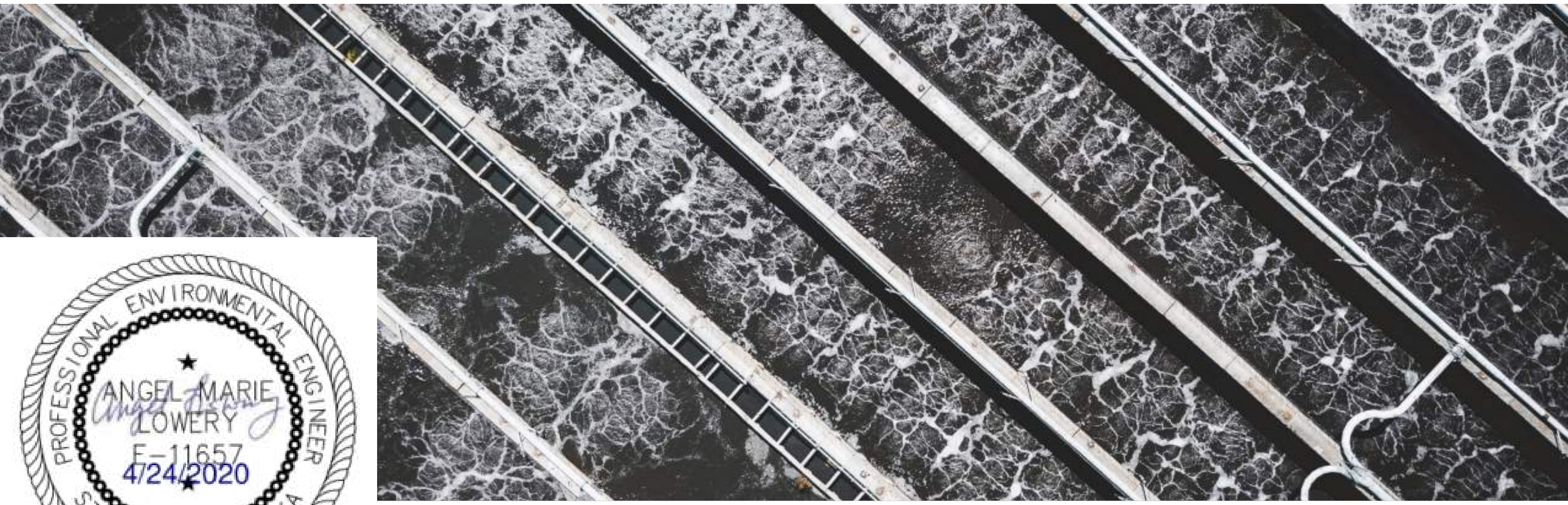
WATER POLLUTION CONTROL PLANT MASTER PLAN

PREPARED FOR: THE CITY OF NORFOLK, NEBRASKA

April 2020
Olsson Project No. 019-1256



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ACRONYMS AND ABBREVIATIONS

AAO	anaerobic anoxic aerobic
AGS	aerobic granular sludge
ASR	alkali-silica reaction
BFP	belt filter press
BHP	brake horsepower
BNR	biological nutrient removal
BOD	biochemical oxygen demand
CBOD	carbonaceous biochemical oxygen demand
cfm	cubic feet per minute
COD	chemical oxygen demand
DO	dissolved oxygen
F:M	Food to Microorganism Ratio
ft/ft	feet per foot
ft/s	feet per second
ft^2	square feet
gpd	gallons per day
gpd/ft^2	gallons per day per square feet
gpd/ lin ft	gallons per day per linear feet
gpm	gallons per minute
HP	horsepower
hr	hour
HVAC	heating, ventilation, and air conditioning
ICFM	inlet cubic feet per minutes
lb	pound
lb/d	pounds per day
lb/d*ft^2	pounds per day per square feet
lb/d*ft^3	pounds per day per cubic feet
lb/hr*m	pounds per hour per meter of bed width
LEED	Leadership in Energy and Environmental Design
MAU	makeup air unit
MCC	motor control cabinet
MGD	million gallons per day
mg/L	milligrams per liter
mL/g	milliliters per gram

MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
NDEE	Nebraska Department of Environment and Energy
NDEQ	Nebraska Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
NPW	non-potable water
OPC	Opinion of Probable Cost
O&M	operation and maintenance
SBR	sequencing batch reactor
TF	trickling filter
TKN	total Kjedahl nitrogen
TN	total nitrogren
TP	total phosphorous
TSS	total supsended solids
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VFD	variable frequency drive
WPC	water pollution control

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

This City of Norfolk Water Pollution Control Plant Master Plan will evaluate existing treatment processes and capacities to support the next 20 years of operations. Analysis and recommendations are separated into sections covering five-year (through 2025), ten-year (through 2030), and twenty-year (through 2040) time periods and includes a detailed analysis of potential internal and external uses for non-potable effluent generated by the plant.

Section 1 of the plan includes historical and projected flow, loading, and population data that supports all subsequent sections of the report. The five-year evaluation (Section 2 of the plan) uses historical and projected hydraulic flows and organic loadings to confirm current process capacities while evaluating the necessary steps to increase capacity by improving or activating existing treatment equipment to support potential industries in the near term. A new potential industry will require the City to increase capacity at the plant. This section of the report will recommend short-term improvements using existing processes.

Section 3 of the plan is a water reuse evaluation. It is an assessment of an integrated water resources management approach that identifies potential internal and external needs for non-potable water reuse including tertiary treatment of plant effluent.

The ten-year evaluation (Section 4 of the plan) includes an inspection of all major existing equipment and facilities to develop an anticipated equipment replacement program.

The twenty-year evaluation (Section 5 of the Plan) will help the City plan for future treatment process needs by looking at anticipated nutrient removal requirements to be imposed by the Nebraska Department of Environment and Energy over the next 20 years. BioWin modeling was used to evaluate the existing facility and as a tool to recommend the most appropriate treatment processes for the anticipated future nutrients to be removed.

Summary of Analysis

Historical data were analyzed to determine projected population and loadings on the WPC Plant to 2040.

Population Projection

The current 2019 population is estimated to be 24,724. Using historical growth and estimates of anticipated industrial growth, it was determined that a 1.0% growth rate was appropriate for the City of Norfolk. This will result in an anticipated population of 30,382 by the year 2040.

Hydraulic Loading Projection

2018 average daily plant flow was 3.11 MGD and was typical of the last five years at the plant. Peak hourly flow is approximately 2.3 average flow for most of the last five years and was 7.38 MGD for 2018.

Utilizing population projections and anticipated future industrial growth, the hydraulic loading for the plant was projected out to 2040. The detailed analysis is shown in Table 5 of this report. Anticipated average daily flow for 2040 is expected to be 8.47 MGD and peak hourly flow 14.25 MGD. 4.45 MGD of this flow is anticipated to be from future industrial users.

Organic Loading Projection

A detailed analysis of domestic and industrial loadings was performed and is presented in Section 1.4 of this plan. Peaking factors were developed based on historic loadings for BOD, TSS, TKN, ammonia, total nitrogen, and total phosphorous and were projected out to 2040. These values serve as the basis for the BNR modeling performed as part of Section 5 of this plan.

Unit Process Analysis

Table 16 of this plan includes a unit process analysis to determine the theoretical capacities of each treatment process at the WPC Plant. Through this analysis it was determined that the current grit removal system is the biggest limiting factor to increasing plant capacity. Current operation of the SBR units is also a limiting factor for capacity out to 2025. Solids handling capacity was also analyzed as part of this process.

BioWin Modeling

Wastewater process simulation software, BioWin by EnviroSim, was used to model the biological processes at the WPC Plant. A complete model of the current treatment process was developed and calibrated using existing loading data. This model was then used to determine the most effective treatment options for expansion of the current processes to treat for BNR. The model will be a useful tool for the City when looking at major treatment changes or additions. Analysis and results are described further in Section 5 of this plan.

Summary of Recommendations

A brief summary of recommendations follows for each phase of this plan. The costs associated with each phase may not be additive between phases, there is some overlap. This is noted where applicable.

Five-Year Plan

A summary of recommendations for the next five years of operations (five-year plan) follows and is summarized in Table 1. The details of these recommendations are covered in Section 2 of this report:

1. An analysis of each process at the WPC Plant indicates that the grit removal system is limiting capacity at the Plant. It is recommended to replace the grit removal system and remove the pre-aeration basins to meet anticipated demands in the next five years. Replacement of the grit removal system will cost approximately $2,385,000.

2. An estimate of cost was developed for returning the four inactive treatment basins to service (two aeration basins and two final clarifiers) as a second treatment train. It was determined that the second treatment train would not be necessary if anticipated flows are realized over the next five years, even if the potential steel industry is brought online in the next few years. This option also does not align well with 20-year treatment alternatives for biological nutrient removal. Introducing a different type of treatment would potentially complicate operations. Costs were provided in the event that situations change and this option is considered in the near future. Cost to rehabilitate the four basins is estimated to be $933,000 and this second treatment train would add 2.6 MGD to the plant capacity.

3. The cost for adding retrievable diffusers to the Sequencing Batch Reactor (SBR) unit was determined in order to facilitate plant operation and maintenance. Currently an entire basin must be taken out of service to work on the air diffusers. It is recommended to install retrievable diffusers if the potential steel industry comes online in the next few years. Estimated cost for this is $1,546,500. This is recommended not only to add capacity but to increase efficiency in the system.

4. Evidence of Alkali-Silica Reaction (ASR) degradation was seen on the concrete associated with the SBR unit (the north trickling filter and some other structures are also affected by this). It is recommended that the extent and condition of the degradation be monitored through visual inspections and sampling over the next two years to determine the lifecycle of the SBR basin(s). This will not affect service over the next five (5) years.

Water Reuse Evaluation

A summary of recommendations from the Water Reuse Evaluation follows. Detailed information is covered in Section 3 of this report. Two options (A and B) were laid out for providing a 50/50 blend of potable water and treated WPC effluent to external industries or commercial facilities. Both options include cost for providing WPC plant effluent for internal plant uses also. Option A would be necessary to provide nonpotable water service to the anticipated steel industry and would be implemented in the next two years. Option B would be to cover all anticipated industrial and commercial nonpotable water needs.

1. Option A includes cost for installation of a pump station, cloth media filter units (AquaDisk® or equivalent unit), storage tank to provide reserve capacity, and force main to provide blended water to the potential steel industry. Both options include cost for providing WPC Plant effluent for internal plant uses also. Option A cost is estimated to be $5,749,700. This does not include the cost for the force main to the steel industry.

2. Option B expands on Option A by providing nonpotable water for other industries and potential other users such as irrigation at the community college. Option B cost is estimated to be $12,781,600 and includes cost outlined for Option A. This does not include the cost for the force mains needed to convey water to users.

3. The total cost for developing the force main to industries is estimated to be $10,790,000. Refer to Section 3 for a breakdown of cost by line. This cost is in addition to either Option A or B above. It is recommended to research funding options for water reuse projects.

Both Option A and B provide the ability to pump effluent to the Elkhorn River during high water conditions on the river.

Ten-Year Plan

Capital replacement recommendations for the next 10 years of operations (ten-year plan) is detailed in Section 4 of this report. Annual capital expenditures average approximately $300,000 over the next ten years. These can be grouped into packages for contracting the work. The north lift station improvements have been identified as an immediate need. These replacements are for equipment, piping, and other associated items that are expected to be used in the future and not included in the improvements listed in other sections of this report. **Appendix H** includes a summary of the recommended repairs for the 10-year plan.

Twenty-Year Plan

A summary of recommendations for the next 20 years of operations (twenty-year plan) follows. Detailed information is covered in Section 5 of this report.

A twenty-year plan was developed to determine treatment options for biological nutrient removal (BNR) and increased demand expected with continued industrial and economic growth of Norfolk. The goal of this analysis is to ensure that all interim work is compatible with the proposed future BNR process. Three treatment alternatives were developed.

1. The first alternative will include expansion of the system's existing SBR system (including roughing filters).
2. The second alternative would replace the current SBR system with an anaerobic anoxic aerobic (AAO) system, which is a continuous flow process.
3. The third alternative explored the feasibility of installing a granular activated sludge treatment system (Aqua Nereda or equivalent). These systems allow for treatment in a small footprint when space is limited.

A summary of costs is presented in **Table 1** below. The City's current SBR system works well to treat the high BOD loading experienced by industries served. Based on current information and economics, the expansion of the current SBR system (Alternative 1) is the most cost-effective option. If concrete degradation due to ASR is determined to be pervasive in the SBR structure, another alternative may become more cost effective.

The Twenty-Year Plan also conceptually evaluated three options for solids handling due to the expected increased solids production. The three options were:

1. pH adjustment – this option is compact but requires the purchase of lime. This produces a class B sludge.
2. Aerobic digestion – this option requires more power and more physical space than option 1 but eliminates need for lime. This produces a class B sludge.
3. Anaerobic digestion – this is the green option since it gives the potential for gas recovery and produces a class A sludge that could be utilized.

Based on economics, solids residual alternative 2 appears to be the most suitable option to meet the City's needs. If the City chooses to switch to anaerobic digestion in the future, the structures could be reused (but not equipment). Further study would be needed to determine if there is a market for class A sludge in the area.

Table 1. Opinion of Probable Cost (OPC) Summary of Recommendations

Five-Year Plan Costs				
	Capital Cost			
Grit Removal Improvements	$2,385,000			
Activate Existing Treatment Train	$933,000			
SBR Retrievable Diffusers	$1,546,000			
Water Reuse Evaluation Costs				
	Capital Cost			
Option A – NPW Use to Industry	$5,749,700			
Option B – Expanded NPW and Effluent Pump System	$12,781,000			
Force Mains to Industry (total in addition to options above)	$10,790,000			
Ten-Year Plan Average Annual Costs				
	Capital Cost			
Capital Improvements (Average Annual Cost)	$300,000			
North Lift Station Improvements	$405,000			
Twenty-Year Plan BNR Treatment Alternatives				
	Capital Cost	Annual O&M	Annualized Cost	Total Cost - Present Worth
Alternative 1 – SBR Expansion	$33,957,000	$2,780,000	$5,279,000	$71,738,000
Alternative 2 – AAO System	$38,824,000	$2,543,000	$5,400,000	$73,384,000
Alternative 3 – Granular System	$49,973,000	$2,988,000	$6,665,000	$90,581,000
Residual Solids Options				
	Capital Cost	Annual O&M	Annualized Cost	Total Cost - Present Worth
Alternative 1 – pH Adjustment	$3,705,000	$770,000	$1,043,000	$14,170,000
Alternative 2 – Aerobic Digestion	$5,843,000	$536,000	$966,000	$13,127,000
Alternative 3 – Anaerobic Digestion	$7,706,000	$410,000	$977,000	$13,278,000

Appendix H offers a more detailed summary of estimated costs for the 5, 10, and 20-year plans.

1. INTRODUCTION

The City of Norfolk (City), Nebraska, is a growing community and home to several food and metal production-related industries that continue to grow and prosper. As a part of this prosperity, ever-increasing flows and loadings are being experienced at the Water Pollution Control (WPC) plant at 610 East Monroe Street. Furthermore, two new significant industries have shown interest in opening facilities in Norfolk that could have a significant impact on the hydraulic and organic loadings experienced at the WPC plant.

The purpose of this technical master plan is to give an overview of the current hydraulic flow and organic loadings capacity at the City WPC plant. The plan will discuss current and future needs and outline a strategy for the City to follow in order to achieve its goals over the next 20 years. The following topics are addressed in the plan, divided into the following objectives:

- Five-Year Plan – Existing Water Pollution Control Facility Capacity (Section 2)
    - Confirm current hydraulic flow and loadings
    - Review current process capacity
    - Develop options to increase facility firm capacity within existing structures
    - Conduct solids handling evaluation
    - Recommend necessary short-term improvements
    - Develop conceptual cost estimates for necessary improvements
- Water Reuse Evaluation (Section 3)
    - Review water quality analysis
    - Identify potential internal/external water reuse options
    - Evaluate water reuse objectives
    - Develop conceptual cost estimates for external water reuse improvement options
- Ten-Year Plan – Equipment and Facility Inspection (Section 4)
    - Conduct high-level building and equipment operation and maintenance (O&M) review
    - Conduct projected life analysis
    - Develop capital improvement program for equipment replacement needs
- Twenty-Year Plan – Projected Nutrient Limits Evaluation (Section 5)
    - Project future biological nutrient removal (BNR) limits
    - Project hydraulic flow and loadings
    - Develop a BioWin model of current and possible future options and present the findings
    - Develop options to increase facility firm capacity
    - Recommend improvements based on the solids handling evaluation
    - Develop conceptual cost estimates for the improvement options
    - Conduct economics evaluation for necessary improvements
    - Recommend improvements for the anticipated future BNR limits

1.1. Background

The City of Norfolk, Nebraska, located in Madison County, is the ninth largest city within the state. It is located approximately 115 miles northwest of Omaha and 85 miles west of Sioux City at the intersection of U.S. Route 81 and Route 275. The local economy is supported by agriculture, manufacturing, and services including those for education and health care businesses. Norfolk continues to grow consistently; therefore, the City has initiated efforts to promote growth while maintaining consistent city services and necessary infrastructure enhancements. Since the original construction of the WPC plant established in 1959, the WPC plant now treats an average of 3.5 million gallons per day (MGD) of wastewater as compared to the original hydraulic capacity of 1 MGD (City of Norfolk 2018a).

Prior to this report the most recent treatment and hydraulic capacity evaluation of the WPC plant was conducted in 1993 (K&M 1993). The prior report projected hydraulic flows and organic loadings to the design year 2015, providing recommendations to process changes as necessary to accommodate the growing community (i.e. food-related industries) at that time. In addition to the increased hydraulic loads at the plant, the Nebraska Department of Environment and Energy (NDEE), implemented additional treatment standards for the WPC plant revising the effluent limitations through the National Pollutant Discharge Elimination System (NPDES). Since the publication of the 1993 WPC Wastewater Treatment Design Memorandum, a large industry has left the City, which resulted in a significant decrease of hydraulic flow and organic loadings at the WPC plant. Therefore, two aeration basins and two final clarifiers were removed from service. However, the recommissioning of these processes is potentially needed to provide additional capacity for anticipated industrial growth. This process equipment has been inactive for approximately 20 years.

1.2. Population Projections

The population of Norfolk has experienced overall growth, especially recent years from 2000 to 2018 (U.S. Census Bureau, 2019). A summary of historical population data is presented in **Table 2**. Note that population statistics are within the population design estimate of 27,500 per the 1993 WPC Wastewater Treatment Design Memorandum (K&M 1993). The City also keeps its own record of population size and those values are shown in the last column of **Table 2**.

Table 2. Historical Population Summary

Source	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018
U.S. Census	23,516	24,278	24,314	24,362	24,414	24,383	24,338	24,341	24,529	24,651
World Population Projections	23,516	24,268	24,312	24,364	24,420	24,362	24,297	24,262	24,434	N/A
1993 WPC Wastewater Treatment Design Memorandum	N/A	N/A	N/A	N/A	N/A	N/A	27,500	N/A	N/A	N/A
City of Norfolk Recorded Population	N/A	N/A	N/A	N/A	23,976	24,098	24,223	24,348	24,479	24,479

Percentage increases ranged significantly dependent on source. Based on the City calculations, an approximate 0.5 annual percent growth was observed in the last five years. From the City Comprehensive Plan and current city correspondence, it was assumed that population growth will increase at a rate of 1.0 percent annually because of anticipated economic growth (City of Norfolk, 2017). The assumed projected populations for the master plan efforts per design year are presented in **Table 3**. A summary of historical and projected population data is presented in **Figure 1**.

Table 3. Projected Population Summary

2019 Current	2020 Year 0	2021 Year 1	2022 Year 2	2023 Year 3	2024 Year 4	2025 Year 5	2030 Year 10	2035 Year 15	2040 Year 20
24,724	24,971	25,221	25,473	25,728	25,985	26,245	27,557	28,935	30,382

Figure 1. Historical and Projected Population Data

1.3. Hydraulic Loading Evaluation

Historic flows were analyzed and used along with population data to project hydraulic demands expected at the WPC plant through design years 2025, 2030, and 2040.

1.3.1. Historical Hydraulic Loading

The City provided historical daily hydraulic flow data for the years 2005 to 2018. Historical average and maximum daily flows were analyzed for the previous five years and summarized in **Table 4** below. The City provided historical daily hydraulic flow data for 11 industrial and other users (i.e. CRC, Hiland Roberts, Flexmag, Henningsen, Milk Specialties, KPR/Covidien, ContiTech, WIS PAC, Woodland Park Sanitary Improvement District, NRC, and the City's East Water Plant backwash system) for the years 2005 to 2018.

It should be noted that the City only has six current sewer use agreements (i.e. Hiland Roberts, Henningsen, Milk Specialties, KPR/Covidien, ContiTech, and Woodland Park Sanitary Improvement District) in which the industrial users have occasionally surpassed both maximum hydraulic and organic loading restrictions as indicated in **Table A4** within **Appendix A.**

Industrial flow has historically accounted for 25 percent of the wastewater flow being treated at the wastewater treatment plant. A summary of historical average daily flow data per user classification (i.e. residential, commercial, industrial) is presented for 2014 to 2018 in **Table 4**.

Table 4. Historical Total Hydraulic Flows (MGD) for years 2014-2018

Description	2014	2015	2016	2017	2018
Average Daily Flow					
Residential /Commercial / Other	2.08	2.12	2.28	2.28	2.44
Industrial (Current) Connections [1]	0.73	0.67	0.73	0.67	0.67
Total Flow Summary					
Average Daily Flow	**2.81**	**2.79**	**3.01**	**2.95**	**3.11**
Peak Daily Flow [2]	**4.54**	**3.63**	**5.62**	**3.90**	**5.35**
Peak Hourly Flow [2]	**10.38**	**6.53**	**7.07**	**6.73**	**7.38**
[1] Industrial (Current) Flow Years 2014-2018 are based on historical data provided by the City.					
[2] With the exception of 2014, peak hourly flow has consistently been 2.3 times the average daily flow. These flow values are based on the maximum recorded flow for the day at the plant.					

1.3.2. Projected Hydraulic Loading

Table 5 is a summary of projected hydraulic flow data per user classification (i.e. residential, industrial, other) and is presented for the next 20 years. During meetings with the City, it was decided that 2.0 was an acceptable peak day factor to represent typical flows at the WPC plant based on historic data and plant operator knowledge.

Table 5. Projected Hydraulic Flows (MGD) for years 2019-2040

Description	2019 Current	2020 Year 0	2021 Year 1	2022 Year 2	2023 Year 3	2024 Year 4	2025 Year 5	2030 Year 10	2035 Year 15	2040 Year 20
Average Flow w/out Projected Industrial Allocations (MGD)										
Residential/Commercial/Other [1]	2.57	2.59	2.62	2.64	2.67	2.70	2.72	2.86	3.00	3.15
Industrial (Current) Connections [2]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Average Flow (no Industrial Allocations)	3.26	3.29	3.31	3.34	3.37	3.39	3.42	3.56	3.70	3.85
Peaking Factors applied prior to Industrial Allocations										
Peak Day Factor [3]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Peak Hour Factor [3]	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Additional Projected Industrial Allocations (MGD)										
Industrial (Existing Users) Allowance [4]	0.00	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Industrial (Future Users) Allowance [4]	0.00	0.00	2.25	2.25	2.25	2.25	2.25	2.45	2.45	4.45
Total Flow Summary with Projected Industrial Allocations (MGD)										
Average Daily Flow	**3.26**	**3.46**	**5.74**	**5.77**	**5.79**	**5.82**	**5.85**	**6.18**	**6.32**	**8.47**
Peak Daily Flow	**6.53**	**6.75**	**9.05**	**9.11**	**9.16**	**9.21**	**9.27**	**9.74**	**10.02**	**12.32**
Peak Hourly Flow	**8.16**	**8.40**	**10.71**	**10.78**	**10.84**	**10.91**	**10.98**	**11.52**	**11.87**	**14.25**

[1] Residential Flow Assumptions include the following:
- Years 2019 - 2040 assumes 1.0% annual population increase and 90 gpd allocation per person.

[2] Industrial (Current) Flow Assumptions include the following:
- Years 2019 - 2040 assume average flow of 0.7 MGD based on a maximum flow of 1.0 MGD observed during historical peak conditions.

[3] Peaking Factor Assumptions include the following:
- Years 2019 - 2040 assumes 2.0 daily peaking factor and 2.5 hourly peaking factor based on historical data and field observations.

[4] Industrial Flow Assumptions include the following:
- A 0.25% annual industrial growth allowance is preferred by the City to be considered for existing industrial customers based on discussions.
- Steel Company to be designed during Year 2019, constructed in year 2020, and brought online by Year 2021. Initial flow calculations assume that only 90% of the peak flow of anticipated 2.5 MGD (i.e. 2.25 MGD) water demand will be sent to the City.
- Commercial food processing facility to be brought online by Year 2030. Flow calculations assume 100% of the peak flow of anticipated 0.2 MGD (i.e. 200,000 gpd with 24/7 operations) processed water will be sent to the City.
- Future industrial growth is anticipated to be brought online by Year 2040. Flow calculations assume additional flows of 2.0 MGD per discussion with the City

1.4. Organic Loading Evaluation

Historic influent organic loadings were analyzed and used along with population data to project anticipated organic loads expected at the WPC plant through design years 2025, 2030, and 2040. Effluent organic loading data was compared to current and potential future organic discharge limits from the WPC plant's NPDES permit.

1.4.1. Historical Organic Loading

The City provided historical daily loading data for the years of 2014 – 2018. A summary of historical average daily loading data from the past five years is presented in **Table 6**. A summary of historical maximum-month loading data (from 2014 to 2018) is presented in **Table 7**.

Table 6. Historical Plant Average Influent Organic Loading (lb/d)

Constituent	2014	2015	2016	2017	2018
TSS	10,134	9,551	9,764	10,109	10,764
CBOD	14,623	12,434	12,256	13,785	15,536
BOD[1]	16,962	14,423	14,217	15,990	18,022
TKN	1,183	1,083	1,092	1,240	1,408
Ammonia	582	614	563	636	670
TN	1194	1,088	1,096	1,246	1,414
TP	446	233	228	294	325

[1]BOD calculated as 1.16 times CBOD (Brake, 2007)
*TSS = total suspended solids; CBOD = carbonaceous biochemical oxygen demand; BOD = biochemical oxygen demand; TKN = total Kjeldahl nitrogen; TN = total nitrogen

Table 7. Historical Plant Maximum-Month[2] Influent Organic Loading (lb/day)

Constituent	2014	2015	2016	2017	2018
TSS	11,964	11,108	11,381	11,336	12,817
CBOD	19,046	14,838	14,619	16,324	22,758
BOD[1]	22,093	17,212	16,958	18,936	26,399
TKN	1,408	1,189	1,205	1,508	1,594
Ammonia	652	672	623	746	795
TN	1460	1193	1205	1526	1594
TP	994	298	293	401	443

[1] BOD calculated as 1.16 times CBOD (Brake, 2007)
[2] **Maximum** values are based on weekly sampling and do not represent a true maximum-month. Samples should be taken every day for a better representation of maximum-month loading.
*TSS = total suspended solids; CBOD = carbonaceous biochemical oxygen demand; BOD = biochemical oxygen demand; TKN = total Kjeldahl nitrogen; TN = total nitrogen

The City provided historical monthly average loading data for six industrial users (Hiland Roberts, Henningsen, Milk Specialties, KPR/Covidien, ContiTech, WIS PAC) for the years of 2014 to 2018. It should be noted that the sewer agreements for KPR/Covidien and WIS PAC are only for flow; however, loading data was measured and reported. The industrial users have occasionally surpassed their loading restrictions as indicated in **Table 8B** within **Appendix B.** The industries located in Norfolk contribute greatly to the total loadings seen by the WPC plant. **Figure 2**, **Figure 3**, and **Figure 4** break down the total industrial loadings into individual contributions from each industry.

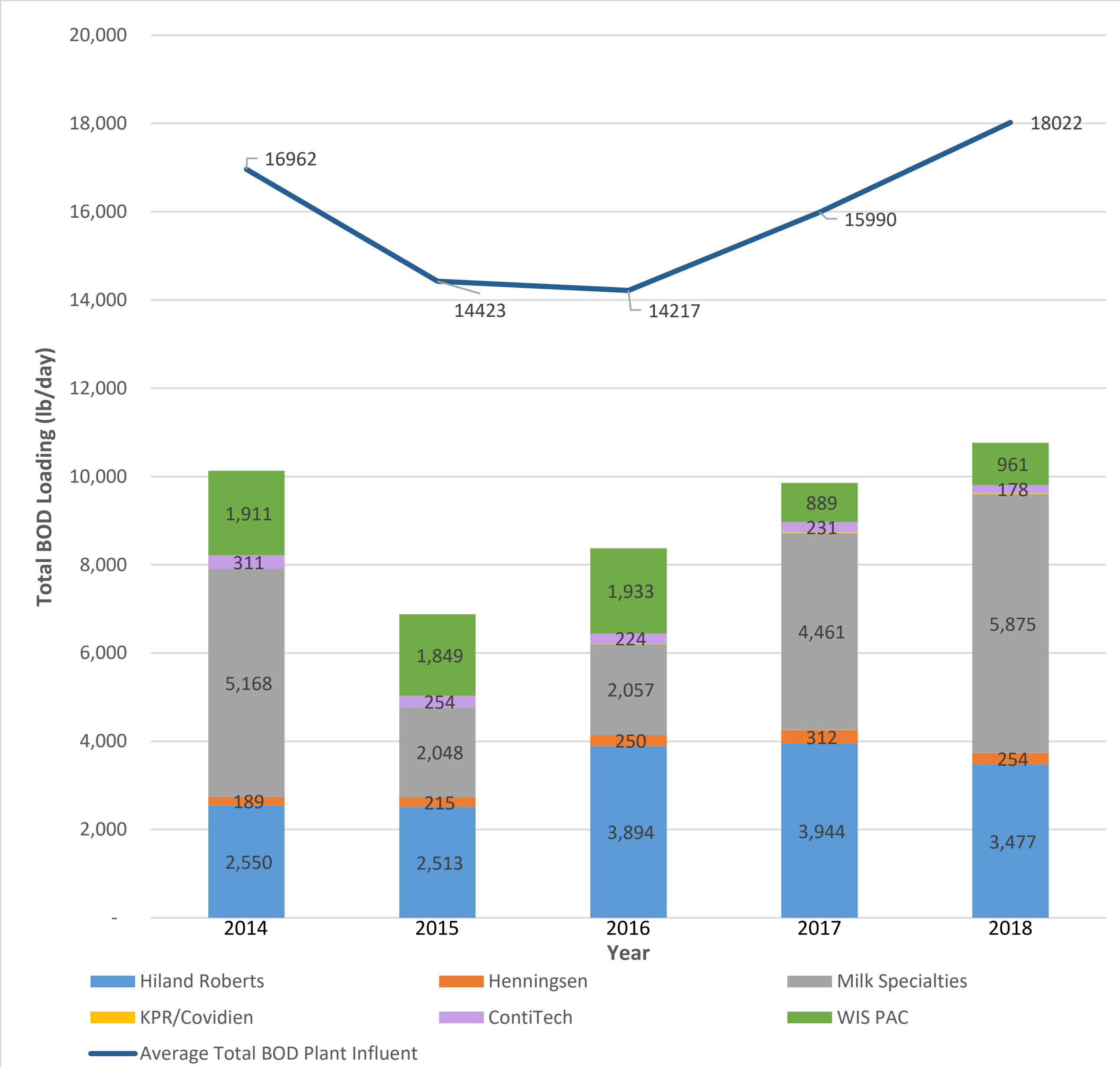


Figure 2. Historical Yearly Average Industrial Biochemical Oxygen Demand (BOD) Loadings (lb/d)

BOD loadings have been increasing consistently since 2015 with the major contributors being Milk Specialties and Hiland Roberts. Both industries deal with food processing.

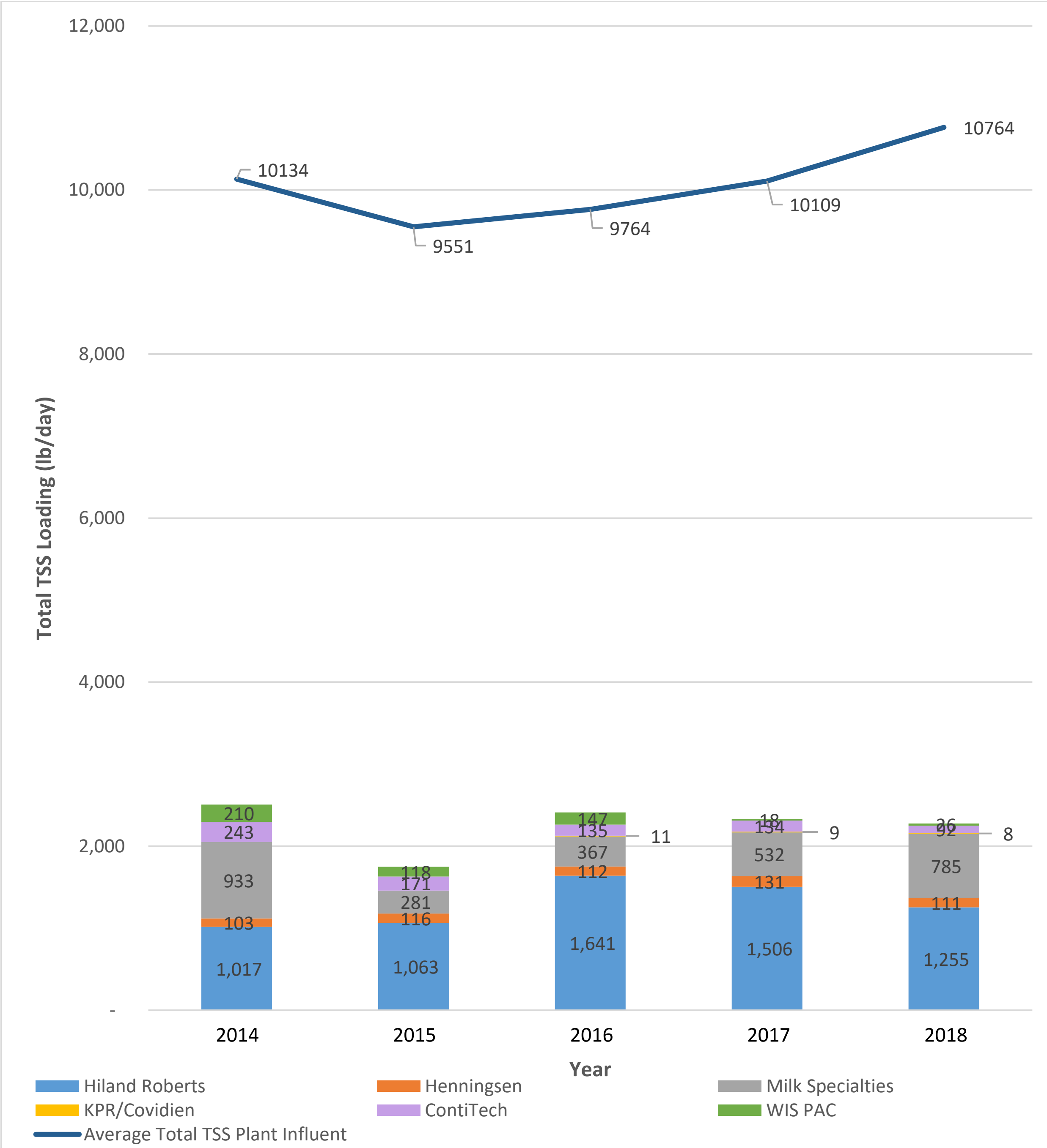


Figure 3. Historical Yearly Average Industrial Total Suspended Solids (TSS) Loadings (lb/d)

Total industrial total suspended solids (TSS) loadings have decreased slightly from 2014 to 2018. Hiland Roberts contributes half of the total industrial TSS loadings on average.

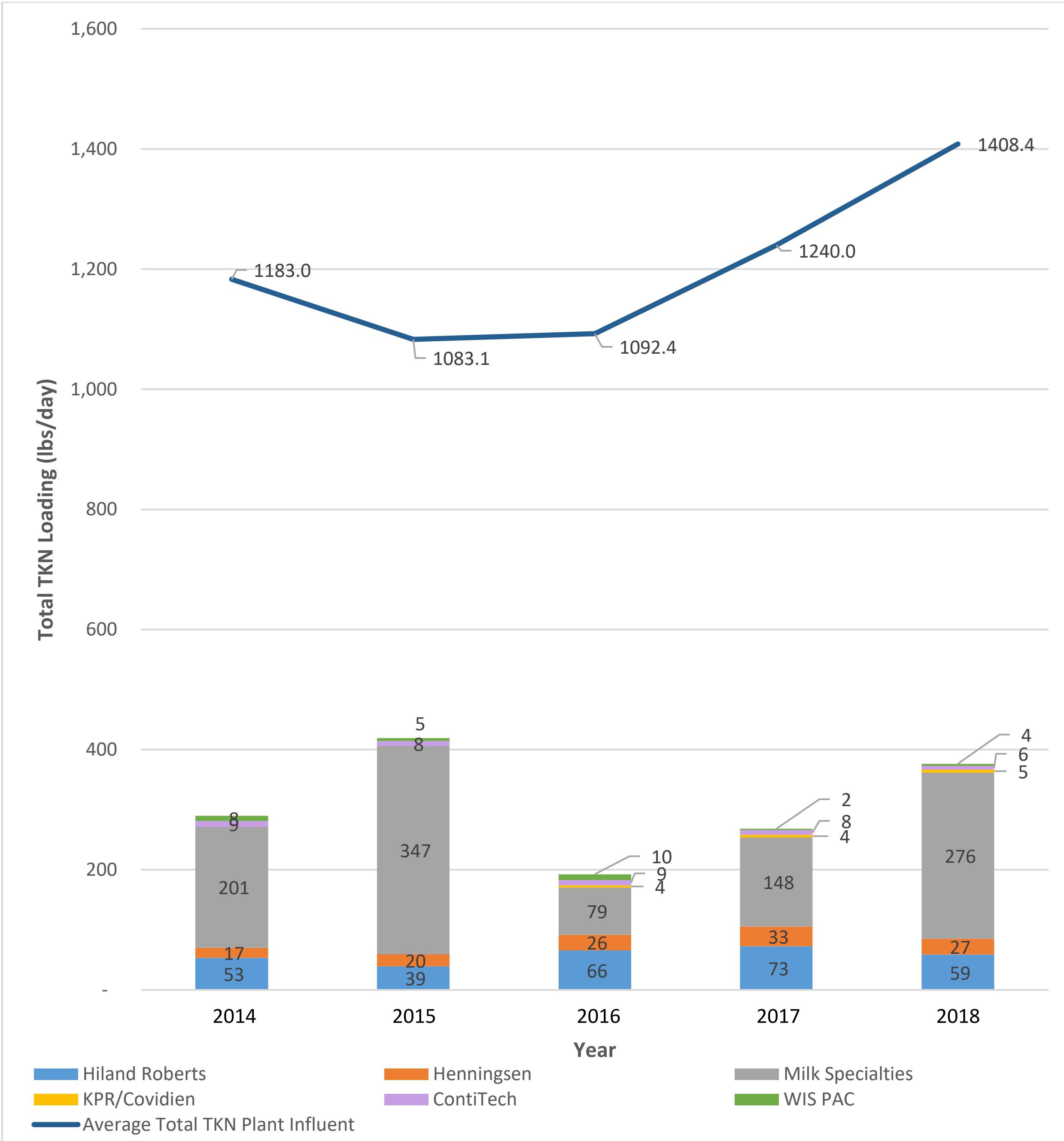


Figure 4. Historical Yearly Average Industrial Total Kjeldahl Nitrogen (TKN) Loadings (lb/d)

Total Kjeldahl nitrogen (TKN) loadings (industrial) decreased significantly from 2015 to 2016 but have been increasing ever since. This is seen in **Figure 4** and is influenced by Milk Specialties.

1.4.2. Projected Organic Loading

Table 8 is a summary of projected organic loading data per user classification (i.e. residential, industrial, other) as projected over the next 20 years.

Table 8. Projected Average Influent Loadings for Years 2019-2040 (lb/d)

Description	2019	2020	2021	2022	2023	2024	2025	2030	2035	2040
BOD[1]										
Average Loading	18,121	18,221	18,323	18,424	18,527	18,631	18,735	19,261	19,808	20,377
Peak Month Loading (PF=1.5)[2]	27,182	27,332	27,484	27,637	27,791	27,946	28,103	28,891	29,712	30,566
TSS										
Average Loading	10,854	10,946	11,038	11,131	11,225	11,320	11,416	11,900	12,407	12,938
Peak Month Loading (PF=1.2)[2]	13,025	13,135	13,245	13,357	13,470	13,584	13,699	14,280	14,888	15,526
TKN										
Average Loading	1,420	1,431	1,442	1,454	1,466	1,478	1,489	1,550	1,612	1,678
Peak Month Loading (PF=1.25)[2]	1,775	1,789	1,803	1,818	1,832	1,847	1,862	1,937	2,016	2,098
Ammonia[4]										
Average Loading	677	684	690	697	704	711	718	754	792	832
Peak Month Loading (PF=1.25)[2]	846	854	863	872	880	889	898	943	990	1,040
TN[4]										
Average Loading	1,428	1,443	1,457	1,472	1,486	1,501	1,516	1,592	1,672	1,755
Peak Month Loading (PF=1.2)[2]	1,714	1,731	1,749	1,766	1,784	1,802	1,820	1,911	2,006	2,106
TP[4]										
Average Loading	328	332	335	338	342	345	348	366	384	403
Peak Month Loading (PF=1.5)[2]	492	497	502	507	512	518	523	549	576	605

[1]BOD calculated as 1.16 times CBOD

[2]Peaking factors (PF) were selected for each constituent based on historical peak month loadings

* BOD = biochemical oxygen demand; TSS = total suspended solids; TKN = total Kjeldahl nitrogen; TN = total nitrogen

1.5. Existing Treatment Process Description

A process flowchart for the WPC plant is shown in **Figure 5**. A more detailed site plan with process flows is shown in **Exhibit 1** of **Appendix C** of this plan.

Wastewater flows into the WPC plant headworks via three primary collection sewers (sized at 21-inch, 30-inch, and 36-inch) at the diversion structure. It then flows to a wet well within the pump building followed by the bar screen (quarter inch) building. A 30-inch force main routes the wastewater through one Parshall flume, two grit removal units, and three pre-aeration basins.

From the pre-aeration basins, flow is split between primary clarifiers #1, #2, and #3. Effluent from primary clarifiers #1 and #2 goes to the south roughing filter/blower pump building to the south trickling filter #1 and then to the aeration splitter box. Effluent from primary clarifier #3 is routed through the north roughing filter/blower pump building to the North Trickling Filter #2. Both roughing filters serve as pretreatment to remove biochemical oxygen demand (BOD) from the influent. Flow is then directed to the four-cell sequencing batch reactor (SBR) unit where it joins effluent from Roughing Filter #1.

Currently, 100 percent of the WPC plant flow is directed to the four-cell SBR unit and then flows to an ultraviolet (UV) system for disinfection during the recreational season. After disinfection, the WPC plant effluent passes through a detention basin and then through the outfall junction box before being discharged through an outfall to the Elkhorn River. Prior to replacement of the chlorine disinfection system with UV disinfection, the detention basin was used to allow appropriate contact time with chlorine disinfectant. The UV disinfection system was installed in 2003. Currently, the detention basin is only used as flow through to the outfall junction box.

The plant also has solids handling facilities consisting of gravity sludge thickeners, a sludge holding tank, and two belt filter presses (BFPs). (See **Exhibit 2** of **Appendix C** for a detailed site plan of sludge process flow.) Generally, the gravity thickener raises the solids content from 1 percent to 3 percent before going to the aerated sludge holding tank. Polymer is used as an aid in the process. The two BFPs dewater the sludge to about 20 percent solids. Lime kiln dust is added to raise the pH to 12.0 for two hours and to 11.5 for 22 hours in order to meet the federal standard for Class B biosolids. City staff apply the biosolids onto 2,500 acres of City-owned cropland. The plant also has a special waste handling facility to receive truckloads of wastewater from various sources.

Two aeration basins and two final clarifiers were removed from service in the late 1990’s when a large wastewater contributing industry closed a plant in the city. Hydraulic flows to the plant decreased by 40-50% on average. Section 2 of this master plan explores the feasibility of returning these processes to service.

The City is considering a future installation of a mud waste receiving station, as indicated by the proposed facility-designated line type on **Exhibit 1** in **Appendix C**. The purpose of the potential facility installation would be to improve O&M efforts by minimizing the number of pumping operations involved in grit handling and reducing the deposition of grit at the existing special waste handling facility. The new facility would include a truck off-loading bay, mud waste tank, and a mud waste pump pit. The mud waste receiving station would operate similarly to the existing facility but would be designated only for liquid waste loads that are primarily mud, silt, sand, gravel, and other abrasives. (Olsson 2018).

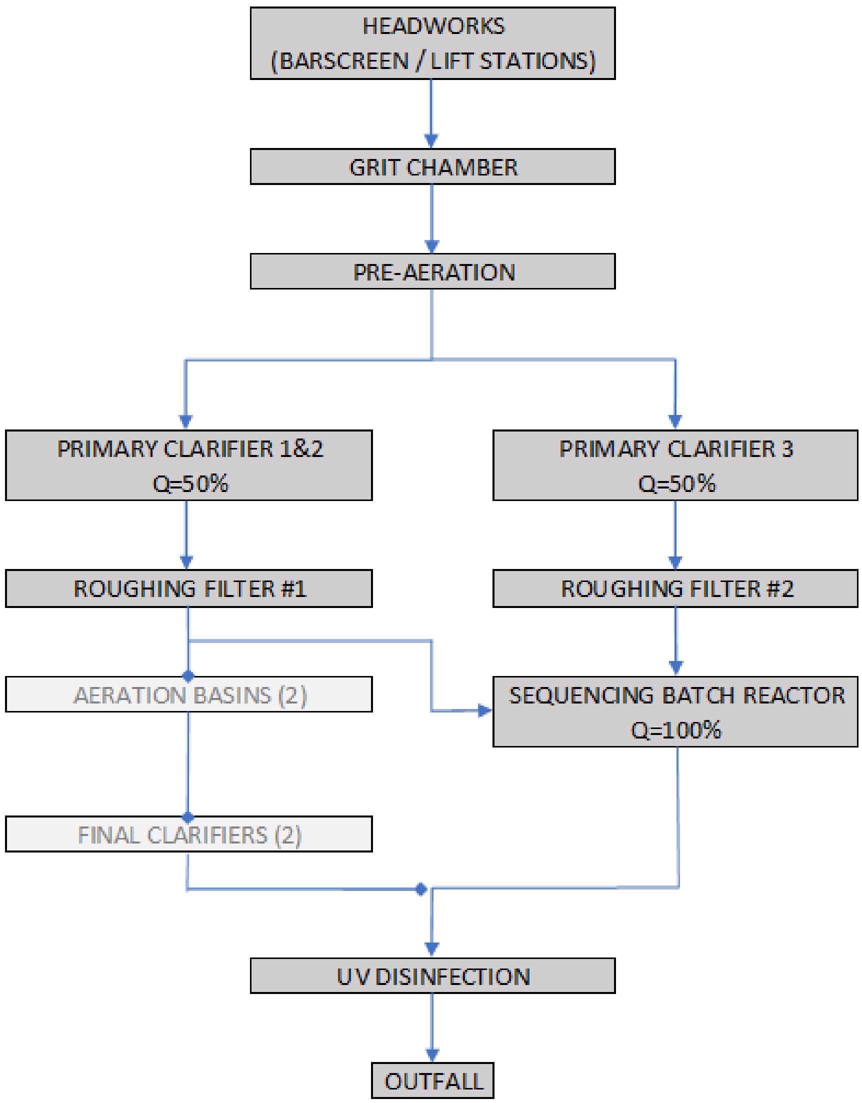


Figure 5. Process Flow Diagram for Current (2019) Operation (lighter color indicates units not currently in service)

1.6. Solids Handling

The City's biosolids treatment process flow diagram is illustrated in **Figure 6** below and represents current (2019) operations. Waste activated sludge from Primary Clarifier #3 and the four-cell SBR unit is directed back to the end of pre-aeration basin 1 (southernmost basin) which is then fed into primary clarifiers #1 and #2. This means that primary clarifiers #1 and #2 settle sludge for the entire treatment process. In discussions with operations personnel, this approach gives them the best characteristics for settling solids.

From primary clarifiers #1 and #2, sludge is fed to gravity Sludge Thickener #1 and is treated with polymer to enhance settling. Thickened sludge is sent to the sludge holding tank and then fed to one of the two BFPs. Solids are stabilized with lime kiln dust before being land applied. A detailed process piping plan is shown in **Exhibit 2** in **Appendix C**.

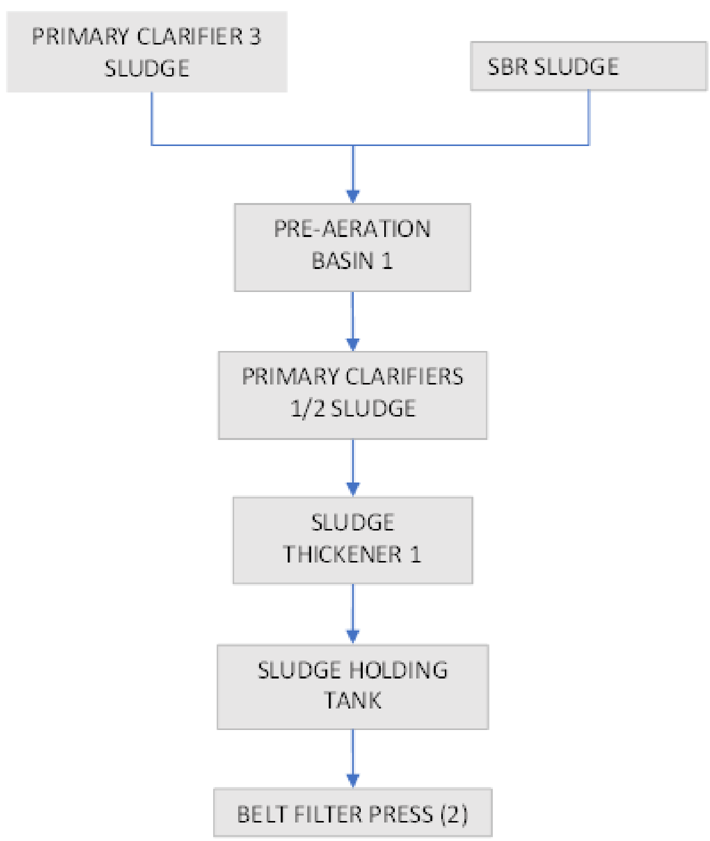


Figure 6. Existing (2019) Biosolids Treatment Process Flow Diagram

1.7. NDEE Regulations

The Nebraska Department of Environment and Energy (NDEE), formerly known as Nebraska Department of Environmental Quality (NDEQ), has recently reissued a National Pollutant Discharge Elimination System (NPDES) permit (No. NE0033421) to the City, effective January 1, 2019 through December 31, 2023 (City of Norfolk, 2018c). The permit defines discharge limits and monitoring requirements at the outfall to the Elkhorn River, biosolids monitoring requirements, and additional requirements and conditions as defined in the full permit in **Appendix D**. The highlights of changes to the current permit requirements are summarized below:

1. Ammonia limits have been revised.
2. Total nitrogen (TN) and total phosphorous (TP) monitoring frequencies have been revised.
3. *Escherichia coli* (*E. coli*) limits have been revised.
4. CBOD and TSS limits are revised to match daily design flow.
5. Dissolved oxygen (DO), nitrate/nitrite, TKN, fats, oil, and grease, and total dissolved solids testing requirements are removed and replaced by the pollution scan requirements.
6. Updates have been made to general conditions and requirements, including the addition of electronic reporting.

A summary of historical data is summarized below in relation to the current permit.

1.7.1. Flow

The NDEE requires daily monitoring to be conducted for hydraulic flow by monitoring of final effluent to the Elkhorn River after all treatment processes. Refer to **Table 4** regarding evaluation of historical flows.

1.7.2. Carbonaceous Biochemical Oxygen Demand

The NDEE requires weekly monitoring to be conducted for carbonaceous biochemical oxygen demand (CBOD) by sampling of the final effluent to the Elkhorn River after all treatment processes. Discharge limits were compared to the last five (5) years of plant effluent data and are presented in **Table 9** below for monthly average and 7-day average.

Table 9. CBOD Permit vs. Historical Actual Monthly Average and 7-Day Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Monthly Average	mg/L	25	6.1	5.1	3.8	5.7	8.3
7-Day Average	mg/L	40	6.3	5.1	3.9	5.9	8.3

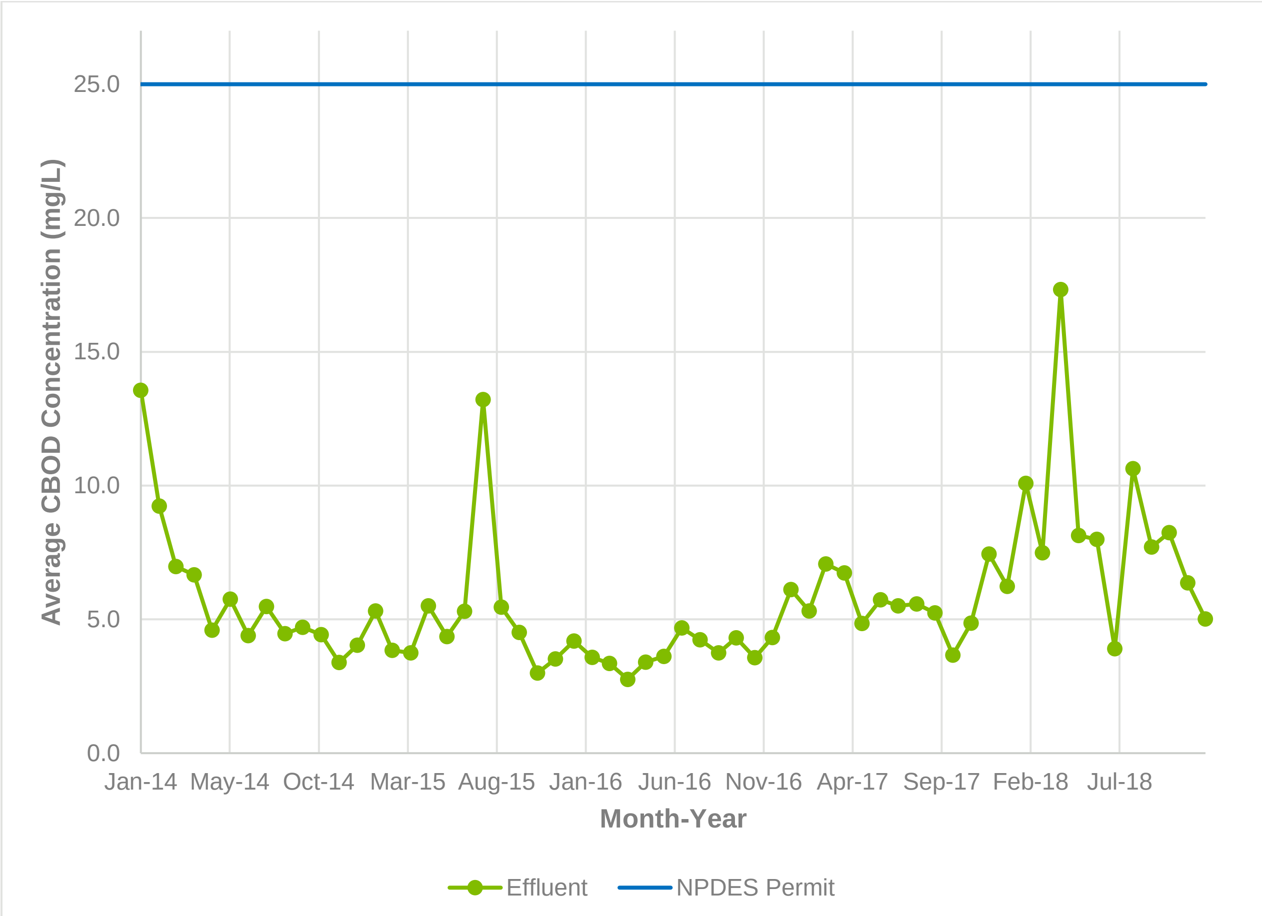


Figure 7. Historical Average Effluent Carbonaceous Biochemical Oxygen Demand (CBOD) Concentration (mg/L)

As shown in **Table 9**, the NPDES discharge limits are much higher than what the WPC plant is discharging both on a monthly and 7-day average. As shown in **Figure 7**, the CBOD discharge concentrations decreased slightly from 2014 to 2016 but increased more rapidly in 2017 and 2018, potentially because of high loading peaks in the summers caused by food processing industries.

1.7.3. Total Suspended Solids (TSS)

The NDEE requires weekly monitoring to be conducted for TSS by sampling of the final effluent to the Elkhorn River after all treatment processes. Discharge limit requirements were compared to the last five (5) years of plant effluent data and are presented in **Table 10** below for monthly average and 7-day average.

Table 10. TSS Permit vs. Historical Actual Monthly Average and 7-Day Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Monthly Average	mg/L	30	6.2	5.6	3.4	6.7	9.9
7-Day Average	mg/L	45	6.5	5.4	3.4	6.8	10.2

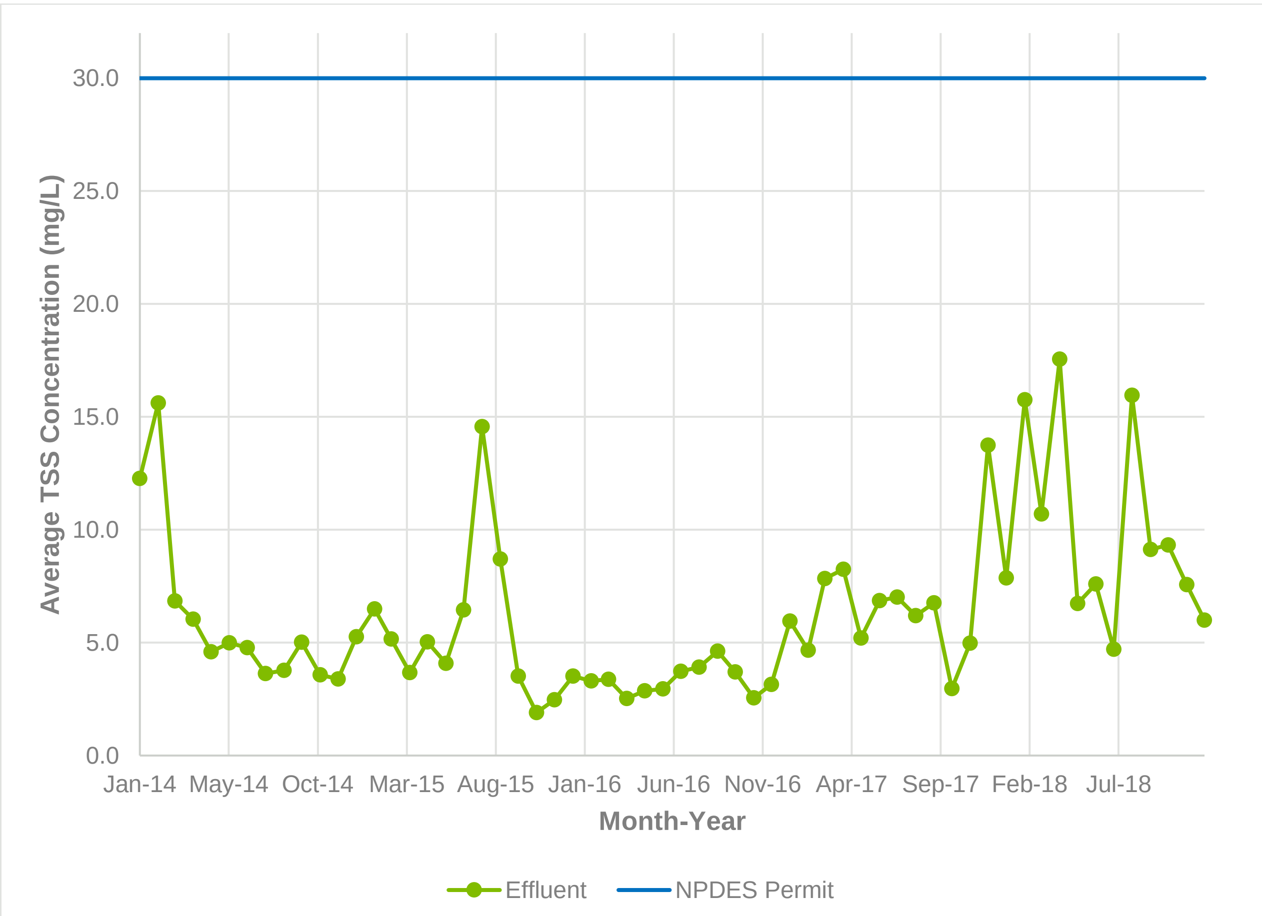


Figure 8. Historical Average Effluent Total Suspended Solids (TSS) Concentration (mg/L)

The monthly and 7-day average historical TSS discharge concentrations are far below the permit limits. The TSS discharge concentrations decreased slightly from 2014 to 2016 but increased more rapidly in 2017 and 2018 because of an increase in industrial loading. As seen in **Figure 8**, TSS loadings in 2017 and 2018 were sporadic with large swings from month to month. This appears to be because of inconsistent loadings from industries.

1.7.4. Potential Hydrogen (pH)

The NDEE requires weekly monitoring to be conducted for pH by sampling of the final effluent to the Elkhorn River after all treatment processes. Discharge limits were compared to the last five (5) years of plant effluent data and are presented in **Table 11** below for daily minimum and daily maximum discharge limits.

Table 11. pH Permit vs. Historical Actual Daily Minimum and Daily Maximum Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Daily Minimum	S.U.	6.5	7.3	7.4	7.2	7.3	7.3
Daily Maximum	S.U.	9.0	7.7	7.6	7.4	7.5	7.6

The effluent pH at the facility is consistent, with the highest variation between daily minimum and maximum being 0.4 standard unit, which occurred in 2014. The pH values are also within the acceptable range for the permit.

1.7.5. Ammonia

The NDEE requires seasonal monitoring to be conducted for ammonia by sampling of the final effluent to the Elkhorn River after all treatment processes. Discharge limits were compared to the last five years of plant effluent data and are presented in **Table 12** and **Table 13** below for monthly average and daily maximum discharge limits.

Table 12. Permit vs. Historical Actual Monthly Average Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Spring Ammonia (March 1 – May 31)	mg/L	7.92	0.24	0.30	0.77	2.51	6.54
Summer Ammonia (June 1 – Oct 31)	mg/L	2.50	0.24	0.15	0.16	0.50	0.25
Winter Ammonia (Nov 1 – Feb 28 [29])	mg/L	7.96	1.99	0.08	0.19	1.68	1.12

Table 13. Permit vs. Historical Actual Daily Maximum Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Spring Ammonia (March 1 – May 31)	mg/L	22.44	0.39	1.60	5.09	8.16	19.00
Summer Ammonia (June 1 – Oct 31)	mg/L	7.03	0.89	0.74	0.27	5.62	0.84
Winter Ammonia (Nov 1 – Feb 28 [29])	mg/L	23.13	7.64	0.12	0.51	11.10	7.79

Spring ammonia levels in 2018 were uncharacteristically high because of maintenance of the four-cell SBR unit done during April. The maintenance required SBR cell #1 to be offline for 7 days and SBR cell #3 to be offline for 9 days.

While the City is currently in compliance, it will be challenging to continue to meet these limits as flow and loadings continue to increase. The current NPDES Permit limit is shown in **Figure 9** to compare historical data to current limits. One instance (April 2018) in the last five (5) years would not have met the new 2019 ammonia limits. Any increase in loading from a new industry or growth may require additional ammonia capacity at the WPC plant.

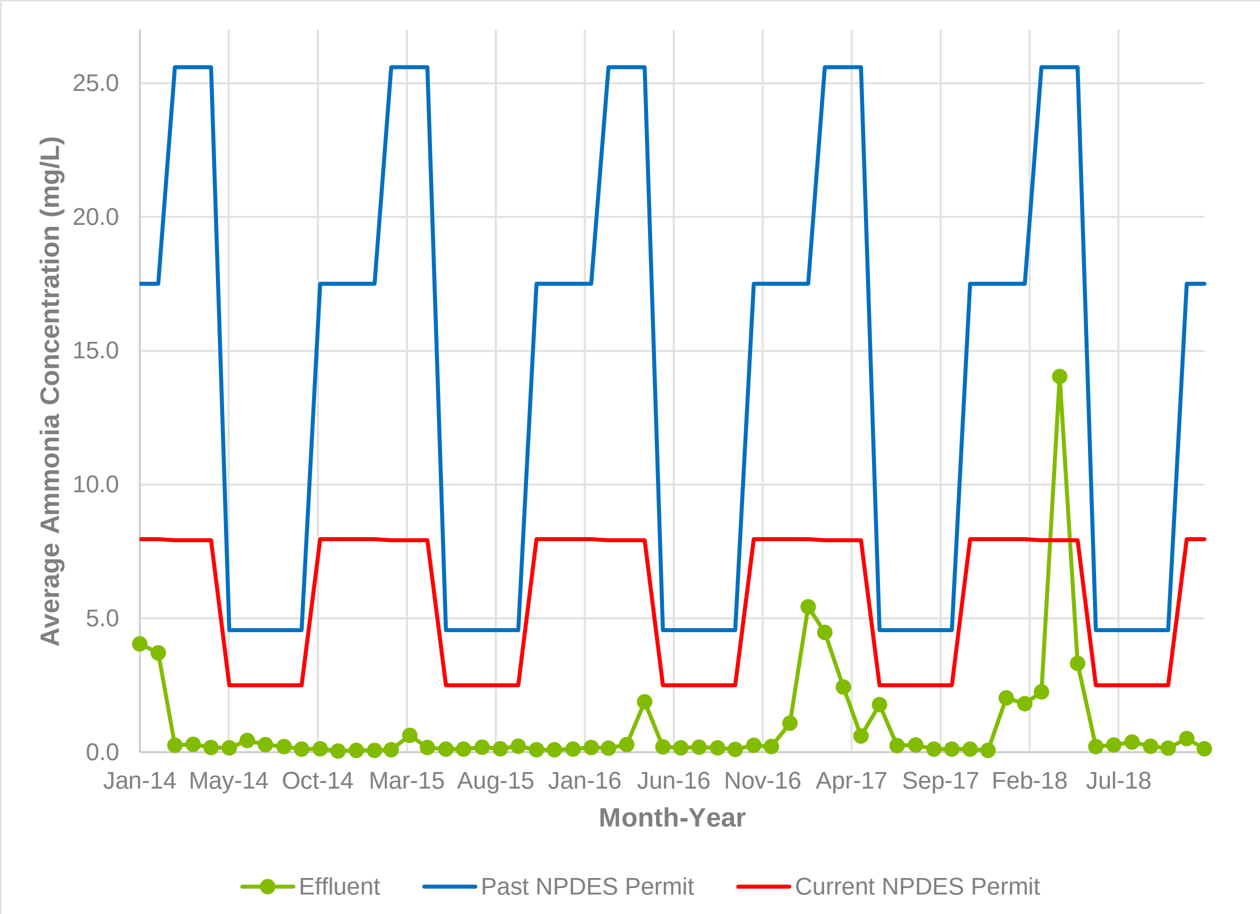


Figure 9. Historical Average Effluent Ammonia Concentration (mg/L)

1.7.6. Total Nitrogen (TN) & Total Phosphorus (TP)

The permit also requires monthly reporting of TN and TP. Discharge limits were compared to the last five years of plant effluent data and are presented in **Table 14** and **Table 15** below for monthly average and 7-day average, respectively. It is anticipated that total nitrogen and total phosphorus will have discharge limits in the next issued permit, effective January 2024. A review of the existing plant and recommendations for improvements are necessary to assure it will meet current and proposed discharge standards. Should the NDEE set limits for TN, TP, and year-round disinfection when the next NPDES permit is issued, the City will have to make improvements to the WPC plant.

Table 14. Total Nitrogen (TN) Permit vs. Historical Actual Monthly Average and Daily Maximum Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Monthly Average	mg/L	Report	7.8	6.8	5.8	7.1	9.8
Daily Maximum	mg/L	Report	16.4	13.3	12.7	20.6	19.6

Table 15. Total Phosphorous (TP) Permit vs. Historical Actual Monthly Average and Daily Maximum Discharge Limits (City of Norfolk, 2018b)

Parameters	Units	Permit	2014	2015	2016	2017	2018
Monthly Average	mg/L	Report	11.5	5.6	5.1	6.9	7.5
Daily Maximum	mg/L	Report	36.2	7.9	8.5	18.3	13.7

2. 5-YEAR PLAN – EXISTING WPC PLANT CAPACITY EVALUATION

The purpose of this section of the master plan is to define current operations and determine upgrades or improvements needed to increase the facility's firm capacity with existing structures within the next five years (2025). The City is planning for potential industry that may be establishing business in the next two to three years. The City is looking to use existing inactive infrastructure to satisfy the increase in demand in the short term if needed.

The capacity of the WPC plant must be compatible with future needs of the area to be served. Population and economic activity are both factors that reflect the future needs and have a bearing on the facilities planning process.

2.1. Unit Process Evaluation

To determine which areas of the plant may need to be improved to meet future demands, an evaluation was conducted to determine the individual unit capacities of key process equipment at the WPC plant. The criteria for capacity and performance of each unit process were determined using typical industry-accepted values and standard engineering reference performance values. Capacities do not account for actual unit performance, which may vary based on plant operations and variance from standard process components.

Table 16 below shows the calculated hydraulic and loading design capacities assumed for evaluation purposes. *The highlighted row in some sections of the table indicates the limiting performance value for each process.* This is the criteria that determines the maximum value for hydraulic and/or organic design capacity. Solids and BOD loading rates were calculated using 2025 maximum-month projections, and the table shows that the process equipment is well within acceptable performance criteria.

Table 16. Design Criteria for Existing WPC Unit Processes (Part 1 of 4)

Description	Unit	Design Criteria	Calculated/ Design Values
Influent pump station (Qty: 6 pumps)			
Firm Capacity	MGD	-	14
Total Capacity	MGD	-	16.8
Parshall Flume Capacity	MGD	-	16
Grit Tanks (Qty: 2 units)			
Retention Time	min	5	-
Water Depth	feet	-	5
Hydraulic Capacity (each)	MGD	-	2.1

Table 16 (cont'd). Design Criteria for Existing WPC Unit Processes (Part 2 of 4)

Description	Unit	Design Criteria	Calculated/ Design Values
Pre-Aeration Basin (Qty: 3 units)			
Retention Time	min	25	-
Hydraulic Capacity (each)	MGD	-	2.62
Primary Clarifier #1			
Percentage of Total Plant Flow	%	-	35
Surface Overflow Rate	gpd/ft^2	1500-2000	1158
Minimum Settling Time	Hour	2-3	2
Water Depth	Feet	>=10	10.5
Weir Overflow Rate	gpd/lin ft weir	30000	18812
Solids Loading Rate	Lb/d*ft^2 surface area	30 max SS	3.9
Hydraulic Capacity	MGD	-	3.13
Primary Clarifier #2			
Percentage of Total Plant Flow	%	-	15
Surface Overflow Rate	gpd/ft^2	1500-2000	1035
Minimum Settling Time	Hour	2-3	2
Water Depth	Feet	>=10	9
Weir Overflow Rate	gpd/lin ft weir	30000	11645
Solids Loading Rate	Lb/d*ft^2 surface area	30 max SS	8.1
Hydraulic Capacity	MGD	-	1.28
Primary Clarifier #3			
Percentage of Total Plant Flow	%	-	50
Surface Overflow Rate	gpd/ft^2	1500-2000	1092
Minimum Settling Time	Hour	2-3	2
Water Depth	Feet	>=10	10.0
Weir Overflow Rate	Gpd/lin ft weir	30000	21835
Solids Loading Rate	Lb/d*ft^2 surface area	30 max SS	1.3
Hydraulic Capacity	MGD	-	4.51
Roughing Filter (Qty: 2)			
Surface Overflow Rate	gpd/ft^2	1150-4600	1150
BOD Loading	lb/d*1000 ft^3	100-500	133
Hydraulic Capacity (each)	MGD	-	5.78
Assumed BOD Reduction from Primary Clarifiers	%	-	25

Note: These values are based on theoretical unit process performance and may be different than those used to evaluate system performance for BNR analysis/modeling in section 5 of this report.

