Municipal Wastewater Denitrification Evaluation

City of Windom, Minnesota

July 29, 2016 – Revised November 4, 2016

Bolton & Menk, Inc. Project No. T22.109023

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MUNICIPAL WASTEWATER DENITRIFICATION EVALUATION

CITY OF WINDOM, MINNESOTA

JULY 2016

BMI Project No. T22.109023

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

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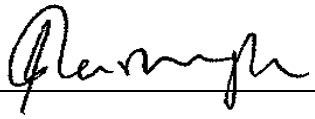
Signature:  Typed or Printed Name: Herman Dharmarajah, Ph.D., P.E.

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BOLTON & MENK, INC.
CONSULTING ENGINEERS AND LAND SURVEYORS

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SECTION 1 INTRODUCTION

A. PROJECT BACKGROUND

In 2014, the Minnesota Pollution Control Agency (MPCA) announced an Emerging Contaminants Wastewater Initiative with a Request for Proposals for Wastewater Treatment Plant (WWTP) Pilot Projects. The pilot project program was designed to generate practical, transferrable strategies for implementing water quality standards and/or reducing emerging contaminants in wastewater effluent. The pilot project program was developed to target chloride, phosphorous, nitrogen, sulfate, endocrine active compounds, parameters associated with pharmaceuticals or personal care products, and other unregulated chemical of emerging concern. The following report evaluates alternate methods for total nitrogen removal, or denitrification, at the City of Windom Wastewater Treatment Plant (WWTF).

The City of Windom has an extended aeration activated sludge treatment system with tertiary filtration. Historically, the influent TKN ranges from 40 mg/L to 100 mg/L. The treatment plant is able to completely nitrify the influent ammonia yielding low effluent ammonia concentrations. However, the effluent nitrate concentrations are high and range from 25 mg/L to 95 mg/L. The high effluent nitrogen concentrations could exceed future potential Total Nitrogen limit of less than 10 mg/L. This would require evaluation of removal strategies designed at reducing the Total Nitrogen level in the wastewater effluent.

Through pilot scale operations, alternate treatment technologies can be evaluated relative to current or proposed water quality standards and overall operational challenges and projected capital and operational cost for additional treatment.

The following report includes design and operational details, monitoring data and analysis for a denitrification filter and a 2-stage activated sludge denitrification process for the City of Windom. The findings of the analysis are transferred to full scale application at this and other facilities.

B. NITRATE STANDARDS AND EFFLUENT LIMITS

In 1972, the United States Environmental Protection Agency (EPA) amended the Federal Water Pollution Control Act (i.e. Clean Water Act) to regulate water quality standards and pollutant discharges from all point-source wastewater contributors through the creation of the National Pollutant Discharge Elimination System (NPDES) permit program. This law required all publicly-owned treatment works (POTW's) to comply with discharge regulations developed from both technological and water quality-based effluent limits (WQBELs). In the State of Minnesota, the NPDES permit program is administered by the Minnesota Pollution Control Agency (MPCA).

Over the years, discharge regulations have become increasingly stringent as the MPCA is enforcing new WQBELs over the technological limitations of POTWs pre-existing treatment infrastructure.

In particular, the removal of nitrate and implementation of a total nitrogen effluent standard was presented in a November 12, 2010 DRAFT of the Aquatic Life Water Quality Standards Technical Support Document for Nitrate completed as part of the Triennial Water Quality Standard Amendments to Minn. Rules. Chapters. 7050 and 7052. Water Quality Standards (WQSs) are designed to be protective of the beneficial uses of groundwater and surface waters. In surface waters, protection encompasses normal growth and reproduction of aquatic and animal and plant populations, human recreational uses, consumption of aquatic biota, and sources of drinking water. The draft nitrate standard relies on available data linking nitrate concentrations to aquatic toxicity.

C. PURPOSE

The purpose of this study is to evaluate the technological capacity for conventional and extended aeration activated sludge facilities to achieve total nitrogen removal, focusing on two commonly available methods for biological denitrification. The experimental procedure includes use of the City of Windom's full-scale extended aeration wastewater treatment facilities, as well as a fabricated pilot-scale denitrification filter and a fabricated post-anoxic denitrification activated sludge treatment process. The study evaluates the effectiveness of these treatment processes as well as alternatives for supplemental chemical demands.

The results and conclusions of this study provide additional technological information regarding nitrogen removal and its role in future permitting and regulatory decisions in the State of Minnesota. This study is funded by the Minnesota Pollution Control Agency (MPCA) under the Emerging Contaminants Wastewater Initiative grant program.

The pilot study operation and this report did not address some of the items and tasks presented in our proposal to the MPCA. Appendix G presents the response to MPCA's questions on the draft report submitted on July 29, 2016.

D. REPORT ORGANIZATION

This report is structured with six sections to adequately address the various aspects of the study. Section 1 is this Introduction; Section 2 provides a review of literature related to nitrogen removal in wastewater treatment systems; Section 3 presents an overview of the existing Windom WWTF and historical performance. Section 4 reviews the pilot study design, procedure, and methodology; Section 5 presents the pilot scale treatment results; and Section 6 provides a summary and cost considerations for implementation of effluent total nitrogen limits.

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SECTION 2 LITERATURE REVIEW

A. NITROGEN FORMS AND REACTIONS

There are commonly understood principles of nitrogen treatment that are well described in wastewater treatment textbook references, three of such being Tchobanoglous, et al. (known as Metcalf & Eddy) (2003), Rittmann & McCarty (2001), and the Manual of Practice for Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants put together by the Water Environment Federation (WEF), American Society of Civil Engineers (ASCE) and Environmental and Water Resource Institute (EWRI) (2005). Their principles of nitrification and denitrification are summarized below.

Nitrogen is an important and essential nutrient for all living organisms. Nitrogen exists naturally in wastewater in two forms, organic nitrogen, and ammonium. Ammonium is created through the bacterial decomposition of organic nitrogen and is present in residential strength wastewater as NH_4^+-N.

High levels of ammonia can be toxic to fish and other aquatic organisms in the receiving waters. Nitrogen removal is usually a process to help protect the surface waters downstream from a POTW from eutrophication. Therefore, because ammonia can present potential toxicity issues if not properly treated, it is important to understand the process and methods behind nitrification.

Nitrification is the microbial oxidation of ammonia (NH_4^+-N) to nitrite (NO_2^-N) and ultimately to nitrate (NO_3^-N) if there is complete nitrification. Nitration is the conversion of ammonia to nitrite. The microorganisms that perform nitrification are only able to act on the inorganic forms of nitrogen (ammonia, nitrite, and nitrate). The bacteria that perform this operation are autotrophs, specifically chemolithotrophs, and obligate aerobes. Meaning, the nitrifying organisms use inorganic carbon dioxide as their carbon source and use oxygen (O_2) for respiration. Therefore, nitrification occurs in aerobic environments. The amount of oxygen required for the complete oxidation of ammonia is 4.57 g O_2/g NH_4-N oxidized.

Nitrification is a two-step process, where ammonia is first oxidized to nitrite (NO_2^-) by the Nitrosomonas species in the following reaction. This reaction requires 3.43 g O_2/g NH_4-N oxidized.

$$2NH^{4+} + 3O_2 \rightarrow 2NO_2^- + 4H^+ + 2H_2O$$

The second step is the conversion of nitrite (NO_2^-) to nitrate (NO_3^-) by the Nitrobacter species, which is done by the following reaction. This reaction requires 1.14 g O_2/g NH_4-N oxidized.

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

A third reaction can be written to explain the total oxidation reaction of ammonia to nitrite:

$$NH^{4+} + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$$

The growth of the Nitrosomonas and Nitrobacter is the result of the oxidation of ammonia and nitrite, respectively. Generally, it is considered that the growth of either species is limited by the concentration of the respective substrate. This is defined by the Monod Equation:

$$\mu_n = \mu_{n\text{-}max}\, S_n / (K_n + S_n)$$

The Monod Equation shows that as the substrate (S_n) level increases, the growth rate (μ_n) will increase and as the substrate level decreases, the growth rate will decrease. Several other variables can affect the growth rate of nitrifying bacteria such as:

- Solids Retention Time (SRT)
- Temperature
- Dissolved oxygen concentration
- pH and alkalinity
- Inhibitory substances
- Flow and load variation

Nitrification is an important first step in total nitrogen removal. Several system designs allow nitrification to occur in a typical wastewater treatment facility. These systems include single sludge suspended growth systems, two sludge suspended growth systems and two stage, high and low rate, activated sludge systems. Nitrification systems require monitoring to ensure the process is working properly. Heterotrophic bacteria, those used to reduce BOD in wastewater, area always competing with the nitrifying bacteria for

oxygen and space in the reactor. Nitrifying bacteria have a large oxygen demand and they are slow growing organisms. This puts them at a disadvantage in a tank containing heterotrophic bacteria because the heterotrophic bacteria will out-compete the nitrifying organisms for oxygen and space, thus limiting nitrification. To overcome the disadvantages of nitrifying bacteria, long solids retention time (SRT) are used to ensure the growth of organisms.

The second part of a nitrogen removal system is denitrification. Denitrification is the reduction of nitrate to nitrite to nitrogen gas (N_2) in the absence of oxygen. Typically, in wastewater treatment facilities, nitrate is formed during nitrification. It is important to reduce the nitrate concentration before discharging the wastewater. Nitrate can have adverse effects on the environment. Elevated levels of nitrate can lead to freshwater eutrophication in lakes and rivers and poses a potential health risk for humans. The US EPA has set a drinking water standard of 10 mg/L of nitrate-nitrogen in freshwater. Denitrification is an important process to protect downstream waters from potentially harmful levels of nitrate.

In a typical wastewater treatment facility, denitrification occurs after nitrification. After the nitrifying organisms have converted the influent ammonia to nitrate, denitrifying organisms convert the nitrate to nitrogen gas. Denitrification differs from nitrification in that the bacteria that perform denitrification are facultative heterotrophic bacteria. They rely on the use organic carbon as their carbon source and organic sources as their electron donor.

Denitrification occurs in environments where the dissolved oxygen level is low (anaerobic or anoxic). When nitrate or nitrite is present, the environment is considered anoxic and is favorable for denitrification. The organisms utilize the oxygen contained in the nitrate or nitrite molecules to metabolize the organic carbon. These organisms can use oxygen, nitrate, or nitrite as their electron acceptor. However, the denitrifying organisms prefer oxygen when it is available, but will change to nitrate or nitrite in low dissolved oxygen environments. The organisms prefer oxygen because they are able to metabolize the substrate more efficiently and a greater amount of energy is available to the bacteria for each unit of carbonaceous material treated.

In some instances, there is not enough carbon in the wastewater to supplement the bacteria's carbon needs. If this happens, an additional carbon source is required. The carbon source can be supplied from an external carbon source, by endogenous respiration, or it can be in the form of the influent BOD in the wastewater. Several carbon sources such as glucose, ethanol, or methanol can be used to add supplemental carbon to promote efficient denitrification (J. Van Rijn et al., 2006). It is important to supply enough carbon to promote denitrification and the growth of denitrifying organisms.

Denitrification occurs in a stepwise manner in which nitrate (NO_3^-) is reduced, sequentially, to nitrite (NO_2^-), nitric oxide (NO), nitrous oxide (N_2O), and ultimately nitrogen gas (N_2) as shown in the following reactions:

$NO_3^- + 2e^- + 2H^+ \rightarrow NO_2^- + H_2O$	Nitrate Reductase
$NO_2^- + e^- + 2H^+ \rightarrow NO + H_2O$	Nitrite Reductase
$2NO + 2e^- + 2H^+ \rightarrow N_2O + H_2O$	Nitric Oxide Reductase
$N_2O + 2e^- + 2H^+ \rightarrow N_{2(g)} + H_2O$	Nitrous Oxide Reductase

There are several designs incorporating denitrification in wastewater treatment facilities. These include separate stage suspended growth systems and attached-growth systems such as moving bed biofilm reactors and denitrification filters. Denitrification filters are a promising technology to aid in biological nitrogen removal.

B. BIOLOGICAL NITROGEN REMOVAL

Biological nitrogen removal is the process of utilizing bacterial organisms (autotrophic for nitrification, and heterotrophic for denitrification) to reduce ammonia to nitrogen gas. This is typically done in a two stage process with nitrification first followed by denitrification. These processes are described above.

Figure 2-1 shows the conventional nitrification-denitrification pathway with required oxygen, alkalinity and carbon for the various reactions in a biological system (Jimenez, Brown Caldwell Presentation).

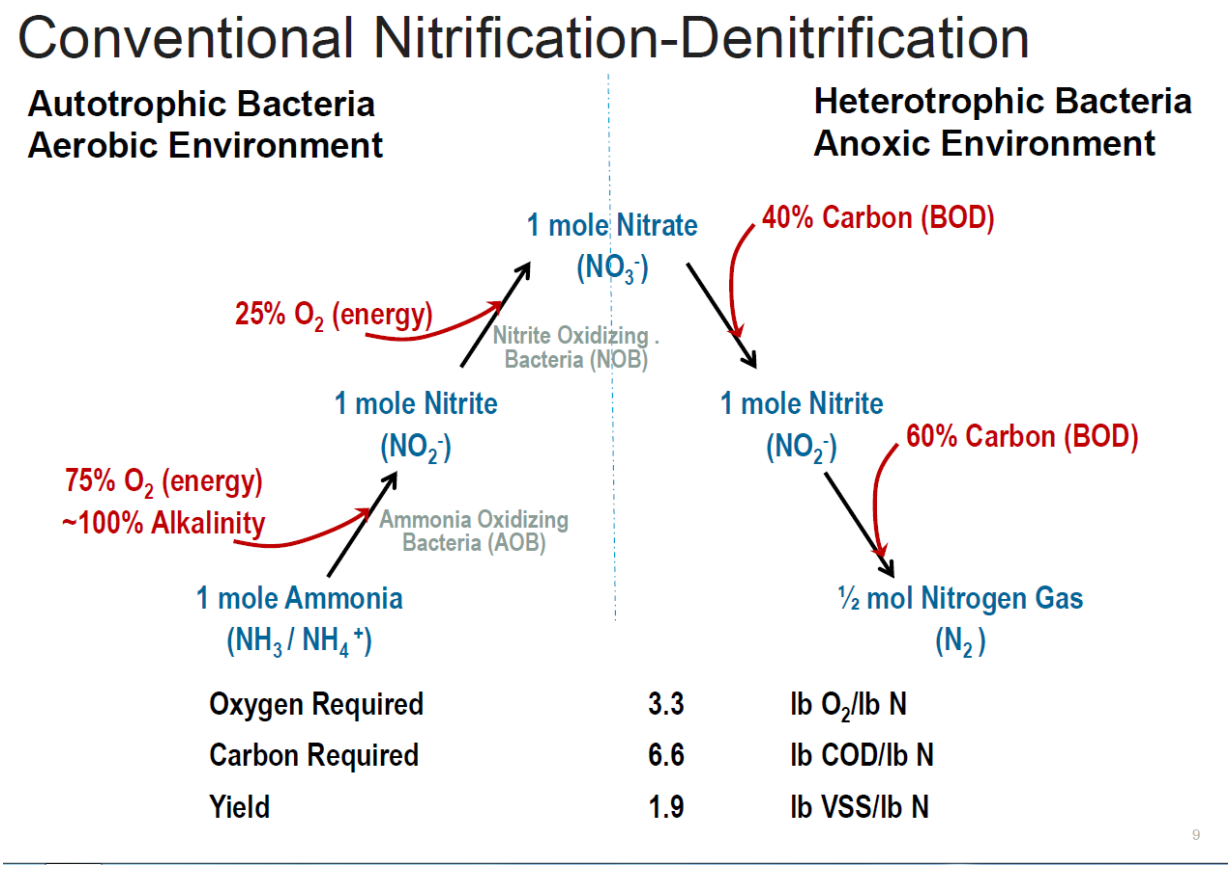

Figure 2.1 Conventional Nitrification-Dentification Pathway

Tchobanoglous, et al. (known as Metcalf & Eddy) (2003), describes the types of biological nitrogen removal processes. These include preanoxic denitrification, postanoxic denitrification, and low dissolved oxygen cyclic nitrification/denitrification.

