1 11/16" DIA. HEADSHAFT ______ "LONG (RH)(LH) 10 TPI

PUMP

15DRLC OR EQUAL
MIN. 4 STAGE

5 STAGE 12H150 BOWL ASSEMBLY, MFG AMERICAN

340 + 1200 USGPM @ 344 FT. T.D.H. ______ "STICKUP

SUCTION PIPE: X YES 10NO 10 " DIA ______ FT

STRAINER: ____ YES ____ NO ____________ TYPE

82%

MATERIALS

BOWLS	C.I. ENAMEL	COLUMN PIPE	STEEL
IMPELLERS	BRONZE	ENCLSG TUBE	N/A
BOWL SHAFT	STAINLESS	BRG RETAINER	BRONZE
BOWL BRGS	BRONZE	LINESHAFT BRGS	RUBBER 1 15/16
STRAINER	NONE	LINESHAFT	STEEL
SLEEVES	MONEL 1 15/16	HEASHAFT	STAINLESS
PACKING	GRAPHITE	SIZE	3/8 "

BRONZE WEAR RINGS

WELL

CASING DIA 18 " to 440 ft OPENHOLE 80 FT

WELL DEPTH 520 ft SCREEN ______ ft ______ "

STATIC WATER LEVEL 160 DATE ______

PUMPING LEVEL OF ______ GPM at ______ XXXX Ft. TDH

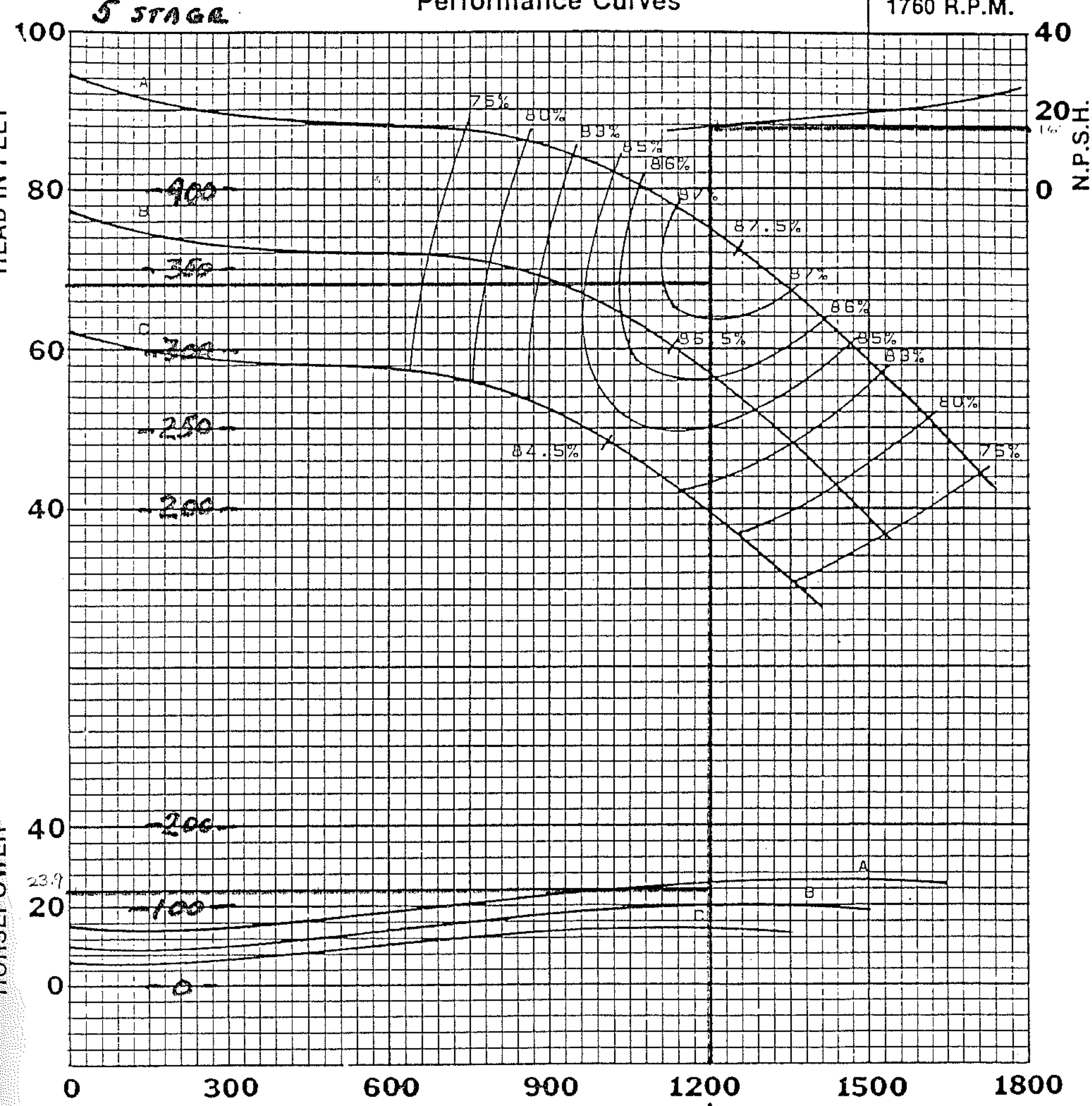
20" X 39" SURGE TANK - AIRLINE

2" WELL VENT - PSI GUAGE (FT. READINGS) 0-240'

american turbine pump co., inc.

Performance Curves

12-H-150
1760 R.P.M.



CAPACITY IN U.S. G.P.M.			
Impeller - Bronze		Bowl Length 1st Stage	30.3
Bowl - Cast Iron/Enamel		Bowl Length Additional Stage	10.875
Bowl Bearings -	BRONZE	Impeller - Weight	15
Bowl Shaft -	S.S.	Impeller Shaft Diameter	1.687
Thrust Factor	6.9	Impeller End Lateral	.750
Bowl Wt. 1st Stage (lbs.)	250	Column Pipe Size	8
Bowl Wt. Additional Stage (lbs.)	110	Suction Pipe Size	8

Minnesota Unique Well Number

505626

County Hennepin
Quad Minneapolis
Quad ID 104A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING REPORT

Minnesota Statutes Chapter 1031

Entry Date 06/29/1992
Update Date 10/05/2015
Received Date

Well Name	**Township**	**Range**	**Dir Section**	**Subsection**
EDINA 19	116	21	W 5	CBCCBC

Elevation 944 ft. **Elev. Method** Calc from DEM (USGS 7.5 min or equiv.)

Address

Contact 4801 50TH ST W EDINA MN 55424

Well 6054 VALLEYVIEW RD EDINA MN 55425

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
CLAY	0	52	YELLOW	
CLAY	52	70	BLUE	
CLAY & GRAVEL	70	182	BROWN	
ST. PETER	182	195	TAN	
ST. PETER	195	207	WHITE	
ST. PETER	207	228	TAN	
SHALE & ST. PETER	228	240	LT. BLU	
ST. PETER	240	260	TAN	
ST. PETER & SHALE	260	302	BLUE	
SHAKOPEE DOLOMITE	302	428	TAN	
JORDAN SANDSTONE	428	521	WHITE	

Remarks

M.G.S. NO. 2963.

Well Depth	**Depth Completed**	**Date Well Completed**
521 ft.	520 ft.	10/26/1989

Drill Method Cable Tool **Drill Fluid**

Use community supply(municipal) **Status** Active

Well Hydrofractured? **Yes** ☐ **No** ☐ **From** **To**

Casing Type Step down **Joint** Welded

Drive Shoe? **Yes** ☒ **No** ☐ **Above/Below** 2 ft.

Casing Diameter **Weight**

30 in. To 30 ft. 118. lbs./ft.

18 in. To 440 ft. 70.5 lbs./ft.

24 in. To 243 ft. 94.6 lbs./ft.

Open Hole From 440 ft. To 520 ft.

Screen? ☐ **Type** **Make**

Static Water Level

163 ft. land surface Measure 10/26/1989

Pumping Level (below land surface)

202 ft. 3 hrs. Pumping at 1200 g.p.m.

Wellhead Completion

Pitless adapter manufacturer Model

☐ Casing Protection ☒ 12 in. above grade

☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
neat cement	63	Cubic yards	0 ft.	440 ft.
neat cement	6	Cubic yards	0 ft.	242 ft.

Nearest Known Source of Contamination

feet Direction Type

Well disinfected upon completion? ☒ Yes ☐ No

Pump ☐ Not Installed Date Installed

Manufacturer's name

Model Number HP Volt

Length of drop pipe ft Capacity g.p. Typ

Abandoned

Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance

Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Miscellaneous

First Bedrock St.Peter Sandstone Aquifer Jordan

Last Strat Jordan Sandstone Depth to Bedrock 182 ft

Located by Minnesota Department of Health

Locate Method GPS Differentially Corrected

System UTM - NAD83, Zone 15, Meters X 470092 Y 4969770

Unique Number Verification Information from Input Date 07/21/1995

Angled Drill Hole

Well Contractor

Renner E.H. Well	71015	LEDBETER, B.
Licensee Business	Lic. or Reg. No.	Name of Driller

Appendix A.C

Well No. 20 Information

PUMP DATA SHEET Turbine 60 Hz

Company: Keys Well Drilling Co
Customer:
Name: Edina # 20
Date: 08/08/08
Order No:

Pump:
Size: 12CHC (5 stages)
Type: Lineshaft
Synch speed: 1800 rpm
Speed: 1770 rpm
Dia: 8.625 in
Curve: E6412CCPC4
Specific Speeds: Ns: 2100
Pump Notes for Standard Sizes:
Suction Size-8",10" Discharge Sizes-6",8",10"
Vertical Turbine:
Bowl size: 11.75 in
Max lateral: 1 in
Thrust K factor: 7.5 lb/ft

Pump Limits for Standard Construction:
Temperature: 120 °F
Sphere size: 0.73 in
Pressure: 340 psi g

Search Criteria:
Flow: 1200 US gpm
Head: 355 ft

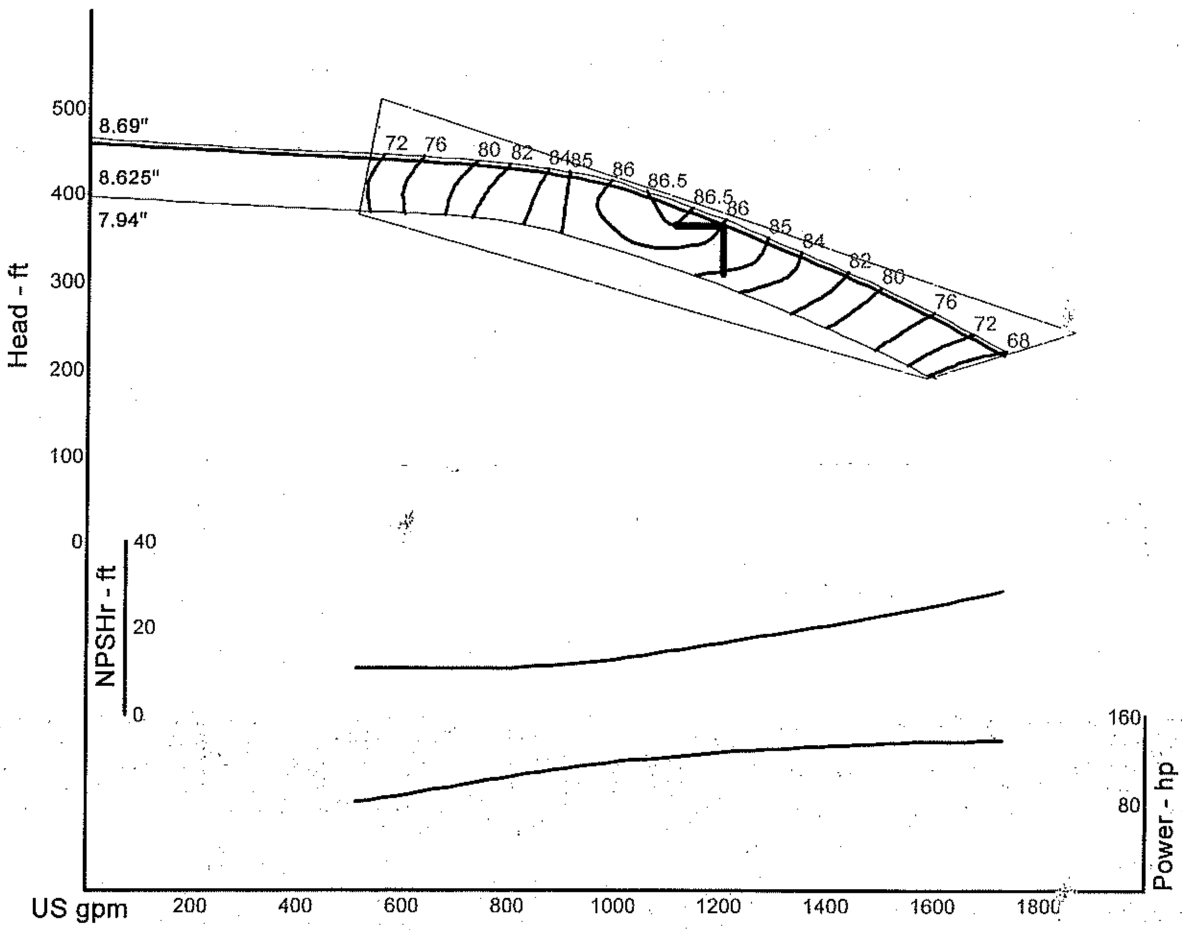
Fluid:
Water
SG: 1
Viscosity: 1.105 cP
NPSHa: --- ft
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:
Standard: NEMA
Size: 150 hp
Speed: 1800
Sizing criteria: Max Power on Design Curve

---- Data Point ----
Flow: 1200 US gpm
Head: 357 ft
Eff: 86%
Power: 126 hp
NPSHr: 16 ft

-- Design Curve --
Shutoff Head: 449 ft
Shutoff dP: 194 psi
Min Flow: --- US gpm
BEP: 86.9% eff
@ 1095 US gpm
NOL Pwr: 137 hp
@ 1720 US gpm

-- Max Curve --
Max Pwr: 139 hp
@ 1733 US gpm



Performance Evaluation:

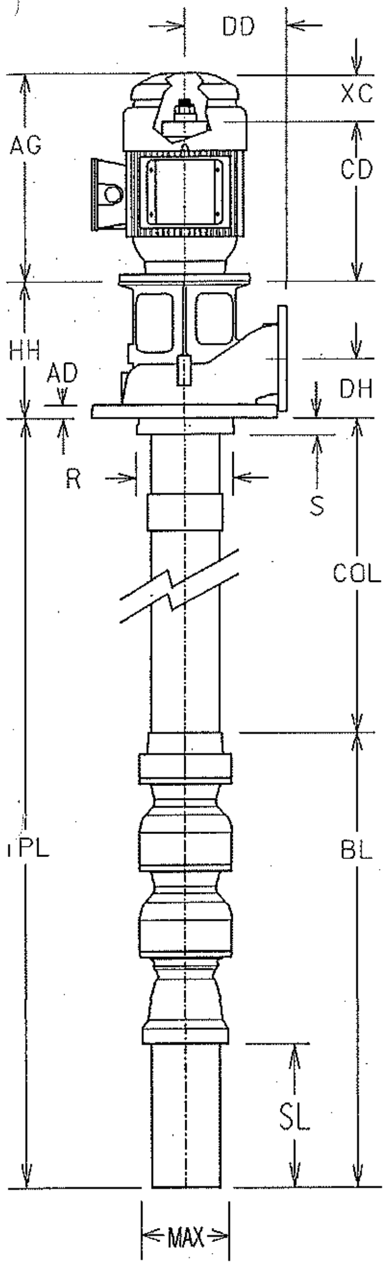
Flow US gpm	Speed rpm	Head ft	Pump %eff	Power hp	NPSHr ft
1440	1770	297	81.6	132	20.9
1200	1770	357	86	126	16
960	1770	405	85.7	114	11.6
720	1770	425	79.8	96.7	10
480	1770	---	---	---	---

Keys Well Drilling Co

DIMENSIONAL OUTLINE

DWT-CATM

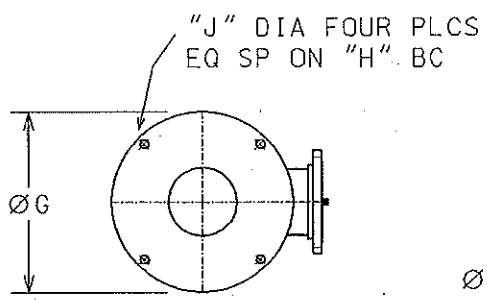
5 Stage 10x12CHC



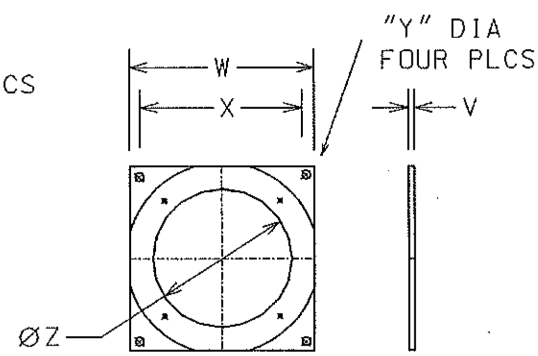
AD:	1.13
AG:	50.06
BD:	16.5
BL:	189.50
CD:	44.78
CL:	N/A
COL:	175.00'
DD:	14.00
DH:	9.25
G:	25.00
H:	22.75
HH:	19.00
J:	0.75
R:	14.60
S:	2.38
SL:	120.00
TPL:	190.8'
UG:	N/A
V:	0.75
W:	26.00
X:	23.00
XC:	5.13
Y:	0.88
Z:	18.00
MAX:	11.75

Pump Data

Size:	12CHC
Stages:	5
BowlShaft:	1.69"
LineShaft:	1.5"
LineShaft Type:	Open
Column:	Standard
Column:	10" Threaded
Bearing Spacing:	10 feet
Section Length:	10 feet
Head:	A:Cast
Flange (Disch.):	10"-125# FF
Inlet:	
Seal:	Packing
Strainer:	None
SubBase:	Yes



DISC HEAD



SOLE PLATE

Hydraulic Data

Flow (gpm):	1200
Pump Head (ft):	224.3
TDH (ft):	357.0
Speed (rpm):	1770
Fluid:	Water
Temperature (F):	60
Viscosity:	1.105
Spec.Grav:	1