Table 16 (cont'd). Design Criteria for Existing WPC Unit Processes (Part 3 of 4)

Description	Unit	Design Criteria	Calculated/ Design Values
Aeration Basin (Qty: 2)			
Assumed Percentage of Total Plant Flow 2025 Operation (both basins)	%	-	20
BOD Loading	lb/d*1000 ft^3	40 Max	23
MLSS Concentration	mg/L	1500-2000	-
Return Sludge Ratio	%	20-30	-
Water Depth	feet	-	15
Hydraulic Retention Time	hour	6.0-8.0	6
Hydraulic Capacity (each)	MGD	-	1.31
Assumed BOD Reduction from Trickling Filter	%	-	60
Final Clarifier #1			
Assumed Percentage of Total Plant Flow 2025 Operation	%	-	10%
Surface Overflow Rate	gpd/ft^2	-	559
Minimum Settling Time	hour	-	2
Water Depth	feet	-	12
Sludge Quality	mg/L	-	
Weir Overflow Rate	gpd/lin ft weir	-	6987
Solids Loading Rate	lb/d*ft^2 surface area	-	0.7
Hydraulic Capacity (each)	MGD	-	2.11
Final Clarifier #2			
Assumed Percentage of Total Plant Flow 2025 Operation	%	-	10%
Surface Overflow Rate	gpd/ft^2	-	462
Minimum Settling Time	hour	-	2
Water Depth	feet	-	12
Sludge Quality	mg/L	-	
Weir Overflow Rate	gpd/lin ft weir	-	6352
Solids Loading Rate	lb/d*ft^2 surface area	-	0.5
Hydraulic Capacity (each)	MGD	-	2.56

Note: These values are based on theoretical unit process performance and may be different than those used to evaluate system performance for BNR analysis/modeling in section 5 of this report.

Table 16 (cont'd). Design Criteria for Existing WPC Unit Processes (Part 4 of 4)

Description	Unit	Design Criteria	Calculated/ Design Values
SBR (Qty: 4 cells)			
Assumed Percentage of Total Plant Flow 2025 Operation	%	-	80%
BOD Loading	lb/d*1000 ft^3	40 Max	38
MLSS Concentration	mg/L	1000-3000	2,250 setpoint
F:M	lb BOD/d /lb MLVSS	0.2-0.5	-
Hydraulic Retention Time	hour	6-8	8
Hydraulic Capacity (each)	MGD	-	3.56
UV System (Qty: 2 units)			
Design Capacity	MGD	-	12
Sludge Thickener #1 *Note: Sludge Thickener #2 not used due to performance inefficiencies*			
Surface Overflow Rate	gpd/ft^2	390-785	585
Retention Time	hour	12-15	3
Water Depth	feet	-	10
Solids Loading Rate	lb/d/ft^2	6-12	10
Sludge Holding Tank			
Retention Time	hour		3
Sludge Belt Press			
Belt Width	meter	1-3	2
Hydraulic Loading Rate	gpm/m belt width	40-50	50
Solids Loading Rate	lb/(hr*m) belt width	800-1000	267.85

Note: These values are based on theoretical unit process performance and may be different than those used to evaluate system performance for BNR analysis/modeling in section 5 of this report.

2.2. Discussion of Unit Process Capacities

As flows increase through 2025, potential hydraulic bottlenecks may be noticed in the individual unit processes. Per **Table 5** in Section 1 of this master plan, the City is anticipating average flows to increase from current 3.26 MGD to 5.85 MGD (Year 5 through 2025). Peak daily flow for 2025 is anticipated to be 9.27 MGD and peak hourly flow to be 10.98 MGD. Hydraulic capacities are compared to peak daily flow and peak hourly flow and organic loadings are compared to peak monthly flow. This is significant when considering what additional design capacity is needed to provide service for future hydraulic and organic loading conditions. It should be noted that unit processes will be limited by hydraulic flow before reaching any organic loading limitations for 2025 as shown in **Table 16** above.

Table 17. Unit Process Hydraulic Design Capacities Compared to 2025 Projected Flows

Description (all units)	Design Capacity (MGD)		Meets Firm Capacity for 2025?		Meets Total Capacity for 2025?	
	Firm Capacity	Total Capacity	Peak Daily Flow	Peak Hourly Flow	Peak Daily Flow	Peak Hourly Flow
Bar Screen	-	15.0	YES	YES	YES	YES
Lift Station	14.0	16.8	YES	YES	YES	YES
Parshall Flume	-	16.0	YES	YES	YES	YES
Grit Tanks	2.1	4.2	NO	NO	NO	NO
Pre-Aeration Basins	5.2	7.9	NO	NO	NO	NO
Primary Clarifiers	5.9	11.9	NO	NO	YES	YES
Roughing Filter	5.8	11.6	NO	NO	YES	YES
Aeration Basin	2.6	2.6	YES	YES	YES	YES
Final Clarifier	4.7	4.7	YES	YES	YES	YES
Four-cell SBR Unit	10.7	14.3	YES	NO	YES	YES
UV Disinfection	-	12.0	YES	YES	YES	YES

[1] The firm capacity is defined as the flows that can be accommodated with the largest pumping or treatment unit out of service. The total capacity is defined as the flows that can be accommodated with all treatment units in service. The design capacity is based on calculation assuming industry design guidelines or City's design characteristic data.

The calculated loading rates for BOD and TSS are calculated in **Table 18** below for key unit processes. Additional design criteria that are important to each of these processes are shown in **Table 17**. As shown in **Table 18**, all key unit processes will meet design standards for organic and solids loading rates using 2025 peak month loadings.

Table 18. Unit Process Solids/Organic Loading Capacities compared to 2025 Projected Flows

Description (all units)	BOD Loading Rate ($lb/d*1000ft^3$)	TSS Loading Rate ($lb/d*ft^2$)	Meets Loading Limits for 2025?
-	-	-	Peak Month Flow
Primary Clarifier #1	-	3.9	YES
Primary Clarifier #2	-	8.1	YES
Primary Clarifier #3	-	1.3	YES
Roughing Filters	133.0	-	YES
Aeration Basins	23.0	-	YES
Final Clarifier #1	0.7	-	YES
Final Clarifier #2	0.5	-	YES
Four-cell SBR Unit	38.0	-	YES
Sludge Thickener	-	10.0	YES

2.3. Discussion of Solids Handling Requirements 2025

The existing solids handling equipment consists of two BFPs with a hydraulic throughput of 100 gallons per minute (GPM) each. Currently, the City staff dewater sludge approximately three days per week, six hours per day, and typically run both BFPs simultaneously. Below in **Table 19** is a summary of historical operating parameters.

Table 19. Average Dewatering Parameters 2014-2018

Parameter	Total	Per BFP	Units
Solids Raw Sludge	2.37	-	%
Run Times (Days)	6	3	days per week
Hours per Run	12.4	6.2	hours
Raw Sludge Pumped	108,000	54,000	gallons/run
Total Solids Dewatered	2,600	1,300	lb/run
Total Solids Dewatered	1.30	0.65	tons/run
Throughput	210	105	lb/hr DWS
Throughput	145	73	gpm
Dewatered Solids	18.64	-	%

Table 20 compares average dewatering hours per run with maximum-month dewatering hours per run. During the maximum month, the City staff will dewater for more hours each run or dewater an additional day during the week. Future loadings are projected to increase approximately 1% per year contributing to an equal increase in solids processing. In 2025, this increase of solids would only relate to an additional 0.4 hours of run time per BFP on average per week.

Table 20. Historical and Projected Dewatering Hours Per Day based on 3 Days per Week

Description	2014	2015	2016	2017	2018	2025
Total Hours						
Average	12.7	13.6	12.5	12.6	12.0	12.8
Maximum Month	17.3	15.2	13.8	12.2	13.7	14.8
Per BFP						
Average	6.3	6.8	6.3	6.3	6.0	6.4
Maximum Month	8.6	7.6	6.9	6.6	6.9	7.3

2.4. Recommendations

To address potential hydraulic bottlenecks at the facility, recommendations are made for improvements to the WPC plant within the next five (5) years (2025), to accommodate the projected peak hourly flow of 10.98 MGD. Costs for adding retrievable diffusers to the four-cell SBR unit and for bringing the dormant aeration basins and final clarifiers back online were included in this section. These may not be needed based on expansion of treatment plant processes discussed in Section 5 of this Plan.

Except for the grit tanks and pre-aeration basins, the existing plant will meet projected peak hourly flows without bringing the activated sludge processes back online (two aeration basins and final clarifiers). Adding retrievable diffusers to the SBR process may be recommended if the steel industry (discussed previously) comes online, since 2025 flows are anticipated to be right at firm capacity of the four-cell SBR unit. This option is more costly than bringing the activated sludge processes back online.

All processes have the capacity to meet 2025 organic loadings with current assumptions and industrial allocations, without the need to add additional treatment processes. Recommendations for increasing hydraulic capacity are discussed below.

2.4.1. Unit Hydraulic Process Capacity

The City observes hydraulic restrictions at current peak hourly flows especially on the primary treatment system, specifically at the grit tanks and pre-aeration basins detailed below.

2.4.1.1. Grit Tanks

As shown in **Table 16**, the grit tanks provide a total flow capacity of 4.2 MGD. This is in comparison to the Design Year 5 (through 2025) anticipated peak hourly flow capacity of 10.98 MGD. Therefore, additional hydraulic capacity is needed. The cost for increasing the capacity of these tanks is estimated in **Table 21** below.

Table 21. Opinion of Probable Cost for Replacement of Grit Removal System

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1	**Grit Improvements**				
1.1	New Concrete Structure	400	CY	$1,500	$600,000
1.2	Grit Removal Equipment	1	LS	$660,000	$660,000
1.3	Grit Pumping Equipment	1	LS	$100,000	$100,000
1.4	Demo Old Structures	1	LS	$100,000	$100,000
1.5	Process Piping Changes	1	LS	$100,000	$100,000
1.6	Electrical	1	LS	$20,000	$20,000
1.7	Instrumentation and Controls	1	LS	$10,000	$10,000
				Subtotal	**$1,590,000**
				Contingency 30%	**$477,000**
				Engineering 20%	**$318,000**
				Total	**$2,385,000**

2.4.1.2. Pre-Aeration Basins

As shown in **Table 16**, the aeration basins only provide a total flow capacity of 7.9 MGD (firm capacity of 5.25 MGD). This is in comparison to the Design Year 5 (through 2025) anticipated peak hourly flow capacity of 10.98 MGD. Expansion of the WPC Plant as discussed in the 20-Year Plan (Section 5) indicate that the pre-aeration basins will no longer be necessary for optimal operation of the plant. Demolition of these structures is included in the cost estimate provided in **Table 21** above.

2.4.2. Reinstatement of Inactive Infrastructure

In 2003, the shutdown of a large industry, substantially reduced the amount of wastewater flow to the WPC plant. It was determined that a second treatment train in operation at that time no longer needed to be online. Two aeration basins and two final clarifiers were taken offline. The treatment process was modified to accommodate this and currently operates as shown in **Figure 5**. If these units are brought back online, the plant process flow would look like **Figure 10** below.

During the facility inspection (see Section 4), the four existing unused basins (aeration basins #1 and #2 and final clarifiers #1 and #2) were evaluated to determine actions necessary to be taken in order to bring these units back online to expand treatment capacity for the next five years.

Reinstating these four basins will add an additional total capacity of 2.6 MGD to the WPC plant. While it has been determined that the existing operation of the plant will meet projected 2025 flows, costs are included here in the event additional capacity is needed for potential industry contributors.

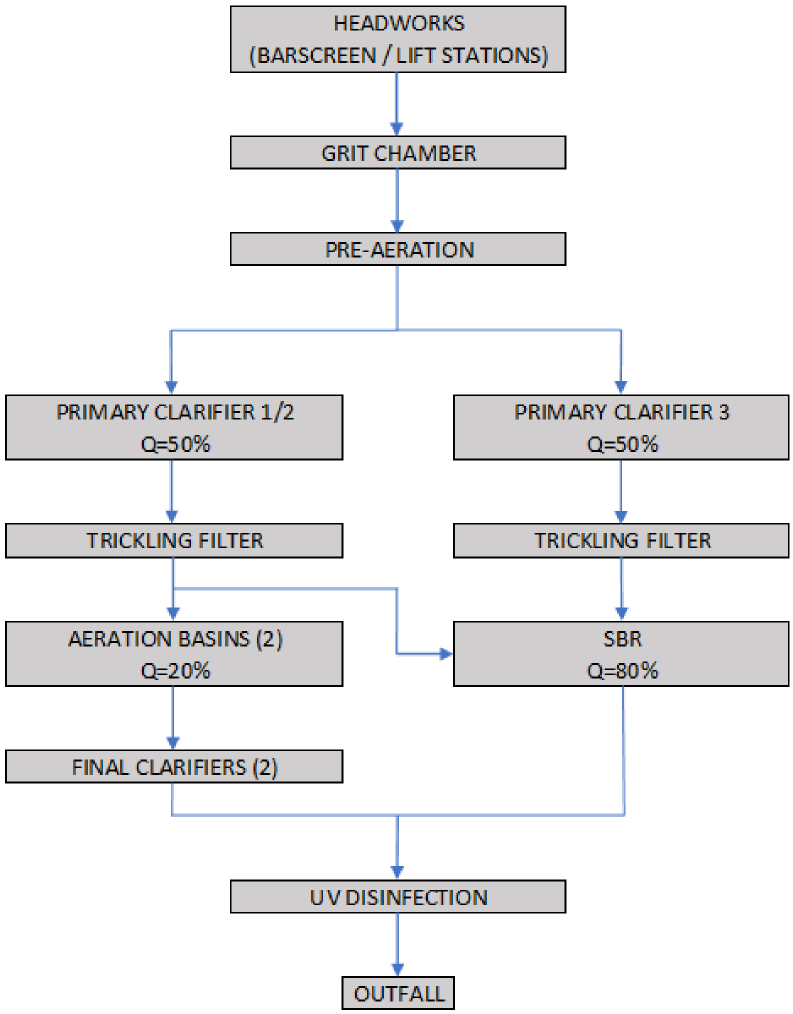


Figure 10. Possible Future Operation Hydraulic Process Flow Diagram

2.4.2.1. Aeration Basins

Both concrete structures appeared to be in overall good condition (see **Figure 11**). The effluent box on each structure shows signs of alkali-silica reaction (ASR) (see Section 4 for more information) in the concrete and the resultant degradation as shown in **Figure 12**. However, the risk of significant concrete failure within the next five years is low, so no action is recommended at this time.

Old sludge, mud, and water have collected in the bottom of each basin since they've been taken out of service, and vegetation has been growing in the bottom of each. All this material will need to be removed, and the basins will need to be thoroughly cleaned.

The above-grade fiberglass air piping shows signs of UV degradation and should be replaced. The submersible pumps for each jet aerator have been removed from the basins and will need to be replaced. New electrical disconnects will need to be installed as well.

The existing three aeration blowers, located in the Trickling Filter Pump Building, have not been serviced or run since the aeration basins have been taken out operation. They will require a maintenance visit from an authorized service representative to ensure proper working condition and cost estimate for any potential repair needs. **Table 22** details the cost estimate for repair to the existing aeration basins.

Figure 11. Photo of Interior of Aeration Basin #2

Figure 12. Photo of Aeration Basin #2 and Evidence of Alkali-Silica Reaction (ASR) Degradation

Table 22. Opinion of Probable Cost for Aeration Basin Improvements

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1	**Aeration Basins #1 & #2**				
1.1	Basin Cleaning	1	LS	$30,000	$30,000
1.2	Above-grade Fiberglass Air Piping	40	LF	$175	$7,000
1.3	Submersible Pumps	6	EA	$20,000	$120,000
1.4	Electrical	1	LS	$25,000	$25,000
1.5	Centrifugal Blower Servicing	3	EA	$15,000	$45,000
				Subtotal	**$227,000**
				Contingency 30%	**$68,100**
				Engineering 20%	**$45,400**
				Total	**$340,500**
*Does not include O&M costs					

2.4.2.2. Final Clarifiers

As with the aeration basins, both final clarifiers are in overall good shape. The effluent boxes here also show signs of ASR, but they also will not likely have structural issues within the next five years. The clarifier mechanism in both basins has not been maintained since the basins were taken out of service. Both drives will potentially need to be rebuilt based on inactive state.

In final clarifier #1, the weirs, baffles, and stilling well look to be in good condition, with some scaling that can be power washed off. The metal supports for the weirs and the launderer trough in this clarifier are corroded and should be replaced before putting this basin in service (see **Figure 13**).

Final clarifier #2 is missing the scum rake, and the sludge rake is in poor condition. It is recommended that this entire unit be replaced. The effluent weirs can remain but should be cleaned, sandblasted, and painted.

As with the aeration basin, old sludge, mud, and water have collected, and vegetation has been allowed to grow. All this material needs to be removed, and the basins need to be cleaned. **Table 23** details the cost estimate for repair to the existing final clarifiers.

Figure 13. Photo of Interior of Final Clarifier #1 (South)

Table 23. Opinion of Probable Cost for Final Clarifier Improvements

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1	**Final Clarifier #1**				
1.1	Basin Cleaning	1	LS	$30,000	$30,000
1.2	Rebuild Drive	1	LS	$50,000	$50,000
1.3	Launderer Supports	25	EA	$600	$15,000
1.4	Electrical	1	LS	$25,000	$25,000
				Subtotal	**$120,000**
2	**Final Clarifier #2**				
2.1	Basin Cleaning	1	LS	$30,000	$30,000
2.2	Complete Clarifier Mechanism	1	LS	$300,000	$300,000
2.3	Electrical	1	LS	$25,000	$25,000
				Subtotal	**$355,000**
				Contingency 30%	**$142,500**
				Engineering 20%	**$95,000**
				Total	**$592,500**
*Does not include O&M costs					

2.4.2.3. Sequencing Batch Reactor (SBR)

Currently the air diffusers are floor-mounted; therefore, if the air diffusers need to be serviced in an SBR cell, there is no way to service them without draining the cell entirely. Installing retrievable diffusers will allow the diffuser racks to be raised out of the basin for service, allowing all cells of the SBR to remain in service. **Table 24** explains the cost estimate for installation of retrievable diffusers.

Table 24. Opinion of Probable Cost for Four-cell Sequencing Batch Reactor (SBR) Unit Retrievable Diffusers

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1	**SBR Retrievable Diffusers Installation**				
1.1	52 Fine Bubble Diffuser Racks	1	LS	$621,000	$621,000
1.2	1 Diffuser Electric Winch				
1.3	Supervision Services and Freight Package				
1.4	Clean Out, Air Piping Changes, Demolition and Installation	1	LS	$410,000	$410,000
				Subtotal	**$1,031,000**
				Contingency 30%	**$309,300**
				Engineering 20%	**$206,200**
				Total	**$1,546,500**
*Does not include O&M costs					

The four-cell SBR unit is exhibiting evidence of ASR degradation that will potentially affect the life of the unit. It is recommended that testing and visual inspections be conducted over the next two years to determine the extent and rate of degradation so that the overall lifecycle of the four-cell SBR unit can be determined.

2.5. Conclusion

The analysis in this section will give the City the tools needed to accommodate any potential industries that build in Norfolk. Short-term improvements can be implemented to service potential industrial contributors. Some or all the improvements can be implemented as needed with a phased approach.

The following are recommended to increase the capacity of the WPC Plant to meet future demands within the next five years:

- Increase capacity of the grit tanks to anticipated peak hourly flow. The cost for grit improvements is estimated to cost $2,385,000.
- With the additional flow from the anticipated steel industry, install retrievable diffusers in the SBR unit for a total cost $1,546,500. This will allow all four cells of the SBR unit to remain in service without needing to be drained during maintenance of the air diffusers.
- Conduct testing of the ASR degradation on the SBR to determine rate and extent of degradation in order to determine expected life of the four-cell SBR unit.
- Currently, it is not necessary to rehabilitate the two aeration basins and two final clarifiers that are currently out of service. Rehabilitation will cost $933,000 and will add 2.6 MGD capacity to the WPC Plant. Rehabilitation of these units would need to be started two years prior to

additional flows from any potential industry. This option is not recommended as it will introduce two different types of treatment (batch and continuous) and complicate the effectiveness of future BNR treatment. (If the City wishes to reinstate all treatment processes to bring the plant up to its potential peak hourly design capacity of 14.5 MGD, additional primary clarifier capacity will need to be considered. Clarifier capacity is anticipated to meet capacity requirements until 2035 based on unit process analysis. This will be discussed further in the 20-year plan.)

3. WATER REUSE EVALUATION

The City has a temporary non-potable water (NPW) system that helps augment existing water resources and maximize the efficient use of the City's water supplies specifically for irrigation purposes. The City is interested in installing a new permanent NPW system based on potential internal and external NPW (i.e. treated effluent water) reuse demand. During the installation of a permanent NPW system, the City is also interested in exploring additional opportunities that involve a combination of water management strategies as part of an integrated water resources management approach.

The purpose of this section within the master plan is to document the state of the existing temporary NPW system and to provide a strategy for improving and expanding the NPW system to serve more reuse purposes in the future in alignment with the City's overall goal of optimizing the use of its NPW system to help reduce demands on the raw and potable water supplies.

The following objectives are addressed in this plan for the existing NPW system to be upgraded:

- Review industry guidelines and best practices for NPW reuse at WPC plant
- Document existing on-site NPW uses
- Identify future potential on-site and external NPW uses
- Identify future infrastructure projects including budgetary cost estimates

3.1. Definition

Non-potable water (NPW) has a variety of definitions, but generally it is water that is not drinking quality, but may still be used for many other purposes, depending on its quality. Sources of NPW include but are generally categorized into (a) rainwater (e.g. roof runoff); (b) grey water (e.g. shower, sink, laundry); (c) black water (e.g. toilet, wastewater); and (d) stormwater (e.g. lawn and surface runoff). The term "non-potable water" is commonly used when referring to water sources that are often considered unacceptable for human consumption (i.e. lake and pond water, drain or discharged water, recycled water, etc.). For the purpose of this plan, when discussing recommendations regarding specific site applications, the intended definition of "non-potable water" is defined as reclaimed/recycled water captured from the WPC plant treated effluent water before being discharged to the Elkhorn River.

3.2. Industry Drivers based on Regional Variations

Approximately 32 billion gallons per day (BGD) of wastewater are treated at municipal water resource recovery facilities in the United States; it is estimated that 12 BGD (nearly 38 percent) can be beneficially reclaimed and reused (NRC, 2012). Only approximately 7 to 8 percent of wastewater is currently being reused in the United States (Miller, 2006 and GWI, 2009). Therefore, there is significant opportunity of expanding integrated water management plans to account for increase reuse of NPW applications. The Water Environment Federation's Committee Leadership Council has also recently recognized the benefits and changing paradigm in the water sector by recommending the replacement of conventional names such as "wastewater treatment plant" with "water resource recovery facility" to focus on the products and benefits of treatment rather than the waste coming into the facilities.

According to the U.S. Environmental Protection Agency's Guidelines for Water Reuse (USEPA 2012), there are five primary areas of variation for each region that affect the drive and need for water (re)use, which is as follows.

3.2.1. Population and Land Use

For the Midwest and Great Lakes Regions sector (i.e. Illinois, Indiana, Iowa, Kanas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin) specifically, the population is around 65 million according to the 2010 United States Census. There is an average overall 3.9 percent population increase and 6.9 percent land use increase (USEPA 2012), which is a key driver for infrastructure development including water reuse facilities. An increase in population is directly related to industrialization and urbanization, which can significantly affect the demand of water and quality of the water supply.

3.2.2. Precipitation and Climate

The Midwest specifically has different climatic regions that have large seasonal temperature differences and are known for extreme weather events (i.e. floods in the winter and spring and droughts in the summer). Wet weather flows and runoff conditions that infiltrate into the sanitary sewer systems during a storm event can significantly affect peak design conditions (USEPA 2012).

3.2.3. Water Use by Sector

In addition, water is used for various purposes (mostly agricultural) and for different types of industries (i.e. commercial, agricultural processing, and heavy industrial). Furthermore, like many Midwest states, the larger users of water are not always in proximity to populated areas which can greatly affect the cost of service for water demand.

The Midwest has a significant number of power generation facilities. In fact, nearly 60 percent of water used in Minnesota is used by the state's power generation facilities (USEPA 2012). The water is only used once typically through these power generation facilities because they are not traditionally good candidates for using reclaimed water. Facilities that have readily available water resources such as municipal dischargers are expected to have lower effluent limit requirements for enforcement, which affects the approach on future water reuse infrastructure projects. Furthermore, the regulations and/or guidelines (if they exist) for states' water reuse applications vary across the nation and region.

The Midwest is currently seeing an increased interest in promoting the conservation of ground water and surface water resources by recycling treated municipal wastewater for industrial (re)use. Benefits include less ground water aquifer depletion because of one-time use and discharge to surface waters, lower demand on finite water resources to support business and growth, and reliable and potentially lower cost water sources for industries. Industrial (re)use of reclaimed water ranges across various specific types of industries (i.e. electronic, power-generation, etc.) for various types of processes (i.e. process water, boiler feed water, cooling tower use, flushing toilets, site irrigation, etc.). In addition, industries and commercial establishments are encouraged to seek Leadership in Energy and Environmental Design (LEED) certification through the United States Green Building Council, which specifically required enhancement of its green profile which encourages water reclamation. (USEPA 2012)

3.2.4. States' Regulatory Context

Local management programs are needed to help reinforce and provide guidelines or regulations regarding water quality parameters and monitoring restrictions that are needed to protect public health. Only few states have developed state water reuse programs since the USEPA's original publication of the Guidelines for Water Reuse (USEPA 2004). The most established water reuse programs are developed for states such as Florida, California, Texas, and Arizona. Additional information regarding the regulations and guidelines for each state can be found in the 2012 Guidelines for Water Reuse. (USEPA 2012)

Nebraska's water reuse criteria are only defined per Title 119 - Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System (NPDES), as administered by Nebraska Department of Environment and Energy (NDEE). Within Title 119, Chapter 12 – Land Application of Domestic Effluent, Land Application of Single Pass Noncontact Cooling Water and Disposal of Domestic Biosolids outlines the standards for the reuse of treated wastewater. Currently, per correspondence with and confirmation by NDEE, water reuse projects are evaluated on a case-by-case basis since limited information and local case studies are available for those exploring water reuse application projects.

Implementation considerations must include continued compliance to existing NPDES and other permits' requirements not to mention future permit conditions. Treatment technologies may result in concentrated waste streams, which causes a concern for pollutant concentration discharge limits (i.e. total dissolved solids, chloride, sulfate, boron, etc.), which will exceed water quality standards for some receiving streams. These treatment technologies are restricting the operations expansion of existing industries that cannot effectively reduce salt concentrations in discharge to meet the NPDES permit.

Fortunately, treatment technologies are available and are becoming more cost effective. These technologies work to protect the public health by (a) reducing or eliminating concentrations of pathogenic bacteria, parasites, and enteric viruses in reclaimed water; (b) controlling chemical constituents in reclaimed water; and (c) limiting public exposure (contact, inhalation, or ingestion) to reclaimed water (USEPA 2012). NDEE strongly supports water reuse projects, and since it would recommend following industry best practices (i.e., pipe color coding, signage, etc.), the agency only requires letter correspondence for upcoming projects regarding any significant change in water reuse.

3.2.5. Context and Miscellaneous Drivers based on Regional Variations

Additional drivers based on the Midwest regional variations can be grouped into water quality, water quantity, sustainable economic growth, and environmental stewardship (MCES, 2007). Higher levels of wastewater treatment will be required to maintain and/or accommodate growing populations and industry trends. With a landscape of low, flat to rolling terrain, geographical barriers limit the groundwater supplies, which are further susceptible to various pollution sources. Historically, the Midwest has practiced agricultural irrigation and land application of solids with respect to meeting implemented water quality standards. However, more recent water reuse applications driven by discharge limitations include golf course irrigation in urban and resort areas and toilet flush water for buildings (USEPA 2012).

The Midwest generally has the lowest cost of service rates in the nation for water supply and treatment; therefore, there would generally be an interest in implementing water reuse to keep the cost increase minimal while providing a more sustaining water supply. In regards to public education and input, research through various surveys presented through US Water Alliance indicates that a majority of the population would be comfortable with using recycled water for irrigation, industry, and household uses once participants were informed of how the reused water could be thoroughly cleaned or treated using latest technologies. (Value of Water, 2019)

Emerging water reuse practices within the Midwest are primarily focused around augmenting or preserving water supply, generating power, and reusing water for recreational/aesthetic purposes. Potential uses include but are not limited to irrigation, cooling towers, industrial process water, stormwater basin cleaning, municipal solid waste truck washout, and wetland augmentation. Additional specific applications are as follows:

- Irrigation / landscape watering (non-food crops but not in playgrounds)
- Landscape water features (i.e. golf course or landscape ponds)
- Industrial cooling water
- Toilet flushing at commercial, industrial, and public facilities
- Commercial car wash facilities
- Commercial, industrial, and public boiler feed water

When evaluating what constituents are present in a wastewater source and to what degree or level of treatment is applicable for reducing constituents to levels that achieve the desired reclaimed water quality, most state regulations evaluate this question on a case-by-case basis. Since Nebraska data is not readily available or generally provided, **Figure 14** illustrates typical wastewater treatment plant effluent quality for Minnesota municipal wastewater treatment facilities. Note that most of the Minnesota wastewater treatment facilities have secondary treatment processes and many have nutrient-removal processes, particularly for nitrogen. Many future plant upgrades will likely require those for additional phosphorous removal. Filtration processes are commonly being added because of the receiving streams reaching their maximum load capacities requiring additional pollutant removal. The degree of treatment generally required when human exposure is considered is summarized in **Figure 15**.

	Constituent Concentration, mg/L		
Constituent	**Secondary Treatment**	**Secondary Treatment with Nutrient Removal***	**Tertiary Treatment with Filtration**
BOD	5-20	5-10	≤5
TSS	5-20	5-10	≤2
Fecal Coliform	< 200/100 ml	< 200/100 ml	< 2.2/100 ml
pH	6-9	6-9	6-9
Total Phosphorus	4-15	≤1	≤0.4
Ammonia	10-30	≤3	≤1

*Ammonia limit of 3 mg/L and total phosphorus limit of 1 mg/L

Figure 14. Typical Wastewater Treatment Plant Effluent Quality (MCES, 2007)

Treatment Level	Increasing Levels of Treatment			
	Primary	Secondary	Filtration and Disinfection	Advanced
Processes	Sedimentation	Biological oxidation and disinfection	Chemical coagulation, biological or chemical nutrient removal, filtration, and disinfection	Activated carbon, reverse osmosis, advanced oxidation processes, soil aquifer treatment, etc.
End Use	No Uses Recommended	Surface irrigation of orchards and vineyards	Landscape and golf course irrigation	Indirect potable reuse including groundwater recharge of potable aquifer and surface water reservoir augmentation and potable reuse
		Non-food crop irrigation	Toilet flushing	
		Restricted landscape impoundments	Vehicle washing	
		Groundwater recharge of nonpotable aquifer	Food crop irrigation	
		Wetlands, wildlife habitat, stream augmentation	Unrestricted recreational impoundment	
		Industrial cooling processes	Industrial systems	
Human Exposure	Increasing Acceptable Levels of Human Exposure			
Cost	Increasing Levels of Cost			

Figure 15. Types of Reuse Appropriate for Increasing Levels of Treatment (USEPA, 2012)

3.3. Integrated Water Management Approach

As discussed previously, water industry stakeholders experience varied challenges that range from drought to flood to water contamination across the nation. Furthermore, there are continued increasing pressures to save costs and demonstrate environmental stewardship to address concerns related to water supply development, water resources and storage, water treatment, water use efficiency, and water recovery efforts.

Water industry stakeholders commonly affected by these dilemmas include but are not limited to utility managers and operators, public officials and community leaders, engineers and designers, businesses and manufacturers, farmers, etc. With increasing regulations and restrictions on water quantity and quality and on water resources and discharges, an integrated water management approach is critical for ensuring reliable and adaptable solutions for various infrastructure needs are implemented (see **Figure 16**).

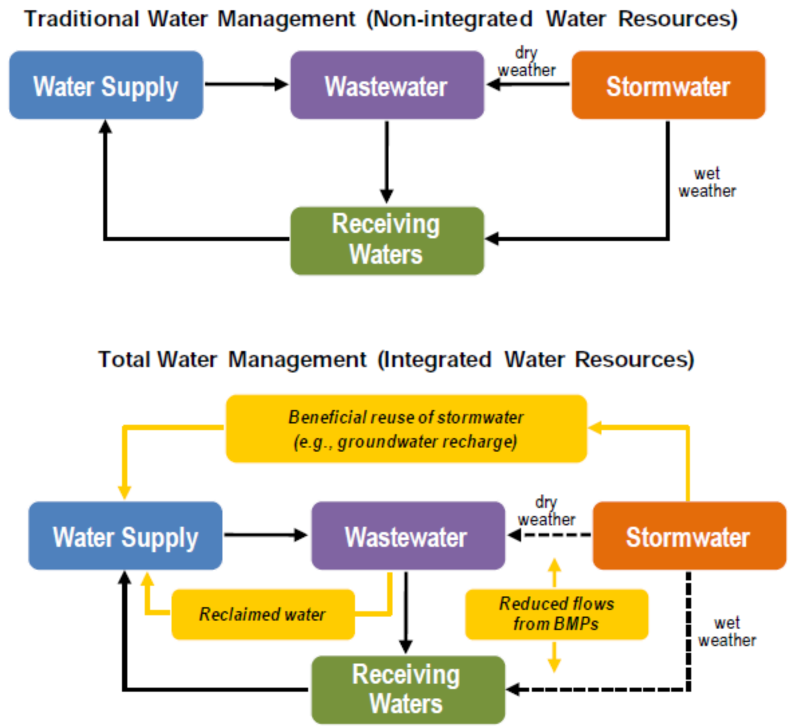


Figure 16. Traditional Non-integrated versus Total Integrated Water Management (USEPA 2012)

The US Water Alliance is a national nonprofit organization that also supports integrated water management plans at the national level. The organization advances policies and programs to build a sustainable water future for all. Through a program of national dialogues and collaborative platforms for knowledge building and peer exchange, U.S. Water Alliance uses its nationwide initiative called One Water to address key strategies related to an integrated water management plan by leveraging resources, compiling best practices engaging new partners, and demonstrating case studies of real-world examples to accelerate a more sustainable water future by developing thriving local economies, community vitality, and healthy ecosystems (US Water Alliance 2016).

Figure 17 illustrates the six key arenas of an integrated water management plan by focusing on the natural interdependence of the complex and interwoven solutions with many industry drivers and water stakeholders' interests across jurisdictions and regional variations. **Table 25** further defines the six key arenas and summarizes the key benefits and strategies recommended for any party interested in potential water reuse.

Figure 17. One Water Approach (U.S. Water Alliance 2016)

Table 25. One Water Approach Key Strategies. (U.S. Water Alliance 2016)

Key Arena	Description	Strategies
1	Reliable and Resilient Water Utilities	Diversifying and stretching water supplies; using green infrastructure to manage flooding and revitalize neighborhoods; transforming wastewater into a resource; forging new business models
2	Thriving Cities	Integrated panning across the water cycle; using onsite water systems; adopting a “dig once” approach; deploying advanced technologies to improve decision-making; managing water to foster climate resilience
3	Competitive Business and Industry	Fully integrating water stewardship into company strategy; deploying water efficiency, stormwater management, and water reuse as industrial facilities; developing upstream and downstream partnerships in priority watersheds
4	Sustainable Agricultural Systems	Using on-farm strategies to reduce water consumption and mange nutrient; creating partnerships among upstream and downstream communities; using watershed-scale planning and monitoring
5	Social and Economic Inclusion	Building a water safety net; leveraging water investments to generate community benefits; fostering community resilience in the face of a changing climate; enhancing community capacity to engage in water planning and governance
6	Healthy Waterways	Maximizing natural infrastructure for healthy ecosystems; managing groundwater for the future; protecting forests to protect water; utilizing citizen science for ecosystem monitoring and watershed restoration

At the WPC plant, one of the main drivers for the use of treated effluent over potable water is cost. The proposed additional industrial demands would require expansion of the drinking water system in the City; in this case, based on discussions between the City and industries, it is more cost effective to treat wastewater effluent to meet some of those demands.

3.4. Potential Non-potable Water (NPW) System Upgrade

The City intends to expand the existing NPW system at the WPC plant to help augment existing water resources, maximize the efficient use of the City's water supplies, and respond to potential external usage demands.

3.4.1. Internal Usage

The current onsite NPW (i.e. treated effluent water) system only consists of an irrigation pump (illustrated in **Figure 18**) that is permanently installed on the sidewall of the detention basin where it recaptures effluent before is discharged to the Elkhorn River (refer to **Exhibit 1** in **Appendix C**). Per City personal correspondence, the entire grassed area on the WPC site encompasses approximately 381,077 square feet and is irrigated with NPW in 16 different irrigation zones on an as-needed basis. Flow data for the existing NPW system is summarized below in **Table 26**.

Figure 18. Photo of Irrigation Pump for WPC Site Irrigation (photo taken 6/25/19)

The City has identified potential internal future uses including but not limited to wash water for the existing BFP within the Solids Handling Building, mechanical seal system for the effluent pumps in the Thickening Building, and wash water for various facilities on site. Flow data for potential internal usage of the NPW system to support the next 20 years of operations at the plant is summarized below in **Table 26**.

3.4.2. External Usage

The City has participated in initial discussions with two potential significant industrial users regarding the potential interest of using NPW to blend with the City's potable water to meet individual industrial water demands (since the City cannot supply demand solely with potable water). The two potential industries interested in NPW are referred to as a commercial food processing industry and a steel company industry as indicated in **Exhibit 3** in **Appendix E**. Although the pipe sizing has not been designed, a proposed alignment has been suggested based on the City's proposed Omaha Lift Station and force main project, right-of-way, and main roadway routes.

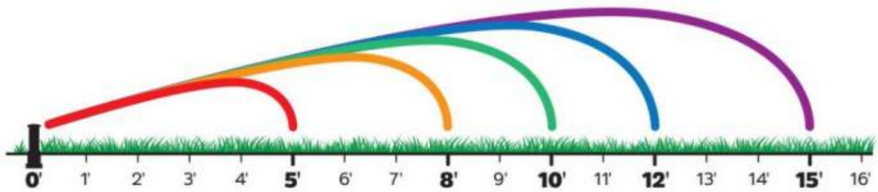
It was assumed that sewer service (and therefore NPW service) for the steel company shall be online by Year 2 (through 2021). It was also assumed that sewer service (and therefore NPW service) for the commercial food processing industry shall be online by Year 10 (through 2030).

The City is interested in identifying other potential industrial users along the predefined alignment of the NPW extension mains. The Northeast Community College and City's Regional Center (as illustrated on **Exhibit 3** in **Appendix E**) have preliminary been identified as potential industrial users that could benefit from the NPW for irrigation purposes. Flow data for potential external users of the NPW system are summarized below in **Table 26**. The flow data supports the next 20 years of operations at the plant.

Table 26. Non-Potable Water (NPW) Demand Calculations (through 2040)

#	Facility Description	Equipment Description	Water Usage Purpose	Unit Water Demand, Q (gpm)		Unit Water Demand, Q (MGD)	
				Average	Peak	Average	Peak
Internal Existing Uses							
1	Overall Site	Irrigation Pump	Site Irrigation 381,077 sq. ft. 16 zones	**121**	**121**	**0.17**	**0.17**
2	Solids Handling Building	Water Booster Pump #1	Belt Filter Press Wash	45	90	0.06	0.13
3		Water Booster Pump #2		30	60	0.04	0.09
4	Aeration Building	Effluent Pump #1 for Thickener	Mechanical Seal	5	10	0.01	0.01
5		Effluent Pump #2 for Thickener		5	10	0.01	0.01
6		Effluent Pump #3 for Thickener		5	10	0.01	0.01
7	Grit Building	Grit Washer	Wash Water (intermittently)	35	70	0.05	0.10
8	Bar Screen Building	Influent Screen Wash Press		9.5	19	0.01	0.03
9	Special Waste Area	Hydrant/Wash Hose		250	500	0.36	0.72
10	UV Detention Basin	Hydrant/Wash Hose		250	500	0.36	0.72
11	New Truck Receiving Area	Hydrant/Wash Hose		250	500	0.36	0.72
Sub Total / Maximum				**884.5**	**1,769**	**1.27**	**2.54**
External Future Uses							
12	Steel Company	Industrial Reuse / Blending	50% blend of 1,700 gpm (24/7 operations)	850	850	1.22	1.22
13	Commercial Food Processing	Industrial Reuse / Blending	50% blend of 325,000 gpd (24/7 operations)	113	113	0.16	0.16
14	Regional Center	Irrigation Pump	Area: 1,530,715 sq. ft. (15 zones)	520	520	0.75	0.75
15	Northeast Community College	Irrigation Pump	Area: 2,729,312 sq. ft. (3 zones)	927	927	1.34	1.34
Sub Total / Maximum				**2,410**	**2,410**	**3.47**	**3.47**
Internal and External Existing and Future Uses							
Grand Total / Maximum				**3,415.5**	**4,300**	**4.91**	**6.18**

Calculations for the purpose of site irrigation assume the industry guidelines illustrated in **Figure 19**, the total site square footage and irrigation zones documented above, and that existing sprinklers have a 10-foot radius rotating in full circle per **Figure 19**. Therefore, an estimated 1.6 gpm water demand is estimated per sprinkler head.



SPRAY HEAD FLOW – *Average Gallons Per Minute (GPM)*

SPRAY HEAD ARC COVERAGE	1 Quarter (1/4) 90° Arc	1 Third (1/3) 120° Arc	1 Half (1/2) 180° Arc	2 Thirds (2/3) 240° Arc	3 Quarters (3/4) 270° Arc	Full Circle 360° Arc
5' Radius	0.10	0.12	0.21	0.25	0.29	0.39
8' Radius	0.25	0.31	0.50	0.70	0.76	1.02
10' Radius	0.40	0.55	0.80	0.97	1.04	1.60
12' Radius	0.61	0.80	1.23	1.60	1.78	2.50
15' Radius	0.91	1.20	1.80	2.34	2.75	3.70

Numbers are based on an average of three top brand sprayheads and at an optimum water pressure of 30psi.
Variations will occur with various brands and at different water pressures.

Figure 19. Spray Head Angles, Throw Distances, and Flow Estimates (Irvine 2019).

3.5. Options

To address how best to implement a long-term water management strategy for NPW reuse purposes, this section of the report is focused on NPW potential improvements to the WPC plant as a phased approach. Flow data referenced previously is in alignment with projected hydraulic flows related to the 20-year plan for future expansion efforts; however, industrial demands will require full implementation of an NPW upgraded system by Year 1 (through 2021).

3.5.1. Non-potable Water (NPW) System Extension

A high-level conceptual cost estimate shown in **Table 27** has been developed for extension of the NPW distribution system as illustrated in **Exhibit 3** in **Appendix E**.

Table 27. Opinion of Probable Cost for NPW Sewer Extension Project (Part 1 of 3)

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1	**Water Main to WPC Plant**				
1.1	Mobilization / Demobilization	1	LS	$9,000	$9,000
1.2	12-inch Water Main, DI	3,000	LF	$50	$150,000
1.3	12-inch Gate Valve w/Box	1	EA	$2,200	$2,200
1.4	Fire Hydrant Assembly	5	EA	$3,200	$16,000
1.5	12-inch Ductile Iron Fittings	8	EA	$900	$7,200
1.6	Connection to Water System	1	EA	$1,200	$1,200
				Subtotal	**$185,600**
				Contingency 30%	**$56,000**
				Engineering 20%	**$37,000**
				Total	**$278,600**
*Does not include O&M costs					

Table 27. (cont'd) Opinion of Probable Cost for NPW Sewer Extension Project (Part 2 of 3)

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
2	**Pipeline to Development along Victory Road**				
2.1	Mobilization / Demobilization	1	LS	$71,000	$71,000
2.2	16-inch Force Main, PVC	23,960	LF	$55	$1,317,800
2.3	16-inch Directionally Drilled Force Main, PVC	850	LF	$210	$178,500
2.4	16-inch Plug Valve w/Box	4	EA	$2,500	$10,000
2.5	Trenchless Crossing w/ 24"x0.375" WT Steel Casing	940	LF	$650	$611,000
2.6	16-inch Ductile Iron Fittings	20	EA	$1,500	$30,000
2.7	Air Release Structure	5	EA	$7,500	$37,500
2.8	Connection to Existing Sewer Manhole	1	EA	$2,000	$2,000
2.9	Tracer Wire Test Box	13	EA	$450	$5,850
2.10	Remove Concrete Pavement	1,205	SY	$5	$6,025
2.11	Place 8-inch Concrete Pavement	655	SY	$55	$36,025
2.12	Place 6-inch Concrete Pavement	550	SY	$50	$27,500
2.13	Remove and Replace Wire Fence	100	LF	$10	$1,000
2.14	Seeding (All Types)	10	AC	$2,500	$25,000
2.15	Traffic Control	1	LS	$10,000	$10,000
2.16	Erosion Control	1	LS	$55,000	$55,000
2.17	Tree Removal / Clearing and Grubbing	1	LS	$7,500	$7,500
				Subtotal	**$2,360,700**
				Contingency 30%	**$708,000**
				Engineering 20%	**$472,000**
				Total	**$3,540,700**
*Does not include O&M costs					

Table 27. (cont'd) Opinion of Probable Cost for NPW Sewer Extension Project (Part 3 of 3)

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
3	**Pipeline to Development along Omaha Avenue**				
3.1	Mobilization / Demobilization	1	LS	$67,000	$67,000
3.2	12-inch Force Main, PVC	12,235	LF	$45	$550,575
3.3	12-inch Directionally Drilled Force Main, PVC	7,240	LF	$180	$1,303,200
3.4	12-inch Plug Valve w/Box	4	EA	$2,000	$8,000
3.5	Trenchless Crossing w/ 20x0.375-inch WT Steel Casing	425	LF	$600	$225,000
3.6	16-inch Ductile Iron Fittings	6	EA	$1,100	$6,600
3.7	Dewatering	1,000	LF	$20	$20,000
3.8	Tracer Wire Test Box	10	EA	$450	$4,500
3.9	Remove Concrete Pavement	670	SY	$5	$3,350
3.10	Place 8-inch Concrete Pavement	200	SY	$55	$11,000
3.11	Place 6-inch Concrete Pavement	470	SY	$50	$23,500
3.12	Remove and Replace Wire Fence	60	LF	$10	$600
3.13	Seeding (All Types)	11	AC	$2,500	$27,500
3.14	Traffic Control	1	LS	$5,000	$5,000
3.15	Erosion Control	1	LS	$25,000	$25,000
3.16	Tree Removal / Clearing and Grubbing	1	LS	$5,000	$5,000
				Subtotal	**$2,248,825**
				Contingency 30%	**$675,000**
				Engineering 20%	**$450,000**
				Total	**$3,373,825**
*Does not include O&M costs					
Summary					
				Grand Subtotal	**$7,193,000**
				Contingency 30%	**$2,158,000**
				Engineering 20%	**$1,439,000**
				Grand Total	**$10,790,000**
*Does not include O&M costs					

3.5.2. Non-potable (NPW) Upgrade Project for Year 1 Implementation (Option A)

Option A includes the construction of an NPW-designated lift station, filtration system, and pump station with a storage tank on the WPC site to then blend with potable water for distribution to external industrial users. **Exhibit 4** within **Appendix E** illustrates the proposed process flow diagram of the NPW system downstream of the WPC plant's discharge effluent sewer to the Elkhorn River. **Exhibit 5** within **Appendix E** illustrates the proposed conceptual site layout for the NPW system for both internal and external NPW water demands, as indicated by the purple line. **Table 28** below presents the opinion of probable costs for Option A implementation.

The preliminary design for Option A based on a design flow of 3.5 MGD assumes two 10-disk Aqua Disk® cloth media filters that would be contained in 304 stainless steel tanks and would provide 100 percent redundancy with one unit out of service. Desired influent loadings for the NPW system have been assumed based on City-provided historical water quality information and shall be verified.

Table 28. Opinion of Probable Cost for NPW Upgrade Project for Year 1 (Option A)

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1.1	Mobilization / Demobilization	1	LS	$111,000	$111,000
1.2	Lift Station / Storage Tank (100,000 gal)	1	LS	$1,138,400	$1,138,400
1.3	Filters w/Building	1	LS	$1,387,600	$1,387,600
1.4	NPW Pump Station w/Tank (100,000 gal)	1	LS	$1,020,700	$1,020,700
1.5	Stand-By Generator or Dual Feed	1	LS	$150,000	$150,000
1.6	Site Work (Seeding, Walks, etc.)	1	LS	$25,000	$25,000
				Subtotal	**$3,832,700**
				Contingency 30%	**$1,150,000**
				Engineering 20%	**$767,000**
				Total	**$5,749,700**
*Does not include O&M costs					

3.5.3. Non-potable Water (NPW) Upgrade Project for Year 20 Implementation (Option B)

Option B includes the construction of a NPW-designated lift station, filtration system, and pump station with a storage tank on the WPC site to then blend with potable water for distribution to external industrial users, as presented with Option A, except that the effluent would have multiple discharge points and bypass systems independent from low- and/or high-level river conditions. This will allow the plant effluent to be discharged to the Elkhorn River in high head situations. **Exhibit 6** within **Appendix E** illustrates the proposed process flow diagram of the NPW system downstream of the WPC plant's discharge effluent sewer to the Elkhorn River. **Exhibit 7** within **Appendix E** illustrates the proposed conceptual site layout for the NPW system for both internal and external NPW water demands, as indicated in the purple line. **Table 29** below presents the opinion of probable costs for Option B implementation.

The preliminary design for Option B based on an average design flow of 5.2 MGD and maximum design flow of 15.6 MGD assumes four 10-disk Aqua Disk® cloth media filters or two 16-disk filters that would be contained in 304 stainless steel tanks and would provide 100 percent redundancy with one unit out of service. Influent loadings have been assumed based on City-provided historical water quality information and shall be verified.

Table 29. OPC for NPW Upgrade Project for Year 20 (Option B) (Part 1 of 3)

Item	Description	Quantity	Unit	Unit Cost	Extended Cost
1.1	Mobilization / Demobilization	1	LS	$247,000	$247,000
1.2	Storage / Surge Tank (1,300,000 gal)	1	LS	$4,204,700	$4,204,700
1.3	Screw Pump & Structure	1	LS	$384,700	$384,700
1.4	Filters w/Building	1	LS	$2,489,500	$2,489,500
1.5	NPW Pump Station w/Tank (100,000 gal)	1	LS	$1,020,700	$1,020,700
1.6	Stand-By Generator or Dual Feed	1	LS	$150,000	$150,000
1.7	Site Work (Seeding, Walks, etc.)	1	LS	$25,000	$25,000
				Subtotal	**$8,521,600**
				Contingency 30%	**$2,556,000**
				Engineering 20%	**$1,704,000**
				Total	**$12,781,600**

3.5.4. Discussion

Both Option A and Option B include a tertiary filtration system as an alternative to the plant effluent discharge to the Elkhorn River. Approximately 3.5 MGD and 5.2 MGD based on average flows would be recaptured from the plant effluent discharge for internal and external reuses, respectively. The water for external industrial users would be captured for additional filtration, blended with equivalent amount of potable water, and pumped to the various sites as depicted on **Exhibit 3** in **Appendix E**. Using this system to supplement flow to the proposed steel industry will delay the need for increased capacity at the City's drinking water treatment plant and eliminate the need for water distribution system improvements to service the processing needs of the industry.

A preliminary design for an Aqua Disk® Cloth Media Filter, which is an alternative to the conventional granular media filtration technologies, has been provided by Aqua-Aerobic Systems Inc. and is included in Appendix F with preliminary design drawings. This product is highlighted for informational purposes only, Olsson does not endorse a specific brand or manufacturer. Treatment is accomplished in three simple phases with use of the exclusive Opti Fiber® cloth media, reducing phosphorus and capable of producing reuse-quality effluent. **Figure 20** illustrates the basic components of the filtration system and highlights of the filtration system are listed below.

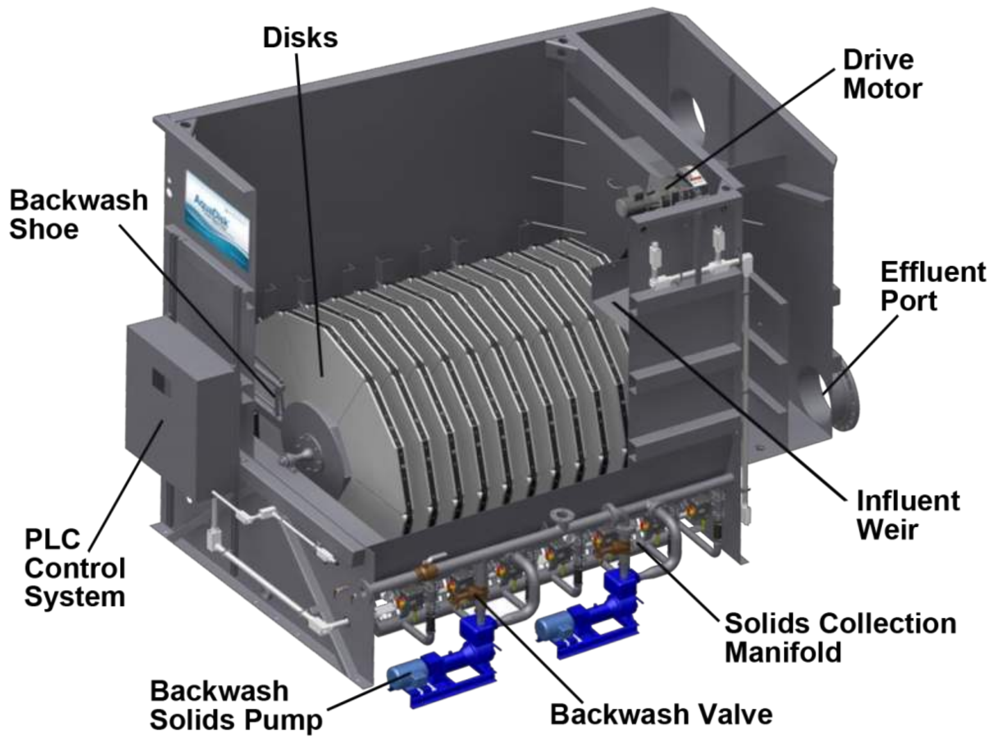


Figure 20. Typical AquaDisk® Cloth Media Filter Configuration (Aqua-Aerobic, 2019)

FEATURES & SPECIFICATIONS

- Uses any of the application specific Opti Fiber® cloth filtration media
- Vertically oriented cloth media disks reduce required footprint
- Each disk has six lightweight, removable segments for ease of maintenance
- Available in painted steel, stainless steel or concrete tanks
- New, used and rental options are available

BENEFITS

- Higher solids and hydraulic loading rates
- Low hydraulic profile
- Low backwash rate
- Fully automatic program logic control system with color touchscreen human machine interface
- Low life-cycle cost

The cloth media filters are designed to treat the anticipated average influent suspended solids to fewer than 10 milligrams per liter (mg/L) TSS. Influent suspended solids were anticipated to average 20 mg/L and be a maximum of 30 mg/L. Both options A and B can be designed to be installed in phases to support additional future growth. Option B can be chosen using either four 10-disk AquaDisk units or two 16-disk units.

During high-flow periods for the plant, the cloth media filters can serve as tertiary treatment if approved by NDEE. As loadings to the plant increase over time, this can help the WPC plant meet NPDES TSS limits. The cloth media filters are not designed to reduce other discharge parameters the WPC plant is required to meet.

Both options serve the additional benefit of allowing WPC plant effluent to be pumped to the Elkhorn River during times when the river level is high. Possible funding for water reuse efforts may be available through the USEPA green infrastructure funding initiative. It is recommended that this funding source be explored as an option for this project.

4. 10-YEAR PLAN – EQUIPMENT/FACILITY EVALUATION

This section of the master plan provides an evaluation of existing equipment and facilities and provides a discussion of improvements that are recommended to occur within the next 10 years. The evaluation accomplished the objectives summarized below. Based on limited maintenance records for current key process equipment, a maintenance program was not developed.

- Gather information regarding facility or process deficiencies for aged or worn structures or equipment requiring correction or repair to maintain long-term integrity and reliability.
- Develop an asset inventory to define purchase year for key equipment.
- Project the remaining anticipated life of key process equipment.
- Review O&M manuals, as required.
- Develop anticipated replacement program based on review of projected equipment life expectancy.
- Develop capital improvement costs for replacement of major process equipment along with building and structure maintenance.

To assist with the evaluation, the City provided a list of the WPC plant's existing assets. The information included the asset number, location, description, acquired date and assumed initial construction cost. As summarized in **Table 30**, a typical lifespan was assigned to each of the assets to then calculate remaining lifespan and to better project potential capital improvements including replacement and repair work needed. For the purposes of this inspection, only equipment valued at greater than $20,000 was reviewed. Also included in the inspection were equipment considered vital to the process, regardless of cost.

Table 30. Typical Facility and Equipment Useful Life

Component	Useful Life (years)
Building (Structural)	50
Building Roof	30
General Mechanical HVAC Equipment	20
General Electrical Equipment	20
General Slide Gates	25
Influent Mechanical Screens	25
Grit Concentration Equipment	25
Grit Pumps	20
Grit Classifiers	25
Lift Station Pumps	25
Lift Station VFDs	20
Pre-Aeration Diffusers	25
Primary/Final Clarifier Mechanism	25
Trickling Filter Media	25
Trickling Filter Mechanism	20
Trickling Filter Pumps	25
SBR Mechanism	20
Sludge Equipment	25
Blower Equipment	25
Jet Aeration Equipment	25
UV Equipment	25
Aeration Blowers	20

June 25-26, 2019, major structural components were inspected as well as equipment for current key processes; electrical; instrumentation and control (I&C); automation; and heating, ventilation, and air conditioning (HVAC). All were checked for functionality, deterioration, and corrosion. Visual inspections were performed with City staff. A narrative summary of findings for each major area of the plant is included in **Table 1**, which summarizes the inspection findings by recommendations with associated capital costs, not including O&M costs. Any work that the City was already addressing or working on at the time of inspection is not reflected in recommendations.

It should be noted that ASR is a commonly observed issue at facilities. ASR is a progressive reaction occurring within the concrete as it is continually exposed to moisture. The most effective treatment for slowing down this reaction is to eliminate contact with moisture, which is not a feasible option in most wastewater treatment facilities. The progression of the reaction will eventually lead to serious structural degradation of the concrete, and the exact timing of this occurrence is not easily predicted. The current condition of the facilities is not of structural concern at this time. With proper monitoring, the structure could be maintained for the foreseeable future. It would be beneficial to engage a specialty concrete material testing agency, such as Jensen Hughes, Inc., to further evaluate the ASR condition of all structures on-site. At a minimum, the testing agency should monitor the degradation and offer its expert opinion on further action.

4.1. Influent Diversion Structure

The influent diversion structure is located at the head of the plant, estimated to be installed around 1970. The gates were replaced between 15-20 years ago and are reported to be operating satisfactorily. Care should be taken to exercise the existing gates shown in **Figure 21** on a regular basis to keep them in good working order. Minor concrete repair and a paint touch-up should be considered to prevent deterioration of metal components, and the abandoned slide gates should be removed, as shown in **Figure 22**.

Figure 21. Existing Slide Gates (photo taken 6/25/19)

Figure 22. Abandoned Slide Gate (photo taken 6/25/19)

4.2. Plant Headworks

4.2.1. Bar Screen Building

Moisture is seeping throughout the concrete masonry unit walls, showing through on both the inside and outside faces of the block, as shown in **Figure 23**. The building should be reinsulated to prevent premature mortar deterioration. Though City staff stated that the electric unit heater was replaced in 2018, the supply air register is covered in winter to prohibit freezing in the building. Therefore, the HVAC system should be evaluated more closely and possibly resized to provide enough heat to keep the equipment from freezing in the winter. The lower explosive limit gas detector unit does not work and has been turned off. This should be replaced immediately for building occupant safety, especially in the winter when doors are typically kept closed.

Figure 23. Moisture Seepage Through Concrete Masonry Unit Walls (photo taken 6/25/19)

4.2.2. Lift Station

The City reported that most HVAC systems on-site, especially in hard environments such as the lift stations, are only good for two or three years before needing to be replaced. A system more suited for these environments should be considered for installation in these areas.

4.2.2.1. South Lift Station

The South Lift Station has been going through renovations for the last couple of years to replace the raw influent pumps #5 and #6, associated piping, and variable frequency drives (VFD)s. A new makeup air unit (MAU) was also installed in April 2019.

Overall, the facility and equipment are in good shape. The only item needing attention is a gap between the sidewalk and the west side of the building that needs to be sealed and caulked.

4.2.2.2. North Lift Station

The pumps, gate valves, and check valves need to be replaced immediately. All four check valves are original to the 1950's, and one is currently broken. The gate valves are also outdated and need replacing. Because the flanged piping is of unknown age and varying valve dimensions, it is recommended that a full valve and pipe replacement project be considered. Overhead valves should be installed with chainwheel operators.

Another factor in considering a full pipe replacement project are the outdated and failing wall connections. At least one lead-oakum wall connection on the north side of the dry pit is beginning to spall and should be replaced soon, as shown in **Figure 24**.

Figure 24. Failing Wall Connection (photo taken 6/25/19)

It was noted during the inspection that the fan supplying fresh air to the dry pit does run, but no air movement was felt at the supply outlet in the lower level. It's possible that the fan simply has a broken belt, but more extensive HVAC updates may be required. Several small exposed wiring and other various electrical code violations should be corrected during upgrades to this facility.

4.3. Grit Removal & Pre-aeration Basins

While the gate for Grit Basin #2 was replaced within the last five years, there is currently no way to fully close off flow to Grit Basin #1 to provide for flexibility in hydraulic operations or provide for O&M needs. Furthermore, the existing grit collection system is inefficient and does a poor job collecting grit. City staff stated that often diffusers (which are also near the end of their life expectancies) in the pre-aeration basins are covered with grit. A replacement for the Grit Basin #1 collector system has already been ordered and is located on-site that the City plans to install. A more efficient grit collection system could be installed, while possibly eliminating the need for the diffusers and aeration system.

Some spalling and cracking of the concrete structure was observed, especially around pipe penetrations, as shown in **Figure 25**. This is different than the ASR cracking seen elsewhere. However, damaged concrete in this basin should be cut out and patched if this structure will remain in service beyond five years. The concrete slab around the south inlet pipe has cracked and heaved, leaving a void beneath it, as shown in **Figure 26**. The concrete in this area should be removed to allow for enough backfill and compaction. The surface could then be covered with rock, as with the north side, or a new concrete slab should be poured.

Figure 25. Concrete Cracking (photo taken 6/25/19)

Figure 26. Concrete Upheaval at South Inlet Pipe (photo taken 6/25/19)

4.4. Primary Clarifiers

4.4.1. Primary Clarifier #1

The overall concrete structure for Primary Clarifier #1 appears to be in good shape. The scum baffle has no gaps or dips, and water is flowing through the weirs evenly. The clarifier mechanism was installed in the 1970's, but the drive was replaced in 2018. Because of the anticipated life expectancy, replacement of the clarifier mechanism should be considered. Since the clarifier was in use, the components below the water surface could not be inspected.

4.4.2. Primary Clarifier #2

Small, vertical cracks are around the perimeter of the clarifier, but City staff indicated there is no evidence of the clarifier leaking. These cracks should be inspected on a regular basis to ensure they are not getting worse over time. The clarifier mechanism appears to be original to the 1958 installation. Because of the anticipated life expectancy, replacement of the clarifier mechanism and drive should be considered. Since the clarifier was in use, the components below the water surface could not be inspected.

4.4.3. Primary Clarifier #3

Small, vertical cracks are around the perimeter of the clarifier, but City staff indicated there is no evidence of the clarifier leaking. These cracks should be inspected on a regular basis to ensure they are not getting worse over time. The clarifier mechanism appears to be original to the 1996 installation. Because of anticipated life expectancy, replacement of the clarifier mechanism and drive should be considered. Since the clarifier was in use, the components below the water surface could not be inspected.

4.5. Trickling Filters

4.5.1. Trickling Filter #1 (South)

Trickling Filter #1 (South), which was constructed in the mid-1980’s, has some cracking of the concrete as shown in **Figure 27**, that does not appear to be associated with ASR as seen elsewhere. The cracks are mostly horizontal and up to a quarter inch in width, and they traverse the entire perimeter of the structure, though no single crack makes it all the way around. Some of the cracks look as though they have been tooled out and an attempt to patch them was made. Stains on the exterior of the structure point to moisture seeping through. It would be prudent to inject epoxy into all cracks greater than an eighth of an inch wide and look at sealing both sides of the structure.

Figure 27. Cracking Observed on Trickling Filter #1 (South) (photo taken 6/25/19)

The interior of the of the trickling filter structure above the media has an existing coating that is sloughing off, as shown in **Figure 28.** Concrete below this layer is showing signs of deterioration, with about a quarter inch of material gone in some places. Blasting the concrete and recoating would provide protection against further deterioration; however, this process would require removing the existing redwood media. The media itself looks to be in decent shape, but once removed should be replaced with synthetic media for better treatment performance. There are no obvious issues with the roof.

Figure 28. Inside Trickling Filter #1 (South) (photo taken 6/25/19)

4.5.2. Trickling Filter #2 (North)

Based on the spiderweb-type cracking around the entire perimeter, the Trickling Filter #2 (North) structure shows symptoms of ASR, as shown in **Figure 29**. The cracks extend up to the level of the media inside, providing further evidence that moisture is getting through the interior coating system and concrete wall. The interior coating system should be removed and reapplied to protect the concrete. The roof structure, trickling filter mechanism, and plastic media all appear to be in good shape.

Figure 29. Alkali-Silica Reaction (ASR) of Trickling Filter #2 (North) (photo taken 6/25/19)

4.5.3. Trickling Filter Pump Building

In the Trickling Filter Pump Building, pumps #1 and #2 are not being used. Pumps #3 and #4 normally run one at a time; however, City staff stated that pump #4 has a leaking mechanical seal so it's not being used at this time. The City reported that new VFD's will be installed on pumps #3 and #4 soon.

The valves are operational, but sticking, and City staff thought that they should be replaced soon. All valves should be on a rotating exercise schedule to ensure they operate when required. These could possibly be sold to another municipality to generate revenue.

The 620-kilowatt D348 Cat Generator appears to be in good shape. No information was available as to installation date. The switchgear and transfer switch appear to be dated. The same can be said of the motor control cabinet (MCC) in this building. Depending on availability and cost of spare and repair parts, the electrical system should be upgraded soon.

4.6. Sequencing Batch Reactor (SBR)

The four-cell SBR unit, as shown in **Figure 30,** was constructed in the mid-90's and is starting to show signs of age. In addition, the four-cell SBR unit is exhibiting evidence of ASR degradation that will potentially affect the life of the unit. It is recommended that testing and visual inspections be conducted over the next two years to determine the extent and rate of degradation so the overall lifecycle of the SBR can be determined.

City staff said that replacing the internal components to the decanters is in this year's budget. The mixers are in good shape, having had the motors rebuilt every four years. The diffusers are also serviced at that time. All the mixer power cords have recently been replaced. The valve actuators and stands should be repainted.

Figure 30. Existing Four-cell Sequencing Batch Reactor (SBR) Unit (photo taken 6/25/19)

There are some concerns with the electrical disconnects on the exterior wall of the SBR. The interior components, outlets and switch boxes are corroding. All electrical boxes and conduit should be replaced with stainless steel and/or aluminum. During the inspection, it was noted that the electrical boxes and transformer in the southeast corner of the SBR are settling and pulling away from the wall. The cause for the settlement should be investigated, and the electrical components should be replaced. The City would like to take the opportunity to replace these boxes with stainless steel for corrosion protection. This project is currently being addressed so was not included in the planning cost estimates for capital projects found at the end of this section.

The City has concerns with corroded gates and piping in the SBR influent box. City staff stated that the piping inside the box was sandblasted and painted a couple of years ago, and some hardware was replaced. However, influent knife gate valves need to be replaced. Packing does not seal, nuts and bolts require replacement because of corrosion, and much of the electrical conduits are corroded and need to be replaced. City staff would like to replace the knife gate valve actuators as part of an overall rehabilitation project for the SBR influent box.

4.7. Blower Building

Though it’s one of the newer structures at the facility, the blower building could use some exterior repairs. Several of the soffit vents were missing. The screen built around the air conditioner unit on the north side of the building has been damaged and should be replaced. City staff reported that the blowers are running well; however, the MCC is original and could be updated. In addition, the building’s HVAC system needs to be replaced.

4.8. Chlorine Contact Chamber

The chlorination building is currently being used as storage, and the structure is in overall good condition. The south unit heater is not working, but as there is no water to the building right now the City is not concerned about heating it. The north unit heater does work. City staff said the MAU has not been used in years, though it did work when it was shut down in the early 2000s when the UV disinfection system was installed.

4.9. Aeration Basin (Offline)

The existing aeration basins #1 and #2 are both offline and abandoned based on current operations. Both concrete structures are in a similar condition. The effluent box on both structures show signs of ASR. Concrete walls on the rest of each structure appear to be sound. While tanks are still out of service, it is recommended that the cast-in-place effluent boxes on both structures be demolished and reconstructed.

Old sludge, mud, and water have collected in the bottom of each basin, and vegetation has been growing in each. All this material will need to be removed, and the basins cleaned. The fiberglass air piping and diffusers show signs of UV degradation and need to be replaced. The ductile iron air piping above grade needs to be sandblasted and repainted at a minimum. The condition of below-grade air piping was not assessed during this investigation. However, it would be advisable to evaluate the condition of the pipe after some minor exploratory excavations. Piping and all metal pipe support and baffles show signs of deterioration and need to be replaced. Metal grating and handrailing should be replaced with the reconstruction of the effluent boxes. The DO sensor control boxes need to be replaced. New control boxes would be provided with new DO sensors. All electrical disconnects, conduit, wiring, receptacles, etc. should be removed and replaced with weatherproof equipment.

4.10. Final Clarifiers (Offline)

Final clarifiers #1 and #2 were built in 1982 and 1970, respectively. The concrete structure for final clarifier #1 appears to be in good shape with minor shrinkage cracking, but nothing that looks like it would cause leakage. Final clarifier #2, however, has some larger vertical cracks every 3-4 feet around the entire perimeter of the concrete structure. It is recommended epoxy be injected at cracks to prevent leakage of the clarifier, and to prevent intrusion of water from causing the cracks to get larger through freeze/thaw cycles. Additionally, the effluent box on final clarifier #2 shows evidence of ASR. This effluent box should be removed and replaced with a new cast-in-place box.

Both clarifiers would require complete removal and replacement of clarifier mechanisms, including electrical and structural components. Stilling wells, sludge rakes, scum baffles, weirs, etc. all would need to be replaced because of corrosion. All exposed piping needs to be replaced because of corrosion. A subsurface investigation should be performed to evaluate the condition of the below-grade piping on both structures. Old sludge, mud, and water have collected in the bottom of each basin, and vegetation has been growing in each. All this material will need to be removed, and the basins cleaned.

Refer to Section 2.4.2 for recommendations and cost estimates.

4.11. Ultraviolet (UV) Disinfection Chamber

The UV disinfection facility was constructed in the early 2000’s, and City staff stated all is running well.

4.12. Detention Basin

This clarifier structure has been converted into a detention basin to equalize the effluent water prior to sending it to the UV disinfection system. The concrete structure is in decent shape. Some of the concrete is cracking, but nothing major. The concrete should be monitored on a regular basis to ensure it does not get worse.

4.13. Outfall Structure

The facility outfall structure was taken out by flooding, and the City would like to rebuild it in a future project. It was reported that the City has had problems pushing effluent out to the river during high water events. The City may consider different pumping options to boost pressure out to the river temporarily during such situations.

4.14. Sludge Process

4.14.1. Sludge Handling Building

The Sludge Handling Building was constructed in 1970 but has had its roof replaced within the last five years. City staff stated that the roof may leak near the roof drains; these leaks should be investigated. Rooftop MAUs and exhaust fans are in working order. MAU hoods and insulation are showing signs of corrosion and should be replaced.

The storage silo on the north side of the building was recoated within the last five years and has had its doors replaced. The City has been working to replace the Unistrut and conduit with PVC pipe and stainless steel. Painting work is ongoing, but it is mostly done during the winter as filler work. Damage to the brick veneer on both ends of the truck bay was likely caused while parking wide City trucks. Relocating bollards may help force the trucks into place, but the damage to the building, as shown in **Figure 31,** should be repaired.