Preanoxic denitrification configurations treat the wastewater by recycling the nitrate produced in the aerobic zone into the mixed preanoxic zone. The denitrifying organisms in the preanoxic zone consume the influent BOD to reduce the nitrate to nitrogen gas. The amount of nitrogen removal in preanoxic system depends on the recycle ratio. Higher recycle ratios are needed to achieve higher total nitrogen removal.

In postanoxic denitrification, systems are commonly used as polishing denitrification steps to remove nitrate to a minimal effluent concentration. Here, sludge is recycled from the clarifier to the aerobic zone. Nitrification is the first process in a postanoxic denitrification system.

In low dissolved oxygen and cyclic nitrification/denitrification, the denitrification can be accomplished in a single-reactor activated sludge system without permanent distinct nitrification and anoxic zones by two methods: simultaneous nitrification/denitrification, and cyclic nitrification/denitrification. Cyclic nitrification/denitrification processes can include oxidation ditches, alternating aerobic/anoxic processes, and phased operation processes.

Denitrification filters are one technology that can be utilized to achieve high levels of nitrogen removal. Denitrification filters come in two main configurations, downflow and upflow continuous backwash filters. Downflow denitrification filters operate in a conventional filtration mode. They consist of sand media with gravel support on top of an underdrain. Backwashing is required in downflow filters to prevent plugging and maintaining the design filtration rate. Upflow continuous backwash filters allow the influent wastewater to flow upward through the sand media, concurrent to the movement of the sand bed.

Denitrification filters utilize filtration equipment, along with attached microbial growth to denitrify wastewater. These denitrification filters are manufactured by a variety of companies, each with varying configurations and design considerations. Denitrification filtration allows microorganisms to attach and grow on a media. As the wastewater passes through the media, the organisms will consume the nitrogen in the wastewater (typically in nitrate form) and convert it to nitrogen gas. The designs for these filtration systems range depending on what company or source is used for the design. The denitrification filter equipment and manufacturers is shown in Table 2.1 while the typical design guidelines are shown in 2.2 below.

Table 2.1 Comparison of Denitrification Filter Manufacturers and Equipment					
Manufacturer /filter	**Severn Trent Services/TETRA® Denite®**	**F. B. Leopold/elimi-NITE**	**USFilter/Davco**	**Parkson/DynaSand**	**Paques and USFilter/Astrasand**
Flow Regime	Downflow	Downflow	Downflow	Upflow	Upflow
Underdrain	T-Block; concrete filled, HDPE jacket	Universal Type S HDPE block	Pipe lateral; or Multiblock HDPE block	None Required	None Required
Air Header Arrangement	Stainless Steel box header; laterals beneath underdrain	Stainless Steel header across filter; laterals	Stainless Steel air header; 50 mm (2 in.) laterals	Vertical air lift	Vertical air lift
Media	457 mm (18 in.) graded gravel, 1.8 m (6 ft) of 6 x 9 mesh silica sand, uniformity coefficient 1.35, 0.8 minimum sphericity	381 mm (15 in.) graded gravel, 1.8m (6 ft) of 6 x 12 mesh sand	2 layers support gravel, 1.8 m (6 ft) of 6 x 9 mesh sand	1.35 to 1.45 mm subround media or 1.55 to 1.65 mm subangular media with uniformity coefficient of 1.3 to 1.6; 2-m (6.6 ft) bed depth	1.2 to 1.4 mm sand, 2-m (6.6 ft) bed depth
Nitrogen-release Cycle	initiated by headloss or time controlled cycle; Speed Bump controls	Initiated by headloss or time controlled cycle	Initiated by headloss or time controlled cycle	None Required	None Required
Backwash water and air requirement	244 L/min·m^2 (6 gal/min·ft^2); 1.5 m^3/min·m^2 (5 scfm/ft^2)	244 L/min·m^2 (6 gal/min·ft^2); 1.5 m^3/min·m^2 (5 scfm/ft^2)	407 L/min·m^2 (10 gal/min·ft^2); 1.5 m^3/min·m^2 (5 scfm/ft^2)	Continuous through air lift and sand washer	Continuous through air lift and sand washer
Influent weir type	Curvilinear Weir block	Curved stainless steel weir	Varies	Feed radials at bottom of unit	feed radials at bottom of unit
Backwash flow as percent of forward flow	< 5; often 1-2	2	Not documented	3 to 5	3 to 12
Patented features	T block underdrain, curvilinear weir block, Speed Bump, TetraPace, TetraFlex	Universal Underdrain and features	None	None	None in United States, Astracontrol in Europe
*Adopted from deBarbadillo et al. (2005) in WE&T					

Table 2.2 Summary of Design Guidelines for Denitrification Filters			
Source	**Hydraulic Loading Rate [L/min·m² (gal/min·ft²)]**	**Volumetric mass loading rate [kg NO_3-N per m^3/d (lb NO_3-N per ft^3/d)]**	**Other information**
***Manual*: *Nitrogen Control* (U.S. Environmental Protection Agency, 1993)**	41 to 82 (1 to 2), 30 minutes empty bed contact time	0.29 to 1.6 (0.018 to 0.1)	Design curves from Savage, E.S. (1983), "Biological Denitrification Deep Bed Filters," Presented at the Filtech Conference, Filtration Society, London England
		1.33 (0.083) [Referenced Tetra data]	Hydraulic loading rate versus effluent nitrate-nitrogen concentration [referenced Tetra data]
***Biological and Chemical Systems for Nutrient Removal, Special Publication* (Water Environment Federation, 1998)**		0.24 to 3.2 (0.015 to 0.2 depending on temperature	Design curves from Savage, 1983
***Wastewater Engineering, Treatment and Reuse* (Metcalf & Eddy, 2003)**	41 to 82 (1 to 2), at 20°C	1.4 to 1.8 (0.087 to 0.112), at 20°C	20 to 30 minute empty bed contact time
	20 to 61 (0.5 to 1.5), at 10°C	0.8 to 1.2 (0.05 to 0.075), at 10°C	
Severn Trent Services TETRA® Denite®	<123 (<3) at average flow, <308 (<7.5) peak hydraulic with one cell out of service	Determined using process Model	In-House kinetic model, extensive full-scale data
F.B. Leopold	41 to 82 (1 to 2), at 20°C	1.12 (0.07)	Full-scale data (North Carolina)
USFilter/Davco	82 (2)	Not Available	Full-scale data (Florida)
Parkson	Up to 183 (4.5)	0.24 to 1.9 (0.015 to 0.12)	Full-scale and pilot data (Puerto Rico, Maryland)
Paques/USFilter	168 (4.1)	2.08 (0.13)	Full-Scale data (Netherlands), dry weather flow only
*Adopted from deBarbadillo et al. (2005) in WE&T			

Studies have proven that biological nutrient removal depends on several factors but can achieve high nitrogen removal. Winkler et al. (2011) used two sequencing batch reactors (SBR's) and operating them in anaerobic/aerobic/anoxic modes for 250 days. During this time, the reactors were run with low and high rate aeration to study the effect of nutrient

removal. Raw wastewater with influent ammonia concentrations ranging from 34 – 42 mg/L was used as the influent solution. The results show that the SBR with headspace open to the atmosphere achieved 85% total nitrogen removal at a low aeration rate while the SBR with closed headspace achieved 90% total nitrogen removal at a low aeration rate. AT high aeration rates, the SBR's that were open to the atmosphere and closed to the atmosphere achieved 97% and 100% removal of nitrogen, respectively.

Carrera et al. (2003) studied the effect of biological nitrogen removal of high-strength ammonium using a two-sludge system in a wastewater treatment facility. The treatment facility contained two separate stages, nitrification, and denitrification. The influent wastewater contained ammonium concentrations ranging from 4000 to 6000 mg/L. Two external carbon sources, by-product of alcohol production consisting of mostly ethanol and a mixture of mostly methanol, were used to supplement carbon into the wastewater. Overall, the ammonium removals ranged from 90 – 100% over the course of the study (450 days). The average nitrification rate ranged between 0.11 and 0.18 g $N\text{-}NH_4^+$/g VSS/day. Complete denitrification was achieved under all scenarios utilizing both external carbon sources. However, the maximum denitrification rate for ethanol (0.64 g $N\text{-}NO_x^-$/g VSS/day) was 6 times higher than for methanol (0.11 g $N\text{-}NO_x^-$/g VSS/day).

Kuba et al. (1996) used a laboratory scale two-sludge system consisting of two SBR's and a "nitrate exchange vessel". Wastewater with influent ammonia (NH_4^+) concentrations of 119 mg/L (days 0-170), 105 mg/L (days 170-183) and 112 mg/L (days 183-193) were loaded into the reactor. In the effluent of the reactor system, NH_4^+ concentrations were approximately 15 mg/L and nitrate was not detected. Overall, the system achieved a 90% total nitrogen removal efficiency. A system of this design was also proposed to remove phosphorus and achieved 100% phosphorus removal during the duration of the study. However, it is important to note that the Solids Retention Time (SRT) was a key variable in controlling the rate of nitrification and denitrification.

Adding additional carbon sources plays a key role in promoting denitrification. Chen et al. (2015) describes the importance of adding additional carbon sources to promote denitrification and biological nutrient removal in Sequencing Batch Reactors (SBR's) using activated sludge. Chen et al. (2015) used several carbon sources: acetate,

propionate, glucose, methanol, and ethanol (typical sources). With an influent ammonia concentration of 40 mg/L, acetate had the highest total nitrogen removal (93%) while ethanol had the lowest total nitrogen removal (63%). The addition of an additional carbon source and type of carbon source can have an impact on the level of denitrification and total nitrogen removal.

Cherchi et al. (2009) evaluated and compared three carbon sources, MicroC, methanol, and acetate, in terms of their denitrification rate and kinetics, effect on overall nitrogen removal performance, and microbial community structure of carbon specific denitrifying enrichments. The three carbon sources were added into laboratory Sequencing Batch Reactors (SBR's) with activated sludge. MicroC had a maximum denitrification rate of 6.4 mg N/g VSS-h while methanol had a maximum denitrification rate of 6.1 mg N/g VSS-h. Acetate had the largest denitrification rate at 13.6 mg N/g VSS-h. All three carbons sources proved to effectively remove nitrate from wastewater.

Determining what carbon source to supplement into a denitrification filter is important. Several common carbon sources are methanol, ethanol, glucose, sucrose, and other proprietary substances, such as MicroC (Onnis-Hayden and Gu, 2008). Onnis-Hayden and Gu, note that MicroC is a proprietary substance that was designed for use as an electron donor for biological denitrification of wastewater. It was developed as a viable option to replace methanol without the safety hazards.

Ledwell et al. (2010) investigated the use of MicroC and optimizing deep bed denitrification filters at a wastewater treatment facility in Colorado. The MicroC was used as an alternative carbon source over methanol. Ledwell et al. (2010) found that total nitrogen removal, as a percent reduction was almost the same for methanol (89.2%) and MicroC (89.3%). During the cold weather testing, the MicroC removed 86.4% of the total nitrogen indicating high removals can be achieved during winter months. Most of the testing was conducted with a nitrate set-point of 1 mg/L. It was noted that although MicroC proved to be a viable alternative carbon source for denitrification filters, these alternative carbon sources can have different yields and denitrification efficiencies. MicroC is a promising alternative carbon source for use in denitrification filters.

Biological nitrogen removal has been studied extensively to understand the process behind nitrification and denitrification. The processes for each required careful consideration and understanding of the basic principles behind how the microorganisms react and consume the substrate. The principles behind nitrification and denitrification can help develop and design systems to effectively remove nitrogen to protect the receiving waters.

C. TOXICITY

High levels of ammonia and nitrate in freshwaters can have a significant impact on the water quality. Nitrogen compounds that are discharged into the environment can cause serious problems such as eutrophication of rivers and deterioration of water sources as well as a human health hazard (Fernandez-Nava et al. 2008).

In freshwater systems, ammonia, nitrite, and nitrate pollution can have a significant impact on water quality as well as economic impact. High nitrate levels can affect freshwater fish species. Lewis et al. (1986) studied the effect of nitrite of certain fish species and found that different nitrite levels can prove toxic to different species of fish.

Camargo et al. (2005) reports that nitrate toxicity to freshwater and marine fishes increases with increasing nitrate concentration and exposure. The level of toxicity depends on the fish species and the concentration of nitrate. Nitrate becomes toxic to aquatic organisms because it coverts oxygen carrying pigments to forms that are incapable of carrying oxygen.

Along with the environmental impacts to fishes and aquatic animals, high concentrations of nitrate and nitrite in drinking water supplies is also a public health concern as it can cause adverse health effects in very young infants, such as methemoglobinaemia (Blowes et al., 1994). This process involves the nitrate and nitrate reacting with haemoglobin in the blood and converting it to methemoglobin, allowing no oxygen transfer to the cell tissues (M.A. Gomez et al. 2000).

Many wastewater treatment facilities have permitted levels of nitrogen they can discharge. These wastewater treatment facilities are considered a point source for discharge of water. Without proper management of nutrients, treatment facilities could

discharge elevated levels of ammonia and nitrate into the receiving waters. New treatment strategies have emerged leading to high total nitrogen removal to help protect water sources from pollution.

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SECTION 3 WINDOM WASTEWATER TREATMENT FACILITY

The City of Windom, Minnesota owns and operates an extended aeration activated sludge treatment facility that discharges into the West Fork of the Des Moines River in accordance with National Pollutant Discharge Elimination System (NPDES/SDS) permit MN0022217. The facility is designed to treat an average wet weather flow of 1.83 million gallons per day (MGD) and a carbonaceous biochemical oxygen demand ($CBOD_5$) load of 1,500 lb/day. The extended aeration facility is designed for complete nitrification, or conversion of influent ammonia and organic nitrogen to nitrate with aeration capacity for a total nitrogen load of up to 1100 lb/day (TKN).

Treatment processes include a main lift station, mechanical screening and grit removal processes, activated sludge basins, final clarifiers, media filtration and chlorine disinfection. Biosolids processes include thickening, aerobic digestion and liquid storage prior to land application. An aerial overview and block process flow diagram for the Windom WWTF are provided as Figures 3.1 and 3.2. The following provides a brief overview of current effluent limits, historical facility loading and performance, as well as current nitrogen removal efficiencies.

A. WINDOM EFFLUENT LIMITS AND MONITORING

Monthly average effluent limits regulated by the NPDES/SDS permit for the Windom WWTF are summarized in Table 3.1. A copy of the NPDES/SDS permit is found in Appendix A. As indicated, current effluent nutrient limits include a 5 mg/L limit for $CBOD_5$ and a seasonal ammonia nitrogen (NH_3-N) limit ranging from 1.0 mg/L to 8.2 mg/L. Additional limits include TSS, fecal coliform, residual chlorine, dissolved oxygen, pH and chronic toxicity.

Monitor only requirements include phosphorus, TKN, nitrate plus nitrite, copper and salty discharge parameters (chloride, calcium and magnesium hardness, specific conductance, total dissolved solids, sulfates, bicarbonates, sodium, calcium, magnesium, potassium and whole effluent toxicity).