Miscellaneous

Thrust At Design (lb):	3788
Thrust At Shutoff (lb):	4478
Pumping Level(in):	1560

Weight

Pump (lb):	9118
Motor (lb):	1500
Total (lb):	10618

Motor Data

Model:	HO150V2SLG
Make:	USEM
HP:	150
RPM:	1800
Type:	RUSI
Efficiency:	96.2
Frame:	H444TP
Ratchet:	NRR

Version: 3.92P Customer: Date: 08-08-2008

Keys Well Drilling Co

HYDRAULIC ANALYSIS
DWT-CATM
5 Stage 10x12CHC

Overall Pump Parameters

Size and Model:	12CHC	Pump Operating Speed, RPM:	1770
Capacity, GPM:	1200	Total Dynamic Head, Ft.:	357.0
Total Pump Length, In.:	2289.5	Impeller Trim, In.:	8.6
Pump Type:	Well	Head Type:	A:Cast
Pump K-Factor:	7.5	Number of Stages:	5
		Pumping Level, In.:	1560.0

LineShaft-Related Data

Shaft Diameter, In.:	1.5	Shaft Limit, HP:	255
Shaft Material:	416SS	Matl Correction Fact:	1.18
LineShaft Length, In.:	2100.00	Shaft Elongation, w/o Adder:	0.11
LineShaft Type:	Open	Impeller Running Clearance:	0.13

Bowl Data

Total Bowl Length, In.:	189.50	Bowl Diameter, In.:	11.75
Bowl Shaft Dia, In.:	1.69	Bowl Shaft Limit, HP:	376
		Bowl Shaft Material:	416SS

Column Data

Column Diameter, In.:	10	Column Load, Lb.:	7952.0
Wall Thickness, In:	0.365	Column Elongation, In.:	0.05

[illegible]rsePower Data

Shaft Friction Loss, Hp.:	1.94	Thrust Load Loss, Hp.:	0.50
Bowl HP At Design, Hp.:	126	Motor HorsePower, Hp.:	150

Other Data

Hydraulic Thrust, Lb.:	2677.5	Thrust at Design, Lb.:	3788.0
Thrust at Shutoff, Lb.:	4478.4	Actual Head above Grade, Ft.:	224.28
Available Lateral, In.:	1.00	Design Lateral, In.:	0.19
Shutoff Lateral, In.:	0.21		
Suction Pressure, psi:	0.0	Shutoff Disc Pressure, psi:	138.1
Column Loss, Ft.:	2.45	NPSHa, Ft.:	83.15
Head Loss, Ft.:	0.27	NPSHr, Ft.:	16.00
Total Loss, Ft.:	2.72	NPSH margin, Ft.:	67.15

Efficiency Data (Efficiencies estimated not guaranteed)

Bowl Efficiency:	86.00	Pump Efficiency:	83.72
Motor Efficiency:	96.20	Overall Efficiency:	80.54
		KWH/1000 gallons:	1.39

Component Weights

Bowl Weight, Lbs.:	1053	Column Weight,Lbs.:	7525
Head Weight, Lbs.:	540	Can Weight,Lbs.:	0
M[illegible]r Weight, Lbs.:	1500	Total Pump Weight,Lbs.:	10618

Version: 3.92P Customer: Date: 08-08-2008

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

MINNESOTA UNIQUE WELL NO. 686286

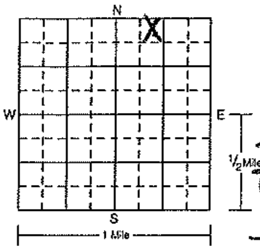
WELL LOCATION

County Name: Hennepin

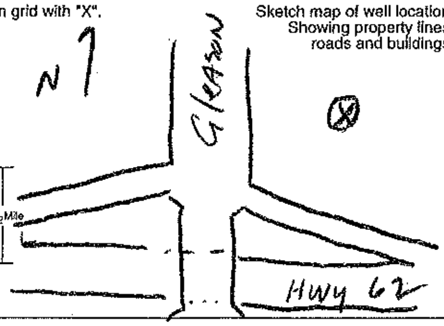
Township Name	Township No.	Range No.	Section No.	Fraction
Edina	116	21	6	NE NW NE ¼

Number, Street Name, City, and Zip Code of Well Location or Fire Number: Hwy 62 & Gleason Rd

Show exact location of well in section grid with "X".



Sketch map of well location. Showing property lines, roads and buildings.



PROPERTY OWNER'S NAME: City of Edina

Property owner's mailing address if different than well location address indicated above.

4801 W 50th St
Edina, MN 55424

WELL OWNER'S NAME

Well owner's mailing address if different than property owner's address indicated above.

GEOLOGICAL MATERIALS	COLOR	HARDNESS OF MATERIAL	FROM	TO
Clay, Sand, Gravel	BN	S	0	40
Clay, Sand, Gravel, Rocks	BN	S	40	125
Sand & Gravel	BN	S	125	180
Clay & Sand	Grey	S	180	200
Sand & Gravel	BN	S	200	207
Sandstone & Shale	Buff	M	207	248
Limestone	Buff	H	248	375
Sandstone	White	M	375	460
Shale	Green	M	460	467

Use a second sheet, if needed

REMARKS, ELEVATION, SOURCE OF DATA, etc.

Well #20

Job #2007141

IMPORTANT - FILE WITH PROPERTY PAPERS
WELL OWNER COPY

686286

WELL DEPTH (completed): 467 ft.

Date Work Completed: 6/30/08

DRILLING METHOD: ☒ Cable Tool ☐ Driven ☐ Dug ☐ Auger ☐ Rotary ☐ Jetted ☐

DRILLING FLUID: Bentonite

WELL HYDROFRACTURED? ☐ YES ☒ NO
FROM ____ ft. to ____ ft.

USE: ☐ Domestic ☐ Irrigation ☐ Environ. Bore Hole ☐ Monitoring ☒ Community PWS ☐ Noncommunity PWS ☐ Dewatering ☐ Heating/Cooling ☐ Industry/Commercial ☐ Remedial ☐

CASING: Drive Shoe? ☒ Yes ☐ No
☒ Steel ☐ Threaded ☐ Welded
☐ Plastic ☐

CASING DIAMETER	WEIGHT	HOLE DIAM.
30 in. to 187 ft.	118.65 lbs./ft.	30 in. to 187 ft.
24 in. to 210 ft.	94.62 lbs./ft.	24 in. to 264 ft.
18 in. to 265 ft.	70.59 lbs./ft.	18 in. to 467 ft.

SCREEN ____
Make ____
Type ____
Slot/Gauze ____
Set between ____ ft. and ____ ft.

OPEN HOLE from 264 ft. to 467 ft.
Diam. ____
Length ____
FITTINGS: ____

STATIC WATER LEVEL: 90 ft. ☒ below ☐ above land surface Date measured 6/11/08

PUMPING LEVEL (below land surface): 105 ft. after 24 hrs. pumping 1200 g.p.m.

WELL HEAD COMPLETION
☐ Pitless adapter manufacturer ____ Model ____
☒ Casing Protection ____ ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

GROUTING INFORMATION
Well grouted? ☒ Yes ☐ No
Grout Material ☒ Neat cement ☐ Bentonite ☐ Concrete ☐ High Solids Bentonite
from 0 to 187 ft. 12 ☒ yds. ☐ bags
from 0 to 264 ft. 16 ☒ yds. ☐ bags
from ____ to ____ ft. ____ ☐ yds. ☐ bags

NEAREST KNOWN SOURCE OF CONTAMINATION
100 feet W direction Storm Sewer type
Well disinfected upon completion? ☒ Yes ☐ No

PUMP
☒ Not installed Date installed ____
Manufacturer's name ____
Model number ____ HP ____ Volts ____
Length of drop pipe ____ ft. Capacity ____ g.p.m.
Type: ☐ Submersible ☐ L.S. Turbine ☐ Reciprocating ☐ Jet ☐ ____

ABANDONED WELLS
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

VARIANCE
Was a variance granted from the MDH for this well? ☐ Yes ☒ No TN# ____

WELL CONTRACTOR CERTIFICATION
This well was drilled under my supervision and in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Keys Well Drilling Company — 1347
Licensee Business Name — *Lic. or Reg. No.*

[signature] — 7/16/08
Authorized Representative Signature — *Date*

Mike Galvin — 7/16/08
Name of Driller — *Date*

HE-01205-07 (Rev. 2/99)

Minnesota Unique Well Number

686286

County Hennepin
Quad Hopkins
Quad ID 104B

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date 07/09/2008
Update Date 10/06/2015
Received Date 07/18/2008

Well Name	Township	Range	Dir Section	Subsection
EDINA 20	116	21	W 6	ABABCD

Elevation 881 ft. **Elev. Method** 7.5 minute topographic map (+/- 5 feet)

Address

Contact 4801 50TH ST W EDINA MN 55424
Well GLEASON RD EDINA MN 55424

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
CLAY, SAND , GRAVEL	0	40	BROWN	SOFT
CLAY, SAND , GRAVEL	40	125	BROWN	SOFT
SAND & GRAVEL	125	180	BROWN	SOFT
CLAY & SAND	180	200	GRAY	SOFT
SAND & GRAVEL	200	207	BROWN	SOFT
SANDSTONE & SHALE	207	211	TAN	MEDIUM
SANDSTONE & SHALE	211	247	TAN	MEDIUM
SANDSTONE & SHALE	247	248	TAN	MEDIUM
LIMESTONE	248	375	TAN	HARD
SANDSTONE	375	380	WHITE	MEDIUM
SANDSTONE	380	460	WHITE	MEDIUM
SHALE	460	463	GREEN	MEDIUM
SHALE	463	467	GREEN	MEDIUM

Remarks

GAMMA LOGGED 6-27-2008. M.G.S. NO. 4841. LOGGED BY JIM TRAEN.

Well Depth	Depth Completed	Date Well Completed
467 ft.	467 ft.	06/30/2008

Drill Method Cable Tool **Drill Fluid** Bentonite

Use community supply(municipal) **Status** Active

Well Hydrofractured? **Yes** ☐ **No** ☒ **From** **To**

Casing Type Step down **Joint**
Drive Shoe? **Yes** ☒ **No** ☐ **Above/Below**

Casing Diameter **Weight**

30 in. To 187 ft. 118. lbs./ft.
18 in. To 265 ft. 20.5 lbs./ft.
24 in. To 210 ft. 94.6 lbs./ft.

Hole Diameter

30 in. To 187 ft.
24 in. To 264 ft.
18 in. To 467 ft.

Open Hole From 264 ft. To 467 ft.
Screen? ☐ **Type** **Make**

Static Water Level
90 ft. land surface Measure 06/11/2008

Pumping Level (below land surface)
105 ft. 24 hrs. Pumping at 1200 g.p.m.

Wellhead Completion
Pitless adapter manufacturer Model
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
neat cement	16	Cubic yards	ft.	264 ft.
neat cement	12	Cubic yards	ft.	187 ft.

Nearest Known Source of Contamination
100 feet West Direction Septic tank/drain field Type
Well disinfected upon completion? ☒ Yes ☐ No

Pump ☒ Not Installed Date Installed
Manufacturer's name
Model Number HP Volt
Length of drop pipe ft Capacity g.p. Typ

Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No

Miscellaneous
First Bedrock St.Peter Sandstone Aquifer Prairie Du Chien-
Last Strat St.Lawrence Formation Depth to Bedrock 211 ft
Located by Minnesota Geological Survey
Locate Method Digitization (Screen) - Map (1:24,000)
System UTM - NAD83, Zone 15, Meters X 469502 Y 4970896
Unique Number Verification Info/GPS from data Input Date 07/09/2008

Angled Drill Hole

Well Contractor

Licensee Business	Lic. or Reg. No.	Name of Driller
Keys Well Drilling Co.	1347	GALVIN, M.

Appendix A.D

Breakpoint Chlorination Testing Results

Well No. 16 Breakpoint Chlorination Curve

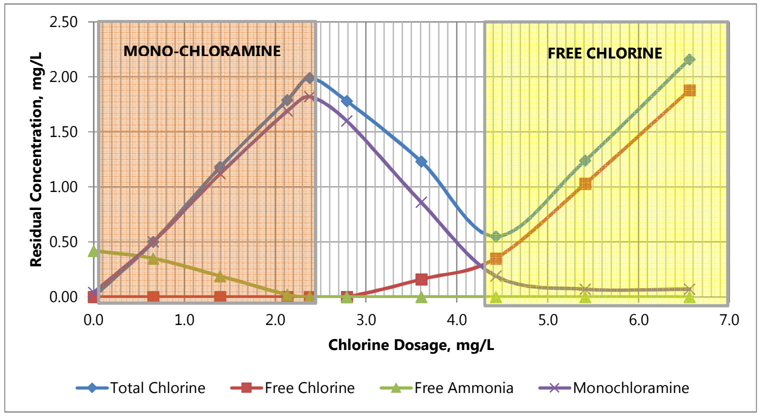
Verified Chlorine Concentration	0.82	mg/L
Current Flow	1000	gpm

Raw Water Quality

Monochloramine	0.04	mg/L	
Free Ammonia	0.42	mg/L	2.1
Iron	0.67	mg/L	
Manganese	0.114	mg/L	
Rotten Egg Odor? (H2S)	Y	Y/N	Stronger hydrogen sulfide smell, ~0.1 per test kit
Additional Comments			

Current Chlorine Feed

Feed Rate	15	lb/day
Feed Rate	1.25	mg/L



Jar	Cl_2 Added	Cl_2 Dose	Total Cl_2	Free Cl_2	Free NH_3	Monochloramine	Cl_2/NH3	
	(mg/L)	mg/L	mg/L	mg/L	mg/L	mg/L	Ratio	
0	0.00	0.0	0.00	0.00	0.42	0.04	0.0	
1	0.80	0.7	0.50	0.00	0.35	0.50	1.6	1:29:00 PM
2	1.70	1.4	1.18	0.00	0.19	1.12	3.3	1:40:00 PM
3	2.60	2.1	1.79	0.00	0.02	1.69	5.1	1:50:00 PM
9	2.90	2.4	1.99	0.00	0.00	1.82	5.7	2:52:00 PM
4	3.40	2.8	1.78	0.00	0.00	1.60	6.6	2:00:00 PM
5	4.40	3.6	1.23	0.16	0.00	0.86	8.6	2:10:00 PM
6	5.40	4.4	0.55	0.35	-	0.19	10.5	2:20:00 PM
7	6.60	5.4	1.24	1.03	-	0.07	12.9	2:30:00 PM
8	8.00	6.6	2.16	1.88	-	0.07	15.6	2:40:00 PM

Chlorine Doses based on Results	(mg/L)	Cl_2/NH_3
Peak Chloramination	2.4	5.7
Breakpoint	4.4	10.5
Breakpoint with 2 mg/L TCR	6.4	15.2

Analysis Reaction Time 30 min

Stoichiometric Calculations

Peak Chloramination 2.7 Assuming reactions reach equilibrium

Well No. 19 Breakpoint Chlorination Curve

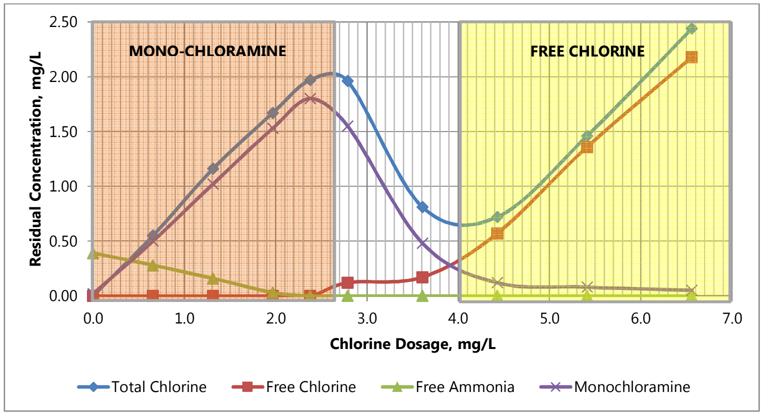
Verified Chlorine Concentration	0.82	mg/L
Current Flow	950	gpm

Raw Water Quality

Monochloramine	0.02	mg/L	
Free Ammonia	0.39	mg/L	1.95
Iron	0.55	mg/L	
Manganese	0.076	mg/L	
Rotten Egg Odor? (H2S)	Y	Y/N	Stronger hydrogen sulfide smell, ~0.1 per test kit
Additional Comments			

Current Chlorine Feed

Feed Rate	25	lb/day
Feed Rate	2.19	mg/L



Jar	Cl_2 Added	Cl_2 Dose	Total Cl_2	Free Cl_2	Free NH_3	Monochloramine	Cl_2/NH3	
	(mg/L)	mg/L	mg/L	mg/L	mg/L	mg/L	Ratio	
0	0.00	0.0	0.00	0.00	0.39	0.02	0.0	
1	0.80	0.7	0.55	0.00	0.28	0.50	1.7	3:58:00 PM
2	1.60	1.3	1.16	0.00	0.16	1.02	3.4	4:08:00 PM
3	2.40	2.0	1.67	0.00	0.03	1.53	5.0	4:18:00 PM
4	2.90	2.4	1.97	0.00	0.00	1.80	6.1	4:28:00 PM
5	3.40	2.8	1.96	0.12	0.00	1.55	7.1	4:38:00 PM
6	4.40	3.6	0.81	0.17	-	0.48	9.3	4:48:00 PM
7	5.40	4.4	0.72	0.57	-	0.12	11.4	4:58:00 PM
8	6.60	5.4	1.46	1.36	-	0.08	13.9	5:08:00 PM
9	8.00	6.6	2.44	2.18	-	0.05	16.8	5:13:00 PM

Chlorine Doses based on Results	(mg/L)	Cl_2/NH_3
Peak Chloramination	2.6	6.7
Breakpoint	4	10.3
Breakpoint with 2 mg/L TCR	6	15.4

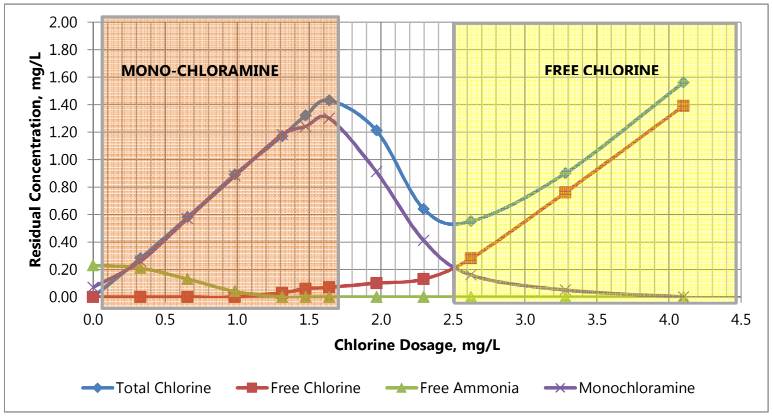
Analysis Reaction Time 30 min

Stoichiometric Calculations

Peak Chloramination 2.4 Assuming reactions reach equilibrium

Well No. 20 Breakpoint Chlorination Curve

Verified Chlorine Concentration	0.82	mg/L		
Current Flow	950	gpm		
Raw Water Quality				
Monochloramine	0.07	mg/L		
Free Ammonia	0.23	mg/L	1.15	
Iron	0.35	mg/L		
Manganese	0.063	mg/L		
Rotten Egg Odor? (H2S)	Y	Y/N		Faint hydrogen sulfide smell, <0.1 per test kit
Additional Comments				
Current Chlorine Feed				
Feed Rate	20	lb/day		
Feed Rate	1.75	mg/L		