Figure 31. Damage to Brick Veneer (photo taken 6/25/19)

The cement kiln dust feed components, including the storage silo on the south side of the building should be recoated, and the screw equipment needs to be replaced.

City staff reported that the existing Komline BFP is in the current capital improvement plan to be rebuilt. Although it was last rebuilt in 2014 with the conveyor, the west backflow preventer and the booster pump are leaking. The hoist was replaced in 2018, though City staff said they wished they had a bridge crane rather than the monorail. The City is looking into replacing the polymer feed room lighting with LED lighting. The furnace in the lab/control room was replaced in 2018.

4.14.2. Sludge Pumping Building

The louvers on the east side of the building are rusting so they should be monitored and replaced before the corrosion worsen. The three sludge transfer pumps are being rebuilt at this time. The two Gardner Denver blowers have been replaced in the last few years. The City is working to replace valves in the Sludge Pumping Building as well.

4.14.3. Sludge Tank

The west side of the sludge tank shown in **Figure 32** should have its roof replaced because of deterioration, though City staff stated that this side is not used much. The east side holds waste from the grease trough from Sludge Thickener #1.

Figure 32. Sludge Holding Tank Cover (photo taken 6/25/19)

4.14.4. Sludge Thickeners

Sludge Thickener #1 had its mechanism replaced in 2018. The bridge has also been recently painted. No major improvements are required at this time.

4.14.5. Sludge Thickener Building

The sludge transfer pumps have been replaced in the last five years. City staff stated that all valves, approximately 20, need to be replaced. If valves are replaced, it is recommended that piping be replaced at the same time or recoated with paint if not replaced.

4.15. Other

4.15.1. Administration Building

The stucco finish around windows and on window corbels is peeling and should be replaced, however. The City is looking at replacing the windows, which could be done as part of a general window replacement project throughout the facility. The walkout door on the west side needs to be replaced, along with some of the door closures throughout the building. The rollup door at northwest corner needs to be replaced. The current budget allows for replacing one overhead door per year at the facility, but a door/window project specifically for the facility could be considered for a single project.

The MAU over the lab was replaced in 2013, but City staff thought it would probably be replaced soon. The laboratory drain and main building drain piping need to be replaced. They currently need to be cleaned out once per year because of corroding pipes.

The women’s restroom also has not been updated and should be upgraded to meet current codes. Regarding the electrical system, the MCC and transfer switch in the control room look to be outdated, and a project to replace these systems should be investigated. Obsolete and hard-to-find parts will continue to make maintaining the current system increasingly difficult and expensive.

4.15.2. Shop

The shop was built in the mid-1980s with additions made in the mid-1990s. The north rollup door is showing signs of corrosion, and the City would like to replace it with a new door. The walk-in door in the northwest corner is rusting near the base and will likely need to be replaced soon. Ceiling insulation and lining is starting to deteriorate and should be replaced.

4.15.3. Pavement

Several sections of the driveway at the facility are in disrepair and should be replaced. Most notably, the drive between the abandoned clarifiers and aeration basins, to the south of the administration building, and to the south of the sludge holding tank all have moderate to severe damage.

4.16. Recommendations

To address the equipment and facility evaluation associated with the master plan, recommendations within are made for improvements to the WPC Plant within the next 10 years (2030), in consideration with the 5-year and 20-year plans to optimize usage and replacement of equipment/facility. Costs for repairing or replacing equipment were summarized in **Table 1** to confirm they were in alignment with the existing/projected WPC Plant capacity evaluation (Sections 1 and 2), non-potable water reuse (Section 3), and the projected nutrient limits evaluation (Section 5).

4.17. Conclusion

The inspections conducted in the field were limited to visible features and elements. Furthermore, the evaluation does not or shall not withdraw or dismiss any of the existing regular maintenance plans. In addition to the repair of identified defects, all applicable maintenance plans should be performed to avoid future deterioration and damage. If such plans and schedules do not exist, a comprehensive maintenance plan should be developed to prevent further structural damage to the existing buildings and structures.

The suggested capital replacements in this Section of the report amount to approximately $300,000 per year over the next ten years. See **Appendix H** for a table summary of all expenditures.

5. 20-YEAR PLAN – PROJECTED NUTRIENT LIMITS EVALUATION AND SOLIDS HANDLING OPTIONS

The purpose of this section of the master plan is to evaluate treatment expansion needs and determine upgrades or modifications needed to increase the facility's firm capacity within the next 20 years (to 2040). Recommended treatment alternatives were developed to address permitted capacities, design hydraulic flow rates, organic and solids loadings, and anticipated regulatory requirements for biological nutrient removal (i.e. nitrogen and phosphorus). An alternatives analysis was also conducted to plan for the increased solids production expected as part of these treatment processes. A BioWin model was developed to evaluate the effectiveness of recommended treatment alternatives in removal of nutrients.

5.1. Anticipated Regulatory Requirements

Conventional biological processes in wastewater treatment plants are typically designed to meet secondary treatment effluent standards, which do not address total nitrogen (TN) and total phosphorus (TP) removal to the extent needed to protect receiving waters. Therefore, wastewater treatment facilities are increasingly being required, through discharge permits, to upgrade treatment processes that reduce nutrient concentrations to safe levels. Challenges associated with major infrastructure upgrades for nutrient removal can include major process modifications and significant changes in treatment operations.

Additional emerging contaminants of concern are synthetic and naturally occurring chemicals or microorganisms that are not commonly monitored. These compounds consist of pharmaceuticals, pesticides, industrial chemicals, surfactants and personal care products in which significant traces are found in wastewater discharges. As state environmental regulatory agencies are increasingly developing new or more stringent standards for removal of TN, TP, and other compounds to protect water quality, compliance strategies must be implemented now to effectively plan and budget for implementation of new technologies, identify potential design and operational issues such as carbon sources and temperature effects, and address potential impacts on sludge handling. PFAS (per- and polyfluoroalkyl substances), for instance, are expected to be regulated more heavily, which will affect treatment and sludge handling options in the future.

Through conversations with NDEE, more stringent nutrient removal requirements are anticipated within the next five to 10 years' timeframe. The extent of nutrient removal requirements is difficult to predict because updated NDEE regulations have not been finalized; however, NDEE is looking to develop a program like those of the Kansas Department of Health and Environment and Iowa Department of Natural Resources. The program may even include contaminant credits and trading.

Potential future permit limits through 2040 were developed that pertain to TN and TP. Effluent TSS and BOD limits are anticipated to be below 10 mg/L. Therefore, the alternatives evaluation assumes that future permit limits will include a limit of 10 mg/L for both constituents once TN (10 mg/L) and TP (1 mg/L) limits are imposed. The current and potential future average monthly effluent permit limits assumed for this portion of the evaluation are summarized in **Table 31**.

Table 31. Current and Potential Future Average Monthly Effluent Permit Limits

Constituent	Current (2018)	2025	2040
Flow, MGD	2.95	5.85	8.47
BOD, mg/L	30	10	10
COD, mg/L	25.00	5	5
TSS, mg/L	30.00	10	10
TN, mg/L	-	10	10
TP, mg/L	-	1	1
Spring Ammonia (March 1 – May 31)	7.92	1	1
Summer Ammonia (June 1 – Oct 31)	2.50	1	1
Winter Ammonia (Nov 1 – Feb 28)	7.96	1	1
***E Coli*, lb/100 mL**	126	126	126

5.2. Biological Nutrient Removal Process

Nutrient removal is achieved by creating different process environments designed to promote the growth of targeted microorganisms and by supporting chemical reactions necessary to reduce specific nutrients. Three process conditions are typical in wastewater treatment and are based on the levels of DO present in the wastewater. All wastewater treatment processes use some combination of these conditions in phases to reduce nutrients. These processes are optimized to ensure the most efficient removal possible and are briefly explained below in **Table 32**. A complete treatment plant has flows and recycle flows that pass through the zones described below to achieve to desired degree of treatment coupled with other physical and chemical processes to create the effluent quality necessary for discharge. In order to achieve future permit conditions, biological nutrient removal will be required.

Table 32. Typical Objective of Various Treatment Process Conditions

Condition	Objective
Anaerobic Zone	Promotes phosphorus release which causes a luxury uptake of phosphorus in the aerobic zone. (reduces TP)
Anoxic Zone	Promotes denitrification, nitrogen gas release, alkalinity recovery from the oxidized ammonia (nitrate) created in the aerobic zone. (reduces TP)
Aerobic Zone	Promotes the uptake of organics, the enmeshment of TSS into microorganisms, the conversion of ammonia to nitrate, and the luxury uptake of phosphorus into cell mass.

5.3. Design Flow Rates and Loadings

Influent wastewater flows and pollutant loadings were developed in Section 2 and forecasted through 2040 based on population growth and economic activity. A summary of the influent flows and loadings used for the model are presented in **Table 33**. Although it is atypical for hydraulic flows to increase while organic loadings decrease, the projected loadings were estimated based on both population growth and anticipated industrial expansion (i.e. non-contact cooling water) in the City of Norfolk. These values will be used as the benchmark for effective treatment in the BioWin model and are based on recent data of plant performance.

Table 33. Modeled Input Influent Flows and Pollutant Loadings

Parameter	Unit	Current (2018)	Projected 5 Year (2025)	Projected 20 Year (2040)
Flow	MGD	3.11	5.85	8.47
BOD_5	mg/L	695	384	293
COD	mg/L	1,360	905	690
TSS	mg/L	415	234	189
TKN	mg/L	54.3	30.6	23.8
Ammonia	mg/L	25.8	14.7	12.1
TP	mg/L	12.5	7.15	5.84
TN	mg/L	54.5	31.1	25.6

5.4. BioWin Modeling of Existing System

A wastewater process simulation software (i.e. BioWin by EnviroSim) was used for modeling purposes to simulate biological, chemical, and physical processes that take place at the WPC plant. The BioWin model is an industry standard that is commonly used to simulate biological models, and it combines mass transfer, oxygen/other gas-liquid interactions, and water chemistry models.

The existing treatment plant processes were modeled to serve as a tool for any future modifications at the WPC plant. The existing model setup and calibration are described here. Future conditions are also modeled later in this report.

5.4.1. Setup of Existing System (2018 Loadings)

To establish base conditions, existing plant conditions were modeled based on plant operations to date. More specifically, the plant was modeled based on the following wastewater treatment processes as illustrated in **Figure 33**. It should be noted that the modeling software does not have chlorine addition systems, UV disinfection systems, or solids handling in its process selection; therefore, solids and sludge wastes were modeled as an effluent to each corresponding process.

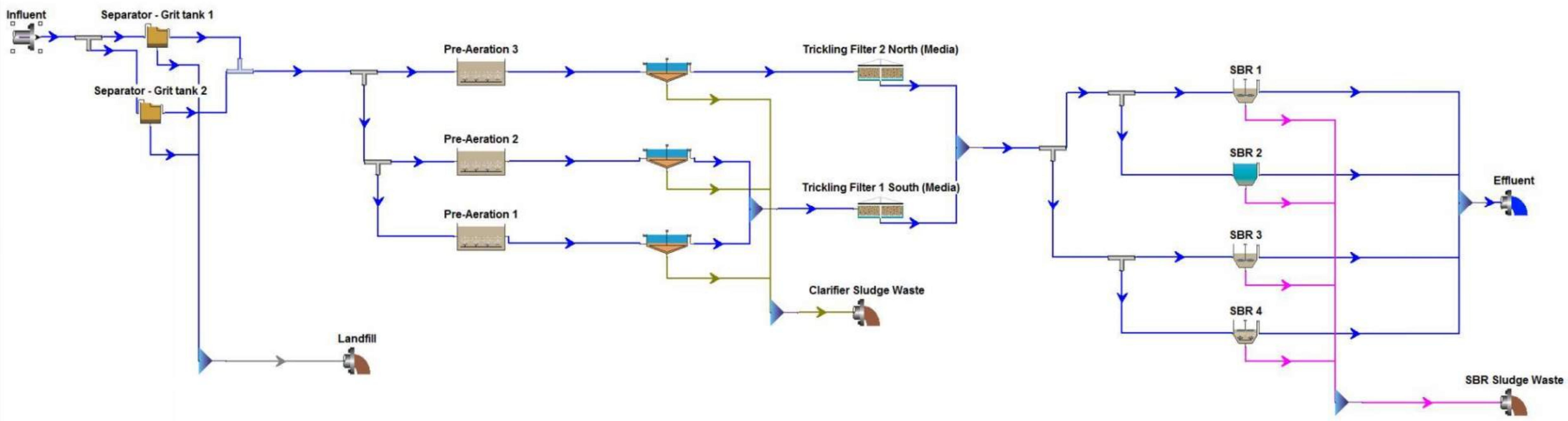


Figure 33. BioWin Model of Existing System

5.4.2. Calibration of Existing System (2018 Loadings)

The City's wastewater stream is different from typical domestic wastewater because of industrial loadings. The organic strength is greater than normal domestic waste. In order to calibrate the model, specific influent characteristics, such as coefficients for various discharge parameters, were modified to approximate the WPC plant's actual laboratory data summarized in **Appendices A and B**.

The model was further refined based on current operational conditions and separated into two models that were ran simultaneously. The first simulation was based on steady state conditions, which captured the influent wastewater being treated by the trickling filters, while the second simulation was based on dynamic state conditions reflected within the SBR operations because time is the driving factor in a batch process. The existing system assumptions are listed in **Table 34**.

Table 34. BioWin Existing System Process Assumptions

Process	Description	Value
Grit Tank	Percent capture of inorganic suspended solids	50
	Underflow sludge volume (grit zone volume, fraction of unit volume)	0.10
	Flow split ratio of waste/through flow	0.005
Pre-Aeration Basin	Diffuser density (%)	25
Primary Clarifier	Percent removal (%)	80
	Sludge blanket (fraction of settler height)	0.05
Trickling Filter 1 South (Media)	Media type	Horizontal
	DO concentration setpoint	Constant at 7.0 mg/L
	Gas phase modeling	DO setpoint concentration applied to top section of trickling filter

After existing conditions were defined, additional data was input into the BioWin model based on City data, which required taking the average daily values for year 2018 and projected average for years 2025 and 2040 for each parameter defined in **Table 35**. It should be specifically noted that the values for total sulfate, nitrate, alkalinity, metal-soluble calcium, metal-soluble magnesium, and DO values are not monitored by the City; therefore, these values were kept at the BioWin model default concentrations.

Table 35. BioWin Total Plant Influent - Model Input Values

Input	Unit	Current (2018)	Projected 5 Year (2025)	Projected 20 Year (2040)
Average Flow	MGD	3.11	5.85	8.47
CBOD	mg/L	1,361.56	905.08	1,018.54
TKN	mg/L	54.30	30.55	29.69
Inorganic Suspended Solids (ISS)	mg/L	166	93.67	87.87
TP	mg/L	12	12	12
Total Sulfate	mg/L	10	10	10
pH	-	7.3	7.3	7.3
Alkalinity	mmol/L	6	6	6
Metal-soluble Calcium	mg/L	80	80	80
Metal-soluble Magnesium	mg/L	15	15	15
DO	mg/L	0	0	0

5.4.3. Loading Analysis of Current Conditions (2018)

To perform a loading analysis based on existing operational conditions at the WPC plant, a comparison of CBOD removal efficiencies was performed. **Table 36** compares CBOD removal based on City-provided laboratory data in comparison to the modeled data. The model was further calibrated so the model effluent results approximated the average effluent data from 2018.

Table 36. Comparison of Model versus Actual Carbonaceous Biochemical Oxygen Demand (CBOD) Removal Percentages for Current Conditions (2018)

Condition	CBOD Percentage Removal (%)		
	Trickling Filter	**SBR**	**Overall Treatment Plant**
Lab Data	71.40	95.12	98.60
Model	70.76	99.61	99.61

The CBOD percentage removals presented above are similar in comparison to City provided laboratory data and modeled results. The modeled SBR removal rate was higher than the WPC plant's, but the overall removal rate of the model closely matched the City provided data. The performance of the model, in terms of percent removals, approximates the performance of the WPC plant as defined by the existing laboratory data.

5.5. Proposed Treatment Alternatives

Three alternatives are provided for the WPC plant to meet 2040 projected flows and BNR treatment objectives. Each subsection below describes the three (3) alternatives for secondary treatment upgrades and is further broken down into effects on individual treatment processes for ease of discussion. A discussion of primary treatment upgrades follows the three alternative discussions and will be the same for all three alternatives. Following these detailed descriptions is a comparison of the alternatives and a discussion of the evaluation performed to validate each of the alternative components. Note that the BioWin modeling process was only used for alternatives 1 and 2 as there is no function to evaluate alternative 3 within the model. The three alternatives are:

1. Expansion of the existing SBR system
2. Addition of an anaerobic, anoxic, and aerobic (AAO) treatment system
3. Replacement of secondary treatment infrastructure with Aqua Nereda® aerobic granular sludge (AGS) system

Section 2 of this plan (five-year plan section) includes a discussion of necessary actions to bring the four existing inactive basins back online to increase hydraulic capacity. Reuse of these basins was not considered in this analysis to confirm optimal BNR treatment goals could be modeled for 2040.

Vendor correspondence is in **Appendix F** for the three treatment alternatives described below.

5.5.1. Treatment Alternative 1 (T-A1): Expansion of Existing Sequencing Batch Reactor (SBR) System

Based on projected hydraulic flows and organic loadings, the existing four-cell SBR system as illustrated in **Exhibit 8** of **Appendix G** will need to be upgraded to accommodate 2040 flows and anticipated loadings Those upgrades would include integral sludge reduction, built-in flow equalization, aeration, and clarification all in one process. To allow for an increase in rated plant capacity while minimizing construction costs, Alternative 1 would expand the existing treatment system by four additional 110 by 110-foot cells. The additional site modifications anticipated beyond ancillary civil improvements and pipe routing in the yard are as detailed below for expansion of the existing SBR system.

5.5.1.1 T-A1: Trickling Filters (Roughing Filters)

The existing south trickling filter 1 was constructed in 1980 and north trickling filter 2 was constructed in 1994. Both trickling filters are 80 feet in diameter; however, south trickling filter 1 has redwood media while north trickling filter 2 has composite media. The total surface area of both combined is 10,060 ft^2. Based on 2040 average day hydraulic and organic loadings, the trickling filters will have an organic loading of 82 lbs. BOD / 1000 ft^3 of media which is in the capacity range for biological demand of 60 to 90 lbs. BOD / 1000 ft^3 of media. This loading includes flow recycle. In order to keep total surface area of media moist, under average day demands, it is recommended to recycle 19% of effluent flow (at minimum) to the trickling filter influent.

The average day and peak day hydraulic demands are 1,000 gpd/ft^2 and 1,400 gpd/ft^2 of media surface area, respectively. This includes the 19% minimum recycle rate and is within the suggested 1,000 to 1,200 gpd/ft^2 capacity range. Based on 2040 peak day hydraulic and organic loadings, the existing TFs will have an organic loading of 91 lbs. BOD / 1000 ft^3 of media which is just outside of the biological demand range of 60 to 90 lbs. BOD / 1000 ft^3 of media. Loadings higher than the 90 lbs. BOD / 1000 ft^3 turn the trickling filter into a roughing filter, which is not as efficient for BOD removal but still sustainable for downstream processes. In conclusion, the existing trickling filters can handle the projected 2040 loadings. However, the capacity of the distributor arm is unknown and needs to be considered. It is recommended that the south trickling filter redwood media be replaced with a synthetic material for more efficient BOD removal and that the media be replaced regularly per manufacturer’s recommendation.

5.5.1.2. T-A1: Biological Treatment (Activated Sludge Sequencing Batch Reactors (SBR))

The current biological treatment consists of the SBR that has four existing cells that operate on 5.5 cycles per day and waste solids from the process during the decant cycle based on the mixed liquor suspended solids (MLSS) concentration in each basin to maintain the desired mean cell residence time. The Norfolk WPC plant’s MLSS concentration is 2,350 mg/L in the summer and 2,400-2,450 mg/L in the winter. The operations assumed for modeling purposes are listed below in **Table 37** in the order of occurrence.

Table 37. T-A1 Summary of Modeling Characteristics for the Two Sequencing Batch Reactor (SBR) Units (8 cells) System

Task Description	Time Duration (minutes)	Process Description
Mix	30	Basin is mixing and filling at the same time
React fill	60	Basin is mixing, aerating, while filling to complete the fill cycle time
React	50	Basin is mixed. Aeration modulates according to a 2.30 ppm set point. Blowers start at 1.00 ppm DO and shut off at 4.00 ppm DO.
Settle	50	Mixing and oxygenation stop to allow settling to occur.
Decant	72	Decant weir opens and waste pump runs to allow wasting during the decant cycle, decant time is dependent on fill volume/time.
Total	262	4.36 hours (5.5 cycles per day)

The existing four-celled SBR unit system will not meet peak hour firm capacity in 2025; furthermore, it has a maximum hydraulic capacity of 7.87 MGD, so this structure will not be able to convey the 2040 peak day flow of 12.32 MGD since the expected year of hydraulic capacity exceedance is 2021 based on current operations.

Alternative 1 objective include maximizing use of existing infrastructure in place, it is recommended to keep the four-celled SBR unit and add an additional four-celled SBR unit system, with each cell sized at 110 by110 feet. The 2040 peak day hydraulic flows and organic loadings were used to size the proposed SBR. The existing and proposed SBR units would be operated simultaneously and flows would be split evenly between each. The summary of the modeling characteristics for the SBR and proposed conditions are listed in **Table 38** below.

Table 38. T-A1 Summary of Modeling Characteristics for the Proposed Sequencing Batch Reactor (SBR) System

Description	Quantity
Design Flow (MGD)	12.32
Number of Existing Basins	4
Number of Additional Basins	4
Cycles /Day	4
Basin Dimension	110'X110'
Sludge Age (days)	20.5
SOR (lb/d)	22,000
ICFM (ft^3/min/basin)	4,600
Blower HP (BHP/Basin)	200
Aeration Time	12 hrs. /day
Maximum Decant Rate (MGD)	24.64

5.5.1.3. T-A1: Aerated Equalization Basin

It is recommended to install or use an existing structure (like current operations utilizing the existing detention basin as an equalization basin) to act as an aerated equalization basin. Proposed non-potable surge tank volume (section 3 of this plan) could potentially serve this function. The proposed equalization basin will require enough volume to convey the proposed SBR decant rate of 24.64 MGD for one cycle. The proposed equalization basin designed effluent flow of 16 MGD, for downstream processes, will need to have a storage volume of 1,582,000 gallons including a 1.5 factor of safety. The basin dimensions for modeling purposes included 20-foot water depth, 11,000 ft^2 surface area, and an oxygen demand of 1,720 lb/d. The basin will require 542 cubic feet per minute (cfm) per basin and a 24-brake horsepower for blower size requirements. Furthermore, the equalization basin will require three 8 MGD transfer pumps (60 horsepower with VFDs) designed to transfer a firm design capacity of 16 MGD to filters.

5.5.1.4. T-A1: Filtration

The proposed filters should be sized for 16 MGD and 5 gpm/ft^2. It was assumed that the filtration system would contain 12 active filters with one out of service. Therefore, it was estimated that 13 total filters would each have a width of 10 feet and length of 20 feet. A backwash rate of 20 gpm/ft^2 for 10 minutes (2,963 gpm) would require a backwash volume of 40,400 gallons. It was assumed that two backwash pumps, each at 3,000 gpm (one duty, one standby), would be 40 horsepower on VFDs with electric actuated valves.

5.5.1.5. T-A1: Reuse Basin

The reuse basin was sized for 3 times the backwash volume; therefore, the design is based on one basin with a total volume of 121,250 gallons.

5.5.2. Treatment Alternate 2 (T-A2): Replacement with Activated Sludge Anaerobic, Anoxic, Aerobic (AAO) Treatment System

Alternative 2 proposes similar treatment objectives based on projected hydraulic flows and organic loadings as Alternative 1; however, the unit processes of equalization, biological treatment, and secondary clarification would be accomplished by using separate tanks for an AAO treatment system as shown in **Exhibit 9** of **Appendix G** as opposed to within a single tank using a timed control sequence. Therefore, additional footprint at the facility will be required for tank expansion. The additional site modifications anticipated beyond ancillary civil improvements and pipe routing in the yard are detailed below for the addition of an activated sludge system.

5.5.2.1. T-A2: Trickling Filters (Roughing Filters)

All recommendations and requirements discussed in 5.5.1.1 for alternative 1 apply to alternative 2 with additional commentary here. For an AAO treatment system to function efficiently, a minimum BOD concentration of 140 mg/L needs to be reached in both anaerobic and anoxic basins to produce a phosphorus concentration of less than 1 mg/L. Under 2040 average day conditions, it is expected that effluent BOD concentrations of around 90 mg/L in the trickling filter effluent. Therefore, flow will be required to be bypassed around the trickling filters into the anaerobic basin to increase BOD concentrations to about 140 mg/L at a minimum. Based on this information, it is recommended to bypass about 20% of flow.

It should be noted that the more flow that is bypassed to increase BOD concentration, which increases phosphorus removal, results in higher oxygen requirements in the aeration basin. If bypass flows are reduced, then phosphorus removal is decreased, and chemical injection will be required at the final clarifiers for effective phosphorus removal.

5.5.2.2. T-A2: Biological Treatment (Anaerobic, Anoxic, Aerobic (AAO) System)

As part of this alternative, it is recommended to decommission the four-celled SBR unit and construct an AAO treatment system, which is a BOD and nutrient removal design that uses anaerobic conditions followed by anoxic conditions and then aerobic conditions. The sizing requirements are listed below in **Table 39**. It is recommended that the proposed aeration basins have an oxygen requirement of 22,434 lb O_2/day or ICFM of 2,308 ft^3/min/basin requiring 102 BHP/basin based on aeration conditions 24 hours per day.

Table 39. T-A2 Summary of Modeling Characteristics for Anaerobic, Anoxic, Aerobic (AAO) System

Basins	Capacity / Basin (gals)	Total Capacity (gals)	Detention Time (hrs.)
Anaerobic	529,000	1,588,000	4.5
Anoxic	1,235,000	3,706,000	10.5
Aeration	1,765,000	5,297,000	15.0
Total	3,529,000	10,591,000	30.0

5.5.2.3. T-A2: Final Clarifier

The existing final clarifiers and aeration basin currently offline could be refurbished and used for the final clarifier design; see Section 2 for more detailed information. For modeling purposes, it was assumed that the proposed design consists of four final clarifiers. Each clarifier would be 82 feet in diameter, have a surface area of 5,294 ft^2 based on organic loading projections, a side water depth of 15 feet and 400 gpd/ft^2 surface overflow with 20 lbs./day/ft^2 solids loading rate based on average conditions. It was assumed that the chemical feed system would be designed for ferric.

5.5.2.4. T-A2: Filtration

The proposed filters should be sized for 16 MGD and 5 gpm/ft^2. It was assumed that the filtration system would contain 11 active filters with one out of service. Therefore, it was estimated that 12 total filters would each have a width of 10 feet and length of 20 feet. A backwash rate of 20 gpm/ft^2 for 10 minutes (3,800 gpm) would require a backwash volume of 38,000 gallons. It was assumed that two backwash pumps, each at 3,800 gpm (one duty, one standby) would be 50 horsepower on VFDs with electric actuated valves.

5.5.2.5. T-A2: Reaeration Basin

The existing detention basin could be used; if not, then the reaeration unit will be one single basin. The proposed reaeration basin was sized for three times the filter backwash volume. The reaeration basin volume was calculated to be 114,000 gallons and has a standard oxygen requirement of 911 lbs./day. The ICFM was determined to be 287 ft^3/min/basin. In order to supply that, the proposed basin requires a 13-horsepower blower.

5.5.3. Treatment Alternate 3 (T-A3): Replacement with Aerobic Granular Sludge (AGS) Treatment System

Alternative 3 proposes similar treatment objectives based on projected hydraulic flows and organic loadings as Alternatives 1 and 2; however, the unit processes would be combined into an optimized batch cycle structure. Instead of using separate tanks (alternative 2) or a timed control sequence for treatment (alternative 1), the Aqua Nereda® AGS technology (or equal) uses an optimized batch cycle structure as illustrated in **Exhibit 10** of **Appendix G** in which the duration of the phases are based upon the specific waste characteristics, the flow, and the effluent objectives. Therefore, additional footprint at the facility will be required for tank expansion. The additional site modifications anticipated beyond ancillary civil improvements and pipe routing in the yard are detailed below for installation of an AGS system.

5.5.3.1. T-A3: Trickling Filter (Roughing Filters)

All recommendations and requirements discussed in 5.5.1.1 for alternative 1 apply to alternative 3.

5.5.3.2. T-A3: Biological Treatment (AGS System)

As part of this alternative, it is recommended to decommission the four-celled SBR unit and construct an AGS treatment system, which is a BOD and nutrient removal design that uses aerobic conditions. The sizing requirements are listed below in **Table 40**.

Table 40. T-A3 Summary of Treatment Characteristics for AGS System

Parameter	Quantity	Unit
Avg. Daily Flow	8.47	MGD
Max Daily Flow	12.32	MGD
Number of Basins	3	EA
Volume of Basin	1,312,935	gallons

5.5.3.3. T-A3: Final Clarifier

The existing final clarifiers and Aeration basin currently offline could be refurbished and used for the final clarifier design; see Section 2 for more detailed information. For modeling purposes, it was assumed that the proposed design consists of four final clarifiers. Each clarifier would be 82 feet in diameter, have a surface area of 5,294 ft^2 based on organic loading projections, a side water depth of 15 feet, and 400 gpd/ft^2 surface overflow with 20 lbs./day/ft2 solids loading rate based on average conditions. It was assumed that the chemical feed system would be designed for ferric.

5.5.3.4. T-A3: Filtration

The proposed filters should be sized for 16 MGD and 5 gpm/ft^2. It was assumed that the filtration system would contain twelve (12) active filters with one out of service. Therefore, it was estimated that 13 total filters would each have a width of 10 feet and length of 20 feet. A backwash rate of 20 gpm/ft^2 for 10 minutes (3,800 gpm) would require a backwash volume of 40,400 gallons. It was assumed that two backwash pumps, each at 3,800 gpm (one duty, one standby) would be 50 horsepower on VFDs with electric actuated valves.

5.5.4. Primary Treatment Expansion Requirements (Common to All Three Alternatives)

The following systems will need to be upgraded or expanded to accommodate the treatment alternatives explained previously in this section. They are separated and listed here since they will be the same regardless of which treatment alternative is chosen.

5.5.4.1. Influent Pipes

Existing influent pipes consist of two 24-inch inch pipes going from the diversion structure to the screen in the headworks. It was assumed that the existing pipes were at a minimum slope of 0.001 ft/ft. The total capacity of those two pipes is 9.28 MGD. The expected year of capacity exceedance is 2021, since the projected flow into the plant in year 2021 is 10.71 MGD. In order to convey the peak hourly flow, it is recommended using the equivalent of a 48-inch pipeline connecting diversion structure to the lift station assuming the hydraulic grade line remains the same. An influent flow meter and an influent sampler are recommended to be installed. This is an opportunity to increase the service boundary of the facility if the influent sewers are lowered.

5.5.4.2. Influent Screen

The existing screening system has two 4-foot-wide bar screens (one mechanical and one manual as standby). The mechanical screen has a design capacity of 15 MGD. The existing bar screen structure is designed to handle peak hourly flow for 2040; however, the proposed treatment alternatives are designed to be operated using fine screens to protect the downstream process equipment. Influent screens are designed to remove non-treatable solids that can damage downstream equipment, the smaller the opening the more non-treatable material removed, resulting in less maintenance. It is highly recommended, if feasible, that the existing bar screen structures be replaced with three 4-foot fine screens, two on duty and one as standby. (For sizing, it was assumed that the bar screens have quarter-inch openings and a 10-foot height maximum.) A screening washer/compactor is recommended to have onsite to clean screens as necessary.

5.5.4.3. Influent Pump Station

The existing (north and south) lift stations have three pumps each pumping at 1,950 gpm with one of the pumps acting as standby. It was assumed that only four pumps would be running during normal operations, providing a firm capacity of 11.23 MGD. In comparison, the expected year of firm capacity exceedance is 2030 with a peak hourly flow of 11.52 MGD. It is recommended that improvements related to hydraulic expansion at the lift station be implemented. If the lift station is replaced entirely based on site constraints, it is recommended that the new lift station consist of five 3,000 gpm pumps with four on duty and one on standby. Each pump would run on a VFD and at 50 horsepower per pump.

5.5.4.4. Grit Removal & Pre-Aeration Units

The existing grit tanks are aerated with a total volume of 109,656 gallons. Based on the evaluation and findings in Section 2, the firm capacity exceedance occurs before the five-year plan as summarized in **Table 16**. In support of the future expansion of the WPC plant, it is recommended that the existing grit/pre-aeration tanks be removed and two new vortex grit chambers (one on duty and one standby), each 12-foot in diameter to meet the 12 MGD peak daily flow for 2040. The 360-degree vortex grit chambers will remove approximately 95 percent of 105 microns and larger particles, maintaining velocity in between 2 and 4 ft/s. Each grit basin will have a grit washer/classifier with organic washing.

5.5.4.5. Primary Clarifiers

All proposed treatment alternatives assume the reuse of the three existing primary clarifiers. The characteristics used for modeling are listed below in **Table 41**.

Table 41. T-A1 Summary of Modeling Characteristics for the Primary Clarifiers

Primary Clarifier	Diameter (ft)	Surface Area (ft^2)
1	65	3,317
2	45	1,590
3	80	5,026

The 2040 hydraulic demand on the clarifiers is based on the average flow of 8.74 MGD, this flow requires an area of 8,470 ft^2 based on a maximum surface overflow rate of 1,000 gpd/ft^2. The existing surface area is 9,933 ft^2; therefore, the existing clarifiers have enough hydraulic capacity to convey the 2040 flow.

5.5.4.6. Trickling Filter Lift Stations

Two existing pump stations pump to each of the two trickling filters independently for the north and south trains. The pump station for north trickling filter has three pumps; however, the pump characteristics could not be found. Each pump was calculated by taking the pumps horsepower and converting to flow rate. The three pumps at the north lift station were calculated to be 3,500 gpm with a firm capacity of 7,000 gpm or 10 MGD. The pump station for south trickling filter has four pumps – two at 2,500 gpm and two at 5,000 gpm. From on-site inspection, the City stated that they typically only operate the two 5,000 gpm pumps. Based on actual field conditions, the south pump station has a firm capacity of 10,000 gpm or 14 MGD. Assuming the plant splits the flow evenly between the two trickling filters, both the north and south pump stations can convey the projected 2040 peak hourly flow of 14.25 MGD.

5.5.4.7. Ultraviolet Disinfection

While the current system will meet hydraulic capacity, it is recommended to replace the disinfection system when expanding the plant. This is primarily due to age of the existing system at the time of replacement.

5.5.4.8. Outfall Structure

The existing outfall structure is hydraulically limited currently and may require replacement based on projected flows. For planning purposes, this was assumed not to be a hydraulic constriction. It is recommended that an effluent flow meter and effluent sampler be installed if the outfall structure is modified.

5.6. BioWin Modeling of Proposed Treatment Alternates

This section describes the factors taken into consideration with the alternatives analysis for secondary treatment processes to meet the projected permit limits. Although the WPC plant currently has adequate capacity to meet future BOD, TSS, and ammonia limits, the WPC plant will need to expand to accommodate projected peak hydraulic conditions (shown in **Table 42**) and achieve future TN and TP removal requirements.

Table 42. Assumed BioWin Modeled Wastewater Flows (MGD)

Type	Current (2018)	Projected 20 Year (2040)
Average	3.11	8.47
Peak Daily	5.38	12.38
Peak Hourly	7.38	14.25

5.7. Comparison of Proposed Treatment Alternatives

The three (3) treatment alternatives described above were compared and analyzed here to determine the most appropriate solution for the City.

5.7.1. Treatment Alternate 1 (T-A1): Expansion of Existing Sequencing Batch Reactor (SBR) System

Alternative 1 involves keeping the existing four-cell SBR unit system and building an additional four-cell SBR unit to help handle the projected 2040 hydraulic and organic load. The existing SBR unit structure has a maximum hydraulic capacity of 7.87 MGD based on current operation, the structure lacks 4.45 MGD to meet the peak day flow of 12.32 MGD. It is recommended that both units operate in pairs so that flow will be split evenly between two cells every cycle. Following the

SBR process is a proposed flow equalization basin with an aeration process and a filter system. For nutrient removal, the process cycles will be modified at the SBR to favor conditions designed to remove biological nutrients.

The BioWin model results are shown below in **Table 43** for overall plant percent removal and predicted plant effluent concentrations in mg/L. These removal percentages show that the existing basins and an additional four-celled SBR unit can adequately remove organic constituents to meet the monthly effluent permit limits of 2040.

Table 43. T-A1 BioWin Modeled Wastewater Characteristics

Constituent	Overall Plant Removal (%)	Plant Effluent (mg/L)
CBOD	99	2.19
TSS	95	8.62
Ammonia	98	0.20
Total N	90	2.53
Total P	70	1.77

Table 31 shows effluent permit limits for 2040. It should be noted that filters following the SBR system will reduce TP concentrations below permit limits. Filtration will reduce particulate phosphorous resulting in a decrease TP concentration to less than 1 mg/L and TSS concentration to less than 10 mg/L to meet 2040 permit limits; however, BioWin does not have filtration modeling capabilities. If phosphorus levels are to be much more stringent than 1 mg/L, then iron salts could be fed upstream of filtration to reduce phosphorus to even lower levels.

FEATURES & SPECIFICATIONS

- Design flow - 12.32 MGD
- Four cycles per day
- Number of existing cells – 4
- Number of proposed cells – 4
- Basin Dimensions – 110 by 110 feet
- Required sludge age – 20.5 days
- SOR – 22,000 lbs. / day
- ICFM – 4,600 cf/min/basin
- Blower horsepower – 200 BHP / basin
- Aeration time – 12 hrs. / day
- Maximum decant rate – 24.64 MGD

BENEFITS

- Minimal footprint (equalization, clarification, biological treatment all in one basin)
- Adjustable processes

CHALLENGES

- Control dependent
- Operational sophistication
- Larger horsepower aeration equipment
- Requires larger downstream unit processes to accommodate decant rate if post equalization is not utilized

5.7.2. Treatment Alternate 2 (T-A2): Replacement with Anaerobic Anoxic Aerobic (AAO) Treatment

AAO treatment is a commonly used three-stage technique to create conditions for biological treatment as well as for TN and TP removal. This treatment alternate would require replacement of the existing four-celled SBR unit and replace it with multiple basins in a continuous flow process. The flow-through AAO process is illustrated in **Exhibit 8** of **Appendix G**. The wastewater and external returned sludge flows into the anaerobic basin with an agitator set to prevent sedimentation of material suspended in the wastewater. Secondly, the wastewater would flow into the anoxic basin aerators with agitators set to control aeration. Thirdly, the wastewater would flow into the aeration basin where BOD in the wastewater undergoes further decomposition by aerobic bacteria present in the tank.

Higher flows and lower influent concentrations will reduce unit removal efficiency. The overall performance of proposed improvements results in a higher quality effluent. This reduction in percent removal does not reflect a decrease in plant performance. The percent removal and predicted effluent concentrations are shown below in **Table 44**.

Table 44. T-A2 BioWin Modeled Wastewater Characteristics

Constituent	Overall Plant Removal (%)	Plant Effluent (mg/L)
CBOD	92	2.2
TSS	74	8.1
Ammonia	90	0.08
TN	58	1.44
TP	58	0.44

Table 31 shows effluent permit limits for 2040. It should be noted that TP concentration was originally calculated to be 2.44 mg/L without chemical addition. This was later confirmed in the model. In order to decrease this concentration to the 1.44 mg/L concentration shown above, approximately 5 mg/L of ferric will need to be added to or prior to the final clarifier. Filtration will further decrease TP concentration to less than 1 mg/L and TSS concentration to less than 10 mg/L to meet 2040 permit limits; however, BioWin does not have filtration modeling capabilities.

FEATURES & SPECIFICATIONS

- Three trains of AAO basins
- Proposed basin volumes
    - Anaerobic – 529,000 gal/basin
    - Anoxic – 1,235,000 gal/basin
    - Aerobic – 1,765,000 gal/basin
- Proposed aeration basin oxygen requirements
    - SOR - 22,434 lb O_2/day
    - ICFM – 2,300 ft^3/min/basin
    - Blower horsepower - 102 BHP/basin
- Basin aerated for 24 hours a day

BENEFITS

- Easy to operate
- Fewer controls needed
- Less subject to interruption
- Not as susceptible to peak flows
- Has smaller downstream processes

CHALLENGES

- Larger footprint than SBR approach
- Process cannot be fundamentally changed

5.7.3. Treatment Alternate 3 (T-A3): Replacement with Aerobic Granular Sludge (AGS) System

The Aqua Nereda® AGS system is an innovative biological wastewater treatment technology that provides advanced treatment using the unique features of aerobic granular biomass while providing for a flexible and compact design process that offers energy efficiency and significantly lower chemical consumption. This product is discussed here for informational purposes as a treatment alternative. Olsson does not endorse a specific brand or manufacturer. The optimized batch cycle structure has three main phases of the cycle to meet advanced wastewater treatment objectives (fill/draw, react, settling). The duration of the phases will be based upon the specific waste characteristics, the flow and the effluent objectives. **Figure 34** illustrates the basic components of the granular system and highlights of the system are listed below.

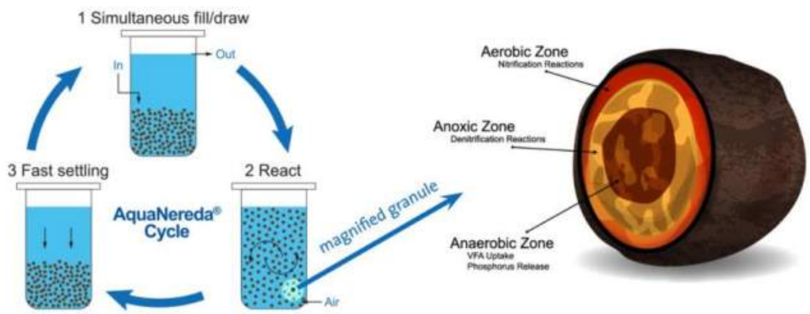


Figure 34. Typical Aqua Nereda® Aerobic Granular Sludge (AGS) System (Aqua-Aerobic 2019)

FEATURES & SPECIFICATIONS

- Robust structure of granule withstands fluctuations in chemical spikes, load, salt, pH and toxic shocks
- No secondary clarifiers, selectors, separate compartments, or return sludge pumping stations
- Settling properties at sludge volume index values of 30-50 milliliters per gram (mL/g) allow MLSS concentrations of 8,000 mg/L or greater
- Proven enhanced nutrient removal
- Simplified operation with fully automated controls

BENEFITS

- Optimal biological treatment is accomplished in one effective aeration step
- Four times less space required compared to conventional activated sludge systems
- Energy savings up to 50% compared to activated sludge processes
- Robust process without a carrier
- Significant reduction of chemicals for nutrient removal because of the layered structure and biopolymer backbone of the granule
- Lowest life-cycle cost

CHALLENGES

- Highest capital cost
- Intensive maintenance by operations staff

3.7.4. Comparison of Treatment Alternates

The project team identified and selected these alternates based on fiscal responsibility, operational risk and complexity, flexibility of existing flow configuration and treatment infrastructure to meet future permit regulations, and environmental benefits such as facility footprint, resource recovery, and community sustainability (i.e. ability to handle shock loads satisfactorily considering high industrial users).

5.8. Solids Production Alternatives Analysis

This section describes the alternatives analysis for sludge processing of the residual solids associated with both the primary and secondary treatment processes to meet the permit limits. Three alternates (pH adjustment, anaerobic digestion, and aerobic digestion) were identified during a planning workshop conducted with the City and were evaluated in detail. Residual solids treatment processes are impacted by the biological treatment liquid processes and must be fine-tuned depending upon the actual processes selected. Capital costs for solids processing were developed from typical residual volumes generated by the liquid treatment processes.

5.8.1. Definition of Solids Production Alternatives

The following three solids handling options for sludge handling expansion were shortlisted as viable alternates that will help the City meet future regulatory compliance requirements for these effluent nutrients: pH adjustment, anaerobic digestion, and aerobic digestion.

5.8.1.1. Solids Production Alternative 1 (SP-A1): Adjustment of pH

This alternate, as illustrated in **Exhibit 11** of **Appendix G**, involves wasting from the primary clarifier at 5% solids and thickened waste (5-7% solids) from the biological process to sludge holding tank. Lime will be added to the sludge holding tank. From there pH will be increased to 12 for two hours to meet class B solids requirements for pathogen density and After sludge has been held for the required time, it will be pumped to dewatering, leaving dewatering at 20% solids to the plug mill where lime will be added and then held at a pH of 11.5 for 22 hours to meet the vector attraction reduction requirement. The sludge will then go to disposal where application will be based upon soil type, agronomic loading rate of crop, and cumulative metals loading.

FEATURES & SPECIFICATIONS

- Lime addition, calcium hydroxide $Ca\ (OH)_2$ dosage
- Waste Activated Sludge 0.30 lb $Ca\ (OH)_2$ / lb of dry solids
- Primary Sludge 0.12 lb $Ca\ (OH)_2$ / lb of dry solids
- Total lime addition of 2,800 lbs. / day
- Holding tank – use existing tank or a 10’ diameter and 10’ tall

BENEFITS

- Low capital cost
- No digesters
- Just must add lime

CHALLENGES

- Add another chemical feed, higher O&M cost

- When adding lime to sludge, raises pH and releases ammonia, need odor control
- High pH conditions degrade metal resulting in shorten equipment life cycle

5.8.1.2. Solids Production Alternative 2 (SP-A2): Anaerobic Digestion

This alternative, as illustrated in **Exhibit 12** of **Appendix G**, involves waste from primary clarifier at a 5% solids concentration and thickened waste activated sludge from biological process at 5-7% solids to go to an anaerobic digester. Anaerobic digesters are governed by volatile solids loading rate and hydraulic detention time. Volatile solids loading rate is 80 lbs. per 1,000 cubic feet and minimum solids/hydraulic detention time is 15 days. The anaerobic digester will be equipped with a heat loop, hydraulic mixing, and gas control system. After digestion sludge will be dewatered to 16-20% solids for land application.

FEATURES & SPECIFICATIONS

- Propose 4 Anaerobic Digesters
- 65’ Diameter
- 20’ Liquid depth
- 474,670 gallon / Digester
- 15 Day HRT
- 63 HP for mixing

BENEFITS

- Net energy gain from methane production, self-sustaining

CHALLENGES

- Capital Cost is much greater than aerobic digestions

5.8.1.3. Solids Production Alternative 3 (SP-A3): Aerobic Digestion

This alternative, as illustrated in **Exhibit 13** of **Appendix G**, involves 5% solids concentration from primary clarifier and thickened waste activated sludge from biological process that is 5-7% into an aerobic digester. Basin has a hydraulic detention time of 60 days at 15 degrees Celsius to meet class B pathogen density and a vector attraction reduction of 38% in volatile solids reduction for land application. From the aerobic digester, sludge will go to an aerated sludge holding tank. The sludge holding tank is sized so the dewatering units only operate intermittently (two to four times a week). From the sludge holding tank, sludge will be pumped to dewater where it will be processed to a cake of 16 – 20% solids concentration to be land applied. The supernatant from the dewatering will be returned to the head of the plant.

FEATURES & SPECIFICATIONS

- Propose 4 Aerobic Digesters
- 18’ Liquid depth
- 826,050 gallon / basin

- 60-day HRT
- 12,000 lb/day oxygen requirement
- Diffused air
    - 1,100 cf/min/basin
    - 60 BHP blower/basin
- Surface Aerators (one per basin)
    - 42 BHP each digester
    - 15 HP each aerator
- Sludge holding tank
    - 1 Basin
    - 2,100 ft^2 surface area
    - 50’ diameter
    - 18’ liquid depth

BENEFITS

- Simple process
- Easy to operate
- Adaptable to process

CHALLENGES

- Blower electric demands can be high
- Digester is larger because of the sludge from primary clarifier

5.9. Recommendations

5.9.1. Estimated Project Cost

High-level cost opinions developed are based upon conceptual information, raw water quality, and anticipated regulatory requirements. Numerous assumptions were required to develop opinions of probable costs that included process, mechanical, electrical, and civil components. Vendor quotes were collected specifically for process equipment. Additional considerations are shown in **Table 45**.

Table 45. Opinion of Probable Costs (OPC) for Alternative Improvements

Twenty-Year Plan BNR Treatment Alternatives				
	Capital Cost	Annual O&M	Annualized Cost	Total Cost - Present Worth
Alternative 1 – SBR Expansion	$33,957,000	$2,780,000	$5,279,000	$71,738,000
Alternative 2 – AAO System	$38,824,000	$2,543,000	$5,400,000	$73,384,000
Alternative 3 – Granular System	$49,973,000	$2,988,000	$6,665,000	$90,581,000
Residual Solids Options				
	Capital Cost	**Annual O&M**	**Annualized Cost**	**Total Cost - Present Worth**
Alternative 1 – pH Adjustment	$3,705,000	$770,000	$1,043,000	$14,170,000
Alternative 2 – Aerobic Digestion	$5,843,000	$536,000	$966,000	$13,127,000
Alternative 3 – Anaerobic Digestion	$7,706,000	$410,000	$977,000	$13,278,000

5.9.2. Schedule

The following schedule shown in **Table 46** has been prepared to help the City determine when improvements may be required to be in-place. This is to serve as an example for planning purposes and may not reflect the actual regulatory schedule determined by NDEE. Based on anticipated industrial growth and need for additional hydraulic capacity, we recommend focusing on upgrades (i.e., headworks and pump station improvements) related to hydraulic needs before implementation of BNR requirements are enacted.

Table 46. Example Compliance Schedule

Activity	Example Date	Time Frame	Cumulative Compliance Time Frame
Current NPDES Permit Issued	January 1, 2019	-	-
Next NPDES Permit Scheduled to be Issued	January 1, 2024	5 Years	5 Years
Design Improvements and Submit Plans & Specifications to the NDEE	January 1, 2029	5 Years	10 Years
Initiate Construction	January 1, 2030	3 Years	11 Years
Complete Construction	January 1, 2032		13 Years

5.10. Conclusion

The analysis in this section will summarize actions to be taken by the City to meet overall objectives of the master plan, which include but are not limited to demonstration of fiscal responsibility, management of risk through critical asset revitalization, identification of cost savings, and positioning for future nutrient removal regulations.

treatment alternatives were developed to address permitted capacities, design hydraulic flow rates, organic and solids loadings, and anticipated regulatory requirements for biological nutrient removal (i.e. nitrogen and phosphorus). Based on discussions with the City, cost, and the City's desire to maximize the use of existing infrastructure, Alternative 1, or expansion of the existing SBR system is recommended for expansion of the WPC Plant. Before full-scale implementation, it will be important to conduct nutrient removal pilot testing to demonstrate the ability to treat effluent water with suitable technology per future permit regulations.

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APPENDIX A

Hydraulic Flow Data Tables and Graphs

Table 1. Historical Average/Maximum Month Flow Data presented in Millions Gallons per Day (MGD) for years 2014-2018.																
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average[1]**	**Maximum Month**	**PF**	**Total**
2014	2.71	2.68	2.66	2.82	2.76	3.12	2.94	2.98	2.86	2.73	2.73	2.70	2.81	3.12	1.11	33.79
2015	2.72	2.75	2.64	2.71	2.75	2.96	3.03	2.90	2.79	2.74	2.66	2.80	2.79	3.03	1.09	33.51
2016	2.79	2.87	2.91	3.13	3.87	3.40	3.03	2.96	2.86	2.78	2.72	2.76	3.01	3.87	1.29	36.31
2017	2.81	2.88	2.85	2.83	3.25	3.05	2.94	3.01	2.80	3.13	2.99	2.84	2.95	3.25	1.10	35.50
2018	2.99	2.95	3.06	2.83	2.87	3.50	3.74	3.32	3.09	3.06	2.93	2.98	3.11	3.74	1.20	37.44

[1] This column of data is comparable to the Average Flow of 3.47 MGD (Design Year 2015) per 1993 Design Memo (page 4).

Table 2. Historical Maximum Day Average Flow Data presented in Millions Gallons per Day (MGD) for years 2014-2018.																
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average[1]**	**Maximum[2]**	**PF[3]**	**Total**
2014	3.02	3.45	3.18	3.05	3.19	3.96	3.21	4.54	3.14	3.35	3.03	4.54	3.47	4.54	1.62	42.10
2015	2.94	3.04	3.49	3.23	3.16	3.45	3.63	3.40	3.20	3.39	3.16	3.63	3.31	3.63	1.30	40.07
2016	3.09	3.22	3.59	4.28	5.62	3.95	3.40	3.68	3.67	3.19	3.27	5.62	3.88	5.62	1.87	47.37
2017	3.23	3.13	3.54	3.60	3.90	3.48	3.48	3.87	3.76	3.45	3.35	3.90	3.56	3.90	1.32	43.02
2018	3.33	3.32	4.08	3.19	3.75	5.35	4.33	3.90	3.39	4.75	3.27	5.35	4.00	5.35	1.72	48.67

[1] This column of data is comparable to the Dry Weather Maximum Flow of 5.09 MGD (Design Year 2015) per 1993 Design Memo (page 4).

[2] This column of data is comparable to the Wet Weather Maximum Flow of 8.68 MGD (Design Year 2015) per 1993 Design Memo (page 4).

[3] An assumed maximum day peaking factor of 2.0 was assumed for future projections.

Table 3. Historical Industrial Average Flow presented in Gallons per Month (GPMo) for years 2014-2018.														
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Total
2014	**22,176,678**	**21,605,900**	**22,511,400**	**24,937,800**	**22,022,300**	**24,844,000**	**23,042,900**	**22,422,223**	**19,910,400**	**19,182,300**	**18,363,900**	**21,784,700**	**21,900,375**	**262,528,198**
CRC	-	-	-	-	-	-	1,500	10,500	26,900	6,700	700	-	3,858	50,158
HILAND ROBERTS	1,118,300	1,190,800	1,230,500	1,525,200	1,537,900	1,629,900	1,430,200	1,461,600	1,291,000	1,167,600	904,300	830,300	1,276,467	15,475,767
FLEXMAG	92,000	76,300	100,200	145,900	178,800	290,200	356,800	394,200	299,900	199,700	154,800	187,000	206,317	2,590,117
HENNINGSEN	1,245,100	1,026,400	1,214,900	1,040,000	1,036,300	1,214,000	1,380,600	1,299,500	1,180,700	1,166,300	1,035,900	1,168,700	1,167,367	13,930,667
Milk Specialties	11,239,200	10,171,000	12,148,000	12,778,900	10,175,800	11,080,300	10,119,600	8,167,800	6,501,700	8,719,100	9,192,500	10,196,300	10,040,850	119,291,850
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ContiTech	1,827,900	1,814,400	2,112,700	2,078,900	2,399,400	3,009,900	2,469,400	2,564,300	2,167,800	1,811,100	1,453,200	1,929,700	2,136,558	25,947,358
WIS PAC	3,214,200	4,296,400	2,427,000	3,269,200	2,531,000	2,397,000	2,638,500	3,924,623	3,752,900	2,903,700	3,117,900	3,787,600	3,188,335	38,234,158
SID	2,918,378	2,570,100	2,850,200	2,509,000	2,461,500	3,654,900	3,039,500	3,049,700	4,589,500	3,003,100	2,398,900	3,535,100	3,048,323	36,709,823
NRC	412,100	361,300	397,900	410,700	351,600	447,300	467,500	-	-	-	-	-	237,367	2,673,667
City East Water Plant backwash	109,500	99,200	30,000	1,180,000	1,350,000	1,120,500	1,139,300	1,550,000	100,000	205,000	105,700	150,000	594,933	7,624,633
2015	**20,301,300**	**20,172,000**	**19,821,500**	**21,841,500**	**19,758,900**	**22,582,500**	**24,344,900**	**22,343,927**	**18,773,000**	**15,022,600**	**13,931,400**	**21,300,500**	**20,016,169**	**239,908,896**
CRC	1,500	-	700	700	1,500	-	700	-	-	-	-	-	425	4,025
HILAND ROBERTS	869,900	973,900	1,191,600	1,513,200	1,468,300	1,760,000	1,487,800	1,590,200	1,285,800	1,023,300	1,601,100	1,442,600	1,350,642	16,688,442
FLEXMAG	154,800	142,100	196,700	181,800	172,000	325,400	377,000	373,300	209,400	112,900	83,800	104,000	202,767	2,481,167
HENNINGSEN	1,074,300	1,351,000	1,457,300	1,395,300	1,227,900	1,518,000	1,459,300	1,424,600	1,665,900	1,720,300	1,366,600	1,640,700	1,441,767	17,668,667
Milk Specialties	9,843,000	8,809,200	8,323,100	9,977,200	8,510,000	8,665,600	10,013,000	8,637,600	7,903,300	5,158,000	4,377,400	7,620,200	8,153,133	96,147,733
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ContiTech	1,975,600	1,950,900	2,080,000	2,400,000	2,313,800	2,505,400	2,345,800	2,297,500	1,914,400	1,587,400	1,449,700	1,653,200	2,039,475	24,537,575
WIS PAC	3,014,800	3,785,100	3,738,400	2,961,400	3,373,700	3,532,900	3,847,500	3,967,527	2,841,400	2,116,000	1,891,800	4,704,500	3,314,586	40,074,813
SID	3,217,400	3,009,800	2,693,700	3,291,900	2,551,700	3,075,200	3,620,300	2,643,200	2,822,800	2,604,700	3,085,000	4,027,300	3,053,583	36,479,183
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	150,000	150,000	140,000	120,000	140,000	1,200,000	1,193,500	1,410,000	130,000	700,000	76,000	108,000	459,792	5,827,292
2016	**20,813,900**	**20,610,800**	**21,994,800**	**25,470,900**	**29,880,200**	**22,661,300**	**21,087,400**	**21,826,300**	**20,479,700**	**20,443,200**	**17,318,000**	**19,483,100**	**21,839,133**	**263,094,833**
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	1,707,300	1,888,400	2,251,400	1,977,200	2,412,100	1,719,600	1,612,000	2,074,000	2,059,000	1,939,400	1,701,000	1,169,400	1,875,900	22,679,400
FLEXMAG	85,300	61,300	102,500	67,300	68,800	265,500	273,800	329,900	232,600	115,200	64,300	47,100	142,800	1,771,100
HENNINGSEN	1,397,800	1,123,900	1,533,100	1,219,800	1,338,200	1,083,800	1,653,500	1,990,200	1,782,200	1,634,600	1,435,000	1,553,200	1,478,775	17,826,275
Milk Specialties	8,679,000	6,488,100	7,271,300	7,231,800	7,722,300	7,234,200	5,553,800	6,631,600	6,468,900	6,924,200	6,081,000	9,378,100	7,138,692	84,123,992
KPR/Covidien	158,900	290,300	234,100	342,000	337,900	176,200	437,000	380,100	306,000	308,300	342,200	226,500	294,958	3,675,558
ContiTech	2,059,300	1,959,100	2,588,600	2,656,800	2,615,600	2,931,400	2,566,700	2,496,500	2,272,300	1,938,800	1,628,600	1,275,800	2,249,125	27,179,325
WIS PAC	2,799,200	3,690,400	2,859,900	3,948,400	5,728,300	3,208,100	4,311,600	3,751,400	4,321,500	4,133,000	2,518,300	2,413,300	3,640,283	44,524,483
SID	3,822,100	4,999,300	5,053,900	7,949,600	9,579,000	4,992,500	3,799,000	3,157,600	2,932,200	3,344,700	3,442,600	3,419,700	4,707,683	57,377,783
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	105,000	110,000	100,000	78,000	78,000	1,050,000	880,000	1,015,000	105,000	105,000	105,000	-	310,917	3,936,917
2017	**21,084,200**	**17,118,800**	**20,753,000**	**19,357,300**	**23,943,200**	**22,671,900**	**22,870,100**	**23,596,500**	**18,353,400**	**19,631,600**	**16,513,500**	**15,859,600**	**20,146,092**	**240,814,992**
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	2,128,200	1,635,500	1,819,600	1,722,000	1,996,200	2,223,000	2,095,200	2,239,000	1,865,200	1,672,100	1,355,400	1,045,100	1,816,375	21,484,675
FLEXMAG	130,900	118,900	-	-	-	-	-	-	-	-	-	-	20,817	139,717
HENNINGSEN	1,712,100	1,421,200	1,748,200	1,556,800	1,784,000	2,073,100	2,608,900	1,869,000	1,773,100	2,006,600	1,724,700	1,234,600	1,792,692	21,592,892
Milk Specialties	10,222,800	5,978,200	7,194,800	7,486,000	8,852,000	9,716,400	10,556,800	9,254,300	7,330,400	7,143,900	5,843,300	6,628,400	8,017,275	94,001,775
KPR/Covidien	432,700	364,200	378,300	379,000	425,700	408,700	274,600	287,500	253,000	320,300	242,900	209,300	331,350	3,874,850
ContiTech	790,600	1,476,500	3,012,200	2,513,000	2,312,300	2,525,500	2,662,600	2,786,100	1,863,000	1,935,900	2,014,300	2,030,700	2,160,225	27,292,325
WIS PAC	2,355,300	1,693,400	2,135,800	1,855,500	2,191,900	2,254,800	1,652,800	1,784,700	2,172,500	2,181,800	1,944,500	1,748,000	1,997,583	23,613,283
SID	3,311,600	3,954,800	3,956,900	3,337,600	5,878,000	2,963,200	2,512,000	4,868,900	3,024,200	4,034,600	3,041,700	2,777,200	3,638,392	43,987,492

NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	-	476,100	507,200	507,400	503,100	507,200	507,200	507,000	72,000	336,400	346,700	186,300	371,383	4,827,983
2018	**19,300,700**	**15,462,600**	**19,306,100**	**18,983,900**	**19,296,100**	**21,501,300**	**25,939,000**	**22,788,200**	**19,234,600**	**20,103,100**	**18,895,100**	**20,990,800**	**20,150,125**	**242,650,925**
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	1,416,700	1,163,400	1,569,000	1,795,500	2,040,000	2,037,500	2,225,600	1,969,900	1,485,600	1,744,000	1,578,700	1,036,300	1,671,850	20,317,350
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	2,052,500	1,260,200	1,636,100	1,379,300	1,850,200	1,736,400	1,872,600	1,913,200	1,815,100	1,625,100	1,278,000	1,533,300	1,662,667	19,562,167
Milk Specialties	8,411,200	6,291,200	7,688,600	7,269,000	6,950,100	7,931,400	9,346,300	8,930,300	8,443,400	8,939,600	8,393,100	9,862,500	8,204,725	98,250,225
KPR/Covidien	281,000	226,300	216,500	250,800	226,500	195,700	392,000	229,900	222,100	255,900	267,400	219,200	248,608	2,950,908
ContiTech	2,352,900	1,943,200	2,189,800	2,269,100	2,117,100	2,223,100	2,390,600	2,065,500	1,720,700	1,538,200	1,235,400	1,419,700	1,955,442	23,067,842
WIS PAC	1,710,400	1,721,200	1,821,400	1,919,200	2,102,500	2,448,500	1,843,900	2,138,800	1,801,500	1,682,400	1,442,200	1,338,700	1,830,892	22,091,192
SID	2,946,600	2,650,100	3,905,200	3,800,800	3,766,500	4,568,700	6,318,000	3,940,600	3,440,900	3,960,800	4,048,200	5,042,900	4,032,442	49,475,142
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	129,400	207,000	279,500	300,200	243,200	360,000	1,550,000	1,600,000	305,300	357,100	652,100	538,200	543,500	6,936,100

Table 4. Historical Industrial Average Flow presented in Gallons per Day (GPD) for years 2014-2018.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Total	Permit
Days per Month	31	28	31	30	31	30	31	31	30	31	30	31	-	-	-
2014	**715,377**	**771,639**	**726,174**	**831,260**	**710,397**	**828,133**	**743,319**	**723,298**	**663,680**	**618,784**	**612,130**	**702,732**	**720,577**	**8,652,124**	-
CRC	-	-	-	-	-	-	48	339	897	216	23	-	127	1,650	-
HILAND ROBERTS	36,074	42,529	39,694	50,840	49,610	54,330	46,135	47,148	43,033	37,665	30,143	26,784	41,999	509,909	50,000
FLEXMAG	2,968	2,725	3,232	4,863	5,768	9,673	11,510	12,716	9,997	6,442	5,160	6,032	6,757	84,876	-
HENNINGSEN	40,165	36,657	39,190	34,667	33,429	40,467	44,535	41,919	39,357	37,623	34,530	37,700	38,353	458,427	120,000
Milk Specialties	362,555	363,250	391,871	425,963	328,252	369,343	326,439	263,477	216,723	281,261	306,417	328,913	330,372	3,932,282	250,000
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25,000
ContiTech	58,965	64,800	68,152	69,297	77,400	100,330	79,658	82,719	72,260	58,423	48,440	62,248	70,224	853,951	159,000
WIS PAC	103,684	153,443	78,290	108,973	81,645	79,900	85,113	126,601	125,097	93,668	103,930	122,181	105,210	1,264,051	-
SID	94,141	91,789	91,942	83,633	79,403	121,830	98,048	98,377	152,983	96,874	79,963	114,035	100,252	1,209,132	varies
NRC	13,294	12,904	12,835	13,690	11,342	14,910	15,081	-	-	-	-	-	7,838	88,600	-
City East Water Plant backwash	3,532	3,543	968	39,333	43,548	37,350	36,752	50,000	3,333	6,613	3,523	4,839	19,445	249,247	-
2015	**654,881**	**720,429**	**639,403**	**728,050**	**637,384**	**752,750**	**785,319**	**720,772**	**625,767**	**484,600**	**464,380**	**687,113**	**658,404**	**7,904,370**	-
CRC	48	-	23	23	48	-	23	-	-	-	-	-	14	131	-
HILAND ROBERTS	28,061	34,782	38,439	50,440	47,365	58,667	47,994	51,297	42,860	33,010	53,370	46,535	44,402	549,159	50,000
FLEXMAG	4,994	5,075	6,345	6,060	5,548	10,847	12,161	12,042	6,980	3,642	2,793	3,355	6,654	81,502	-

HENNINGSEN	34,655	48,250	47,010	46,510	39,610	50,600	47,074	45,955	55,530	55,494	45,553	52,926	47,430	581,942	120,000
Milk Specialties	317,516	314,614	268,487	332,573	274,516	288,853	323,000	278,632	263,443	166,387	145,913	245,813	268,312	3,170,546	250,000
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25,000
ContiTech	63,729	69,675	67,097	80,000	74,639	83,513	75,671	74,113	63,813	51,206	48,323	53,329	67,092	808,472	159,000
WIS PAC	97,252	135,182	120,594	98,713	108,829	117,763	124,113	127,985	94,713	68,258	63,060	151,758	109,018	1,319,987	-
SID	103,787	107,493	86,894	109,730	82,313	102,507	116,784	85,265	94,093	84,023	102,833	129,913	100,469	1,202,316	varies
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	4,839	5,357	4,516	4,000	4,516	40,000	38,500	45,484	4,333	22,581	2,533	3,484	15,012	190,316	-
2016	**671,416**	**736,100**	**709,510**	**849,030**	**963,877**	**755,377**	**680,239**	**704,074**	**682,657**	**659,458**	**577,267**	**628,487**	**718,124**	**8,664,199**	-
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	55,074	67,443	72,626	65,907	77,810	57,320	52,000	66,903	68,633	62,561	56,700	37,723	61,725	747,350	50,000
FLEXMAG	2,752	2,189	3,306	2,243	2,219	8,850	8,832	10,642	7,753	3,716	2,143	1,519	4,681	58,095	-
HENNINGSEN	45,090	40,139	49,455	40,660	43,168	36,127	53,339	64,200	59,407	52,729	47,833	50,103	48,521	585,680	120,000
Milk Specialties	279,968	231,718	234,558	241,060	249,106	241,140	179,155	213,923	215,630	223,361	202,700	302,519	234,570	2,769,440	250,000
KPR/Covidien	5,126	10,368	7,552	11,400	10,900	5,873	14,097	12,261	10,200	9,945	11,407	7,306	9,703	121,012	25,000
ContiTech	66,429	69,968	83,503	88,560	84,374	97,713	82,797	80,532	75,743	62,542	54,287	41,155	73,967	895,141	159,000
WIS PAC	90,297	131,800	92,255	131,613	184,784	106,937	139,084	121,013	144,050	133,323	83,943	77,848	119,746	1,466,395	-
SID	123,294	178,546	163,029	264,987	309,000	166,417	122,548	101,858	97,740	107,894	114,753	110,313	155,032	1,892,117	varies
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	3,387	3,929	3,226	2,600	2,516	35,000	28,387	32,742	3,500	3,387	3,500	-	10,181	128,968	-
2017	**680,135**	**611,386**	**669,452**	**645,243**	**772,361**	**755,730**	**737,745**	**761,177**	**611,780**	**633,277**	**550,450**	**511,600**	**661,695**	**7,921,897**	-
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	68,652	58,411	58,697	57,400	64,394	74,100	67,587	72,226	62,173	53,939	45,180	33,713	59,706	707,525	50,000
FLEXMAG	4,223	4,246	-	-	-	-	-	-	-	-	-	-	706	4,952	-
HENNINGSEN	55,229	50,757	56,394	51,893	57,548	69,103	84,158	60,290	59,103	64,729	57,490	39,826	58,877	710,169	120,000
Milk Specialties	329,768	213,507	232,090	249,533	285,548	323,880	340,542	298,526	244,347	230,448	194,777	213,819	263,065	3,090,083	250,000

KPR/Covidien	13,958	13,007	12,203	12,633	13,732	13,623	8,858	9,274	8,433	10,332	8,097	6,752	10,909	127,854	25,000
ContiTech	25,503	52,732	97,168	83,767	74,590	84,183	85,890	89,874	62,100	62,448	67,143	65,506	70,909	896,312	159,000
WIS PAC	75,977	60,479	68,897	61,850	70,706	75,160	53,316	57,571	72,417	70,381	64,817	56,387	65,663	777,643	-
SID	106,826	141,243	127,642	111,253	189,613	98,773	81,032	157,061	100,807	130,148	101,390	89,587	119,615	1,448,165	varies
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	-	17,004	16,361	16,913	16,229	16,907	16,361	16,355	2,400	10,852	11,557	6,010	12,246	159,194	-
2018	**622,603**	**552,236**	**622,777**	**632,797**	**622,455**	**716,710**	**836,742**	**735,103**	**641,153**	**648,487**	**629,837**	**677,123**	**661,502**	**7,976,921**	-
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	45,700	41,550	50,613	59,850	65,806	67,917	71,794	63,545	49,520	56,258	52,623	33,429	54,884	667,789	50,000
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	66,210	45,007	52,777	45,977	59,684	57,880	60,406	61,716	60,503	52,423	42,600	49,461	54,554	642,989	120,000
Milk Specialties	271,329	224,686	248,019	242,300	224,197	264,380	301,494	288,074	281,447	288,374	279,770	318,145	269,351	3,230,237	250,000
KPR/Covidien	9,065	8,082	6,984	8,360	7,306	6,523	12,645	7,416	7,403	8,255	8,913	7,071	8,169	97,128	25,000
ContiTech	75,900	69,400	70,639	75,637	68,294	74,103	77,116	66,629	57,357	49,619	41,180	45,797	64,306	760,076	159,000
WIS PAC	55,174	61,471	58,755	63,973	67,823	81,617	59,481	68,994	60,050	54,271	48,073	43,184	60,239	727,930	-
SID	95,052	94,646	125,974	126,693	121,500	152,290	203,806	127,116	114,697	127,768	134,940	162,674	132,263	1,624,368	varies
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant backwash	4,174	7,393	9,016	10,007	7,845	12,000	50,000	51,613	10,177	11,519	21,737	17,361	17,737	226,405	-

Table 5. Historical and Projected Population Count Characteristics.