Historically, the treatment facility has maintained effluent compliance with the exception of *Ceriodaphnia dubia* chronic toxicity. A toxicity reduction evaluation (TRE) for the facility identified nitrate+nitrite as a suspected source of observed toxicity. Therefore,

the proposed denitrification evaluation provided an opportunity to evaluate denitrification potential as well and the associated impact of nitrate concentrations on effluent toxicity.

Table 3.1 Windom Calendar Month Average Effluent Limits

Parameter	Month of Year											
	D	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	5 mg/L				25 mg/L							
Total Suspended Solids (TSS)	30 mg/L											
Nitrogen, Ammonia (NH_3-N)	8.2 mg/L				7.2 mg/L	1.0 mg/L					3.3 mg/L	
Total Kjeldahl Nitrogen (TKN)	Monitor only											
Nitrate Plus Nitrate (NO_2+NO_3)	Monitor only											
Phosphorus (P)	Monitor only											
Chronic Toxicity	1.0 TUc											
Fecal Coliform	--				200 / 100 mL							--
Chlorine, Total Residual	0.038 mg/L											
Dissolved Oxygen (DO)	10 mg/L											
pH	6.0 – 9.0 SU											
Salty Discharge Parameters	Monitor only											
Copper	Monitor only											

Figure 3.1. Windom WWTF Aerial Overview

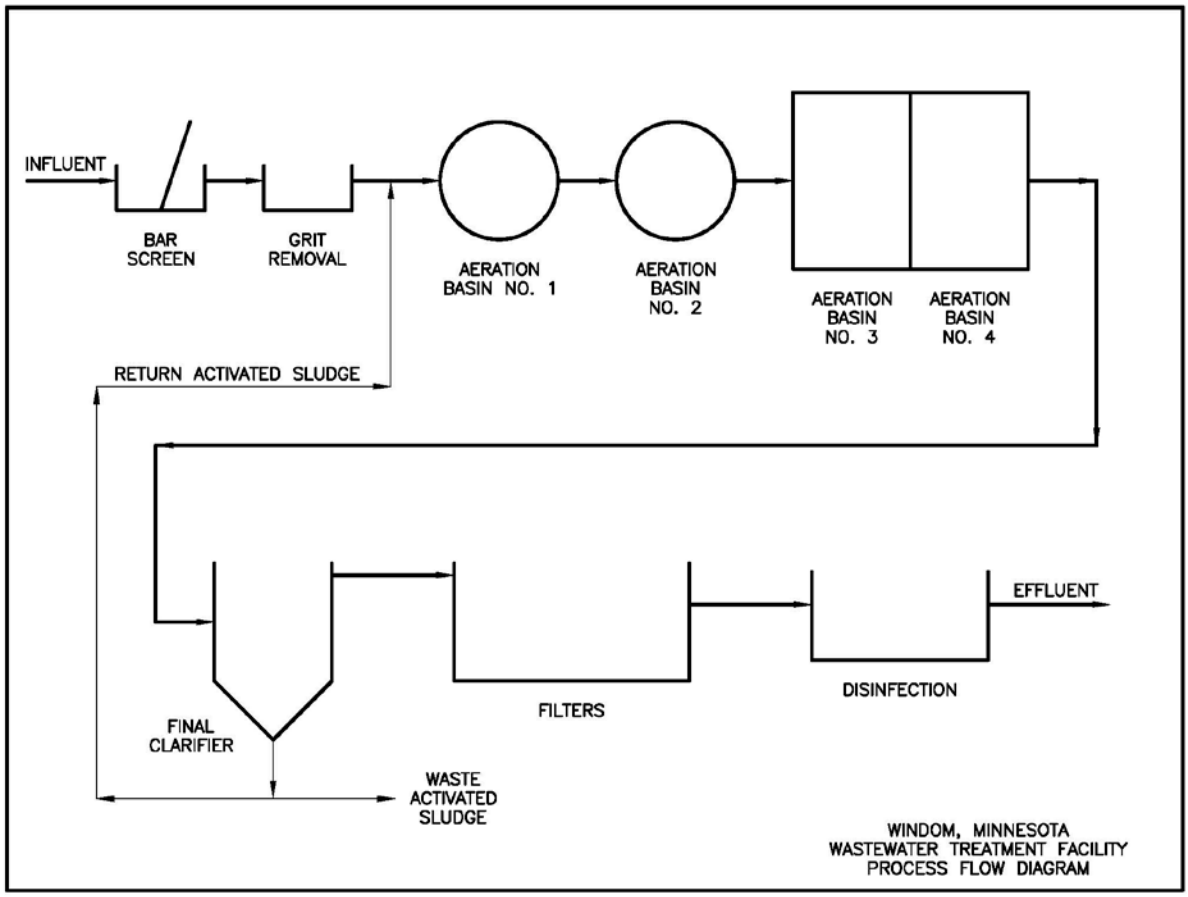

Figure 3.2. Windom WWTF Process Flow Diagram

B. INFLUENT FLOW AND LOAD

Influent wastewater characteristics include both municipal contributions as well as contributions from significant industrial users (SIU). Total influent flow and pollutant loads for $CBOD_5$, nitrogen and phosphorus are shown in Figures 3.3 through 3.6 along with the contribution from PM Beef Holdings. As indicated, in 2010, PM Beef contributed nearly 74 percent of the influent nitrogen and approximately 25 percent of the influent $CBOD_5$. By 2014 and 2015, PM Beef nitrogen contributions dropped to approximately 50 percent of the influent TKN load prior to closing operations in November 2015.

PM Beef Holdings was a leading processor and supplier of meat products to consumers, retailers, and food service operators. Products included private-label and branded (Nature's Pride and Angus Beef Preferred Stock) case-ready beef supplied to food retailers, as well as other specialty meat products for restaurants and hospitality operators.

Beginning in 2011-2012, PM Beef's rate of production decreased and flow and waste loads declined. As of November 2015, PM Beef ceased operations and stopped discharge from the pretreatment lagoons to the Windom WWTF. Prior to that point in time, industrial wastewater passed through a lagoon pretreatment process which provided a reduction in $CBOD_5$. Nitrogen contributions from PM Beef were predominately received in the form of ammonia confirming the lack of nitrification in the pretreatment lagoons.

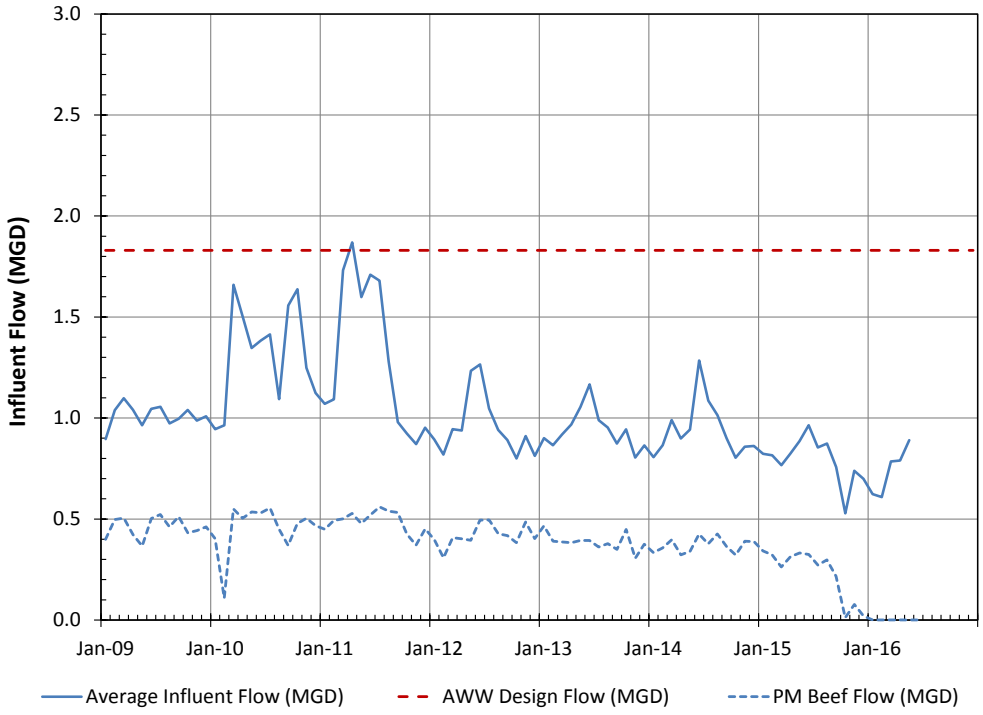

Figure 3.3 Windom WWTF and PM Beef Monthly Average Flow (MGD)

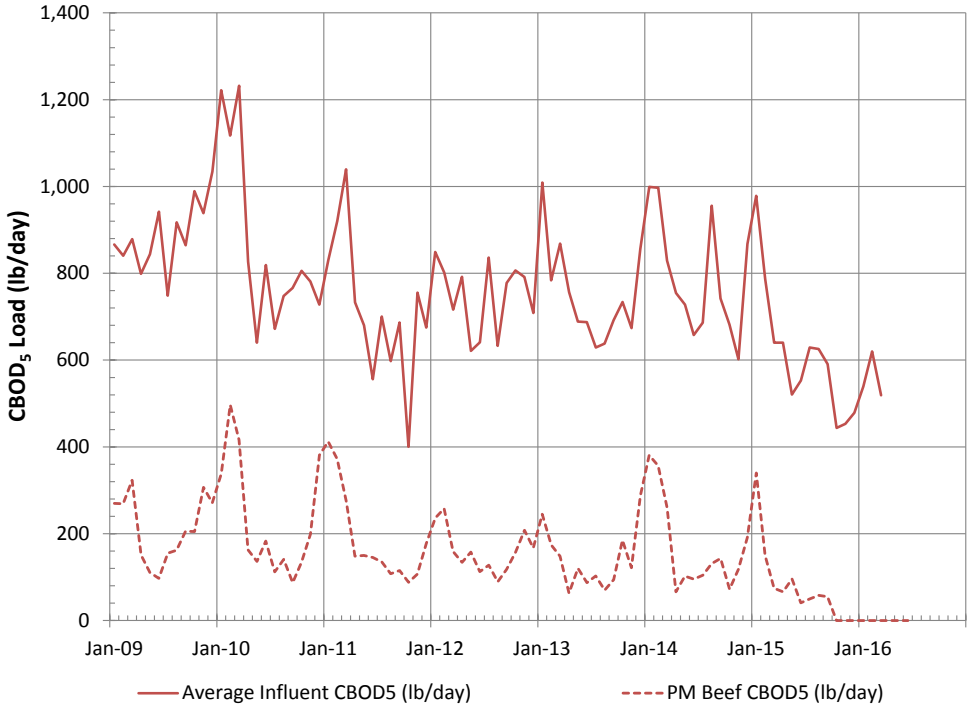

Figure 3.4 Windom WWTF and PM Beef Monthly Average $CBOD_5$ (lb/day)

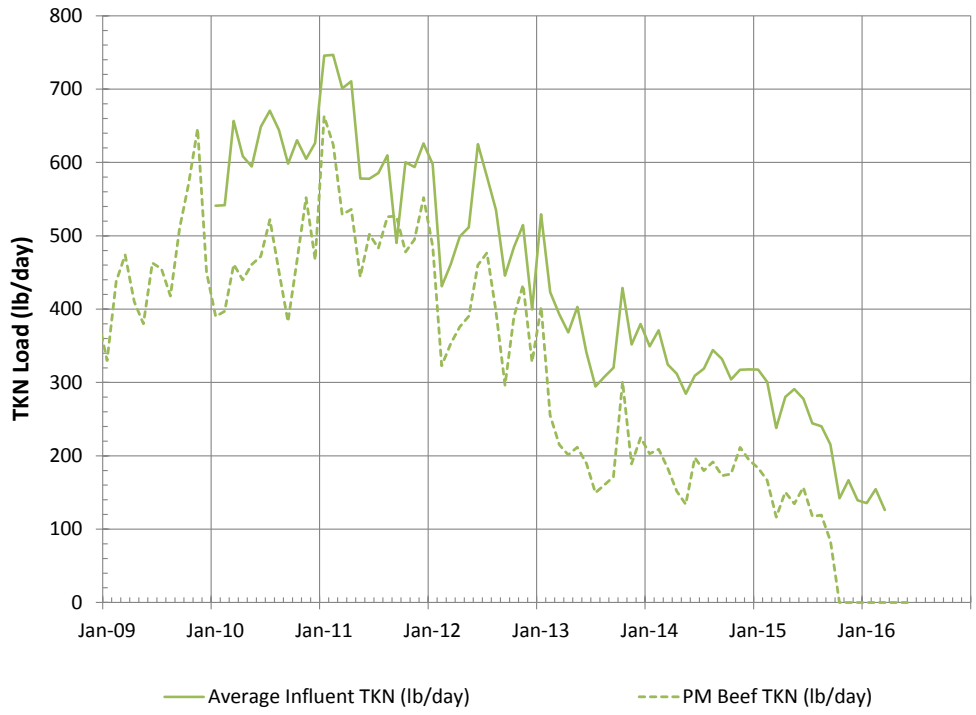

Figure 3.5 Windom WWTF and PM Beef Monthly Average Nitrogen (lb/day)

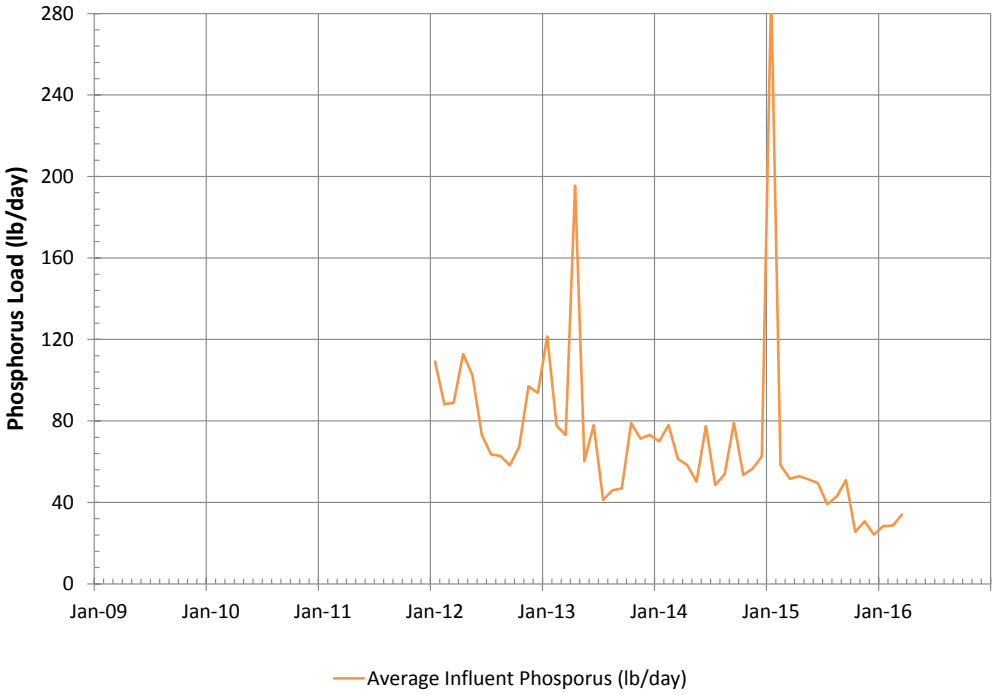

Figure 3.6 Windom WWTF and PM Beef Monthly Average Phosphorus (lb/day)

C. EFFLUENT NITROGEN AND WHOLE EFFLUENT TOXICITY

As indicated previously, the Windom WWTF is designed for complete nitrification and consistently provides treatment in compliance with the NPDES/SDS effluent total ammonia requirement. Although the facility consistently complies with $CBOD_5$, TSS, and ammonia effluent limits, a toxicity reduction evaluation (TRE) process was implemented in October 2010 as a result of observed chronic toxicity to *Ceriodaphnia dubia*. Effluent toxicity is reported in terms of chronic toxicity units (TUc) or inhibition concentrations (IC25). The IC25 value is the statistical determination of the effluent concentration that results in a 25 percent reduction in growth or reproduction. Chronic toxicity units (TUc) are equivalent to the inverse of the IC25 (TUc=1/IC25). Allowable effluent toxicity is based on the available dilution associated with the receiving stream. The Windom WWTF discharges to the West Fork of the Des Moines River with an effluent chronic toxicity limit of 1.0 TUc (IC25≥100 percent).