Jar	Cl_2 Added	Cl_2 Dose	Total Cl_2	Free Cl_2	Free NH_3	Monochloramine	Cl_2/NH3	
	(mg/L)	mg/L	mg/L	mg/L	mg/L	mg/L	Ratio	
0	0.00	0.0	0.00	0.00	0.23	0.07	0.0	
1	0.40	0.3	0.28	0.00	0.21	0.26	1.4	11:02:00 AM
2	0.80	0.7	0.58	0.00	0.13	0.57	2.9	11:11:00 AM
3	1.20	1.0	0.89	0.00	0.04	0.88	4.3	11:21:00 AM
4	1.60	1.3	1.17	0.03	0.00	1.18	5.7	11:31:00 AM
8	1.80	1.5	1.32	0.06	0.00	1.24	6.4	12:12:00 PM
5	2.00	1.6	1.43	0.07	0.00	1.30	7.1	11:41:00 AM
6	2.40	2.0	1.21	0.10	0.00	0.91	8.6	11:51:00 AM
7	2.80	2.3	0.64	0.13	0.00	0.41	10.0	12:01:00 PM
9	3.20	2.6	0.55	0.28	-	0.16	11.4	12:27:00 PM
10	4.00	3.3	0.90	0.76	-	0.05	14.3	12:52:00 PM
10	5.00	4.1	1.56	1.39	-	-	17.8	1:37:00 PM

Chlorine Doses based on Results	(mg/L)	Cl_2/NH_3
Peak Chloramination	1.7	7.4
Breakpoint	2.5	10.9
Breakpoint with 2 mg/L TCR	4.6	20.0

Analysis Reaction Time 30 min

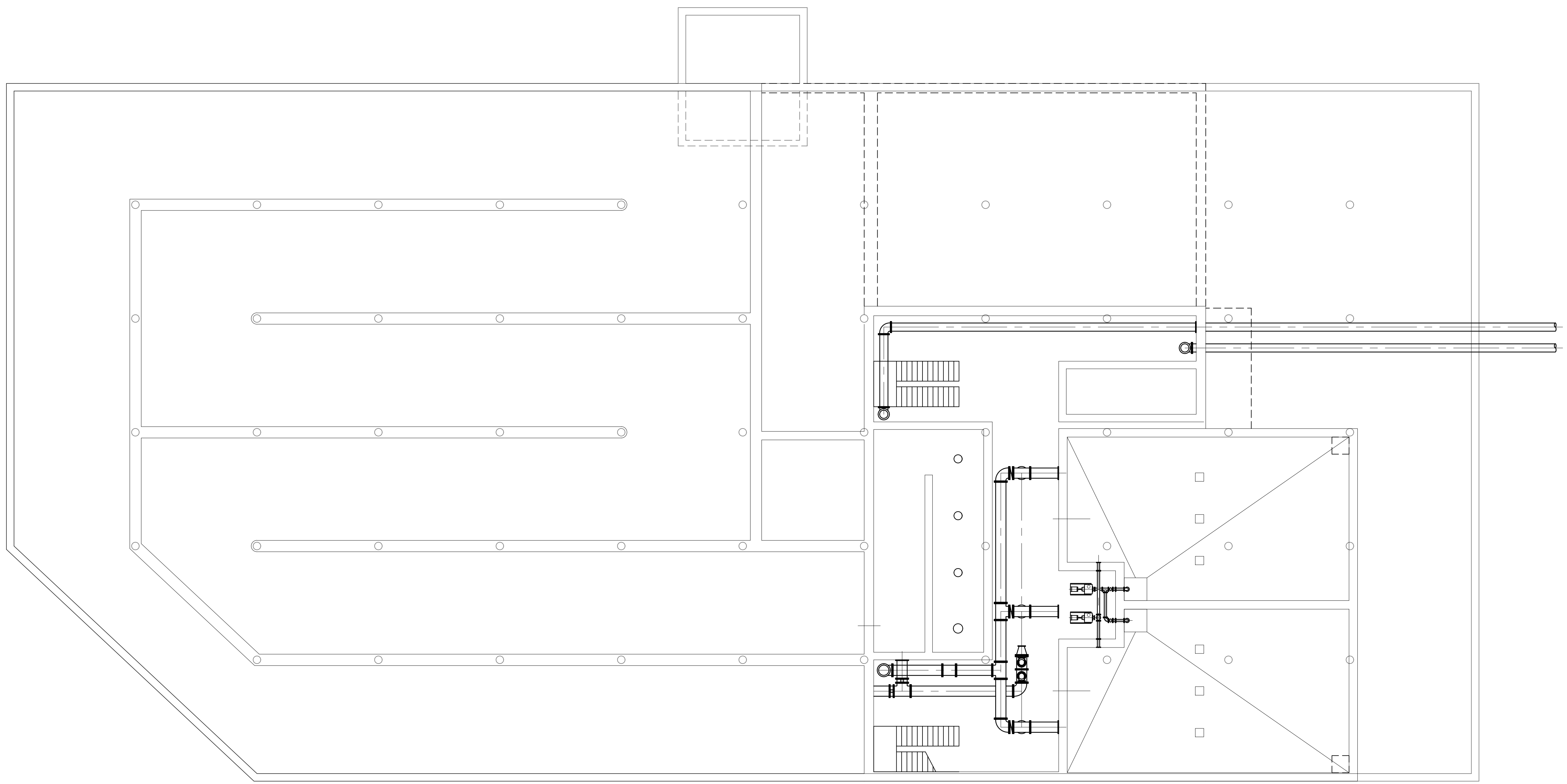
Stoichiometric Calculations

Peak Chloramination 1.5 Assuming reactions reach equilibrium

Appendix A.E

Option 5A – Dublin Site with Gravity Filters Site Layout

Layout: LOWER LEVEL PLAN
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 06.dwg



1
P1
LOWER LEVEL PLAN
0 4' 8' 12' 16' 20' 24' 28'

NORTH

Plotted: By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved: By: Randy Leppala Date: Wednesday, October 10, 2018 2:07:36 PM

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

LOWER LEVEL PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	1 of 04
DRAWING	P1

Layout: MAIN LEVEL PLAN
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 06.dwg

Plotted By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved By: Randy Leppala Date: Wednesday, October 10, 2018 2:07:36 PM

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

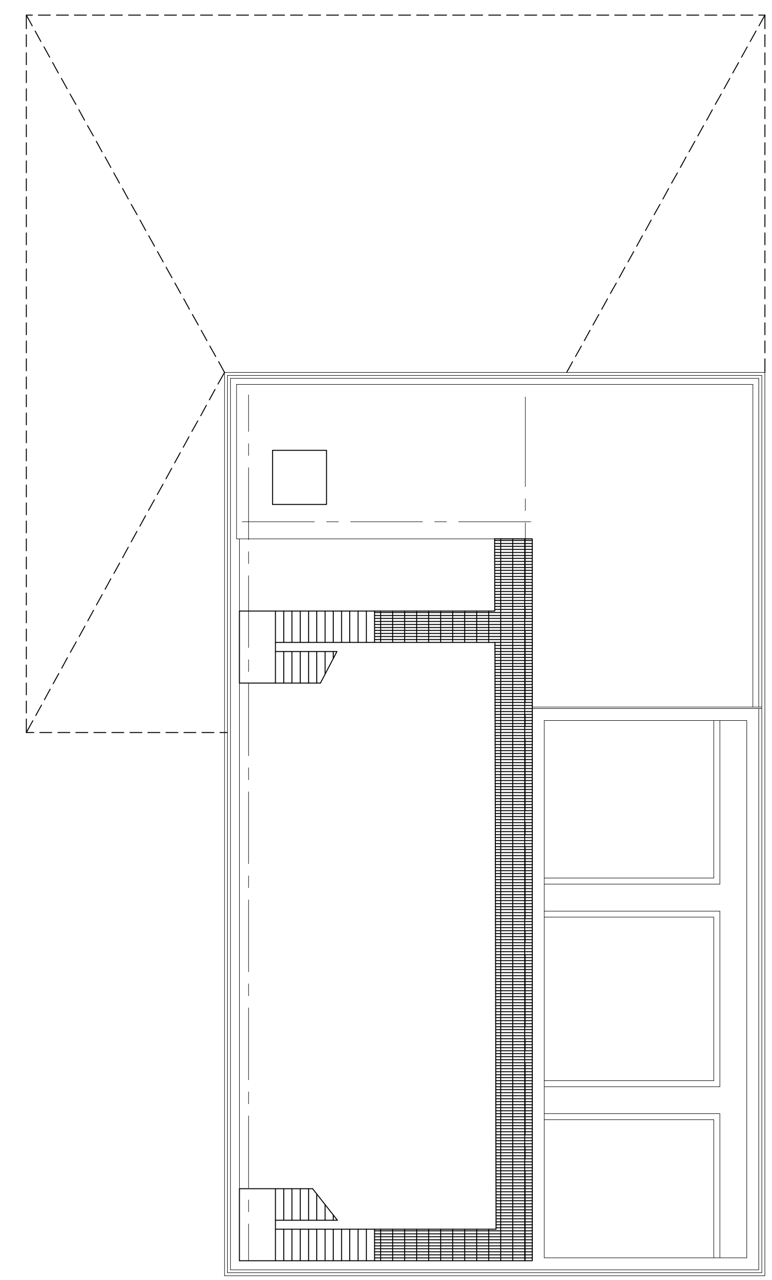
AE2S

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA
MAIN LEVEL PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	2 of 04
DRAWING	P2

Layout: UPPER LEVEL PLAN
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 06.dwg

Plotted: By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved: By: Randy Leppala Date: Wednesday, October 10, 2018 2:07:36 PM



1
P3
UPPER LEVEL PLAN
0 4' 8' 12' 16' 20' 24' 28'

NORTH

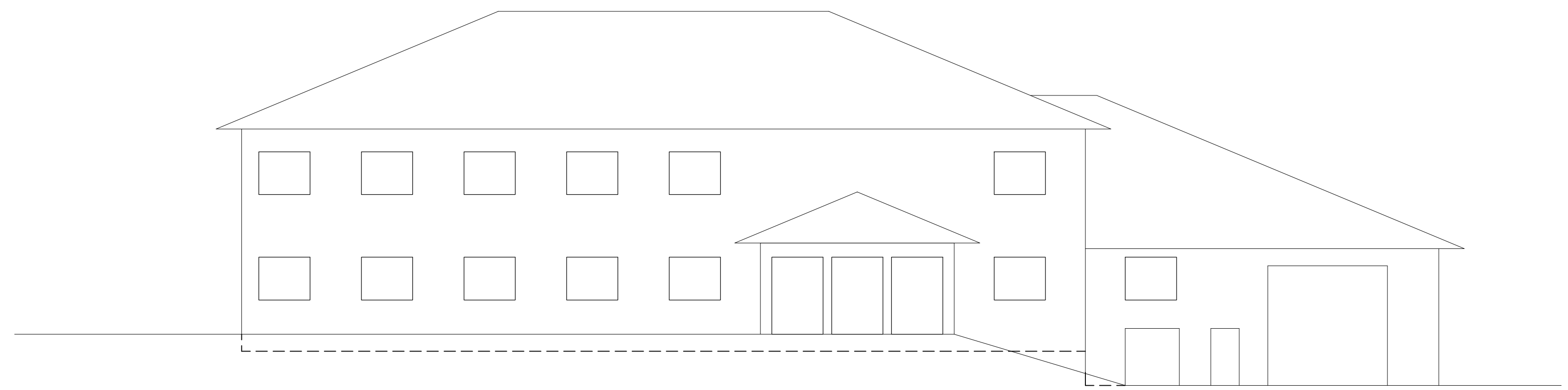
PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

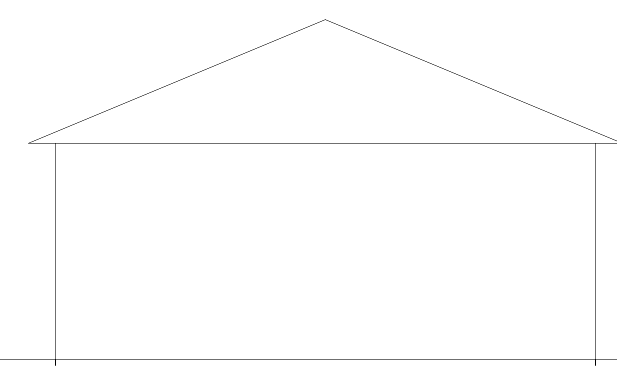
UPPER LEVEL PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	3 of 04
DRAWING	P3



1 / P4 **ELEVATION**

0 4' 8' 12' 16' 20' 24' 28'



2 / P4 **ELEVATION**

0 4' 8' 12' 16' 20' 24' 28'

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

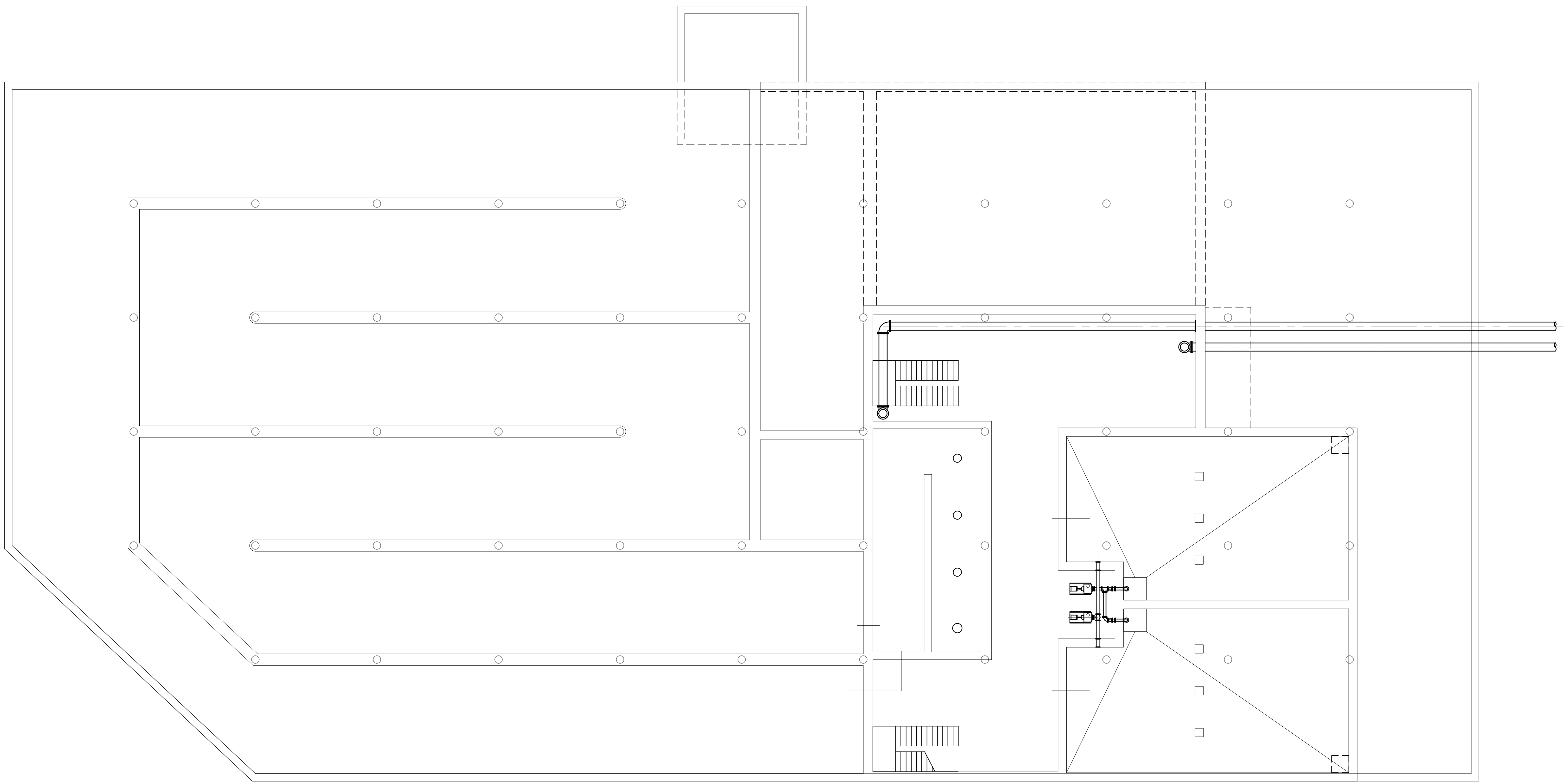
ELEVATIONS

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	4 of 04
DRAWING	P4

Appendix A.F

Option 5B – Dublin Site with Pressure Filters Site Layout

Layout: LOWER LEVEL PLAN
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 07.dwg



1
P1
LOWER LEVEL PLAN
0 4' 8' 12' 16' 20' 24' 28'
NORTH

Plotted: By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved: By: Randy Leppala Date: Wednesday, October 10, 2018 2:33:57 PM

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

PRESSURE FILTERS - LOWER LEVEL PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	1 of 04
DRAWING	P1

Layout: MAIN LEVEL PLAN
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 07.dwg

Plotted: By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved: By: Randy Leppala Date: Wednesday, October 10, 2018 2:33:57 PM