Source	2000	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030	2035	2040
US Census	23,516	24,278	24,314	24,362	24,414	24,384	24,338	24,341	24,529	24,651	-	-	-	-	-	-	-	-	-	-
World Population Projections	23,516	24,268	24,312	24,364	24,420	24,362	24,297	24,262	24,434	-	-	-	-	-	-	-	-	-	-	-
1994 City Design Memo	-	-	-	-	-	-	27,500	-	-	-	-	-	-	-	-	-	-	-	-	-
City Customer Count	-	-	-	-	9,113	9,166	9,221	9,285	9,285	9,285	9,285	9,285	9,285	9,285	9,285	-	-	-	-	-
Residential	-	-	-	-	7,861	*7,901*	*7,942*	*7,983*	*8,026*	*8,026*	*8,026*	*8,026*	*8,026*	*8,026*	*8,026*	-	-	-	-	-

Commercial	-	-	-	-	*1,243*	*1,256*	*1,270*	*1,292*	*1,251*	*1,251*	*1,251*	*1,251*	*1,251*	*1,251*	*1,251*	-	-	-	-	-
Industrial	-	-	-	-	*9*	*9*	*9*	*10*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	-	-	-	-	-
Persons Per Household	-	-	-	-	2.50	2.50	2.50	2.50	2.50	2.50	-	-	-	-	-	-	-	-	-	-
City Calculated Population	-	-	-	-	23,976	24,098	24,223	24,348	24,479	24,479	24,479	24,479	24,479	24,479	24,479	-	-	-	-	-
City Comprehensive Plan	-	23,961	23,945	24,079	24,311	24,364	-	-	-	-	-	-	-	-	-	-	-	-	-	29,646
2020-2040 Master Plan											**24,724**	**24,971**	**25,221**	**25,473**	**25,728**	**25,985**	**26,245**	**27,557**	**28,935**	**30,382**

Table 6. Historical and Projected Population Percentage Characteristics.

Source	**2000**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
US Census	-	0.32%	0.15%	0.20%	0.21%	-0.12%	-0.19%	0.01%	0.77%	0.50%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
World Population Projections	-	0.32%	0.18%	0.21%	0.23%	-0.24%	-0.27%	-0.14%	0.71%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
City Customer Count	-	N/A	N/A	N/A	N/A	0.58%	0.60%	0.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	N/A	N/A	N/A	N/A	N/A
Residential	-	N/A	N/A	N/A	N/A	0.51%	0.52%	0.52%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	N/A	N/A	N/A	N/A	N/A
Commercial	-	N/A	N/A	N/A	N/A	1.05%	1.11%	1.73%	-3.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	N/A	N/A	N/A	N/A	N/A
Industrial	-	N/A	N/A	N/A	N/A	0.00%	0.00%	11.11%	-20.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	N/A	N/A	N/A	N/A	N/A
City Calculated Population	-	-	-	-	N/A	0.51%	0.52%	0.52%	0.54%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	-	-
2020-2040 Master Plan	-	-	-	-	-	-	-	-	-	-	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%

APPENDIX B

Organic Loading Data Tables and Graphs

Table 1. Historical Average Influent TSS Loading presented in Pounds per Day (lbs/day) for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	10228	11964	10674	9512	9861	11425	10157	11609	8826	8641	9341	9365	10134	11964	121602
2015	9079	8871	8714	8853	9425	11108	9826	10216	9496	9291	9844	9893	9551	11108	114616
2016	10398	9440	11291	11381	10808	11103	9604	8755	8794	8283	8510	8807	9764	11381	117173
2017	10075	11336	10731	9839	9748	10637	8455	9665	8839	10011	11117	10855	10109	11336	121307
2018	9908	10152	12459	11005	10578	12817	11864	11512	10418	9345	10236	8869	10764	12817	129164

Table 2. Historical Average Influent CBOD Loading presented in Pounds per Day (lbs/day) for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	17223	14924	15268	15733	14500	19046	15915	13178	14071	13167	11696	10754	14623	19046	175474
2015	10813	10857	12479	11952	11887	13324	14838	13689	12527	10951	12556	13331	12434	14838	149204
2016	12488	12232	12886	14619	11040	11012	12453	13168	12589	11272	12366	10944	12256	14619	147070
2017	13496	12250	13272	12994	16123	16324	15315	11624	12968	12774	14768	13508	13785	16324	165416
2018	12206	12167	14166	15460	14499	21404	22758	16765	18085	13464	13529	11929	15536	22758	186432

Table 3. Historical Average Influent BOD* Loading presented in Pounds per Day (lbs/day) for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	19978	17312	17711	18250	16820	22093	18462	15286	16322	15273	13567	12475	16962	22093	203550
2015	12543	12594	14476	13864	13789	15455	17212	15880	14531	12703	14565	15464	14423	17212	173076
2016	14487	14190	14947	16958	12806	12774	14445	15275	14603	13076	14345	12695	14217	16958	170601
2017	15655	14210	15395	15073	18702	18936	17765	13483	15043	14818	17131	15669	15990	18936	191882
2018	14159	14114	16433	17933	16819	24829	26399	19447	20978	15618	15694	13837	18022	26399	216261
*BOD calculated as 1.16 times CBOD															

Notes

Average of all samples taken per Month

Calc done on 2014-2018 sheet. Loading (lb/d) = Flowrate (mgd) x Concentration (mg/L) x 8.34

Table 4. Historical Average Influent TKN Loading presented in Pounds per Day (lbs/day) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	1198.5	1151.3	1407.7	1256.7	1263.3	1388.4	1180.9	1115.3	1132.0	1084.7	845.7	1171.4	1183.0	1407.7	14195.9
2015	1027.0	1058.4	1178.0	1085.0	1054.1	1188.8	1069.3	1162.2	1146.6	992.8	1010.5	1024.0	1083.1	1188.8	12996.7
2016	1056.5	1140.4	1102.7	1121.7	1143.3	1017.9	1017.4	990.2	1135.7	1053.8	1123.9	1205.4	1092.4	1205.4	13108.9
2017	1181.4	1128.3	1144.0	1212.9	1362.2	1167.1	1103.1	1162.9	1126.6	1307.2	1476.9	1507.6	1240.0	1507.6	14880.2
2018	1357.4	1361.1	1201.0	1475.3	1245.0	1594.2	1554.2	1254.0	1509.3	1445.4	1378.4	1524.9	1408.4	1594.2	16900.3

Table 5. Historical Average Influent Ammonia Loading presented in Pounds per Day (lbs/day) for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	568.9	540.8	606.2	612.7	587.2	570.2	566.0	594.2	599.1	521.4	570.3	651.9	582.4	651.9	6988.9
2015	564.9	620.8	567.3	645.0	629.8	586.8	583.2	593.3	671.3	634.6	671.6	599.1	614.0	671.6	7367.6
2016	594.2	622.4	621.5	585.7	425.4	508.5	453.2	534.2	602.2	623.2	607.3	582.2	563.3	623.2	6760.0
2017	619.4	635.2	640.4	636.4	602.2	504.1	741.0	587.4	634.5	617.9	745.6	669.3	636.1	745.6	7633.5
2018	644.0	681.4	623.9	694.2	685.0	638.6	595.5	632.1	639.5	757.7	795.4	654.3	670.1	795.4	8041.5

Table 6. Historical Average Influent Phosphorus Loading presented in Pounds per Day (lbs/day) for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	994.2	757.1	803.7	327.5	445.3	337.9	335.7	227.1	298.1	318.0	261.0	252.0	446.5	994.2	5357.6
2015	269.6	199.4	227.9	212.0	221.2	232.7	219.9	243.9	227.2	297.7	176.8	269.0	233.1	297.7	2797.3
2016	212.3	192.1	246.9	229.8	293.5	174.5	125.5	238.6	257.8	245.7	268.4	247.8	227.7	293.5	2732.9
2017	278.8	401.1	288.6	242.5	353.9	294.8	349.0	334.1	254.5	264.6	233.8	235.4	294.3	401.1	3531.1
2018	245.3	320.0	305.5	346.4	248.8	390.0	346.3	356.9	442.6	267.4	264.3	366.8	325.0	442.6	3900.4

Notes
Average of all samples taken per Month
Calc done on 2014-2018 sheet. Loading (lb/d) = Flowrate (mgd) x Concentration (mg/L) x 8.34

Table 7. Industrial Sewer Discharge Permit Limits							
Constituent	**BOD (lb/day)**	**TSS (lb/day)**	**TKN (mg/L)**	**pH Minimum**	**pH Maximum**	**Lead (mg/L)**	**Zinc (mg/L)**
CRC	-	-	-	-	-	-	-
HILAND ROBERTS	3500	1500	140	5.5	9.5		
FLEXMAG	-	-	-	-	-	-	-
HENNINGSEN	800	500	-	5.5	9.5	-	-
Milk Specialties	4500	700	150	5.5	9.5	-	-
KPR/Covidien	-	-	-	-	-	-	-
ContiTech	275	560	-	5.5	9.5	0.4	0.5
WIS PAC	-	-	-	-	-	-	-
SID	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-

Table 8-A. Historical Industrial Loadings for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**	**Total**	**Max Month**
Days per Month	31	28	31	30	31	30	31	31	30	31	30	31			
2014															
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	2,467	2,652	2,543	2,998	2,691	3,611	2,884	2,597	2,000	2,393	1,993	1,775	2,550	30,605	3,611
TSS (lbs/day)	937	1,217	850	1,175	1,456	1,488	1,072	855	758	1,028	679	690	1,017	12,204	1,488
TKN (mg/L)	186	211	152	178	121	146	150	160	86	128	169	150	153	-	211
TKN (lbs/day)	56	75	50	76	50	66	58	63	31	40	42	34	53	640	76
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-		-	-
HENNINGSEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	191	139	182	161	135	206	243	197	267	218	185	140	189	2,263	267
TSS (lbs/day)	130	94	85	83	72	70	84	71	161	93	206	92	103	1,239	206
TKN (mg/L)	38	34	52	55	37	68	68	43	69	70	73	27	53	-	73
TKN (lbs/day)	13	11	17	16	10	23	25	15	23	22	20.92	9	17	203	25
Milk Specialties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	9,098	8,149	6,919	5,982	5,982	6,694	5,663	3,485	2,547	3,469	1,799	2,230	5,168	62,017	9,098
TSS (lbs/day)	1,627	1,581	1,451	1,176	994	1,362	790	870	197	385	335	428	933	11,194	1,627
TKN (mg/L)	107	93	87	75	82	119	56	52	28	51	36	50	70	-	119
TKN (lbs/day)	325	283	285	266	225	366	151	115	51	120	93	137	201	2,418	366
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ContiTech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	253	442	401	291	336	253	215	437	197	289	330	286	311	3,729	442
TSS (lbs/day)	198	337	449	191	327	238	138	277	60	157	351	197	243	2,921	449
TKN (mg/L)	17	22	25	14	17	9	13	14	12	18	30	12	17	-	30
TKN (lbs/day)	8	12	14	8	11	7	9	10	7	9	12	6	9	114	14
WIS PAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	2,197	3,089	1,614	1,808	1,021	1,126	1,320	2,879	2,093	1,773	1,963	2,046	1,911	22,929	3,089
TSS (lbs/day)	180	642	72	151	67	513	296	171	169	91	106	61	210	2,519	642
TKN (mg/L)	6	14	11	5	7	12	9	5	17	6	12	8	9	-	17
TKN (lbs/day)	5	17	7	5	5	8	6	5	17	5	11	8	8	100	17
SID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant Backwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total BOD (lbs/day)	14,206	14,472	11,659	11,240	10,165	11,889	10,324	9,595	7,103	8,143	6,270	6,477	10,129	121,543	14,472
Total TSS (lbs/day)	3,071	3,872	2,907	2,776	2,914	3,670	2,379	2,244	1,345	1,754	1,676	1,468	2,506	30,077	3,872
Total TKN (lbs/day)	407	397	374	370	301	471	250	207	129	196	180	194	290	3,476	471

Table 8-B. Historical Industrial Loadings for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**	**Total**	**Max Month**
2015															
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	1,709	1,680	2,339	3,043	2,625	3,214	3,160	2,916	1,390	2,064	2,605	3,415	2,513	30,160	3,415
TSS (lbs/day)	652	614	840	1,133	1,065	1,435	1,401	1,110	786	960	1,174	1,589	1,063	12,759	1,589
TKN (mg/L)	105	94	145	128	110	106	108	102	79	81	80	129	106	-	145
TKN (lbs/day)	24	27	47	54	43	52	43	44	28	22	36	50	39	471	54
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	121	295	273	223	109	176	200	202	268	282	234	194	215	2,578	295
TSS (lbs/day)	134	176	137	104	54	89	124	113	138	127	105	87	116	1,389	176
TKN (mg/L)	39	45	88	53	19	37	35	46	59	58	64	51	50	-	88
TKN (lbs/day)	11	18	35	20	6	16	14	18	27	27	24	23	20	239	35
Milk Specialties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	2,473	1,333	1,966	2,444	2,816	2,525	2,319	2,682	2,049	1,471	605	1,898	2,048	24,580	2,816
TSS (lbs/day)	297	205	184	227	321	260	431	407	299	216	118	410	281	3,374	431
TKN (mg/L)	51	32	40	35	69	57	44	52	43	35	10	22	41	-	69
TKN (lbs/day)	492	553	339	494	278	351	405	371	189	178	206	308	347	4,163	553
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ContiTech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	273	286	245	455	260	167	279	291	194	158	187	252	254	3,049	455
TSS (lbs/day)	199	165	143	270	92	49	189	301	178	85	170	206	171	2,048	301
TKN (mg/L)	19	15	16	17	9	6	11	21	12	12	19	24	15	-	24
TKN (lbs/day)	10	9	9	11	6	4	7	13	7	5	8	11	8	99	13
WIS PAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	1,643	2,496	2,515	1,549	1,801	1,671	1,901	3,150	1,176	972	1,033	2,283	1,849	22,190	3,150
TSS (lbs/day)	135	171	200	103	94	243	138	69	28	86	59	84	118	1,411	243
TKN (mg/L)	8	5	5	5	4	13	4	6	3	7	5	5	6	-	13
TKN (lbs/day)	6	6	5	4	4	13	4	7	2	4	3	6	5	62	13
SID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant Backwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total BOD (lbs/day)	6,219	6,091	7,339	7,713	7,611	7,753	7,860	9,241	5,077	4,947	4,663	8,042	6,880	82,556	9,241
Total TSS (lbs/day)	1,418	1,330	1,504	1,838	1,627	2,076	2,283	2,000	1,430	1,474	1,626	2,376	1,748	20,981	2,376
Total TKN (lbs/day)	544	612	434	583	337	436	473	452	253	236	276	397	419	5,034	612

Table 8-C. Historical Industrial Loadings for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**	**Total**	**Max Month**
2016															
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	3,901	4,715	4,600	4,582	4,079	2,989	3,466	3,570	4,132	4,251	4,200	2,242	3,894	46,727	4,715
TSS (lbs/day)	1,793	1,807	1,575	1,528	3,875	1,162	1,255	1,247	1,394	1,651	1,656	745	1,641	19,687	3,875
TKN (mg/L)	156	145	118	136	87	102	157	137	130	125	129	129	129	-	157
TKN (lbs/day)	72	82	71	75	57	49	68	76	75	65	61	41	66	791	82
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	289	215	185	232	258	220	300	309	254	275	177	287	250	3,001	309
TSS (lbs/day)	158	120	106	128	108	67	144	125	102	114	85	87	112	1,345	158
TKN (mg/L)	47	45	44	99	98	97	46	58	49	63	42	96	65	-	99
TKN (lbs/day)	18	15	18	33	35	29	20	31	24	28	17	40	26	309	40
Milk Specialties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	1,740	1,053	1,827	1,803	1,425	2,279	1,254	3,085	3,122	2,250	2,827	2,019	2,057	24,683	3,122
TSS (lbs/day)	255	280	767	404	324	636	293	450	356	203	262	174	367	4,403	767
TKN (mg/L)	19	39	38	37	22	50	30	36	53	61	48	51	40	-	61
TKN (lbs/day)	44	75	74	75	45	101	45	63	96	115	82	130	79	944	130
KPR/Covidien	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	11	22	14	15	17	13	25	23	17	13	16	16	17	202	25
TSS (lbs/day)	8	12	11	6	16	5	15	14	11	8	10	9	11	126	16
TKN (mg/L)	61	35	76	36	48	42	55	34	58	29	47	69	49	-	76
TKN (lbs/day)	3	3	5	3	4	2	6	3	5	2	4	4	4	46	6
ContiTech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	225	151	366	332	191	214	141	212	202	244	224	187	224	2,691	366
TSS (lbs/day)	123	82	453	180	75	107	61	114	74	106	117	128	135	1,620	453
TKN (mg/L)	14	11	19	17	9	9	8	10	20	12	28	16	14	-	28
TKN (lbs/day)	8	7	14	12	6	7	5	7	13	6	13	5	9	103	14
WIS PAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	1,505	2,449	1,523	1,913	2,766	1,692	2,262	1,827	2,554	1,756	1,728	1,226	1,933	23,201	2,766
TSS (lbs/day)	94	132	113	91	367	69	506	199	72	54	20	42	147	1,759	506
TKN (mg/L)	7	12	8	5	8	5	26	9	14	4	8	7	9	-	26
TKN (lbs/day)	5	13	6	6	12	4	30	9	17	5	6	5	10	118	30
SID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant Backwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total BOD (lbs/day)	7,672	8,606	8,516	8,877	8,737	7,406	7,447	9,025	10,281	8,788	9,172	5,978	8,375	100,505	10,281
Total TSS (lbs/day)	2,431	2,434	3,025	2,338	4,766	2,044	2,274	2,148	2,009	2,137	2,150	1,185	2,412	28,939	4,766
Total TKN (lbs/day)	149	195	188	204	160	193	175	190	229	221	182	225	193	2,312	302

Table 8-D. Historical Industrial Loadings for years 2014-2018.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Total	Max Month
2017															
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	5,177	3,544	3,523	3,041	4,293	4,702	3,878	5,414	4,391	3,747	3,358	2,265	3,944	47,332	5,414
TSS (lbs/day)	2,092	943	1,333	1,248	1,753	1,771	1,683	2,488	1,548	1,274	975	967	1,506	18,074	2,488
TKN (mg/L)	155	126	147	89	115	173	92	228	154	153	150	161	145	-	228
TKN (lbs/day)	89	61	72	42	62	107	52	138	80	69	57	45	73	873	138
FLEXMAG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	183	264	326	388	391	382	304	193	369	425	248	268	312	3,740	425
TSS (lbs/day)	55	106	156	159	147	127	128	75	179	193	103	137	131	1,566	193
TKN (mg/L)	47	76	67	96	103	79	36	34	78	70	66	62	68	-	103
TKN (lbs/day)	22	32	32	41	50	46	25	17	39	38	32	20	33	393	50
Milk Specialties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	4,898	4,106	4,537	4,578	7,011	7,196	6,075	4,994	3,892	2,312	1,944	1,982	4,461	53,527	7,196
TSS (lbs/day)	481	641	377	668	598	578	483	622	505	467	565	403	532	6,390	668
TKN (mg/L)	43	50	45	62	73	70	82	68	87	69	76	89	68	-	89
TKN (lbs/day)	119	90	87	128	173	189	234	170	176	133	123	158	148	1,780	234
KPR/Covidien		-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	21	20	23	19	18	17	10	20	23	21	18	17	19	228	23
TSS (lbs/day)	8	12	11	10	9	13	9	10	12	9	6	5	9	114	13
TKN (mg/L)	35	40	46	49	46	45	46	42	58	56	58	63	49	-	63
TKN (lbs/day)	4	4	5	5	5	5	3	3	4	5	4	4	4	52	5
ContiTech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	113	268	306	390	286	272	155	196	141	205	181	264	231	2,777	390
TSS (lbs/day)	58	190	166	180	269	211	69	56	62	101	77	164	134	1,602	269
TKN (mg/L)	18	24	10	17	24	10	6	11	10	12	14	15	14	-	24
TKN (lbs/day)	4	10	8	12	15	7	4	8	5	6	8	8	8	96	15
WIS PAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	1,057	759	1,069	762	964	1,056	769	637	1,023	868	1,017	684	889	10,664	1,069
TSS (lbs/day)	24	11	22	20	19	19	15	15	19	16	19	11	18	211	24
TKN (mg/L)	5	4	3	4	3	3	5	3	5	4	4	4	4	-	5
TKN (lbs/day)	3	2	2	2	2	2	2	1	3	2	2	2	2	26	3
SID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant Backwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total BOD (lbs/day)	11,450	8,961	9,784	9,179	12,962	13,624	11,192	11,454	9,839	7,577	6,766	5,480	9,856	118,269	13,624
Total TSS (lbs/day)	2,719	1,903	2,065	2,286	2,795	2,718	2,388	3,268	2,325	2,059	1,746	1,687	2,330	27,958	3,268
Total TKN (lbs/day)	241	199	206	231	306	356	320	337	307	253	225	238	268	3,219	444

Table 8-E. Historical Industrial Loadings for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**	**Max Month**
2018															
CRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HILAND ROBERTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	3,023	2,891	2,952	3,869	4,571	4,833	4,654	4,255	2,869	3,335	2,595	1,880	3,477	41,728	4,833
TSS (lbs/day)	903	1,349	1,239	1,263	1,772	1,699	1,760	1,417	1,106	976	1,048	534	1,255	15,066	1,772
TKN (mg/L)	118	120	95	185	109	132	130	168	139	95	90	153	128	-	185
TKN (lbs/day)	45	42	40	92	60	75	78	89	57	45	40	43	59	705	92
FLEXMAG		-	-	-	-	-	-	-	-	-	-	-	-	-	-
HENNINGSEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	383	242	313	227	356	243	278	196	187	224	165	231	254	3,044	383
TSS (lbs/day)	163	95	125	114	162	122	95	96	67	105	65	122	111	1,330	163
TKN (mg/L)	73	54	90	63	86	48	38	44	46	65	58	43	59	-	90
TKN (lbs/day)	40	20	40	24	43	23	19	22	23	29	20	18	27	322	43
Milk Specialties	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	4,834	4,205	5,649	6,242	4,703	8,115	7,739	5,943	6,892	5,161	6,144	4,874	5,875	70,501	8,115
TSS (lbs/day)	654	468	819	671	817	1,045	1,662	786	695	344	929	528	785	9,418	1,662
TKN (mg/L)	82	151	129	138	116	119	205	93	146	115	109	79	123	-	205
TKN (lbs/day)	185	283	266	280	218	263	515	223	342	277	254	210	276	3,314	515
KPR/Covidien		-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	22	19	19	24	24	18	19	24	14	20	14	23	20	241	24
TSS (lbs/day)	8	9	7	15	9	8	9	7	8	8	5	8	8	101	15
TKN (mg/L)	68	67	61	81	95	92	48	67	81	102	48	85	75	-	102
TKN (lbs/day)	5	5	4	6	6	5	5	4	5	7	4	5	5	59	7
ContiTech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	188	189	174	237	221	162	179	138	113	139	161	231	178	2,134	237
TSS (lbs/day)	85	81	101	118	136	77	113	71	54	70	38	161	92	1,104	161
TKN (mg/L)	10	11	11	12	15	8	9	10	11	15	13	20	12	-	20
TKN (lbs/day)	6	6	7	8	8	5	6	6	5	6	4	8	6	75	8
WIS PAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOD (lbs/day)	593	909	956	911	996	1,210	815	1,216	802	1,003	1,304	818	961	11,532	1,304
TSS (lbs/day)	12	29	25	22	28	82	18	21	18	20	20	23	26	318	82
TKN (mg/L)	6	6	10	9	5	5	7	8	6	8	8	9	7	-	10
TKN (lbs/day)	3	3	5	5	3	3	3	5	3	4	3	3	4	43	5
SID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City East Water Plant Backwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total BOD (lbs/day)	9,042	8,455	10,063	11,510	10,871	14,581	13,685	11,770	10,877	9,882	10,383	8,058	10,765	129,180	14,581
Total TSS (lbs/day)	1,824	2,030	2,316	2,203	2,924	3,032	3,657	2,398	1,947	1,525	2,105	1,375	2,278	27,336	3,657
Total TKN (lbs/day)	284	359	361	414	337	375	627	349	435	366	325	286	377	4,518	671

Table 9. Historical Average Effluent TSS Concentration presented in milligrams per Liter (mg/L) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	12.3	15.6	6.9	6.0	4.6	5.0	4.8	3.6	3.8	5.0	3.6	3.4	6.2	74.53
2015	5.3	6.5	5.2	3.7	5.0	4.1	6.4	14.6	8.7	3.5	1.9	2.5	5.6	67.32
2016	3.5	3.3	3.4	2.5	2.9	3.0	3.7	3.9	4.6	3.7	2.6	3.2	3.4	40.21
2017	5.9	4.7	7.8	8.3	5.2	6.9	7.0	6.2	6.8	3.0	5.0	13.7	6.7	80.41
2018	7.9	15.8	10.7	17.6	6.7	7.6	4.7	16.0	9.1	9.3	7.6	6.0	9.9	118.90

Table 10. Historical Average Effluent CBOD Concentration presented in milligrams per Liter (mg/L) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	13.6	9.2	7.0	6.7	4.6	5.8	4.4	5.5	4.5	4.7	4.4	3.4	6.1	73.65
2015	4.0	5.3	3.8	3.8	5.5	4.4	5.3	13.2	5.5	4.5	3.0	3.5	5.1	61.79
2016	4.2	3.6	3.4	2.8	3.4	3.6	4.7	4.2	3.7	4.3	3.6	4.3	3.8	45.77
2017	6.1	5.3	7.1	6.7	4.8	5.7	5.5	5.6	5.2	3.7	4.9	7.4	5.7	68.10
2018	6.2	10.1	7.5	17.3	8.1	8.0	3.9	10.6	7.7	8.2	6.4	5.0	8.3	99.14

Table 11. Historical Average Effluent Ammonia Concentration presented in milligrams per Liter (mg/L) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	4.1	3.7	0.3	0.3	0.2	0.2	0.4	0.3	0.2	0.1	0.1	0.0	0.8	9.88
2015	0.1	0.1	0.1	0.6	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2	1.97
2016	0.1	0.2	0.1	0.3	1.9	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.3	3.89
2017	1.1	5.4	4.5	2.4	0.6	1.8	0.3	0.3	0.1	0.1	0.1	0.1	1.4	16.73
2018	2.0	1.8	2.3	14.0	3.3	0.2	0.3	0.4	0.2	0.2	0.5	0.1	2.1	25.31

Table 12. Historical Average Effluent pH for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	7.4	7.4	7.4	7.7	7.3	7.6	7.7	7.7	7.7	7.7	7.5	7.4	7.6	90.62
2015	7.4	7.4	7.4	7.6	7.6	7.5	7.5	7.6	7.5	7.5	7.6	7.4	7.5	90.10
2016	7.4	7.4	7.3	7.4	7.4	7.3	7.3	7.3	7.4	7.4	7.4	7.2	7.4	88.28
2017	7.4	7.3	7.4	7.4	7.4	7.5	7.5	7.5	7.5	7.5	7.5	7.3	7.4	89.16
2018	7.4	7.3	7.3	7.4	7.6	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4	89.04

Table 13. Historical Average Effluent Total Nitrogen Concentration presented in miligrams per Liter (mg/L) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	8.7	8.2	5.9	6.8	5.0	8.2	6.3	9.4	9.3	8.6	8.6	8.1	7.8	93.02
2015	4.0	7.0	7.3	5.9	5.8	6.7	6.2	11.1	9.2	6.3	6.5	5.8	6.8	81.72
2016	4.0	5.0	4.8	5.2	4.9	3.1	5.7	7.8	8.5	7.4	7.5	6.0	5.8	69.89
2017	6.3	5.0	10.0	9.9	5.5	7.3	3.9	6.4	8.8	8.1	6.2	8.3	7.1	85.73
2018	8.4	7.2	8.0	15.9	11.3	5.6	5.5	11.1	9.4	11.3	9.6	13.8	9.8	117.05

Table 14. Historical Average Effluent Total Phosphorus Concentration presented in miligrams per Liter (mg/L) for years 2014-2018.														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Total**
2014	29.2	18.0	23.2	7.2	11.7	8.3	7.4	6.8	6.9	6.6	7.1	6.2	11.5	138.55
2015	4.9	4.6	5.8	5.4	5.5	5.5	6.3	6.4	6.0	5.9	5.2	5.3	5.6	66.83
2016	3.6	4.5	4.5	4.3	2.7	5.0	5.5	6.0	6.4	6.6	6.0	5.7	5.1	60.88
2017	5.8	7.9	7.1	5.1	6.4	5.8	7.7	10.2	7.5	6.8	5.7	6.4	6.9	82.43
2018	5.6	5.3	5.7	7.3	8.1	8.4	5.9	10.0	9.6	8.6	7.6	8.1	7.5	90.16

Table 15. Assumed Design BOD Loadings (lbs/day) based on Historical and Projected Population Data.															
Description	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
Average Loading	16962	14423	14217	15990	18022	16034	16126	16218	16311	16404	16499	16594	17073	17572	18092
Residential[2]	6834	7543	5841	6134	7257	6833	6902	6971	7041	7111	7182	7254	7617	7997	8397
Per Capita	0.28	0.31	0.24	0.25	0.30	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Industrial	10129	6880	8375	9856	10765	9201	9224	9247	9270	9293	9316	9340	9456	9575	9694
Industrial Allowance[3]	-	-	-	-	-	-	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Peaking Factor[5]	1.30	1.19	1.19	1.18	1.46	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Max Month	22093	17212	16958	18936	26399	24052	24189	24327	24466	24606	24748	24890	25610	26358	27138

Table 16. Assumed Design TSS Loadings (lbs/day) based on Historical and Projected Population Data.															
Description	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
Average Loading	10134	9551	9764	10109	10764	10192	10277	10362	10449	10536	10625	10714	11164	11635	12129
Residential[2]	7627	7803	7353	7779	8486	7937	8016	8096	8177	8259	8342	8425	8846	9288	9753
Per Capita	0.32	0.32	0.30	0.32	0.35	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Industrial	2506	1748	2412	2330	2278	2255	2260	2266	2272	2277	2283	2289	2318	2346	2376
Industrial Allowance[3]	-	-	-	-	-	-	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Peaking Factor	1.18	1.16	1.17	1.12	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Max Month	11964	11108	11381	11336	12817	12230	12332	12435	12539	12644	12750	12857	13396	13962	14554

Table 18. Assumed Design TKN Loadings (lbs/day) based on Historical and Projected Population Data.															
Description	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
Average Loading	1183	1083	1092	1240	1408	1530	1543	1556	1569	1583	1596	1610	1678	1750	1826
Residential[2]	893	664	900	972	1032	1221	1233	1245	1258	1270	1283	1296	1361	1429	1500
Per Capita	0.05	0.04	0.04	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Industrial	290	419	193	268	377	309	310	311	312	312	313	314	318	322	326
Industrial Allowance[3]	-	-	-	-	-	-	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Peaking Factor	1.19	1.10	1.10	1.22	1.13	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Max Month	1408	1189	1205	1508	1594	1912	1929	1945	1962	1978	1995	2012	2098	2188	2282

Table 19. Assumed Design Ammonia Loadings (lbs/day) based on Historical and Projected Population Data.															
Description	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
Average Loading	582.4	614.0	563.3	636.1	670.1	623.1	629.3	635.6	642.0	648.4	654.9	661.4	694.5	729.2	765.7
Per Capita	0.0242	0.0253	0.0231	0.0260	0.0274	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252	0.0252
Peaking Factor[5]	1.1	1.1	1.1	1.2	1.2	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Max Month	651.9	671.6	623.2	745.6	795.4	778.9	786.7	794.5	802.5	810.5	818.6	826.8	868.1	911.6	957.1

Table 20. Assumed Design Phosphorus Loadings (lbs/day) based on Historical and Projected Population Data.															
Description	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**	**2035**	**2040**
Average Loading	446.5	233.1	227.7	294.3	325.0	310.5	313.7	316.8	320.0	323.2	326.4	329.7	346.1	363.4	381.6
Per Capita	0.0185	0.0096	0.0094	0.0120	0.0133	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126
Peaking Factor[5]	2.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Max Month	994.2	297.7	293.5	401.1	442.6	465.8	470.5	475.2	479.9	484.7	489.6	494.5	519.2	545.2	572.4

Table 21. Historical Total Dewatering Hours per Run for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	15.3	8.3	7.8	8.0	17.3	16.7	15.8	12.0	13.8	13.3	13.4	10.6	12.7	17.3	152.21
2015	11.7	14.8	13.2	14.3	13.9	15.0	10.6	15.2	14.9	14.7	11.9	12.4	13.6	15.2	162.71
2016	12.2	13.1	11.7	13.4	13.4	13.2	12.5	13.8	12.6	11.6	11.0	12.1	12.5	13.8	150.51
2017	13.0	12.4	13.2	13.2	12.9	12.6	12.9	12.4	12.5	11.2	12.3	12.5	12.6	13.2	151.08
2018	11.1	11.7	13.7	12.3	11.5	12.8	13.1	12.8	9.5	9.8	13.6	11.8	12.0	13.7	143.68

Table 22. Historical Average Dewatering Hours per BFP for years 2014-2018.															
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**	**Max Month**	**Total**
2014	7.6	4.1	3.9	4.0	8.6	8.4	7.9	6.0	6.9	6.7	6.7	5.3	6.3	8.6	76.11
2015	5.8	7.4	6.6	7.2	6.9	7.5	5.3	7.6	7.5	7.4	6.0	6.2	6.8	7.6	81.36
2016	6.1	6.5	5.8	6.7	6.7	6.6	6.3	6.9	6.3	5.8	5.5	6.1	6.3	6.9	75.25
2017	6.5	6.2	6.6	6.6	6.5	6.3	6.5	6.2	6.3	5.6	6.1	6.2	6.3	6.6	75.54
2018	5.6	5.9	6.9	6.1	5.7	6.4	6.5	6.4	4.8	4.9	6.8	5.9	6.0	6.9	71.84

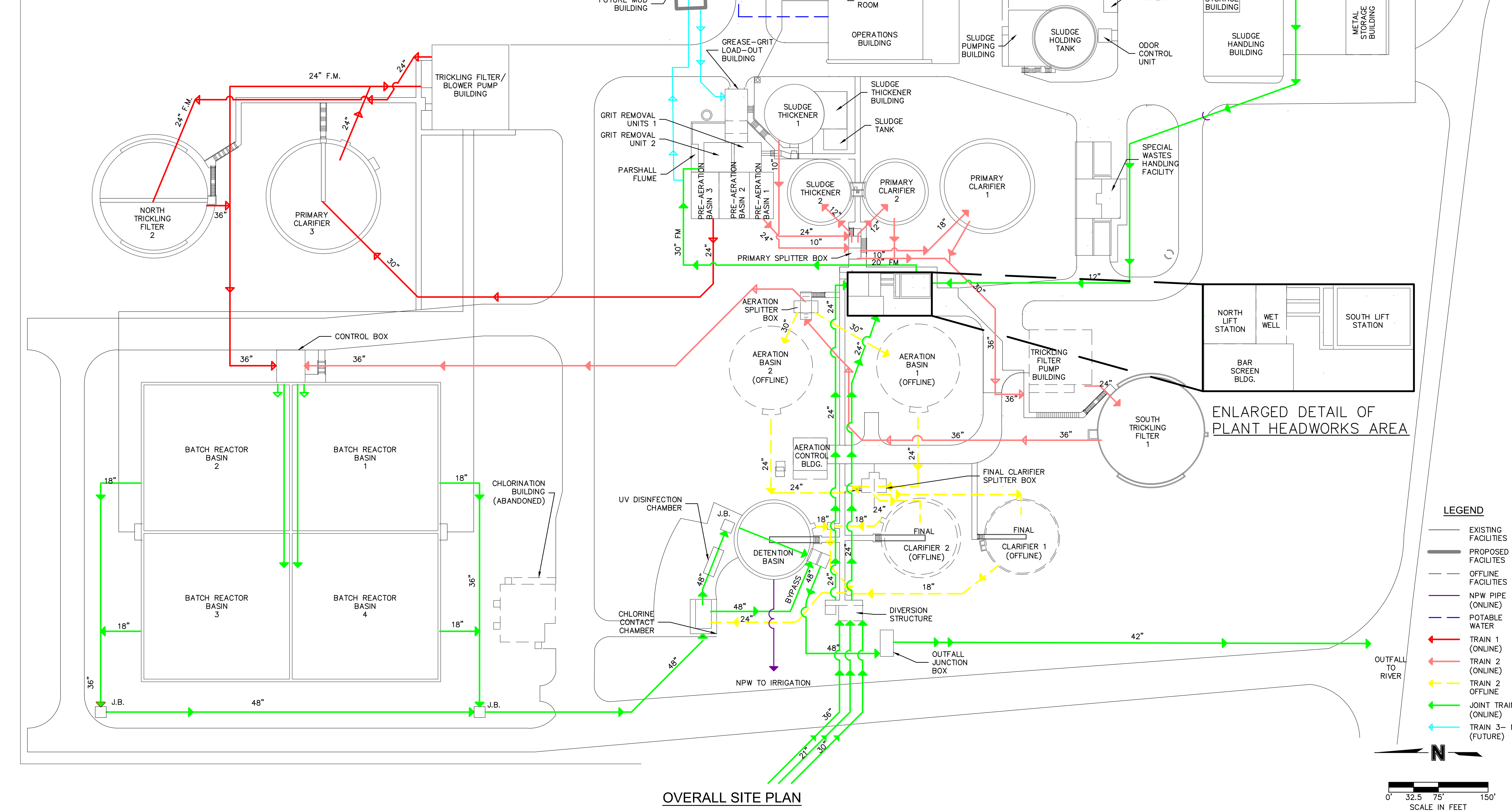
APPENDIX C

Existing Water Pollution Control (WPC) Site Exhibits

DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony Water Basemap
DATE: Jul 25, 2019 9:33am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256

NOTES:

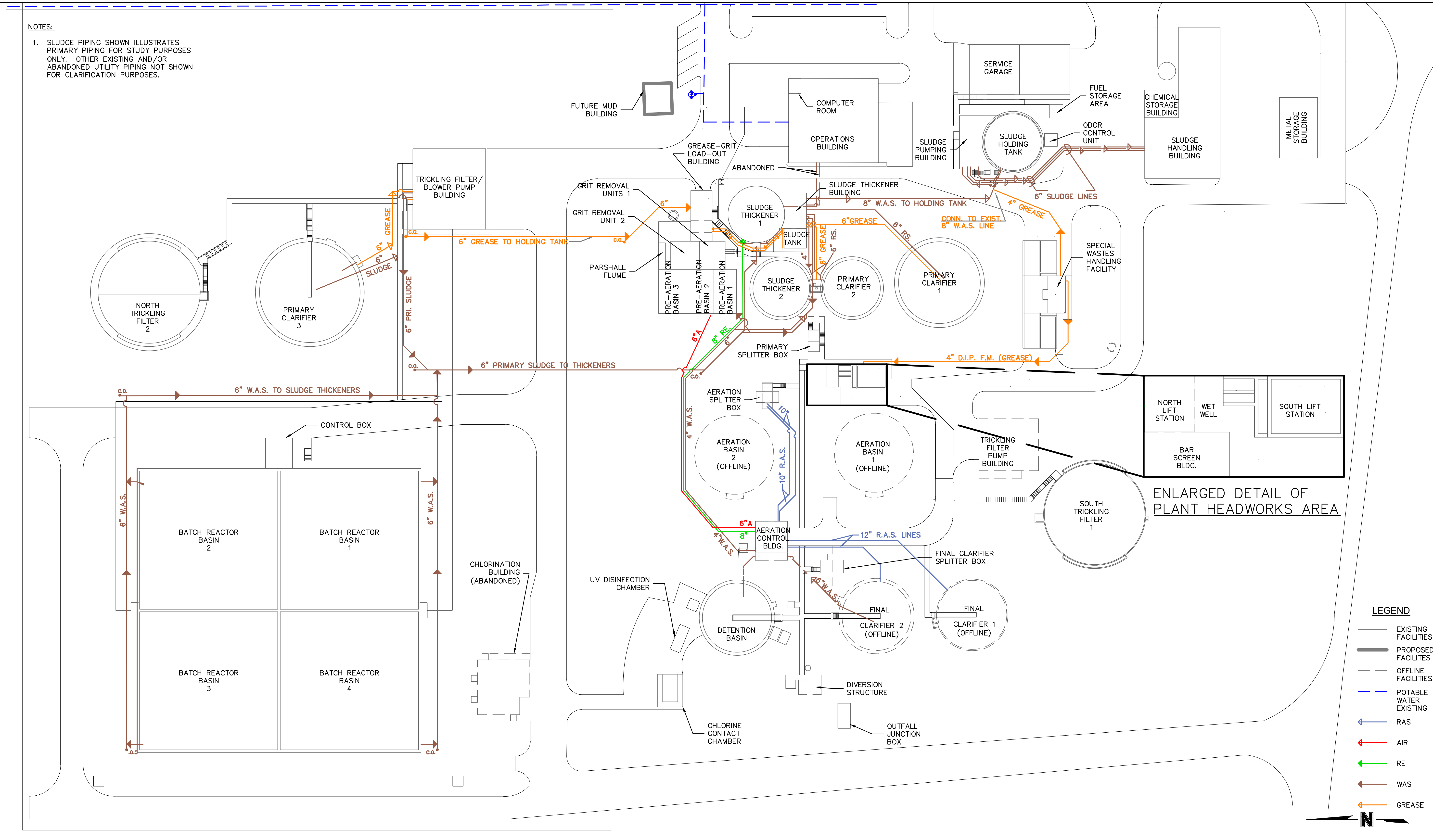
1. PROCESS PIPING SHOWN ILLUSTRATES PRIMARY HYDRAULIC FLOW FOR STUDY PURPOSES ONLY. OTHER EXISTING AND/OR ABANDONED UTILITY PIPING NOT SHOWN FOR CLARIFICATION PURPOSES.



OVERALL SITE PLAN

PROJECT NO: 019-1256	NORFOLK WPC EXISTING PROCESS PIPING PLAN PLANT FLOW PER 2019 OPERATIONS	EXHIBIT
DRAWN BY: ALA		1
DATE: 06/17/2019		

olsson



OVERALL SITE PLAN

PROJECT NO:	019-1256
DRAWN BY:	ALA
DATE:	06/25/2019

NORFOLK WPC EXISTING SLUDGE PIPING PLAN
PLANT FLOW PER 2019 OPERATIONS

olsson

EXHIBIT 2

DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony
DATE: Jul 25, 2019 9:33am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap

APPENDIX D

2019-2023 National Pollutant Discharge Elimination System (NPDES) Permit

NEBRASKA

Good Life. Great Environment.

DEPT. OF ENVIRONMENTAL QUALITY

Pete Ricketts, Governor

Authorization to Discharge Under the National Pollutant Discharge Elimination System (NPDES)

This NPDES permit is issued in compliance with the provisions of the Federal Water Pollution Control Act (33- U.S.C. Secs. 1251 *et. seq.* as amended to date), the Nebraska Environmental Protection Act (Neb. Rev. Stat. Secs. 81-1501 *et. seq.* as amended to date), and the Rules and Regulations promulgated pursuant to these Acts. The facility and outfall(s) identified in this permit are authorized to discharge wastewater and are subject to the limitations, requirements, prohibitions and conditions set forth herein. This permit regulates and controls the release of pollutants in the discharge(s) authorized herein. This permit does not relieve permittees of other duties and responsibilities under the Nebraska Environmental Protection Act, as amended, or established by regulations promulgated pursuant thereto.

NPDES Permit No.	**NE0033421**
NDEQ ID.	**57780**
Permittee:	**City of Norfolk**
Facility Name:	**Norfolk Water Pollution Control**
Facility Location	**610 E. Monroe Avenue, Norfolk NE, 68701**
Facility Mailing Address	**610 E. Monroe Avenue, Norfolk NE, 68701**
Latitude/Longitude	**42.00715 °N, 97.39749 °W**
Legal Description	**SE ¼, SW ¼, Section 35, Township 24 N, Range 1 W, Madison County, NE**
Receiving Water	**Elkhorn River, EL4-10000, Elkhorn River Basin**
Effective Date	**January 1, 2019**
Expiration Date	**December 31, 2023**

Pursuant to the Delegation Memorandum dated December 28, 2015 and signed by the Director, the undersigned hereby executes this document on the behalf of the Director.

Signed this 29th day of November, 2018

Steven M. Goans
Deputy Director – Water

2018002914

Table of Contents

Part I. Discharge Limits and Monitoring Requirements for Outfall 001

The discharge of treated sanitary wastewater from Outfall 001, final effluent to the Elkhorn River, is authorized and shall be monitored and limited as specified in the tables below. Monitoring shall be conducted by sampling after all treatment processes and prior to discharge to the receiving stream, unless an alternative or more specific monitoring point is specified by the NDEQ.

A. Non-seasonal Limits and Monitoring Requirements

Table 1: Discharge Limits and Monitoring Requirements

Parameters	Storet #	Units	Discharge Limits		Monitoring Frequency	Sample Type
			Monthly Average	**Daily Maximum**		
Flow	50050	MGD	Report	Report	Daily	Measured or Calculated
Temperature	00011	°F	Report	Report	Weekly	Grab[(b)]
Total Nitrogen	00600	mg/L	Report	Report	Monthly	24-Hour Composite
Total Phosphorus	00665	mg/L	Report	Report	Monthly	24-Hour Composite
Parameters	**Storet #**	**Units**	**Discharge Limits**		**Monitoring Frequency**	**Sample Type**
			Monthly Average	**7 Day Average**		
Carbonaceous Biochemical Oxygen Demand, (5-Day)	80082	mg/L	25.0	40.0	Weekly	24-Hour Composite
		kg/day	543	869		
Total Suspended Solids	00530	mg/L	30.0	45.0	Weekly	24-Hour Composite
		kg/day	652	978		
Parameter	**Storet #**	**Units**	**Requirements**		**Monitoring Frequency**	**Sample Type**
Pollutant Scan[(a)]	51168	Yes = 1 No = 0	Report		Three Times per Term[(c)]	Grab and/or Composite
Parameters	**Storet #**	**Units**	**Discharge Limits**		**Monitoring Frequency**	**Sample Type**
			Daily Minimum	**Daily Maximum**		
pH	00400	S.U.	6.5	9.0	Weekly	Grab[(b)]

[(a)] Pollution scan requirements are located on the Department website. If a pollution scan is conducted this monitoring period, enter 1 on the DMR. If it was not conducted during this period, enter 0.
[(b)] Analysis shall occur within 15 minutes of sample collection.
[(c)] One scan per spring, one for summer, one for winter.
Abbreviations: mg/L – milligrams per liter MGD – million gallons per day S.U. – standard units
kg/day – kilograms per day °F – degrees Fahrenheit

B. Seasonal Requirements

Table 2: Seasonal Discharge Limits and Monitoring Requirements

Parameters	Storet #	Units	Discharge Limits		Monitoring Frequency	Sample Type
			Monthly Average	Daily Maximum		
Spring Ammonia (March 1 – May 31)	00610	mg/L	7.92	22.44	Weekly	24-Hour Composite
		kg/day	84.74	239.95		
Summer Ammonia (June 1 – Oct. 31)	00610	mg/L	2.50	7.03	Weekly	24-Hour Composite
		kg/day	27.89	78.49		
Winter Ammonia (Nov. 1 – Feb. 28 [29])	00610	mg/L	7.96	23.13	Weekly	24-Hour Composite
		kg/day	83.64	242.95		

Abbreviations: mg/L – milligrams per liter kg/day – kilograms per day TUa – acute toxic units

Table 3: Recreation Season[(a)] Discharge Limits and Monitoring Requirements for *Escherichia coli*

Parameters	Storet #	Units	Discharge Limits		Monitoring Frequency	Sample Type
			Monthly Geo Mean	Daily Maximum		
E. coli	31648	#/100 mL	126	298	Weekly	Grab[(a)]

Recreation season limits apply during May1 through September 30.
[(a)] *E. coli* analysis has a six hour holding time.
Abbreviations: #/mL – number of colonies per 100 milliliters

C. Annual Monitoring Requirements

Table 3: Annual Monitoring Requirements					
Parameters	**Storet #**	**Units**	**Discharge Limits**	**Monitoring Frequency**	**Sample Type**
			Value		
Cadmium, Dissolved[(a), (b)]	01025	mg/L	Report	Annual	24-Hour Composite
Chromium, Dissolved[(a), (b)]	01030	mg/L	Report	Annual	24-Hour Composite
Copper, Dissolved[(a), (b)]	01040	mg/L	Report	Annual	24-Hour Composite
Lead, Dissolved[(a), (b)]	01049	mg/L	Report	Annual	24-Hour Composite
Nickel, Dissolved[(a,) (b)]	01065	mg/L	Report	Annual	24-Hour Composite
Zinc, Dissolved[(a), (b)]	01090	mg/L	Report	Annual	24-Hour Composite
Acute Toxicity [(a), (b)] *Ceriodaphnia sp*	61425	TUa	Report	1.22	Once per Permit Term
Acute Toxicity [(a), (b)] *Pimephales promelas*	61427	TUa	Report	1.22	Once per Permit Term

[(a)] The analytical procedure used for the determination of metals limits must be sufficiently sensitive to provide accurate results to 0.010 mg/L.
[(b)] The sample collection for metals and whole effluent toxicity must occur on the same day.
Abbreviations: mg/l – milligrams per liter, TUa – acute toxicity unit

Part II. Influent Requirements

To comply with these monitoring requirements, samples shall be taken at the headworks of the wastewater treatment facility prior to the treatment system. Influent wastewater shall be monitored as specified below.

Table 4: Monitoring Requirements for Influent Wastewater[(a)]					
Parameters	**Storet #**	**Units**	**Discharge Limits**	**Monitoring Frequency**	**Sample Type**
			Value		
Flow	50050	MGD	Report	Quarterly	Measured or Calculated
Carbonaceous Biochemical Oxygen Demand	80082	mg/L	Report	Quarterly	24-Hour Composite
Total Suspended Solids	00530	mg/L	Report	Quarterly	24-Hour Composite
pH	00400	S.U.	Report	Quarterly	Grab[(b)]

[(a)]Influent flow must be monitored on the sample day as sample collection for CBOD, TSS, and pH.
[(b)]Analysis shall occur within 15 minutes of sample collection.
Abbreviations: mg/L – milligrams per liter S.U.– Standard Units MGD – million gallons per day

Part III. Biosolids Monitoring Requirements

The sludge disposal requirements of this permit are set forth below. The disposal of domestic sewage sludge is subject to the requirements of 40 CFR Part 503. While Title 119 adopts 40 CFR 503 and allows the Department to administer sludge requirements under State law, the Federal sludge program is not delegated to the State. The Federal regulatory program is administered by EPA Region VII. The permittee should contact EPA Region VII to ensure they are in compliance with this Federal regulatory program. The current contact at EPA can be obtained upon request from Department.

A. Approval

Submission of the Sludge Application Form, available on the Department website, constitutes notice that the Wastewater Treatment Facility intends to land apply sludge and requests approval by the Department. The applicant is eligible to receive automatic approval provided the applicant indicates compliance with and understanding of the regulations and conditions contained in 40 CFR Part 503, and when all of the conditions set forth below are met, unless the Department acts to provide a conditional or circumstantial approval.

1. Sludge application is in compliance with the Federal 503 regulations, including all requirements related to vector and pathogen control.
2. Sludge is not applied within 200 feet of any actively used groundwater well, except for those used exclusively for irrigation.
3. Sludge is not being applied within 1000 feet of any public drinking water supply well.
4. Application sites are not subject to public access.
5. Retain a listing for review by the Department of land application sites used during the year and their legal descriptions plus total tonnage of sludge that was land-applied or disposed of during the year.

B. Non-compliance Reporting Requirements

The permittee shall report to the Department any instance(s) of noncompliance with 40 CFR Part 503. This Non-compliance Report shall be submitted to the Department no later than 7 days after the permittee becomes aware of the non-compliance. The Non-compliance Report shall contain the basic information required and specified in Appendix A of this NPDES permit.

C. Withdrawal of Site Approval(s)

The Department may withdraw site approval(s) for any of the following:

1. Failure to comply with the regulations contained in 40 CFR Part 503.
2. Potential risks or known impacts to surface or ground water quality.
3. Potential risks to the environment.
4. Potential risks to public health and / or welfare.
5. Other site specific or facility specific considerations.

D. Biosolids Reporting Requirements

The State of Nebraska is not delegated the Federal sludge program. An annual sludge report shall be submitted to EPA by February 19th of each year as implemented through 503 Sludge regulations.

The NPDES Electronic Reporting Rule was signed in September 2015. In accordance with this rule, Biosolids Annual Reporting will be conducted electronically for the EPA administered biosolids program. The Biosolids Annual Report will be filed using the NPDES eReporting Tool (NeT), which is accessed via EPA's Central Data Exchange (CDX) located at cdx.epa.gov.

EPA regulations specify that representative samples of sewage sludge that is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator must be collected and analyzed. These regulations also specify the analytical methods that must be used to analyze samples of sewage sludge.

EPA requires facilities to monitor for the certain parameters, (listed in Tables 1, 2, 3, and 4 at 40 CFR §503.13 and Tables 1 and 2 40 CFR §503.23. See also 40 CFR §503.8).

Part IV. Other Requirements and Conditions

A. Requirements for Removal of CBOD and TSS

The 30-day average percent removal of CBOD and TSS by the WWTF shall not be less than 85%.

B. Narrative Limits, Discharges authorized under this permit

1. Shall not be toxic to aquatic life in surface waters of the State outside the mixing zones allowed in NDEQ Title 117, *Nebraska Surface Water Quality Standards*,
2. Shall not contain pollutants at concentrations or levels that produce objectionable films, colors, turbidity, deposits, or noxious odors in the receiving stream or waterway, and
3. Shall not contain pollutants at concentrations or levels that cause the occurrence of undesirable or nuisance aquatic life in the receiving stream.

C. Additional Monitoring

The Department may require increases in the monitoring frequencies set forth in this permit to address new information concerning a discharge, evidence of potential noncompliance, suspect water quality in a discharge, evidence of water quality impacts in the receiving stream or waterway, or other similar concerns.

The Department may require monitoring for additional parameters not specified in this permit to address new information concerning a discharge, evidence of potential noncompliance, suspect water quality in a discharge, evidence of water quality impacts in the receiving stream or waterway, or other similar concerns.

D. Method Detection Limit Reporting Requirements

The minimum detection limit (MDL) is defined as the level at which the analytical system gives acceptable calibration points. If the analytical results are below MDL then the reported value on the DMR shall be a numerical value less than the MDL (e.g. <0.005).

E. Certified Operator Requirement

This facility is to be operated and maintained by operators certified in accordance with NDEQ Title 197, *Rules and Regulations for the Certification of Wastewater Treatment Facility Operators in Nebraska.*

F. Permit Attachments

The attachments to this permit may be modified without a formal modification of the permit.

G. Permit Modification and Reopening

This permit may be reopened and modified after public notice and opportunity for a public hearing for reasons specified in NDEQ Title 119 – *Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System*, Chapter 24.

H. Whole Effluent Toxicity Corrective Action

If the whole effluent toxicity tests results exceed the toxicity limitations in this permit, this is a permit violation and the permittee must initiate corrective actions according to the United States Environmental Protection Agency Document EPA 833-B-99-002, *Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants*.

I. Electronic Submission of Discharge Monitoring Reports

The National Pollutant Discharge Elimination System (NPDES) Electronic Reporting Rule requires electronic reporting of NPDES information rather than the currently required paper based reports from the permitted facilities. To comply with the federal rule, permittees will be required to submit DMRs electronically using the EPA NetDMR tool (Appendix A of 40 CFR part 127). Permittees may seek an electronic reporting waiver by submitting a letter to the department with a brief written statement regarding the basis for needing such a temporary waiver. The department will either approve or deny this electronic reporting waiver request. The duration of a temporary waiver may not exceed 5 years, which is the normal period for an NPDES permit term.

Table of Contents for Appendix A
Standard Conditions that Apply to NPDES and NPP Permits

Appendix A

Conditions Applicable to all NPDES Permits

The following conditions apply to all NPDES permits:

1. **Information Available**

   All permit applications, fact sheets, permits, discharge data, monitoring reports, and any public comments concerning such shall be available to the public for inspection and copying, unless such information about methods or processes is entitled to protection as trade secrets of the owner or operator under Neb. Rev. Stat. §81-1527, (Reissue 1999) and NDEQ Title 115, Chapter 4.

2. **Duty to Comply**

   a. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Federal Clean Water Act and the Applicable State Statutes and Regulations and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

   b. The permittee shall comply with effluent standards or prohibitions established under section 307(a) of the Clean Water Act for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish these standards or prohibitions or standards for sewage sludge use or disposal, even if the permit has not yet been modified to incorporate the requirement.

3. **Violations of this Permit**

   a. Any person who violates this permit may be subject to penalties and sanctions as provided by the Clean Water Act.

   b. Any person who violates this permit may be subject to penalties and sanctions as provided by the Nebraska Environmental Protection Act.

4. **Duty to Reapply**

   If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit.

5. **Need to Halt or Reduce Activity not a Defense**

   It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

6. **Duty to Mitigate**

   The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

7. **Proper Operation and Maintenance**

   The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes effective performance based on designed facility removals, effective management, adequate operator staffing and training, adequate process controls, adequate funding that reflects proper user fee schedules, adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of this permit.

8. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

9. Property Rights

This permit does not convey any property rights of any sort, or any exclusive privilege.

10. Duty to Provide Information

The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The permittee shall also furnish to the Director upon request, copies of records required to be kept by this permit.

11. Inspection and Entry

The permittee shall allow the Director, or an authorized representative (including an authorized contractor acting as a representative of the Administrator), upon presentation of credentials and other documents as may be required by law, to:

a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and

d. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

12. Monitoring and Records

a. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

b. Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503), the permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

c. Records of monitoring information shall include:

    i) The date(s), exact place, time and methods of sampling or measurements;

    ii) The individual(s) who performed the sampling or measurements;

    iii) The date(s) analyses were performed;

    iv) The individual(s) who performed the analyses;

    v) The analytical techniques or methods used; and

vi) The results of such analyses.

d. Monitoring must be conducted according to test procedures approved under NDEQ Title 119, Chapter 27 002 unless another method is required under 40 CFR Subchapters N – Effluent Guidelines and Standards Parts 425 to 471 or O – Sewer Sludge Parts 501 and 503.

e. Falsifies, Tampers, or Knowingly Renders Inaccurate

i) On actions brought by EPA, the Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction: be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or both.

ii) On action brought by the State, The Nebraska Environmental Protection Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished pursuant to Neb. Stat. §81-1508.01.

13. Signatory requirements

a. All applications, reports, or information submitted to the Director shall be signed and certified.

i) All permit applications shall be signed as follows:

(a) For a corporation

(i) By a responsible corporate officer: For the purpose of this section, a responsible corporate officer means:

(a) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or

(b) The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

(b) For a partnership or sole proprietorship

(i) By a general partner or the proprietor.

(c) For a municipality, State, Federal, or other public agency

(i) By either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:

(a) The chief executive officer of the agency, or

(b) A senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of EPA).

b. Reports and Other Information

i) All reports required by permits, and other information requested by the Director shall be signed by a person described in this section [paragraphs13. a. i) (a),(b), or (c)], or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(a) The authorization is made in writing by a person described in paragraphs 13. a. i) (a),(b), or (c);

(b) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company, (a duly authorized representative may thus be either a named individual or any individual occupying a named position) and;

(c) The written authorization is submitted to the Director.

c. Changes to Authorization

If an authorization of paragraphs 13. a. i) (a),(b), or (c) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of this section must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

d. Certification

All applications, reports and information submitted as a requirement of this permit shall contain the following certification statement:

i) I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

e. False Statement, Representation, or Certification

i) The CWA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

ii) The Nebraska Environmental Protection Act provides criminal penalties and sanctions for false statement, representation, or certification in any application, label, manifest, record, report, plan, or other document required to be filed or maintained by the Environmental Protection Act, the Integrated Solid Waste Management Act, the Livestock Waste Management Act or the rules or regulations adopted and promulgated pursuant to such acts.

14. Reporting Requirements

a. Planned Changes

i) The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

(a) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in NDEQ Title 119, Chapter 4 and 8.

(b) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements under NDEQ Title 119, Chapter 15.

(c) The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan. The sludge program is not delegated to the State so notification to the EPA Regional Administrator in addition to the State is required.

b. Anticipated Noncompliance

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

c. Transfers

This permit is not transferable to any person except after notice to the Director. The Director may require modification or revocation and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under NDEQ Title 119, Chapter 24 in some cases, modification or revocation and reissuance is mandatory.

d. Monitoring Reports

i) Monitoring results shall be reported at the intervals specified elsewhere in this permit.

ii) Monitoring results must be reported on a Discharge Monitoring Report (DMR) or forms provided or specified by the Director.

iii) Monitoring results shall be submitted on a quarterly basis using the reporting schedule set forth below, unless otherwise specified in this permit or by the Department.

Monitoring Quarters	**DMR Reporting Deadlines**
January - March	April 28
April - June	July 28
July - September	October 28
October - December	January 28

iv) For reporting results of monitoring of sludge use or disposal practices

v) Additional reports may be required by the EPA Regional Administrator.

vi) If the permittee monitors any pollutant more frequently than required by the permit using test procedures approved in NDEQ Title 119, Chapter 27 002, or another method required for an industry-specific waste stream under 40 CFR Subchapters N – Effluent Guidelines and Standards Parts 425 to 471 and O – Sewer Sludge Parts 501 and 503, the results of such monitoring shall be included in the calculation and reporting of the data submitted in the DMR or sludge reporting form specified by the Director or EPA Regional Administrator.

vii) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Director in the permit.

e. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

f. Twenty-four Hour Reporting

i) The permittee shall report any noncompliance which may endanger human health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

ii) The following shall be included as information which must be reported within 24 hours under this paragraph.

(a) Any unanticipated bypass which exceeds any effluent limitation in this permit.

(b) Any upset which exceeds any effluent limitation in this permit.

(c) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Director in the permit to be reported within 24 hours.

g. The Director may waive the written report on a case-by-case basis for reports under section 14. f. ii) (a), (b) and (c) if the oral report has been received within 24 hours.

h. Other noncompliance

The permittee shall report all instances of noncompliance not reported under paragraphs d., e., and f. of this section, at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph f. of this section.

i. Other information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information.

j. Noncompliance Report Forms

i) Noncompliance Report Forms are available from the Department and shall be submitted with or as the written noncompliance report.

ii) The submittal of a written noncompliance report does not relieve the permittee of any liability from enforcement proceedings that may result from the violation of permit or regulatory requirements.

15. Bypass

a. Definitions

i) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

ii) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypass Not Exceeding Limitations

The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 15.c. and d. of this section.

c. Notice

i) Anticipated Bypass

If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

ii) Unanticipated Bypass

The permittee shall submit notice of an unanticipated bypass as required in paragraph 14.f. of this section (24-hour notice).

d. Prohibition of Bypass

Bypass is prohibited, and the Director may take enforcement action against a permittee for bypass, unless:

i) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

iii) The permittee submitted notices as required under paragraph 15.c. of this section.

e. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed above in paragraph 15.d.

16. Upset

a. Definition

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. Effect of an Upset

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph 16.c. of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

c. Conditions Necessary for a Demonstration of Upset.

A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

i) An upset occurred and that the permittee can identify the cause(s) of the upset;

ii) The permitted facility was at the time being properly operated;

iii) The permittee submitted notice of the upset as required in paragraph 14.f. ii) (a), of this section (24-hour notice).

iv) The permittee complied with any remedial measures required under paragraph (d) of this section.

d. Burden of Proof

In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

17. Other Rules and Regulations Liability

The issuance of this permit in no way relieves the obligation of the permittee to comply with other rules and regulations of the Department.

18. Severability

If any provision of this permit is held invalid, the remainder of this permit shall not be affected.

19. Other Conditions that Apply to NPDES and NPP Permits

a. Land Application of Wastewater Effluent

The permittee shall be permitted to discharge treated domestic wastewater effluent by means of land application in accordance with the regulations and standards set forth in NDEQ Title 119, Chapter 12 002.

The Wastewater Section of the Department must be notified in writing if the permittee chooses to land apply effluent.

b. Toxic Pollutants

The permittee shall not discharge pollutants to waters of the state that cause a violation of the standards established in NDEQ Titles 117, 118 or 119. All discharges to surface waters of the state shall be free of toxic (acute or chronic) substances which alone or in combination with other substances, create conditions unsuitable for aquatic life outside the appropriate mixing zone.

c. Oil and Hazardous Substances/Spill Notification

Nothing in this permit shall preclude the initiation of any legal action or relieve the permittee from any responsibilities, liabilities or penalties under section 311 of the Clean Water Act. The permittee shall conform to the provisions set forth in NDEQ Title 126, Rules and Regulations Pertaining to the Management of Wastes. If the permittee knows, or has reason to believe, that oil or hazardous substances were released at the facility and could enter waters of the state or any of the outfall discharges authorized in this permit, the permittee shall immediately notify the Department of a release of oil or hazardous substances. During Department office hours (i.e., 8:00 a.m. to 5:00 p.m., Monday through Friday, except holidays), notification shall be made to the Nebraska Department of Environmental Quality at telephone numbers (402) 471-2186 or (877) 253-2603 (toll free). When NDEQ cannot be contacted, the permittee shall report to the Nebraska State Patrol for referral to the NDEQ Immediate Response Team at telephone number (402) 471-4545. It shall be the permittee's responsibility to maintain current telephone numbers necessary to carry out the notification requirements set forth in this paragraph.

d. Removed Substances

i) Solids, sludge, filter backwash or other pollutants removed in the course of treatment or control of wastewater shall be disposed of at a site and in a manner approved by the Nebraska Department of Environmental Quality.

(a) The disposal of nonhazardous industrial sludges shall conform to the standards established in or to the regulations established pursuant to 40 CFR Part 257.

(b) The disposal of sludge shall conform to the standards established in or to the regulations established pursuant to 40 CFR Part 503.

(c) If solids are disposed of in a licensed sanitary landfill, the disposal of solids shall conform to the standards established in NDEQ Title 132.

ii) Publicly owned treatment works shall dispose of sewage sludge in a manner that protects public health and the environment from any adverse effects which may occur from toxic pollutants as defined in Section 307 of the Clean Water Act.

iii) This permit may be modified or revoked and reissued to incorporate regulatory limitations established pursuant to 40 CFR Part 503.

e. Representative Sampling

i) Samples and measurements taken as required within this permit shall be representative of the discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points shall not be changed without notification to the Department and with the written approval of the Director.

ii) Composite sampling shall be conducted in one of the following manners;

(a) Continuous discharge - a minimum of one discrete aliquot collected every three hours,

(b) Less than 24 hours - a minimum of hourly discrete aliquots or a continuously drawn sample shall be collected during the discharge, or

(c) Batch discharge - a minimum of three discrete aliquots shall be collected during each discharge.

(d) Composite samples shall be collected in one of the following manners:

(i) The volume of each aliquot must be proportional to either the waste stream flow at the time of sampling or the total waste stream flow since collection of the previous aliquot,

(ii) A number of equal volume aliquots taken at varying time intervals in proportion to flow,

(iii) A sample continuously collected in proportion to flow, and

(e) Where flow proportional sampling is infeasible or non-representative of the pollutant loadings, the Department may approve the use of time composite samples.

(f) Grab samples shall consist of a single aliquot collected over a time period not exceeding 15 minutes.

iii) All sample preservation techniques shall conform to the methods adopted in NDEQ Title 119, Chapter 21 006 unless:

(a) In the case of sludge samples, alternative techniques are specified in 40 CFR Part 503, or

(b) Other procedures are specified in this permit.

iv) Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be used to insure the accuracy and reliability of measurements. The devices shall be installed, calibrated and maintained to insure the accuracy of the measurements. The accepted capability shall be consistent with that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of +/- 10%. The amount of deviation shall be from the true discharge rates throughout the range of expected discharge volumes. Guidance can be obtained from the following references for the selection, installation, calibration and operation of acceptable flow measurement devices:

(a) "Water Measurement Manual," U.S. Department of the Interior, Bureau of Reclamation, Third Edition, Revised Reprint, 2001.
(Available online at http://www.usbr.gov/tsc/techreferences/mands/wmm/index.htm)

(b) "NPDES Compliance Flow Measurement Manual, "U.S. Environmental Protection Agency, Office of Water Enforcement, Publication MCD-77, September 1981, 147 pp.
(Available online at http://www.epa.gov/nscep, and enter 'NPDES Compliance Flow Measurement Manual, Publication MCD-77' in the search box)

f. Changes of Loadings to Publicly Owned Treatment Works (POTWs)

All POTWs must provide adequate notice to the Director of the following:

i) Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to NDEQ Title 119, Chapter 26, if it were directly discharging those pollutants;

ii) Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit.

iii) For purposes of this paragraph, adequate notice shall include information on the quality and quantity of effluent introduced into the POTW, and any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

20. Definitions

Administrator: The Administrator of the USEPA.

Aliquot: An individual sample having a minimum volume of 100 milliliters that is collected either manually or in an automatic sampling device.

Annually: Once every calendar year.

Authorized Representative: Individual or position designated the authorization to submit reports, notifications, or other information requested by the Director on behalf of the Owner under the circumstances that the authorization is made in writing by the Owner, the authorization specifies the individual or position who is duly authorized, and the authorization is submitted to the Director.

Bimonthly: Once every other month.

Biosolids: Sewage sludge that is used or disposed through land application, surface disposal, incineration, or disposal in a municipal solid waste landfill.

Biweekly: Once every other week.

Bypass: The intentional diversion of wastes from any portion of a treatment facility.

Certifying Official: See Section 13, Standard Conditions above.

Daily Average: An effluent limitation that cannot be exceeded and is calculated by averaging the monitoring results for any given pollutant parameter obtained during a 24-hour day.

Department: Nebraska Department of Environmental Quality.

Director: The Director of the Nebraska Department of Environmental Quality.

Industrial Discharge: Wastewater that originates from an industrial process and / or is noncontact cooling water and / or is boiler blowdown.

Industrial User: A source of indirect discharge (a pretreatment facility).

Monthly Average: An effluent limitation that cannot be exceeded. It is calculated by averaging any given pollutant parameter monitoring results obtained during a calendar month.

Operator: A person (often the general contractor) designated by the owner who has day to day operational control and/or the ability to modify project plans and specifications related to the facility.

Owner: A person or party possessing the title of the land on which the activities will occur; or if the activity is for a lease holder, the party or individual identified as the lease holder; or the contracting government agency responsible for the activity.

Outfall: A discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, or container from which pollutants are or may be discharged into Waters of the State.

Passive Discharge: A discharge from a POTW that occurs in the absence of an affirmative action and is not authorized by the NPDES permit (e.g. discharges due to a leaking valve, discharges from an overflow structure) and / or is a discharge from an overflow structure not designed as part of the POTW (e.g. discharges resulting from lagoon berm / dike breaches).

Publicly Owned Treatment Works (POTW): A treatment works as defined by Section 212 of the Clean Water Act (Public Law 100-4) which is owned by the state or municipality, excluding any sewers or other conveyances not leading to a facility providing treatment.

Semiannually: Twice every year.

Significant Industrial User (SIU): All industrial users subject to Categorical Pretreatment Standards or any industrial user that, unless exempted under Chapter 1, Section 105 of NDEQ Title 119, discharges an average of 25,000 gallons per day or more of process water; or contributes a process waste stream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW; or is designated as such by the Director on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any National Pretreatment Standard or requirement.

Sludge: Any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect.

30-Day Average: An effluent limitation that cannot be exceeded. It is calculated by averaging any given pollutant parameter monitoring results obtained during a calendar month.

Total Toxic Organics (TTO): The summation of all quantifiable values greater than 0.01 milligrams per liter (mg/l) for toxic organic compounds that may be identified elsewhere in this permit. (If this term has application in this permit, the list of toxic organic compounds will be identified, typically in the Limitations and Monitoring Section(s) and/or in an additional Appendix to this permit.)

Toxic Pollutant: Those pollutants or combination of pollutants, including disease causing agents, after discharge and upon exposure, ingestion, inhalation or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains will, on the basis of information available to the administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunction (including malfunctions in reproduction), or physical deformations in such organisms or their offspring.

Upset: An exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee, excluding such factors as operational error, improperly designed or inadequate treatment facilities, or improper operation and maintenance or lack thereof.

Volatile Organic Compounds (VOC): The summation of all quantifiable values greater than 0.01 milligrams per liter (mg/l) for volatile, toxic organic compounds that may be identified elsewhere in this permit. (See the definition for Total Toxic Organics above. In many instances, VOCs are defined as the volatile fraction of the TTO parameter. If the term VOC has application in this permit, the list of toxic organic compounds will be identified, typically in the Limitations and Monitoring Section(s) and/or in an additional Appendix to this permit.)

Waters of the State: All waters within the jurisdiction of this state including all streams, lakes, ponds, impounding reservoirs, marshes, wetlands, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, situated wholly or partly within or bordering upon the state.