The TRE process linked effluent toxicity to elevated concentrations of nitrate+nitrite (NO_3+NO_2). The proposed pilot study evaluation was expected to confirm the toxic effects relative to the presence of nitrate+nitrite in the Windom WWTF effluent.

Figure 3.7 provides a monthly average summary indicating recent changes in influent nitrogen (TKN) content and the observed reduction in effluent nitrate+nitrite concentrations. This, coupled with observed changes, or lack of, effluent toxicity in recent months prevented the proposed denitrification pilot study the opportunity to confirm the role nitrate+nitrite played in historical observations of effluent toxicity.

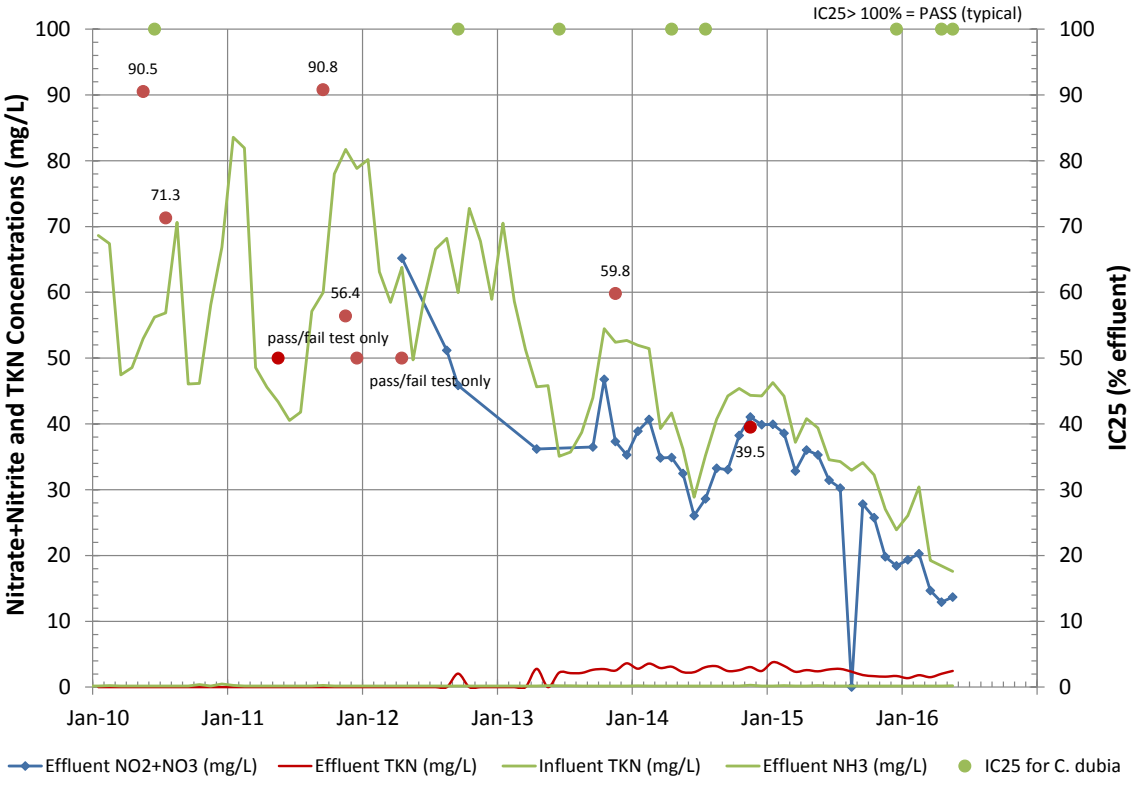

Figure 3.7 Influent TKN, Effluent TKN and NO_3+NO_2 and *C. dubia* IC25

Although recent effluent toxicity testing (2015-2016) report no observed effluent chronic toxicity and the pilot scale denitrification could not be used to demonstrate the effectiveness of denitrification for control and elimination of effluent chronic toxicity, the pilot study was useful in demonstrating the effectiveness of biological systems for achieving biological total nitrogen removal.

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SECTION 4 PILOT SCALE PLAN AND PROCEDURES

The nitrogen removal pilot study evaluated two separate biological systems including design requirements, performance monitoring, operational considerations, and the effectiveness of total nitrogen removal. Piloted systems include a denitrification filter system and a 2-stage activated sludge denitrification system designed to achieve nitrogen removal through the processes of nitrification/denitrification, or conversion of ammonia to nitrate followed sequentially by conversion of nitrate to nitrogen gas. Both systems were constructed with a design flow rate of 0.4 gallons per minute (576 gpd) representing approximately 0.05 percent of the full scale flow of approximately 1.1 million gallons per day (MGD).

A. DENITRIFICATION FILTER SYSTEM

A process flow diagram for the denitrification filter system is shown in Figure 4.1. As indicated, nitrified effluent from the full scale activated sludge process (secondary treatment) was utilized as influent to the pilot scale denitrification filter. Carbonaceous biochemical oxygen demand ($CBOD_5$) concentrations at this point were consumed. Therefore an external carbon source was provided to meet the carbon requirements for denitrification. Additional system requirements include periodic air and water as required for filter backwash.

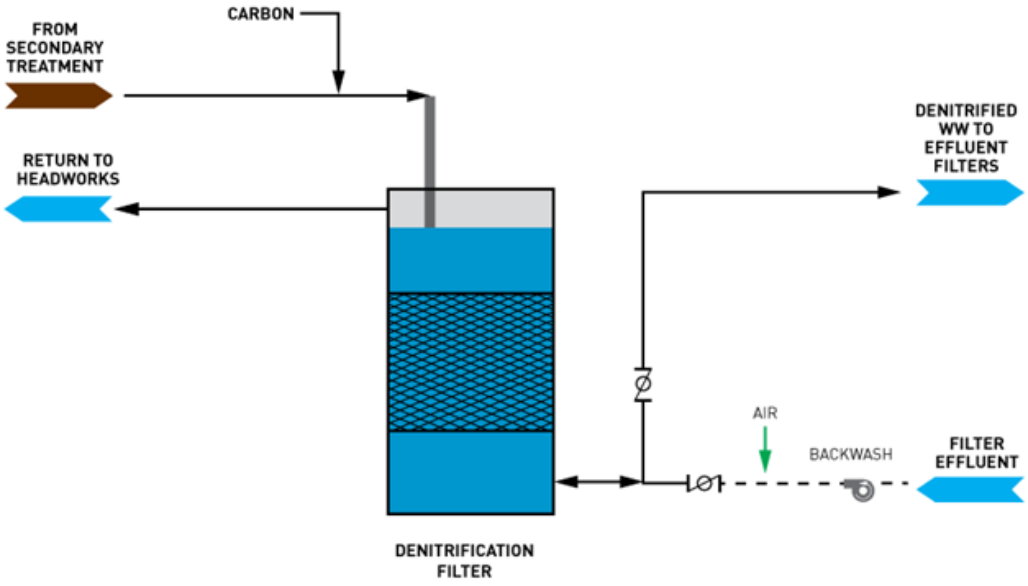

Figure 4.1 Denitrification Filter System Process Flow Diagram

The denitrification filter system was designed for a continuous 0.4 gpm flow of nitrified wastewater from the full-scale secondary treatment facilities with a design filtration rate of 2.0 gpm/sf ft of filter surface area. The backwash cycle was modeled after TETRA Denite in Table 1 of the EPA Wastewater Management Fact Sheet: Water backwash rate of 6 gpm/sf of filter area with air at 5 scfm/sqft^2 of filter area.

The denitrification filter was constructed using a 6-in diameter clear PVC pipe with a perforated screen flange at the bottom. A silica sand media depth of 6-ft was utilized with an average grain size of 2.2 mm, a Coefficient of Uniformity of 1.24 (particle size distribution report found in Appendix B. A photo indicating the in-place set up of the denitrification filter system is provided as Figure 4.2.

Figure 4.2 Pilot Scale Denitrification Filter System Construction

Process monitoring included sampling and analysis of the pilot system influent and effluent 1-2 times weekly for nitrate+nitrite (NO_3^-+NO_2^-), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH_3-N) and carbonaceous biochemical oxygen demand (BOD_5). Periodic analysis for pH and alkalinity was also recommended.

Continuous nitrate, nitrite, and COD monitoring was conducted on the pilot influent and pilot effluent using YSI IQ-SensorNet-NiCaVis sensors.

B. 2-STAGE ACTIVATED SLUDGE

A process flow diagram for the 2-stage activated sludge system is shown in Figure 4.3. As indicated, pretreated raw wastewater (after screening) was utilized for influent to the pre-anoxic basin where it was available to meet the carbon requirements for denitrification. Supplemental carbon was added to supplement the carbon demand at elevated influent nitrogen concentrations. Additional system requirements include continuous mixing and aeration as well as recirculation of mixed liquor and return activated sludge. Waste activated sludge (WAS) wasting was provided manually with a batch wasting.

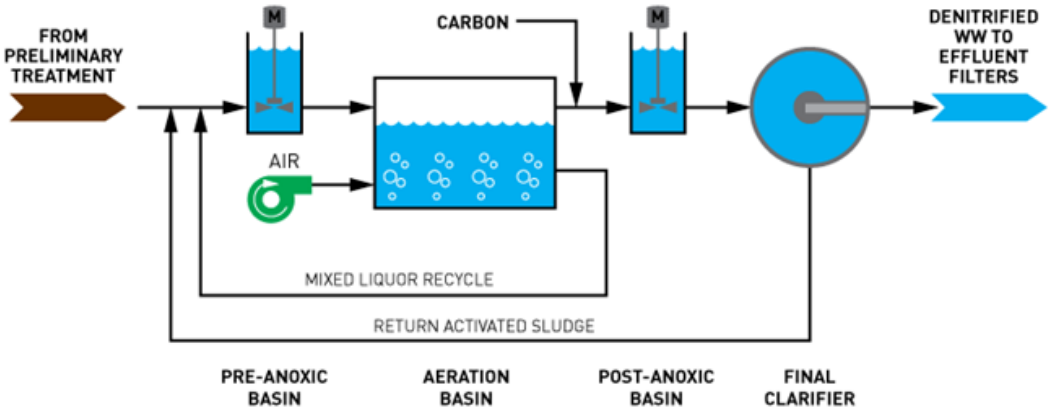

Figure 4.3 2 Stage Activated Sludge System Process Flow Diagram

The 2-stage activated sludge pilot was constructed with one pre-anoxic basin, two aeration basins (due to constructability constraints), one post-anoxic basin, and a final clarifier that had 18-in diameter and 6-ft depth with manual sludge wasting. The system received pre-screened WWTF influent (from preliminary treatment) with hydraulic retention times (HRT) for each zone at a design flow rate of 0.4 gpm were 2 hours in pre-anoxic, 18 hrs in aeration, and 2 hrs in post-anoxic. Pre and post-anoxic basins were constructed with a mechanical mixer and the aeration zones included fine bubble membrane aeration with a minimum airflow provided to maintain excess dissolved oxygen. The design return sludge rate (RAS) was 0.6 gpm, or 150 percent and the design mixed liquor (ML) recycle rate ranged from 0.4-1.6 gpm, or 100-400 percent. Due to operational limitations, only ML recycle rates of approximately 150-300 percent were evaluated. Figures 4.4 and 4.5 show the setup and construction of the 2-stage activated sludge nitrification/denitrification pilot system.

Figure 4.4 Pilot Scale 2-Stage Activated Sludge Construction (pre-anoxic and aeration basins).

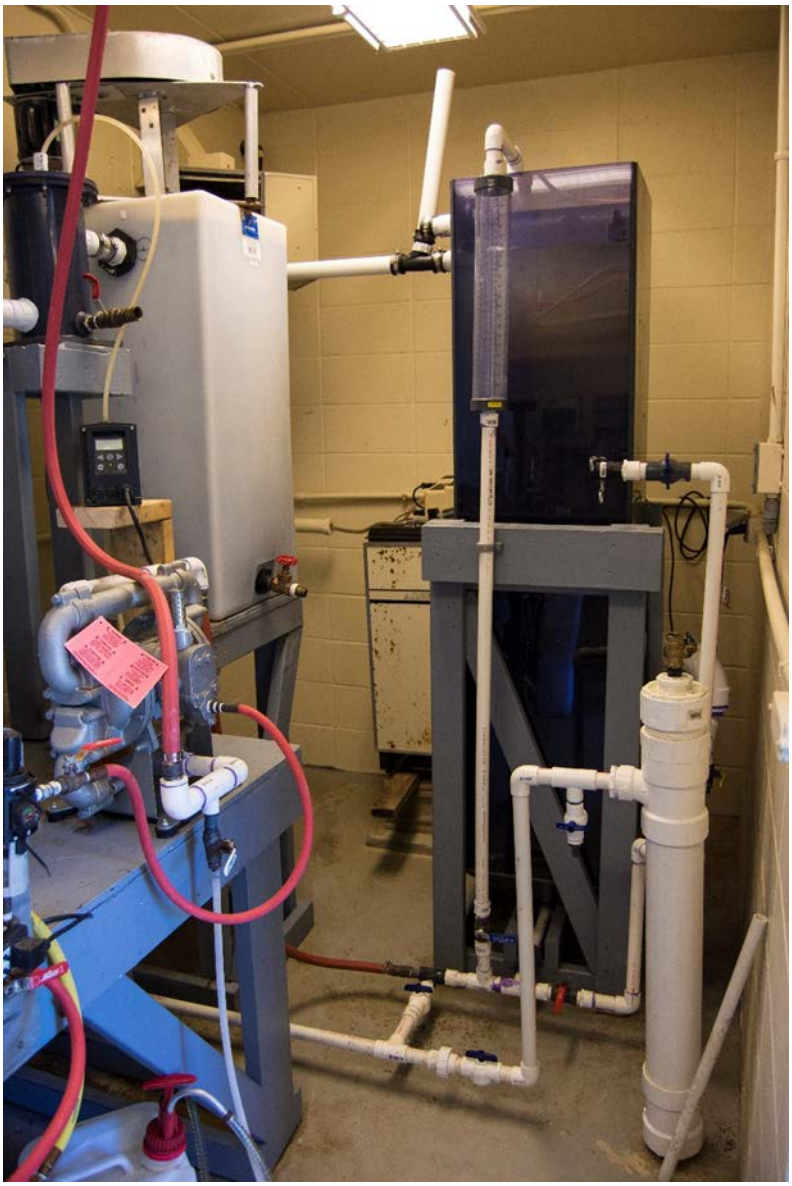

Figure 4.5 Pilot Scale 2-Stage Activated Sludge Construction (post-anoxic and clarifier).

Design pilot scale influent $CBOD_5$ concentrations were based on WWTF influent concentrations ranging from approximately 80-120 mg/L. Influent total nitrogen content peaked at 80 mg/L in 2011 and 2012 and dropped to less than 30 mg/L over the duration of the 2-stage activated sludge pilot operation. Therefore, supplemental nitrogen was provided to evaluate the system with a design total nitrogen content ranging from 30-60 mg/L TN. Design mixed liquor (ML) recycle rates ranged from of 50% to 400%.