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

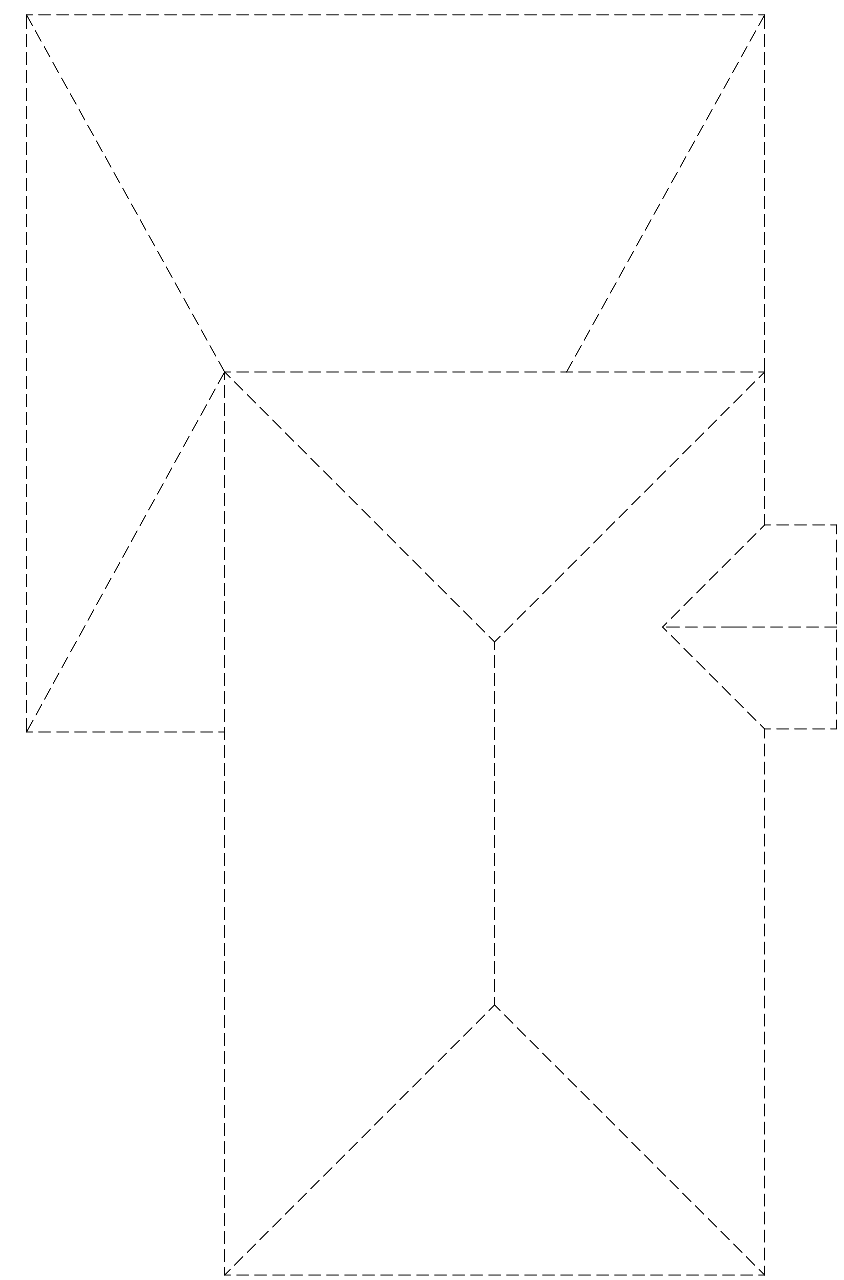
AE2S

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

PRESSURE FILTERS - MAIN LEVEL PLAN

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	2 of 04
DRAWING	P2

Advanced Engineering and Environmental Services, Inc. ● 4050 Garden View Dr Ste 200 Grand Forks, ND 58201 ● (t) 701-746-8087 (f) 701-746-0370 ● www.ae2s.com



1
P3
ROOF LEVEL PLAN
0 4' 8' 12' 16' 20' 24' 28'

NORTH

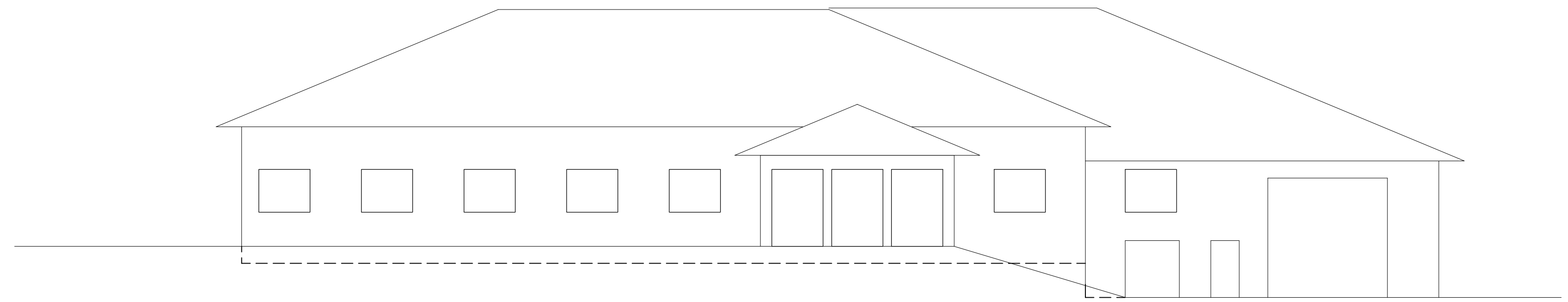
PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

PRESSURE FILTERS - ROOF LEVEL PLAN

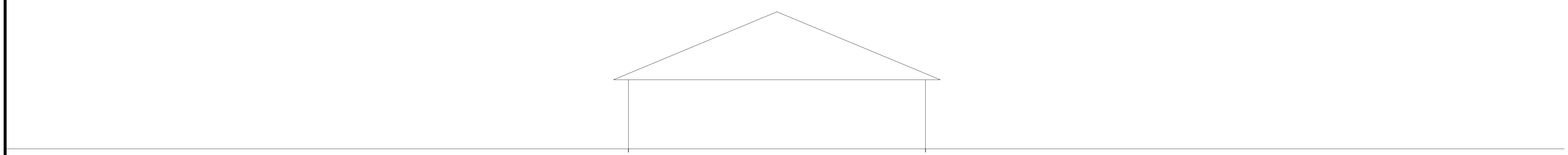
DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	3 of 04
DRAWING	P3

Layout: ELEVATIONS
File: W:\E\Edina\05177-2016-000\CAD Dwgs\04-Process\Autocad\Plan Sheets\Edina WTP Dublin Site 07.dwg



1 / P4 ELEVATION

0 4' 8' 12' 16' 20' 24' 28'



2 / P4 ELEVATION

0 4' 8' 12' 16' 20' 24' 28'

Plotted By: Randy Leppala Date: Thursday, November 08, 2018
Last Saved By: Randy Leppala Date: Wednesday, October 10, 2018 2:33:57 PM

PRELIMINARY
NOT FOR CONSTRUCTION
MILESTONE - 30%

AE2S

EDINA WTP - DUBLIN RESERVOIR SITE
CITY OF EDINA
EDINA, MINNESOTA

PRESSURE FILTERS - ELEVATIONS

DRAWING TYPE	PRELIMINARY
PREPARED BY	RCL
CHECKED / APPROVED	AMB / ASV
DATE	OCT 2018
PROJECT NUMBER	P05177-2018-003
SHEET	4 of 04
DRAWING	P4

Appendix A.G

SEH Dublin Site Water System Analysis

SEH

Building a Better World for All of Us®

MEMORANDUM

TO: Aaron Vollmer, PE

FROM: Chad T. Katzenberger, PE

DATE: November 29, 2018

RE: Water Treatment Plant No.5 – Dublin Location Analysis
SEH No. EDINA 143535 14.00

This technical memo is in response to the correspondence with AE_2S and the City of Edina requesting assistance with strategic water distribution system modeling related to the analysis of a proposed water treatment plant site, located at the existing Dublin Storage reservoir. In August 2017, extensive work was completed to analyze the merits of four potential water treatment plant sites. This memo will serve to summarize the hydraulic feasibility of a fifth water plant site option located at the Dublin Reservoir. The intent of this memo serves to summarize the assumptions and findings related to the water distribution system modeling analysis requested as well as analyze the impacts to the overall water system planning related to water system storage.

PROJECT UNDERSTANDING

Advanced Engineering and Environmental Services, Inc. (AE_2S) is in the processing of preparing an amendment to the Water Treatment Plant No. 5 Preliminary Engineering Report for the City of Edina, which will consider a fifth potential water treatment plant site, located at the Dublin storage reservoir. Short Elliott Hendrickson Inc. (SEH®) currently maintains the City's water distribution system model and recently completed a 2018 water supply plan. The City has requested that AE_2S and SEH work together to evaluate the hydraulic implications of the proposed water treatment plant site located at the Dublin reservoir.

The City previously considered four (4) sites for future WTP No.5. The potential locations included: Southdale, Median (near Southdale), Yorktown and Existing WTP No. 3 Site, which are examined in greater detail in the previous report.

SEH has recently completed a new water system supply plan for the City of Edina, which included the update and calibration of the City's water distribution system model and future water system facility recommendations. The updated model can now be used to analysis an additional water treatment plant site, which was identified as part of the 2018 water supply planning project. In addition to the system implications mentioned in the previous water plant site analysis work, special care should be given to analyze the impacts to the operation and function of the Dublin storage tank as it relates to the accommodation of a potential water treatment facility.

Below is a summary of the requested Water Distribution Model Scenario Analysis outcomes per the previous site analysis:

1. Evaluate hydraulic capacity of the site using the latest water distribution system model.
2. Evaluate pressure increase surrounding the proposed treatment plant site during an average day demand condition.
3. Evaluate site function and operation during peak demands in relation to water tank operation and overall water distribution system function.

Requested Data (Results):

1. What impact does the proposed facility have during average day demands?
2. What impact does the proposed facility have during peak demands?
3. Identify concerns, if any, in existing pipe capacity and/or fluctuations in water storage levels.
   - Does the water main need to be upsized to accommodate proposed WTP capacity?
   - Are the velocities less than 5 feet per second?
   - Is headloss (per 1000 ft) limited to less than 2-3 ft/1000 ft?

Additional Results:

1. What overall system impacts would result with the reduction in storage volume at the Dublin site.
2. What are the hydraulic impacts if the WTP capacity were increased to 5,000 gpm.

Water Model Scenario Summary

Scenario	Site	Total Plant Capacity (gpm)	General Description
5A	Dublin	3,000	Utilize existing facility effluent piping
5B		5,000	Utilize 2040 assumed pipe improvements (pipe upgraded to 16-inch main from Dublin to Metro Blvd along 70^{th})

DUBLIN RESEVOIR REVIEW

The Dublin Reservoir is a 4.0 million gallon (mg) tank that serves the City with dump and re-pump capabilities. The facility includes a booster pumping station that serves the City with reserve storage, fire protection and system equalization. The Dublin reservoir is lower in elevation than the hydraulic grade line of the other four tanks. Water flows from the distribution system by gravity into the reservoir through a flow control valve in the pump station. The booster pumps are used to return the water to the distribution system.

For the 2018 water supply plan, a particular goal for the City was to utilize the Dublin Street booster station and reservoir to behave as a peak water supply source by filling with treated water during off-peak periods and discharging during peak periods. This facility is located on a hilltop, surrounded by customers at approximately the same elevation as the base of the tank. Per city standards, normal working pressure should be at least 35 psi. Since pressure decreases with elevation, maintaining 35 psi in these service connections is challenging when headloss is required to flow water into the tank. As a result, use of the Dublin facility is limited due to re-fill restrictions. In summary, the water supply plan analysis identified the filling cycle (from the distribution system) of the Dublin storage as the limiting factor in utilization of the tank. In short, use of the tank is limited by the ability to re-fil the tank on a regular basis. When the tank is operated in a way that maximizes tank turnover (maximized emptying and filling cycles, limited by the re-fill rate), the effective daily volume available from the Dublin tank is 1.8 MG. For the purposes of overall water system storage volume needs analysis, the effective available volume of water available from the Dublin tank on a daily basis is 2.88 MG (Assuming constant pumping with no refill).

The function of a water storage tank can be equated to reserve storage for emergencies, reserve storage for fire protection and storage for system equalization. As the use of the storage facility rates to equalization, peak hourly demands throughout the system are met from water supply sources (wells/treatment) and water drawn from storage facilities. Although the rate of consumption during peak hour is very high, the duration is short. A moderate amount of water supplied from strategically located storage facilities throughout the system provides satisfactory service (pressure and flow) to all users, while minimizing the total peak hour pumping required, minimizes distribution pipe sizing, and permits more uniform operation of supply facilities. System storage also increases the reliability of service by providing additional supply in the event of a mechanical breakdown, power outage, or fire. Storage facilities can be provided in one of two ways: a gravity feed (elevated tank) systems or pumped systems.

Currently the Dublin tank operates during peak demand hours, expelling water to satisfy Peak demands. If the Dublin tank is to provide a similar function in the future, the high service pumping facilities located at the treatment facility should have the ability to pump a higher capacity than the supply wells to enable supply to the system beyond the normal well production rate during peak hour demands.

HYDRAULIC ANALYSIS

The City's most current water distribution system model was utilized to evaluate each of the water model scenarios identified above. Each of the scenarios described above was constructed into the model incorporating both a steady state and extended period simulation (EPS) for each scenario alternative.

Steady State Analysis

This model operation provides for a comprehensive assessment of overall system operating conditions at a given point in time. For this analysis, average day demands were assumed to be present in the system with WTP's No.2, No.3 & No.6 in operation and elevated storage tank levels at 2-feet below overflow. The purpose of this analysis is to take a comparative look at system pressure and pipe headloss in relation to what is experienced in the current water system. For example, the proposed site may not have large enough distribution piping to transfer the WTP flow to other parts of the system, which in turn will result in elevated discharge pressures and excessive headloss. It should be noted that for purposes of site comparison, similar demand and water tower levels for each scenario were considered. Though the results may indicate a certain pressure increase, in practice, the proposed water plant could be designed and subsequently operated to modulate flow. This in turn would reduce dynamic system pressures and observed pressure increases.

Extended Period Simulation (EPS)

An EPS water model operation is utilized to evaluate the effect of the proposed water treatment plant locations in relation to water tank balance. Evaluation of the effect on hydraulic balance of the water towers on the distribution system can depend on many factors such as the geographic distribution of system demands and on the accuracy of pump controls. In most cases, it is during peak demand conditions that tower balance becomes a concern. This is because there is a greater amount of water being moved through the distribution system from supply sources and storage facilities to points of use. Under these conditions it becomes more difficult to push water long distances, and towers tend to drain quickly during periods of the day when demands are highest. As a result, it becomes difficult to keep some towers full without overflowing other towers when these conditions are present.

For purposes of this analysis, a similar water tower balance exercise to what was done as part of the 2013 Water System Demand and Capacity Analysis was completed. The model was run for three consecutive days, with average July water demand, to evaluate tower levels over time. Controls for other water treatment plant sites were set to operate the various facilities on and off to maintain water tower levels. A control assumption was made for the WTP No.5 operation with the plant operating on a continuous basis since each location site location would have unique control implications. This allows for each scenario to be compared against one another while utilizing similar assumptions. For comparison purposes, a model operation utilizing the existing system facilities as completed so that proposed scenario results could be compared with current system hydraulics. Initial water tower levels for all simulations was set to 10-feet below overflow with average July summer demands in place. It should be noted that extensive analysis of system diurnal demands have not been completed, therefore model results for EPS simulations should be relied upon for hydraulic comparison between scenarios and should not be considered a replacement for actual field results.

Maximum Day (MD) fixed Grade Flow Capacity – EPS simulation

An additional site comparison metric was developed analyzing the amount of water that could be pushed into the distribution system at each site while maintaining a fixed hydraulic grade. In essence, signifies the quantity of water that the distribution piping move while maintaining system pressures that consistent with current system pressure and do not exceed the hydraulic grade established by the system water towers. An EPS model simulation for each scenario was conducted assuming maximum day diurnal system demands. In general, as more water is demanded by customers in the system, throughout the day, additional water will be able to be supplied by the WTP without exceeding pressure thresholds. The average 24-hour flow rate from each site is summarized in the model results table. In practice, this type of operation would be consistent with WTP high service pumps operated at variable flows while utilizing variable frequency drives (VFD's) and reserve clearwell storage capacity at each treatment plant site.

Supply & Storage & High Service Pumping Impacts

Currently two potential plant capacities have been discussed (3,000 gpm or 5,000 gpm). Presumably, the ability to pump at a higher rate than the plant production with the high service pumps would be preferred. With the Dublin tank satisfying water system storage needs, system equalization support (in addition to emergency reserve and fire protection) is an important function of a water storage facility. Currently, the primary function of the Dublin storage tank is that of emergency reserve storage, with the tank operated in fill and dump cycles to keep water circulating through the tank. The 2018 water supply plan (Table 3-5) made estimates for future water storage needs though year 2040 with 1.4 MG attributed to equalization storage, 0.63 MG to fire protection reserve and 4.0 MG for emergency reserve for a total recommended storage volume of 6.0 MG. The four existing elevated tanks in the system provide 3.0 MG of storage. These elevated tanks can be assumed to provide the equalization portion of the storage requirements with storage in the Dublin tank supporting emergency reserve storage and fire protection storage. However, it may be beneficial to have the ability to deliver equalization supply (flow rates beyond the well and water treatment plant capacity) to the distribution system.

Using the assumption that the peak hour demand of the water system is 1.6 times greater than the daily demand, the ability to pump up to 4,800 gpm should be planned for I the WTP is rated for 3,000 gpm (Option 5A). Utilizing the same pump sizing estimation for the 5,000 gpm WTP option would require up to 8,000 gpm of firm high service pumping capacity (Option 5B). Rates of this magnitude may not be feasible, or necessary since the majority of water contained in the Dublin facility could be considered emergency reserve and fire storage, while the elevated tanks in the system support the majority of the equalization needs. In this case, viewing the 4.0 storage facility (largest storage option) at the site as entirely emergency reserve storage, the ability to pump the entirety of the tank to distribution over a period of 12 hours would be required. This would equate to a flow rate of 5,500 gpm, which would be achievable with existing piping that is in place, during an emergency.

MODEL ANALYSIS RESULTS

Steady State and EPS simulations were completed for each of the scenarios identified above. The results of these simulations are summarized below. In addition, figures presenting results from each scenario alternative are attached. Each figure shows the expected system pressure increase on the system with the proposed scenario facilities in place, during average day demand when compared to the existing system average day demand pressures. Additionally, each figure presents simulated tank levels over a 72-hour period during peak demands. The figures help to document the system wide effects of the proposed facilities defined in each scenario.

Scenario 5A – Dublin Site – Existing System Piping – 3,000 gpm Supply

This Scenario assumes additional supply capacity would be pushed into the water system at the existing Dublin storage reservoir. This scenario would function similar to what is currently done at the Dublin site by pushing water supply into the existing 16-inch nearby water main. Rather than pumping at 2,000 gpm like the current Dublin pump station, water would be produced and pumped at a rate of 3,000 gpm. Without any specific water main improvements, it appears as though model results are favorable. However, nearby water mains velocities would approach but not exceed 5 fps in some areas. The operation of the water system in this manor would not produce excessive pressures.