Weekly Average: An effluent limitation that cannot be exceeded. It is calculated by averaging any given pollutant parameter monitoring results obtained during a fixed calendar week. The permittee may start their week on any weekday but the weekday must remain fixed. The Department approval is required for any change of the starting day.

"X" Day Average: An effluent limitation defined as the maximum allowable "X" day average of consecutive monitoring results during any monitoring period where "X" is a number in the range of one to seven days.

21. Abbreviations

CFR: Code of Federal Regulations

kg/Day: Kilograms per Day

MGD: Million Gallons per Day

mg/L: Milligrams per Liter

NOI: Notice of Intent

NDEQ: Nebraska Department of Environmental Quality

NDEQ Title 115: Rules of Practice and Procedure

NDEQ Title 117: Nebraska Surface Water Quality Standards

NDEQ Title 118: Ground Water Quality Standards and Use Classification

NDEQ Title 119: Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System

NDEQ Title 126: Rules and Regulations Pertaining to the Management of Wastes

NDEQ Title 132: Integrated Solid Waste Management Regulations

NPDES: National Pollutant Discharge Elimination System

NPP: Nebraska Pretreatment Program

POTW: Publicly Owned Treatment Works

μg/L: Micrograms per Liter

WWTF: Wastewater Treatment Facility

Nebraska Department of Environmental Quality

NPDES Permits and Compliance Section

1200 'N' Street, Suite 400, The Atrium
P.O. Box 98922
Lincoln, NE 68509-8922
Tel. (402) 471-4220
Fax (402) 471-2909

Fact Sheet
Norfolk Water Pollution Control
City of Norfolk, Madison County, Nebraska
NPDES NE0033421 / NDEQ ID 57780

Attachment 1 – WLA Spreadsheets
Attachment 2 – Site Maps

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A. Proposed Action – Tentative Determination

On the basis of a preliminary staff review, the Nebraska Department of Environmental Quality has made a tentative determination to reissue, with change, the NPDES Permit Number NE0033421 to the City of Norfolk for discharge of treated wastewater from Norfolk Water Pollution Control to the Elkhorn River in the Elkhorn River Basin.

B. Applicant and Facility Information

Applicant	City of Norfolk
Mailing Address	610 East Monroe Ave., Norfolk Nebraska 68710
Location of Facility	610 East Monroe Ave., Norfolk Nebraska 68710
Legal Description	SE ¼, SW ¼, Section 35, Township 24 N, Range 1 W, Madison County, NE
SIC Number	4952
Other Information	Norfolk Water Pollution Control is a publicly owned treatment works (POTW) that receives and treats domestic and industrial wastewater.

C. Segment, Use Designations, and Impairment

Norfolk Water Pollution Control discharges treated wastewater to the Elkhorn River, segment EL4-10000, the Elkhorn River Basin. Segment, basin, and use designation are set forth in NDEQ Title 117, Chapter 5, *Nebraska Surface Water Quality Standards*. Impairments and pollutants are from the NDEQ *2018 Water Quality Integrated Report*.

Receiving Stream for WWTF	Elkhorn River
Basin / Segment	EL4-10000 in the Elkhorn River Basin

Water Quality Usage Designations for the Elkhorn River

State Resource Water	No
Recreation	Yes
Aquatic Life	Warmwater A
Public Drinking Water Supply	No
Agriculture Water Supply	A
Industrial Water Supply	No
Aesthetics	Yes
Key Species	*Northern pike, Channel Catfish, Flathead catfish, Largemouth bass*

Impairments and Parameters of Concern for Elkhorn River

Impairments	Recreation – Bacteria, Aquatic Life – Selenium
Parameters of Concern	*E. coli*, Selenium
TMDL	*E. coli*
Comments/Actions	*E. coli* TMDL approved 9/09, Aquatic community assessment, Fish consumption assessment

D. Description of Discharge, Compliance History, and Potential Pollutants

1. Description of Discharge

Norfolk Water Pollution Control wastewater treatment system consists of a debris screen followed by grit removal using a grit chamber, three preaeration basins, three primary clarifiers, two trickling filters followed by a four-cell sequence batch reactor (SBR) system. An activated sludge treatment system that is currently offline can be used when needed to provide additional treatment. An ultraviolet (UV) system is used to provide disinfection of the wastewater during the recreational season. Treated wastewater is discharged through Outfall 001 to the Elkhorn River. Biosolids from the treatment system are pumped to gravity thickeners followed by an aerated holding tank. The biosolids are then dewatered using a 2-belt filter press and then stabilized with lime kiln dust before being land applied.

The treatment system serves a population of 26,248 with an average daily flow of 2.95 MGD. The facility has a design daily flow of 5.74 MGD.

Significant industrial users discharging to the Norfolk POTW include;

- Hiland Roberts an ice cream producer.
- Henningsen Foods cooks and dehydrates beef, pork, and chicken products.
- Milk Specialties processes milk protein isolates.
- ContiTech, also known as Veyance, produces rubber hose products.
- Wis-Pak produces soda pop and bottled water.

2. Compliance History

The last inspection performed at Norfolk Water Pollution Control occurred on March 28, 2017. None of the findings of the inspection will have an impact on the permit and the plant was found to be running well. New ammonia criteria are implemented in the permit draft, but the facility is anticipated to meet the proposed lower water quality-based limits.

3. Potential Pollutants

The residential wastewater originates from domestic and industrial sources. The most prevalent pollutants are biodegradable organic material, suspended solids, nutrients, and fats & oils. Other pollutants such as machine oil, grease, metals, and synthetic organic compounds can also be found in sanitary wastewater. SIUs discharging to the facility contribute increased organic loading (CBOD and TSS), toxic organics, hydrocarbons, and metals. State regulations put restrictions on wastewater discharges to protect the wastewater treatment system from over-loading, pass-through, and upset. The permit establishes discharge limits and monitoring requirements to ensure that the pollutant removal efficiency of the WWTF is adequate to meet secondary treatment standards and to protect water quality.

E. Existing Permit Limits

Listed below is a summary of the existing permit monitoring requirements and limitations for the treated effluent discharged to the receiving stream.

Table FS – 1. Norfolk Water Pollution Control- Existing Monitoring Requirements for Outfall 001

Parameter	Monthly Average	Maximum	Monitoring Frequency
Flow	Report	Report	Daily
Temperature	Report	Report	Weekly
CBOD	25.0 mg/L	40.0 mg/L (7-day)	Weekly
TSS	30.0 mg/L	45.0 mg/L (7 day)	Weekly
Spring Ammonia	25.6 mg/L	51.3 mg/L	Weekly
Summer Ammonia	4.54 mg/L	9.10 mg/L	Weekly
Winter Ammonia	17.5 mg/L	35.1 mg/L	Weekly
Total Nitrogen	Report	Report	Weekly
Total Phosphorus	Report	Report	Weekly
Spring Acute Toxicity *Ceriodaphnius sp*	Report	1.22 TUa	Annually
Spring Acute Toxicity *Pimephales promelas*	Report	1.22 TUa	Annually
Summer Acute Toxicity *Ceriodaphnius sp*	Report	1.0 TUa	Annually
Summer Acute Toxicity *Pimephales promelas*	Report	1.0 TUa	Annually
Winter Acute Toxicity *Ceriodaphnius sp*	Report	1.0 TUa	Annually
Winter Acute Toxicity *Pimephales promelas*	Report	1.0 TUa	Annually
Dissolved Oxygen	Report	Report	Annually
Nitrate/Nitrite	Report	Report	Annually
Total Kjeldahl Nitrogen	Report	Report	Annually
Oil and Grease	Report	Report	Annually
Total Dissolved Solids	Report	Report	Annually
Cadmium, Dissolved	Report	Report	Annually
Chromium, Dissolved	Report	Report	Annually
Copper, Dissolved	Report	Report	Annually
Lead, Dissolved	Report	Report	Annually
Nickel, Dissolved	Report	Report	Annually
Zinc, Dissolved	Report	Report	Annually
E. coli	126	Report	Weekly
pH	6.5 – 9.0 Standard Units (S.U.)		Weekly

F. Summary of the Proposed Changes in the Draft Permit

The highlights of the proposed draft permit requirements are summarized below. See the attached permit for specific information on the permit conditions.

1. Ammonia limits have been revised.
2. Total nitrogen and total phosphorous monitoring frequencies have been revised.
3. *E. coli* limits have been revised.
4. CBOD and TSS limits are revised to match daily design flow.
5. Dissolved oxygen, nitrate/nitrite, total Kjeldahl nitrogen, oil and grease, and total dissolved solids testing requirements are removed and replaced by the pollution scan requirements.
6. Updates to general conditions and requirements, including the addition of electronic reporting.

G. Basis for Requirements in the Draft Permit

1. Overview of Permit Requirements

When developing effluent limits for a NPDES permit, the NDEQ considers limits based on both the technology available to treat the pollutants (technology-based effluent limits) and limits that are protective of the designated uses of the receiving water (water quality-based effluent limits). Technology-based effluent limits for facilities are derived from secondary treatment standards. The intent of technology-based effluent limitations is to require a minimum level of treatment for point sources based on currently available treatment technology. Water quality-based effluent limits are developed by the State of Nebraska to protect the beneficial uses of the receiving waters. The water quality-based effluent limits involve a site-specific evaluation of the effluent discharge and its effect on the receiving water. Permit limits are developed by a comprehensive assessment of both technology-based limits and water quality-based limits.

a. Secondary Treatment Standards

Secondary treatment is the biological component of a municipal wastewater treatment plant and technological limits in the permit are based on the manner of treatment employed at the plant. The Norfolk WWTF employs a sequence batch reactor system to reduce organic loadings before discharge to the Elkhorn River. The secondary limits for CBOD and TSS were derived by comparing the treatment efficiency of various mechanical treatment systems and thereby establishing a reasonable level of treatment based on similar technologies.

b. Water Quality-Based Effluent Limits

Water quality monitoring and limitations are included in the permit to protect the receiving stream from the discharge of toxic substances in toxic amounts. In NDEQ Title 117, *Nebraska Surface Water Quality Standards*, the water quality criteria for ammonia are determined as acute and chronic in-stream criteria. The NDEQ develops seasonal (spring, summer, winter) wasteload allocations (WLA) to protect these criteria. If there is a reasonable potential to cause an in-stream excursion of the water quality criteria for a parameter, then limitations are included in the NPDES permit. The permit limitations are established from the WLAs according to the procedures given in the *Technical Support Document for Water Quality-based Toxics Control* (TSD).

c. Schedule of Compliance

The NPDES regulations at Title 119, Chapter 16 allow the Department to establish schedules of compliance to give permittees additional time to achieve compliance with the CWA and applicable regulations but may not extend the date for final compliance beyond compliance dates established by the Clean Water Act. The Department may not establish a compliance schedule in a permit for technology based effluent limits (TBELs) because the statutory deadlines for meeting technology standards (i.e., secondary treatment standards and effluent guidelines) have passed.

d. Best Professional Judgment

Best professional judgment (BPJ) is the method used by permit writers to develop technology-based NPDES permit conditions when effluent guidelines and standards do not include limitations for an industrial category or subcategory. BPJ based limits are developed on a case-by-case basis using all reasonably available and relevant data. Technology-based treatment requirements, including BPJ, are adopted and incorporated by reference in Title 119, Chapter 20.

e. Reasonable Potential

Reasonable potential, in accordance with Title 119, Chapter 17, is the likelihood a pollutant could lead to an excursion above an applicable water quality standard. A reasonable potential calculation is applied to determine whether there is a reasonable potential for the effluent from the facility to cause an exceedance of in-stream criteria. If the results of this calculation indicate there is no reasonable potential to exceed in-stream criteria, report only monitoring may be included in the permit for that pollutant. If the results of this calculation indicate a reasonable potential to exceed in-stream criteria, a limit is included in the permit.

f. Anti-backsliding

Anti-backsliding is a statutory provision that prohibits the renewal, reissuance, or modification of an existing NPDES permit that contains effluent limitations, permit conditions, or standards that are less stringent than those established in the previous permit. Anti-backsliding provisions and exceptions are promulgated in Title 119, Chapter 17. If any of the limitations are less stringent than limitations on the same pollutant or narrative in the previous NPDES permit, the permit writer then conducts an anti-backsliding analysis and, if necessary, revises the limitations accordingly.

2. Antidegradation Review

An antidegradation review was performed for purposes of developing the permit pursuant to 40 CFR 131.12. The results of the evaluation indicate that the Elkhorn River, the receiving water body of the discharge addressed by the permit, is a habitat for aquatic life. The designated uses of the Elkhorn River were considered during permit development. The limitations in the draft permit are protective of the Clean Water Act § 101(a)(2) fishable/swimmable goals and ensure the existing quality of water in the receiving stream is not lowered.

3. Outfall 001 – Basis for Monitoring and Limitations

The effluent from Norfolk Water Pollution Control Outfall 001 discharges to the Elkhorn River after being treated by a mechanical treatment system. The treatment system is operated and maintained to meet the secondary and water quality requirements of the Clean Water Act. The basis for permit monitoring requirements and limitations are specified below.

a. Basis for Monitoring Frequencies

Monitoring frequencies are based on the Department's guidelines for mechanical facilities.

b. Basis for Flow Monitoring

NDEQ Title 119, Chapter 17.012.01B requires facilities to monitor the volume of effluent from each outfall. The median flow rate from the facility will be used in subsequent permits to determine water quality limits. Daily flow monitoring is required to obtain accurate discharge data for mechanical facilities.

c. Basis for Temperature Limits and Monitoring

Temperature monitoring is included in the permit. Temperature standards to protect aquatic life are set forth in NDEQ Title 117 *Nebraska Surface Water Quality Standards* Chapter 4 – *General Criteria for Aquatic Life*. According to the requirements of Title 117, the temperature of a receiving water shall not be increased by a total of more than 5° F. For warm waters, the maximum limit is 90° F. Facilities not directly adding heat to their effluent discharges are required to monitor the temperature of their effluent without limits. Norfolk Water Pollution Control does not add heat to the plant effluent. Therefore, weekly monitoring is maintained in the permit.

d. Basis for Total Nitrogen and Total Phosphorus Monitoring

High levels of nitrogen and phosphorus in rivers and streams can cause the degradation of water bodies and harm fish, wildlife, and human health. Excessive levels of nutrients in water bodies are often the direct result of human activities. Nitrogen and phosphorus are contributed to water bodies by both point and nonpoint sources, but the extent to which they contribute to water quality degradation varies by watershed and surrounding land uses. Monitoring for nitrogen and phosphorus is maintained in the permit so that the Department can evaluate the input of the wastewater effluent loadings of these pollutants in the receiving stream. Monitoring frequency is changed to monthly on the best professional judgement of the permit writer as the facility DMRs have not shown excessive levels.

e. Basis for CBOD Discharge Limits

Carbonaceous Biochemical Oxygen Demand (CBOD) monitoring and limitations are included in the permit based on the secondary treatment standards set forth in NDEQ Title 119 for mechanical facilities. For all treatment systems, the 30-day average for CBOD shall not exceed 25 mg/L and the 7-day average shall not exceed 40 mg/L. Mass (kg/day) monitoring requirements for CBOD are also included in the permit. Mass limits are based off the daily design flow of 5.74 million gallons per day (MGD). Weekly monitoring is maintained in the permit.

f. Basis for TSS Discharge Limits

The total suspended solids (TSS) monitoring and limitations are continued in the permit based on the secondary treatment standards set forth in NDEQ Title 119 for mechanical treatment facilities. For mechanical treatment systems, the 30-day average for TSS shall not exceed 30 mg/L and the 7-day average shall not exceed 45 mg/L. Mass limits are based on the daily design flow of 5.74 MGD. Weekly monitoring is maintained in the permit.

g. Basis for Ammonia Limits

In NDEQ Title 117 *Nebraska Surface Water Quality Standards*, the water quality criteria for ammonia are determined as acute and chronic criteria. Seasonal (spring, summer, winter) wasteload allocations (WLAs) are developed to ensure that the effluent discharge from the end of the pipe of the treatment system does not exceed these criteria. The WLAs are developed to protect the assigned beneficial uses of the stream. The calculation of the WLAs from the ammonia criteria is based on stream design flows, receiving stream parameters, effluent flow design parameters, and receiving stream information and is chosen using the most protective long-term average. NDEQ Title 117, Chapter 2 requires that all mixing zones be based on critical condition of minimum dilution, which have been defined as the 1Q10 and 30Q5 flows (design flows).

Temperature, pH, and background ammonia content for the receiving stream were obtained from NDEQ data for the Elkhorn River (EL4-10000). Acute temperature, ammonia, and pH data were obtained from Norfolk Water Pollution Control discharge monitoring reports (DMRs). Effluent flow was obtained from the facility DMRs. Data and criteria were modeled in the program CORMIX. The model inputs and results are located in NDEQ Document # 20180001099. The results of the CORMIX model are included in a mass balance wasteload allocation worksheet below and in Attachment 1.

Table FS-2. Norfolk Water Pollution Control Ammonia Waste Load Allocations (WLAs)

Parameter	Spring	Summer	Winter
Acute Ammonia	34.79 mg/L	11.63 mg/L	39.24 mg/L
Chronic Ammonia	12.18 mg/L	3.81 mg/L	12.66 mg/L

The ammonia permit limits are calculated from the WLAs according to the procedures given in the TSD for permit limit derivation from two-value, steady-state outputs for acute and chronic protection. The permit limits are chosen using the most protective long-term average, which is the chronic for the spring, summer, and winter seasons. The calculation of projected ammonia limits are documented in Attachment 1 and presented in Table FS-3.

Table FS-3. Norfolk Water Pollution Control – Projected Ammonia Limitations Derived from WLAs		
Parameter	**Monthly Average**	**Daily Maximum**
Spring Ammonia (March 1 – May 31)	7.92 mg/L 84.74 kg/day	22.44 mg/L 239.95 kg/day
Summer Ammonia (June 1 – October 31)	2.50 mg/L 27.89 kg/day	7.03 mg/L 78.49 kg/day
Winter Ammonia (Nov. 1 – February 28 [29])	7.96 mg/L 83.64 kg/day	23.13 mg/L 242.95 kg/day

The projected ammonia limits are revised based on changes to the new ammonia criteria, temperature and pH of the effluent, and temperature and pH of the Elkhorn River. A CORMIX model was utilized to provide a higher level of confidence in the WLA (see NDEQ document number 20180001099). The draft ammonia chronic limits are lower than the previously calculated limits, and are therefore implemented in the permit. Weekly monitoring is maintained in the permit.

h. Basis for pH Discharge Limits

According to NDEQ Title 117, Chapter 4 003.01A, hydrogen ion concentrations, expressed as pH, shall be maintained between 6.5 to 9.0 standard units (S.U.) in order to ensure water quality is not impacted. Therefore, the pH limits for Norfolk Water Pollution Control are included in the permit in the range of "6.5 to 9.0" based on an assessment of mechanical treatment facilities, NDEQ permitting procedures, and to protect water quality. Weekly monitoring is maintained in the permit.

i. Basis for Whole Effluent Toxicity (WET) Testing Requirements

Acute whole effluent toxicity (WET) monitoring is included in the permit to determine if the effluent from Norfolk Water Pollution Control will cause toxicity in the receiving stream. Whole effluent toxicity limits are included in the permit because toxicity to aquatic life shall not be allowed at any time outside of either an acute or chronic mixing zone. According to Title 117, the pollutant levels or concentrations of wastewaters, which contain unknown or complex mixtures or potentially, additive or synergistic toxic pollutants, shall not exceed 0.3 acute toxic units (TUa) or 1.0 chronic toxic units (TUc). The permit limitations are established from the acute toxic criteria according to the procedures given in the *Technical Support Document for Water Quality-based Toxics Control* (TSD) and are documented in Attachment 1. The toxicity permit limits are calculated from the WLAs according to the procedures given in the TSD for permit limit derivation from two-value, steady-state outputs for acute and chronic protection. The permit limits are chosen using the most protective long-term average, which is the acute for the spring, summer, and winter seasons. The facility has met WET limits throughout the permit term, and testing frequency is reduced to once per permit term based on the best professional judgment of the permit writer.

j. *Escherichia coli*

Norfolk Water Pollution Control discharges to Elkhorn River segment EL4-10000 in the Elkhorn River Basin. The Elkhorn River segment EL4-10000 which is designated as a recreation use stream in NDEQ Title 117, *Nebraska Surface Water Quality Standards*. In addition, the river is listed in the *2018 Water Quality Integrated Report* as impaired for bacteria. The recreational use applies to surface waters, which are used, or have a high potential to be used, for primary contact recreational activities. Primary contact recreation includes activities where the body may come into prolonged or intimate contact with the water, such that water may be accidentally ingested and sensitive body organs may be exposed.

According to the requirements set forth in NDEQ Title 117, *E. coli* bacteria shall not exceed a monthly geometric mean of 126/100mL and a maximum of 298/100 mL in the effluent during the recreational period that is May 1 through September 30. Weekly monitoring is continued.

k. Basis for Dissolved Metals Monitoring Requirements

Norfolk Water Pollution Control receives wastewater from industrial facilities, and there is a possibility that the effluent from PC facility might contain elevated dissolved metals. Annual testing conducted by PC has indicated that the facility is not discharging levels of dissolved metals that would impact water quality. All data indicated levels at or near method detection limit. Annual sampling for dissolved metals is continued based on the best professional judgment of the permit writer.

l. Basis for Pollutant Scan Requirements

40 CFR Part 122.21(j) requires direct discharging publicly owned treatment facilities to scan for multiple parameters, many not regularly monitored by the POTW. Currently, the permit requires annual testing for *E.* coli, dissolved oxygen, nitrate/nitrite, total Kjeldahl nitrogen, oil and grease, and total dissolved solids. These parameters are all required in the pollution scan and are now included as an attachment rather than on DMRs. As the facility discharges more than 1.0 MGD, Norfolk Water Pollution Control must conduct a larger pollution scan with more requirements than what are currently required.

Testing is required three times per permit term and account for seasonal variations. Any parameters that are monitored regularly by the POTW do not need to be tested during the scan. Pollutant scan requirements are located on the Department website in the NPDES Guidance documents section.

4. Influent Monitoring Requirements

The requirement that the influent be monitored for CBOD, TSS, and pH is included in the permit to provide data to evaluate influent quality and loadings. Quarterly monitoring is implemented in this permit based on the best professional judgement of the permit writer. Influent flow must be monitored on the same day as sample collection for all influent parameters.

5. Sludge Requirements

The sludge requirements for monitoring and disposal are in accordance with 40 CFR Part 503. EPA Region VII administers the sludge regulations for Norfolk Water Pollution Control.

6. Other Conditions and Requirements

a. Removal of CBOD and TSS

The requirement to achieve at least 85% removal for CBOD and TSS is based on the treatment standards for mechanical treatment systems set forth in NDEQ Title 119.

b. Narrative Limits

The narrative limits on toxicity, noxious odors, objectionable materials, and undesirable aquatic life are in accordance with water quality criteria in NDEQ Title 117.

c. Additional Monitoring

The conditions under which the Department may require increases in monitoring frequencies and monitoring for additional parameters are in accordance with NDEQ Title 119.

d. Method Detection Limit Reporting Requirements

The requirement to report the method detection limits on the Discharge Monitoring Report (DMR) instead of zero (0) when an analyte is not detected is according to NDEQ permitting procedures.

e. Certified Operator Requirement

The requirement that the wastewater treatment plant is to be operated and maintained by certified operators is in accordance with NDEQ Title 119.

f. Permit Modification and Reopening

The permit may be reopened and modified in accordance with NDEQ Title 119.

g. Revision of Permit Attachments

The option to revise permit attachments is according to NDEQ permitting procedures. These attachments can be modified without public hearing since the attachments are not a component of the NPDES Permit terms and conditions.

h. Whole Effluent Toxicity Corrective Action

If the whole effluent toxicity tests results exceed the toxicity limitations in this permit, this is a permit violation and the permittee must initiate corrective actions according to the United States Environmental Protection Agency Document EPA 833-B-99-002, *Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants*.

i. Electronic Submission of Discharge Monitoring Reports

On October 22, 2015, EPA published the Clean Water Act National Pollutant Discharge Elimination System (NPDES) Electronic Reporting Rule, which requires electronic reporting of NPDES information rather than the currently required paper based reports from the permitted facilities. To comply with the federal rule, permittees will be required to submit DMRs electronically using the EPA NetDMR tool (Appendix A of 40 CFR part 127).

H. Supporting Documentation

The following documents and regulations were used in the preparation of the draft permit.

1. NDEQ Title 117, *Nebraska Surface Water Quality Standards*, December 13, 2014.
2. NDEQ Title 118, *Ground Water Quality Standards and Use Classifications*, March 27, 2006.
3. NDEQ Title 119, *Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System*, July 2, 2017.
4. NDEQ Title 197, *Rules and Regulations for the Certification of Wastewater Treatment Facility Operators in Nebraska*, May 11, 2014.
5. NDEQ, *2018 Water Quality Integrated Report*, April 1, 2018.
6. *Technical Support Document for Water Quality-based Toxic Control* (EPA 505/2-90-001 PB91-127415, March 1991).
7. 40 CFR Parts 122, 124, and 125, NPDES Regulations.
8. 40 CFR Part 503, Sludge Regulations.
9. Permit application form 1 and 2A from Norfolk Water Pollution received by the NDEQ on February 28, 2018.
10. DMR data and facility file data for Norfolk Water Pollution; NPDES NE0033421; NDEQ ID 57780.
11. NDEQ document number 20180001099 with best professional judgement information regarding the CORMIX model and WLAs.

I. Information Requests

Inquiries concerning the draft permit, its basis or the public comment process may be directed to:

Kim Bubb Tel. (402) 471-8830 or (402) 471-4220 Fax: (402) 471-2909

Individuals requiring special accommodations or alternate formats of materials should notify the Department by calling (402) 471-2186. TDD users should call (800) 833-7352 and ask the relay operator to call the Department at (402) 471-2186.

Copies of the application and other supporting material used in the development of the permit are available for review and copying at the Department's office between 8:00 A.M. and 5:00 P.M. on weekdays.

Office Location: The Atrium, 1200 N Street, Suite 400, Lincoln, NE

Mail Address: NPDES Permits and Compliance Section, Nebraska Department of Environmental Quality, P.O. Box 98922; Lincoln, Nebraska 68509-8922

J. Submission of Formal Comments or Requests for Hearing

The date on which the public comment period ends is specified in the public notice. During the public notice period, the public may submit formal comments or objections, and/or petition the Department to hold a public hearing concerning the issuance of the draft permit. All such requests need to: be submitted in written form, state the nature of the issues to be raised, and present arguments and factual grounds to support them. The Department shall consider all written comments, objections and/or hearing petitions, received during the public comment period, in making a final decision regarding permit issuance.

Formal comments, objections and/or hearing requests need to be submitted to:

Kim Bubb; NPDES Permits and Compliance Section

Mailing Address: Nebraska Department of Environmental Quality
P.O. Box 98922
Lincoln, Nebraska 68509-8922

Location Address: Nebraska Department of Environmental Quality
The Atrium, 1200 N Street, Suite 400
Lincoln, Nebraska

Attachment 1 – WLA Spreadsheets

Facility Name:	Norfolk WCP		
Permit Number:	NE0033421		
Date:	21-Mar-18		
Permit Writer:	Anne Thompson		
Receiving Stream:	Elkhorn River		
Title 117 ID:	EL4-10000		
Aquatic Use:	WWA		
Pollutant of Concern:	NH3		
Coefficient of Variation (CV):			
Spring	1.399		
Summer	1.37		
Winter	1.536		
Samples/Month (N):	4		
Chronic (N) day average:	4		
Data from WLA Worksheet			
	Spring	Summer	Winter
Effluent Flow in cfs:	4.371	4.565	4.294
1q10 Stream Flow in cfs:	229.69	64.74	111.29
7q10 Stream Flow in cfs:	256.35	72.32	161.67
30q5 Stream Flow in cfs:	353.6	113.03	212.58
% 1q10 used for mixing:	7.01	22.53	14.77
% 7q10 used for mixing:	23.21	58.04	17.63
% 30q5 used for mixing:	23.21	58.04	17.63
Acute WLA:	34.79	11.63	39.24
Chronic WLA:	12.18	3.81	12.66

Calculated WLA Multipliers			
	Spring	Summer	Winter
acute WLA multiplier:	0.153	0.155	0.142
chronic WLA multiplier:	0.281	0.286	0.259
MDL LTA multiplier:	6.55	6.44	7.06
AML LTA multiplier:	2.31	2.29	2.43

Water Quality Based Permit Limit Calculations for: NH3			
	Spring	Summer	Winter
Acute WLA	34.79	11.63	39.24
Chronic WLA	12.18	3.81	12.66
Acute LTA	5.309	1.806	5.557
Chronic LTA	3.425	1.091	3.276
Concentration Based Permit Limits:			
Maximum Daily (mg/L)	***22.44***	***7.03***	***23.13***
Average Monthly (mg/L)	***7.92***	***2.50***	***7.96***
Mass Based Permit Limits:			
Maximum Daily (kg/day)	***239.95***	***78.49***	***242.95***
Average Monthly (kg/day)	***84.74***	***27.89***	***83.64***

Whole Effluent Toxicity Limits			
****Based on CV of 0.6**			
	Spring	Summer	Winter
Acute WLA	1.41	1.26	1.45
Chronic WLA	14.61	10.19	7.64
Acute LTA	0.45	0.40	0.47
Chronic LTA	7.71	5.38	4.03
Acute Toxicity (TUa)	1.41	1.26	1.45
Chronic Toxicity (TUc)	24.00	16.75	12.55
Permit Limits:			
Acute Toxicity (TUa)	***1.41***	***1.26***	***1.45***

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		Norfolk WPC - Ammonia					
		Spring		Summer		Winter	
		Chronic	Acute	Chronic	Acute	Chronic	Acute
K_d	d^{-1}	0.10541	0.13129	0.16338	0.20206	0.06042	0.08162
C_e	mg/l	12.18	34.79	3.81	11.63	12.66	39.24
Q_e	MGD	2.825	2.825	2.95	2.95	2.775	2.775
Q_e	cfs	4.371	4.371	4.565	4.565	4.294	4.294
T_e	^oC	13.889	16.611	22.222	23.944	8.056	13.111
D_s	ft	1.42869	1.06313	1.19482	0.87192	0.99831	1.15927
Vel_s	ft/s	1.65	1.49	1.72	0.99	1.17	1.6
W_s	ft	150	145	55	75	182	60
Q_s	cfs	353.6	229.69	113.03	64.74	212.58	111.29
n		0.03	0.03	0.03	0.03	0.03	0.03
T_s	^oC	12.32	17.1	21.86	26.487	0.2	6.75
u	mph	12.3	12.3	9.88	9.88	11.4	11.4
θ	deg	0	0	0	0	0	0
σ	deg	90	90	90	90	90	90
w_e	ft	1.58	1.58	1.615	1.615	1.566	1.566
d_e	ft	0.79	0.79	0.808	0.808	0.783	0.783
C_s	mg/l	0.05	0.17	0.05	0.074	0.11	0.158
C_{std}	mg/l	0.687	9.341	0.303	3.468	1.525	9.96
$C_{std'}$	mg/l	0.637	9.171	0.253	3.394	1.415	9.802
L_s	ft	5000	250	5000	250	5000	250
$Width_{mix}$	ft	34.81	10.17	31.92	16.9	32.09	8.86
Mix	%	0.23207	0.07014	0.58036	0.22533	0.17632	0.14767
Cormix #		3	3	3	3	3	3
Steps		100	100	100	100	100	100

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Warmwater Aquatic Life Use Class Specific Criteria.

Total Ammonia (as nitrogen).

Median In-stream pH and Temperature

Spring			Summer			Winter		
Chronic Criteria	Median pH	Median Temp	Chronic Criteria	Median pH	Median Temp	Chronic Criteria	Median pH	Median Temp
0.687	**8.390**	**12.320**	**0.303**	**8.510**	**21.860**	**1.525**	**8.110**	**0.200**

003.04A2 Thirty-day average concentration in mg/l not to exceed the numerical value given by

$$CV = 0.8876\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\left(2.126\times 10^{0.028\times(20-\text{Maximum of }\{Temp,\ \text{or } 7\})}\right)$$

where Temp is °C

003.04A2a The highest four-day average concentration within a thirty-day period shall not exceed 2.5 times the thirty-day criterion.

003.04A2b The following table shows thirty-day average criteria for total ammonia at various temperatures and pHs.

THIRTY-DAY AVERAGE CRITERIA FOR TOTAL AMMONIA (mg/l)
Warmwater Aquatic Life Use Classes

Temperature (°C) \ pH	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0
0.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
2.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
4.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
6.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
8.0	4.54	4.36	4.09	3.73	3.28	2.75	2.20	1.68	1.24	0.89	0.64	0.46	0.34
10.0	3.99	3.83	3.60	3.28	2.88	2.42	1.94	1.48	1.09	0.78	0.56	0.40	0.30
12.0	3.51	3.37	3.16	2.88	2.53	2.13	1.70	1.30	0.96	0.69	0.49	0.35	0.26
14.0	3.09	2.96	2.78	2.53	2.23	1.87	1.50	1.14	0.84	0.61	0.43	0.31	0.23
16.0	2.71	2.60	2.44	2.23	1.96	1.64	1.32	1.01	0.74	0.53	0.38	0.27	0.20
18.0	2.38	2.29	2.15	1.96	1.72	1.44	1.16	0.88	0.65	0.47	0.33	0.24	0.18
20.0	2.10	2.01	1.89	1.72	1.51	1.27	1.02	0.78	0.57	0.41	0.29	0.21	0.16
22.0	1.84	1.77	1.66	1.51	1.33	1.12	0.89	0.68	0.50	0.36	0.26	0.19	0.14
24.0	1.62	1.55	1.46	1.33	1.17	0.98	0.79	0.60	0.44	0.32	0.23	0.16	0.12
26.0	1.42	1.37	1.28	1.17	1.03	0.86	0.69	0.53	0.39	0.28	0.20	0.14	0.11
28.0	1.25	1.20	1.13	1.03	0.90	0.76	0.61	0.46	0.34	0.25	0.18	0.13	0.09
30.0	1.10	1.05	0.99	0.90	0.79	0.67	0.53	0.41	0.30	0.22	0.15	0.11	0.08

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Warmwater Aquatic Life Use Class Specific Criteria.

Total Ammonia (as nitrogen).

90th Percentile Effluent pH and Temperature

Spring			Summer			Winter		
Acute Criteria	P_{90} pH	P_{90} Temp	Acute Criteria	P_{90} pH	P_{90} Temp	Acute Criteria	P_{90} pH	P_{90} Temp
9.341	**7.670**	**16.611**	**3.468**	**7.888**	**23.944**	**9.960**	**7.801**	**13.111**

003.04A1 One-hour average concentration in mg/l not to exceed the numerical value given by

$$AV = 0.7249\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right) \times \text{Minimum of } \{51.93, \text{ or } 23.12(10^{0.036(20-Temp)})\}$$

where Temp is °C

ONE-HOUR AVERAGE CRITERIA FOR TOTAL AMMONIA (mg/l)
Warmwater Aquatic Life Use Classes

Temperature (°C)	pH 6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0
0.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
2.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
4.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
6.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
8.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
10.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
12.0	42.22	37.85	32.53	26.62	20.70	15.35	10.94	7.58	5.16	3.50	2.39	1.66	1.19
14.0	35.77	32.07	27.56	22.56	17.54	13.01	9.27	6.42	4.37	2.97	2.02	1.41	1.01
16.0	30.30	27.17	23.35	19.11	14.86	11.02	7.85	5.44	3.71	2.51	1.72	1.19	0.86
18.0	25.67	23.02	19.78	16.19	12.59	9.34	6.65	4.61	3.14	2.13	1.45	1.01	0.73
20.0	21.75	19.50	16.76	13.72	10.67	7.91	5.64	3.90	2.66	1.80	1.23	0.86	0.62
22.0	18.43	16.52	14.20	11.62	9.04	6.70	4.78	3.31	2.25	1.53	1.04	0.73	0.52
24.0	15.61	14.00	12.03	9.85	7.66	5.68	4.05	2.80	1.91	1.29	0.88	0.62	0.44
26.0	13.23	11.86	10.19	8.34	6.49	4.81	3.43	2.37	1.62	1.10	0.75	0.52	0.37
28.0	11.21	10.05	8.64	7.07	5.50	4.08	2.90	2.01	1.37	0.93	0.63	0.44	0.32
30.0	9.50	8.51	7.32	5.99	4.66	3.45	2.46	1.70	1.16	0.79	0.54	0.37	0.27

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Segment	STATION #	DATE	Month	Temp	pH	Ammonia				
EL4-10000	SEL4ELKHR109	03/15/2011	3			0.178				
EL4-10000	SEL4ELKHR109	03/06/2012	3	7.19	8.55	0.843				
EL4-10000	SEL4ELKHR109	03/05/2013	3	0.19	8.75	0.089				
EL4-10000	SEL4ELKHR109	03/19/2014	3	5.62	8.13	0.050				
EL4-10000	SEL4ELKHR109	04/04/2011	4	7.68	7.8	0.05				
EL4-10000	SEL4ELKHR109	04/02/2012	4	17.1	8.3	0.0529				
EL4-10000	SEL4ELKHR109	04/01/2013	4	2.91	8.37	0.081				
EL4-10000	SEL4ELKHR109	04/07/2014	4	12.32	8.39	0.050				
EL4-10000	SEL4ELKHR109	05/03/2011	5	12.81	8.75	0.05				
EL4-10000	SEL4ELKHR109	05/08/2012	5	16.82	8.87	0.102				
EL4-10000	SEL4ELKHR109	05/13/2013	5	19.43	8.89	0.050				
EL4-10000	SEL4ELKHR109	05/06/2014	5	13.64	8.08	0.050				
		Spring	Median	12.32	8.39	0.05	AcTemp	17.100	AcAm	0.170
EL4-10000	SEL4ELKHR109	06/06/2011	6	23.03	8.14	0.0659				
EL4-10000	SEL4ELKHR109	06/04/2012	6	20.52	8.13	0.05				
EL4-10000	SEL4ELKHR109	06/10/2013	6	16.62	8.16	0.050				
EL4-10000	SEL4ELKHR109	06/03/2014	6	22.07	8.64	0.050				
EL4-10000	SEL4ELKHR109	07/12/2011	7	24.59	8.2	0.05				
EL4-10000	SEL4ELKHR109	07/11/2012	7	27.45	9.29	0.05				
EL4-10000	SEL4ELKHR109	07/09/2013	7	30.98	8.77	0.056				
EL4-10000	SEL4ELKHR109	07/08/2014	7	23.86	8.72	0.050				
EL4-10000	SEL4ELKHR109	08/01/2011	8	25.25	8.91	0.05				
EL4-10000	SEL4ELKHR109	08/13/2012	8	17.71	8.08	0.0864				
EL4-10000	SEL4ELKHR109	08/05/2013	8	22.34	8.75	0.050				
EL4-10000	SEL4ELKHR109	08/05/2014	8	22.46	8.27	0.050				
EL4-10000	SEL4ELKHR109	09/07/2011	9	19.87	8.82	0.0615				
EL4-10000	SEL4ELKHR109	09/11/2012	9	19.46	7.94	0.05				
EL4-10000	SEL4ELKHR109	09/10/2013	9	26.38	8.95	0.059				
EL4-10000	SEL4ELKHR109	09/03/2014	9	21.66	9.00	0.050				
EL4-10000	SEL4ELKHR109	10/03/2011	10	19.94	8.19	0.0517				
EL4-10000	SEL4ELKHR109	10/08/2012	10	6.77	8.3	0.0721				
EL4-10000	SEL4ELKHR109	10/07/2013	10	9.21	8.38	0.173				
EL4-10000	SEL4ELKHR109	10/07/2014	10	12.44	8.82	0.050				
		Summer	Median	21.86	8.51	0.05	AcTemp	26.487	AcAm	0.074
EL4-10000	SEL4ELKHR109	01/19/2011	1	0	7.52	0.154				
EL4-10000	SEL4ELKHR109	01/10/2012	1	2.2	8.49	0.0575				
EL4-10000	SEL4ELKHR109	01/08/2013	1	0.04	8.96	0.099				
EL4-10000	SEL4ELKHR109	01/14/2014	1	0.20	7.86	0.166				
EL4-10000	SEL4ELKHR109	02/08/2011	2	0	7.01	0.14				
EL4-10000	SEL4ELKHR109	02/06/2012	2	1.14	8	0.107				
EL4-10000	SEL4ELKHR109	02/12/2013	2	0.20	7.90	0.147				
EL4-10000	SEL4ELKHR109	02/10/2014	2	0.07	8.13	0.105				
EL4-10000	SEL4ELKHR109	11/08/2011	11	6.15	8.35	0.0667				
EL4-10000	SEL4ELKHR109	11/06/2012	11	7.35	9.41	0.0552				
EL4-10000	SEL4ELKHR109	11/05/2013	11	4.75	8.37	0.050				
EL4-10000	SEL4ELKHR109	11/04/2014	11	8.27	8.71	0.069				
EL4-10000	SEL4ELKHR109	12/05/2011	12	0.16	7.73	0.131				
EL4-10000	SEL4ELKHR109	12/03/2012	12	4.43	8.12	0.0793				
EL4-10000	SEL4ELKHR109	12/16/2013	12	0.09	6.79	0.132				
EL4-10000	SEL4ELKHR109	12/01/2014	12	-0.03	8.09	0.162				
		Winter	Median	0.20	8.11	0.11	AcTemp	6.750	AcAm	0.158

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Facility	Norfolk WPC					
Season	Spring		Summer		Winter	
Type	Chronic	Acute	Chronic	Acute	Chronic	Acute
Effluent Flow (cfs)	4.371	4.371	4.565	4.565	4.294	4.294
Area (ft^2)	1.248857	1.248857	1.304286	1.304286	1.226857	1.226857
Depth (ft)	0.790208	0.790208	0.807554	0.807554	0.783217	0.783217
Width (ft)	1.580416	1.580416	1.615107	1.615107	1.566434	1.566434

Effluent Velocity (ft/s)	3.5

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Effluent Data

NPDES ID	rm Feature	Set Desig	rameter Co	Parameter	Limit Freq	Value Type	DMR Value	Limit Unit	Statistical	Limit Value	NODI Code	NODI Desc	Monitoring	Month
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.64	MGD	MO AVG				03/31/2015	3
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.66	MGD	MO AVG				03/31/2014	3
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.85	MGD	MO AVG				03/31/2017	3
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.91	MGD	MO AVG				03/31/2016	3
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.71	MGD	MO AVG				04/30/2015	4
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.82	MGD	MO AVG				04/30/2014	4
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.83	MGD	MO AVG				04/30/2017	4
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.13	MGD	MO AVG				04/30/2016	4
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.75	MGD	MO AVG				05/31/2015	5
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.76	MGD	MO AVG				05/31/2014	5
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.25	MGD	MO AVG				05/31/2017	5
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.87	MGD	MO AVG				05/31/2016	5
					Spring	Median	2.825							
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.96	MGD	MO AVG				06/30/2015	6
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.05	MGD	MO AVG				06/30/2017	6
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.12	MGD	MO AVG				06/30/2014	6
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.95	MGD	MO AVG				06/30/2016	6
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.94	MGD	MO AVG				07/31/2014	7
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.94	MGD	MO AVG				07/31/2017	7
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.03	MGD	MO AVG				07/31/2015	7
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.03	MGD	MO AVG				07/31/2016	7
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.9	MGD	MO AVG				08/31/2015	8
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.96	MGD	MO AVG				08/31/2016	8
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.98	MGD	MO AVG				08/31/2014	8
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.01	MGD	MO AVG				08/31/2017	8
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.79	MGD	MO AVG				09/30/2015	9
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.8	MGD	MO AVG				09/30/2017	9
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.86	MGD	MO AVG				09/30/2014	9
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.86	MGD	MO AVG				09/30/2016	9
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.73	MGD	MO AVG				10/31/2014	10
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.74	MGD	MO AVG				10/31/2015	10
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.78	MGD	MO AVG				10/31/2016	10
NE003342	001	M	50050	Flow, in cor	Daily	Q1	3.13	MGD	MO AVG				10/31/2017	10
					Summer	Median	2.95							
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.71	MGD	MO AVG				01/31/2014	1
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.72	MGD	MO AVG				01/31/2015	1
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.79	MGD	MO AVG				01/31/2016	1
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.81	MGD	MO AVG				01/31/2017	1
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.99	MGD	MO AVG				01/31/2018	1
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.68	MGD	MO AVG				02/28/2014	2
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.75	MGD	MO AVG				02/28/2015	2
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.87	MGD	MO AVG				02/29/2016	2
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.88	MGD	MO AVG				02/28/2017	2
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.95	MGD	MO AVG				02/28/2018	2
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.66	MGD	MO AVG				11/30/2015	11
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.72	MGD	MO AVG				11/30/2016	11
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.73	MGD	MO AVG				11/30/2014	11
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.99	MGD	MO AVG				11/30/2017	11
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.7	MGD	MO AVG				12/31/2014	12
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.76	MGD	MO AVG				12/31/2016	12
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.8	MGD	MO AVG				12/31/2015	12
NE003342	001	M	50050	Flow, in cor	Daily	Q1	2.84	MGD	MO AVG				12/31/2017	12
					Winter	Median	2.775							

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NPDES ID	rm Feature	t Set Desig	rameter Cc	Parameter	Limit Frequ	Value Type	DMR Value	Limit Unit	Statistical	Limit Value	NODI Code	NODI Desc	Monitoring	Month
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.09	mg/L	MO AVG	25.6			03/31/2015	3
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.15	mg/L	MO AVG	25.6			03/31/2016	3
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.26	mg/L	MO AVG	25.6			03/31/2014	3
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	4.48	mg/L	MO AVG	25.6			03/31/2017	3
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.29	mg/L	MO AVG	25.6			04/30/2014	4
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.29	mg/L	MO AVG	25.6			04/30/2016	4
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.63	mg/L	MO AVG	25.6			04/30/2015	4
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	2.43	mg/L	MO AVG	25.6			04/30/2017	4
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.17	mg/L	MO AVG	25.6			05/31/2015	5
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.18	mg/L	MO AVG	25.6			05/31/2014	5
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.61	mg/L	MO AVG	25.6			05/31/2017	5
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	1.89	mg/L	MO AVG	25.6			05/31/2016	5
					Spring	Mean	0.956	StDev	1.338	CV	1.399			
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			06/30/2015	6
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.17	mg/L	MO AVG	4.54			06/30/2014	6
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	2	mg/L	MO AVG	4.54			06/30/2016	6
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	1.77	mg/L	MO AVG	4.54			06/30/2017	6
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			07/31/2015	7
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.16	mg/L	MO AVG	4.54			07/31/2016	7
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.25	mg/L	MO AVG	4.54			07/31/2017	7
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.43	mg/L	MO AVG	4.54			07/31/2014	7
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.18	mg/L	MO AVG	4.54			08/31/2016	8
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.19	mg/L	MO AVG	4.54			08/31/2015	8
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.26	mg/L	MO AVG	4.54			08/31/2017	8
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.29	mg/L	MO AVG	4.54			08/31/2014	8
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			09/30/2017	9
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.13	mg/L	MO AVG	4.54			09/30/2015	9
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.17	mg/L	MO AVG	4.54			09/30/2016	9
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.21	mg/L	MO AVG	4.54			09/30/2014	9
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			10/31/2014	10
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			10/31/2016	10
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.11	mg/L	MO AVG	4.54			10/31/2017	10
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.23	mg/L	MO AVG	4.54			10/31/2015	10
					Summer	Mean	0.265	StDev	0.363	CV	1.370			
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.06	mg/L	MO AVG	17.5			01/31/2015	1
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.12	mg/L	MO AVG	17.5			01/31/2016	1
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	1.08	mg/L	MO AVG	17.5			01/31/2017	1
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	2.02	mg/L	MO AVG	17.5			01/31/2018	1
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	4.05	mg/L	MO AVG	17.5			01/31/2014	1
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.07	mg/L	MO AVG	17.5			02/28/2015	2
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.17	mg/L	MO AVG	17.5			02/29/2016	2
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	1.81	mg/L	MO AVG	17.5			02/28/2018	2
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	3.71	mg/L	MO AVG	17.5			02/28/2014	2
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	5.44	mg/L	MO AVG	17.5			02/28/2017	2
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.09	mg/L	MO AVG	17.5			11/30/2015	11
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.12	mg/L	MO AVG	17.5			11/30/2017	11
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.13	mg/L	MO AVG	17.5			11/30/2014	11
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.25	mg/L	MO AVG	17.5			11/30/2016	11
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.05	mg/L	MO AVG	17.5			12/31/2014	12
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.07	mg/L	MO AVG	17.5			12/31/2017	12
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.09	mg/L	MO AVG	17.5			12/31/2015	12
NE003342	001	M	00610	Nitrogen, a	Weekly	C2	.21	mg/L	MO AVG	17.5			12/31/2016	12
					Winter	Mean	1.086	StDev	1.668	CV	1.536			

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NPDES ID	rm Feature	Set Desig	rameter Cc	Parameter	Limit Freq	Value Type	DMR Value	Limit Unit	Statistical	Limit Value	NODI Code	NODI Desc	Monitoring	Month	
NE003342	001	M	00011	Temperatu	Weekly	Q1	50	deg F	MO AVG				03/31/2014	3	
NE003342	001	M	00011	Temperatu	Weekly	Q1	50	deg F	MO AVG				03/31/2015	3	
NE003342	001	M	00011	Temperatu	Weekly	Q1	51	deg F	MO AVG				03/31/2017	3	
NE003342	001	M	00011	Temperatu	Weekly	Q1	52	deg F	MO AVG				03/31/2016	3	
NE003342	001	M	00011	Temperatu	Weekly	Q1	55	deg F	MO AVG				04/30/2016	4	
NE003342	001	M	00011	Temperatu	Weekly	Q1	56	deg F	MO AVG				04/30/2015	4	
NE003342	001	M	00011	Temperatu	Weekly	Q1	58	deg F	MO AVG				04/30/2017	4	
NE003342	001	M	00011	Temperatu	Weekly	Q1	59	deg F	MO AVG				04/30/2014	4	
NE003342	001	M	00011	Temperatu	Weekly	Q1	60	deg F	MO AVG				05/31/2017	5	
NE003342	001	M	00011	Temperatu	Weekly	Q1	61	deg F	MO AVG				05/31/2016	5	
NE003342	001	M	00011	Temperatu	Weekly	Q1	62	deg F	MO AVG				05/31/2015	5	
NE003342	001	M	00011	Temperatu	Weekly	Q1	63	deg F	MO AVG				05/31/2014	5	
				Spring	Median	Deg F	57.000	Deg C	13.889	Crit - 90%	Deg F	61.900	Deg C		16.611
NE003342	001	M	00011	Temperatu	Weekly	Q1	69	deg F	MO AVG				06/30/2016	6	
NE003342	001	M	00011	Temperatu	Weekly	Q1	71	deg F	MO AVG				06/30/2014	6	
NE003342	001	M	00011	Temperatu	Weekly	Q1	71	deg F	MO AVG				06/30/2015	6	
NE003342	001	M	00011	Temperatu	Weekly	Q1	72	deg F	MO AVG				06/30/2017	6	
NE003342	001	M	00011	Temperatu	Weekly	Q1	74	deg F	MO AVG				07/31/2014	7	
NE003342	001	M	00011	Temperatu	Weekly	Q1	74	deg F	MO AVG				07/31/2016	7	
NE003342	001	M	00011	Temperatu	Weekly	Q1	76	deg F	MO AVG				07/31/2015	7	
NE003342	001	M	00011	Temperatu	Weekly	Q1	77	deg F	MO AVG				07/31/2017	7	
NE003342	001	M	00011	Temperatu	Weekly	Q1	63	deg F	MO AVG				08/31/2014	8	
NE003342	001	M	00011	Temperatu	Weekly	Q1	74	deg F	MO AVG				08/31/2015	8	
NE003342	001	M	00011	Temperatu	Weekly	Q1	75	deg F	MO AVG				08/31/2016	8	
NE003342	001	M	00011	Temperatu	Weekly	Q1	75	deg F	MO AVG				08/31/2017	8	
NE003342	001	M	00011	Temperatu	Weekly	Q1	72	deg F	MO AVG				09/30/2014	9	
NE003342	001	M	00011	Temperatu	Weekly	Q1	72	deg F	MO AVG				09/30/2015	9	
NE003342	001	M	00011	Temperatu	Weekly	Q1	72	deg F	MO AVG				09/30/2016	9	
NE003342	001	M	00011	Temperatu	Weekly	Q1	72	deg F	MO AVG				09/30/2017	9	
NE003342	001	M	00011	Temperatu	Weekly	Q1	65	deg F	MO AVG				10/31/2014	10	
NE003342	001	M	00011	Temperatu	Weekly	Q1	65	deg F	MO AVG				10/31/2015	10	
NE003342	001	M	00011	Temperatu	Weekly	Q1	65	deg F	MO AVG				10/31/2016	10	
NE003342	001	M	00011	Temperatu	Weekly	Q1	66	deg F	MO AVG				10/31/2017	10	
				Summer	Median	Deg F	72.000	Deg C	22.222	Crit - 90%	Deg F	75.100	Deg C		23.944
NE003342	001	M	00011	Temperatu	Weekly	Q1	42	deg F	MO AVG				01/31/2015	1	
NE003342	001	M	00011	Temperatu	Weekly	Q1	43	deg F	MO AVG				01/31/2018	1	
NE003342	001	M	00011	Temperatu	Weekly	Q1	45	deg F	MO AVG				01/31/2014	1	
NE003342	001	M	00011	Temperatu	Weekly	Q1	46	deg F	MO AVG				01/31/2016	1	
NE003342	001	M	00011	Temperatu	Weekly	Q1	47	deg F	MO AVG				01/31/2017	1	
NE003342	001	M	00011	Temperatu	Weekly	Q1	41	deg F	MO AVG				02/28/2015	2	
NE003342	001	M	00011	Temperatu	Weekly	Q1	41	deg F	MO AVG				02/28/2018	2	
NE003342	001	M	00011	Temperatu	Weekly	Q1	44	deg F	MO AVG				02/28/2014	2	
NE003342	001	M	00011	Temperatu	Weekly	Q1	46	deg F	MO AVG				02/29/2016	2	
NE003342	001	M	00011	Temperatu	Weekly	Q1	49	deg F	MO AVG				02/28/2017	2	
NE003342	001	M	00011	Temperatu	Weekly	Q1	47	deg F	MO AVG				11/30/2014	11	
NE003342	001	M	00011	Temperatu	Weekly	Q1	55	deg F	MO AVG				11/30/2017	11	
NE003342	001	M	00011	Temperatu	Weekly	Q1	57	deg F	MO AVG				11/30/2015	11	
NE003342	001	M	00011	Temperatu	Weekly	Q1	64	deg F	MO AVG				11/30/2016	11	
NE003342	001	M	00011	Temperatu	Weekly	Q1	42	deg F	MO AVG				12/31/2017	12	
NE003342	001	M	00011	Temperatu	Weekly	Q1	48	deg F	MO AVG				12/31/2015	12	
NE003342	001	M	00011	Temperatu	Weekly	Q1	48	deg F	MO AVG				12/31/2016	12	
NE003342	001	M	00011	Temperatu	Weekly	Q1	50	deg F	MO AVG				12/31/2014	12	
				Winter	Median	Deg F	46.500	Deg C	8.056	Crit - 90%	Deg F	55.600	Deg C		13.111

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NPDES ID	rm Feature	Set Desig	rameter Cc	Parameter	Limit Freq	Value Type	DMR Value	Limit Unit $	Statistical	Limit Value	NODI Code	NODI Desc	Monitoring	Month
NE003342	001	M	00400	pH	Weekly	C3	7.45	SU	DAILY MX				03/31/2017	3
NE003342	001	M	00400	pH	Weekly	C3	7.47	SU	DAILY MX				03/31/2016	3
NE003342	001	M	00400	pH	Weekly	C3	7.52	SU	DAILY MX				03/31/2015	3
NE003342	001	M	00400	pH	Weekly	C3	7.54	SU	DAILY MX				03/31/2014	3
NE003342	001	M	00400	pH	Weekly	C3	7.45	SU	DAILY MX				04/30/2016	4
NE003342	001	M	00400	pH	Weekly	C3	7.51	SU	DAILY MX				04/30/2017	4
NE003342	001	M	00400	pH	Weekly	C3	7.67	SU	DAILY MX				04/30/2015	4
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NE003342	001	M	00400	pH	Weekly	C3	7.48	SU	DAILY MX				05/31/2017	5
NE003342	001	M	00400	pH	Weekly	C3	7.62	SU	DAILY MX				05/31/2014	5
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NE003342	001	M	00400	pH	Weekly	C3	7.65	SU	DAILY MX				06/30/2015	6
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NE003342	001	M	00400	pH	Weekly	C3	7.67	SU	DAILY MX				08/31/2015	8
NE003342	001	M	00400	pH	Weekly	C3	8.07	SU	DAILY MX				08/31/2014	8
NE003342	001	M	00400	pH	Weekly	C3	7.43	SU	DAILY MX				09/30/2016	9
NE003342	001	M	00400	pH	Weekly	C3	7.54	SU	DAILY MX				09/30/2017	9
NE003342	001	M	00400	pH	Weekly	C3	7.58	SU	DAILY MX				09/30/2015	9
NE003342	001	M	00400	pH	Weekly	C3	7.87	SU	DAILY MX				09/30/2014	9
NE003342	001	M	00400	pH	Weekly	C3	7.48	SU	DAILY MX				10/31/2016	10
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					Summer	Crit -90%	7.888							
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NE003342	001	M	00400	pH	Weekly	C3	7.49	SU	DAILY MX				01/31/2017	1
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NE003342	001	M	00400	pH	Weekly	C3	7.58	SU	DAILY MX				01/31/2015	1
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NE003342	001	M	00400	pH	Weekly	C3	7.43	SU	DAILY MX				02/28/2015	2
NE003342	001	M	00400	pH	Weekly	C3	7.45	SU	DAILY MX				02/29/2016	2
NE003342	001	M	00400	pH	Weekly	C3	7.63	SU	DAILY MX				02/28/2014	2
NE003342	001	M	00400	pH	Weekly	C3	7.52	SU	DAILY MX				11/30/2016	11
NE003342	001	M	00400	pH	Weekly	C3	7.57	SU	DAILY MX				11/30/2017	11
NE003342	001	M	00400	pH	Weekly	C3	7.63	SU	DAILY MX				11/30/2014	11
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NE003342	001	M	00400	pH	Weekly	C3	7.5	SU	DAILY MX				12/31/2016	12
NE003342	001	M	00400	pH	Weekly	C3	7.54	SU	DAILY MX				12/31/2015	12
NE003342	001	M	00400	pH	Weekly	C3	7.58	SU	DAILY MX				12/31/2017	12
NE003342	001	M	00400	pH	Weekly	C3	7.89	SU	DAILY MX				12/31/2014	12
					Winter	Crit -90%	7.801							

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Mixing Zones and Wasteload Calculations

Target Velocity – V_t

$$V_t = \frac{V_k}{\left(\frac{Flow_k}{Flow_t} \right)^{0.5}}$$

Target Depth – D_t

$$D_t = \frac{D_k}{\left(\frac{Flow_k}{Flow_t} \right)^{0.4}}$$

Target Cross-Sectional Area - CSA_t

$$CSA_t = \frac{CSA_k}{\left(\frac{Flow_k}{Flow_t} \right)^{0.5}}$$

Stream width at design flow - W_t

$$W_t = \frac{CSA_t}{D_t}$$

V_k – Known velocity

$Flow_k$ – Known flow

D_k – Known depth

CSA_k – Known cross-sectional area

Shear velocity – v*

$$v^* = \sqrt{g \cdot D_t \cdot s}$$

g – Gravity, 32.2 ft/s/s

s – Channel slope, ft/mile

Lateral dispersion – d_y

$$d_y = (1.5 \cdot c \cdot D_t \cdot v^*)$$

c – Channel sinuosity

Distance to complete lateral mixing - X_m

$$X_m = \frac{m \cdot W_t^2 \cdot V_t}{d_y}$$

m – 0.2, coefficient of uniformity

Maximum allowable effluent concentration - C_s

$$C_e = \frac{C_x(Q_e + Q_s) - C_s(Q_s)}{Q_e}$$

C_x – Water quality criteria

C_s – Background pollutant concentration

Q_s – Seasonal design flow of receiving stream

X – Maximum mixing zone (Title 117)

Q_e – Median seasonal effluent flow

Volume of stream utilized at mixing zone boundary - Q_{sb}

$$Q_{sb} = \frac{C_e(Q_e) - C_x(Q_e)}{C_x - C_s}$$

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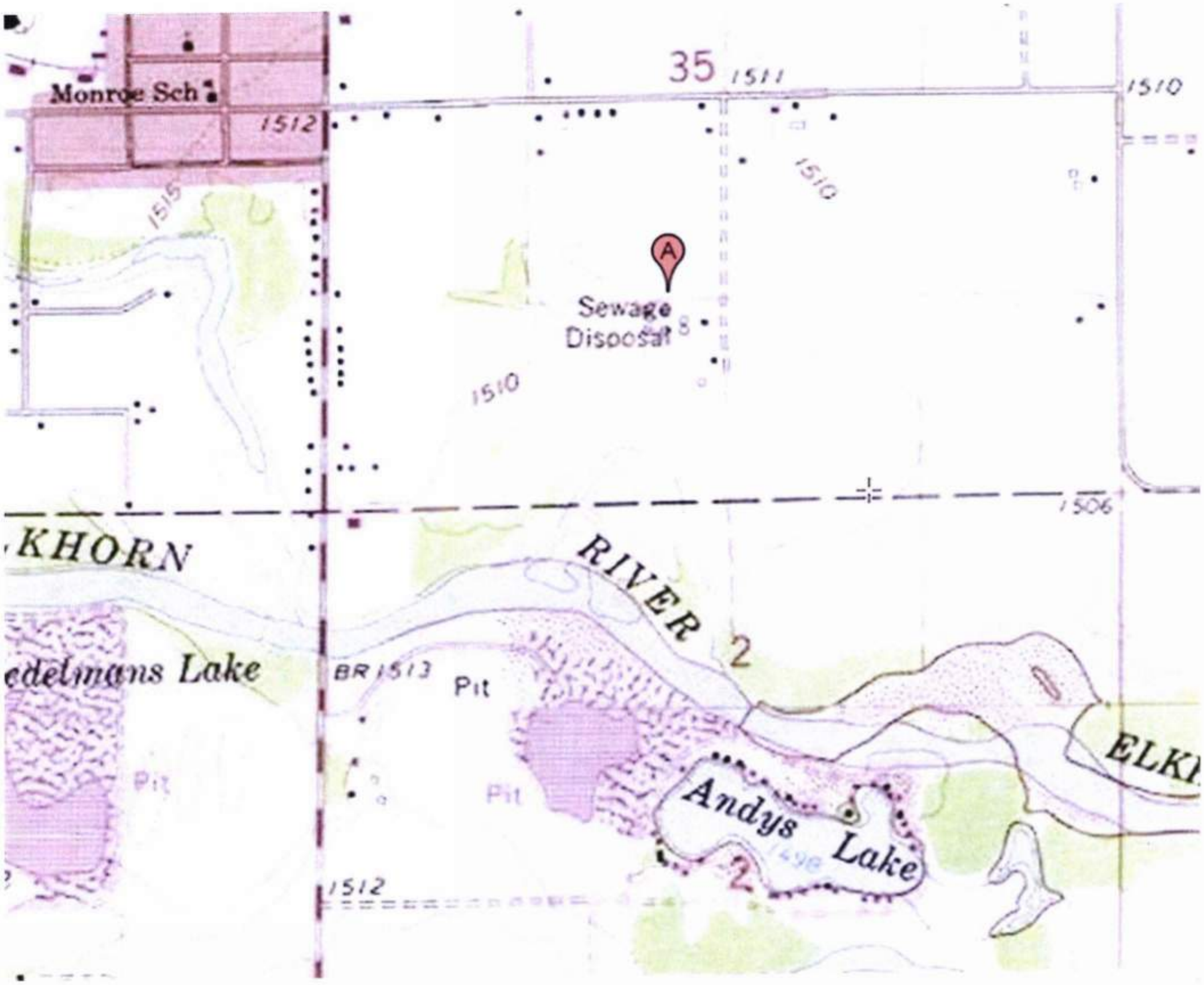
Attachment 2 – Site Maps
Map 1 – Topographic Map
A – Norfolk Water Pollution Control



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Attachment 2 – Site Maps
Map 2 – Aerial Photograph
A – Norfolk Water Pollution Control

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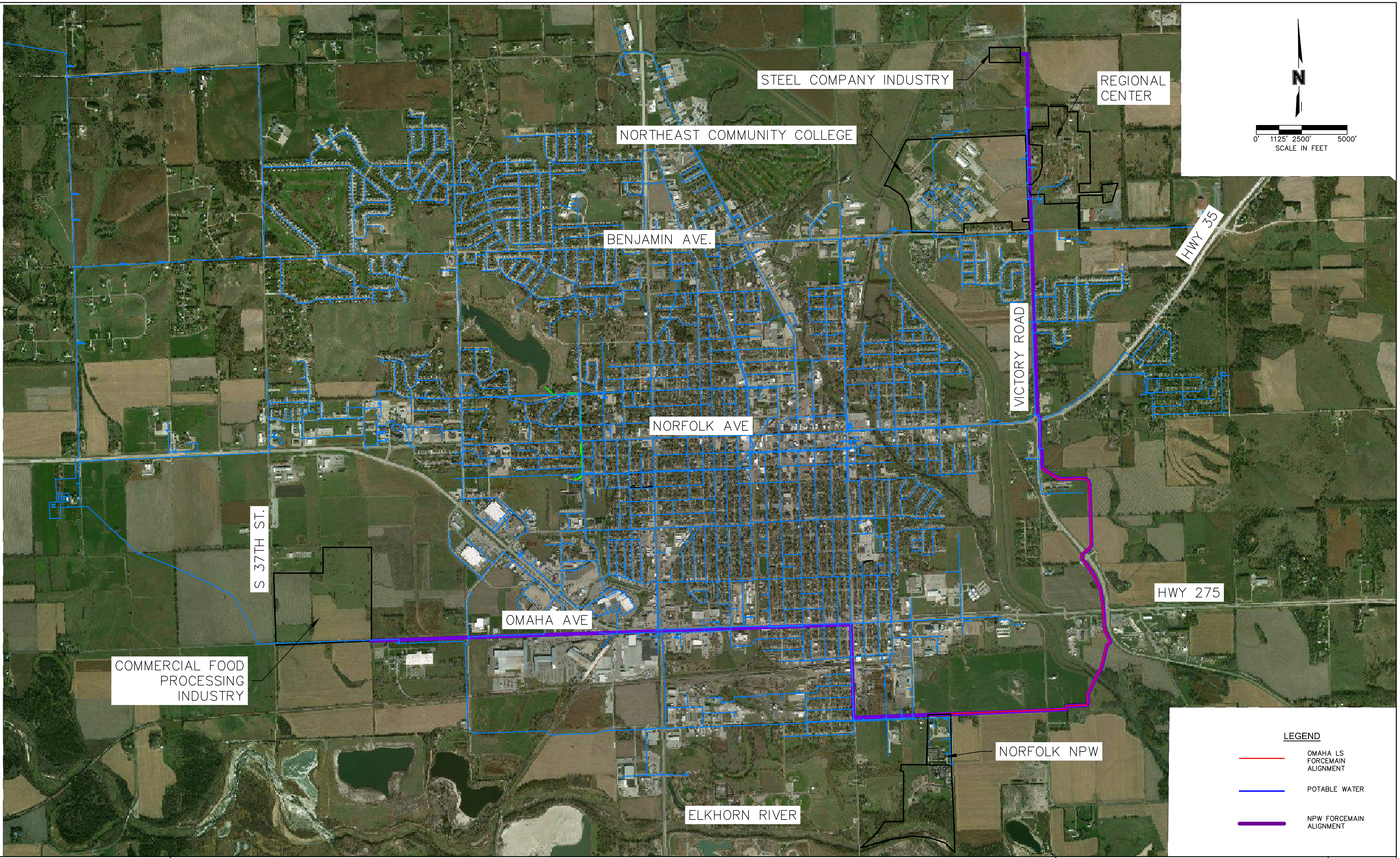
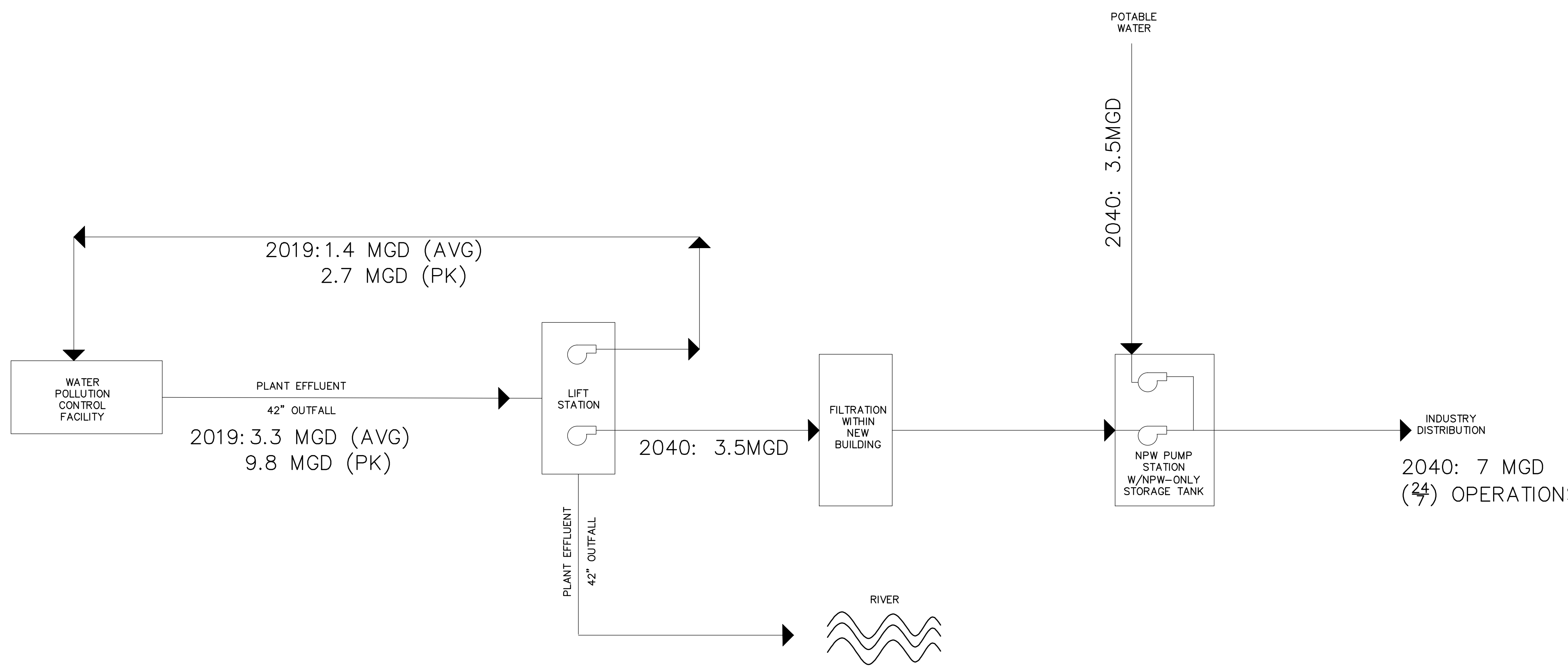
APPENDIX E

Alternative Proposed Water Pollution Control (WPC) Site Exhibits

DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony
DATE: Jul 25, 2019 9:26am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap



PROJECT NO: 019-1256	Non-Potable Water Pipe Alignment to Potential Industrial Customers	olsson	EXHIBIT
DRAWN BY: ALA			3
DATE: 06/25/2019			



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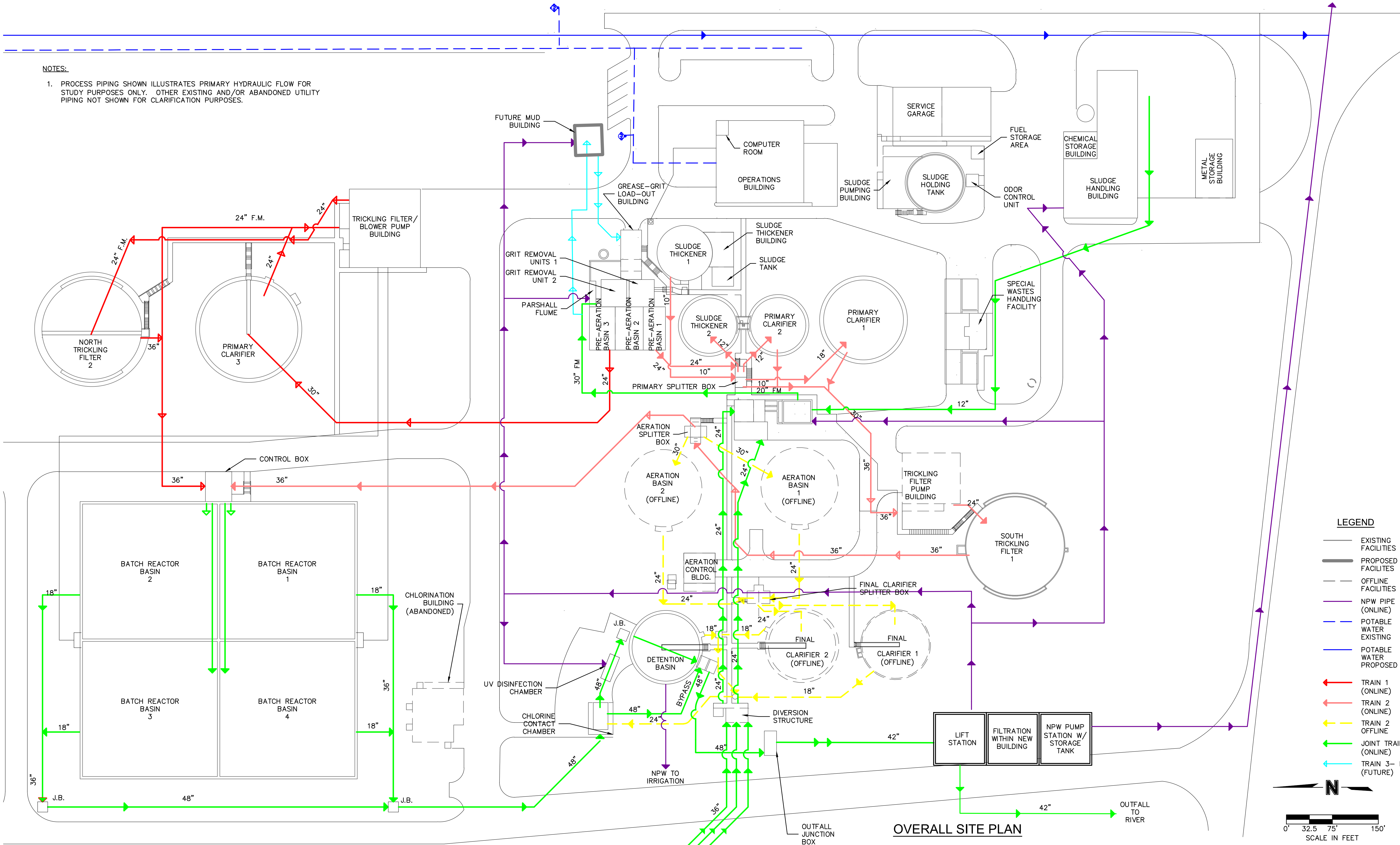
DATE: Jul 25, 2019 9:26am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap

PROJECT NO: 019-1256	NPW PROCESS FLOW DIAGRAM (OPTION A)	olsson	EXHIBIT
DRAWN BY: ALA			4
DATE: 06/25/2019			

DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony
DATE: Jul 25, 2019 9:26am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap

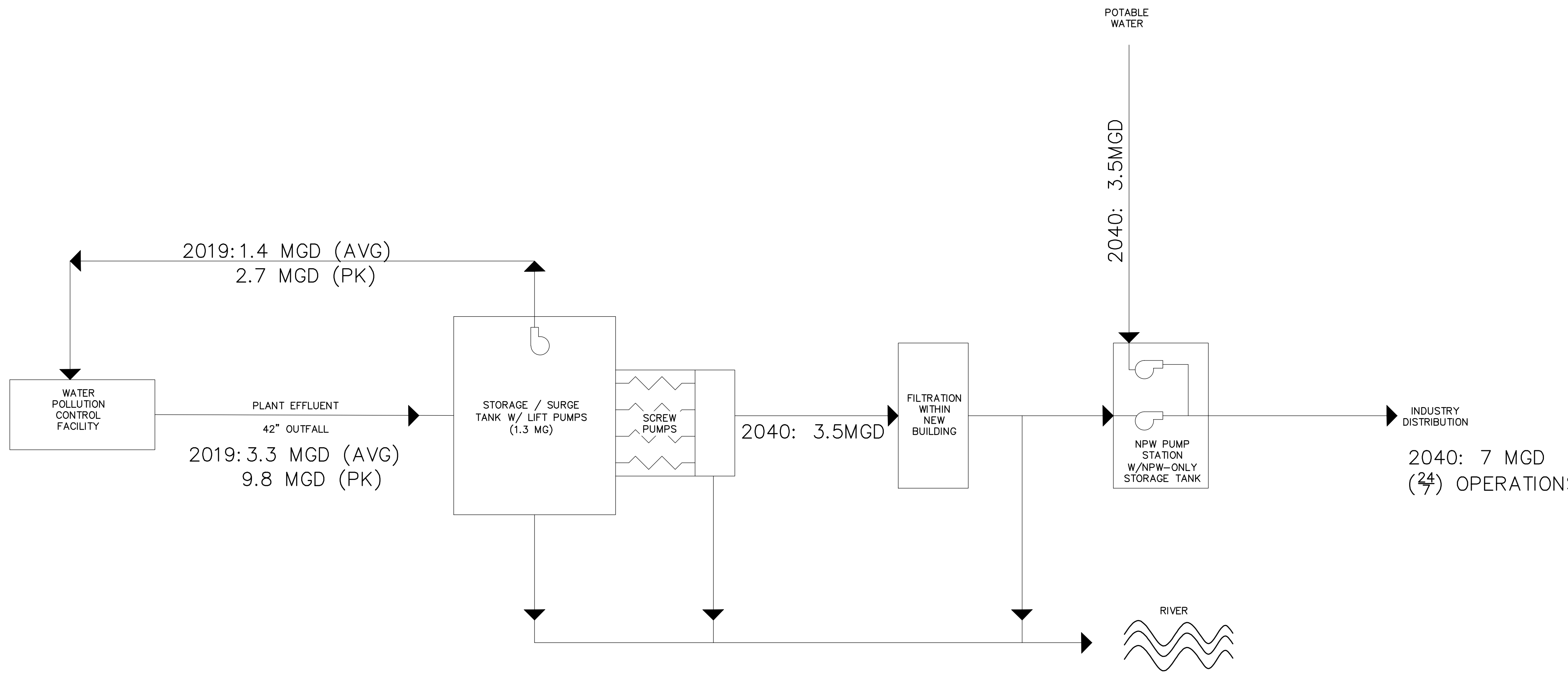
NOTES:

1. PROCESS PIPING SHOWN ILLUSTRATES PRIMARY HYDRAULIC FLOW FOR STUDY PURPOSES ONLY. OTHER EXISTING AND/OR ABANDONED UTILITY PIPING NOT SHOWN FOR CLARIFICATION PURPOSES.