Process monitoring included sampling and analysis of the pilot system influent and effluent 1-2 times weekly for nitrate+nitrite (NO_2^-+NO_3^-), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH_3-N), carbonaceous biochemical oxygen demand ($CBOD_5$) and alkalinity.

Continuous nitrate, nitrite, and COD monitoring was not available for the 2-stage activated pilot system due to the lack of availability to the YSI IQ-SensorNet-NiCaVis sensors.

C. SUPPLEMENTAL CHEMICAL ADDITION

Supplemental chemical requirements were evaluated for carbon, alkalinity and nitrogen.

1. Carbon

Carbon is required in association with the denitrification process. Supplemental carbon is essential to the denitrification filter system as all available $CBOD_5$ has been consumed prior to the filtration process. Although the 2-stage activated sludge process returns the nitrified effluent and utilizes the raw $CBOD_5$, supplemental carbon may be required as the influent nitrogen content increases and the $CBOD_5$:N ratio decreases.

Supplemental carbon was provided as needed to both the denitrification filter system and the 2-stage activated sludge pilot system to maintain a design minimum carbon to nitrogen ratio of 4:1 for denitrification. The carbon source used for both pilots was MicroC (Appendix C). Glycerin, or Fremont 8028, is available at a lower cost for full-scale operation but was not utilized in the pilot scale operation.

2. Alkalinity

Due to alkalinity demands associated with nitrification, the need for supplemental alkalinity was evaluated. Influent alkalinity concentrations proved to be adequate for the calculated the demand associated with nitrification of the design range of 30-60 mg/L total nitrogen.

3. Nitrogen

After PM beef ceased operation the ammonia (and TKN) load to the WWTP decreased significantly and ranged between 20 mg/l and 25 mg/L. This necessitated adding supplemental nitrogen to increase the ammonia load to the pilot operation. Supplemental nitrogen requirements are based solely on achieving the design nitrogen feed rates as determined by the pilot study design parameters.

The supplemental nitrogen source used for the study was RLT 4710 (no odor ammonia) (Appendix D) as provided by Fremont Industries. This products was used to supplement influent nitrogen concentrations associated with the 2-stage activated sludge system from the observed concentrations as low as 20 mg/L to achieve design nitrogen concentrations ranging from 30-60 mg/L.

Nitrate-nitrogen was present in the range of 30-40 mg/L in the nitrified secondary treatment effluent utilized for the denitrification filter system. This system was did not receive supplemental nitrogen to evaluate performance at elevated nitrogen concentrations.

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SECTION 5 PILOT SCALE RESULTS

As previously discussed, the nitrogen removal pilot study included operation of a denitrification filter system and a 2-stage activated sludge system. Both systems were designed to operate at a rate of 0.4 gpm.

The denitrification filter system operated from mid-April through August 2015 and received nitrified effluent from the full scale WWTF with nitrate concentrations in the range of 30-40 mg/L. The 2-stage activated sludge system operated from March 2016 through June 2016. At this point in time, influent nitrogen concentrations to the Windom WWTF decreased to approximately 20 mg/L. Due to the lower than anticipated nitrogen content during this period, supplemental nitrogen was provided to increase the available nitrogen throughout the course of the 2-stage activated sludge nitrification/denitrification evaluation.

A. DENITRIFICATION FILTER PILOT SCALE PERFORMANCE

Denitrification filter system performance over the period of April through August 2015 is summarized below in Figure 5.1. As indicated, the system was operated at the Windom WWTF for a period of approximately 4 months. Characteristics of the filter influent, or full-scale nitrified effluent, were relatively consistent with nitrate concentrations ranging between 30 and 40 mg/L.

Operational challenges observed during start-up and operation include 1) calibration and operation of the carbon feed system, 2) backwash frequency, flow and aeration requirements, and 3) filter headloss or plugging.

The carbon feed rate was designed to provide a minimum 4:1 carbon to nitrogen ratio to ensure adequate carbon for denitrification. Due to the small scale of the pilot system, management of the desired feed rate proved to be challenging. Influent and effluent $CBOD_5$, chemical oxygen demand (COD) and filtered COD values were monitored periodically to ensure the presence of carbon as necessary for denitrification. Effluent, or pass-through $CBOD_5$ was acceptable, as post-aeration would be provided with a full-scale denitrification filter installation.

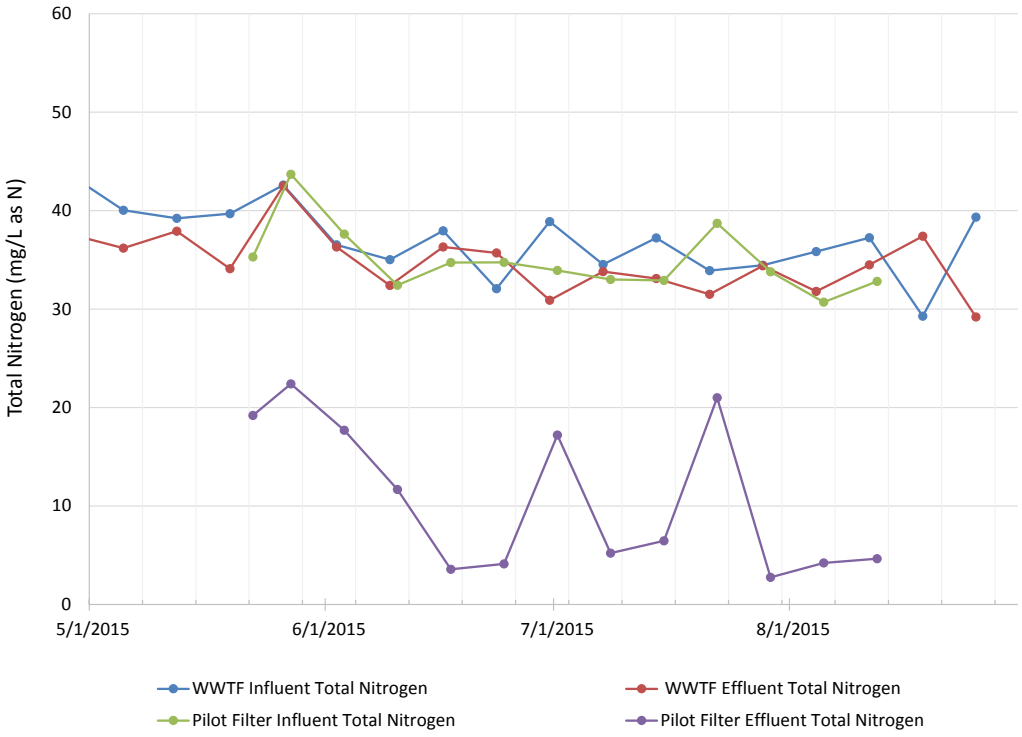

Figure 5.1 Denitrification Filter System Performance

Operation of the pilot scale filter system included continuous flow of nitrified effluent periodically interrupted for filter backwash cycles. Each backwash cycle included manual initiation of air and water to remove particulates and release nitrogen gas. Algae present in the clarifier effluent as pass through from the pretreatment lagoons created frequent operational and plugging issues with the pilot scale filter.

Backwash cycles were typically implemented daily, however, plugging as a result of excessive influent TSS (algae) periodically occurred while the filter was not attended and resulted in loss of media and biomass. This phenomena is associated with the observed decrease in total nitrogen removal observed in early and mid-July.

In summary, short of periodic pilot scale operational challenges, results from the denitrification filter system confirmed the ability of the filter technology to reduce total nitrogen concentrations from 30-40 mg/L to 10 mg/L or less. The goal was to achieve a total nitrogen concentration of 5 mg/L or less. However, the results in Figure 5.1 and Figure 5.2 show that it was achieved only for three data points. The reason for widely

varying effluent TN level cannot be explained except for the operational problems encountered in running the pilot treatment system.

In addition, continuous on-line monitoring of nitrate+nitrite with a YSI sensor is presented in Figure 5.2. As indicated, on-line nitrate+nitrite monitoring provided a reasonable representation of the pilot scale influent nitrate+nitrite concentrations. Effluent concentrations, however, appear to be over-estimated by the YSI sensor as compared to grab samples analyzed by a certified testing laboratory (Minnesota Valley Testing Laboratories).

Figure 5.2 Denitrification Filter System On-Line Process Monitoring

B. 2-STAGE DENITRIFICATION PILOT SCALE PERFORMANCE

Performance of a pilot scale 2-stage activated sludge system over the period of March through June 2015 is summarized below in Figure 5.3. As indicated, the system was operated at the Windom WWTF for a period of approximately 4 months with significant variability. Characteristics of the influent, or full-scale preliminary treatment effluent, were relatively consistent with total nitrogen concentrations of approximately 20 mg/L.

Supplemental nitrogen feed was provided to simulated design influent nitrogen concentrations ranging from 30-60 mg/L.

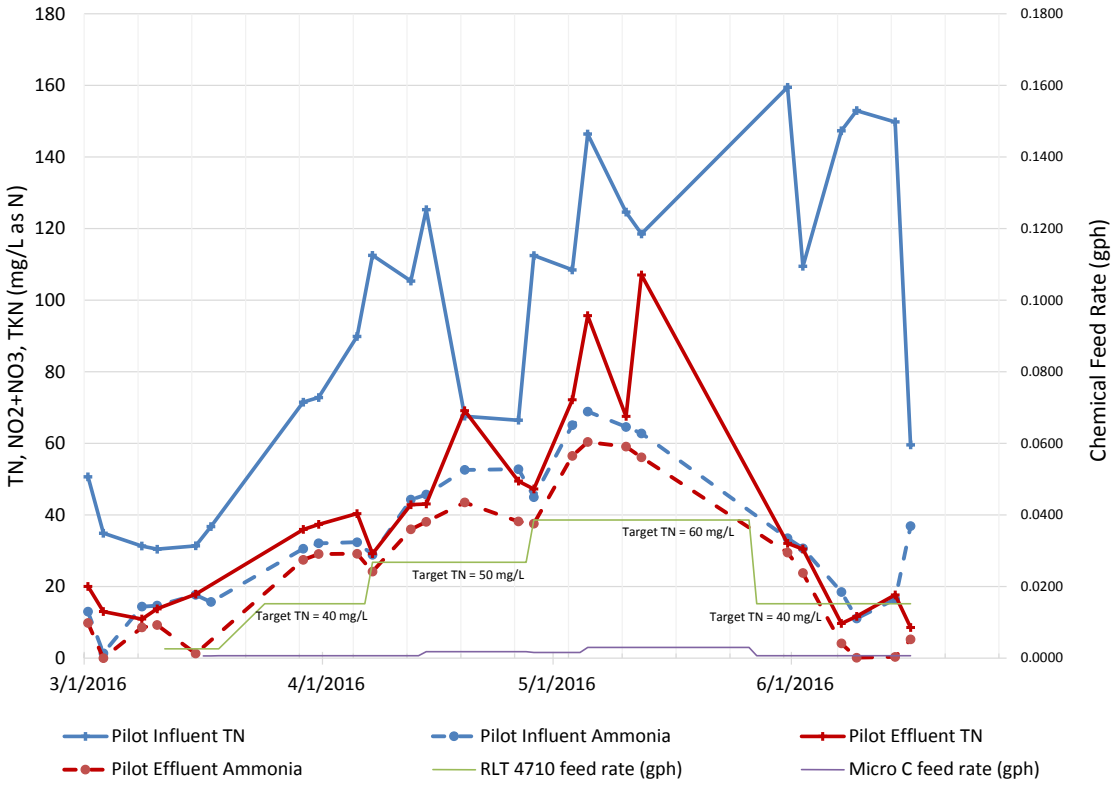

Figure 5.3 2-Stage Activated Sludge Nitrogen Removal Performance

Operational challenges observed during start-up and operation of the 2-stage activated sludge system include 1) calibration and operation of the chemical feed systems, 2) line plugging and solids management at elevated carbon feed rates, and 3) solids maintenance including mixed liquor concentrations and solids retention time.

As indicated in Figure 5.3, monitored influent total nitrogen concentrations, including supplemental chemical feed, ranged from 30 to 160 mg/L. These highly variable observed concentrations were considerably higher than the design concentrations of 30-60 mg/L. The discrepancy between design concentrations and observed pilot influent total nitrogen concentrations is attributed to operational challenges associated with the chemical feed system. Higher than anticipated nitrogen concentrations were not

accompanied with additional carbon feed. Alkalinity was also monitored to verify that the nitrification process was not limited as alkalinity was consumed.

Figure 5.3 also demonstrates the 2-stage activated sludge system's ability to achieve effluent total nitrogen concentrations ranging from 8.5-17 mg/L TN by the end of June 2016. Prior monitoring data from March through early June demonstrate the system's limited performance, or lack of nitrification and subsequent denitrification, as carbon feed was increased in relationship to higher than anticipated nitrogen concentrations. Alkalinity demands at higher than anticipated nitrogen concentrations were also evaluated to ensure nitrification was not limited as a result of alkalinity depletion. Observed effluent alkalinity concentrations ranged from 290-560 mg/L as $CaCO_3$.

In summary, although the drastic reduction in influent total nitrogen concentration resulted in the need for supplemental nitrogen feed and the associated challenges with the nitrogen feed system, after several months of operation, the 2-stage activated sludge process provided support for the system's ability to achieve effluent total nitrogen concentrations below 20 mg/L with a mixed liquor (ML) recycle rate of 150 percent.

Although removal rates to less than 10 mg/L total nitrogen were not observed throughout the pilot scales operation, performance to this level is believed to be achievable with the process technology in combination with increased mixed liquor recycle rates, supplemental carbon feed and establishment of steady state operation with a healthy culture of nitrifiers and denitrifiers. Due to the relatively slow growth rate of nitrifying bacteria, and the rapid increase in supplemental nitrogen content during the course of the pilot study, it is assumed that the nitrogen feed rate increased too rapidly for the biological system and distribution of organisms to adjust. Therefore, insufficient concentrations of nitrifying bacteria resulted in reduced ammonia conversion and higher effluent ammonia and total nitrogen concentrations during this phase of the pilot study.

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SECTION 6 FULL SCALE PROJECTIONS

A. GENERAL

This section provides a description of full scale projections of adding denitrification filters or a two-stage denitrification system to the Windom wastewater treatment facility. The section also includes a summary of capital and operations and maintenance costs.

B. FULL-SCALE RECOMMENDATIONS

1. Denitrification Filter

Denitrification filters have proven advantageous in removing excessive levels of nitrogen from wastewater. Denitrification filters vary in size and efficiency. A pilot scale denitrification filter system was operated at Windom WWTF for 4 months with nitrate levels ranging from 30 – 40 mg/L. The denitrification filter reduced total nitrogen levels to a range from 3 – 21 mg/L. However, the effluent total nitrogen levels fluctuated very widely and the results obtained from the pilot study does not support it would be possible to sustain a TN level below 5 mg/L on a continuous basis.

Full scale operation of a denitrification filter would be an effective method for treating nitrified wastewater. However, there were several operational concerns with the pilot filter. Algae created frequent plugs in the system leading to frequent cleaning and poor efficiency. A filtration system prior to the denitrification filters would remove algae to prevent the filters from being plugged. Therefore, it is recommended to add a filtration system prior to denitrification filters to remove large particles that could potentially plug the denitrification filters.

In the pilot study, additional carbon was added into the denitrification filter to promote denitrification. Carbon addition would be required in full scale operation as a majority of the carbon in the wastewater (as $CBOD_5$) would be used up in the aeration basin. Two supplemental carbon sources have been proven to promote denitrification, MicroC and glycerin (Fremont 8028). The purpose of the carbon source is to supplement the microorganisms' carbon need for cell synthesis and

function. Section 2 describes in detail why carbon addition is important for denitrification.