The peak demand EPS simulation indicates that the Southdale storage tank level may lag during large system demands, as may currently be experienced. This phenomenon is primarily due to the proximity of system supply to areas of demand (The majority of the system demand is in the Southdale area). The MD fixed grade flow analysis indicates that if system pressures were to be limited to current levels, the maximum amount of flow that could be conducted from this site would be 2,800 gpm which is near what is needed for the proposed facility. A slight increase in head at the supply point would allow for full flow delivery. In short, increasing supply at this location appears to be a viable option, however, in the long run, increasing the East-West flow capacity would be recommended to deliver water to the Southdale area more efficiently.

Scenario 5B – Dublin Site – 2040 System Piping – 5,000 gpm Supply

This Scenario is similar to Scenario 5A except it includes portions of trunk water main upgrades that match the water mains recommended in the 2018 water supply plan for long range planning. These pipes were included in the model operation runs in an effort to alleviate excessive pipe headloss and pressure increase at the anticipated 5,000 gpm design flow. The most substantial and necessary pipe for this alternative includes a 16-inch main from Dublin to Metro Blvd along 70th or equivalent. The steady state model operations of this site include an increase in system pressure, however, existing low pressures already exist in this area and the pressure increase could be considered a benefit. The proposed pipe upgrades help to keep system pipe velocity at a manageable level, however it would be recommended that a 24-inch water main be installed from the plant discharge to the intersection of Antrim/70th. Ultimately, the anticipated pipe upgrades would help to move water across the system from the point of supply to area of demand and aid in the operational balance of the elevated storage tanks.

A summary table of each model scenario is provided below:

Water Model Output Results Summary

Site	Scenario	Existing Average Day Discharge Pressure at Main (psi)	Anticipated Average Day Discharge Pressure at Main (psi)	Nearby System Pressure Increase (psi)	Maximum Nearby System Pipe Velocity (fps)	Maximum Nearby pipe Headloss (per 1000 ft)	*MD Fixed Grade Average Flow Capacity (gpm)	Average Summer Day EPS Simulation - Tank Balance
Dublin	**5A**	**39**	42	2	4.8	6	2,800	Southdale Tank Lags other tanks by 10’
	5B		45	4	8.0	17	3,600	All tanks trend together – Southdale lags

*Indicates flow capacity of site assuming a fixed hydraulic grade operation during a maximum day demand, limiting system pressure to the Hydraulic grade of the existing water towers.

KEY FINDINGS

Water Storage Impacts

Currently the Dublin water storage reservoir has a capacity of 4.0 MG, 2.88 MG of which is currently useable on a daily basis. Correspondence with AE$_2$S indicated that if a new water treatment facility were to be located at the Dublin reservoir, the storage capacity may be reduced by 1.4 to 2.0 MG. Construction of a WTP at this site would change the ultimate water storage recommendations previously set forth in the 2018 water supply plan. The plan indicated a 2040 storage shortfall of 0.5 MG which could be satisfied by either adding additional elevated storage or optimization of the Dublin site (increasing the existing 2.8 MG Useable capacity). With the reduction in storage capacity, it would be recommended that an additional 1.0-1.5 MG of water storage be added to the system by the year 2040 (assuming projected system demand growth). Potential alternatives to accomplish this could include:

Option 1: Reconstruction of the Community Center water tower: This is a legged style water tank with a capacity of 0.5 MG. Inevitably this tank will require complete reconditioning. An alternative to reconditioning would be to construct an entirely new elevated storage tank in its place with a larger capacity (1.5-2.0 MG). This would provide a positive benefit in that it would provide elevated storage in a closer proximity to the majority of water use.

Option 2: Increase Storage at Dublin: An additional alternative to replacing lost storage at Dublin (displaced in the horizontal) would be to add additional storage vertically. While this would likely require complete reconstruction of the Dublin tank, it would allow storage to be added as needed. Presuming this alternative would provide 4.0 MG of effective storage at Dublin, it would be recommended that the high service pumps be sized to support flows of 4,800 gpm which would equate to the peak hour demand supported by the Dublin storage facility. (Scenario 5A)

Option 3: Add storage at Water Treatment Plant 3: A 1.0-1.5 MG ground storage tank with high service pumps could be constructed at existing water plant No.3 (near Fred Richards Golf course) to provide emergency reserve storage, which would replace what would be lost at the Dublin tank and support effective storage needs. Changes would need to be made at this plant site to support high service pumping since this facility currently utilizes pressure filtration (water is pumped directly from the wells, through the filters to the distribution system).

If the new water treatment facility were to be constructed at a site other thanks Dublin, the recommended improvements for optimization set forth in the water supply plan would remain and include: The East/West trunk water main improvements, pump, control and metering upgrades as well general facility improvements to all for more controlled operation of the facility.

Water Supply-Storage Impacts

If water plant option 5A were to be constructed, it is recommended that higher service pumping system be designed to achieve a firm pumping capacity of 4,800 gpm. In the short term, the high service pumps could be operated at the 3,000 gpm rate and 4,800 gpm rate in an emergency. As the water system piping is upgraded in the future, regular operation of the higher service pumps at a rate of 4,800 gpm would be possible without elevated flow velocity in the distribution system.

If water plant option 5B were to be constructed, future east/west water system pipe upgrades should be in place in order to operate at full capacity. For purposes of this review, it will be assumed that delivery of equalization storage from the Dublin tank under this option would not be prudent, in which case utilization wholly as an emergency reserve storage facility would be assumed. Sizing the high service pumps to a firm capacity of 5,500 gpm would be recommended.

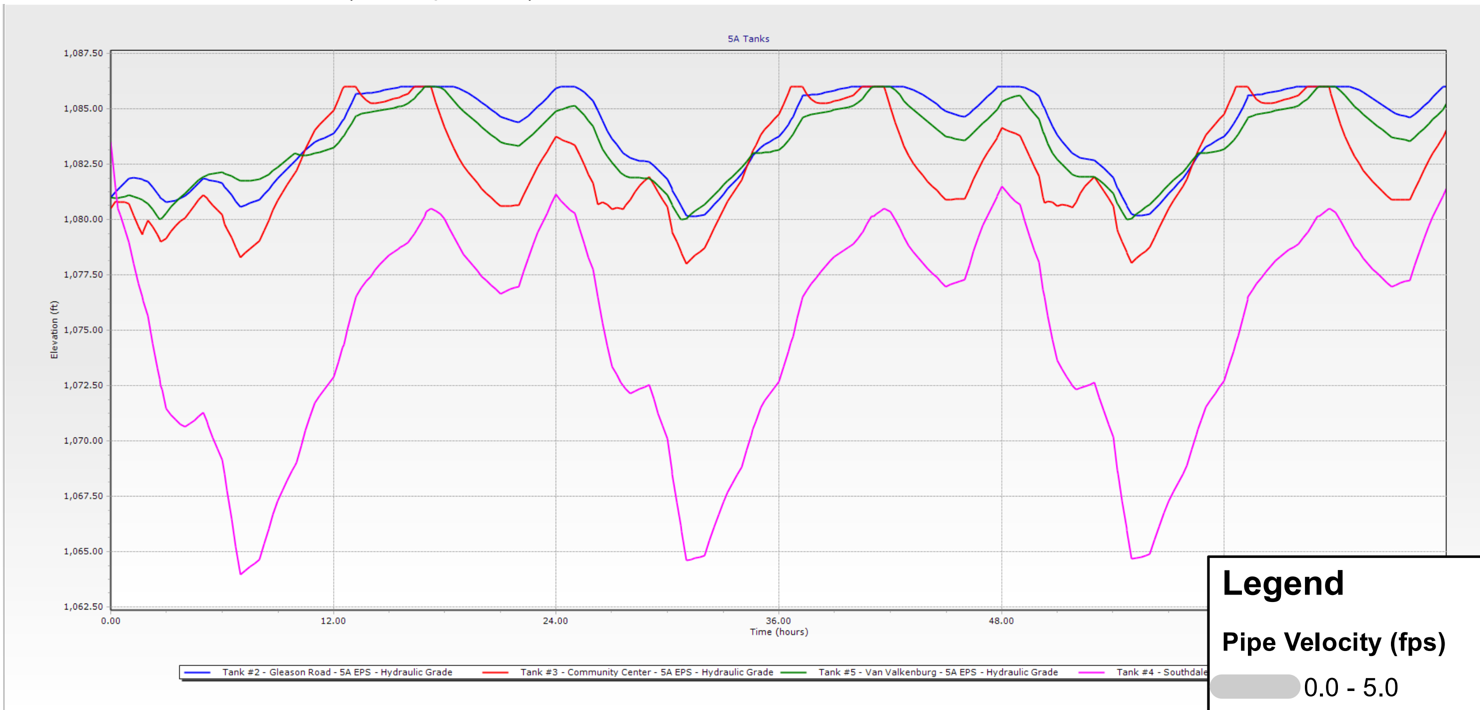
CONCLUSIONS

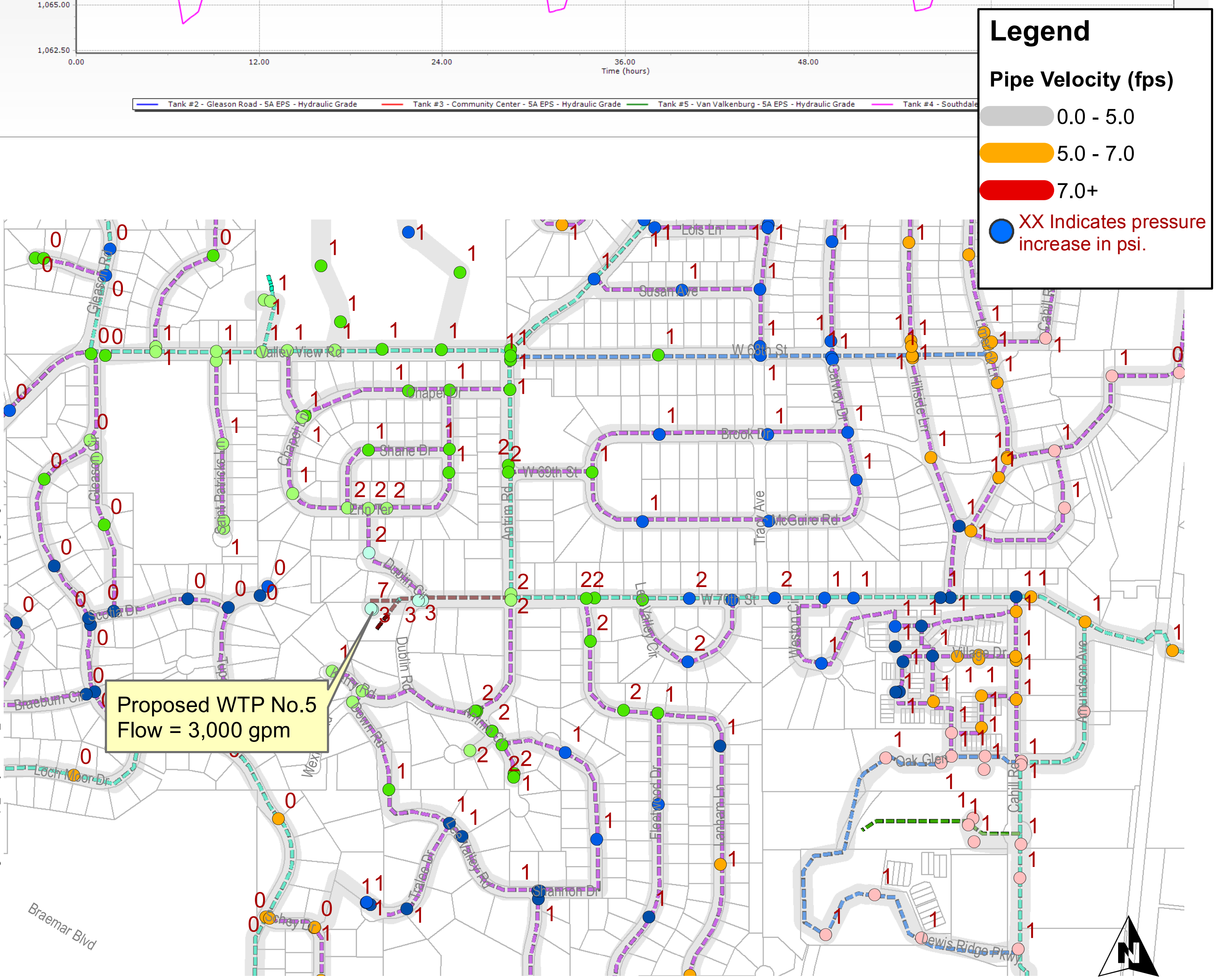
The following conclusions were developed as part of the analysis of the Dublin site:

1. Supplying water from the Dublin site at a rate of 3,000 gpm (Scenario 5A) appears to be feasible with minor water distribution system upgrades. Additional water main upgrades would be recommended in the future. High service pumping should be sized to produce a firm capacity of 4,800 gpm from the Dublin storage tank/Clearwell to the distribution system.
2. Supplying water from the Dublin site at a rate of 5,000 gpm (Scenario 5B) would require portions of the 2040 recommended water main improvements to be in place to accommodate the higher flows on a regular basis. High service pumping should be sized to produce a firm capacity of 5,500 gpm from the Dublin storage tank/Clearwell to the distribution system.
3. The reduction of storage volume at the Dublin site would influence the additional long term storage needs for the City with an additional storage volume of 1.5 MG recommended.
4. Conversion of the Dublin site to a supply/treatment location would eliminate the current fill limitations of the Dublin tank facility operation and would ultimately benefit system wide water age reductions.
5. It is assumed that the proposed water treatment facility at the Dublin site would function by utilizing the Dublin tank as a combined clearwell and storage facility, which would cycle water through the tank, to achieve plug flow, and reduce water age.

ck/mrb
Attachments
c: Ross Bintner, City of Edina
Toby Muse, SEH

Water Tower Tank Balance (EPS Operation)





Path: C:\Users\ckatzenberger\Desktop_ Project Links_ Water Model Initiative\Edina\old\WTP\gis\Figure 5A.mxd

Project Number: EDINA 128385
Print Date: 11/12/2018

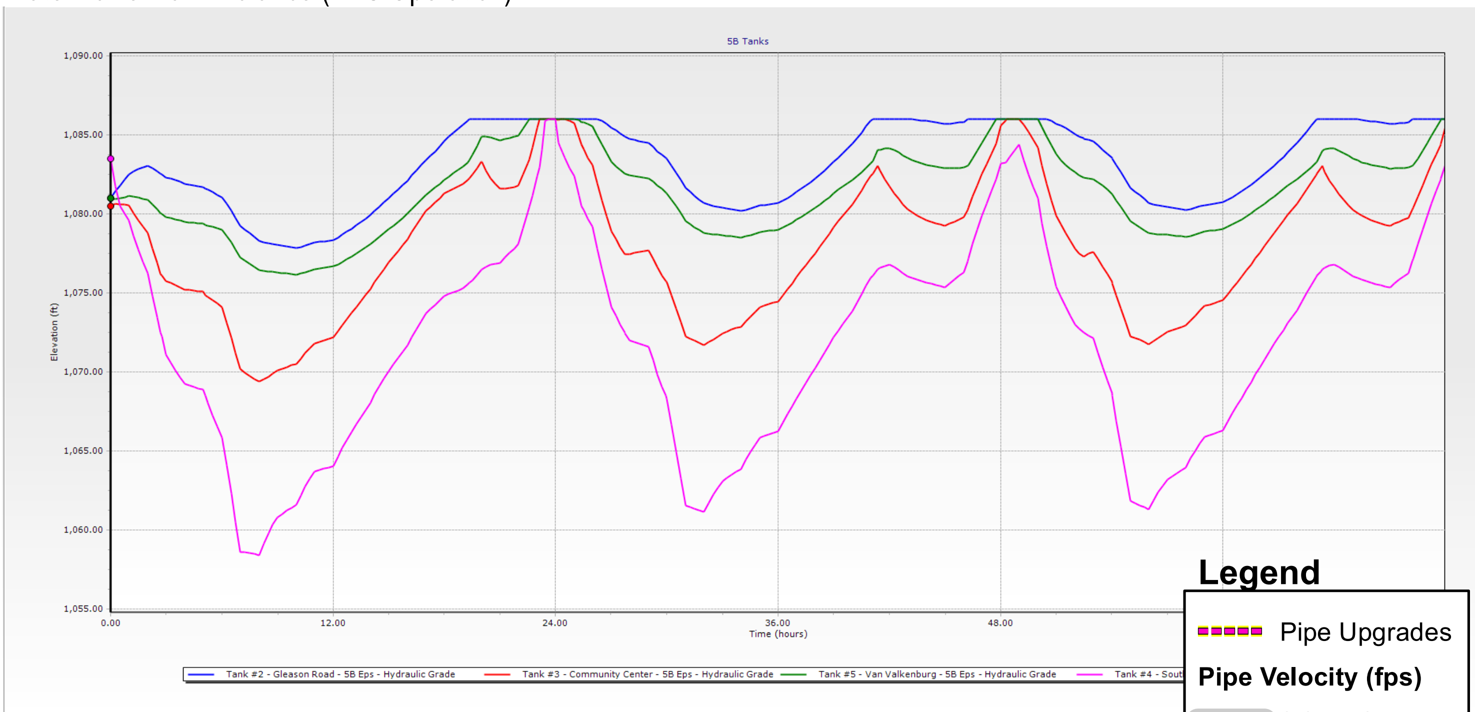
Map by: CTK
Projection: CC
Source: WaterCAD V8i