PROJECT NO: 019-1256	SITE LAYOUT FOR NON-POTABLE WATER PROCESS FLOW (OPTION A)	EXHIBIT
DRAWN BY: ALA		5
DATE: 06/25/2019		

olsson



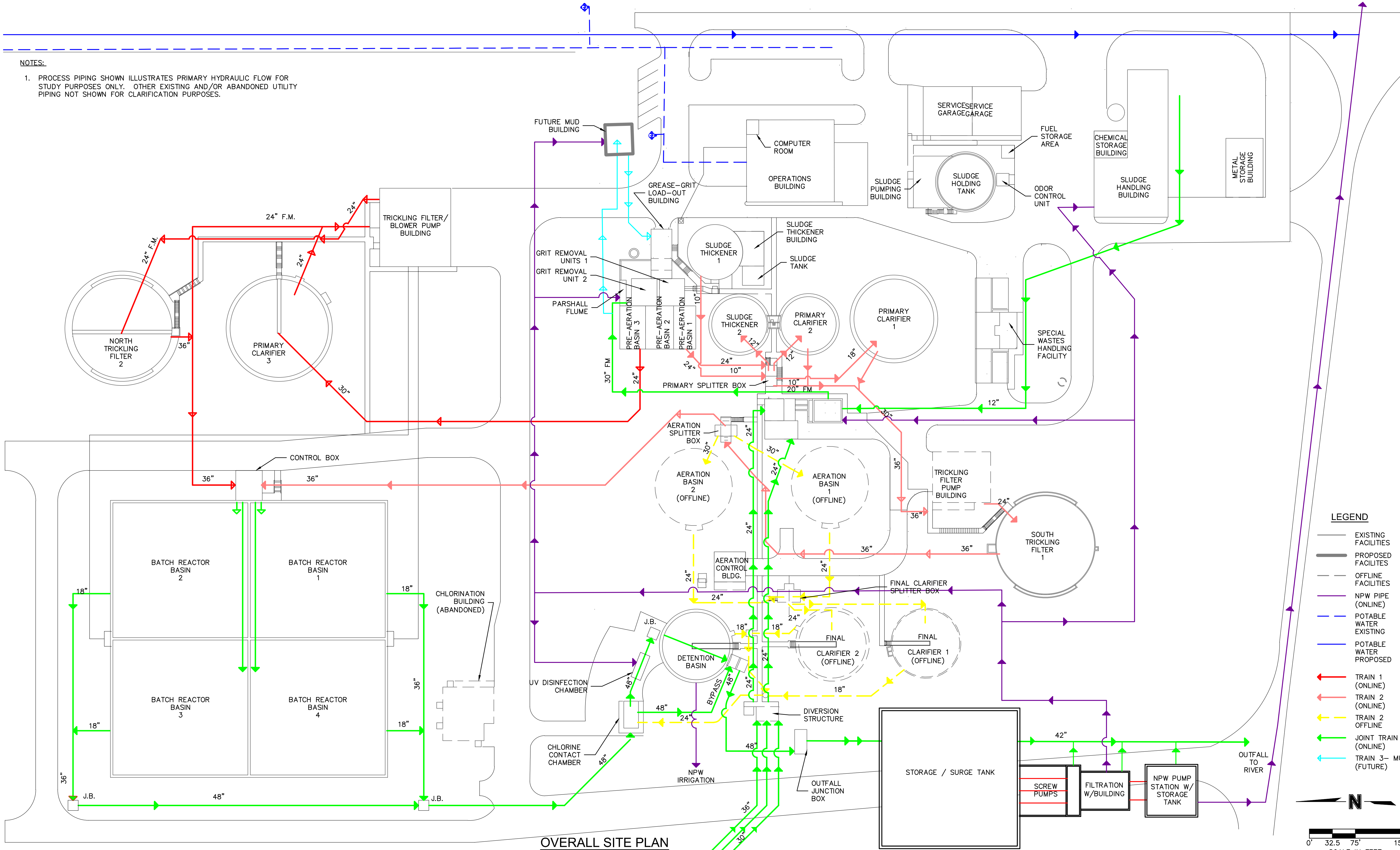
DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony
DATE: Jul 25, 2019 9:27am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap

PROJECT NO: 019-1256	NON-POTABLE WATER PROCESS FLOW DIAGRAM (OPTION B)	olsson	EXHIBIT
DRAWN BY: ALA			6
DATE: 06/25/2019			

DWG: F:\2019\1001-1500\019-1256\40-Design\AutoCAD\Final Plans\Sheets\WTWW\P_SIT_0192156.dwg USER: aanthony
DATE: Jul 25, 2019 9:27am XREFS: P_TBLK_73133_Slide Gates JEREMY_WALKER_PE_NE P_XTOPO_0191256 Water Basemap

NOTES:

1. PROCESS PIPING SHOWN ILLUSTRATES PRIMARY HYDRAULIC FLOW FOR STUDY PURPOSES ONLY. OTHER EXISTING AND/OR ABANDONED UTILITY PIPING NOT SHOWN FOR CLARIFICATION PURPOSES.



OVERALL SITE PLAN

PROJECT NO:	019-1256
DRAWN BY:	ALA
DATE:	06/25/2019

YEAR 20 FULL BUILD OUT WITH NON-POTABLE WATER PROCESS FLOW (OPTION B)

olsson

EXHIBIT

7

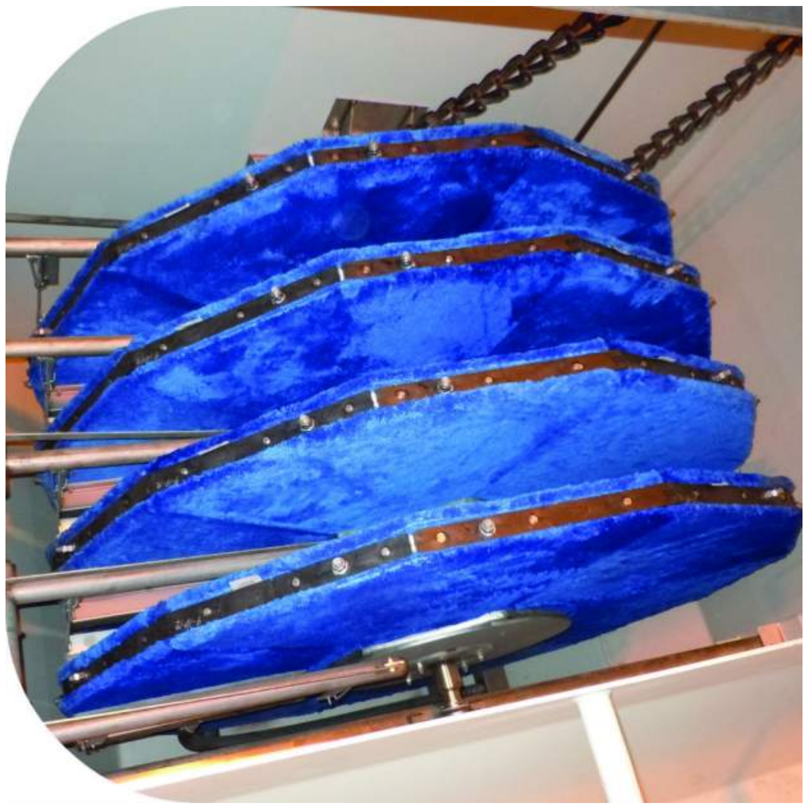
APPENDIX F

Vendor Correspondence

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

NORFOLK WPC NE
Design# 156975
Option: Preliminary Design



AquaDisk®
Cloth Media Filter

July 17, 2019
Designed By: Kristy Chycota

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Design Notes

Filtration

- The cloth media filter recommendation and anticipated effluent quality are based upon the assumed influent water quality conditions as shown under "Design Parameters" of this Process Design Report. Engineer is to verify the influent assumptions.

- The filter influent should be free of algae and other solids that are not filterable through a nominal 10 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- For this application, pile filter cloth is recommended.

- The cloth media filter has been designed to handle the maximum design flow while maintaining one unit out of service.

- The cloth media filter has been designed at a hydraulic loading rate of 4.5 gpm/ft^2 under a constant flow (average flow = maximum flow).

Equipment

- Equipment selection is based upon Aqua Aerobic Systems' standard materials of construction and electrical components.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	Secondary		
Avg. Design Flow	= 3.50 MGD	= 2430.56 gpm	= 13248.94 m^3/day
Max Design Flow	= 3.50 MGD	= 2430.56 gpm	= 13248.94 m^3/day

DESIGN PARAMETERS	**Influent**	**mg/l**	**Effluent Required**	**Effluent <= mg/l**	**Effluent Anticipated**	**Effluent <= mg/l**
Avg. Total Suspended Solids:	TSSa	20	TSSa	10	TSSa	10
Max. Total Suspended Solids:	TSSm	30	--	--	--	--

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 2
Number Of Disks Per Unit	= 10
Total Number Of Disks Recommended	= 20
Total Filter Area Provided	= 1076.0 ft^2 = (99.96 m^2)
Filter Model Recommended	= AquaDisk Package: Model ADFSP-54 x 10E-PC
Filter Media Cloth Type	= OptiFiber PA2-13

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading
= Avg. Design Flow (gpm) / Recommended Filter Area (ft^2)
= 2430.6 / 1076 ft^2
= 2.26 gpm/ft^2 (5.52 m/hr) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading
= Max. Design Flow (gpm) / Recommended Filter Area (ft^2)
= 2430.6 / 1076 ft^2
= 2.26 gpm/ft^2 (5.52 m/hr) at Max. Flow

Solids Loading:

Solids Loading Rate
= (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft^2)
= 875.7 lbs/day / 1076 ft^2
= 0.81 lbs. TSS /day/ft^2 (3.97 kg. TSS/day/m^2)

The above recommendation is based upon the provision to maintain a satisfactory hydraulic surface loading with (1) unit out of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 4.5 gpm / ft^2 = (11.1 m/hr)

Cloth Media Filters

AquaDisk Tanks/Basins

2 AquaDisk Model # ADFSP-54x10E-PC Package Filter 304 Stainless Steel Tank(s) consisting of:

- 10 Disk 304 SS tank(s).
- 3" ball valve(s).

AquaDisk Centertube Assemblies

2 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Effluent seal plate.
- Centertube bearing kit(s).
- Effluent centertube lip seal(s).
- Pile cloth media and non-corrosive support frame assemblies.
- Disk segment 304 stainless steel support rods.
- Neoprene media sealing gaskets.

AquaDisk Drive Assemblies

2 Drive System(s) consisting of:

- Gearbox with motor.
- Drive spocket(s).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

2 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 1 1/2" flexible hose.
- Stainless steel backwash shoe springs.
- Hose clamps.

2 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- Stainless steel anchors.
- 0 to 15 psi pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- Throttling gate valve(s).
- 3" ball valve(s).

AquaDisk Instrumentation

2 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

2 Float Switch(es) consisting of:

- Float switch(es).

2 Vacuum Transmitter(s) consisting of:

- Vacuum transmitter(s).

AquaDisk Valves

2 Set(s) of Backwash Valves consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

2 Solids Waste Valve(s) consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

AquaDisk Controls w/Starters

2 Conduit Installation(s) consisting of:

- PVC conduit and fittings.

2 Control Panel(s) consisting of:

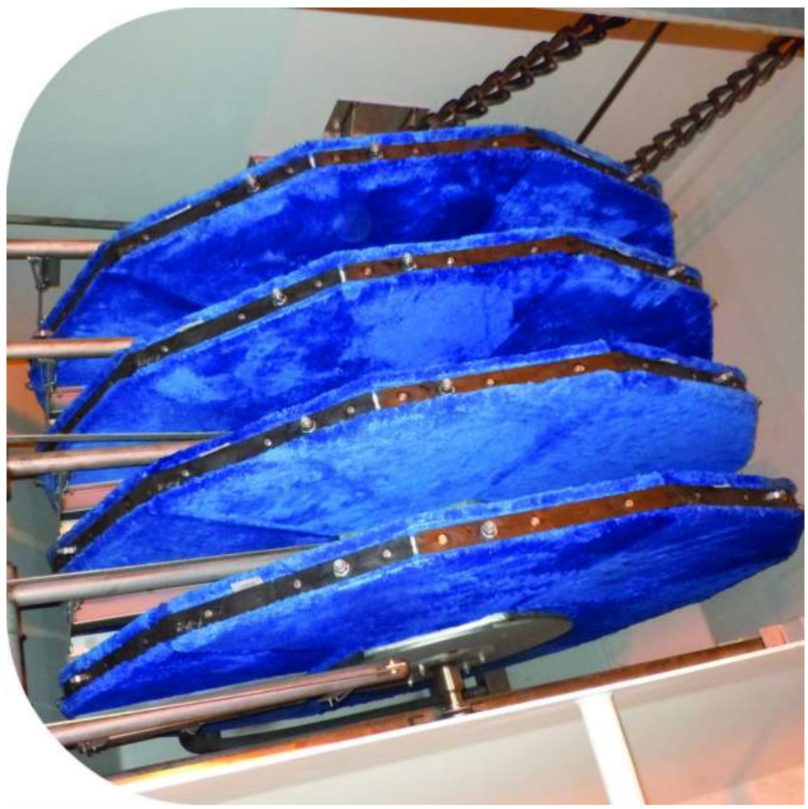
- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s).
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Ethernet switch(es).
- Power supply(ies).
- Operator interface(s).
- Motor starter(s).
- Terminal blocks.
- UL label(s).

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

NORFOLK WPC NE

Design# 157165
Option: Preliminary Design Full Plant Flow
AquaDisk



AquaDisk®
Cloth Media Filter

July 25, 2019
Designed By: Kristy Chycota

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Filtration

- The cloth media filter recommendation and anticipated effluent quality are based upon influent water quality conditions as shown under "Design Parameters" of this Process Design Report

- The filter influent should be free of algae and other solids that are not filterable through a nominal 10 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- For this application, pile filter cloth is recommended.

- The cloth media filter has been designed to handle the maximum design flow while maintaining one unit out of service.

Equipment

- Equipment selection is based upon Aqua Aerobic Systems' standard materials of construction and electrical components.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	Secondary		
Avg. Design Flow	= 5.20 MGD	= 3611.11 gpm	= 19684.14 m³/day
Max Design Flow	= 15.62 MGD	= 10847.22 gpm	= 59128.13 m³/day

DESIGN PARAMETERS			**Effluent**			
	Influent	**mg/l**	**Required**	**<= mg/l**	**Anticipated**	**<= mg/l**
Avg. Total Suspended Solids:	TSSa	20	TSSa	10	TSSa	10
Max. Total Suspended Solids:	TSSm	30	--	--	--	--

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 4
Number Of Disks Per Unit	= 10
Total Number Of Disks Recommended	= 40
Total Filter Area Provided	= 2152.0 ft² = (199.93 m²)
Filter Model Recommended	= AquaDisk Package: Model ADFSP-54 x 10E-PC
Filter Media Cloth Type	= OptiFiber PA2-13

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading = Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 3611.1 / 2152 ft²
= 1.68 gpm/ft² (4.10 m/hr) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading = Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 10847.2 / 2152 ft²
= 5.04 gpm/ft² (12.32 m/hr) at Max. Flow

Solids Loading:

Solids Loading Rate = (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
= 3908.1 lbs/day / 2152 ft²
= 1.82 lbs. TSS /day/ft² (8.85 kg. TSS/day/m²)

The above recommendation is based upon the provision to maintain a satisfactory hydraulic surface loading with (1) unit out of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 6.7 gpm / ft² = (16.4 m/hr)

Cloth Media Filters

AquaDisk Tanks/Basins

4 AquaDisk Model # ADFSP-54x10E-PC Package Filter 304 Stainless Steel Tank(s) consisting of:

- 10 Disk 304 SS tank(s).
- 3" ball valve(s).

AquaDisk Centertube Assemblies

4 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Effluent seal plate.
- Centertube bearing kit(s).
- Effluent centertube lip seal(s).
- Pile cloth media and non-corrosive support frame assemblies.
- Disk segment 304 stainless steel support rods.
- Neoprene media sealing gaskets.

AquaDisk Drive Assemblies

4 Drive System(s) consisting of:

- Gearbox with motor.
- Drive spocket(s).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

4 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 1 1/2" flexible hose.
- Stainless steel backwash shoe springs.
- Hose clamps.

4 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- Stainless steel anchors.
- 0 to 15 psi pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- Throttling gate valve(s).
- 3" ball valve(s).

AquaDisk Instrumentation

4 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

4 Float Switch(es) consisting of:

- Float switch(es).

4 Vacuum Transmitter(s) consisting of:

- Vacuum transmitter(s).

<u>AquaDisk Valves</u>

4 Set(s) of Backwash Valves consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

4 Solids Waste Valve(s) consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or equal.
- 2" flexible hose.
- Victaulic coupler(s).

<u>AquaDisk Controls w/Starters</u>

4 Conduit Installation(s) consisting of:

- PVC conduit and fittings.

4 Control Panel(s) consisting of:

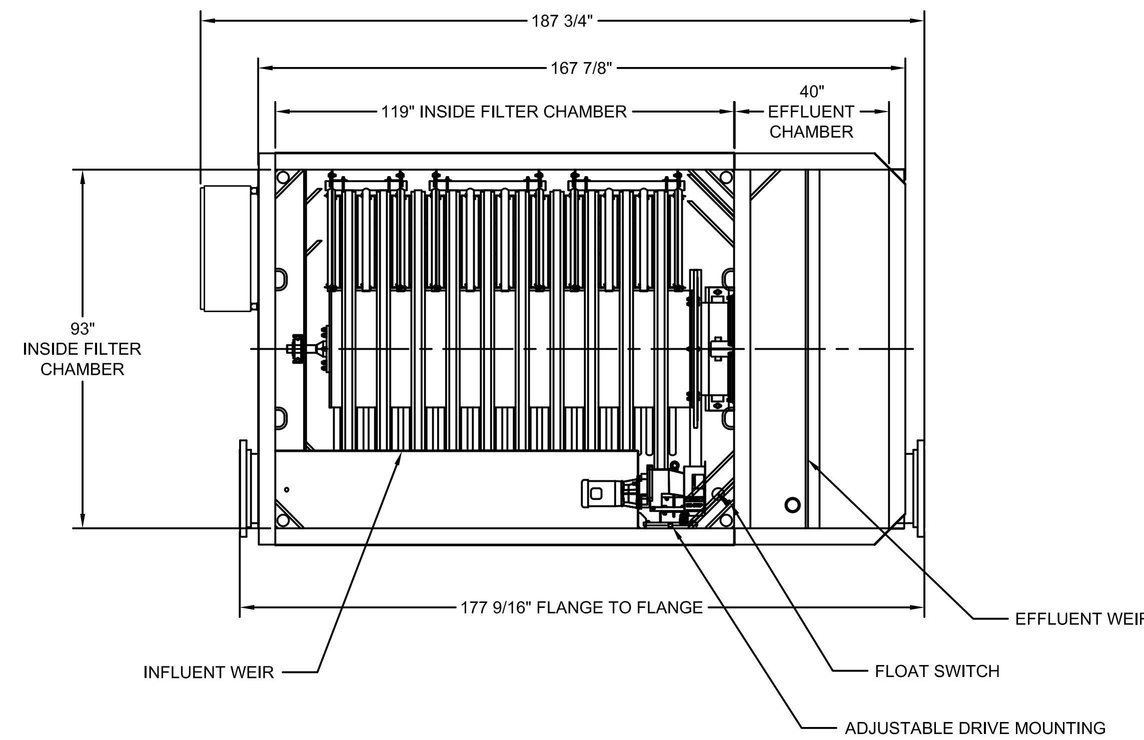
- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s).
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Ethernet switch(es).
- Power supply(ies).
- Operator interface(s).
- Motor starter(s).
- Terminal blocks.
- UL label(s).

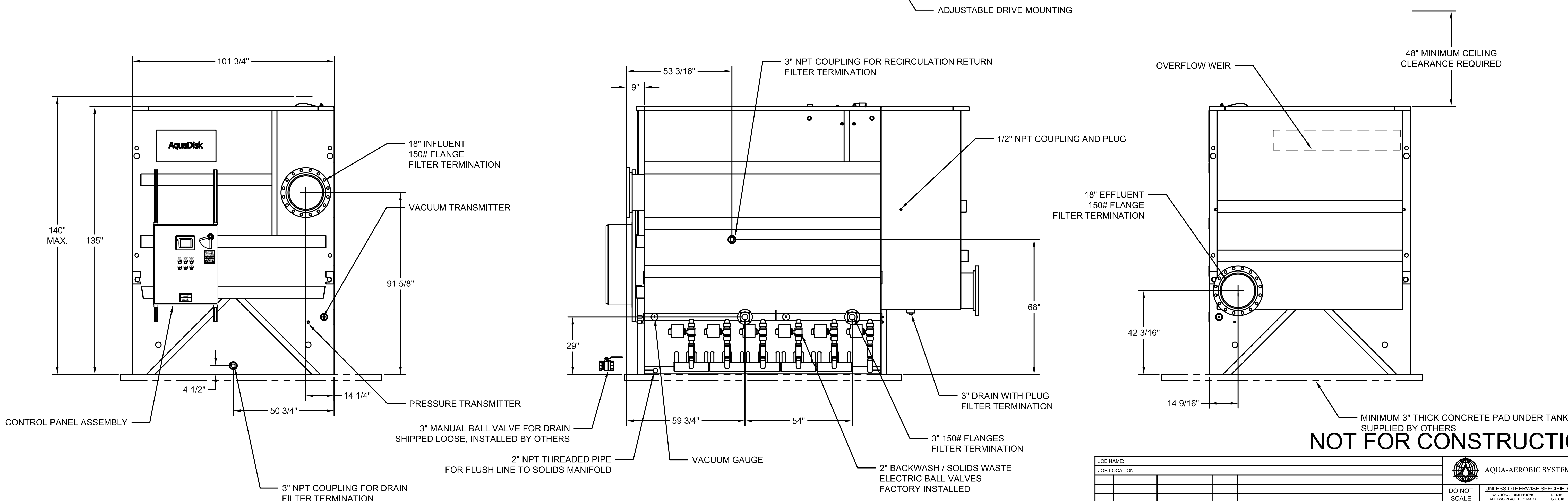
1. IF FREEZING IS A CONCERN AQUA-AEROBIC SYSTEMS RECOMMENDS THE FILTERS BE PLACED IN A HEATED BUILDING. IF A BUILDING IS NOT PROVIDED, ANY NECESSARY PROTECTION, INCLUDING BUT NOT LIMITED TO, HEAT TRACING AND INSULATION OF PUMPS AND PIPING, AS WELL AS PROTECTION AGAINST INTERNAL TANK FREEZING, SHALL BE PROVIDED BY THE INSTALLING CONTRACTOR.

2. THE FILTER CONTROL PANEL IS SHOWN IN THE STANDARD LOCATION. IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL MAY BE RELOCATED TO THE SIDE OF THE FILTER FACING NORTH, TO LIMIT EXPOSING THE H.M.I. TO DIRECT SUNLIGHT.

3. THE GRAPHIC ELEMENTS OF THIS COMPUTER GENERATED DRAWING ARE DRAWN FULL SIZE. THE DIMENSIONS ARE ASSOCIATIVE. IF THE SIZE OF THE GRAPHIC ELEMENTS IS CHANGED THE DIMENSIONS WILL NOT BE CORRECT.

4. AN INFLUENT VALVE IS REQUIRED FOR ISOLATION / MAINTENANCE OF THE FILTER UNIT. THE INFLUENT VALVE SHALL BE PROVIDED BY OTHERS AND INSTALLED BY OTHERS.

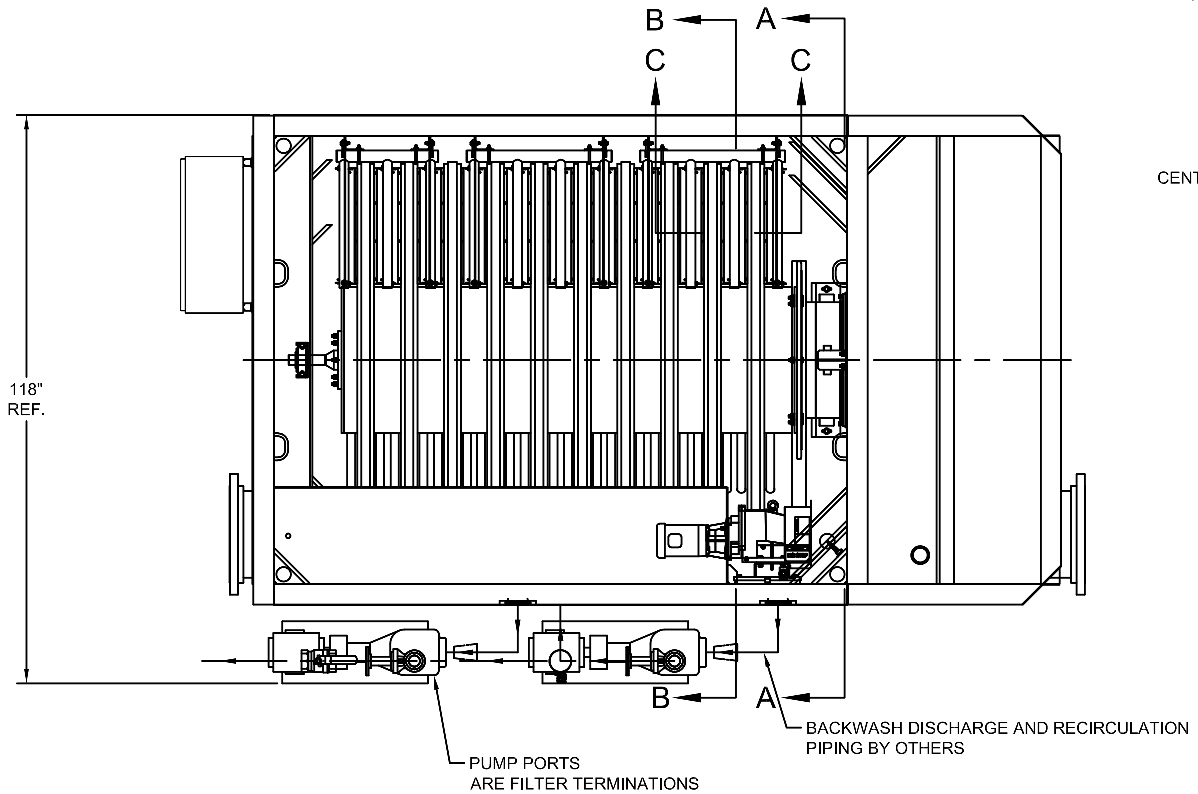


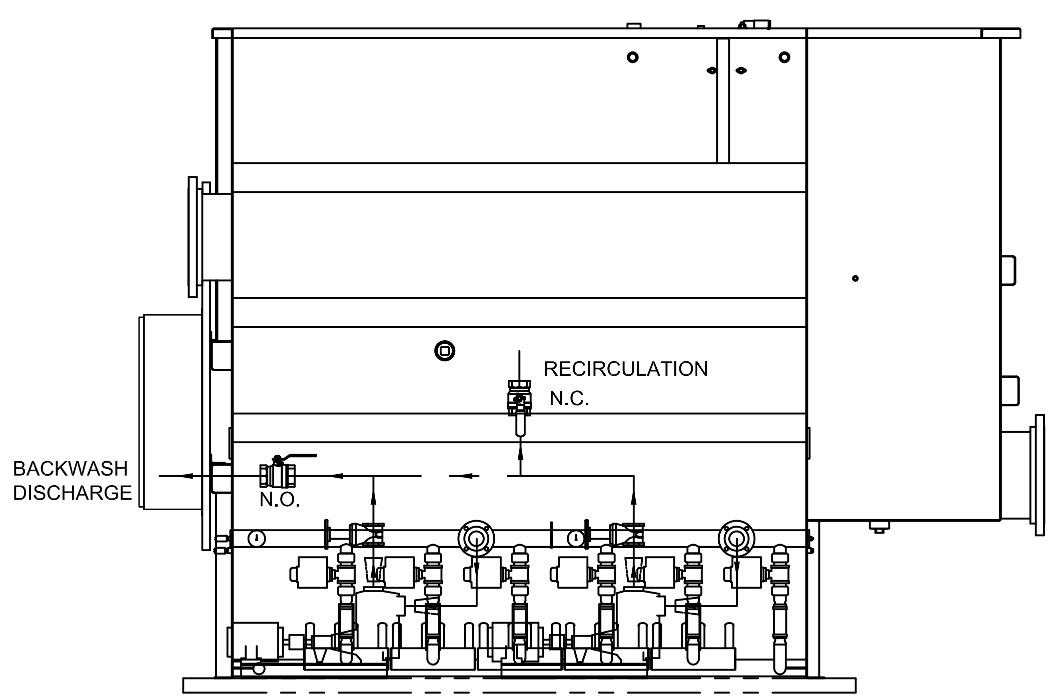


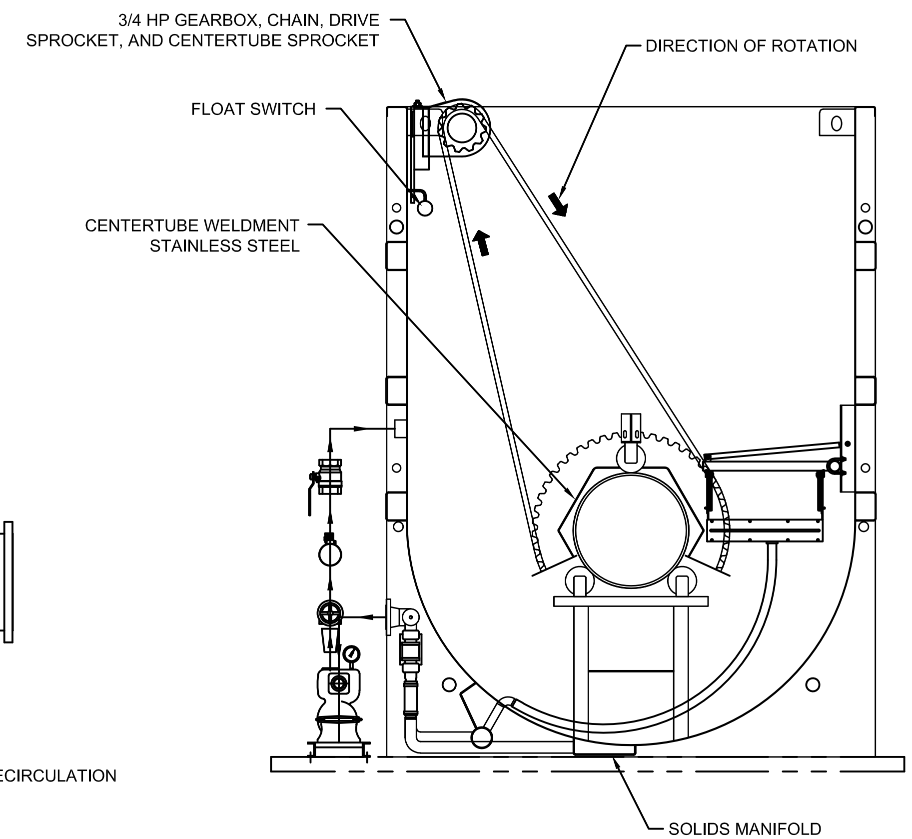
DRY WT (LBS)	OPER. WT. (LBS)
12,000	54,000

NOT FOR CONSTRUCTION

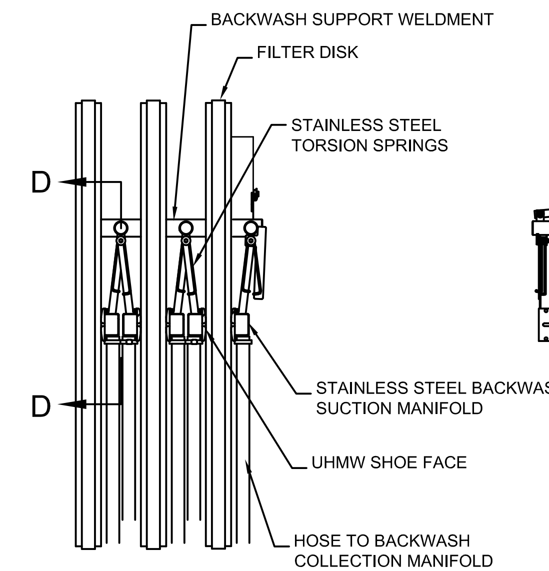
JOB NAME:	AQUA-AEROBIC SYSTEMS, INC.
JOB LOCATION:	DO NOT SCALE DRAWING — UNLESS OTHERWISE SPECIFIED: FRACTIONAL DIMENSIONS +/- 1/16; ALL TWO PLACE DECIMALS +/- 0.010; ALL THREE PLACE DECIMALS +/- 0.005; ALL ANGLES +/- 1/2° — ANSI
	MATERIAL:
	SIMILAR TO:
	TYPE:
	DRAWN BY: SLT — DATE: 3-29-2011
	CHECKED BY: — DATE:
REV / ERN / ECO / DATE / BY / REVISION DESCRIPTION	WEIGHT: — SHEET: 1 OF 4
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 10E-PC - RH	DRAWING NUMBER: 2801908 — SCALE: — SIZE: D



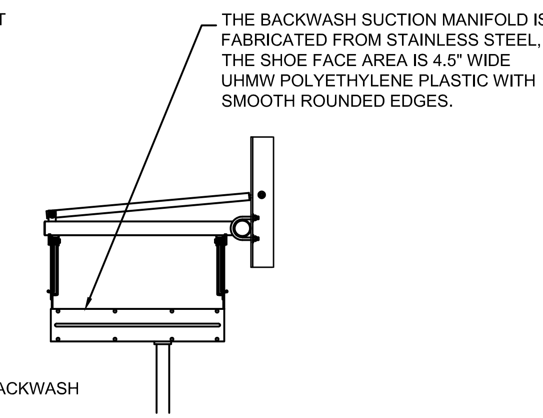




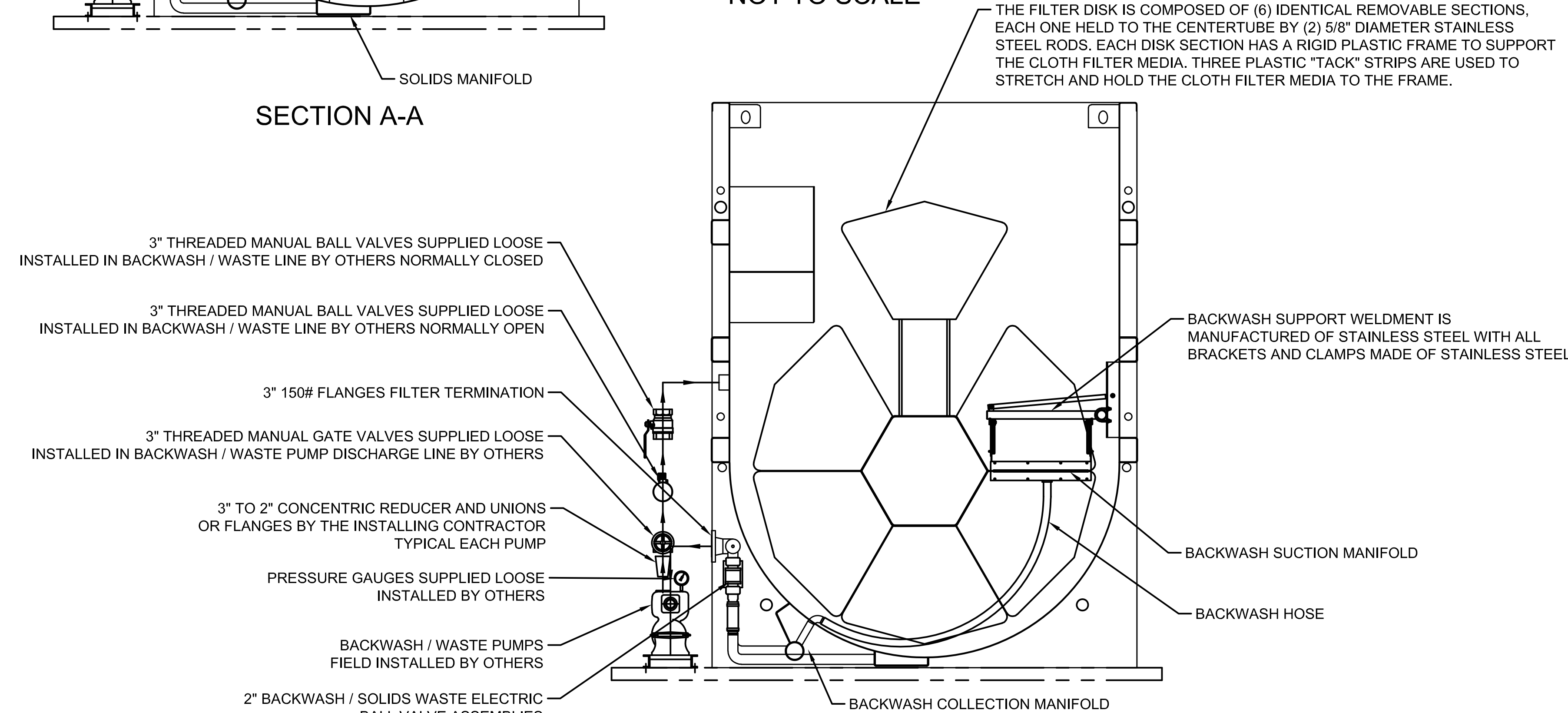
SECTION A-A



SECTION C-C
NOT TO SCALE



SECTION D-D
NOT TO SCALE



SECTION B-B

NOT FOR CONSTRUCTION

1. ALL EXTERNAL PIPING AND FITTINGS SHALL BE PROVIDED BY OTHERS
ACTUAL PIPING LAYOUT AND PUMP LOCATION TO BE DETERMINED BY OTHERS
WHEN THREADED OR WELDED PIPE IS USED IN LIEU OF FLANGED
PIPE, UNIONS SHALL BE USED AT EACH PUMP AND VALVE
CONNECTION TO FACILITATE SERVICE.

2. 2 H.P. BACKWASH / WASTE PUMP CONNECTIONS ARE 2" N.P.T. BACKWASH / WASTE
PIPING IS 3" DIAMETER. 3" TO 2" CONCENTRIC REDUCER FITTINGS SHALL BE
PROVIDED AND INSTALLED BY OTHERS AT EACH PUMP PORT.

3. THE BACKWASH / WASTE PUMP CAPABILITIES ARE AS FOLLOWS:

- HORSEPOWER: 2 HP
- FLOW: 130 GPM
- TOTAL DYNAMIC HEAD: 23.2 FT
- ALLOWABLE DISCHARGE HEAD, AFTER FILTER LOSSES: 12 FT

FOR INSTALLATIONS THAT REQUIRE MORE DISCHARGE HEAD,
ALTERNATIVE PUMPS ARE AVAILABLE. PLEASE CONSULT
ENGINEERING TO VERIFY THE SUITABILITY OF THE DISCHARGE
PIPING OR FOR SPECIAL PUMP REQUIREMENTS.

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

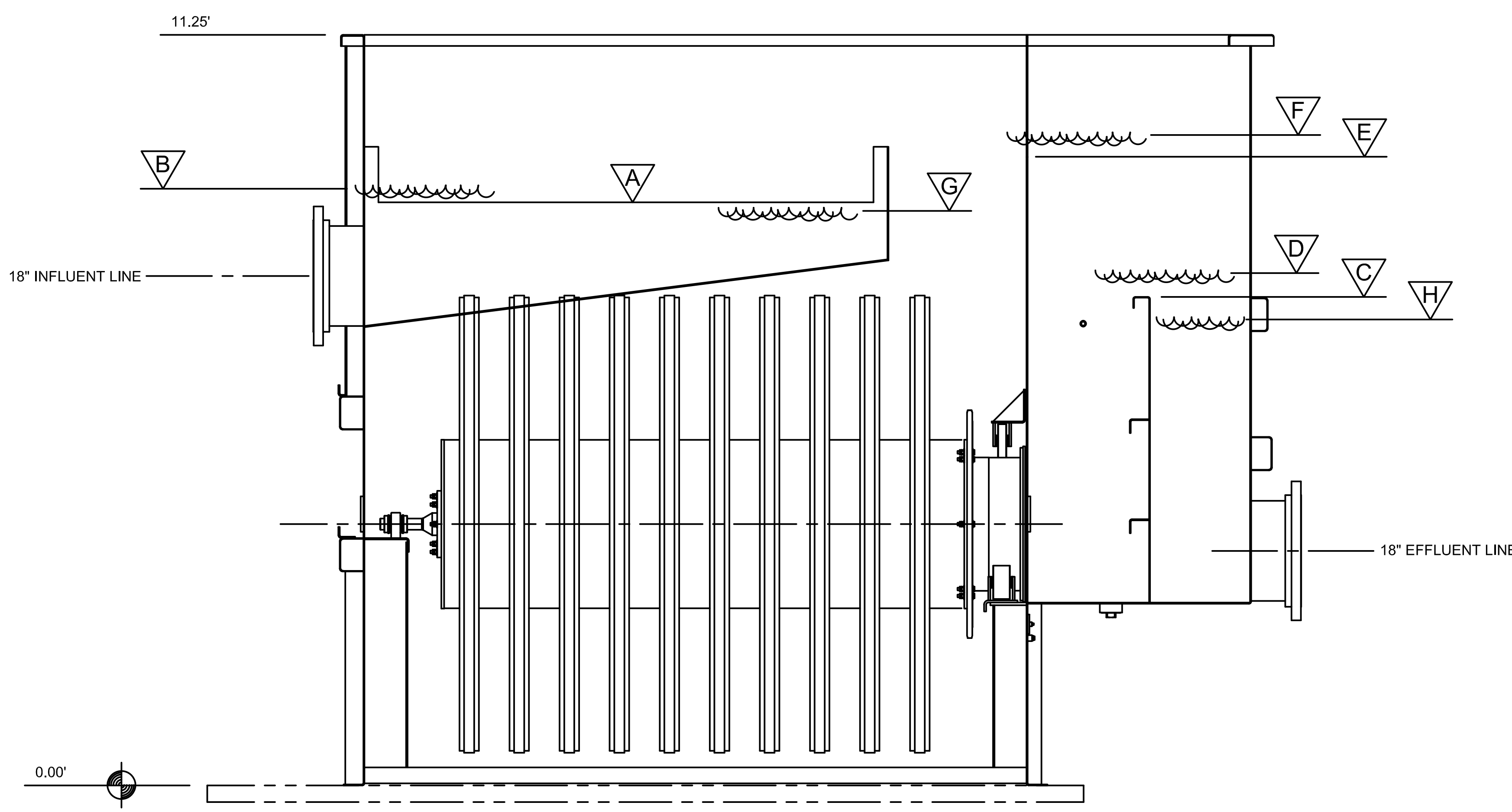
AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
FRACTIONAL DIMENSIONS +/- 1/16
ALL TWO PLACE DECIMALS +/- 0.010
ALL THREE PLACE DECIMALS +/- 0.005
ALL ANGLES +/- 1/2°
ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: SLT DATE: 3-29-2011
CHECKED BY: DATE:
WEIGHT: SHEET: 2 OF 4

DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 10E-PC - RH
DRAWING NUMBER: 2801908
SCALE:
SIZE: D



ELEVATION

A	8.74'	INFLUENT WEIR ELEVATION
B	9.03'	NAPPE OVER INFLUENT WEIR AVERAGE FLOW
	9.20'	NAPPE OVER INFLUENT WEIR MAXIMUM FLOW
C	7.32'	EFFLUENT WEIR ELEVATION
D	7.60'	NAPPE OVER EFFLUENT WEIR AVERAGE FLOW
	7.77'	NAPPE OVER EFFLUENT WEIR MAXIMUM FLOW
E	9.42'	OVERFLOW WEIR ELEVATION
F	9.78'	NAPPE OVER OVERFLOW WEIR AVERAGE FLOW
	9.99'	NAPPE OVER OVERFLOW WEIR MAXIMUM FLOW
G	8.70'	BACKWASH INITIATE LEVEL
H	6.82'	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

HYDRAULIC PROFILE

BASED UPON AVERAGE FLOW RATE OF 3.25 GPM PER SQUARE FOOT (2.5 MGD)
BASED UPON MAXIMUM FLOW RATE OF 6.5 GPM PER SQUARE FOOT (5.0 MGD)

WEIR LENGTHS

INFLUENT = 7.42'
EFFLUENT = 7.75'
OVERFLOW = 5.33'

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED

FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

ANSI

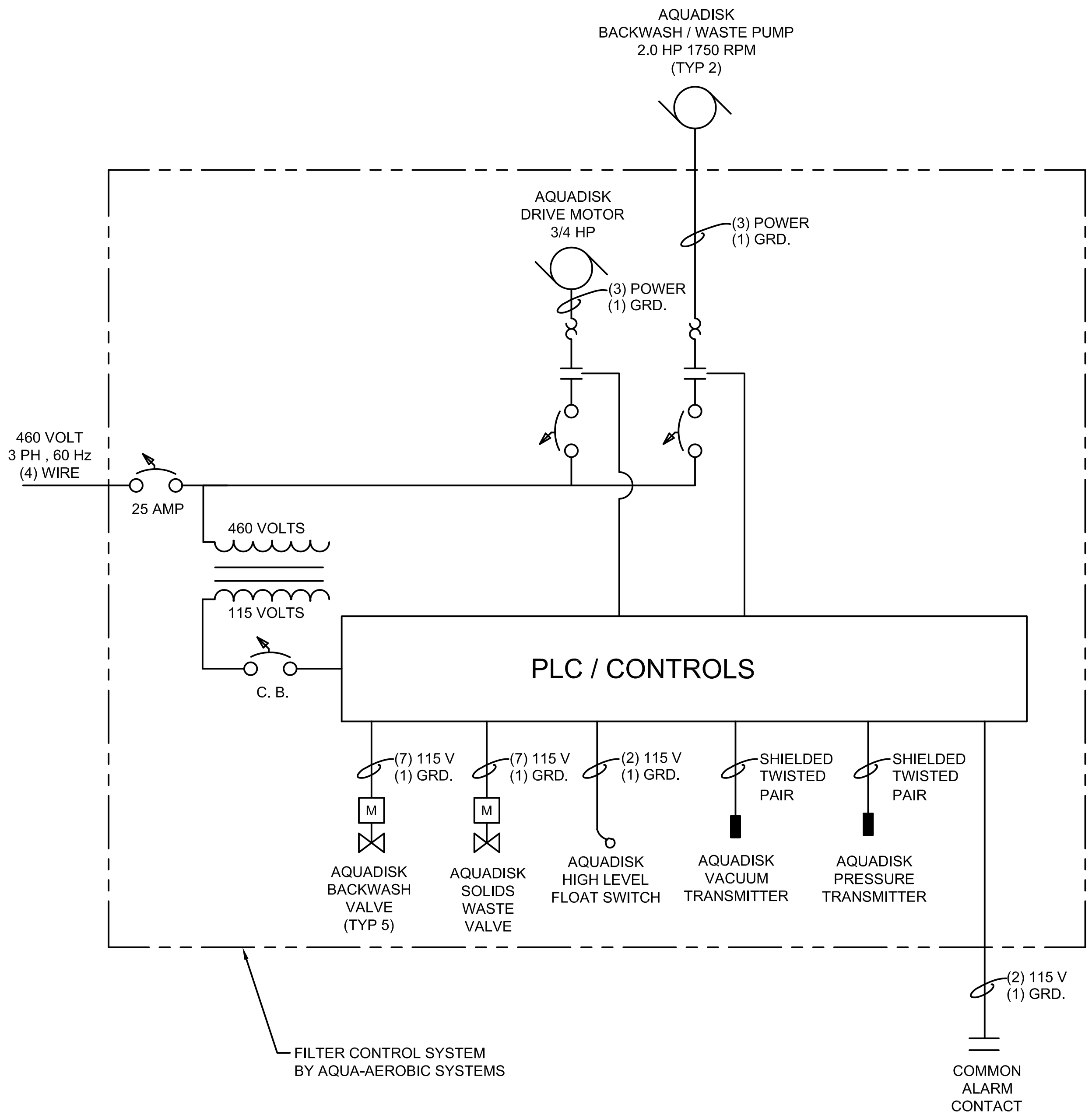
MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: SLT — DATE: 3-29-2011
CHECKED BY: — DATE:
WEIGHT: — SHEET: 3 OF 4

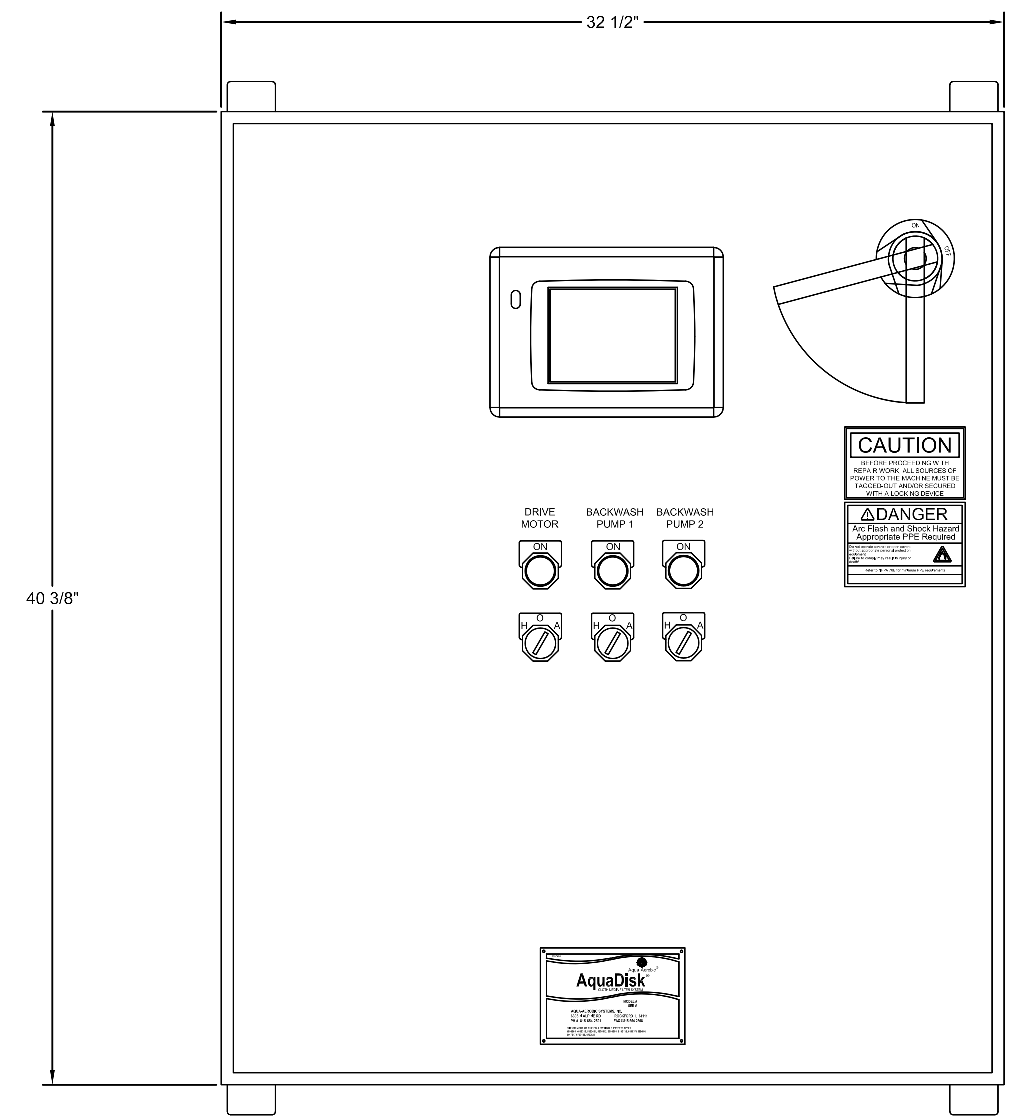
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 10E-PC - RH
DRAWING NUMBER: 2801908 — SCALE: — SIZE: D

SYMBOL KEY

	MOTOR		CIRCUIT BREAKER		ELECTRICAL DISCONNECT	VFD	VARIABLE FREQUENCY DRIVE		TRANSDUCER		STARTER CONTACTOR
M	MOTOR OPERATED VALVE		TRANSFORMER		MOTOR OVERLOAD	P	PNEUMATIC OPERATED VALVE		FUSE		FLOAT SWITCH

NOTE: SOME SYMBOLS MAY NOT BE APPLICABLE





1. CONTROL PANEL
   ENCLOSURE NEMA 4X WALL MOUNTED TYPE FIBERGLASS
   FACTORY ASSEMBLED ON THE FILTER, DISASSEMBLED AND SHIPPED LOOSE.
   REASSEMBLED ON-SITE BY CONTRACTOR.
   IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL
   MAY BE RELOCATED TO THE SIDE OF THE FILTER
   FACING NORTH TO LIMIT THE H.M.I. EXPOSURE TO DIRECT SUNLIGHT.

2. STANDARD CONTROL PANEL SIZE
   40" HEIGHT X 32" WIDE X 12" DEEP

3. (1) CONTROL PANEL PER FILTER

NOT FOR CONSTRUCTION

JOB NAME:	AQUA-AEROBIC SYSTEMS, INC.
JOB LOCATION:	DO NOT SCALE DRAWING — UNLESS OTHERWISE SPECIFIED: FRACTIONAL DIMENSIONS +/- 1/16; ALL TWO PLACE DECIMALS +/- 0.010; ALL THREE PLACE DECIMALS +/- 0.005; ALL ANGLES +/- 1/2° — ANSI
	MATERIAL:
	SIMILAR TO:
	TYPE:
	DRAWN BY: SLT — DATE: 3-29-2011
	CHECKED BY: — DATE:
REV / ERN / ECO / DATE / BY / REVISION DESCRIPTION	WEIGHT: — SHEET: 4 OF 4
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 10E-PC - RH	DRAWING NUMBER: 2801908 — SCALE: — SIZE: D

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

NORFOLK WPC NE

Design# 157202
Option: Preliminary Design Full Plant Flow Mega

Aqua MegaDisk®
Cloth Media Filter

July 25, 2019
Designed By: Kristy Chycota

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Design Notes

Filtration

- The cloth media filter recommendation and anticipated effluent quality are based upon influent water quality conditions as shown under "Design Parameters" of this Process Design Report

- The filter influent should be free of algae and other solids that are not filterable through a nominal 10 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- For this application, pile filter cloth is recommended.

- The cloth media filter has been designed to handle the maximum design flow while maintaining one unit out of service.

Equipment

- Equipment selection is based upon Aqua Aerobic Systems' standard materials of construction and electrical components.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	Secondary		
Avg. Design Flow	= 5.20 MGD	= 3611.11 gpm	= 19684.14 m³/day
Max Design Flow	= 15.62 MGD	= 10847.22 gpm	= 59128.13 m³/day

DESIGN PARAMETERS

	Influent	mg/l	Effluent Required	<= mg/l	Effluent Anticipated	<= mg/l
Avg. Total Suspended Solids:	TSSa	20	TSSa	10	TSSa	10
Max. Total Suspended Solids:	TSSm	30	--	--	--	--

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 2
Number Of Disks Per Unit	= 16
Total Number Of Disks Recommended	= 32
Total Filter Area Provided	= 3443.2 ft² = (319.88 m²)
Filter Model Recommended	= AquaDisk Package: Model ADFSP-108 x 16E-PC
Filter Media Cloth Type	= OptiFiber PA2-13

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading
= Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 3611.1 / 3443.2 ft²
= 1.05 gpm/ft² (2.56 m/hr) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading
= Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 10847.2 / 3443.2 ft²
= 3.15 gpm/ft² (7.70 m/hr) at Max. Flow

Solids Loading:

Solids Loading Rate
= (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
= 3908.1 lbs/day / 3443.2 ft²
= 1.14 lbs. TSS /day/ft² (5.53 kg. TSS/day/m²)

The above recommendation is based upon the provision to maintain a satisfactory hydraulic surface loading with (1) unit out of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 6.3 gpm / ft² = (15.4 m/hr)

Cloth Media Filters

AquaDisk Tanks/Basins

2 AquaDisk Model # ADFSP-108x16E-PC Package Filter Stainless Steel Tank(s) consisting of:

- 16 Disk stainless steel tank(s).

AquaDisk Centertube Assemblies

2 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Centertube bearing kit(s).
- Centertube support weldment(s).
- Bearing spacer plate(s
- Effluent centertube lip seal(s).
- Pile cloth media and non-corrosive support frame assemblies.
- Neoprene media sealing gaskets.
- Disk segment 304 stainless steel support rods.

AquaDisk Drive Assemblies

2 Drive System(s) consisting of:

- Gearbox with motor.
- Drive sprocket assemby(ies).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

2 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 3" flexible hose.
- 304 stainless steel backwash collection manifold(s).
- PVC solids manifold installation(s).

2 Backwash/Solids Waste Pump(s) consisting of:

- 20HP Pump assembly(ies).
- Pressure gauge(s).
- 6" Manual plug valve(s).
- 6" magnetic flow-meter and converter(s).

AquaDisk Instrumentation

2 Vacuum Gauge with Transmitter(s) consisting of:

- 0 to 30 inches mercury vacuum gauge(s).
- Vacuum transmitter(s).
- 1/4" Threaded bronze ball valve.

2 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

2 Float Switch(es) consisting of:

- Float switch(es).

AquaDisk Valves

2 Set(s) of Backwash Valves consisting of:

- 6 inch electrically operated plug valve(s).

2 Solids Waste Valve(s) consisting of:

- 6 inch electrically operated plug valve(s).

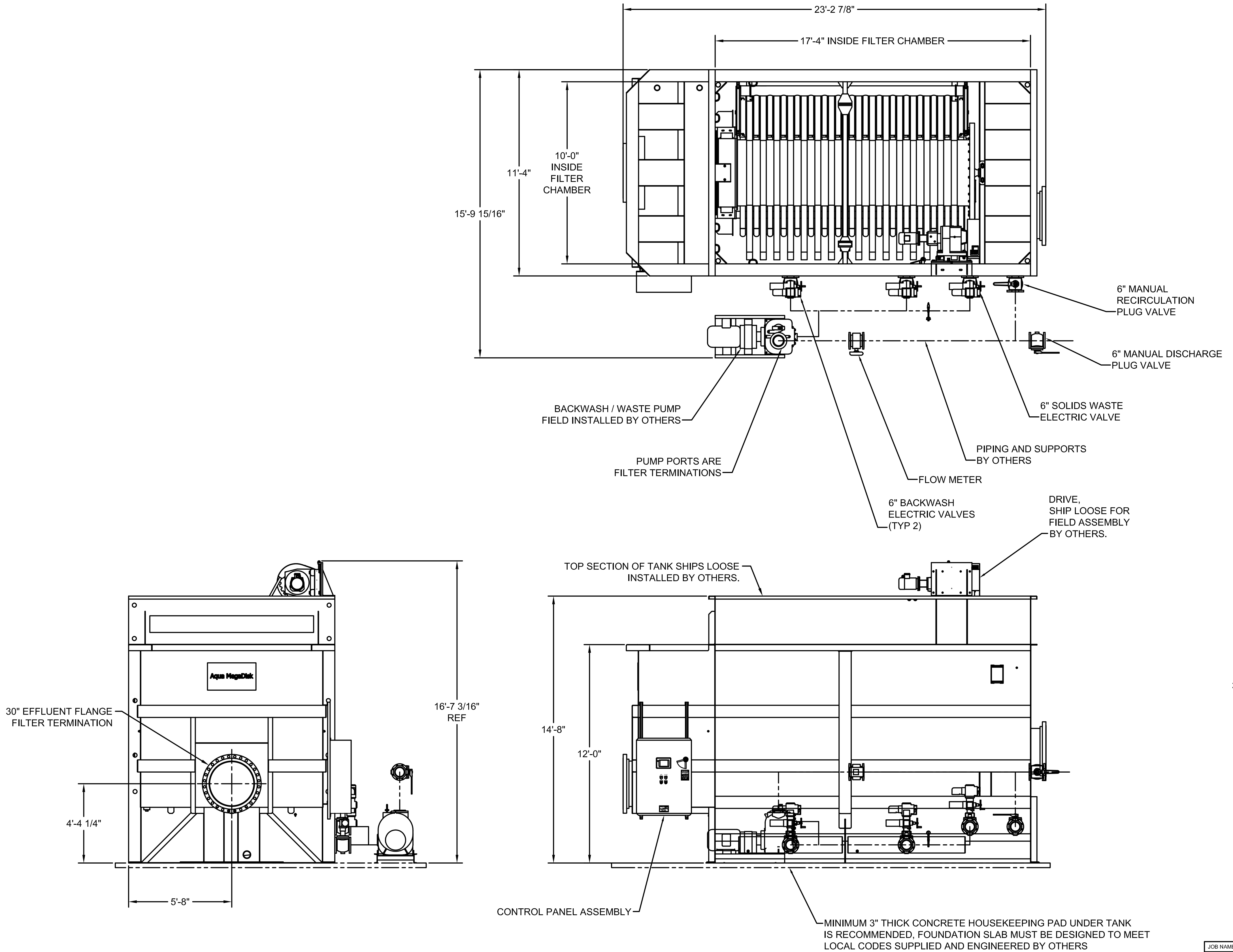
AquaDisk Controls w/Starters

2 Control Panel(s) consisting of:

- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s) with fuses.
- 4 inch NEMA 4X fan(s).
- GFI receptacle.
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Analog output card(s).
- Operator interface(s).
- Ethernet switch(es).
- 20 HP VFD(s).
- 5 HP VFD(s).
- Power supply(ies).
- Terminal blocks.
- UL label(s).

2 Conduit Installation(s) consisting of:

- PVC conduit and fittings.



1. IF FREEZING IS A CONCERN AQUA-AEROBIC SYSTEMS RECOMMENDS THE FILTERS BE PLACED IN A HEATED BUILDING. IF A BUILDING IS NOT PROVIDED, ANY NECESSARY PROTECTION, INCLUDING BUT NOT LIMITED TO, HEAT TRACING AND INSULATION OF PUMPS AND PIPING, AS WELL AS PROTECTION AGAINST INTERNAL TANK FREEZING, SHALL BE PROVIDED BY THE INSTALLING CONTRACTOR.
2. THE FILTER CONTROL PANEL IS SHOWN IN THE STANDARD LOCATION. IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL MAY BE RELOCATED TO THE SIDE OF THE FILTER FACING NORTH, TO LIMIT EXPOSING THE H.M.I. TO DIRECT SUNLIGHT.
3. THE GRAPHIC ELEMENTS OF THIS COMPUTER GENERATED DRAWING ARE DRAWN FULL SIZE. THE DIMENSIONS ARE ASSOCIATIVE. IF THE SIZE OF THE GRAPHIC ELEMENTS IS CHANGED THE DIMENSIONS WILL NOT BE CORRECT.
4. AN INFLUENT VALVE IS REQUIRED FOR ISOLATION / MAINTENANCE OF THE FILTER UNIT. THE INFLUENT VALVE SHALL BE PROVIDED BY OTHERS AND INSTALLED BY OTHERS.
5. ALL PIPING AND FITTINGS SHALL BE PROVIDED BY OTHERS. ACTUAL PIPING LAYOUT AND PUMP LOCATION TO BE DETERMINED BY OTHERS WHEN THREADED OR WELDED PIPE IS USED IN LIEU OF FLANGED PIPE, UNIONS SHALL BE USED AT EACH PUMP AND VALVE CONNECTION TO FACILITATE SERVICE.
6. 20 H.P. BACKWASH / WASTE PUMP CONNECTIONS ARE 6" BACKWASH PIPING IS 6" DIAMETER. WASTE PIPING IS 6".
7. THE BACKWASH / WASTE PUMP CAPABILITIES ARE AS FOLLOWS:

   - HORSEPOWER: 20 HP
   - FLOW: 782 GPM
   - TOTAL DISCHARGE HEAD: 57.9 FT
   - ALLOWABLE DISCHARGE HEAD, AFTER FILTER LOSSES: 33.9 FT

   FOR INSTALLATIONS THAT REQUIRE MORE DISCHARGE HEAD, ALTERNATIVE PUMPS ARE AVAILABLE. PLEASE CONSULT ENGINEERING TO VERIFY THE SUITABILITY OF THE DISCHARGE PIPING OR FOR SPECIAL PUMP REQUIREMENTS.