The size of the denitrification filters and pre-filters to the denitrification filters would depend on the treatment plant capacity. As the flow increases, the filter size increases, and potentially the number of filters increases. The filters would use coarse silica sand for media. For full scale operation with treatment plant capacities ranging from 0.5 MGD to 2.5 MGD, the design filter loading rate would range from 1.2 – 1.3 gpm/ft^2 per filter. The filtration rate with one filter in backwash would vary depending on the flow into the plant. Table 6.1 below shows the cost breakdown for adding a proprietary denitrification filtration system (elimi-NITE®) to a wastewater treatment facility.

2. 2-Stage Denitrification

A 2-stage denitrification system provides both nitrification and denitrification. This system requires additional tanks to promote both nitrification and denitrification. Typically, nitrification is done first in aerobic zones followed by denitrification in anoxic or anaerobic zones. In a typical design, the aeration basin is sized to maintain a hydraulic retention time to allow microorganisms to consume the substrate in the wastewater, and nitrify the influent ammonia. Air is supplied to promote respiration for the microorganisms. Once the wastewater has been aerated, it enters a denitrification basin.

In the denitrification tanks (anoxic or anaerobic), carbon addition is important since all of the $CBOD_5$ has been consumed in the aeration basin. The carbon source can vary, but it is important to maintain a Carbon to Nitrogen ratio (C:N) of 4:1. Recycle in 2-stage activated sludge systems plays a critical role in the level of effectiveness. The recycle of organisms from the final clarifier helps to maintain a solids retention time in the system. Generally, the return activated sludge (from final clarifier) would be recycled at 150% of the influent flow and the mixed liquor recycle (from aeration basin) would be 150 – 300% of the influent flow.

Nevertheless, due to operational problems with the pilot treatment set up, we did not achieve consistent results to demonstrate that the 2-stage activated sludge treatment process is a viable treatment process to achieve an effluent TN level of 5 mg/L or less.

C. FULL-SCALE CAPITAL AND OPERATIONAL COST OPINIONS

Table 6.1 presents the general costs of nitrogen removal using denitrification filters. The costs present a range of flows to reflect variability in treatment schemes and technologies, as well as the economics of scale for varying sized facilities. The costs consider upgrading conventional wastewater treatment facilities to achieve high levels of nitrogen removal. The filter loading rates remain relatively constant for the range of flows. However, as the plant capacity increases, the number of filters increases, driving the capital cost higher. To meet the MPCA reliability criteria, at least two (2) filter units shall be provided and with one unit out of service, the maximum hydraulic loading rate shall not exceed 3 gpm/ft^2.

Table 6.1
General Cost Analysis of Adding Denitrification System

Plant Capacity	Number of Filters	Filter Loading Rate (gpm/ft^2)	Filter Loading Rate with One Filter Out of Service (gpm/ft^2)	Filter Area (ft^2)	Capital Cost*
0.5 MGD	2	1.0 gpm/ft^2	2.0 gpm/ft2	174 ft^2	$1,000,000
1.0 MGD	3	1.33 gpm/ft^2	2.0 gpm/ft2	174 ft^2	$1,500,000
1.5 MGD	3	1.33 gpm/ft^2	2.0 gpm/ft2	260 ft^2	$2,250,000
2.0 MGD	4	1.50 gpm/ft^2	2.0 gpm/ft2	230 ft^2	$2,650,000
2.5 MGD	4	1.54 gpm/ft^2	2.0 gpm/ft2	290 ft^2	$3,350,000

*Costs are associated with the elimi-NITE denitrification system

Table 6.2 presents the costs associated with adding disk filters prior to denitrification filtration. The disk filters would help remove solids and algae (present during pilot testing) prior to the denitrification filter to prevent the denitrification filters from becoming plugged. The cost of adding a disk filter is much less than the cost of adding an entire denitrification system as noted in Table 6.1. However, to ensure the denitrification filters are not plugged, these filters are an important piece in the process design. Tertiary disk filters are recommended ahead of the denitrification filters if the influent to the

denitrification filters have a TSS concentration higher than 5 mg/L. Disk filters have been sized according to the MPCA's reliability criterion which states that at less two units shall be provided and with one units out of service maximum hydraulic lading rate does not exceed 5.9 gpm/ft^2.

Table 6.2
General Cost Analysis of adding Disk Filters

Plant Capacity	Number of Filters	Normal Filter Loading Rate (gpm/ft^2)	Filter Loading Rate with One Filter Out of Service (gpm/ft^2)	Filter Area per unit ft ^{2}	Capital Cost*
0.5 MGD	2	2.90	5.9	60	$270,000
1.0 MGD	2	2.94	5.9	118	$315,000
1.5 MGD	2	2.96	5.9	176	$380,000
2.0 MGD	2	2.94	5.9	236	$435,000
2.5 MGD	2	2.93	5.9	296	$475,000

*Costs associated with adding disk filters

One of the major cost components for this system is the carbon addition. Carbon addition is important to supplement the wastewater to promote denitrification. There are two types of carbon that were investigated for addition as a supplemental carbon source, MicroC and glycerin (Fremont 8028). The pricing of these two carbon sources are presented in Table 6.3. Methanol addition was not considered because of the hazardous condition associated with storing methanol.

Table 6.3
General Cost Analysis of Carbon Addition

Product	Cost
MicroC	$0.56/lb
Glycerin (Fremond 8028)	$0.373/lb

Table 6.4 presents the breakdown of costs of adding denitrification filters to wastewater treatment facilities for various design flow rates. As the flow increases, the cost of the equipment and processes increase. These costs include the filtration equipment and the process equipment, such as piping, buildings, and electrical and controls. Two of the major costs to construction of denitrification filters are the building cost and the filtration equipment. Table 6.1 breaks down the design criteria for the denitrification filters within the range of flow rates, while Table 6.4 provides a general overview of capital costs for

adding a complete denitrification filter system. Generally, the cost for adding a denitrification filter system will range from $2.8 million to $5.7 million.

Table 6.4
Opinion on Capital Cost for Denitrification Filters

Plant Capacity	0.5 MGD	1.0 MGD	1.5 MGD	2.0 MGD	2.5 MGD
Denitrification Filter Equipment Cost	$1,000,000	$1,500,000	$2,250,000	$2,650,000	$3,350,000
Disk Filter Equipment Cost	$270,000	$315,000	$380,000	$435,000	$475,000
Equipment Installation Cost	$500,000	$720,000	$1,050,000	$1,230,000	$1,530,000
Piping Costs	$380,000	$540,000	$780,000	$920,000	$1,140,000
Electrical & Controls Costs	$310,000	$450,000	$650,000	$770,000	$950,000
Building Costs	$380,000	$540,000	$780,000	$920,000	$1,140,000
Engineering	$420,000	$600,000	$880,000	$1,030,000	$1,280,000
Contingency	$280,000	$400,000	$580,000	$690,000	$850,000
Total	$3,540,000	$5,065,000	$7,350,000	$8,645,000	$10,715,000

Table 6.5 presents the breakdown of tank volumes for a new two stage activated sludge process for total nitrogen removal. Again, the table breaks down tank sizes based on the treatment plant capacity. It is assumed the existing wastewater treatment facility contains an aeration basin for BOD removal and a final clarifier with return activated sludge and waste activated sludge, with all necessary pumping facilities. The four tanks presented in the table below represent the four tanks that would need to be constructed to achieve total nitrogen removal.

Table 6.5
New Tank Volume for Two Stage Activated Sludge System for Total Nitrogen Removal

Plant Capacity	0.5 MGD	1.0 MGD	1.5 MGD	2.0 MGD	2.5 MGD
Anaerobic Tank Capacity (gallons)	50,000	100,000	150,000	200,000	250,000
Pre-Anoxic Tank Capacity (gallons)	100,000	200,000	300,000	400,000	500,000
Post-Anoxic Tank Capacity (gallons)	50,000	100,000	150,000	200,000	250,000
Re-Aeration Tank Capacity (gallons)	15,000	30,000	50,000	75,000	100,000
Total	215,000	430,000	650,000	875,000	1,100,000

Based on the assumptions noted above, a two stage activated sludge process begins with an anaerobic tank. The purpose of the anaerobic tank is to convert any of the influent nitrate into nitrogen gas. In addition, the first anaerobic tank will produce Phosphorus

Accumulating Organisms (PAO's). These PAO's help to reduce phosphorus in the wastewater. After the anaerobic tank, the wastewater enters a primary anoxic tank. In this tank, the nitrate that is recycled from the existing aerobic tank is converted into nitrogen gas through denitrification. It is assumed that the mixed liquor recycle into this tank contains only nitrate and all of the ammonia has been oxidized to nitrate. The preliminary denitrified wastewater then enters the existing aerobic tank. The ammonia contained in the influent waste stream is converted into nitrate (nitrification is an aerobic process).

After passing through the aerobic tank, the wastewater enters a secondary anoxic tank (post-anoxic tank). Carbon is typically added into this basin to promote denitrification. A majority of the $CBOD_5$ has been used up in the aerobic tank. The denitrifying organisms require a carbon source for cell functions. After the denitrification tank, the wastewater enters a re-aeration tank. This tank will aerate the wastewater and allow microorganisms to utilize any remaining carbon from the denitrification tank (post-anoxic tank). The wastewater then enters the existing final clarifier where there is return activated sludge and waste activated sludge. The process is shown below in Figure 6.1.

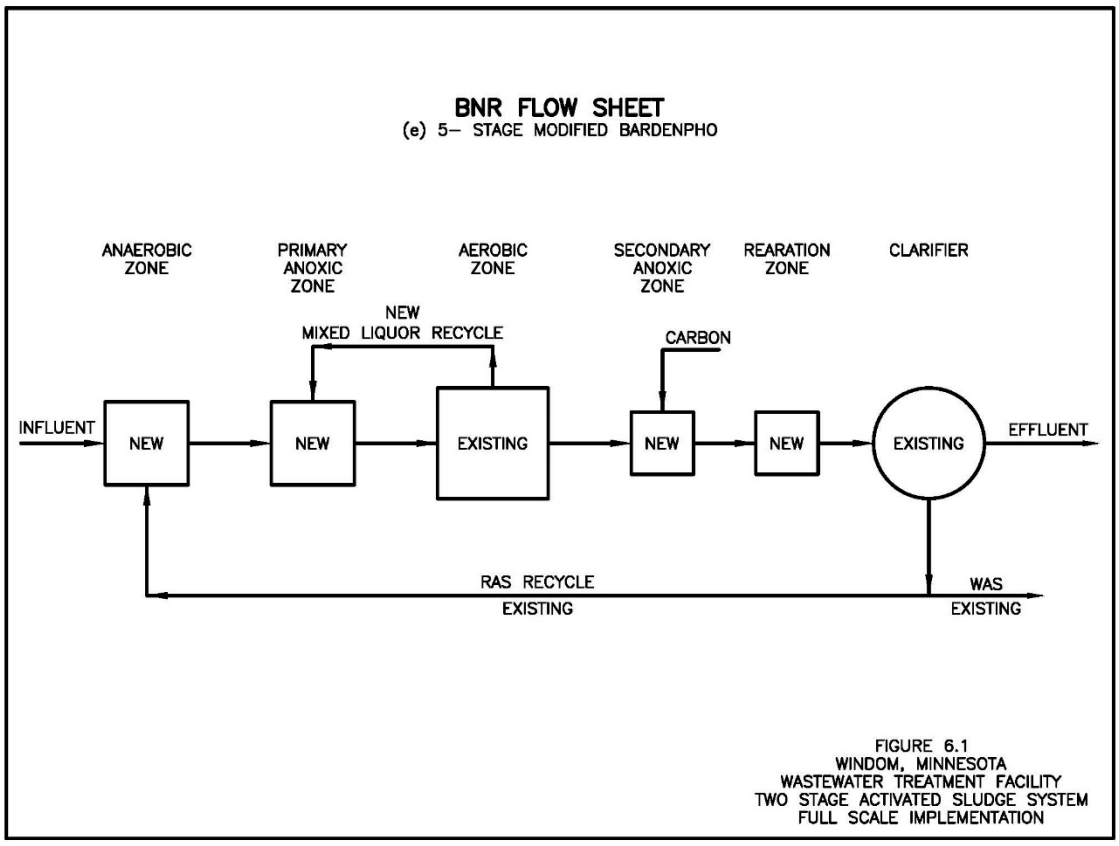


Figure 6.1: Biological Nutrient Removal – 2 Stage Activated Sludge System

Table 6.6 presents the costs breakdown of adding a 2-stage activated sludge system onto an existing activated sludge wastewater treatment facility for a range of treatment plant capacities. The table below describes the approximate pricing for adding the processes shown in Figure 6.1. The new concrete tank pricing includes the four tanks described in Table 6.5. The concrete tanks are the items with the highest capital cost. As the plant capacity increases, more tanks are needed at larger sizes, increasing costs. Generally, the costs for adding 2-stage activated sludge for denitrification will range from $3.8 million to $9.0 million. However, in order to compare these costs with the costs presented in Table 6.4 Denitrification Filters, tertiary filter costs need to be added to these costs. Denitrification filter costs presented in Table 6.4 is capable of producing effluent with TP <1 mg/L due to low TSS in the effluent. Since the TN effluent limit is mostly likely to have a TP limit of 1.0 mg/L or less, a fair comparison of the costs for denitrification filters and two-stage activated sludge process can be made only after the addition of tertiary filter costs to Table 6.6.

Table 6.6
Cost Opinion for Two Stage Activated Sludge System for Total Nitrogen Removal

Plant Capacity	0.5 MGD	1.0 MGD	1.5 MGD	2.0 MGD	2.5 MGD
New Concrete Tanks	$750,000	$1,200,000	$1,500,000	$2,000,000	$2,500,000
Mixers	$112,500	$150,000	$225,000	$300,000	$450,000
Pumps	$75,000	$112,500	$150,000	$187,500	$225,000
Post-Aeration Equipment	$30,000	$60,000	$100,000	$150,000	$200,000
Building	$600,000	$700,000	$800,000	$900,000	$1,000,000
Piping	$600,000	$800,000	$900,000	$1,000,000	$1,100,000
Equipment & Piping Installation	$250,000	$300,000	$400,000	$500,000	$600,000
Site/Civil Work	$300,000	$337,500	$375,000	$450,000	$525,000
Electrical & Controls	$300,000	$375,000	$450,000	$525,000	$600,000
Subtotal	$3,017,500	$4,035,000	$4,900,000	$6,012,500	$7,200,000
Engineering	$453,000	$606,000	$735,000	$902,000	$1,080,000
Contingency	$310,000	$410,000	$490,000	$610,000	$720,000
Total	$3,780,500	$5,051,000	$6,125,000	$7,524,500	$9,000,000

Capital costs for two-stage activated sludge system with tertiary filters to product low effluent TSS and possibly TP less than 1mg/L is presented in Table 6.7.

Table 6.7
Cost Opinion for Two Stage Activated Sludge System with Tertiary FIlters

Plant Capacity	0.5 MGD	1.0 MGD	1.5 MGD	2.0 MGD	2.5 MGD
2-Stage Activated Sludge Process and Cost	$3,780,500	$5,051,000	$6,125,000	$7,524,500	$9,000,000
Tertiary Filter Cost Addition	$675,000	$785,000	$950,000	$1,100,500	$1,200,000
Total Cost	$4,455,500	$5,836,000	$7,075,000	$8,625,000	$10,200,000

D. SUMMARY

In terms of transferability to other communities, these costs represent a general cost associated with the proposed equipment. Higher range costs might be applicable to smaller communities where the advantages of economics of scale are not a factor. Treatment systems have a high degree of variability in infrastructure and equipment, but the designs and associated accosts are largely dependent on influent wastewater characteristics and discharge permit requirements.