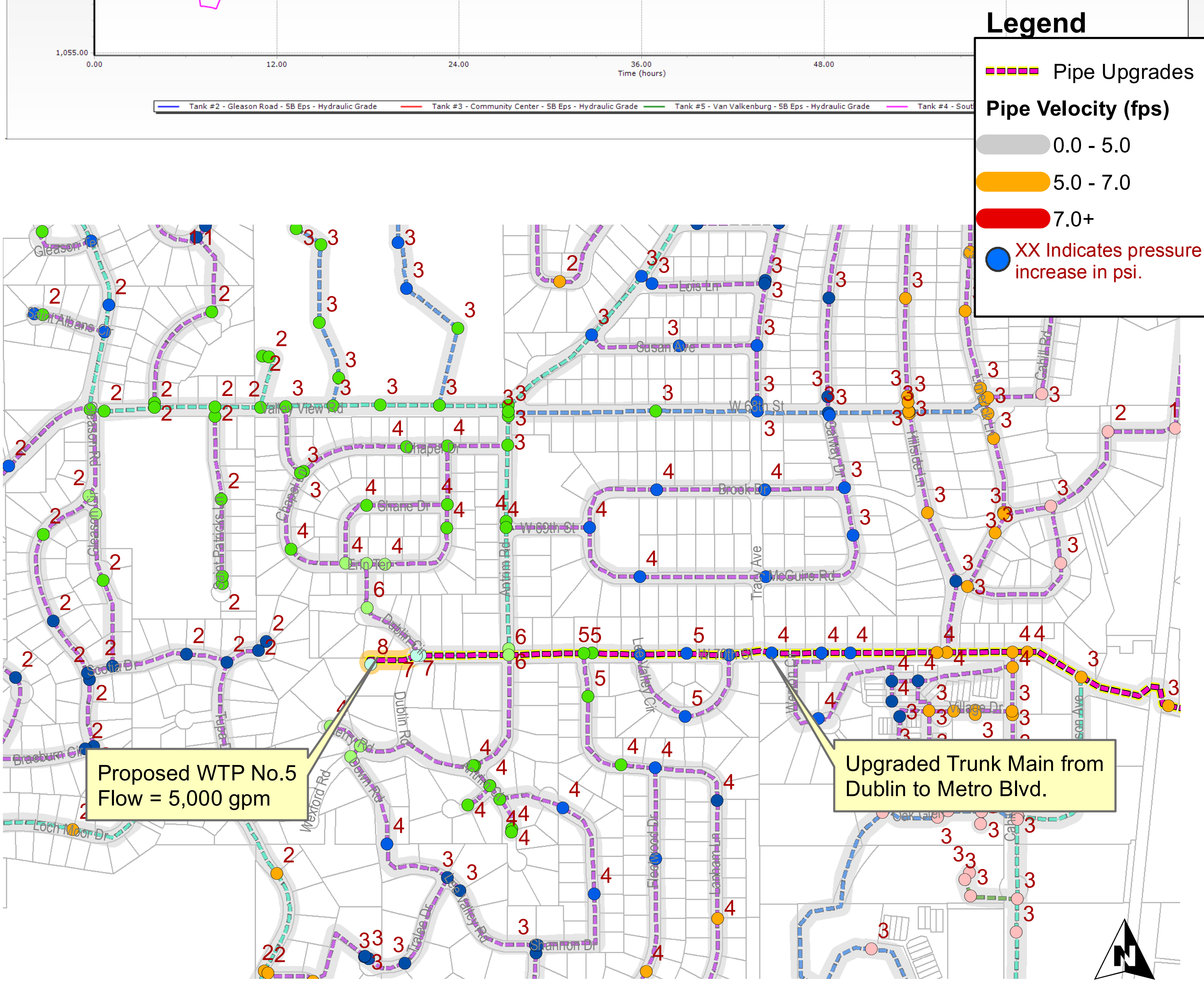
SEH

Water Treatment Plant No.5
Edina, Minnesota

SCENARIO 5A
Average Day Pressure and Flow Results Dublin WTP. No.5

Water Tower Tank Balance (EPS Operation)





Path: C:\Users\ckatzenberger\Desktop_Project Links_Water Model Initiative\Edina\old\WTP\gis\Figure 5B.mxd

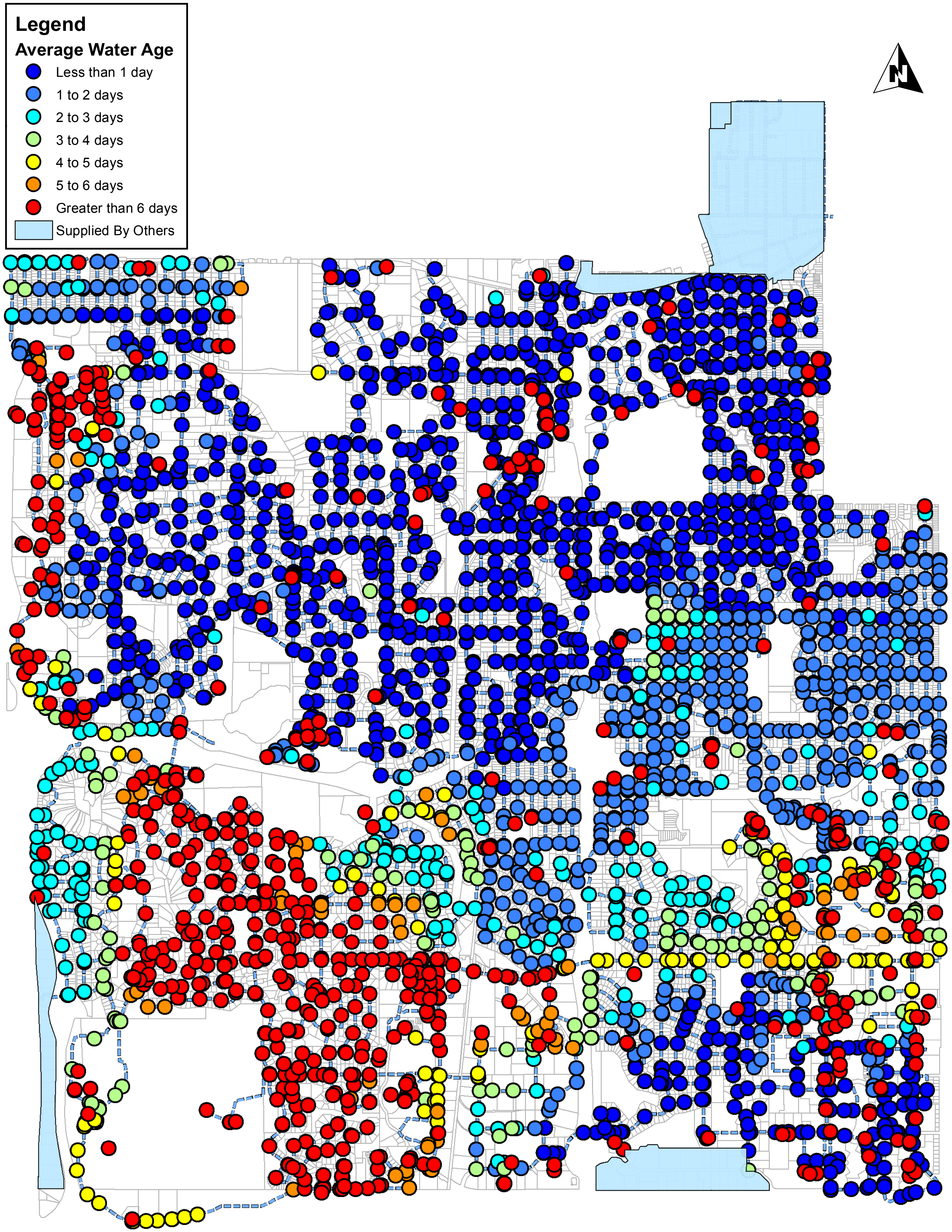
SEH

Project Number: EDINA 128385
Print Date: 11/12/2018

Map by: CTK
Projection: CC
Source: WaterCAD V8i

Water Treatment Plant No.5
Edina, Minnesota

SCENARIO 5B
Average Day Pressure and
Flow Results Dublin WTP. No.5



Path: C:\Projects\AE\E\Edina\1435358-planning\Task 3_WTP at Dublin Analysis\Figure EX -Dublin On.mxd

Project Number: EDINA 128385
Print Date: 12/3/2018

Map by: CTK
Projection: CC
Source: WaterCAD V8i

SEH

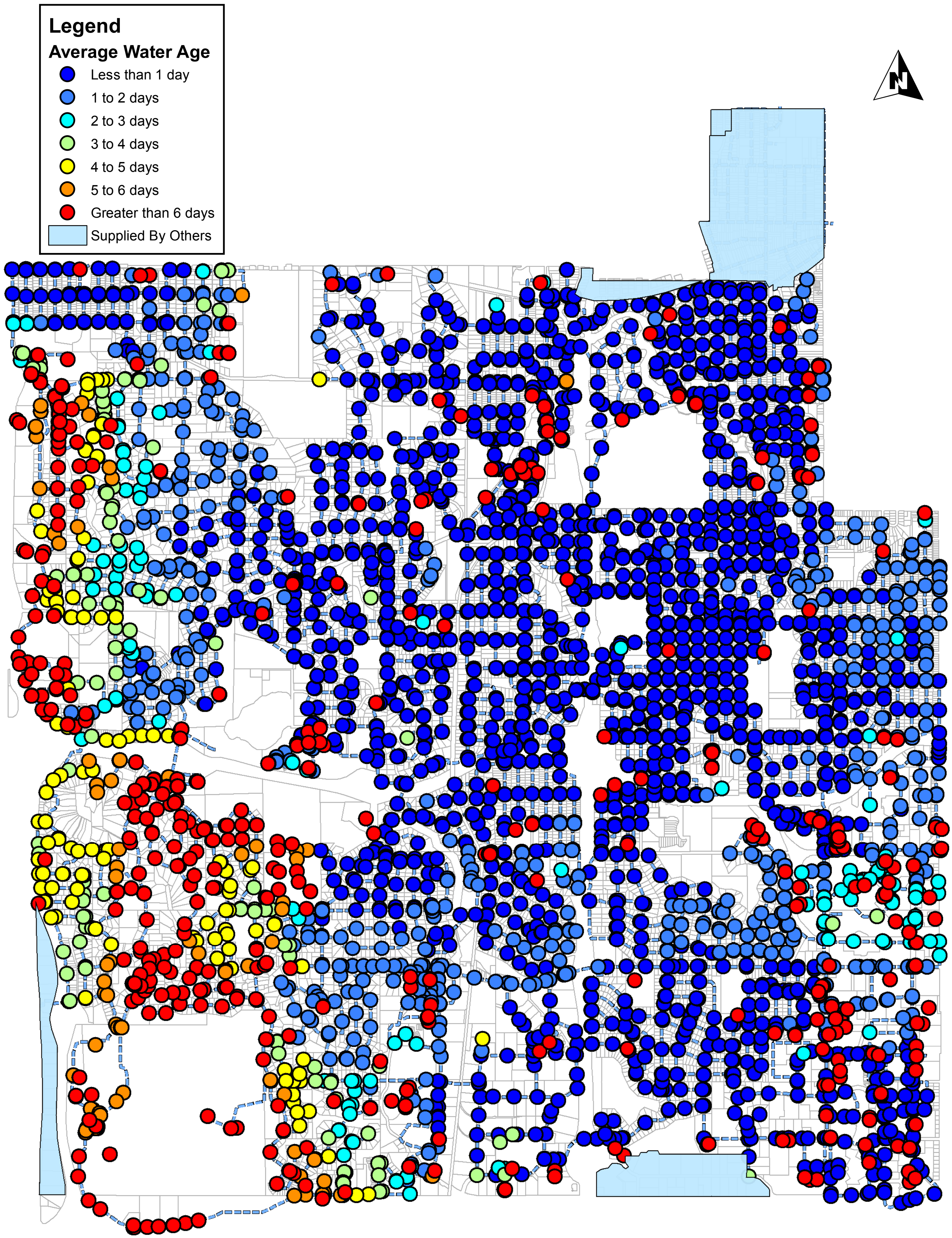
Water Treatment Plant No.5

Edina, Minnesota

SCENARIO EX-ON

Existing Estimated Avg. Winter Day

Water Age - Dublin ON



Path: C:\Projects\AE\E\Edina\143535\8-planning\Task 3_WTP at Dublin Analysis\Figure EX -Dublin OFF.mxd

Project Number: EDINA 128385
Print Date: 12/3/2018

Map by: CTK
Projection: CC
Source: WaterCAD V8i

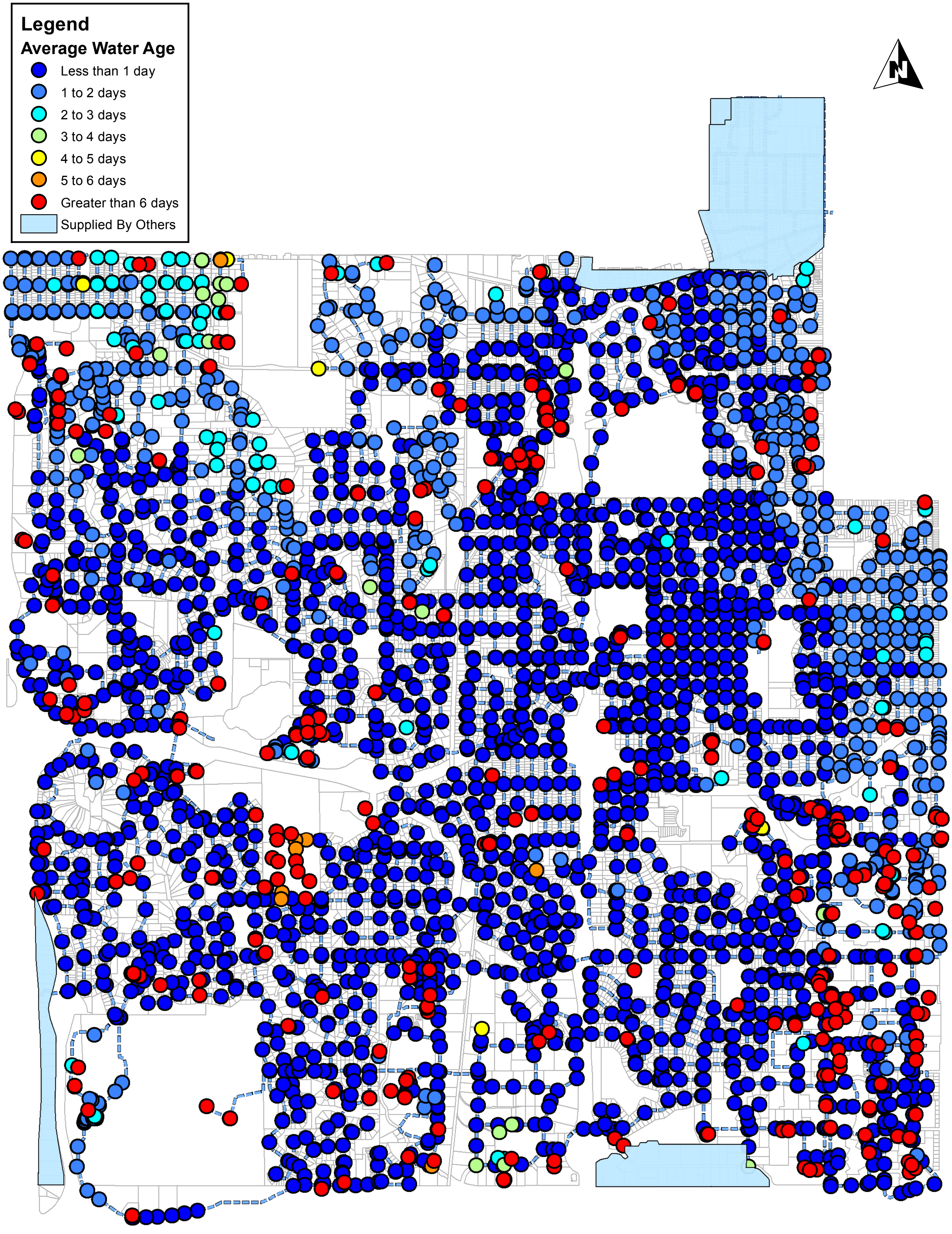
SEH

Water Treatment Plant No.5

Edina, Minnesota

SCENARIO EX-OFF

Existing Estimated Avg. Winter Day
Water Age - Dublin OFF



Path: C:\Projects\AE\E\Edina\1435358-planning\Task 3_WTP at Dublin Analysis\Figure 5A - Age.mxd

Project Number: EDINA 128385
Print Date: 11/21/2018

Map by: CTK
Projection: CC
Source: WaterCAD V8i

Water Treatment Plant No.5
Edina, Minnesota

SCENARIO 5A
Existing Estimated Avg. Winter Day
Water Age - WTP at Dublin

Appendix A.H

Dublin Site Preliminary Architectural Renderings

Edina Water Treatment - Dublin

Concept Elevation

Edina Water Treatment - Dublin

Concept Elevation

Appendix A.I

Option 5A – Dublin Site with Gravity Filters Cost Estimate

Edina WTP Design *Revision: 12/2/2018*
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Gravity Filtration With Traditional Backwash Reclaim - Option 5A

Construction Cost Estimate - Summary

Subtotal 00/01 0000 Contracting and General Requirements	$745,817
Subtotal 02 0000 Existing Conditions	$20,000
Subtotal 03 0000 Concrete	$2,485,600
Subtotal 04 0000 Masonry	$129,387
Subtotal 05 0000 Metals	$238,000
Subtotal 06 0000 Woods,Plastics, and Composits	$30,600
Subtotal 07 0000 Thermal and Moisture Protection	$213,000
Subtotal 08 0000 Doors and Windows	$202,500
Subtotal 09 0000 Finishes	$114,989
Subtotal 10 0000 Specialties	$18,000
Subtotal 12 0000 Furnishings	$10,000
Subtotal 21 0000 Fire Protection	$40,000
Subtotal 22 0000 Plumbing	$150,000
Subtotal 23 0000 Mechanical	$300,000
Subtotal 26 0000 Electrical	$1,525,040
Subtotal 31 0000 Earthwork	$420,000
Subtotal 32 0000 Exterior Improvements	$140,000
Subtotal 33 0000 Utilities	$100,000
Subtotal 40 0000 Process Integration	$733,700
Subtotal 43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment	$328,440
Subtotal 46 0000 Water and Wastewater Equipment	$461,534
Subtotal	**$8,406,606**

00/01 0000 Contracting and General Requirements

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Legal/Administrative**				0.75%	$57,456	1.00
B.	**Mobilization**				0.75%	$57,456	1.00
C.	**Supervision**				1.0%	$76,608	1.00
D.	**Temporary Facilities**				0.75%	$57,456	1.00
E.	**Temporary Utilities**				0.75%	$57,456	1.00
F.	**Equipment Rental and Misc. Costs**				0.75%	$57,456	1.00
G.	**Bonding and Insurance**				1.2%	$91,929	1.00
H.	**Allowances:**						
a.	Security and Access Control Hardware					$50,000	1.00
b.	Computer Hardware, Software, and Equipment, SCADA Licensing					$120,000	1.00
c.	Instrumentation & Controls Programming					$120,000	1.00
					Subtotal Allowances	**$290,000**	
					Subtotal 00/01 0000 Contracting and General Requirements	**$745,817**	