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

DO NOT SCALE DRAWING

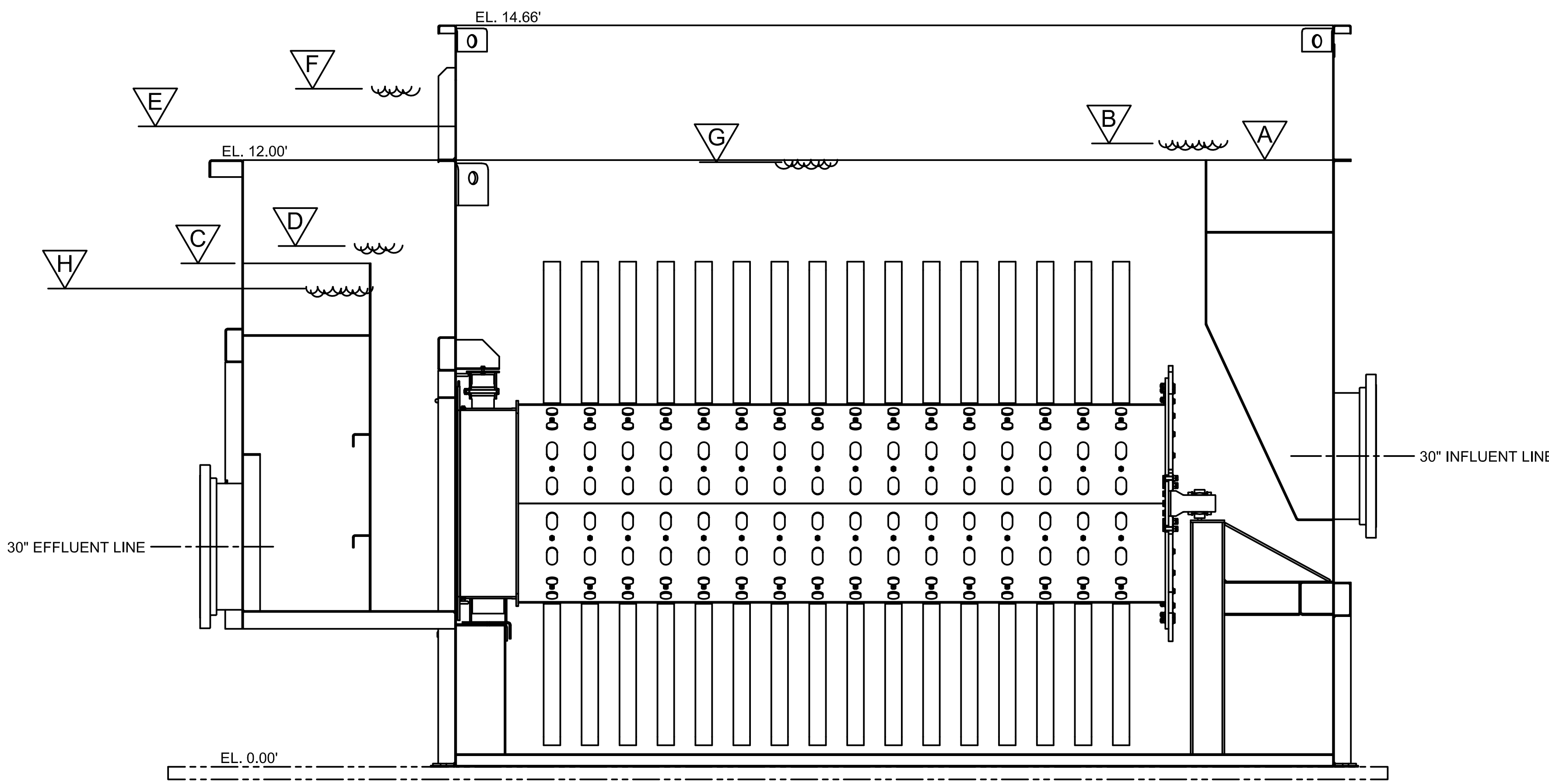
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: AMG — DATE: 2016-06-08
WEIGHT: — SHEET: 1 OF 3

DRAWING NAME: AQUADISK FILTER MODEL ADFSP-108X16E LH
DRAWING NUMBER: 2802268 — SCALE: — SIZE: D



ELEVATION

A	12.00'	INFLUENT WEIR ELEVATION
B	12.33'	NAPPE OVER INFLUENT WEIR AVERAGE FLOW
	12.52'	NAPPE OVER INFLUENT WEIR MAXIMUM FLOW
C	9.96'	EFFLUENT WEIR ELEVATION
D	10.28'	NAPPE OVER EFFLUENT WEIR AVERAGE FLOW
	10.48'	NAPPE OVER EFFLUENT WEIR MAXIMUM FLOW
E	12.67'	OVERFLOW WEIR ELEVATION
F	13.22'	NAPPE OVER OVERFLOW WEIR AVERAGE FLOW
	13.55'	NAPPE OVER OVERFLOW WEIR MAXIMUM FLOW
G	11.96'	BACKWASH INITIATE LEVEL
H	9.46'	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

HYDRAULIC PROFILE

BASED UPON AVERAGE FLOW RATE OF 3.25 GPM PER SQUARE FOOT (8.1 MGD)
BASED UPON MAXIMUM FLOW RATE OF 6.5 GPM PER SQUARE FOOT (16.1 MGD)

WEIR LENGTHS

INFLUENT = 20.00'
EFFLUENT = 20.00'
OVERFLOW = 9.00'

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

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ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

ANSI

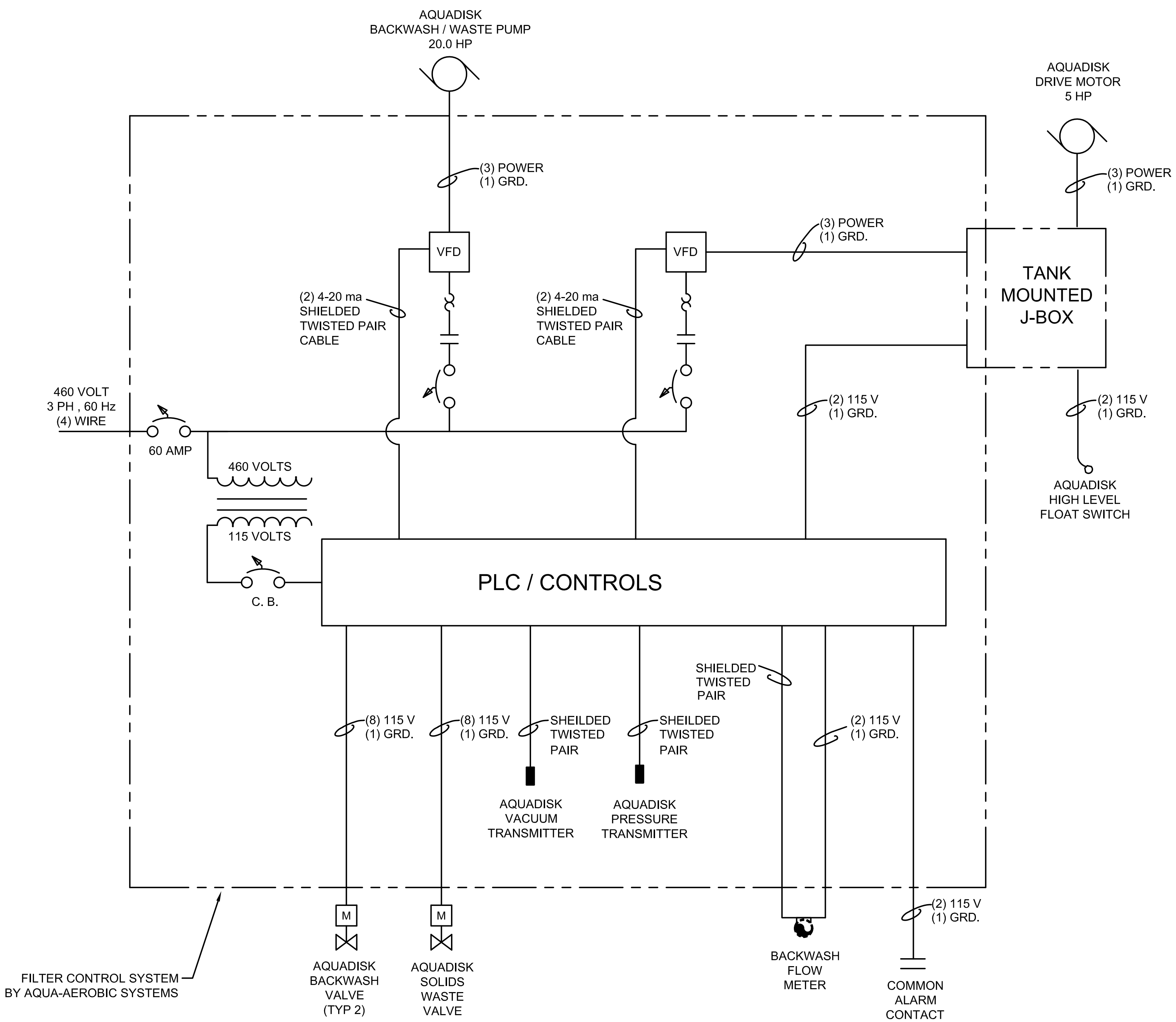
MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: AMG DATE: 2016-06-08
WEIGHT: SHEET: 2 OF 3

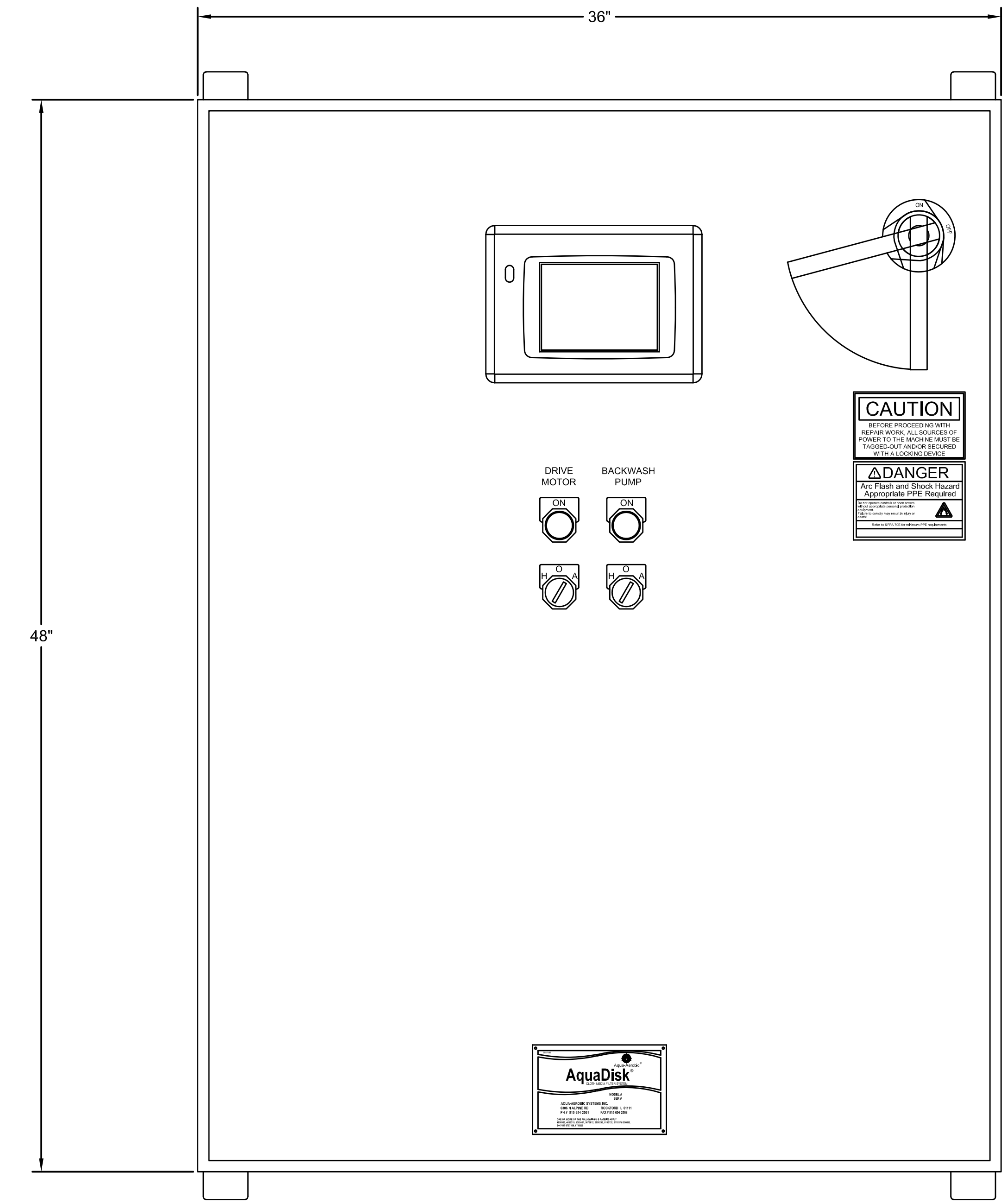
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-108X16E LH
DRAWING NUMBER: 2802268 SCALE: SIZE: D

SYMBOL KEY

	MOTOR		CIRCUIT BREAKER		ELECTRICAL DISCONNECT	VFD	VARIABLE FREQUENCY DRIVE		TRANSDUCER		STARTER CONTACTOR
M	MOTOR OPERATED VALVE		TRANSFORMER		MOTOR OVERLOAD	P	PNEUMATIC OPERATED VALVE		FUSE		FLOAT SWITCH

NOTE: SOME SYMBOLS MAY NOT BE APPLICABLE





1 CONTROL PANEL
ENCLOSURE NEMA 4X WALL MOUNTED TYPE FIBERGLASS
FACTORY ASSEMBLED ON THE FILTER, DISASSEMBLED AND SHIPPED LOOSE.
REASSEMBLED ON-SITE BY CONTRACTOR.
IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL
MAY BE RELOCATED TO THE SIDE OF THE FILTER
FACING NORTH TO LIMIT THE H.M.I. EXPOSURE TO DIRECT SUNLIGHT.

2 STANDARD CONTROL PANEL SIZE
48" HEIGHT X 36" WIDE X 12" DEEP

3 (1) CONTROL PANEL PER FILTER

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

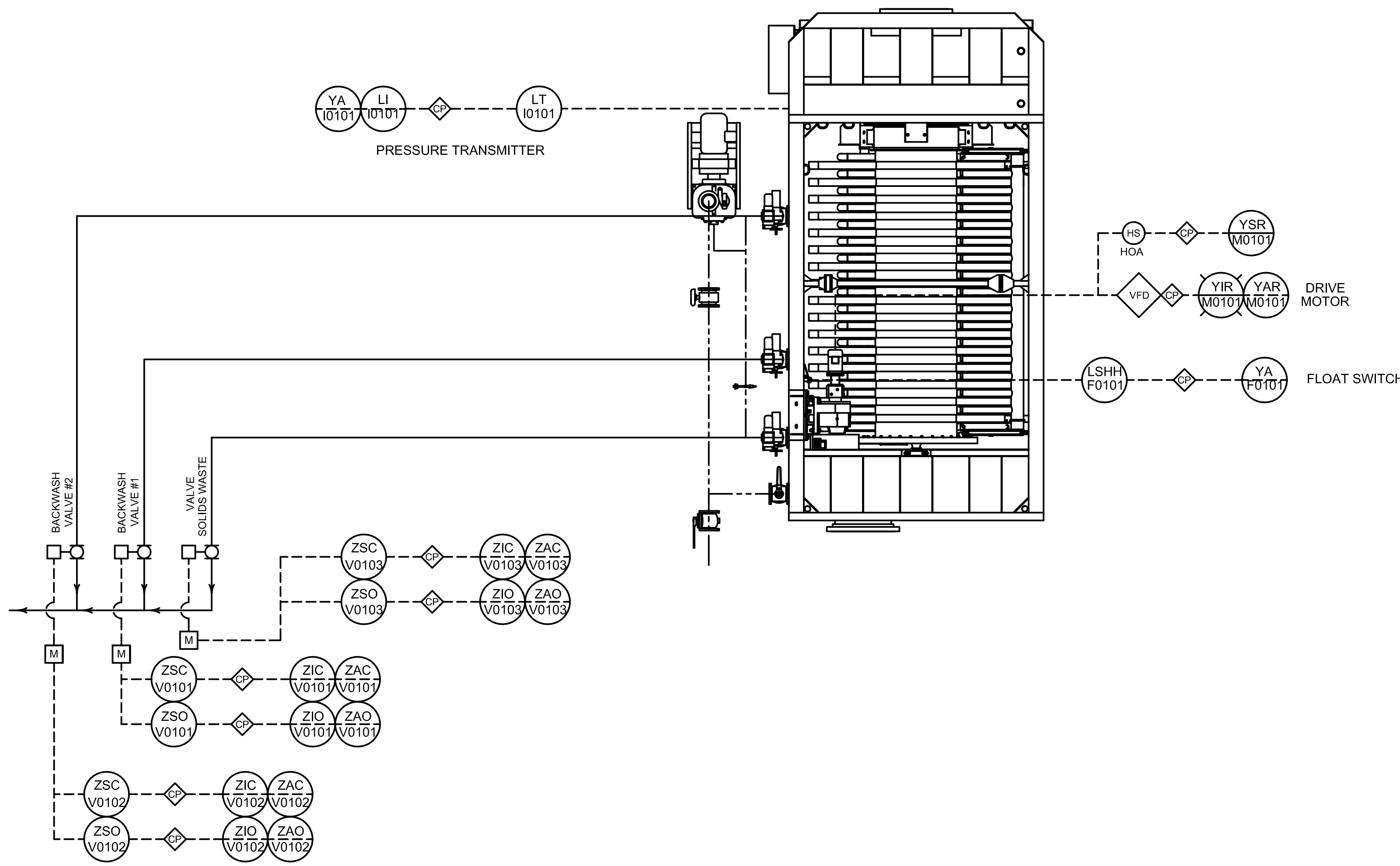
AQUA-AEROBIC SYSTEMS, INC.

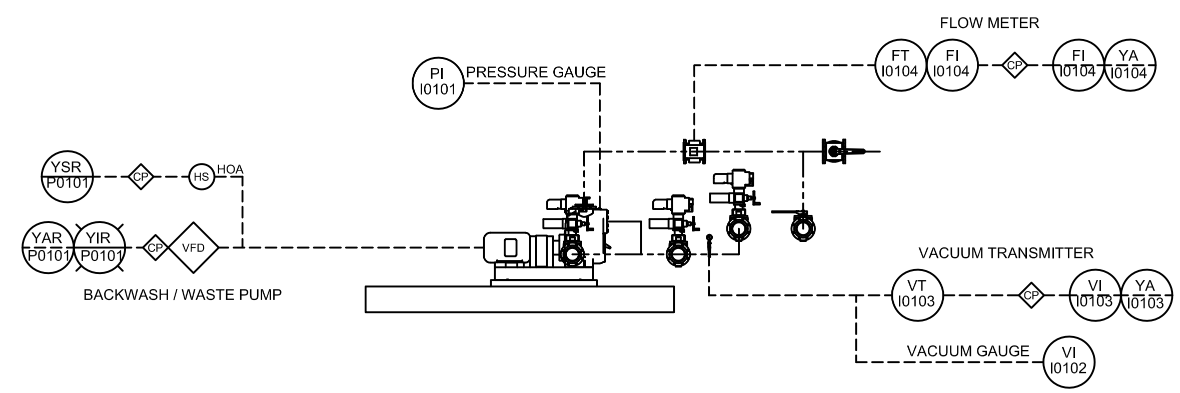
DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
FRACTIONAL DIMENSIONS +/- 1/16
ALL TWO PLACE DECIMALS +/- 0.010
ALL THREE PLACE DECIMALS +/- 0.005
ALL ANGLES +/- 1/2°
ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: AMG DATE: 2016-06-08
CHECKED BY: DATE:
WEIGHT: SHEET: 3 OF 3

DRAWING NAME: AQUADISK FILTER MODEL ADFSP-108X16E LH
DRAWING NUMBER: 2802268 SCALE: SIZE: D





P.& I. DIAGRAM SYMBOL KEY

XXX XXXXX — TOP LINE INDICATES FUNCTION AS FOLLOWS:

ZSO	POSITION SWITCH OPEN
ZIO	POSITION INDICATE OPEN
ZAO	POSITION ALARM OPEN
ZSC	POSITION SWITCH CLOSE
ZIC	POSITION INDICATE CLOSE
ZAC	POSITION ALARM CLOSE
ZA	POSITION ALARM
YSR	STATUS SWITCH RUN
YIR	STATUS INDICATE RUN
YIS	STATUS INDICATE STOP
YIO	STATUS INDICATE OPEN
YIC	STATUS INDICATE CLOSE
YAR	STATUS ALARM RUN
YAS	STATUS ALARM STOP
YA	STATUS ALARM
TSH	TEMP. SWITCH HIGH
TSL	TEMP. SWITCH LOW
TAH	TEMP. ALARM HIGH
TI	TEMP. INDICATE
LSLL	LEVEL SWITCH LOW/LOW
LALL	LEVEL ALARM LOW/LOW
LSL	LEVEL SWITCH LOW
LSM	LEVEL SWITCH MID-RANGE
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH/HIGH
LAHH	LEVEL ALARM HIGH/HIGH
LT	LEVEL TRANSMITTER
LI	LEVEL INDICATOR
VT	VACUUM TRANSMITTER
VI	VACUUM INDICATOR
AIT	ANALYZER INDICATOR/TRANSMITTER
AI	ANALYZER INDICATOR
AT	ANALYZER TRANSMITTER
AAH	ANALYZER ALARM HIGH
AAL	ANALYZER ALARM LOW
ASH	ANALYZER SWITCH HIGH
ASL	ANALYZER SWITCH LOW
FE	FLOW ELEMENT
FI	FLOW INDICATOR
PI	PRESSURE INDICATION
MS	MOISTURE SENSOR
PSV	PRESSURE SAFETY VALVE

XXX XXXXX — BOTTOM LINE TAGS EQUIPMENT IDENTIFICATION

XXXXX — EQUIPMENT NO. / TANK NO. / EQUIPMENT I.D.

A0000	AERATOR
B0000	BLOWER
D0000	DECANTER
F0000	FLOAT SWITCH
I0000	INSTRUMENT
M0000	MIXER
P0000	PUMP
S0000	SOLENOID VALVE
V0000	VALVE
W0000	MISC.

XXX XXXXX — FIELD LOCATED DEVICE (LIMIT SWITCH, TEMP. SWITCH, TRANSMITTER, ETC.)

XXX XXXXX — CONTROL PANEL MOUNTED INDICATOR OR INSTRUMENT (RUN LIGHT, LEVEL INDICATOR, D.O. TRANSMITTER, ETC.)

XXX XXXXX — OPERATOR INTERFACE DISPLAY READOUT (ALARM STATUS, CYCLE STATUS, ETC.)

CP — CONTROL PANEL / FIELD DEVICE TRANSITION POINT

HS XXX — HAND SWITCH — OCA OPEN/CLOSE/AUTO; HOA HAND/OFF/AUTO; HOAB HAND/OFF/AUTO A/AUTO B

M — MOTOR

PB — PUSH BUTTON

NOT FOR CONSTRUCTION

JOB NAME:	
JOB LOCATION:	
REV / ERN / ECO / DATE / BY / REVISION DESCRIPTION	
DRAWING NAME:	AQUADISK FILTER MODEL ADFSC-108X16E P&ID
	AQUA-AEROBIC SYSTEMS, INC.
DO NOT SCALE DRAWING	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°
	ANSI
MATERIAL:	
SIMILAR TO:	
TYPE:	
DRAWN BY:	DATE:
WEIGHT:	SHEET: 4 OF
DRAWING NUMBER:	2802268
SCALE:	SIZE: D

Process Design Report

NORFOLK WPC EXP NE

Design# 159076
Option: Preliminary SBR Design

AquaSBR®

Sequencing Batch Reactor

January 27, 2020
Designed By: Sara Altimimi

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Pre-SBR

- Elevated concentration of Hydrogen Sulfide can be detrimental to both civil and mechanical structures. If anaerobic conditions exist in the collection system, steps should be taken to eliminate Hydrogen Sulfide prior to the treatment system.

- Neutralization is recommended/required ahead of the SBR if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse solids removal/reduction is recommended prior to the SBR.

SBR

- The maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

- When flows are in excess of the maximum daily flow of 12.32 MGD, the SBR system has been designed to advance cycles in order to process a peak hydraulic flow of 14.25 MGD.

- The decanter performance is based upon a free-air discharge following the valve and immediately adjacent to the basin. Actual decanter performance depends upon the complete installation including specific liquid and piping elevations and any associated field piping losses to the final point of discharge. Modification of the high water level, low water level, centerline of discharge, and / or cycle structure may be required to achieve discharge of full batch volume based on actual site installation specifics.

Aeration

- The aeration system has been designed to provide 1.25 lbs. O2/lb. BOD5 applied and 4.6 lbs. O2/lb. TKN applied at the design average loading conditions.

Process/Site

- An elevation, ambient and waste temperature has been given as displayed on the design.

- The anticipated effluent TP requirement is predicated upon an influent waste temperature of 10° C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification and denitrification below 10° C can be unpredictable, requiring special operator attention.

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- It is assumed that there are no substances in the influent stream that would be inhibitory for a biological system.

- To achieve the effluent monthly average total phosphorus limit, the biological process and chemical feed systems need to be designed to facilitate optimum performance.

- A minimum of twelve (12) daily composite samples per month (both influent and effluent) shall be obtained for total phosphorus analysis.

- Influent to the biological system is a typical municipal wastewater application with a TP range of 6–8 mg/l. Influent TP shall be either in a particle associated form or in a reactive soluble phosphate form or in a soluble form that can be converted to reactive phosphorus in the biological system. Soluble hydrolyzable and organic phosphates are not removable by chemical precipitation with metal salts. A water quality analysis is required to determine the phosphorus speciation with respect to soluble and insoluble reactive, acid hydrolyzable and total phosphorus at the system influent, point(s) of chemical addition, and final effluent.

- Chemical feed lines (i.e. metal salts) shall be furnished to each reactor, aerobic digester and dewatering supernatant streams as necessary. Metal salts shall be added to each reactor during the React phase of the cycle.

- pH monitoring of the biological reactor is required when adding metal salts.

Post-SBR

- Provisions should be made by others for a post-equalization basin overflow.

Equipment

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square, rectangular or sloped with construction materials including concrete, steel or earthen.

- Rectangular or sloped basin construction with length to width ratios greater than 1.5:1 may require alterations in the equipment recommendation.

- The basins are not included and shall be provided by others.

- Influent is assumed to enter the reactor above the waterline, located appropriately to avoid proximity to the decanter, splashing or direct discharge in the immediate vicinity of other equipment.

- If the influent is to be located submerged below the waterline, adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- A minimum freeboard of 2.0 ft is recommended for diffused aeration.

- Equipment selection is based uponthe use of Aqua-Aerobic Systems' standard materials of construction and electrical components.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

AquaSBR - Sequencing Batch Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow	= 8.47 MGD	= 32062 m3/day
Max Design Flow	= 12.32 MGD	= 46636 m3/day
Peak Hyd. Flow	= 14.25 MGD	= 53942 m3/day (with advancing cycles)

DESIGN PARAMETERS	Influent	mg/l	Effluent Required	<= mg/l	Effluent Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	BOD5	432	BOD5	10	BOD5	10
Total Suspended Solids:	TSS	220	TSS	10	TSS	10
Total Kjeldahl Nitrogen:	TKN	30	TKN	--	TKN	--
Ammonia Nitrogen:	--	--	NH3-N	1	NH3-N	1
Total Nitrogen:	--	--	TN	10	TN	10
Phosphorus:	Total P	9	--	--	--	--

SITE CONDITIONS	Maximum		Minimum		Design		Elevation (MSL)
Ambient Air Temperatures:	85 F	29.4 C	30 F	-1.1 C	85 F	29.4 C	1,510 ft
Influent Waste Temperatures:	68 F	20.0 C	50 F	10.0 C	68 F	20.0 C	460.2 m

SBR BASIN DESIGN VALUES

No./Basin Geometry:	= 6 Rectangular Basin(s) (4 existing, 2 new basins)	
Freeboard:	= 2.0 ft	= (0.6 m)
Length of Basin:	= 110.0 ft	= (33.5 m)
Width of Basin:	= 110.0 ft	= (33.5 m)

	Water Depth			Basin Vol./Basin	
Min	= 12.6 ft	= (3.8 m)	**Min**	= 1.137 MG	= (4,304.2 m³)
Avg	= 15.7 ft	= (4.8 m)	**Avg**	= 1.419 MG	= (5,373.2 m³)
Max	= 17.1 ft	= (5.2 m)	**Max**	= 1.547 MG	= (5,859.0 m³)

Number of Cycles:	= 5 per Day/Basin	
Cycle Duration:	= 4.8 Hours/Cycle	
Food/Mass (F/M) ratio:	= 0.119 lbs. BOD5/lb. MLSS-Day	
MLSS Concentration:	= 4500 mg/l @ Min. Water Depth	
Hydraulic Retention Time:	= 1.005 Days @ Avg. Water Depth	
Solids Retention Time:	= 13.6 Days	
Est. Net Sludge Yield:	= 0.595 lbs. WAS/lb. BOD5	
Est. Dry Solids Produced:	= 18143.0 lbs. WAS/Day	= (8229.6 kg/Day)
Est. Solids Flow Rate:	= 1000 GPM (217542 GAL/Day)	= (823.6 m³/Day)
Decant Flow Rate @ MDF:	= 13689.0 GPM (as avg. from high to low water level)	= (863.6 l/sec)
LWL to CenterLine Discharge:	= 3.0 ft	= (0.9 m)
Lbs. O2/lb. BOD5	= 1.25	
Lbs. O2/lb. TKN	= 4.60	
Actual Oxygen Required:	= 47894 lbs./Day	= (21724.5 kg/Day)
Air Flowrate/Basin:	= 9277 SCFM	= (262.7 Sm3/min)
Max. Discharge Pressure:	= 9.0 PSIG	= (62 KPA)
Avg. Power Required:	= 9754.5 KW-Hrs/Day	

Post-Equalization - Design Summary

POST-SBR EQUALIZATION DESIGN PARAMETERS

Avg. Daily Flow (ADF):	= 8.47 MGD	= (32,062 m^3/day)
Max. Daily Flow (MDF):	= 12.32 MGD	= (46,636 m^3/day)
Decant Flow Rate from (Qd):	= 13,689 gpm	= (51.8 m^3M)
Decant Duration (Td):	= 60 min	
Number Decants/Day:	= 15	
Time Between Start of Decants:	= 96 min	

POST-SBR EQUALIZATION VOLUME DETERMINATION

The volume required for equalization/storage shall be provided between the high and the low water levels of the basin(s). This Storage Volume (Vs) has been determined by the following:

Vs = [(Qd -(MDF x 694.4)] x Td = 308,007 gal = (41,177.4 ft^3) = (1,166.0 m^3)

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

Based upon liquid level inputs from each SBR reactor prior to decant, the rate of discharge from the Post-SBR Equalization basin shall be pre-determined to establish the proper number of pumps to be operated (or the correct valve position in the case of gravity flow). Level indication in the Post-SBR Equalization basin(s) shall override equipment operation.

POST-SBR EQUALIZATION BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Length of Basin:	= 110.0 ft	= (33.5 m)			
Width of Basin:	= 50.0 ft	= (15.2 m)			
Min. Water Depth:	= 1.5 ft	= (0.5 m)	**Min. Basin Vol. Basin:**	= 61,709.9 gal	= (233.6 m^3)
Max. Water Depth:	= 9.0 ft	= (2.7 m)	**Max. Basin Vol. Basin:**	= 369,716.6 gal	= (1,399.6 m^3)

POST-SBR EQUALIZATION EQUIPMENT CRITERIA

Mixing Energy with Diffusers:	= 15 SCFM/1000 ft^3	
SCFM Required to Mix:	= 741 SCFM/basin	= (1,260 Nm^3/hr/basin)
Max. Discharge Pressure:	= 4.5 PSIG	= (30.79 KPA)
Avg. Power Required:	= 255.2 kW-hr/day	

AquaSBR

Influent Valves

6 Influent Valve(s) will be provided as follows:

- 20 inch electrically operated plug valve(s).

Mixers

6 AquaDDM Direct Drive Mixer(s) will be provided as follows:

- 40 HP Aqua-Aerobic Systems Endura Series Model FSS DDM Mixer(s).

Mixer Mooring

6 Mixer Cable Mooring System(s) consisting of:

- #4 AWG-four conductor electrical service cable(s).
- Aerial support tie(s).
- Electrical cable strain relief grip(s), 2 eye, wire mesh.
- 304 stainless steel cable.
- Maintenance mooring cable loop(s).
- Stainless steel mooring spring(s).
- Stainless steel anchors.

Decanters

6 Decanter Assembly(ies) consisting of:

- 12" X 11" Decanter(s) with fiberglass float, 304 stainless steel weir, 304 stainless steel restrained mooring frame, and stainless steel power section with #16-10 conductor signal cable and #12-4 conductor power cable.
- Decant pipe(s).
- 4" schedule 40 galvanized restrained mooring post(s) with base plate.
- Galvanized steel dewatering support posts.
- 20 inch electrically operated butterfly valve(s).
- Auma actuator will be upgraded from open/close service to modulating service.

Transfer Pumps/Valves

6 Submersible pump assembly(ies) consisting of the following items:

- 10 HP Submersible Pump(s) with painted cast iron pump housing, discharge elbow, and multi-conductor electrical cable.
- 6" Manual plug valve(s).
- 6 inch diameter swing check valve.
- Guide bar(s).
- Miscellaneous Materials-Pump/Valves.
- Miscellaneous Materials-Pump/Valves.
- Galvanized steel intermediate support(s).
- Upper guide bar bracket(s).

Fixed Fine Bubble Diffusers

6 Fixed Fine Bubble Diffuser Assembly(ies) consisting of:

- 304 SS, 12 Ga. drop pipe(s).
- PVC, Sch 40 Manifold(s) with connection to drop pipe.
- PVC, Air distributor(s) with connection to the manifold and required PVC pipe joint connections.
- 304 Stainless steel piping supports with vertical supports, clamps, adjusting mechanism and anchor bolts.
- Fine bubble diffuser assemblies.
- 12" manual butterfly valve(s).

Positive Displacement Blowers

7 Positive Displacement Blower Package(s), with each package consisting of:

- Aerzen 250HP Rotary Positive Displacement Blower(s).
- 12" manual butterfly valve(s).

Air Valves

8 Air Control Valve(s) will be provided as follows:

- 20 inch electrically operated butterfly valve(s).

Level Sensor Assemblies

6 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

6 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Instrumentation

6 Dissolved Oxygen Assembly(ies) consisting of:

- Thermo Fisher RDO dissolved oxygen probe with electric cable. Probe includes stainless steel stationary bracket and retrievable pole probe mounting assembly. One (1) probe per basin.
- Thermo Fisher AV38 controller and display module(s).

AquaSBR: Post-Equalization

Fixed Coarse Bubble Diffusers

1 Aqua-Aerobic's Fixed Coarse Bubble Diffuser System(s) consisting of the following components:

- PVC diffuser(s).
- Schedule 40 galvanized steel riser pipe(s).
- Stainless steel anchors.

Positive Displacement Blowers

1 Positive Displacement Blower Package(s), with each package consisting of:

- Aerzen 25HP Rotary Positive Displacement Blower(s).
- 6" manual butterfly valve(s).

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Submersible pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Compactlogix Processor.
- Operator interface(s).
- Remote Access Ethernet Modem.

OVIVO Worldwide Experts in Water Treatment

PROPOSAL LETTER

PROPOSAL # 200206-1-BW-R0

FEBRUARY 6, 2020

NORFOLK WPCF

NORFOLK, NE

ANAEROBIC AND AEROBIC DIGESTION SLUDGE STABILIZATION OFFERINGS

PREPARED FOR

Olssom
Gabriel Meidl
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AREA REPRESENTATIVE

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Ovivo USA, LLC
2300 Greenhill Dr. Bldg. #100
Round Rock, Texas, 78664, USA
http://www.ovivowater.com

ANAEROBIC DIGESTER DESIGN PARAMETERS

Number of Digesters	Four (4)
Cover Type	Fixed-Steel
Tank Diameter	65.00 ft
Top of Tank Elevation*	22.00 ft
Maximum Liquid Level Elevation	20.00 ft
Minimum Liquid Level Elevation*	18.00 ft
Bottom of Wall Elevation	0.00 ft
Tank Height	20.00 ft
Cone Height*	4.00 ft
Volume Approx.	475,000 gal
Concentration*	2-6%
Design Pressure*	16 in w.c
Operating Pressure*	10 in w.c
Live Load*	50 psf
Wind Load*	20 psf

** Assumed Parameters. Please confirm.*

ANAEROBIC DIGESTION PRODUCT HIGHLIGHTS

OVIVO® FIXED STEEL COVER

Ovivo provides a variety of digester steel covers. Each digester cover is constructed as a dome-shaped segment of a sphere, offering maximum strength and structural integrity.

Figure 1: Ovivo® Fixed Steel Cover

The digester steel covers are radial beam designed to be erected quickly and efficiently, this is a simple, rigged structural design. The thrust ring is installed at the periphery of each cover to absorb all design loads without transmitting excessive forces to the concrete digester wall. During erection, the cover is supported by radial beams attached to a center ring and the thrust ring which add strength to the complete unit.

For the Fixed steel cover design, the side sheet should be extended 1 ft below the minimum liquid level (at least). Otherwise, two options are recommended: 1) the supplier of the filler material should confirm that it can withstand the design pressure 2) an independent clean liquid launder should be provided (pricing not included) that allows for a pressure seal at any given sludge level (Contact Ovivo for additional details should you like to pursue this option).

TECHNICAL DATA

For this application and based on the design parameters, Ovivo recommends Four (4) Ovivo® 65 F1 Fixed Steel Covers installed on anaerobic digesters.

Model	**65 F1**
Size	65'Ø
Max Side Sheet Length	48 In
Total Weight [1]	64,700 lbs
Estimated Field Welding[1]	2,200 ln ft
Estimated Field Painting (Inside and Outside)[1]	8,400 sq. ft

[1] The weights, welding and painting requirement are estimates only. The contractor should verify these estimates prior to the bid.

<u>Ovivo's scope of supply does not include installation. We provide the estimate weight, welding and painting requirements and the contractor should verify these estimates prior to the bid.</u> The above field welding estimate was based on the overall welding requirements on Figure 2.

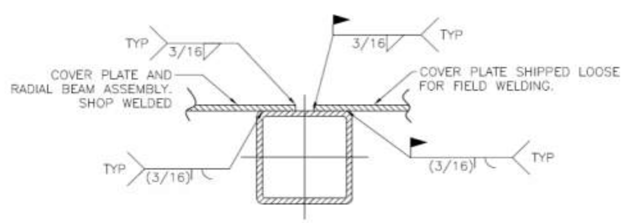


Figure 2: Typical Weld Detail for Radial Beam Connections

BUDGET INFORMATION[1]

Model	**65 F1**
Quantity	**Four (4)**
Scope of Supply	Table No. 1
Total Price	**$1,051,000**

[1] All prices in US Dollars.

EZ-RECT™ SYSTEM

The EZ-RECT™ cover erection system is a feature with the digester cover. Ovivo will provide the digester cover with cover plate/radial beam sections pre-assembled and finish welded in the shop to facilitate the erection of the cover. Each assembly will consist of two (2) beams and one (1) cover plate.

Ovivo offers this option to reduce the amount of field welding required to erect a cover of this diameter. **This will reduce the total amount of field welding for the digester steel cover.** Furthermore, this will reduce the number of pieces to be handled during erection.

Ovivo suggests a careful consideration of the various offerings in regards to the amount of field welding disclosed by the cover manufacturers. The variance in the various estimates should be within a reasonable amount of the quantity expressed in this proposal. Ultimately, the Contractor is required to make their own estimate of welding requirements.

Painting: The cover side sheets are shipped unpainted, so all necessary cleaning, sandblasting and painting must be done progressively as the assembly proceeds. Be aware that the side sheets will be difficult to paint if they are installed inside the tank. Do not paint within 3 inches of all areas to be welded. It is also imperative that all welds are per the erection drawings and gas tight. Therefore, the erector must be able to certify that no leaks exist prior to painting.

Cover erection is completed in five steps:

1- Side Sheet Assembly
2- Center Ring and Erection Beam Installation
3- EZ-Rect Cover Plate Assembly Installation
4- Remaining Cover Plate Installation
5- Manholes, Spools, Tubes, Etc., Installation

ADDITIONAL INFORMATION

FIELD SERVICE:

Ovivo's scope includes the service of a qualified service engineer for the following:

One (1) trip of two (2) days total of service, per digester, for the supervision of equipment start-up, testing supervision, and instructing the operators

Additional service days can be purchased at the current rate.

ESTIMATED LEAD TIMES:

Submittals: Eight (8) weeks after Purchaser's receipt of Ovivo's written acknowledgement of an approved purchase order.
Shipping: Twenty four (24) weeks after receipt of approved drawings from Purchaser.

TESTING:

After field erection is complete, the Contractor shall test the covers for gas tight construction by filling the tank with water and trapping air under the cover plates. All welded seams and appurtenances shall be checked for leaks by means of a soap suds solution.
The air pressure underneath the dome during the test shall be not less than 14" W.C.

FINISHES:

Steel plates, structural shapes and fabricated assemblies shall be shipped unpainted, for field painting by others. After erection, welding, testing and final inspection of erection by manufacturer's representative, the covers shall be painted (not by Ovivo).

GENERAL:

The design of the digester steel cover does not fall under any specific code or standard for the design analysis. The current codes and standards are be used as guide lines for the design and analysis of the equipment. The analysis will result with a conservative approach that meets the intent of the present codes and standards.

LM™ MIXER

LM™ (Linear Motion) Mixers offer solutions to the challenges of mixing wastewater in both thin sludge and thick sludge applications, providing homogeneous mixing by creating a turbulent liquid-core of micro and macro eddy currents. These currents are accelerated rapidly through the central opening of an oscillating ring-shaped hydro-disk, which moves up and down through the mix, creating the distinctive linear motion mixing action of the LM™ Mixer.

The frequency, stroke and size of the hydro-disk control the force and velocity of the liquid-core. The LM™ Mixer's oscillating motion produces a flow pattern that approaches nearly isotropic (uniform) mixing. Additionally, LM™ Mixers use pulsating pressure waves in conjunction with the oscillating velocity. In this type of concurrent action the oscillating pressure wave and velocity are coupled together to enhance mass transfer and produce a uniform mixture of the tank's contents.

Figure 3: LM™ Mixer

TECHNICAL DATA

For this application and based on the design parameters, Ovivo recommends One (1) LM™ Mixer for each 65 ft digester.

Model	**LM12/7.5/72**
Motor Size	7.5 hp
Estimated Dead Weight	5,100 lbs
Estimated Max. Dynamic Load	2,700 lbs
Number of Mixers per Tank	One (1)

ENERGY CONSUMPTION COMPARISON

LM™ Mixer vs. Conventional Mixing System

Motor Size	Years			
(hp)	1	5	10	20
7.5	$3,307	$19,169	$44,443	$119,456
20	$8,819	$51,116	$118,515	$318,549
Difference	**$5,512**	**$31,948**	**$74,072**	**$199,093**

The operation cost estimated is based on 0.09 $/kW-h, running the mixer at 75% of the total motor horsepower continuously.

BUDGET INFORMATION[1]

Model	**LM12/7.5/72**
Total Quantity	Four (4)
Scope of Supply	Table No. 2
Estimated Yearly Energy Cost[23]	$3,300
Price	**$675,000**

[1] All prices in US Dollars.
[2] Estimated per Digester.
[3] The energy cost estimate based on 0.09 $/kW-hr, running the mixer at 75% of the horse power continuously.

ADDITIONAL INFORMATION

SURFACE PREPARATION AND PAINTING

Ovivo will ship all fabricated steel painted as listed below:

Submerged Surface	
Surface Preparation:	SSPC-SP-10, near-white blast cleaning
Prime Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Finish Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Non-Submerged Surface	
Surface Preparation:	SSPC-SP-10, near-white blast cleaning
Prime Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Intermediate Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Finish Coat:	Tnemec Series 73 or equal @ 3-5 mils DFT.

Stainless steel components will not be painted. The Field touchup is not included.

FIELD SERVICE:

Ovivo's scope includes the service of a qualified service engineer for the following:

One (1) trip of two (2) days total of service, per digester at the site for the supervision of equipment start-up, testing supervision, and instructing the operators.

Additional service days can be purchased at the current rate.

ESTIMATED LEAD TIMES:

Submittals: Eight (8) weeks after Purchaser's receipt of Ovivo's written acknowledgement of an approved purchase order.

Shipping: Twenty-four (24) weeks after receipt of approved drawings from Purchaser.

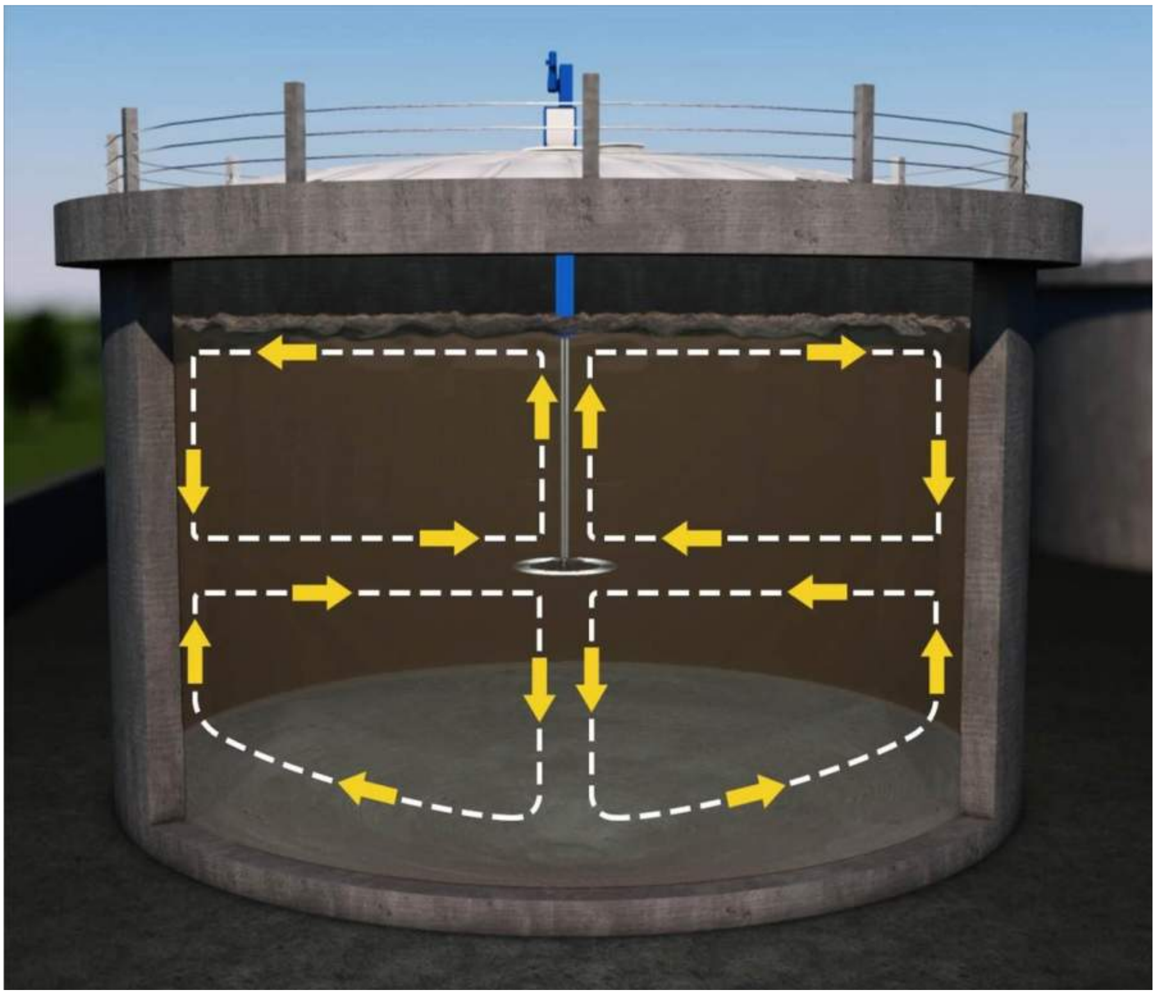


Figure 4: LM™ Mixer (showing flow pattern inside Digester)
(Click Link to Watch Video)

PRODUCT HIGHLIGHTS

EIMIX® DRAFT TUBE SLUDGE MIXERS

The Eimix® Mechanical Sludge Mixers create a tangential, spiralling flow pattern within the tank. The Eimix® propeller is symmetrical about both axes and can pump sludge with equivalent capacity in both directions. The reversible direction of flow (up or down) allows the adjustments in the mixing dynamics of the digester.

The performance of the Eimix® Mechanical Sludge Mixers varies between 0.20 to 0.30 hp/1,000 ft^3 per ASCE/WEF Design of Municipal Wastewater Treatment Plants, Manual of Practice (MOP 8) Recommendations and Design Parameters to achieve 30 to 45 minute turnover time.

Figure 5: Eimix® Roof Mounted Tube Mixer

TECHNICAL DATA

For this application and based on the design parameters, Ovivo recommends two (2) Eimix® RDT (Roof Mounted) to be installed on each digester.

Model	**RDT-T/7.5/24**
Motor Size	7.5 hp
Turnover Time[1]	29 min
Power To Volume Ratio[1]	0.22 hp/1,000 ft^3
Estimated Dead Weight[2]	5,800 lbs
Quantity per Tank	Two (2)

[1]These parameters comply with the recommendations of the ASCE /WEF MOP # 8 1998 Ed. for digester mixing.
[2]Estimate per unit.

BUDGET INFORMATION[1]

Model	**RDT-T/7.5/24**
Total Quantity	Eight (8)
Scope of Supply	Table No. 3
Estimated Yearly Energy Cost [23]	**$6,600**
Total Price	**$721,000**

[1] All prices in US Dollars.
[2] Estimated per Digester.
[3]The Operation cost estimate based on 0.09 $/kW-hr, running the mixer at 75% of the horse power continuously.

ADDITIONAL INFORMATION

SURFACE PREPARATION AND PAINTING

Ovivo will ship all fabricated steel painted as listed below:

Submerged Surface	
Surface Preparation:	SSPC-SP-10, near-white blast cleaning
Prime Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Finish Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Non-Submerged Surface	
Surface Preparation:	SSPC-SP-10, near-white blast cleaning
Prime Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Intermediate Coat:	Tnemec Series 66HS or equal @ 4-6 mils DFT.
Finish Coat:	Tnemec Series 73 or equal @ 3-5 mils DFT.

Stainless steel components will not be painted. The Field touchup is not included.

FIELD SERVICE:

Ovivo’s scope includes the service of a qualified service engineer for the following:

One (1) trip of two (2) days total of service, per digester at the site for the supervision of equipment start-up, testing supervision, and instructing the operators in maintenance, troubleshooting, and repair of the equipment.

Additional service days can be purchased at the current rate.

ESTIMATED LEAD TIMES:

Submittals: Eight (8) weeks after Purchaser’s receipt of Ovivo’s written acknowledgement of an approved purchase order.

Shipping: Twenty four (24) weeks after receipt of approved drawings from Purchaser.

AEROBIC PRODUCT HIGHLIGHTS

The Norfolk, NE is considering aerobic digestion process improvements to handle solids produced at its wastewater treatment plant (WWTP). One of the solutions Ovivo proposes is a **M**echanical **T**hickened **A**erobic **D**igester (M-TAD™) Process.

The M-TAD™ process will use a mechanical thickener to thicken the sludge before it enters aerobic digesters. Thickening of the sludge offers advantages such as Class B sludge treatment with longer solids retention times (SRT) in a reduced footprint, reduced air requirements, and the ability of sludge to retain heat and be more resistant to colder climates. The document below describes the design and technology.

In addition, this process makes use of our unique air diffuser system which has a non-clogging design and is especially suited to deep tanks or for use with thick sludges found in mechanically thickened systems.

This proposal outlines the Ovivo technology and design of the M-TAD™ process as applied to the requirements and needs of the Norfolk, NE facility.

BASIS OF DESIGN

The information used for design is listed as follows:

- Total Design Sludge Loading Rate = 23,158 ppd
- Volatile Fraction of 0.80 (Assumed)
- Class B Biosolids
- Sludge to be thickened up to 4% solids concentration
- New Tank Construction
- Temperature 15°C - 30°C
- Site Elevation 1500 ft

Please inform Ovivo of any additional design criteria or changes to the assumptions made above.

M-TAD™ SYSTEM GENERAL OPERATION

OVERVIEW

The M-TAD™ aerobic digestion system consists of a mechanical thickening device feeding pre-thickened sludge at 3% - 4% total solids concentration to two or more aerobic digester basins operating in either series or parallel mode. Figures 1 shows the process flow diagram for a M-TAD® system operating in parallel and series respectively. The M-TAD® process has the primary advantage of reducing the volume of sludge to be digested. For existing digesters, this provides three to eight times more solids retention time. For new digesters, the required design volume is reduced.

In addition, the thickened sludge will reach a higher temperature during digestion, increasing the reaction rate of digestion, and potentially further reducing the required digester volume.

For a typical waste activated sludge feed, the digesters operate in series. Multiple digesters provide optimum pathogen destruction and volatile solids reduction. Due to the nature of the digestion process, most of the digestion takes place in the first digester. This digester requires the most oxygen and will achieve the majority of the volatile solid reduction. When thickened sludge is fed to the aerobic digester as much as 80% of the total oxygen requirement is in the first digester.

The second digester achieves the remaining volatile solids and pathogen reduction. A third digester, when used, is isolated from any untreated sludge and serves mainly as a polishing basin to meet Class B biosolids criteria.

For a typical waste activated sludge feed, the three digesters can be operated in series as discussed above. When primary sludge is combined with secondary sludge, it may be necessary to operate two of the basins in parallel, as first stage digesters, and use the third basins as a second stage digester. This mode of operation increases the volume of the first stage and more evenly distributes the large oxygen demand of the primary sludge over the total digestion volume.

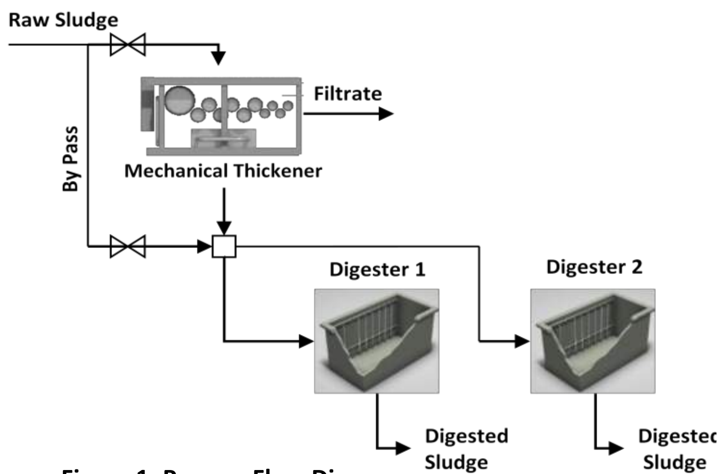


Figure 1: Process Flow Diagram

The design of the sludge handling system includes the flexibility to bypass the thickener if necessary, to control the concentration of sludge in the digesters. Bypass capability allows the mechanical thickener to be operated at optimum thickening capacity, which may be greater than 7-8%, while allowing the operator the ability to vary digester concentration as required to ensure that oxygen demand is met, and to control the temperature during summer and winter operations.

Summer and winter conditions pose different challenges for aerobic digestion of thickened sludge. For optimum digester performance water temperature should be maintained between 20 °C and 35 °C year-round. When the water temperature drops to 10°C or lower, biological activity, especially nitrification, is severely reduced. Above 37 °C, thermophilic bacteria begin to propagate and nitrification is inhibited.

Pre-thickening is beneficial in winter conditions because a concentrated sludge releases more heat per unit volume during digestion. This results in a greater temperature increase which in turn promotes more rapid digestion

For sites with severe winter climates, or at high altitude, this temperature effect can be enhanced by placing covers over the digesters. Ovivo provides covers that are integrated with the air delivery and air diffuser systems to form a single unit. These covers can be adapted to almost any digester configuration.

In summer conditions, where excess temperature can be a problem, sludge concentration to the digester can be reduced to keep the digester within the proper temperature range. In this situation, sludge concentration in the first digester is controlled by bypassing a certain volume of sludge around the thickener and feeding it directly to the digester. Digesters with covers can be cooled by opening the access hatches in the cover.

THE AERATION EQUIPMENT

Ovivo’s aeration equipment consists of medium bubble diffusers designed to operate without the need for maintenance. The equipment is especially suited for digesters and sludge holding tanks which typically see a range of materials and handle thicker solids concentrations.

The TransMAX® (or MS®) diffuser is a single drop diffuser with upper deflector and an above-water orifice. This diffuser achieves medium bubble oxygen transfer rates of up to 14%. A figure of this diffuser is shown in Figure 2.

Both the TransMAX® and its larger diameter counterpart, the MS® diffuser, offer excellent mixing and aerating abilities by establishing a clear roll pattern within the basins. These diffusers are recognized as being truly non-clog diffusers. The air metering orifices are located above water level and can be accessed without draining the tank if the system is to be cleaned or altered. However, because the orifice is above water, the need for cleaning is eliminated, even if the air is turned off. This is a guarantee no other diffuser can make.

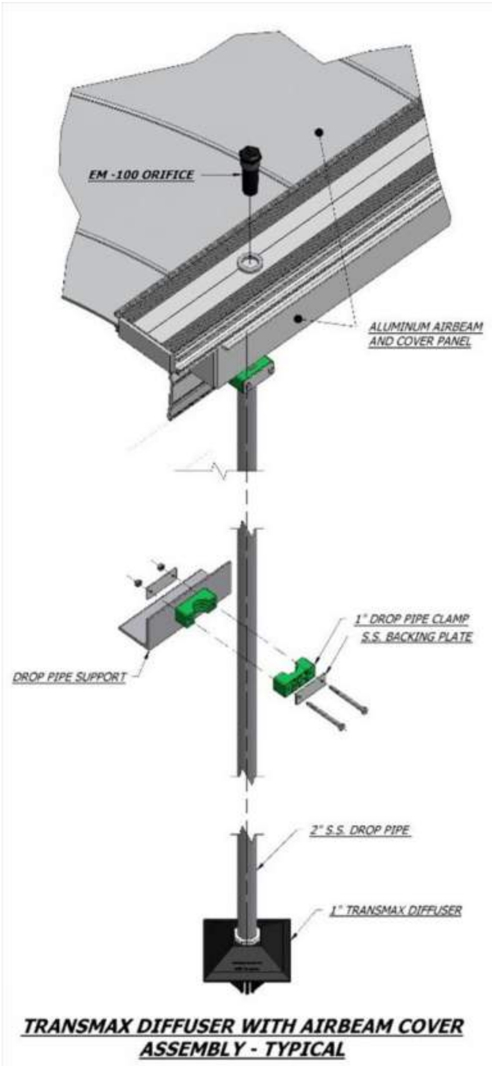


Figure:2. TransMAX® Diffuser (For Air Beam Cover)

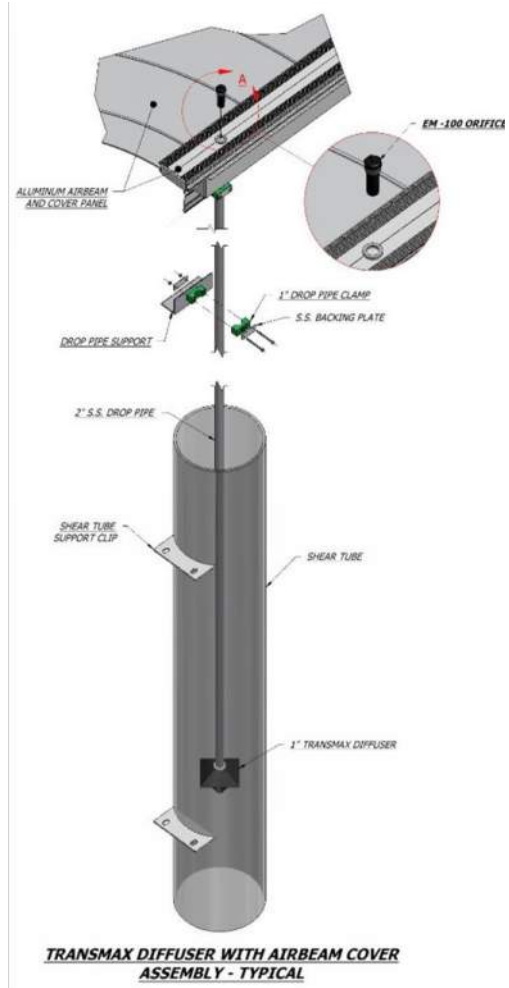


Figure:3. TransMAX® Diffuser with Shear Tube (For Air Beam Cover)

In addition to the benefits of the diffuser assembly itself, the TransMAX® and MS® diffusers can be combined with shear tubes or draft tubes. This is done when the sludge to be aerated is thickened prior to aeration or when the tanks to be aerated are very deep. A shear tube assembly is shown in Figure 3 and a draft tube assembly is shown in Figure 4.

In deep tanks, blower horsepower is saved by reducing the submergence and extending the shear tubes. The diffuser heads are mounted only partially down the depth of the tank and thus the system saves blower horsepower compared to aerating a floor mounted system.

Due to the differential pressure between the bottom of the tube and the highly aerated sludge at the top of the tube, sludge is drawn up inside the tube and discharged out the top. This causes a rolling pattern out from each tube, down the depth of the water, and back up the tube. The pumping action is similar to that of an airlift pump and has been quantified with test data. By bringing the full pumped volume into the confined area of the tube the velocity is maintained between 4 and 6 fps thereby reducing the viscosity of the thickened sludge.

NORFOLK, NE M-TAD™ PROCESS

PROCESS LAYOUT

The M-TAD™ process proposed for the Norfolk, NE will operate identical to the layout shown in Figure 1 above but there will be two parallel trains operating two aerobic digesters in series with a mechanical thickener.

TANK LAYOUT

The tank layout for the Norfolk, NE facility is based on new construction and is described in Table 1 below. (Construction by others)

Table 1: Tank Layout				
Train	Tank	Dimensions	Side Water Depth	Volume (Gallons)
Train-1	Digester-1A	82’ x 50’	24'	736,083
	Digester-2A	82’ x 50’	24'	736,083
Train-2	Digester-1B	82’ x 50’	24'	736,083
	Digester-2B	82’ x 50’	24'	736,083

AERATION DESIGN

Aeration is required for process and mixing air in the aerobic digesters. The process air requirements are shown in Table 2, below.

Table 2: Aeration Requirements				
Tank	Mixing Air (40 scfm/kcf)	Scouring Air	Winter Process Air	Summer Process Air
Digester-1A	4,920 scfm	N/A	9,781 scfm	<u>11,372 scfm</u>
Digester-2A	<u>4,920 scfm</u>	N/A	2,401 scfm	1,836 scfm
Digester-1B	4,920 scfm	N/A	9,781 scfm	<u>11,372 scfm</u>
Digester-2B	<u>4,920 scfm</u>	N/A	2,401 scfm	1,836 scfm

Note: <u>Underlined</u> airflows are the design values.

The maximum mixing airflows are based on 40 scfm per 1,000 cubic feet multiplied by the appropriate viscosity correction factor. The process air requirement is based on 2.3 lb O2/lb Volatile Solids destruction.

Digester Blowers are not provided by Ovivo. The blowers shall be capable of providing the airflows listed in Table 2 above at 9.66 psig. It is also recommended that the blowers are on VFDs, have a 3:1 turndown ratio and have timers for automated air on/off operation to achieve nitrification and denitrification conditions.

The equipment selected for each aerobic digester is a MS® diffuser with shear tube which is similar to the equipment shown in Figure 3 above will be located in the fifteen rows of each digester spanning to 50’ dimension and is fed air from an Airbeam® Cover allowing the operator to walk to the center of the tank for sampling and observation. Ovivo’s scope shall terminate at a butterfly valve located at the end of air supply pipe feeding the Airbeam® Cover which will be located approximately 1’ inside the tank wall.

DIGESTER COVER DESIGN

To further increase the effectiveness of the sludge to retain heat during the cold climate period at the Norfolk, NE facility an aluminum Airbeam® cover shall cover all the aerobic digesters. The cover consists of flat aluminum panels while using the panel support beams as air headers.

The Airbeam® cover allows for full access to the above water orifice system resulting in no solids contact with the orifice. The airflow is completely uninhibited through the complete length of the drop pipe with no mechanical devices or swivel joints required to service the orifice.

MATERIALS OF CONSTRUCTION

Table 5 lists the proposed construction materials for the elements proposed by Ovivo.

Table 5: Materials of Construction

Item	Material
Drop Pipes	Type 304 Stainless Steel
TransMAX® / MS® Diffusers	ABS Plastic
Butterfly Valves	Cast Iron
Fasteners	Type 304 Stainless Steel
Air Supply Piping	Hot Dipped Galvanized Steel
Airbeam® Cover	Aluminum
Shear Tubes	HDPE
Digester Floor and Wall Supports	Type 304 Stainless Steel

ANCILLARY EQUIPMENT REQUIREMENTS

A mechanical thickener is required to thicken the sludge prior to digestion. The thickener should be capable of thickening sludge up to 4% solids. Sludge bypass should be provided to thin the sludge back out to the desired concentration.

SCOPE OF SUPPLY ANAEROBIC DIGESTION

TABLE No. 1
65 F1 FIXED COVER - SCOPE OF SUPPLY

Items Included
One (1) 79"Ø center ring with cover plate, flange bolts, nuts and gasket
Two (2) 36"Ø manholes with bolts, gaskets and cover flange
Two (2) 8"Ø sample tubes. Covers provided by others
Two (2) 6"Ø flanged open nozzles for PRVB assembly. Valves provided by others
Twenty-eight (28) Erection radial beams
Twenty-eight (28) Cover plates
Twenty-eight (28Anchoring assemblies including necessary anchor bolts
Seven (7) Side skirts sections with 4 ft long side sheet plates
Mild Steel construction except as noted
EZ Rect™ System
Operation and Maintenance manuals
Service as noted in the "Field Service" segment of this proposal section
FCA Factory, Freight allowed to the jobsite
Items Not Included (But Not Limited to The Following)
Gas handling equipment, unless included above
Valves, unless included above
Sample tube covers
Cover position indicators
Sight glasses
Walkways, stairs, steps, ladders, unless included above
Handrails grates, platforms, grating, unless included above
Piping, fittings, tubing and pipe supports
Coating, prime paint, field touch up or finishing painting
Flange bolts, nuts and gaskets
Grout
Insulation or Roofing
Cover sealant, filling material, caulking, oakum or asphalt
Modifications digester tank or other equipment

Installation
Testing, testing materials and / or testing equipment
Conduit, wiring, or any other control or electrical items
Any items not specifically listed in the "Items Included" table

TABLE No. 2
LM12 MIXER - SCOPE OF SUPPLY

Items Included
7.5 hp Explosion proof, 1800 rpm 230/460 V, 3 Ø, 60 Hz
Mounting plate matching mounting port bolt pattern
Seal tube
Fasteners for mounting plate, 304 stainless steel
Hydro-disk, 304L stainless steel
Lower shaft, 304L stainless steel
Drive system including: - Drive mechanism stand, - Drive mechanism enclosure, - Driver mechanism (scotch yoke design), - Driving shaft with seals, - Gearbox and motor (as listed above)
Spare Parts per Digester: - Four (4) Mixer Sliding Blocks - Two (2) Mixer Rails - Four (4) Auto Greasers - One (1) CAM Follower Assembly
Motor Control Panel: - NEMA 4X - Motor starter - Monitoring instrumentation for vibration, temperature and power draw. *Note:* - *The data collection shall be transmittable to the plant SCADA through an Ethernet gateway.* - *Wiring between instrumentation and control panel not included.*
Local control station, NEMA 7: - Hand/Off/Auto - Remote/local operation
Coating as noted in the "Surface Preparation and Painting" segment
Mild Steel construction except as noted
Service as noted in the "Field Service" segment
FCA Factory, Freight allowed to the jobsite

Items Not Included (But Not Limited To The Following)
Main control panel
VFD’s
Mixer port
Cover modifications/reinforcement
Piping, fittings, tubing and pipe supports
Digester cleaning and temporary dewatering
Wiring, conduit
Finish or field touch-up paint
Handrail, grating, ladder or any other platform item not specifically listed above
Sealant, insulation, lubricants
Unloading, storage, Installation
Any items not specifically listed in the “Items Included” table

TABLE No. 3
RDT MIXER - SCOPE OF SUPPLY

Items Included
24 inch Ø cast iron Eimix® propeller
7.5 hp Explosion proof, 1800 rpm 230/460 V, 3 Ø, 60 Hz
Drive belts and sheaves
FRP belt guard w/ fasteners
Mounting flange
Neoprene mounting gasket
Adjustable centering device
Drive shaft
Shaft housing with flow deflector
Upper / lower drive shaft bearings w/ seals
Upper / lower draft tubes
Mild Steel construction except as noted
Spare Parts per Digester: - One (1) Set of Mechanical Seal - One (1) Set of upper bearing - One (1) Set of lower bearing - Two (2) Sets of drive belts
Local On/Off/Auto control station: - NEMA 7, Remote/local operation, FWD/REV operation
Coating as noted in the "Surface Preparation and Painting" segment
Service as noted in the "Field Service" segment
FCA Factory, Freight allowed to the jobsite

Items Not Included (But Not Limited To The Following)
Main control panel
VFD's or Motor Starters
Mixer port
Cover modifications/ reinforcement
Piping, fittings, tubing and pipe supports
Digester cleaning and temporary dewatering
Wiring / conduit
Finish or field touch-up paint
Flooring walkways, stairs, steps, ladders, etc.
Sealant, insulation, lubricants
Unloading, storage
Installation
Any items not specifically listed in the "Items Included" table

TABLE NO. 4: SCOPE OF SUPPLY AEROBIC DIGESTION

The preliminary scope of supply for the Norfolk, NE M-TAD™ process is as follows:

Items Included
Aerobic Digester – 1A and Aerobic Digester -1B: - One (1) Airbeam® Cover approximately 4,100 SQFT. - Two hundred and Seventy (270) 1.5-inch diameter MS® Diffuser drops and 18" Shear Tubes. Diffuser assemblies complete with orifice adapter, stainless steel drop pipe, and lower diffuser - Thirty (30) Airbeam supports - Fifteen (15) 8-inch Butterfly Valves - One lot of 8-inch and 4-inch Air Supply Piping - Supports and fasteners as needed **Aerobic Digester – 2A and Aerobic Digester – 2B:** - One (1) Airbeam® Cover approximately 4,100 SQFT. - Two hundred and Seventy (270) 1-inch diameter TransMAX® Diffuser drops and 14" Shear Tubes. Diffuser assemblies complete with orifice adapter, stainless steel drop pipe, and lower diffuser - Thirty (30) Airbeam supports - Fifteen (15) 6-inch Butterfly Valve - One lot of 6-inch and 4-inch Air Supply Piping - Supports and fasteners as needed
Items Not Included (But Not Limited to The Following)

Vacuum break and associated piping and fittings
Yard Piping and associated fittings
Ground Supports for Yard Piping
Piping and fittings of any kind unless listed above
Air Supply Piping between tank walls and blowers
Wall sleeves or link seals
Installation
Concrete Work
Controls of any kind
Digester Blowers
Motor Starters and/or VFDs
Mechanical Thickener
Pumps of any kind
Instrumentation of any kind
Electrical Wiring
Testing and Testing materials
Valves unless specifically listed above
Hoist and Hoist Stand unless specifically listed above
Any items not specifically listed in the “Items Included” table

BUDGET INFORMATION[1]

M-TAD System	
Quantity	**One (1)**
Scope of Supply	Table No. 4
Total Price	**$6,250,000**

[1] *All prices in US Dollars.*

PROCESS CALCULATIONS

OVIVO M-TAD PROCESS DESIGN

Project Description				
Project Name:	Norfolk, NE		Proposal Number:	200206
Project Location:	Norfolk, NE		Engineer:	Jones & Henry Engineers, Ltd.
Owner:			Representative:	Waterworks Systems & Equipments, Inc
Bid Date:	06 February 2020			

	Mandatory User Input Values
	Optional User Input Values

Design Scenario:				
Sludge Load:	11579	PPD	Select PPD/GPD	Total Flow is 23,158 ppd. Flow to each train 11,579 ppd
Thickener Type:	Mechanical			

Table 1: WAS Profile				
PARAMETER		UNIT	NOTES	
Influent WAS Conc.:	3.00%	%		
Sludge Flow:	46,249	gpd	32.117 GPM	
Sludge Load:	11,579	ppd		
Volatile Fraction:	80.00%	-	Customer	

Table 2: Design Parameters				
PARAMETER		UNIT	NOTES	
Minimum Temperature:	15	degrees C		
Maximum Temperature:	30	degrees C		
Site Elevation:	1500	ft msl	Source:	Wikipedia
Design SRT:	42	days	42 Days for Min Temp 15°C and 28 days for Min Temp 20°C [HRT (neglects burn-down)]	
Design Volume:	194,765	cf	1,456,946	Gal
Actual Winter SRT:	42.4	days	Actual SRT includes burn-down of volatile solids	
Actual Summer SRT:	31.8	days	Actual SRT includes burn-down of volatile solids	

Table 4: Tank Dimensions							
TANK NAME	L/DIA.	WIDTH	HEIGHT (SWD)	Cone Height	VOLUME	VOLUME	Remark
	feet	feet	feet	feet	cubic feet	Gal	
In-Loop Digester (Digester-1)	82	50	24		98,400	736,083	
Isolated Digester (Digester-2)	82	50	24		98,400	736,083	
Total Volume					196,800	1,472,166	

Table 3: Thickener Performance				
PARAMETER			UNIT	NOTES
Influent WAS Flow:	46,249		gpd	
Influent WAS Flow:	11,579		ppd	
	WINTER	SUMMER		
Est. Thickened Conc.:	4.00%	3.00%	gpd	Winter and Summer concentrations can be different.
Thickened Flow:	34,687	46,249	gpd	
Winter Removed Flow:	11,562	0	gpd	

Table 5A: In-Loop Process Calculations (Digester 1)				
PARAMETER			UNIT	EQUATION / NOTES
WAS Volatile Fraction:	0.80		-	
WAS Volatile Solids:	9,263		ppd	Volatile Fraction * WAS Sludge Flow
	WINTER	SUMMER		
SRT:	21.21	15.91		Total SRT * (In-loop Vol./Total Vol.)
Min. Temp x SRT:	318.17	477.26	C-days	SRT * Min. Temp
Min. Volatile Solids Red.:	34.02%	39.55%	-	*per MOP 8*
	3,151	3,663	ppd	WAS Volatile Solids * Volatile Solids Reduction Percentage
Max. Finished Sludge:	8,428	7,916	ppd	WAS Sludge Flow - WAS Volatile Solids Reduced
Ave. Process Conc.:	2.91%	2.05%	-	Digested Sludge/Thickened Flow/8.34
1st Stage Volume Req'd:	98,400	98,400	cf	(Digested Sludge * SRT) / Digester Conc. / 62.4 lb/cf
(Based on Min. Temp.)	736,032	736,032	gallons	

Table 5B: Isolation Digester Process Calculations (Digester 2)				
PARAMETER			UNIT	EQUATION / NOTES
WAS Volatile Fraction:	0.80		-	
WAS Volatile Solids:	9,263		ppd	Volatile Fraction * WAS Sludge Flow
	WINTER	SUMMER		

SRT:	**21.21**	**15.91**		Total SRT * (In-loop Vol./Total Vol.)
Min. Temp x SRT:	**318.17**	**477.26**	C-days	SRT * Min. Temp
Min. Volatile Solids Red.:	**8.35%**	**6.39%**	-	*per MOP 8*
	773	**592**	ppd	WAS Volatile Solids * Volatile Solids Reduction Percentage
Max. Finished Sludge:	**7,655**	**7,324**	ppd	WAS Sludge Flow - WAS Volatile Solids Reduced
Ave. Process Conc.:	**2.64%**	**1.90%**	-	Digested Sludge/Thickened Flow/8.34
2nd Stage Volume Req'd:	**98,400**	**98,400**	cf	(Digested Sludge * SRT) / Digester Conc. / 62.4 lb/cf
(Based on Min. Temp.)	**736,032**	**736,032**	gallons	

Table 6: Air Demands

PARAMETER		UNIT	EQUATION / NOTES
Oxygen Requirement:	**2.3**	lbs O_2 / lb Volatile Solids Reduced (Nitrification included)	
AOR/SOR for In-loop Digester(Digester-1)	**0.366**	per AOR/SOR Table 8, below	
AOR/SOR for Isolation Digester (Digester-2)	**0.366**	*per AOR/SOR Table 8, below*	

Table 7: Air Flow Summary

TANK NAME	**Process Air** scfm	**Process** scfm/kcf	**Min. Mixing** scfm	**Max. Mixing** scfm	**Scouring** scfm
WINTER:					
In-Loop Digester (Digester-1)	9,781	99	1,845	4,920	NA
Isolated Digester (Digester-2)	2,401	24	1,845	4,920	NA
Total Winter Air:		14,701	scfm		
SUMMER:					
In-Loop Digester (Digester-1)	11,372	116	1,845	4,920	NA
Isolated Digester (Digester-2)	1,836	19	1,845	4,920	NA
Total Summer Air:		16,292	scfm		

EQUIPMENT BROCHURE

COST EFFECTIVE SLUDGE STABILIZATION

- Simple installation operation & maintenance
- Flexible design to suit many applications
- Variable sludge storage capabilities
- No moving parts for simplified maintenance
- 30+ year life span

Easy to insulate using commonly available roofing materials. Call us at 1.855.GO.OVIVO to learn more!