Both denitrification filtration systems and 2-stage activated sludge nutrient removal systems have their advantages. Costs presented in Table 6.4 and 6.7 indicate that capital costs for denitrification filters and two-stage activated sludge treatment process are comparable except for the 0.5 MGD plant where a denitrification filter is more cost effective. For treatment plant capacities ranging from 0.5 MGD to 2.5 MGD, denitrification filter systems will range in cost from $3.5 – $10.7 million and 2-stage activated sludge treatment will have costs ranging from $4.4 – $10.2 million. Overall, both processes have the potential to remove high level of nitrogen from wastewater.

APPENDIX A

National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Permit MN0022217 – City of Windom Windom Wastewater Treatment Facility

STATE OF MINNESOTA

Minnesota Pollution Control Agency

Municipal Division

National Pollutant Discharge Elimination System (NPDES)/ State Disposal System (SDS) Permit MN0022217

PERMITTEE: City of Windom

FACILITY NAME: Windom Wastewater Treatment Facility

RECEIVING WATER: Des Moines River, West Fork (Class 2B, 3B, 4A, 4B, 5, 6 water)

TOWNSHIP: Great Bend **COUNTY: Cottonwood**

ISSUANCE DATE: **EXPIRATION DATE:**

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7041, 7049, 7050, 7053, 7060, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, and supersedes the previous permit that was issued for this facility on February 16, 2005. This permit expires at midnight on the expiration date identified above.

Signature: _____

Randall G. Hukriede
Manager, Southwest Region
Regional Division

for The Minnesota Pollution Control Agency

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Questions on this permit?

- For DMR and other permit reporting issues, contact: Tamara Dahl, 507-476-4252.
- For specific permit requirements or permit compliance status, contact: Brad Gillingham, 507-476-4255.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

Table of Contents

Facility Description

The Windom Wastewater Treatment Facility (Facility) is located at the NW¼ of the NE¼ of Section 36, Township 105 North, Range 36 West, Great Bend Township, Cottonwood County, Minnesota. This is a Class B facility.

The application indicates that the existing treatment system consists of the main lift station, mechanical grit removal process which includes a grit separator, grit cyclone and a grit dewatering screw, mechanical and manual bar screens, four aeration basins followed by two final clarifiers, an effluent filtration system, and a chlorine contact tank for disinfection followed by dechlorination prior to discharge. The treatment system also includes a sludge thickening tank, a heated aerobic sludge digester, and three sludge storage tanks. Sludge is land applied and injected and incorporated into the soil about twice a year.

The Facility is designed to treat an average wet weather flow of 1.83 million gallons per day (mgd) with an influent five-day carbonaceous biochemical oxygen demand ($CBOD_5$) strength of 98 milligrams per liter. The Facility has a continuous discharge to the Des Moines River (Class 2B, 3C, 4A, 4B, 5, and 6 water).

The residences on Fish Lake are proposing to send their domestic wastewater to the Facility. The connection is proposed to take place during this five-year permit cycle.

The location of the Facility is shown on the map on page 3. The location of designated monitoring stations is specified on the "Summary of Stations and Station Locations" report on page 4.

In accordance with MPCA rules regarding nondegradation for all waters that are not Outstanding Resource Value Waters (ORVW), nondegradation review is required for any new or expanded significant discharge (Minn. R. 7050.0185). A significant discharge is: 1) a new discharge (not in existence before January 1, 1988) that is greater than 200,000 gallons per day to any water other than a Class 7 water; 2) an expanded discharge that expands by greater than 200,000 gallons per day that discharges to any water other than a Class 7 water; or 3) a new or expanded discharge containing any toxic pollutant at a mass loading rate likely to increase the concentration of the toxicant in the receiving water by greater than one percent over the baseline quality. The flow rate used to determine significance is the design

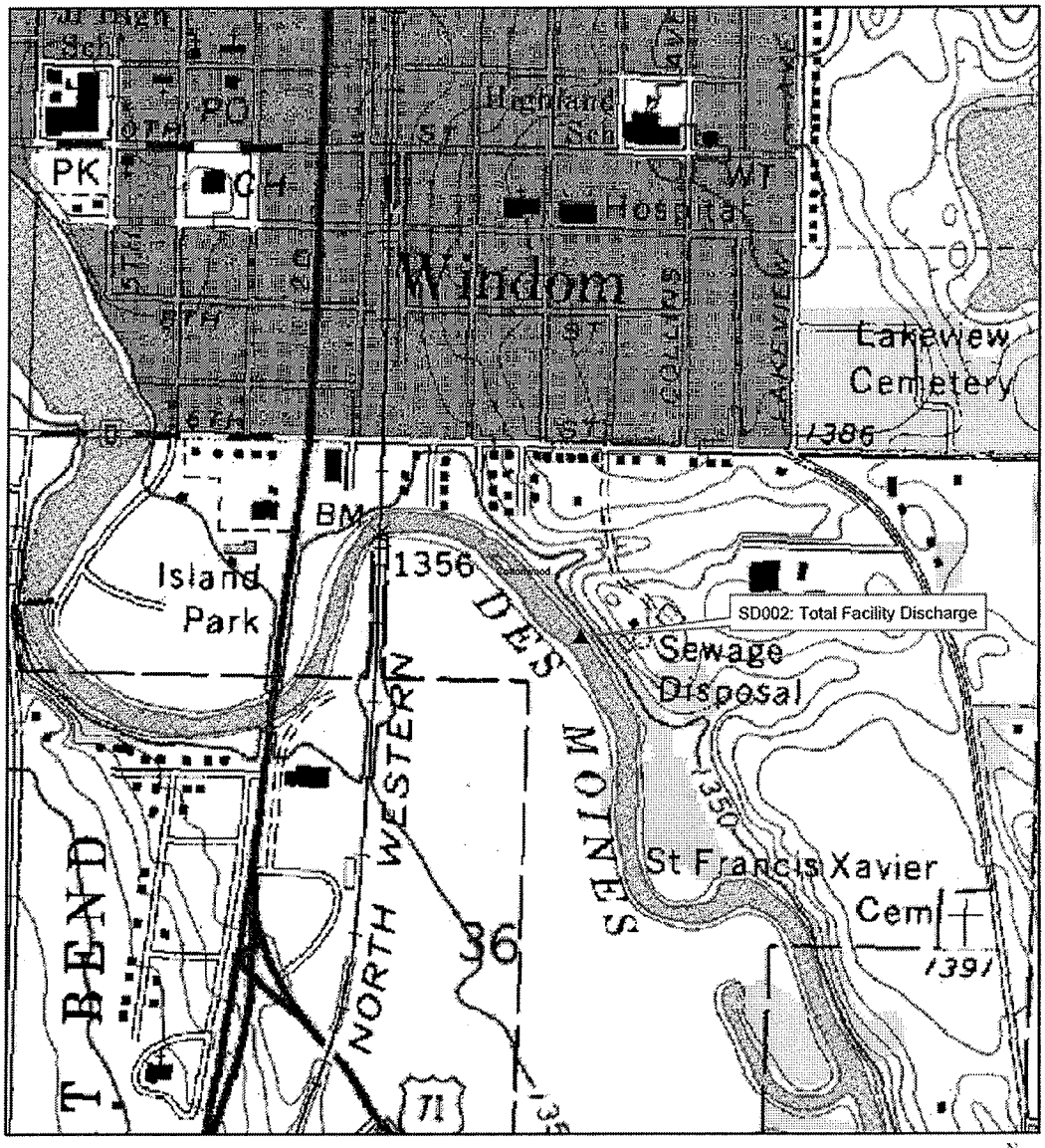
average wet weather flow. The January 1, 1988, design average wet weather flow for this Facility is 0.90 mgd.

This Permit also complies with Minn. R. 7053.0275 regarding anti-backsliding.

Any point source discharger of sewage, industrial, or other wastes for which a National Pollutant Discharge Elimination System permit has been issued by the Agency that contains effluent limits more stringent than those that would be established by parts 7053.0215 to 7053.0265 shall continue to meet the effluent limits established by the permit, unless the permittee establishes that less stringent effluent limits are allowable pursuant to federal law, under section 402(o) of the Clean Water Act, United States Code, title 33, section 1342.

Map of Permitted Facility

MN0022217, Windom Wastewater Treatment Facility
T105N, R36W, Section 36
Great Bend Township, Cottonwood County, Minnesota



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Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD002	Effluent To Surface Water	Main Discharge	NE Quarter of the NW Quarter of Section 36, Township 105 North, Range 36 West

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS001	Influent Waste	Influent Waste Stream	NW Quarter of the NE Quarter of Section 36, Township 105 North, Range 36 West

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The Permittee shall comply with the limits and monitoring requirements as specified below.

SD 002: Main Discharge

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Bicarbonates	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
BOD, Carbonaceous 05 Day (20 Deg C)	34	kg/day	Calendar Month Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	5	mg/L	Calendar Month Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	69	kg/day	Maximum Calendar Week Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	10	mg/L	Maximum Calendar Week Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	173	kg/day	Calendar Month Average	Apr-Nov	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Apr-Nov	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	277	kg/day	Maximum Calendar Week Average	Apr-Nov	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	40	mg/L	Maximum Calendar Week Average	Apr-Nov	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C) Percent Removal	85	%	Minimum Calendar Month Average	Jan-Dec	Calculation	2 x Week	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Chloride, Total	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Chlorine, Total Residual	0.038	mg/L	Daily Maximum	Jan-Dec	Grab	1 x Day	6
Chronic Toxicity Testing	1	TUc	Annual WET Testing	Jan-Dec, effective October 01, 2011	Grab or Composite	1 x Year	
Chronic Toxicity Testing	1	TUc	Quarterly WET Testing	Jan-Dec, effective October 01, 2010	Grab or Composite	1 x Quarter	
Copper, Dissolved (as Cu)	Monitor Only	ug/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	2
Copper, Total (as Cu)	Monitor Only	ug/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	2
Fecal Coliform, MPN or Membrane Filter 44.5C	200	#100ml	Calendar Month Geometric Mean	Apr-Oct	Grab	2 x Week	
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement, Continuous	1 x Day	4
Flow	Monitor Only	mgd	Calendar Month Maximum	Jan-Dec	Measurement, Continuous	1 x Day	4
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement, Continuous	1 x Day	4
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Magnesium, Total (as Mg)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
Nitrite Plus Nitrate, Total (as N)	Monitor Only	mg/L	Calendar Month Average	Apr, Sep	24-Hour Flow Composite	1 x Month	
Nitrogen, Ammonia, Total (as N)	57	kg/day	Calendar Month Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	8.2	mg/L	Calendar Month Average	Dec-Mar	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	50	kg/day	Calendar Month Average	Apr-May	24-Hour Flow Composite	2 x Week	

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The Permittee shall comply with the limits and monitoring requirements as specified below.

SD 002: Main Discharge

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Nitrogen, Ammonia, Total (as N)	7.2	mg/L	Calendar Month Average	Apr-May	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	7	kg/day	Calendar Month Average	Jun-Sep	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	1.0	mg/L	Calendar Month Average	Jun-Sep	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	23	kg/day	Calendar Month Average	Oct-Nov	24-Hour Flow Composite	2 x Week	
Nitrogen, Ammonia, Total (as N)	3.3	mg/L	Calendar Month Average	Oct-Nov	24-Hour Flow Composite	2 x Week	
Nitrogen, Kjeldahl, Total	Monitor Only	mg/L	Calendar Month Average	Apr, Sep	24-Hour Flow Composite	1 x Month	
Oxygen, Dissolved	10.0	mg/L	Calendar Month Minimum	Dec-Mar	Grab	1 x Day	1
Oxygen, Dissolved	6.0	mg/L	Calendar Month Minimum	Apr-Nov	Grab	1 x Day	1
pH	9.0	SU	Calendar Month Maximum	Jan-Dec	Grab	1 x Day	1
pH	6.0	SU	Calendar Month Minimum	Jan-Dec	Grab	1 x Day	1
Phosphorus, Total (as P)	Monitor Only	kg/day	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Week	
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Week	
Potassium, Total (as K)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Sodium, Total (as Na)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5
Solids, Total Suspended (TSS)	208	kg/day	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
Solids, Total Suspended (TSS)	311	kg/day	Maximum Calendar Week Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
Solids, Total Suspended (TSS)	45	mg/L	Maximum Calendar Week Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
Solids, Total Suspended (TSS) Percent Removal	85	%	Minimum Calendar Month Average	Jan-Dec	Calculation	2 x Week	
Specific Conductance	Monitor Only	umh/cm	Calendar Month Maximum	Jan-Dec	Measurement	1 x Month	5
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	1 x Month	5

Windom WWTP
Limits and Monitoring Requirements

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The Permittee shall comply with the limits and monitoring requirements as specified below.

WS 001: Influent Waste Stream

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
BOD, Carbonaceous 05 Day (20 Deg C)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
BOD, Carbonaceous 05 Day (20 Deg C)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	2 x Week	
Mercury, Total (as Hg)	Monitor Only	ng/L	Calendar Quarter Maximum	Jan-Dec	Grab	1 x Quarter	3
pH	Monitor Only	SU	Calendar Month Maximum	Jan-Dec	Grab	1 x Day	1
pH	Monitor Only	SU	Calendar Month Minimum	Jan-Dec	Grab	1 x Day	1
Phosphorus, Total (as P)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	1 x Week	
Precipitation	Monitor Only	in	Calendar Month Total	Jan-Dec	Measurement	1 x Day	
Solids, Total Suspended (TSS)	Monitor Only	mg/L	Calendar Month Average	Jan-Dec	24-Hour Flow Composite	2 x Week	
Solids, Total Suspended (TSS)	Monitor Only	mg/L	Calendar Month Maximum	Jan-Dec	24-Hour Flow Composite	2 x Week	

Notes:
1 -- Analyze immediately.
2 -- EPA Method 200.8
3 -- EPA method 1631, with clean techniques method 1669, and any revisions to those methods. Please refer to Chapter 2 Mercury Minimization plan for further information.
4 -- Influent flow measurements are to be reported on the SD002 DMR. You do not need to install effluent flow meters.
5 -- See Chapter 1: Special Requirements - Salty Discharge Monitoring for additional Information.
6 -- Whenever chlorine is added. Analyze immediately. This means within 15 minutes or less of sample collection. A Method Detection Limit and a Reporting Limit must be established for this parameter. The Reporting Limit cannot be greater than 0.1 mg/L.

Chapter 1. Special Requirements

1. Special Requirements

Salty Discharge Monitoring

1.1 The Permittee may request a reduction in monitoring after 2 years of sampling results, if the monitoring does not indicate a reasonable potential to exceed a water quality standard limit.

1.2 If monitoring results indicate a reasonable potential for any of the parameters, the Permittee will be required to submit an application for a permit modification. If necessary, a compliance schedule will be added to the permit to ensure progress towards meeting the water quality standards.

Chapter 2. Non-waste Streams -- Mercury Minimization Plan

1. Mercury Pollutant Minimization Plan

1.1 Mercury is present in all municipal and many industrial wastewater discharges. Mercury is a powerful neurotoxin that affects human health and the environment. A naturally-occurring element, mercury does not break down into less-harmful substances over time. Instead, mercury released into the environment accumulates in fish and animal tissues, a process known as bioaccumulation. Widespread mercury contamination has prompted the Minnesota Department of Health (MDH) to issue fish consumption advisories throughout the state. Most of Minnesota's impaired waters are contaminated by mercury and other bioaccumulative toxins. The MPCA is carefully evaluating all mercury discharges in the state.

1.2 The Permittee is required to complete and submit a Mercury Pollutant Minimization Plan (MMP) to the MPCA as detailed in this section. If the Permittee has previously submitted a MMP, it must update its MMP and submit the updated MMP to the MPCA. The purpose of the MMP is to evaluate collection and treatment systems to determine possible sources of mercury as well as potential mercury reduction options. Guidelines for developing a MMP are detailed in this section.