02 0000 Existing Conditions

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**General Demolition**	1	LS	$10,000.00	$10,000.00	$10,000	1.00
B.	**Existing Reservoir and Pump Station Select Demolition (Concrete)**						
1.	Concrete Removal	0	CY	$80.00	$0.00	$0	1.20
C.	**Dewatering**	1	LS	$10,000.00	$10,000.00	$10,000	1.00
					Subtotal 02 0000 Existing Conditions	**$20,000**	

03 0000 Concrete

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**General Cast in Place Concrete - Facility**	2,220	CY	$750.00	$1,665,000.00	$1,665,000	1.00
B.	**General Cast in Place Concrete - Reservoir**	0	CY	$750.00	$0.00	$0	1.00
C.	**Precast Walls**	14,300	SF	$38.00	$543,400.00	$543,400	1.00
D.	**8-inch Precast Hollowcore Roof Plank**	9,900	SF	$28.00	$277,200.00	$277,200	1.00
					Subtotal 03 0000 Concrete	**$2,485,600**	

04 0000 Masonry

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**8" CMU**	3,130	EA	$10.00	$31,300.00	$31,300	1.00
B.	**12" CMU**	340	EA	$15.55	$5,287.00	$5,287	1.00
C.	**Modular Brick (N**	5,800	SF	$16.00	$92,800.00	$92,800	1.00
					Subtotal 04 0000 Masonry	**$129,387**	

Edina WTP Design *Revision: 12/2/2018*
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Gravity Filtration With Traditional Backwash Reclaim - Option 5A

05 0000 Metals

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Misc. Metals & Structural Steel	1	LS	$150,000.00	$150,000.00	$150,000	1.00
B.	Metal Stairs	1	LS	$30,000.00	$30,000.00	$30,000	1.00
C.	Metal Railings	1	LS	$40,000.00	$40,000.00	$40,000	1.00
D.	Floor Hatches	6	EA	$3,000.00	$18,000.00	$18,000	1.00
					Subtotal 05 0000 Metals	**$238,000**	

06 0000 Woods,Plastics, and Composits

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Wood Cabinets	1	LS	$4,000.00	$4,000.00	$4,000	1.00
B.	Misc. Carpentry	1	LS	$2,000.00	$2,000.00	$2,000	1.00
C.	Fiberglass Grating	820	SF	$30.00	$24,600.00	$24,600	1.00
D.	FRP Baffling for Reservoir	0	SF	$30.00	$0.00	$0	1.30
					Subtotal 06 0000 Woods,Plastics, and Composits	**$30,600**	

07 0000 Thermal and Moisture Protection

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Nail Base Roof Insulation	1	LS	$30,000.00	$30,000.00	$30,000	1.00
B.	Cavity Wall Vapor Barrier	1	LS	$30,000.00	$30,000.00	$30,000	1.00
C.	Below Grade Waterproofing	1	LS	$45,000.00	$20,000.00	$20,000	1.00
D.	Foundation Insulation	1	LS	$8,000.00	$8,000.00	$8,000	1.00
E.	Glue Lam Roof System	9000	SF	$11.00	$99,000.00	$99,000	1.00
F.	Caulking	1	LS	$26,000.00	$26,000.00	$26,000	1.00
					Subtotal 07 0000 Thermal and Moisture Protection	**$213,000**	

08 0000 Doors and Windows

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Doors, Frames & Hard.	27	EA	$2,500.00	$67,500.00	$67,500	1.00
B.	Overhead door	2	EA	$7,500.00	$15,000.00	$15,000	1.00
C.	Windows	1	LS	$120,000.00	$120,000.00	$120,000	1.00
					Subtotal 08 0000 Doors and Windows	**$202,500**	

09 0000 Finishes

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Floor Tile & Base	100	SF	$25.00	$2,500.00	$2,500	1.00
B.	Vinyl Wall Base	75	LF	$3.02	$226.50	$227	1.00
C.	Acoustic @ Blower	200	SF	$2.39	$478.00	$478	1.00
D.	Paintings & Coatings	1	LS	$75,000.00	$75,000.00	$75,000	1.00
E.	Flooring Epoxy Coating	8800	SF	$4.18	$36,784.00	$36,784	1.00
					Subtotal 09 0000 Finishes	**$114,989**	

10 0000 Specialties

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Plaque & Signs	1	LS	$14,000.00	$14,000.00	$14,000	1.00
B.	Toilet & Bath Accessories	1	LS	$2,500.00	$2,500.00	$2,500	1.00
C.	Fire Exsting. & LK. Box	1	LS	$1,000.00	$1,000.00	$1,000	1.00
D.	Wall Guards and Corner Protection	1	LS	$500.00	$500.00	$500	1.00
					Subtotal 10 0000 Specialties	**$18,000**	

WTP Alternative - Dublin

Opinion of Probable Total Construction Cost

Dublin - Gravity Filtration With Traditional Backwash Reclaim - Option 5A

12 0000 Furnishings

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Laboratory Countertops	1	LS	$10,000.00	$10,000.00	$10,000	1.00
				Subtotal 12 0000 Furnishings		$10,000	

21 0000 Fire Protection

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Fire Suppression	1	LS	$40,000.00	$40,000.00	$40,000	1.00
				Subtotal 21 0000 Fire Protection		$40,000	

22 0000 Plumbing

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Plumbing	1	LS	$150,000.00	$150,000.00	$150,000	1.00
				Subtotal 22 0000 Plumbing		$150,000	

23 0000 Mechanical

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Mechanical	1	LS	$300,000.00	$300,000.00	$300,000	1.00
				Subtotal 23 0000 Mechanical		$300,000	

26 0000 Electrical

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Site Work						
1.	Metering Cabinets	1	EA	$10,000.00	$10,000.00	$12,000	1.20
2.	Equipment Concrete Pads/Basements	1	EA	$10,000.00	$10,000.00	$12,000	1.20
3.	Grounding	1	EA	$10,000.00	$10,000.00	$12,000	1.20
4.	800A Feeder in Ductbank	120	LF	$400.00	$48,000.00	$57,600	1.20
5.	Generator	1	EA	$420,000.00	$420,000.00	$504,000	1.20
B.	Interior Work						
1.	Main Switchboard	1	EA	$100,000.00	$100,000.00	$120,000	1.20
2.	Large Junction Boxes	6	EA	$3,000.00	$18,000.00	$21,600	1.20
3.	Small Junction Boxes	16	EA	$2,000.00	$32,000.00	$38,400	1.20
4.	LED lights	100	EA	$500.00	$50,000.00	$60,000	1.20
5	Color Changing LEDs and Programming	0	EA	$1,000.00	$0.00	$0	1.20
6	Receptacles/ Wall Jacks	30	EA	$500.00	$15,000.00	$18,000	1.20
7	Process Terminations	60	EA	$500.00	$30,000.00	$36,000	1.20
8	Fire alarm System	1	EA	$50,000.00	$50,000.00	$60,000	1.20
9	Access Control and Security	1	EA	$40,000.00	$40,000.00	$48,000	1.20
10	Motor Control Centers	8	EA	$10,000.00	$80,000.00	$96,000	1.20
11	High Service VFDs	3	EA	$25,000.00	$75,000.00	$90,000	1.20
12	BW VFD	1	EA	$35,000.00	$35,000.00	$42,000	1.20
13	Feeders Less than 60A	800	LF	$40.00	$32,000.00	$38,400	1.20
14	100A Feeder	200	LF	$65.00	$13,000.00	$15,600	1.20
15	Analog I/O	2800	LF	$4.25	$11,900.00	$14,280	1.20
16	Digital I/O	2800	LF	$5.00	$14,000.00	$16,800	1.20
17	Cat 6	1500	LF	$5.00	$7,500.00	$9,000	1.20
18	Distribution Panelboard	4	EA	$6,000.00	$24,000.00	$28,800	1.20
19	Step Down Dry Type Transformer	2	EA	$15,000.00	$30,000.00	$36,000	1.20
20	30A Disconnect Switches (NEMA 12)	28	EA	$320.27	$8,967.42	$10,760	1.20
21	HVAC Equipment	24	EA	$500.00	$12,000.00	$14,400	1.20
22	Unit Heaters	5	EA	$1,500.00	$7,500.00	$9,000	1.20
23	Lighting Panelboards	3	EA	$5,000.00	$15,000.00	$18,000	1.20
24	Electrical Distribution Equipment	24	EA	$750.00	$18,000.00	$21,600	1.20
25	Life Safety System	1	EA	$38,000.00	$38,000.00	$45,600	1.20
26	Lightning Protection	1	EA	$16,000.00	$16,000.00	$19,200	1.20
				Subtotal 26 0000 Electrical		$1,525,040	

Edina WTP Design *Revision:* *12/2/2018*
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Gravity Filtration With Traditional Backwash Reclaim - Option 5A

31 0000 Earthwork

Item Description			Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Building Excavation**							
	1.	Common Excavation, (EV)	3,800	CY	$20.00	$76,000.00	$76,000	1.00
	2.	Common Excavation, TOPSOIL STRIP (EV)	240	CY	$15.00	$3,600.00	$3,600	1.00
B.	**Building Backfill**							
	1.	Backfill, Placement of Excavated Material	3800	CY	$20.00	$76,000.00	$76,000	1.00
	2.	Backfill, Imported Material	5100	CY	$25.00	$127,500.00	$127,500	1.00
	3.	Aggregate Base Below Slab	9900	CF	$12.00	$118,800.00	$118,800	1.00
	4.	Road Subgrade Prep	1	LS	$8,000.00	$8,000.00	$8,000	1.00
	5.	Spread Topsoil	1	LS	$7,000.00	$7,000.00	$7,000	1.00
						Subtotal 31 0000 Earthwork	**$420,000**	

32 0000 Exterior Improvements

Item Description				Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Landscaping**								
	1.	Site Grading		1	LS	$5,000.00	$5,000.00	$5,000	1.00
	2.	Seeding		1,200	SY	$5.00	$6,000.00	$6,000	1.00
	3.	Irrigation		1	LS	$15,000.00	$15,000.00	$15,000	1.00
	4.	Plantings/Miscellaneous		1	LS	$15,000.00	$15,000.00	$15,000	1.00
B.	**Site Work**								
	1.	Removals							
		a.	Pavement Removal	240	SY	$12.00	$2,880.00	$3,460	1.20
		b.	Utility Relocations/Removals	1	LS	$10,000.00	$10,000.00	$12,000	1.20
		c.	SWPPP Items (silt fence, fiber rolls, etc…)	1	LS	$10,000.00	$10,000.00	$12,000	1.20
	2.	Road and Parking Lot							
		a.	Site Paving	470	SY	$100.00	$47,000.00	$47,000	1.00
		b.	Sidewalk and Building Entrance Stoops	70	SY	$100.00	$7,000.00	$8,400	1.20
		c.	Road Restoration	120	SY	$100.00	$12,000.00	$14,400	1.20
							Subtotal 32 0000 Exterior Improvements	**$140,000**	

33 0000 Utilities

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Misc. Site Piping**	1	LS	$100,000.00	$100,000.00	$100,000	1.00
					Subtotal 33 0000 Utilities	**$100,000**	

40 0000 Process Integration

Item Description				Size	Length	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Process Piping, Valves, Appurtenances, Fittings**					1	LS	$50,000.00	$50,000.00	$60,000	1.20
	1.	WTP Influent to Detention Basin				1	LS	$50,000.00	$50,000.00	$60,000	1.20
	2.	Detention Basin Bypass				1	LS	$7,000.00	$7,000.00	$8,400	1.20
	3.	Detention Basin Overflow				1	LS	$18,000.00	$18,000.00	$21,600	1.20
	4.	Filter Influent Manifold				1	LS	$32,000.00	$32,000.00	$38,400	1.20
	5.	Filter Bypass to Clearwell				1	LS	$7,000.00	$7,000.00	$8,400	1.20
	6.	Filter Overflow				1	LS	$12,000.00	$12,000.00	$14,400	1.20
	7.	Filter Effluent				1	LS	$55,000.00	$55,000.00	$66,000	1.20
	8.	Backwash Supply				1	LS	$74,000.00	$74,000.00	$88,800	1.20
	9.	Backwash Waste				1	LS	$25,000.00	$25,000.00	$30,000	1.20
	10.	High Service Pump Piping				1	LS	$8,000.00	$8,000.00	$9,600	1.20
	11.	Finished Water Piping				1	LS	$30,000.00	$30,000.00	$36,000	1.20
	12.	Backwash Reclaim System (Recycle, Sludge)				1	LS	$60,000.00	$60,000.00	$72,000	1.20
	13.	Clearwell and Detention Basin Overflow and Vent				1	LS	$25,000.00	$25,000.00	$30,000	1.20
	14.	Detention Basin Sludge Piping				1	LS	$2,000.00	$2,000.00	$2,400	1.20
	15.	Air Backwash Piping				1	LS	$25,000.00	$25,000.00	$30,000	1.20
B.	**Instrumentation and Control System Devices (40 91 00)**										
	1.	Chemical Feed System Instrumentation									
		a.	Mono/Free Ammonia Analyzer			1	ea	$35,000.00	$35,000.00	$42,000	1.20
	2.	Conventional Filter Instrumentation									
		a.	Ultrasonic Level Transmitters			8	ea	$1,300.00	$10,400.00	$12,480	1.20
		b.	Level Float Switches			5	ea	$100.00	$500.00	$600	1.20
	3.	Pressure Transmitters (w/ Gauge)				3	ea	$1,040.00	$3,120.00	$3,740	1.20
	4.	Pressure Gauge				6	ea	$400.00	$2,400.00	$2,880	1.20

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
C, Instrumentation and Control, Control Panels (40 91 10)						
1. Control Panels	-					
a. Master Control Panel	1	ea	$60,000.00	$60,000.00	$60,000	1.00
b. Network Panel	1	ea	$30,000.00	$30,000.00	$36,000	1.20

Subtotal 40 0000 Process Integration $733,700

43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Vertical Turbine Pump						
1. High Service Pumps						
a. 1500 GPM (125HP)	3	ea	$60,000.00	$180,000.00	$216,000	1.20
2. Backwash Supply Pump	1	ea	$70,000.00	$70,000.00	$84,000	1.20
B. Sumbersible Liquid Pumps (43 21 39)						
1. Backwash Reclaim Submersible Reclaim Pumps	2	ea	$7,900.00	$15,800.00	$18,960	1.20
2. Backwash Reclaim Submersible Sludge Pumps	1	ea	$7,900.00	$7,900.00	$9,480	1.20

Subtotal 43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment $328,440

46 0000 Water and Wastewater Equipment

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Pre-Negotiated Chemical Feed System Components	1	ls	$30,000.00	$30,000.00	$36,000	1.20
1. All Chemical Feed Pumps on Skids (4 total)						
2. Valves, appurtenances, piping on feed skid						
3. Chemical Diffusers						
B. Fluoride Chemical Feed System						
1. 400-gallon Bulk Storage Tank	1	ea	$1,200.00	$1,200.00	$1,440	1.20
2. Bulk Chemical Delivery Connection	1	ls	$800.00	$800.00	$960	1.20
3. Break Tank	1	ea	$300.00	$300.00	$360	1.20
4. Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
5. 1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
6. Carrier Piping, Appurtenances, and Valves	1	ls	$1,500.00	$1,500.00	$1,800	1.20
C. HMO Feed System						
1. 960-gallon Bulk Storage Tank	1	ea	$2,500.00	$2,500.00	$3,000	1.20
2. Tank Mixer (3/4 HP)	1	ea	$2,800.00	$2,800.00	$3,360	1.20
3. 1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
4. Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
5. Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
6. Bulk Chemical Delivery Connection	1	ea	$800.00	$800.00	$960	1.20
D. Poly/Orthophosphate Feed System						
1. 800-gallon Storage Tank	1	e.a.	$2,100.00	$2,100.00	$2,520	1.20
2. Bulk Chemical Delivery Connection	1	e.a.	$800.00	$800.00	$960	1.20
3. Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
4. 1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
5. Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
E. Ammonium Sulfate Feed System						
1. 540-gallon Bulk Tank	1	e.a.	$1,320.00	$1,320.00	$1,584	1.20
2. Bulk Chemical Delivery Connection	1	e.a.	$800.00	$800.00	$960	1.20
3. Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
6. 1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
7. Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
F. Chlorine Chemical Feed System						
1. Chlorine Feed System	1	e.a.	$35,000.00	$35,000.00	$42,000	1.20
2. Extra Chlorine Piping for Solution and Diffusers	1	l.s.	$2,000.00	$2,000.00	$2,400	1.20
3. Chlorine Gas Emergency Shutoff System	1	e.a.	$10,000.00	$10,000.00	$12,000	1.20
G. Filter Equipment						
1. Sand Media	1,520	CF	$10.00	$15,200.00	$18,240	1.20
2. Anthracite Media	1,012	CF	$20.00	$20,240.00	$24,290	1.20
3. Filter Troughs	135	LF	$350.00	$47,250.00	$56,700	1.20
4. Underdrain / In-Cell Airwash	1,012	SF	$150.00	$151,800.00	$182,160	1.20
H. Filter Air Scour Equipment						
1. PD Airwash Blower	1	ea	$45,000.00	$45,000.00	$54,000	1.20

Subtotal 46 0000 Water and Wastewater Equipment $461,534

Appendix A.J

Option 5B – Dublin Site with Pressure Filters Cost Estimate

Edina WTP Design *Revision:* *12/2/2018*

AE2S Project #P05177-2018-003

WTP Alternative - Dublin

Opinion of Probable Total Construction Cost

Dublin - Pressure Filtration With Traditional Backwash Reclaim - Option 5B

Construction Cost Estimate - Summary

Subtotal 00/01 0000 Contracting and General Requirements	$771,913
Subtotal 02 0000 Existing Conditions	$20,000
Subtotal 03 0000 Concrete	$1,909,580
Subtotal 04 0000 Masonry	$82,987
Subtotal 05 0000 Metals	$238,000
Subtotal 06 0000 Woods,Plastics, and Composits	$18,000
Subtotal 07 0000 Thermal and Moisture Protection	$213,000
Subtotal 08 0000 Doors and Windows	$202,500
Subtotal 09 0000 Finishes	$114,989
Subtotal 10 0000 Specialties	$18,000
Subtotal 12 0000 Furnishings	$10,000
Subtotal 21 0000 Fire Protection	$40,000
Subtotal 22 0000 Plumbing	$150,000
Subtotal 23 0000 Mechanical	$300,000
Subtotal 26 0000 Electrical	$1,521,040
Subtotal 31 0000 Earthwork	$420,000
Subtotal 32 0000 Exterior Improvements	$140,000
Subtotal 33 0000 Utilities	$100,000
Subtotal 40 0000 Process Integration	$784,700
Subtotal 43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment	$328,440
Subtotal 46 0000 Water and Wastewater Equipment	$1,488,144
Subtotal	**$8,871,293**