OVIVO® ANAEROBIC DIGESTER STEEL COVERS

A VARIETY OF STEEL DIGESTER COVERS

Ovivo provides a variety of steel digester covers. Each cover is constructed as a dome-shaped segment of a sphere, offering maximum strength and structural integrity. The steel digester covers are radial beam designed to be erected quickly and efficiently. A thrust ring is installed at the periphery of each cover to absorb all design loads without transmitting excessive forces to the digester wall. During erection, the cover is supported by radial beams attached to a center ring and the thrust ring which add strength to the complete unit.

Our radial beam design includes the following configurations: Fixed, Gasholder, HydroSeal® type and Buoyant steel cover. Ovivo will provide the best option for each application based on the customer needs.

Spanish Fork STP, UT (50' F1) :

Fixed Steel Cover Installation

Salt Lake City WRF, UT (90' G2VL) :

Gasholder Steel Cover Installation

Honouliuli WWTP, HI (90' G2VL):

Gasholder Steel Cover

DC WASA, DC (98.5' F2) :

Fixed Steel Cover

A NUMBER OF BENEFITS

- The use of radial beams allows the cover to be erected quickly and efficiently.
- Ovivo's cover design is compatible with all our available mixing systems to ensure adequate anaerobic digestion process.
- The covers are designed based on the requirements specified for each application, using the latest structural standards.
- A variety of accessories are available with our covers to effectively interface with the consulting engineer's design and comply with the customer requirements.

FIXED STEEL COVER (TYPE F)

The Type F cover is the most economical steel cover. The main application is on digesters with constant water level (primary or first stage digesters). The Fixed covers can be sealed against the tank to combat odors. For this design, the side sheet should be extended below the minimum liquid level. Otherwise, two options are recommended: 1) the supplier of the filler material should confirm that it can withstand the operating pressure 2) an independent clean liquid launder should be provided that allows for a pressure seal at any given sludge level (Contact Ovivo for additional details for this option).

GASHOLDER STEEL COVER (TYPE GV)

The Type GV uses the radial beam design structure with added side sheet and ballast for digester gas storage. Submerged ballast blocks are used to maximize cover stability and maintain adequate gas pressure. The design includes a vertical guide arrangement with guides attached to the tank wall. Guide devices, spanning from the top to the bottom of the cover side sheet, are engaged to stabilize the cover.

HYDROSEAL® STEEL COVER (TYPE GVL)

The separate launder and liquid seal between the digester tank and the cover eliminates gas and VOC emissions, improves service access and improves the maintenance access.

This design allows variable sludge storage capabilities since the side sheet operates independent of sludge storage in clean area. No components come in contact with the sludge.

BUOYANT STEEL COVER (TYPE B)

The Type B uses the radial beam design structure including a peripheral buoyant chamber. The cover floats directly on the digester contents. Precast concrete ballast blocks are placed to maintain a specified gas pressure. A major portion of the buoyant volume which keeps the cover afloat is located at the cover periphery; this feature provides an excellent resistance to tipping. The slide guide system will provide vertical movement without rotation or binding.

EZ-RECT™ SYSTEM

The EZ-RECT™ cover erection system is a feature with the digester cover. Ovivo offers this option to reduce the amount of field welding.

Ovivo will provide the digester cover with cover plate/radial beam sections pre-assembled and finish welding in the shop to facilitate the erection of the cover. Each assembly will consist of two (2) beams and one (1) cover plate.

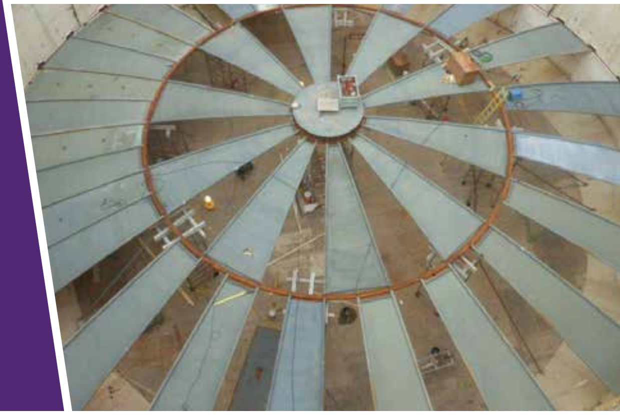
COVER ERECTION IS COMPLETED IN FIVE STEPS:

1. Side Sheet Assembly
2. Center Ring and Erection Beam Installation
3. EZ-Rect Cover Plate Assembly Installation
4. Remaining Cover Plate Installation
5. Manholes, Spools, Tubes, Etc., Installation

ANCILLARY EQUIPMENT

Ovivo can supply all plant required equipment for a complete Sludge Treatment / Anaerobic Digestion plant, including but not limited to:

- Ultrastore™ Membrane Gasholder
- Eimix® Mechanical Sludge Mixer
- LM™ Mixer
- Sonolyzer™ Ultrasound Sludge Disintegrator



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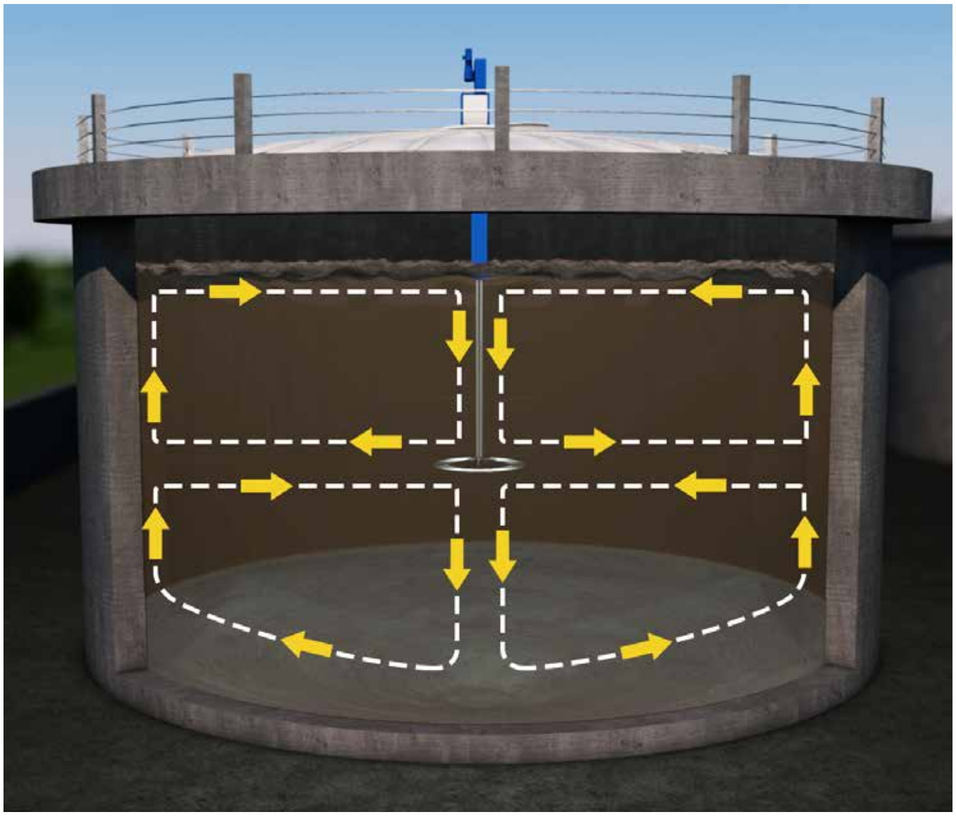
EFFICIENT LOW ENERGY SLUDGE MIXING

- Capable of mixing viscous fats, oils and greases
- Ragless design and low cost maintenance
- Significant energy savings compared to conventional mixing systems
- Installation and Capital cost savings
- Suitable for both new and existing tanks

Proven to achieve over 90% active tank volume! Give us a call at 1.855.GO.OVIVO to learn more.

LM™ MIXER



ANAEROBIC DIGESTION

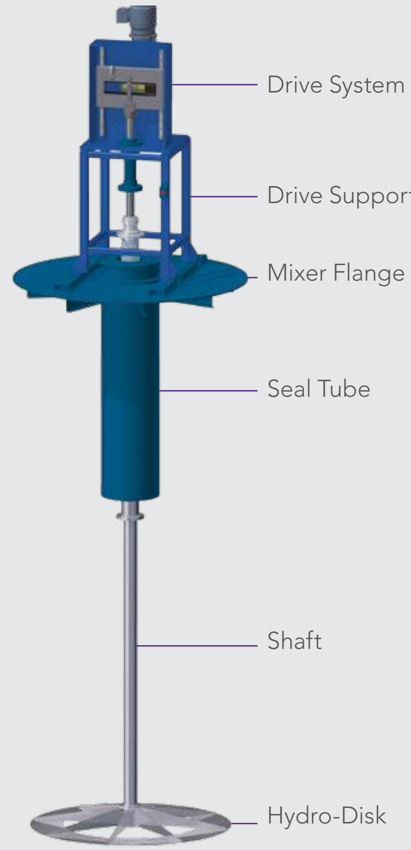
Anaerobic Digestion is highly dependent upon effective sludge mixing. When tank content is inadequately mixed, stratification occurs and the tank volume is not properly utilized. Most wastewater treatment facilities require thorough and complete mixing to ensure uniform temperature, solids distribution and microorganism contact with incoming sludge, to increase gas production and maximize the solids destruction.

MAJOR ENERGY SAVINGS

- Efficient mixing is critical; therefore, the goal is to achieve the optimal mixing efficiency with the least amount of power.
- Achieving a unique mixing pattern allows for efficient mixing while keeping the energy requirements lower (allowing for the amount saved to be used elsewhere at the plant).
- Independent full scale testing has proven the lower energy needs compared to conventional mixing systems.

ENGINEERING

DESIGNED FOR PERFORMANCE



MAIN CONFIGURATIONS FOR THE LM™ MIXER:

- Operating Speed:
  30 CPM (cycles per minute)
- Stroke Length:
  12 inches, 16 inches or 20 inches
- Disk Size:
  72 inches, 84 inches or 96 inches

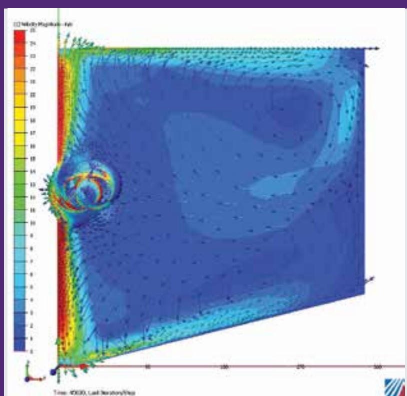
LESS HP, MORE SAVINGS

Motor Size	1 Year	5 Years	10 Years	20 Years
10HP	$4,409	$25,558	$59,258	$159,275
90HP	$39,684	$230,023	$533,319	$1,433,471
Difference	$35,275	$204,465	$474,061	$1,274,197

Assuming $ 0.09/kWh, 75% nameplate power and 3% appreciation per year

HOW IT WORKS

UNIFORM MIXING



The LM™ mixer is designed to mix the viscous slurries in order to achieve a homogeneous mixture in the tank while using less energy at the same time. The LM mixer offers solutions to the challenges of mixing wastewater in both thin and thick sludge applications.

The frequency, stroke and size of the hydro-disk control the force and velocity of the liquid core. The LM mixer's oscillating motion produces a flow pattern that approaches nearly isotropic (uniform) mixing and does not display the turbulence intensity or vortices of rotary mixers. Additionally, LM mixers operate by using pulsating pressure waves in conjunction with the oscillating velocity. In this type of concurrent action the oscillating pressure wave and velocity are coupled together to enhance mass transfer and produce a uniform mixture of the tank's contents.

Each tank configuration is different and therefore the LM mixer is custom designed to meet a variety of mixing demands by varying the frequency, stroke and disk size. Utilizing the power of Computational Fluid Dynamics (CFD), tanks can be modeled and analyzed for proper mixer sizing.

KEY BENEFITS

EFFICIENT MIXING TO HELP IMPROVE THE DIGESTION PROCESS

- Does not rely on induced flow to create the necessary mixing.
- Rags do not build up on disk
- Uniform mixing throughout the tank

PROVEN TECHNOLOGY

- Multiple LiCl tests performed by third parties demonstrate an active volume of 90% or greater.

INSTALLATION COST SAVINGS

- Installation of a single mixer can be completed in a day or less.
- No additional piping needed.
- No core drilling necessary

SUITABLE FOR BOTH NEW AND EXISTING TANKS

- Little to no changes are needed on existing structures

THE **OVIVO** DIFFERENCE

200+ YEARS OF HERITAGE • 100% FOCUSED ON WATER

OUR EXPERTISE

Anaerobic Digestion is highly dependent upon effective sludge mixing. Ovivo sludge mixers are designed to provide powerful mixing, without accumulating stringy or fibrous material. Highly efficient and featuring low maintenance requirements, they can be used for existing or new digesters. Their configuration is adpated to suit best the specific tank design and application.

ANCILLARY EQUIPMENT

Ovivo can supply all plant required equipment for a complete Sludge Treatment / Anaerobic Digestion plant, including but not limited to:

- Ultrastore™ Membrane Gasholder
- Eimix® Mechanical Sludge Mixer
- Ovivo® Anaerobic Digester Steel Cover
- Sonolyzer™ Ultrasound Sludge Disintegrator

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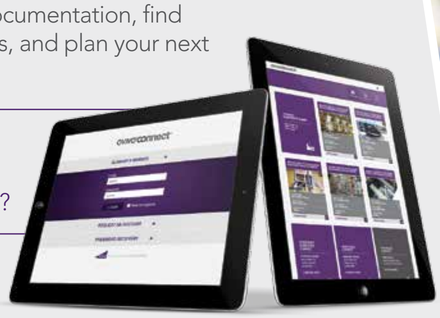

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MUNICIPAL WATEWATER
ANAEROBIC DIGESTION

AUTOMATIC TROUBLE-FREE, EFFECTIVE SLUDGE MIXING

- Ease of operation and maintenance
- Heat exchanger jacket compatibility
- Ragless propeller design
- Improved uptime & long continuous service periods
- Removable mixing mechanism to avoid de-gassing or de-watering the digester

Interested in preventing fouling while retaining high efficiency? Call us at 1.855.GO.OVIVO to learn more!

EIMIX® MECHANICAL SLUDGE MIXER

DC WASA, DC: (5) RDT-T-25-36

Largest RDT-T In USA

ANAEROBIC DIGESTION

Anaerobic Digestion is highly dependent upon effective sludge mixing. When tank content is inadequately mixed, stratification occurs and the tank volume is not properly utilized. Most wastewater treatment facilities require thorough and complete mixing to ensure uniform temperature, solids distribution and microorganism contact with incoming sludge, to increase gas production and maximize the solids destruction.

Reversing motor

BUT WHY CHOOSE THE EIMIX® MIXER?

MECHANISM

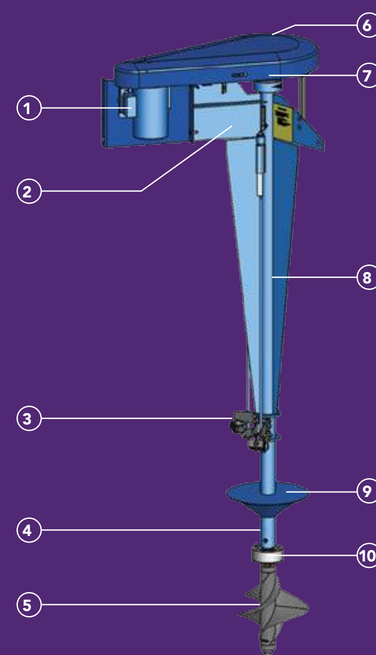
- Eimix® ragless propellers have been designed to run clean without accumulation of stringy and fibrous material. This design prevents fouling while retaining high efficiency and low maintenance requirements.
- Positive Lower Lubrication:
  - Oil lubrication provides a positive pressure to the lower bearing
  - Dipstick for manual inspection and monitoring
  - Electronic oil level sensor available (SCADA compatible)
- Upper bearing is located well above liquid level, next to the motor, with the lower bearing next to the propeller. This increases bearing span and minimizes overhung loads for extended bearing life.

BENEFITS

- Use of a reversing motor enables to pump sludge with equivalent capacity in both directions, which maximizes system flexibility by altering mixing dynamics.
- Mixer assembly can be removed without dewatering or degassing the digester.

ENGINEERING

DESIGNED FOR PERFORMANCE



1. Reversible, Explosion-Proof, Inverter Duty Motor
2. Oil Dipstick
3. Adjustable Centering Device
4. Lower Shaft Housing
5. EIMIX® Ragless Reversible Propeller
6. Belt Guard (FRP / Stainless Steel)
7. Upper Bearing
8. Upper Shaft Housing
9. Flow Deflector
10. Mechanical Seal and Lower Bearing

DRAFT TUBE MIXERS

- Internal roof mounted (RDT) or external (EDT) draft tube design.
- Available for installation on existing, new, primary or secondary digesters.
- One or more units can be installed to suit specific mixing needs.
- Optional heat exchanger jackets reduce maintenance, installation and operational costs while providing effective, uniform heating for the digester.

EIMIX® RDT TYPE MIXERS

Mounted on the tank cover, this design allows the upper draft tube and mixer mechanism to be easily removed.

One or more RDT mixers can be distributed across the tank or can be installed in conjunction with an EDT mixer for additional scum breaking and mixing capacity.

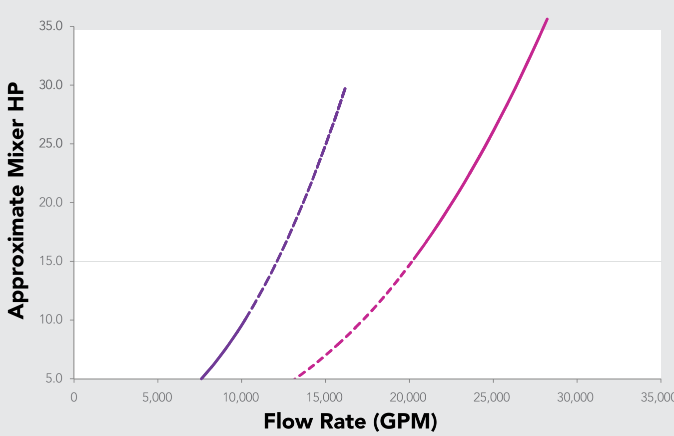
EIMIX® EDT TYPE MIXERS

Easy access for maintenance is achieved by mounting the mixer outside of the tank.

Maximum energy input occurs at the periphery of the tank near the surface and at the bottom of the tank, creating a tangential, spiral flow pattern within the tank. Includes a maintenance platform for easy access.

HONOULIULI WWTP, HI:
(3) EDT-TJ-10-24

CERTIFIED CURVES



24" PROPELLER
- < 10 hp (Recommended)
- > 10 hp

36" PROPELLER
- < 15 hp (Recommended)
- > 15 hp

The Eimix propellers are offered in two diameters:

- 24" diameter, typically recommended for mixers between 5 and 10 hp
- 36" diameter, typically used for mixers greater than 15 hp.

This performance graph included the pump up operation. Ovivo's design offers equivalent capacity.

THE **OVIVO** DIFFERENCE

200+ YEARS OF HERITAGE • 100% FOCUSED ON WATER

ATOTONILCO PTAR, MEXICO:
(1) RDT-T-75-36 with over 60' long Draft tubes.

OUR EXPERTISE

Anaerobic Digestion is highly dependent upon effective sludge mixing. Ovivo sludge mixers are designed to provide powerful mixing, without accumulating stringy or fibrous material. Highly efficient and featuring low maintenance requirements, they can be used for existing or new digesters. Their configuration is adpated to suit best the specific tank design and application.

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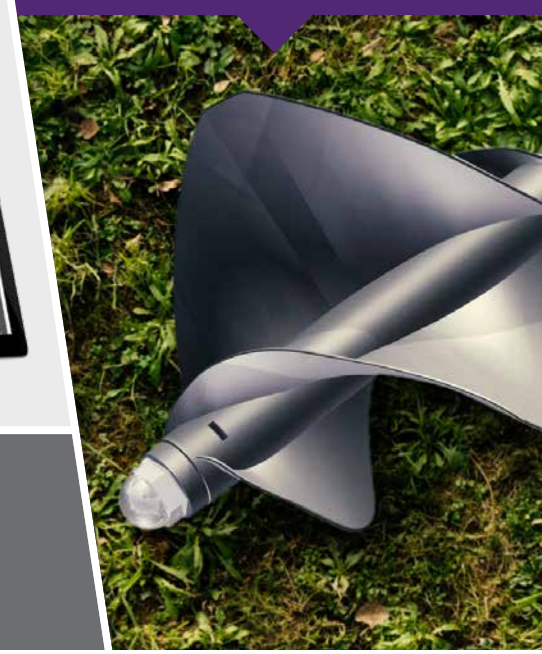
EIMIX® RAGLESS PROPELLER



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AEROBIC
DIGESTION

M-TAD™ Process

Mechanically thickened aerobic digestion

What are your needs?

- Class B biosolids
- Compact footprint
- Convert anaerobic digestion to aerobic digestion
- Smaller sludge volumes for disposal

Key Benefits

- Lowers cost of anaerobic digester retrofits
- Minimizes footprint of new construction or expands capacity of existing tanks
- Enhanced pH and temperature control
- Minimizes operator intervention

ovivowater.com

OVIVO® Bringing water to life®

Description

The M-TAD™ (Mechanically Thickened Aerobic Digestion) system is a controlled aerobic digestion system specifically designed to handle sludges produced by mechanical thickeners such as gravity belts or rotary drums.

Do you have existing thickening equipment? Are you interested in converting from anaerobic digestion to aerobic digestion? Do you need to meet Class B biosolids requirements? If you answered yes to any of these questions then an Ovivo M-TAD system may be right for you. The M-TAD system is specifically designed to handle the high viscosity created by the polymer addition of mechanical thickening devices such as gravity belt or rotary drum thickeners.

Overcoming mixing and aeration problems with equipment designed specifically to handle viscous sludge up to 5% TS

- Meets 503 regulations in a reduced footprint
- Enhanced pH and temperature control
- Increased SRT in existing basins
- Enhanced nutrient removal
- Affordably retrofit anaerobic digesters

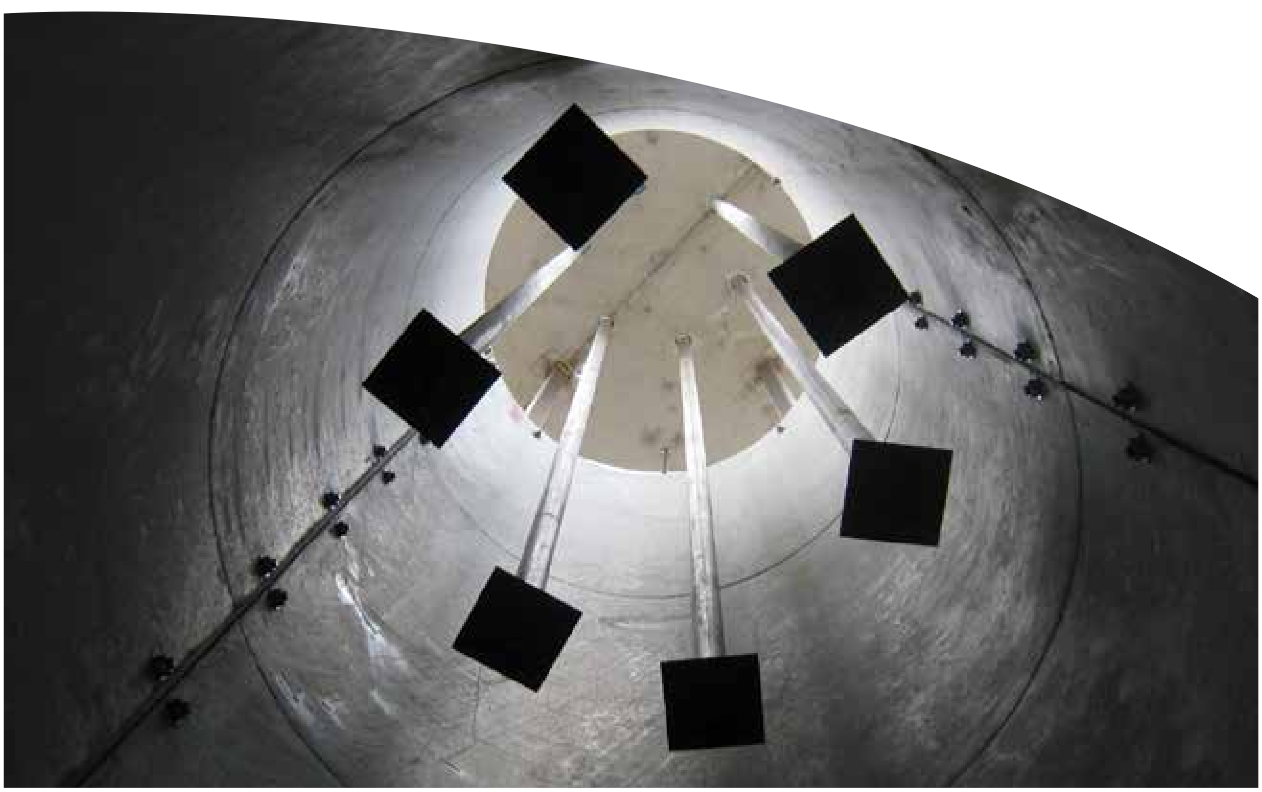
How It Works

The M-TAD aerobic digestion system consists of a mechanical thickening device feeding pre-thickened sludge at 3%-5% total solids concentration to two or more aerobic digester basins operating in either series or parallel mode. The M-TAD process has the primary advantage of reducing the volume of sludge to be digested. For existing digesters, this provides three to eight times more solids retention time. For new digesters, the required design volume is reduced.

In addition, the thickened sludge will reach a higher temperature during digestion, increasing the reaction rate of digestion and potentially further reducing the required digester volume.

For a typical waste activated sludge feed, the digesters operate in series. Multiple digesters provide optimum pathogen destruction and volatile solids reduction. Due to the nature of the digestion process, most of the digestion takes place in the first digester. This digester requires the most oxygen and will achieve the majority of the volatile solids reduction. When thickened sludge is fed to the aerobic digester as much as 80% of the total oxygen requirement is in the first digester.

The second digester achieves the remaining volatile solids and pathogen reduction. A third digester, when used, is isolated from any untreated sludge and serves mainly as a polishing basin.



Anaerobic to aerobic

The Ovivo M-TAD system can offer those looking to retrofit anaerobic digesters value that other aerobic digestion technologies can't. Whereas bottom mounted diffuser systems necessitate the cone of the anaerobic digesters to be filled, our unique single drop diffuser allows the cone bottom to remain in place. This provides additional aerobic digestion process volume and lowers construction costs. All of this while being backed by Ovivo's Class B guarantee.

OVIVO® CONNECT℠

Get Connected! Like all Ovivo equipment, your new M-TAD™ process will provide you with access to the Ovivo® Connect℠ portal, our innovative client resource application.

- Need access to your O&M Manual?
- Needs spare parts?
- Want the latest tips and news on your product?

Just scan the QR Code, or type-in the URL featured on the nameplate, to access dedicated web pages that will help you maintain and optimize your plant and your Ovivo equipment!

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AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

NORFOLK WPC EXP NE

Design# 159105
Option: Preliminary AGS Design

AquaNereda®

Aerobic Granular Sludge System

January 24, 2020
Designed By: Sara Altimimi

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Pre-AGS

- Screening (by others) is required ahead of the AquaNereda system, with an opening of 6mm depending upon the characteristics of the screen. Punched hole or wire mesh up to 6 mm is preferred.

- It is assumed that there will be reduction in FOG prior to the AGS system as required to maintain a low concentration of FOG in the system. Acceptable levels are approximately 60 mg/l on a daily average basis (based on a 24-hour composite sample.)

- Neutralization is required ahead of the AquaNereda system if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Coarse solids removal is recommended prior to the AquaNereda System.

- Elevated concentration of Hydrogen Sulfide can be detrimental to both civil and mechanical structures. If anaerobic conditions exist in the collection system, steps should be taken to eliminate Hydrogen Sulfide prior to the treatment system.

Flow

- The maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

Aeration

- The aeration system has been designed to provide 1.25 lbs. O2/lb. BOD5 applied and 4.6 lbs. O2/lb. TKN applied at the design average loading conditions.

Process/Site

- An elevation, ambient and waste temperature has been given as displayed on the design.

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- It is assumed that there are no substances in the influent stream that would be inhibitory for a biological system.

- To achieve the effluent monthly average total phosphorus limit, the biological process and chemical feed systems need to be designed to facilitate optimum performance.

- A minimum of twelve (12) daily composite samples per month (both influent and effluent) shall be obtained for total phosphorus analysis.

- Influent to the biological system is a typical municipal wastewater application with a TP range of 6–8 mg/l. Influent TP shall be either in a particle associated form or in a reactive soluble phosphate form or in a soluble form that can be converted to reactive phosphorus in the biological system. Soluble hydrolyzable and organic phosphates are not removable by chemical precipitation with metal salts. A water quality analysis is required to determine the phosphorus speciation with respect to soluble and insoluble reactive, acid hydrolyzable and total phosphorus at the system influent, point(s) of chemical addition, and final effluent.

- Chemical feed lines (i.e. metal salts) shall be furnished to each reactor, aerobic digester and dewatering supernatant streams as necessary. Metal salts shall be added to each reactor during the React phase of the cycle.

- pH monitoring of the biological reactor is required when adding metal salts.

Equipment

- The basins are not included and shall be provided by others.

- A minimum freeboard of 2.0 ft is recommended for diffused aeration.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

- VFDs for all motors are to be provided by others. MCC to be provided by others.

- AquaNereda is a proprietary technology; in order to protect this technology some additional safeguards are typical. At time of plans and specification development typically a Non Disclosure Agreement is required between Aqua-Aerobic and the Consulting Engineer. At time of project execution the End User is required to sign an End User Agreement which includes non disclosure obligations and limits distribution of the granules.

- The basin dimensions reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square, and rectangular with construction materials including concrete, or steel.

Influent Buffer - Design Summary

INFLUENT BUFFER DESIGN PARAMETERS

Avg. Daily Flow:	= 8.47 MGD	= 32,062 m3/day
Max. Daily Flow:	= 12.32 MGD	= 46,636 m3/day
No. of AGS Reactors:		= 3

INFLUENT BUFFER VOLUME DETERMINATION

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

INFLUENT BUFFER BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)	
Max. Basin Vol. Basin:	= 1,312,935 gallons	= (4,970.0 m³)

INFLUENT BUFFER EQUIPMENT CRITERIA

Max. Flow Rate Required Basin:	= 16,130 GPM	= (3,710 m³/hr)
Avg. Power Required:	= 819 kWhr/day	

AquaNereda - Aerobic Granular Sludge Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow	= 8.47 MGD	= 32,062 m3/day
Max Design Flow	= 12.32 MGD	= 46,636 m3/day

DESIGN PARAMETERS	Influent	mg/l	Effluent Required	<= mg/l	Effluent Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	BOD5	432	BOD5	10	BOD5	10
Total Suspended Solids:	TSS	220	TSS	10	TSS	10
Total Kjeldahl Nitrogen:	TKN	30	TKN	--	TKN	--
NH3-N	--	--	NH3-N	1.0	NH3-N	1.0
Total Nitrogen:	--	--	TN	10.0	TN	10.0
Phosphorus:	Total P	9	Total P	1.0	Total P	1.0

SITE CONDITIONS	Maximum		Minimum		Design		Elevation (MSL)
Ambient Air Temperatures:	85 F	29.0 C	30 F	-1.0 C	85 F	29.0 C	1,510 ft
Influent Waste Temperatures:	68 F	20.0 C	50 F	10.0 C	50 F	10.0 C	460.0 m

AGS BASIN DESIGN VALUES

			Water Depth			Basin Vol./Basin	
No./Basin Geometry:	3 Rectangular Existing Basin(s)		**Process Level (PWL):**	17.1 ft	(5.20 m)	1.55 MG	(5,859 m³)
Freeboard (from PWL):	2.0 ft	(0.6 m)	**Discharge Level (DWL):**	18.2 ft	(5.60 m)		
Length of Basin:	110.0 ft	(33.5 m)					
Width of Basin:	110.0 ft	(33.5 m)					

Cycle Duration:	= 4.8 Hours/Cycle
Food/Mass (F/M) ratio:	= 0.099 lbs. BOD5/lb. MLSS-Day
MLSS Concentration:	= 8000 mg/l
Hydraulic Retention Time:	= 0.53 Days
Solids Retention Time:	= 14.50 Days
Est. Net Sludge Yield:	= 0.38 lbs. WAS/lb. BOD5
Est. Dry Solids Produced:	= 21735.0 lbs. WAS/Day
Lbs. O2/lb. BOD5	= 1.25
Lbs. O2/lb. TKN	= 4.60
Actual Oxygen Required:	= 47894 lbs./Day
Air Flowrate/Basin:	= 5452 SCFM
Max. Discharge Pressure:	= 9.18 PSIG
Avg. Power Required:	= 7486 KW-Hrs/Day

Sludge Buffer - Design Summary

SLUDGE BUFFER DESIGN VALUES

No./Basins Geometry:	= 2 Rectangular Basin(s)	
Max Water Depth:	= 10.0 ft	= (3.0 m)
Max Basin Vol. Basin	= 108,517 gallons	= (411 m³)
Length of Basin:	= 36.3 ft	= 11.1 m
Width of Basin:	= 40.0 ft	= 12.2 m

SLUDGE BUFFER VOLUME DETERMINATION

The sludge buffer volume has been determined based on the sludge production and the concentration of sludge from the AquaNereda reactors. The Sludge from this basin will be pumped to the sludge handling system, and the supernatant back to the head of the plant.

SLUDGE BUFFER EQUIPMENT CRITERIA

Max. Sludge Flow Rate Required:	= 561 gpm	= (129 m³/hr)
Max. Supernatant Flow Rate Required:	= 2,243 gpm	= (516 m³/hr)
Avg. Power Required:	= 187 kW-hr/day	

Post-Equalization - Design Summary

POST-EQUALIZATION DESIGN PARAMETERS

Avg. Daily Flow (ADF):	= 8.47 MGD	= (32,062 m^3/day)
Max. Daily Flow (MDF):	= 12.32 MGD	= (46,636 m^3/day)
Decant Flow Rate from (Qd):	= 16,106 gpm	= (3,704 m^3/hr)
Decant Duration (Td):	= 40 min	

POST-EQUALIZATION VOLUME DETERMINATION

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua-Aerobic. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

POST- EQUALIZATION BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)	
Max. Basin Vol. Basin:	= 464,197 gal	= (1,757 m^3)

POST- EQUALIZATION EQUIPMENT CRITERIA

Max. Flow Rate Required Basin:	= 9,401.7 gpm	= (2,162.4 m^3/hr)

AquaNereda: Influent Buffer

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Submersible pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

AquaNereda

Influent Valves

3 Influent valve(s) will be provided as follows:

- 36 inch electrically operated knife gate valve(s).

Influent Distribution System

3 Influent Distribution Assembly(ies) consisting of:

- Influent distribution system consisting of HDPE and PVC pipe with supports.

Effluent Weir Assembly

3 Effluent Weir Assembly(ies) consisting of:

- Concrete main effluent channel(s) provided by others.
- Stainless steel weir assembliy(ies) with supports.

Sludge Removal System

3 Solids Waste System(s) consisting of:

- Stainless steel solids waste system(s).
- 4 inch electrically operated butterfly valve(s) with actuator.
- 30 inch electrically operated butterfly valve(s).

Fixed Fine Bubble Diffusers

3 Fixed Fine Bubble Diffuser Assembly(ies) consisting of:

- 304 SS, 12 Ga. drop pipe(s).
- PVC, Sch 40 Manifold(s) with connection to drop pipe.
- PVC, Air distributor(s) with connection to the manifold and required PVC pipe joint connections.
- 304 Stainless steel piping supports with vertical supports, clamps, adjusting mechanism and anchor bolts.
- Fine bubble diffuser assemblies.
- 12" manual butterfly valve(s).

Positive Displacement Blowers

6 Positive Displacement Blower Package(s), with each package consisting of:

- Aerzen 150HP Rotary Positive Displacement Blower(s)
- 10" manual butterfly valve(s)

Air Valves

3 Air Control Valve(s) will be provided as follows:

- 30 inch electrically operated butterfly valve(s).
- Auma actuator will be upgraded from open/close service to modulating service.
- Air flow meter(s).

Level Sensor Assemblies

3 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

3 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Instrumentation

1 Process Control System will be provided as follows:

Instrumentation including sensors and/or analyzers along with mounting assemblies shall be provided to measure the following for the AquaNereda basin(s):
- Dissolved Oxygen
- pH
- ORP
- TSS
- Nitrate
- Ammonium
- Phosphorus

Instrumentation including sensors and/or analyzers along with mounting assemblies shall be provided to measure the following for the Sludge Buffer basin(s):
- TSS

- Air cleaning system(s).
- Controller(s).

AquaNereda: Post-Equalization

Level Sensor Assemblies

1 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

AquaNereda: Sludge Buffer

Transfer Pumps/Valves

2 Sludge/Supernate Valve(s) consisting of the following items:

- 14 inch electrically operated plug valve(s).
- 10 inch electrically operated plug valve(s).
- 8 inch diameter Milliken 601 electrically operated eccentric plug valve(s) with 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, EPDM coated ductile iron plug, assembled and tested with an Auma, 115 VAC, 60 hertz, single phase open/close service electric actuator. Valve actuator includes compartment heater.

5 External Pump Assembly(ies) consisting of the following items:

- 20HP Pump assembly(ies).

- 6" Manual plug valve(s).
- 6 inch diameter swing check valve.

Sludge Removal System

2 Solids Removal Assembly(ies) consisting of:

- Solids removal assembly(ies) consisting of PVC and/or HDPE pipe with supports.

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Submersible pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

AquaNereda: PLC Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Compactlogix Processor.
- Operator interface(s).
- Remote Access Ethernet Modem.

Brittni Yates

From: Brittany Travers <brittany@e-equipmentsolutions.com>
Sent: Tuesday, February 4, 2020 3:19 PM
To: Brittni Yates
Cc: Angel Lowery; Kevin Rood; Gabe Meidl
Subject: FW: Norfolk WPC EXP, NE #104487B - Preliminary Design Report
Attachments: 2020-01-29 Preliminarry Design AGS Report 159105.pdf; 2020-01-27 Preliminary Design SBR Report 159076.pdf

Hi Brittni,

Please find attached the preliminary design from Aqua Aerobic Systems (Design #159076 and #159105) for the Norfolk WPC EXP project in NE.

Design #159076, SBR Option:

The design is able to process an average flow of 8.47 MGD and a maximum flow of 12.32 MGD. When flows are in excess of the maximum daily flow, the SBR system has been designed to advance cycles in order to process a peak hydraulic flow of 14.25 MGD. With that, we recommend adding two (2) 110 ft. x 110 ft. AquaSBR®, Sequencing Batch Reactors, along with the four (4) existing basins for a six (6) basin system. We have also included one (1) 110 ft. x 50 ft. post-equalization basin.

Preliminary pricing for the system, including freight to the job site and our standard start-up supervision services, is **$3,599,515.** Please note that as requested we have incorporated all new equipment for all the basins.

Design #159105, Nereda Option:

As requested, we have provided a Nereda Design for this project to handle the 2040 flows and loadings. We recommend retrofitting the existing three (3) 110 ft. x 110 ft. basins into AGS basins. An influent buffer with a capacity of 1,312,935 gallons and a post-equalization with a 464,197 gallon capacity would be required.

In addition, we have also included two (2) 108,517 gallons sludge buffer tank for thickening the WAS from the AGS reactors to 8,000-10,000 mg/l, prior to the solids handling system.

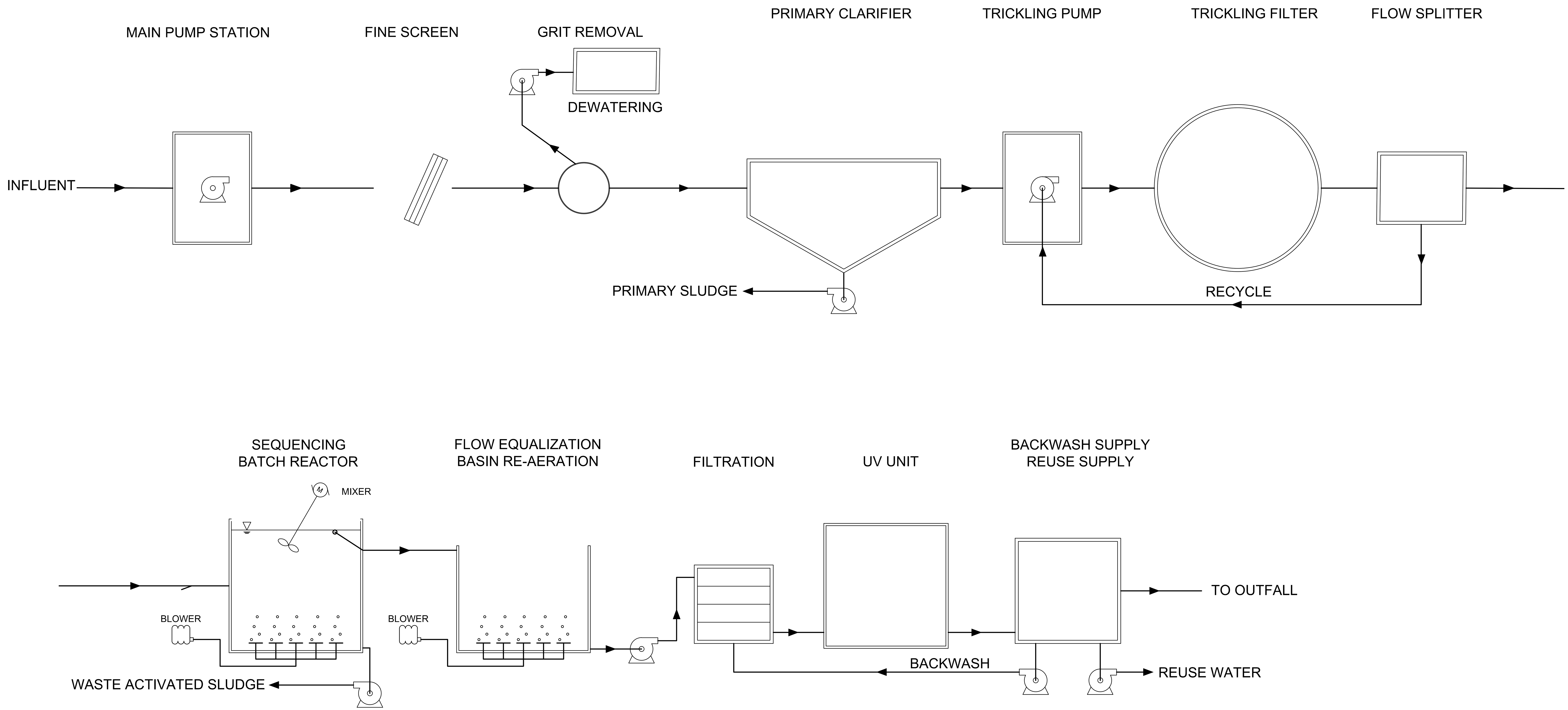
Preliminary pricing for the system, including freight to the job site and our standard start-up supervision services, is **$9,796,440.**

Please do not hesitate to contact us if you have any questions or need additional information.

Brittany Travers | Engineered Equipment Solutions
Clocktower Village | 643 N 98th St, MB 145 | Omaha, NE 68114
Cell 402-880-0321 | Fax 888-421-2856 | IA office: 641-483-2904
brittany@e-equipmentsolutions.com
www.e-equipmentsolutions.com

APPENDIX G

Future Water Pollution Control (WPC) Treatment and Sludge Alternatives – Process Flow Diagrams



olsson
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TEL 402.474.6311
www.olsson.com

REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

TREATMENT ALTERNATE 1 [T-A1]

NORFOLK WPC FACILITY

NORFOLK, NE

2020

drawn by:
checked by:
approved by:
QA/QC by:
project no.:
drawing no.:
date:

SHEET

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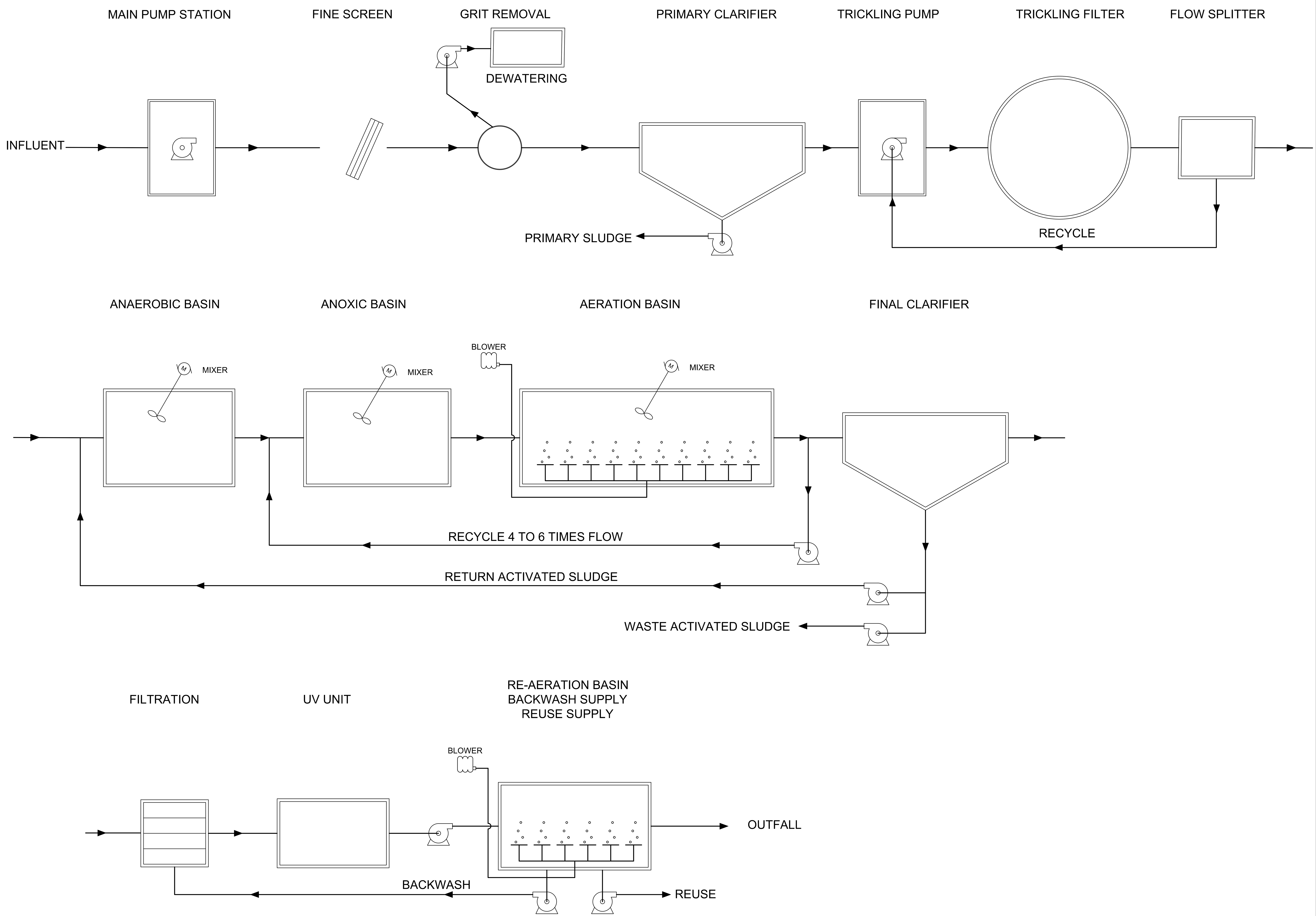

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REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

TREATMENT ALTERNATE 2 [T-A2]

NORFOLK WPC FACILITY

2020

NORFOLK, NE

drawn by:
checked by:
approved by:
QA/QC by:
project no.:
drawing no.:
date:

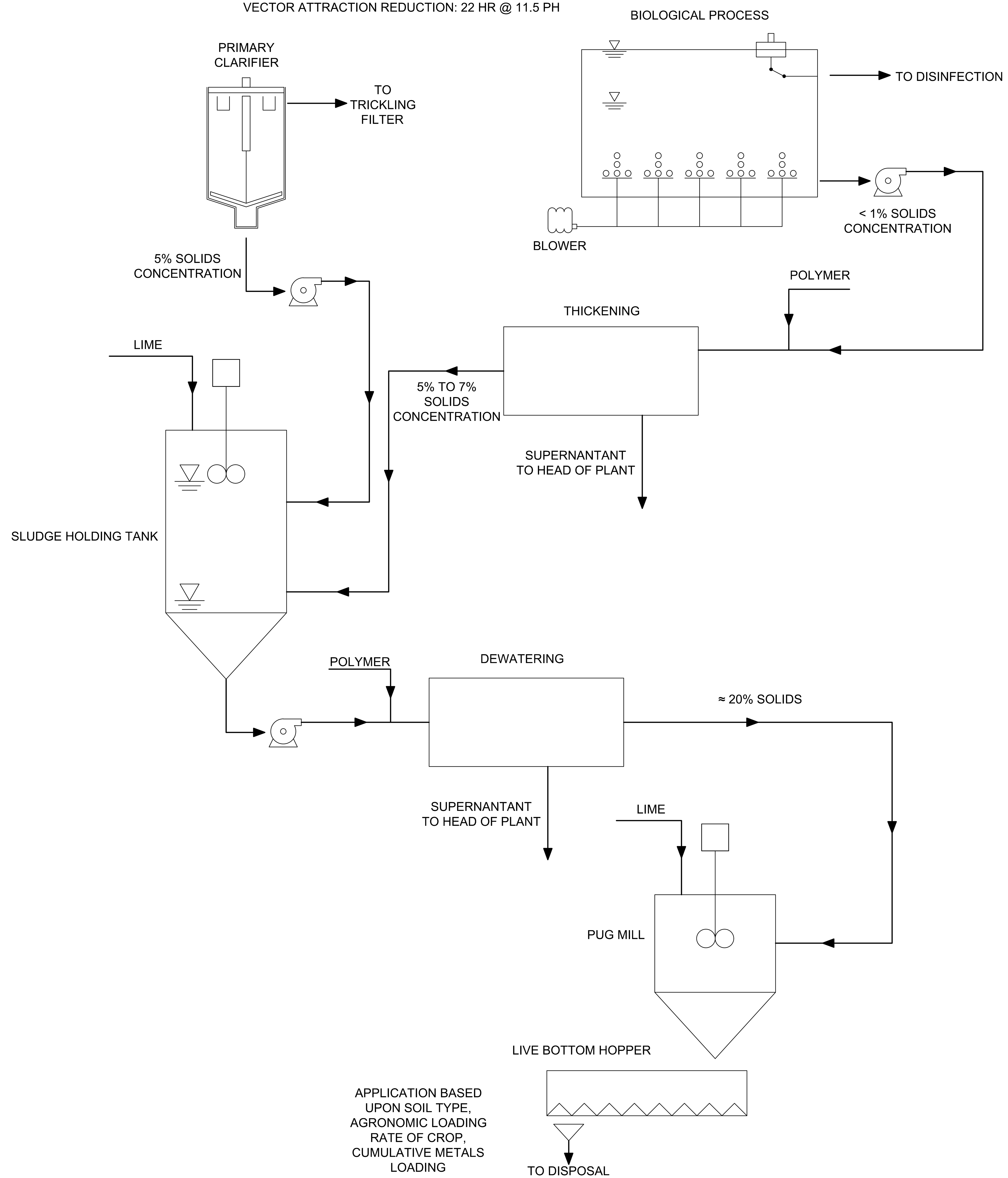
SHEET

DWG: C:\Temp\AcPublish_16620\P_PFD_0191256.dwg USER: gmeidl
DATE: Feb 04, 2020 11:56am XREFS: P_PTBLK_40742 TBLK TBLK-0191256

PH ADJUSTMENT

PSRP - CLASS B: 2 HR @ 12 PH

VECTOR ATTRACTION REDUCTION: 22 HR @ 11.5 PH



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REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

SOLIDS PRODUCTION ALTERNATE 1 [SP-A1]

NORFOLK WPC FACILITY

2020

NORFOLK, NE

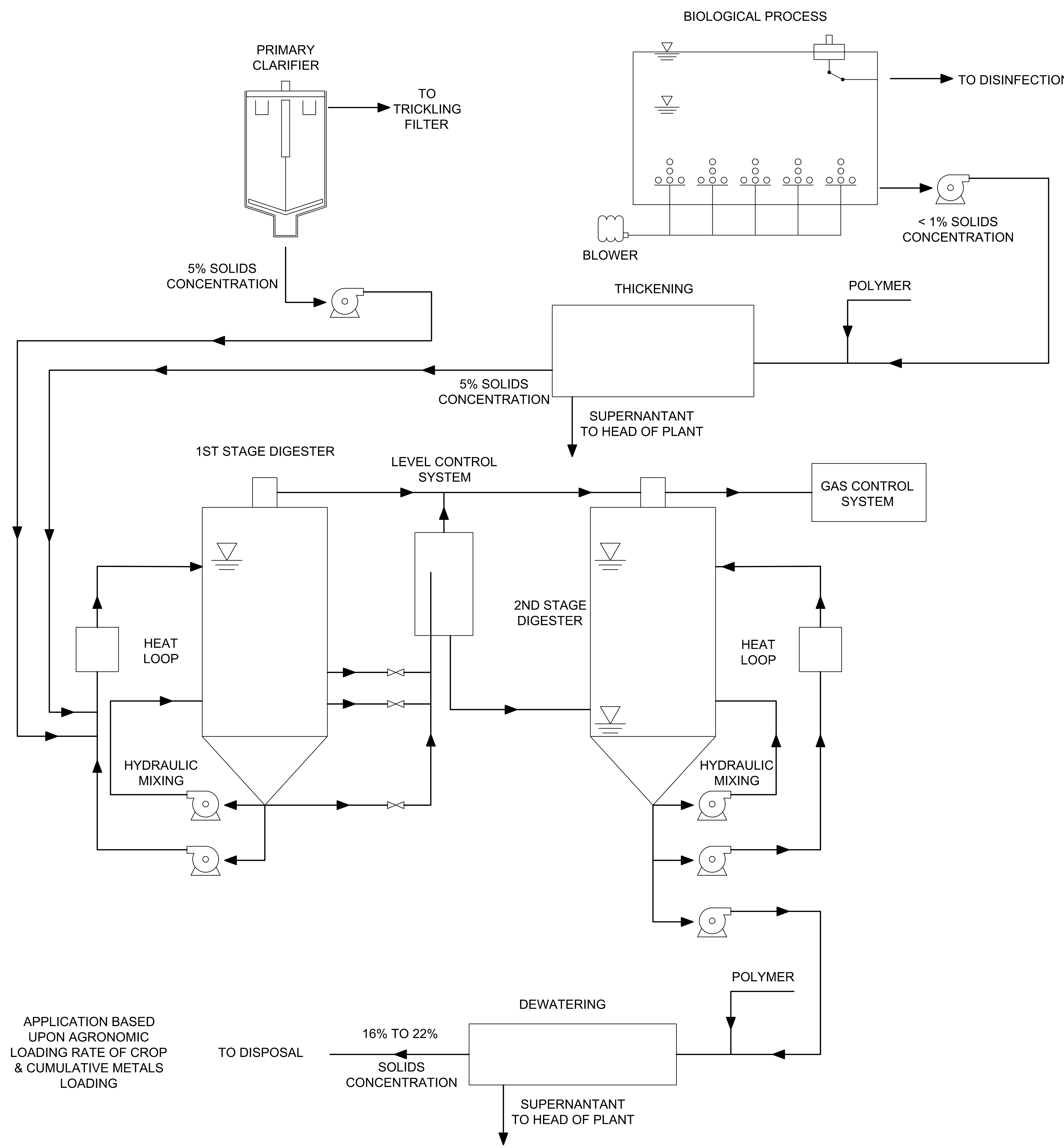
drawn by:
checked by:
approved by:
QA/QC by:
project no.:
drawing no.:
date:

SHEET

DWG: C:\Temp\AcPublish_16620\P_PFD_91256.dwg USER: gmeidl TBLK-0191256
DATE: Feb 04, 2020 11:58am XREFS: TBLK W_PTBLK_0193351

ANAEROBIC DIGESTION

15 DAYS HYDRAULIC DETENTION TIME MINIMUM
<160 LBS VSS/1000 FT ORGANIC LOADING RATE



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REV. NO.	DATE	REVISIONS DESCRIPTION

SOLIDS PRODUCTION
ALTERNATE 2 [SP-A2]

NORFOLK WPC FACILITY

2020

NORFOLK, NE

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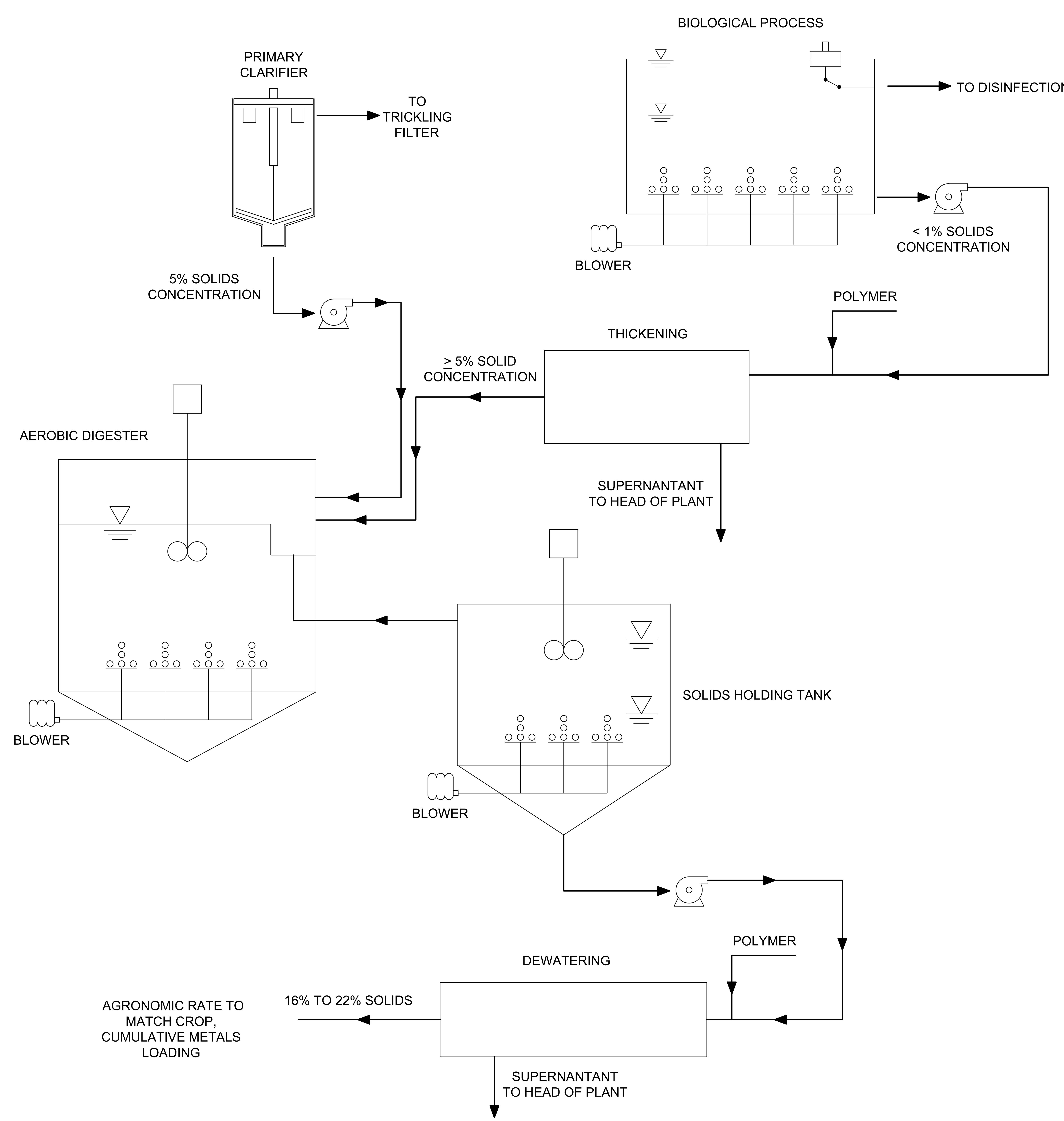
DATE: Feb 04, 2020 11:58am XREFS: TBLK W_PTBLK_0193351

AEROBIC DIGESTION

PSRP: 40 DAYS AT 20°C

VECTOR ATTRACTION REDUCTION: 38% REDUCTION IN VOLATILE SOLIDS



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REVISIONS

REV. NO.	DATE	REVISIONS DESCRIPTION

SOLIDS PRODUCTION
ALTERNATE 3 [SP-A3]

NORFOLK WPC FACILITY

NORFOLK, NE

2020

drawn by:
checked by:
approved by:
QA/QC by:
project no.:
drawing no.:
date:

SHEET

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DATE: Feb 04, 2020 11:58am XREFS: TBLK W_PTBLK_0193351 TBLK-0191256

APPENDIX H

Summary of Recommendations

Facility Name	Project Type			Improvement Description	Detailed Recommendation	Driver(s)				Discipline(s)				Cost Breakdown			Total Cost
	Major	Minor	O&M			Condition	Age	Safety	O&M	Process	Structural	Mechanical	Electrical / I&C	5-Year	10-Year	20-Year	
Influent Diversion Structure		X		Concrete Repair	Implement thin/minor concrete repairs to prevent further concrete damage/deterioration.	X	X			X	X				$ 2,500		**$ 2,500**
		X		Paint Touchup	Paint should be touched up to prevent deterioration of metal components.	X	X			X	X				$ 1,000		**$ 1,000**
		X		Remove Abandoned Slide Gates	Abandoned slide gates should be removed.				X	X	X				$ 1,500		**$ 1,500**
			X	Operations Program	Care should be taken to exercise the gates on a regular basis to keep them in good working order.	X			X	X					N/A		N/A
Bar Screen Building		X		Insulation	Reinsulate building to prevent premature mortar deterioration.	X	X				X				$ 3,500		**$ 3,500**
		X		vg	Reevaluate if HVAC system sized properly to provide enough heat to keep the equipment from freezing in the winter.	X						X		$ 500			**$ 500**
		X		Replace LEL Gas Detector	The LEL gas detector unit does not work and has been turned off. This should be replaced immediately.	X		X					X	$ 2,500			**$ 2,500**
South Lift Station		X		Seal sidewalk	Seal and caulk at gap between sidewalk and building on westside.				X		X			N/A			N/A
North Lift Station	X			Upgrade Project	The gate valves, check valves, piping, and wall connections need to be replaced immediately. During project, exposed wiring and addressing electrical code violations should be addressed.	X	X	X	X	X	X		X	$ 280,000			**$ 280,000**
	X			**Electrical Upgrades**	Overall electrical upgrades throughout LS	X						X		$ 75,000			**$ 75,000**
	X			Fan Belt	The fan simply has a broken belt, but more extensive HVAC updates may be required	X						X		$ 50,000			**$ 50,000**
Grit Removal / Pre-Aeration Basins	X			Replacement	Replacement of the Grit Removal system	X	X			X				$ 2,385,000			$ 2,385,000
Primary Clarifier #1	X			Upgrade Project	Replace clarifier mechanism.		X			X							
Primary Clarifier #2	X			Upgrade Project	Replace clarifier mechanism and drive.					X				$ 150,000			**$ 150,000**
			X	Monitor Concrete	Monitor vertical Cracking			X	X		X			N/A			N/A
Primary Clarifier #3	X			Upgrade Project	Replace clarifier mechanism and drive.					X					$ 150,000		**$ 150,000**
			X	Monitor Concrete	Monitor vertical cracking			X	X		X			N/A			N/A
Sludge Handling Building		X		MAU	MAU hoods and insulation showing corrosion and will need to be replaced	X						X		$ 25,000			**$ 25,000**
		X		Facility Improvements	Damage to brick veneer should be repaired in truck bay.	X					X			$ 5,000			**$ 5,000**
		X		Facility Improvements	Relocate Bollards to prevent further damage.			X			X			$ 5,000			**$ 5,000**
		X		CKD	CKD feed components should be recoated, and screw replaced	X				X					$ 15,000		**$ 15,000**
	X			Belt Filter Press	Komline Belt Filter Press to be rebuilt										$ 250,000		$ 250,000
			X	Operations Program	West backflow preventer and the booster pump are leaking				X		X			N/A			N/A
			X	Facility Improvements	Replace lighting in Polymer Feed Room				X		X			N/A			N/A
			X	Facility Improvements	Electrical rehab, MCC wiring	X							X		$ 100,000		**$ 100,000**
Sludge Pumping Building		X		Facility Improvements	Louvers on east side should be monitored for replacement	X			X			X			$ 3,000		**$ 3,000**
Sludge Tank		X		Facility Improvements	Roof of west side to be replaced	X					X				$ 2,000		**$ 2,000**
Sludge Thickeners				N/A	N/A				N/A								N/A
Sludge Thickener Building	X			Valves	Valves to be replaced	X	X		X	X		X		$ 100,000			**$ 100,000**
Tricking Filter #1 (South)		X		Concrete Repair	Inject epoxy into all cracks	X			X		X				$ 50,000		**$ 50,000**
Trickling Filter #1 (North)	X			Concrete Repair	ASR	X			X		X				$ -		
	X			Concrete Repair	Remove and Recoat interior coating	X			X		X				$ 155,000		**$ 155,000**
Trickling Filter Pump Building	X			Valves	Valves to be replaced	X			X	X					$ 232,000		**$ 232,000**
Trickling Filter Lift Station			X	Valves	All valves should be on a rotating exercise schedule to ensure performance				X						N/A		N/A

Facility Name	Project Type			Improvement Description	Detailed Recommendation	Driver(s)				Discipline(s)				Cost Breakdown			Total Cost
	Major	Minor	O&M			Condition	Age	Safety	O&M	Process	Structural	Mechanical	Electrical / I&C	5-Year	10-Year	20-Year	
SBR Structure	X			Operational Upgrades	Replacement Project	X	X		X	X	X	X	X	$ 176,000			**$ 176,000**
	X			Upgrade Project - Alternate (5 year Option)		X	X		X	X	X	X	X	$ 1,546,500			**$ 1,546,500**
Blower Building		X		Upgrade Project	Mechanical/electrical upgrades.		X			X	X	X	X		$ 50,000		**$ 50,000**
Chlorine Contact Chamber				N/A	N/A	N/A											N/A
Detention Basin			X	Monitor Concrete	Monitor Concrete Cracking				X						N/A		N/A
Admin Building		X		Minor Repair Work	Windows to be replaced	X					X				$ 12,000		**$ 12,000**
		X		Minor Repair Work	Walkout door on west side	X					X				$ 2,500		**$ 2,500**
		X		Minor Repair Work	Replace rollup door at northwest corner	X					X				$ 8,500		**$ 8,500**
		X		Minor Repair Work	Replace laboratory drain and main building drain piping.	X					X				$ 2,500		**$ 2,500**
		X		Minor Repair Work	Update women's restroom to current codes	X									$ 10,000		**$ 10,000**
		X		Minor Repair Work	Replacement of MCC	X	X						X		$ 10,000		**$ 10,000**
Shop		X		Minor Repair Work	Replace north rollup door	X					X				$ 8,500		**$ 8,500**
		X		Minor Repair Work	Replace walk-in door in the northwest corner	X					X				$ 2,500		**$ 2,500**
		X		Minor Repair Work	Replace ceiling insulation and lining	X					X				$ 12,000		**$ 12,000**
Pavement		X		Minor Repair Work	Replace drive between the abandoned clarifiers and aeration basins	X					X				$ 10,000		**$ 10,000**
		X		Minor Repair Work	Replace drive south of the Admin Building	X					X				$ 10,000		**$ 10,000**
BNR Treatment Upgrade Alternative 1 - SBR Expansion	X			NPW Upgrade Project Year 20		X	X		X	X	X	X	X			$ 33,957,000	**$ 33,957,000**
Residual Solids Alternative 2 - Aerobic Digestion	X			NPW Upgrade Project Year 20		X	X		X	X	X	X	X			$ 5,843,000	**$ 33,957,000**
TOTAL														**$ 4,800,500**	**$ 1,104,000**	**$ 39,800,000**	**$ 73,818,500**

FACILITY MASTER PLAN PROJECT

Norfolk, Nebraska

April 2020

Olsson Project No. 019-1256