00/01 0000 Contracting and General Requirements

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Legal/Administrative				0.75%	$60,745	1.00
B.	Mobilization				0.75%	$60,745	1.00
C.	Supervision				1.0%	$80,994	1.00
D.	Temporary Facilities				0.75%	$60,745	1.00
E.	Temporary Utilities				0.75%	$60,745	1.00
F.	Equipment Rental and Misc. Costs				0.75%	$60,745	1.00
G.	Bonding and Insurance				1.2%	$97,193	1.00
H.	Allowances:						
a.	Security and Access Control Hardware					$50,000	1.00
b.	Computer Hardware, Software, and Equipment, SCADA Licensing					$120,000	1.00
c.	Instrumentation & Controls Programming					$120,000	1.00
					Subtotal Allowances	**$290,000**	
					Subtotal 00/01 0000 Contracting and General Requirements	**$771,913**	

02 0000 Existing Conditions

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	General Demolition	1	LS	$10,000.00	$10,000.00	$10,000	1.00
B.	Existing Reservoir and Pump Station Select Demolition (Concrete)						
1.	Concrete Removal	0	CY	$80.00	$0.00	$0	1.20
C.	Dewatering	1	LS	$10,000.00	$10,000.00	$10,000	1.00
					Subtotal 02 0000 Existing Conditions	**$20,000**	

03 0000 Concrete

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	General Cast in Place Concrete - Facility	1,720	CY	$750.00	$1,290,000.00	$1,290,000	1.00
B.	General Cast in Place Concrete - Reservoir	0	CY	$750.00	$0.00	$0	1.00
C.	Precast Walls	9,010	SF	$38.00	$342,380.00	$342,380	1.00
D.	8-inch Precast Hollowcore Roof Plank	9,900	SF	$28.00	$277,200.00	$277,200	1.00
					Subtotal 03 0000 Concrete	**$1,909,580**	

04 0000 Masonry

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	8" CMU	3,130	EA	$10.00	$31,300.00	$31,300	1.00
B.	12" CMU	340	EA	$15.55	$5,287.00	$5,287	1.00
C.	Modular Brick (N	2,900	SF	$16.00	$46,400.00	$46,400	1.00
					Subtotal 04 0000 Masonry	**$82,987**	

Edina WTP Design
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Pressure Filtration With Traditional Backwash Reclaim - Option 5B

Revision: *12/2/2018*

05 0000 Metals

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Misc. Metals & Structural Steel	1	LS	$150,000.00	$150,000.00	$150,000	1.00
B.	Metal Stairs	1	LS	$30,000.00	$30,000.00	$30,000	1.00
C.	Metal Railings	1	LS	$40,000.00	$40,000.00	$40,000	1.00
D.	Floor Hatches	6	EA	$3,000.00	$18,000.00	$18,000	1.00
					Subtotal 05 0000 Metals	$238,000	

06 0000 Woods,Plastics, and Composits

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Wood Cabinets	1	LS	$4,000.00	$4,000.00	$4,000	1.00
B.	Misc. Carpentry	1	LS	$2,000.00	$2,000.00	$2,000	1.00
C.	Fiberglass Grating	400	SF	$30.00	$12,000.00	$12,000	1.00
D.	FRP Baffling for Reservoir	0	SF	$30.00	$0.00	$0	1.30
					Subtotal 06 0000 Woods,Plastics, and Composits	$18,000	

07 0000 Thermal and Moisture Protection

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Nail Base Roof Insulation	1	LS	$30,000.00	$30,000.00	$30,000	1.00
B.	Cavity Wall Vapor Barrier	1	LS	$30,000.00	$30,000.00	$30,000	1.00
C.	Below Grade Waterproofing	1	LS	$45,000.00	$20,000.00	$20,000	1.00
D.	Foundation Insulation	1	LS	$8,000.00	$8,000.00	$8,000	1.00
E.	Glue Lam Roof System	9000	SF	$11.00	$99,000.00	$99,000	1.00
F.	Caulking	1	LS	$26,000.00	$26,000.00	$26,000	1.00
					Subtotal 07 0000 Thermal and Moisture Protection	$213,000	

08 0000 Doors and Windows

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Doors, Frames & Hard.	27	EA	$2,500.00	$67,500.00	$67,500	1.00
B.	Overhead door	2	EA	$7,500.00	$15,000.00	$15,000	1.00
C.	Windows	1	LS	$120,000.00	$120,000.00	$120,000	1.00
					Subtotal 08 0000 Doors and Windows	$202,500	

09 0000 Finishes

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Floor Tile & Base	100	SF	$25.00	$2,500.00	$2,500	1.00
B.	Vinyl Wall Base	75	LF	$3.02	$226.50	$227	1.00
C.	Acoustic @ Blower	200	SF	$2.39	$478.00	$478	1.00
D.	Paintings & Coatings	1	LS	$75,000.00	$75,000.00	$75,000	1.00
E.	Flooring Epoxy Coating	8800	SF	$4.18	$36,784.00	$36,784	1.00
					Subtotal 09 0000 Finishes	$114,989	

10 0000 Specialties

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	Plaque & Signs	1	LS	$14,000.00	$14,000.00	$14,000	1.00
B.	Toilet & Bath Accessories	1	LS	$2,500.00	$2,500.00	$2,500	1.00
C.	Fire Exsting. & LK. Box	1	LS	$1,000.00	$1,000.00	$1,000	1.00
D.	Wall Guards and Corner Protection	1	LS	$500.00	$500.00	$500	1.00
					Subtotal 10 0000 Specialties	$18,000	

Edina WTP Design | Revision: 12/2/2018
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Pressure Filtration With Traditional Backwash Reclaim - Option 5B

12 0000 Furnishings

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Laboratory Countertops	1	LS	$10,000.00	$10,000.00	$10,000	1.00
				Subtotal 12 0000 Furnishings	$10,000	

21 0000 Fire Protection

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Fire Suppression	1	LS	$40,000.00	$40,000.00	$40,000	1.00
				Subtotal 21 0000 Fire Protection	$40,000	

22 0000 Plumbing

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Plumbing	1	LS	$150,000.00	$150,000.00	$150,000	1.00
				Subtotal 22 0000 Plumbing	$150,000	

23 0000 Mechanical

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Mechanical	1	LS	$300,000.00	$300,000.00	$300,000	1.00
				Subtotal 23 0000 Mechanical	$300,000	

26 0000 Electrical

Item Description	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A. Site Work						
1. Metering Cabinets	1	EA	$10,000.00	$10,000.00	$12,000	1.20
2. Equipment Concrete Pads/Basements	1	EA	$10,000.00	$10,000.00	$12,000	1.20
3. Grounding	1	EA	$10,000.00	$10,000.00	$12,000	1.20
4. 800A Feeder in Ductbank	120	LF	$400.00	$48,000.00	$57,600	1.20
5. Generator	1	EA	$500,000.00	$500,000.00	$500,000	1.00
B. Interior Work						
1. Main Switchboard	1	EA	$100,000.00	$100,000.00	$120,000	1.20
2. Large Junction Boxes	6	EA	$3,000.00	$18,000.00	$21,600	1.20
3. Small Junction Boxes	16	EA	$2,000.00	$32,000.00	$38,400	1.20
4. LED lights	100	EA	$500.00	$50,000.00	$60,000	1.20
5 Color Changing LEDs and Programming	0	EA	$1,000.00	$0.00	$0	1.20
6 Receptacles/ Wall Jacks	30	EA	$500.00	$15,000.00	$18,000	1.20
7 Process Terminations	60	EA	$500.00	$30,000.00	$36,000	1.20
8 Fire alarm System	1	EA	$50,000.00	$50,000.00	$60,000	1.20
9 Access Control and Security	1	EA	$40,000.00	$40,000.00	$48,000	1.20
10 Motor Control Centers	8	EA	$10,000.00	$80,000.00	$96,000	1.20
11 High Service VFDs	3	EA	$25,000.00	$75,000.00	$90,000	1.20
12 BW VFD	1	EA	$35,000.00	$35,000.00	$42,000	1.20
13 Feeders Less than 60A	800	LF	$40.00	$32,000.00	$38,400	1.20
14 100A Feeder	200	LF	$65.00	$13,000.00	$15,600	1.20
15 Analog I/O	2800	LF	$4.25	$11,900.00	$14,280	1.20
16 Digital I/O	2800	LF	$5.00	$14,000.00	$16,800	1.20
17 Cat 6	1500	LF	$5.00	$7,500.00	$9,000	1.20
18 Distribution Panelboard	4	EA	$6,000.00	$24,000.00	$28,800	1.20
19 Step Down Dry Type Transformer	2	EA	$15,000.00	$30,000.00	$36,000	1.20
20 30A Disconnect Switches (NEMA 12)	28	EA	$320.27	$8,967.42	$10,760	1.20
21 HVAC Equipment	24	EA	$500.00	$12,000.00	$14,400	1.20
22 Unit Heaters	5	EA	$1,500.00	$7,500.00	$9,000	1.20
23 Lighting Panelboards	3	EA	$5,000.00	$15,000.00	$18,000	1.20
24 Electrical Distribution Equipment	24	EA	$750.00	$18,000.00	$21,600	1.20
25 Life Safety System	1	EA	$38,000.00	$38,000.00	$45,600	1.20
26 Lightning Protection	1	EA	$16,000.00	$16,000.00	$19,200	1.20
				Subtotal 26 0000 Electrical	$1,521,040	

Edina WTP Design *Revision:* *12/2/2018*
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Pressure Filtration With Traditional Backwash Reclaim - Option 5B

31 0000 Earthwork

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Building Excavation**						
1.	Common Excavation, (EV)	3,800	CY	$20.00	$76,000.00	$76,000	1.00
2.	Common Excavation, TOPSOIL STRIP (EV)	240	CY	$15.00	$3,600.00	$3,600	1.00
B.	**Building Backfill**						
1.	Backfill, Placement of Excavated Material	3800	CY	$20.00	$76,000.00	$76,000	1.00
2.	Backfill, Imported Material	5100	CY	$25.00	$127,500.00	$127,500	1.00
3.	Aggregate Base Below Slab	9900	CF	$12.00	$118,800.00	$118,800	1.00
4.	Road Subgrade Prep	1	LS	$8,000.00	$8,000.00	$8,000	1.00
5.	Spread Topsoil	1	LS	$7,000.00	$7,000.00	$7,000	1.00
					Subtotal 31 0000 Earthwork	**$420,000**	

32 0000 Exterior Improvements

Item Description			Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Landscaping**							
1.	Site Grading		1	LS	$5,000.00	$5,000.00	$5,000	1.00
2.	Seeding		1,200	SY	$5.00	$6,000.00	$6,000	1.00
3.	Irrigation		1	LS	$15,000.00	$15,000.00	$15,000	1.00
4.	Plantings/Miscellaneous		1	LS	$15,000.00	$15,000.00	$15,000	1.00
B.	**Site Work**							
1.	Removals							
	a.	Pavement Removal	240	SY	$12.00	$2,880.00	$3,460	1.20
	b.	Utility Relocations/Removals	1	LS	$10,000.00	$10,000.00	$12,000	1.20
	c.	SWPPP Items (silt fence, fiber rolls, etc…)	1	LS	$10,000.00	$10,000.00	$12,000	1.20
2.	Road and Parking Lot							
	a.	Site Paving	470	SY	$100.00	$47,000.00	$47,000	1.00
	b.	Sidewalk and Building Entrance Stoops	70	SY	$100.00	$7,000.00	$8,400	1.20
	c.	Road Restoration	120	SY	$100.00	$12,000.00	$14,400	1.20
						Subtotal 32 0000 Exterior Improvements	**$140,000**	

33 0000 Utilities

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Misc. Site Piping**	1	LS	$100,000.00	$100,000.00	$100,000	1.00
					Subtotal 33 0000 Utilities	**$100,000**	

40 0000 Process Integration

Item Description			Size	Length	Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Process Piping, Valves, Appurtenances, Fittings**				1	LS	$50,000.00	$50,000.00	$60,000	1.20
1.	WTP Influent to Detention Basin				1	LS	$50,000.00	$50,000.00	$60,000	1.20
2.	Detention Basin Bypass				1	LS	$7,000.00	$7,000.00	$8,400	1.20
3.	Detention Basin Overflow				1	LS	$18,000.00	$18,000.00	$21,600	1.20
4.	Filter Influent Piping				1	LS	$70,000.00	$70,000.00	$84,000	1.20
5.	Filter Bypass to Clearwell				1	LS	$10,000.00	$10,000.00	$12,000	1.20
6.	Filter Effluent				1	LS	$60,000.00	$60,000.00	$72,000	1.20
7.	Backwash Supply				1	LS	$74,000.00	$74,000.00	$88,800	1.20
8.	Backwash Waste				1	LS	$35,000.00	$35,000.00	$42,000	1.20
9.	High Service Pump Piping				1	LS	$8,000.00	$8,000.00	$9,600	1.20
10.	Finished Water Piping				1	LS	$30,000.00	$30,000.00	$36,000	1.20
11.	Backwash Reclaim System (Recycle, Sludge)				1	LS	$60,000.00	$60,000.00	$72,000	1.20
12.	Clearwell Overflow and Vent				1	LS	$25,000.00	$25,000.00	$30,000	1.20
13.	Detention Basin Sludge Piping				1	LS	$2,000.00	$2,000.00	$2,400	1.20
14.	Air Backwash Piping				1	LS	$30,000.00	$30,000.00	$36,000	1.20
B.	**Instrumentation and Control System Devices (40 91 00)**									
1.	Chemical Feed System Instrumentation									
	a.	Mono/Free Ammonia Analyzer			1	ea	$35,000.00	$35,000.00	$42,000	1.20
2.	Conventional Filter Instrumentation									
	a.	Ultrasonic Level Transmitters			3	ea	$1,300.00	$3,900.00	$4,680	1.20
	b.	Level Float Switches			5	ea	$100.00	$500.00	$600	1.20
3.	Pressure Transmitters (w/ Gauge)				3	ea	$1,040.00	$3,120.00	$3,740	1.20
4.	Pressure Gauge				6	ea	$400.00	$2,400.00	$2,880	1.20

Edina WTP Design *Revision:* *12/2/2018*
AE2S Project #P05177-2018-003
WTP Alternative - Dublin
Opinion of Probable Total Construction Cost
Dublin - Pressure Filtration With Traditional Backwash Reclaim - Option 5B

C,	**Instrumentation and Control, Control Panels (40 91 10)**							
1.	Control Panels	-						
	a. Master Control Panel	1	ea	$60,000.00	$60,000.00	$60,000	1.00
	b. Network Panel	1	ea	$30,000.00	$30,000.00	$36,000	1.20

Subtotal 40 0000 Process Integration $784,700

43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Vertical Turbine Pump**						
1.	High Service Pumps						
	a. 1500 GPM (125HP)	3	ea	$60,000.00	$180,000.00	$216,000	1.20
2.	Backwash Supply Pump	1	ea	$70,000.00	$70,000.00	$84,000	1.20
B.	**Sumbersible Liquid Pumps (43 21 39)**						
1.	Backwash Reclaim Submersible Reclaim Pumps	2	ea	$7,900.00	$15,800.00	$18,960	1.20
2.	Backwash Reclaim Submersible Sludge Pumps	1	ea	$7,900.00	$7,900.00	$9,480	1.20

Subtotal 43 0000 Process Gas and Liquid Handling, Purification, and Storage Equipment $328,440

46 0000 Water and Wastewater Equipment

Item Description		Quantity	Unit	Unit Cost	Cost	Installed Cost	Multiplier
A.	**Pre-Negotiated Chemical Feed System Components**	1	ls	$30,000.00	$30,000.00	$36,000	1.20
1.	All Chemical Feed Pumps on Skids (4 total)						
2.	Valves, appurtenances, piping on feed skid						
3.	Chemical Diffusers						
B.	**Fluoride Chemical Feed System**						
1.	400-gallon Bulk Storage Tank	1	ea	$1,200.00	$1,200.00	$1,440	1.20
2.	Bulk Chemical Delivery Connection	1	ls	$800.00	$800.00	$960	1.20
3.	Break Tank	1	ea	$300.00	$300.00	$360	1.20
4.	Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
5.	1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
6.	Carrier Piping, Appurtenances, and Valves	1	ls	$1,500.00	$1,500.00	$1,800	1.20
C.	**HMO Feed System**						
1.	960-gallon Bulk Storage Tank	1	ea	$2,500.00	$2,500.00	$3,000	1.20
2.	Tank Mixer (3/4 HP)	1	ea	$2,800.00	$2,800.00	$3,360	1.20
3.	1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
4.	Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
5.	Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
6.	Bulk Chemical Delivery Connection	1	ea	$800.00	$800.00	$960	1.20
D.	**Poly/Orthophosphate Feed System**						
1.	800-gallon Storage Tank	1	e.a.	$2,100.00	$2,100.00	$2,520	1.20
2.	Bulk Chemical Delivery Connection	1	e.a.	$800.00	$800.00	$960	1.20
3.	Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
4.	1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
5.	Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
E.	**Ammonium Sulfate Feed System**						
1.	540-gallon Bulk Tank	1	e.a.	$1,320.00	$1,320.00	$1,584	1.20
2.	Bulk Chemical Delivery Connection	1	e.a.	$800.00	$800.00	$960	1.20
3.	Radar Level Transmitter	1	ea	$2,000.00	$2,000.00	$2,400	1.20
6.	1/8" Polyethylene Tubing Installed in Carrier	50	lf	$3.50	$175.00	$210	1.20
7.	Carrier Piping, Appurtenances, and Valves	1	ea	$1,500.00	$1,500.00	$1,800	1.20
F.	**Chlorine Chemical Feed System**						
1.	Chlorine Feed System	1	e.a.	$35,000.00	$35,000.00	$42,000	1.20
2.	Extra Chlorine Piping for Solution and Diffusers	1	l.s.	$2,000.00	$2,000.00	$2,400	1.20
3.	Chlorine Gas Emergency Shutoff System	1	e.a.	$10,000.00	$10,000.00	$12,000	1.20
G.	**Filter Equipment**						
1.	Pressure Filters	3	EA	$330,000.00	$990,000.00	$1,188,000	1.20
2.	Detention Pressure Vessel	1	EA	$100,000.00	$100,000.00	$120,000	1.20
H.	**Filter Air Scour Equipment**						
1.	PD Airwash Blower	1	ea	$45,000.00	$45,000.00	$54,000	1.20

Subtotal 46 0000 Water and Wastewater Equipment $1,488,144