1.3 The Permittee shall submit a Mercury Minimization Plan by 180 days after permit issuance. At a minimum, the MMP must include the following:

a) A summary of mercury influent and effluent concentrations and biosolids monitoring data using the most recent five years of monitoring data, if available.

b) Identification of existing and potential sources of mercury concentrations and/or loading to the facility. As appropriate for your facility, you should consider residential, institutional, municipal, and commercial sources (such as dental clinics, hospitals, medical clinics, nursing homes, schools, and industries with potential for mercury contributions). You should also consider other influent mercury sources, such as stormwater inputs, ground water (inflow & infiltration) inputs, and waste streams or sewer tributaries to the wastewater treatment facility.

c) An evaluation of past and present WWTF operations to determine those operating procedures that maximize mercury removal.

d) A summary of any mercury reduction activities implemented during the last five years.

e) A plan to implement mercury management and reduction measures during the next five years.

Chapter 2. Non-waste Streams -- Mercury Minimization Plan

1. Mercury Pollutant Minimization Plan

1.4 In addition to the sampling required in the Limits and Monitoring section of this permit, the Permittee shall sample effluent from the total facility discharge station for Dissolved Mercury and TSS on a quarterly basis throughout the life of this permit. The sampling method is a concurrent grab sample for the two parameters. Dissolved Mercury shall be analyzed using an EPA approved low level mercury analysis method. Samples shall be taken at any time during the calendar quarter and reported on the custom supplemental form provided by the MPCA. The custom supplemental form must be submitted with the DMR for the last month of each quarter.

Chapter 3. Phosphorus Management Plan

1. General Requirements

1.1 Phosphorus is a common constituent in many wastewater discharges and a pollutant that has the potential to negatively impact the quality of Minnesota's lakes, wetlands, rivers and streams. Therefore, phosphorus discharges are being carefully evaluated throughout the state.

The Permittee is required to complete and submit an updated Phosphorus Management Plan (PMP) to the MPCA as detailed in this section. If the Permittee has already submitted a PMP, the Permittee must update that PMP and submit the updated PMP to the MPCA as detailed in this section.

While the PMP does not require specific reductions at this time, the MPCA strongly encourages the Permittee to identify and eliminate/reduce sources of phosphorus to, and improve phosphorus management within, the permitted wastewater treatment facility. However, be aware that new or expanding discharges may be required to actively manage and reduce phosphorus, including complying with new or tighter phosphorus effluent limits.

For additional information about completing the PMP below, please contact the MPCA at 651-282-6143 or 800-657-3864.

1.2 The Permittee shall submit and updated Phosphorus Management Plan (PMP) to the MPCA 180 days prior to permit expiration.

At a minimum, the PMP shall include the following:

a. A summary of influent and effluent concentrations, mass loadings, and percent removal calculations using the most recent five years of monitoring data, if available.

b. Identification of existing and potential sources of elevated phosphorus concentrations and/or loading to the facility. As appropriate for the facility, consider residential, institutional, municipal, and commercial sources.

c. An evaluation of past and present WWTF operations to determine those operating procedures that maximize phosphorus removal.

d. A summary of any phosphorus reduction activities implemented during the last five years.

e. Phosphorus management and reduction goals for the next five years using the information collected in A through D above.

f. A plan to implement phosphorus management and reduction measures during the next five years.Submit a Phosphorus Management Plan by 180 days before permit expiration.

Chapter 4. Total Residual Oxidants - Domestic

1. General Requirements

1.1 "Daily Maximum" for Total Residual Chlorine (TRC) concentration limits means:

a. The value of a single sample in a 24-hour period if the concentration of TRC in that sample is 0.038 mg/L or less, or below the Reportable Limit (RL).

b. If the concentration of TRC in the first sample is greater than 0.038 mg/L or greater than the RL, reporting the average of two to twelve samples analyzed in a 24-hour period is allowed. The second sample must be taken two hours after the first sample and subsequent samples are to be taken at one-hour intervals thereafter, not to exceed a total of twelve samples in a 24-hour period. Values below the Reportable Limit for TRC are assumed to be zero for averaging purposes only. Whenever daily TRC values are averaged, the 0.038 mg/L limit must be met and the average value must be reported, not < the RL.

c. The average value of multiple daily TRC effluent sample analyses must meet the 0.038 mg/L limit to be in compliance.

1.2 Total Residual Chlorine must be analyzed immediately. This means within 15 minutes or less of sample collection. (40 CFR Part 136 and Standard Methods for the Examination of Water and Wastewater, Latest Edition)

1.3 A Method Detection Limit (MDL) must be established for this parameter.

1.4 The Reportable Limit must be established for this parameter. This should be based on the Method Detection Limit and laboratory, analyst, and equipment used in the analysis. The Reportable Limit cannot be greater than 0.1 mg/L.

1.5 The Method Detection Limit and Reportable Limit should be reassessed when the method, equipment, laboratory, or analyst changes.

1.6 Monitoring results below the Reportable Limit should be reported as "<" the Reportable Limit. For example, if the Reportable Limit is 0.01 mg/L and a parameter is not detected at a value of 0.01 mg/L or greater, the concentration shall be reported as "<0.01mg/L." The symbol "<" means "less than."

1.7 The equipment should be checked against a known standard at least monthly.

Chapter 5. Whole Effluent Toxicity (WET) Testing - Chronic

1. General Requirements

1.1 The Permittee shall conduct quarterly chronic toxicity test batteries on Discharge SD002 beginning with the first full calendar year quarter following the issuance date of the permit. The first quarter results are due by the end of the first full calendar quarter following permit issuance.

1.2 Annual chronic test batteries shall be conducted in each succeeding year for the remainder of the permit. The first annual results are due one year from the due date of the final quarter results and annually thereafter.

1.3 The Permittee shall conduct annual chronic toxicity test batteries on Discharge SD002 beginning with the issuance date of the permit. The first set of annual results are due one year from the end of the first full calendar quarter following permit issuance and annually thereafter.

1.4 Any test that exceeds 1.0 TUc shall be re-tested according to the Positive Toxicity Results requirement(s) that follow to determine if toxicity is still present above 1.0 TUc.

Chapter 5. Whole Effluent Toxicity (WET) Testing - Chronic

2. Species and Procedural Requirements

2.1 Tests shall be conducted in accordance with procedures outlined in EPA-821-R-02-013 "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" - Fourth Edition (Chronic Manual) and any revisions to the Manual. Any test that is begun with an effluent sample that exceeds a total ammonia concentration of 5 mg/l shall use the carbon dioxide-controlled atmosphere technique to control pH drift.

2.2 Test organisms for each test battery shall include the fathead minnow (Pimephales promelas)-Method 1000.0 and Ceriodaphnia dubia-Method 1002.0.

2.3 Static renewal chronic serial dilution tests of the effluent shall consist of a control, 12, 25, 50, 75 and 100% effluent.

2.4 All effluent samples shall be flow proportioned, 24-hour composites. Test solutions shall be renewed daily. Testing of the effluent shall begin within 36 hours of sample collection. Receiving water collected outside of the influence of discharge shall be used for dilution and controls. Chronic toxicity tests shall be conducted in accordance with procedures outlined in EPA-821-R-02-013 "Short-term Methods for Measuring the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" - Fourth Edition (Chronic Manual) and any revisions to the Manual.

2.5 Any other circumstances not addressed in the previous requirements or that require deviation from that specified in the previous requirements shall first be approved by the MPCA.

3. Quality Control and Report Submittals

3.1 Any test that does not meet quality control measures, or results which the Permittee believes reflect an artifact of testing shall be repeated within two (2) weeks. These reports shall contain information consistent with the report preparation section of the Chronic Manual. The MPCA shall make the final determination regarding test validity.

4. Positive Toxicity Result for WET

4.1 Should a test exceed 1.0 TUc for whole effluent toxicity based on results from the most sensitive test species, the Permittee shall conduct two repeat test batteries on all species. The repeat tests are to be completed within forty-five (45) days after completion of the positive test. These tests will be used to determine if toxicity exceeding 1.0 TUc remains present for any test species. If no toxicity is present above 1.0 TUc for any test species, the Permittee shall return to the test frequency specified by the permit. If the repeat test batteries indicate toxicity above 1.0 TUc for any test species, the Permittee shall submit for MPCA review a plan for conducting a Toxicity Reduction Evaluation (TRE), including the Facility Performance Review (to be submitted to the MPCA WQ Submittals Center within 60 days after toxicity discovery date) and, at a minimum, provide quarterly reports starting from the date of TRE submittal, regarding progress towards the identity, source, and any plans for the removal of the toxicity. The TRE shall be consistent with EPA guidance or subsequent procedures approved by the MPCA in attempting to identify and remove the source of the toxicity. Routinely scheduled chronic toxicity test batteries required in this permit section shall be suspended for the duration of the TRE. The return to routine chronic toxicity testing is subject to successful completion of conformation testing, as determined by the MPCA. Amendments to the initial TRE shall be approved by MPCA staff and the schedules identified therein.

Chapter 5. Whole Effluent Toxicity (WET) Testing - Chronic

5. WET Data and Test Acceptability Criteria (TAC) Submittal

5.1 All WET test data and TAC must be submitted to the MPCA by the dates required by this section of the permit using the following form(s) and associated instruction forms:
Minnesota Pollution Control Agency Acute Toxicity Test Report/ Minnesota Pollution Control Agency Ceriodaphnia dubia Chronic Toxicity Test Report/ Minnesota Pollution Control Agency Fathead Minnow Chronic Toxicity Test Report. Data not submitted on the correct form(s), or submitted incomplete, will be returned to the permittee and deemed incomplete until adequately submitted on the designated form (identified above). Data should be submitted to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

6. Whole Effluent Toxicity Requirement Definitions

6.1 "Chronic Whole Effluent Toxicity (WET) Test is a static renewal test conducted on an exponentially diluted series of effluent. The purpose is to calculate appropriate biological effect endpoints (NOEC/LOEC or IC25), specified in the referenced chronic manual. A statistical effect level less than or equal to the Receiving Water Concentration (RWC) constitutes a positive test for chronic toxicity. The RWC equals the 100 percent effluent concentration or 1.0 TUc.

6.2 "Chronic toxic unit (TUc)" is the reciprocal of the effluent dilution that causes no unacceptable effect on the test organisms by the end of the chronic exposure period. For example, a TUc equals [7Q10flow (mgd) + effluent average dry weather flow (mgd)]/[effluent average dry weather flow (mgd)].

Chapter 6. Surface Discharge Stations

1. Requirements for Specific Stations

1.1 SD 002: Submit a monthly DMR by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Samples for Station SD002 shall be taken at a point representative of the effluent discharged to the receiving water.

2.2 Samples and measurements required by this permit shall be representative of the monitored activity.

3. Surface Discharges

3.1 Floating solids or visible foam shall not be discharged in other than trace amounts.

3.2 Oil or other substances shall not be discharged in amounts that create a visible color film.

3.3 The Permittee shall install and maintain outlet protection measures at the discharge stations to prevent erosion.

4. Winter Sampling Conditions

4.1 The Permittee shall sample flows at the designated monitoring stations including when this requires removing ice to sample the water. If the station is completely frozen throughout a designated sampling month, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR) and note the ice conditions in Comments on the DMR.

Chapter 6. Surface Discharge Stations

5. Priority Pollutants - Monitoring Requirements

5.1 The Permittee shall monitor the effluent three times in the life of the permit for the following specified priority pollutants. Sampling events shall not be less than one year apart.

Monitoring shall be for the organic priority pollutants identified under the volatile, acid, base/neutral, and pesticide fractions using EPA methods 624, 625 and 608 (40 CFR Part 136, October 25, 1984) as listed in Table II of 40 CFR Part 122, Appendix D.

The following priority pollutant total metals shall also be monitored using either EPA method 200.8 or their corresponding graphite furnace method found in Table IB of 40 CFR Part 136: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc. In addition, the Permittee shall monitor for Total Cyanide (EPA method 335), Total Phenolic Compounds (EPA method 420), and Hardness (total as CaCO3) (EPA method 130). Total Mercury shall be monitored by EPA method 1631, if not already required by the permit.

5.2 Submit the results of the first sampling event no later than three years prior to the expiration date of this permit.

5.3 Submit the results of the second sampling event no later than two years prior to the expiration date of this permit.

5.4 Submit the results of the third or final sampling event no later than one year prior to the expiration date of this permit.

6. Discharge Monitoring Reports

6.1 The Permittee shall submit monitoring results for discharges in accordance with the limits and monitoring requirements for this station. If no discharge occurred during the reporting period, the Permittee shall check the "No Discharge" box on the Discharge Monitoring Report (DMR).

Chapter 7. Waste Stream Stations

1. Requirements for Specific Stations

1.1 WS 001: Submit a monthly DMR by 21 days after the end of each calendar month following permit issuance.

2. Sampling Location

2.1 Samples for station WS001 shall be collected at a point representative of total influent flow to the system.

Chapter 8. Domestic Wastewater -- Mechanical System

1. Bypass Structures

1.1 All structures capable of bypassing the treatment system shall be manually controlled and kept locked at all times.

2. Sanitary Sewer Extension Permit

2.1 The Permittee may be required to obtain a Sanitary Sewer Extension Permit from the MPCA prior to the start of construction of any addition, extension or replacement to the sanitary sewer. If a sewer extension permit is required, no construction of any part of the system may begin until that permit has been issued.

Chapter 8. Domestic Wastewater -- Mechanical System

3. Operator Certification

3.1 The Permittee shall provide a Class B state certified operator who is in direct responsible charge of the operation, maintenance and testing functions required to ensure compliance with the terms and conditions of this permit.

3.2 The Permittee shall provide the appropriate number of operators with a Type IV certification to be responsible for the land application of biosolids or semisolids from commercial or industrial operations.

3.3 If the Permittee chooses to meet operator certification requirements through a contractual agreement, the Permittee shall provide a copy of the contract to the MPCA, WQ Submittals Center. The contract shall include the certified operator's name, certificate number, company name if appropriate, the period covered by the contract and provisions for renewal; the duties and responsibilities of the certified operator; the duties and responsibilities of the permittee; and provisions for notifying the MPCA 30 days in advance of termination if the contract is terminated prior to the expiration date.

3.4 The Permittee shall notify the MPCA within 30 days of a change in operator certification or contract status.

Chapter 9. Biosolids Land Application

1. Authorization

1.1 This permit authorizes the Permittee to store and land apply domestic wastewater treatment biosolids in accordance with the provisions in this chapter and Minnesota Rules, ch. 7041.

1.2 Permittees who prepare bulk biosolids must obtain approval of the sites on which bulk biosolids are applied before they are applied unless they are exceptional quality biosolids. Site application procedures are set forth in Minnesota Rules, pt. 7041.0800.

2. Compliance Responsibility

2.1 The Permittee is responsible for ensuring that the applicable requirements in this chapter and Minnesota Rules ch. 7041 are met when biosolids are prepared, distributed, or applied to the land.

3. Notification Requirements

3.1 The Permittee shall provide information needed to comply with the biosolids requirements of Minnesota Rules, ch. 7041 to others who prepare or use the biosolids.

Chapter 9. Biosolids Land Application

4. Pollutant Limits

4.1 Biosolids which are applied to the land must not exceed the ceiling concentrations in Table 1 and must not be applied so that the cumulative amounts of pollutant in Table 2 are exceeded.

Table 1 Ceiling Concentrations (dry weight basis)

Parameter in units mg/kg	
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7500

Table 2 Cumulative Loading Limits

Parameter in units lbs/acre	
Arsenic	37
Cadmium	35
Copper	1339
Lead	268
Mercury	15
Molybdenum	not established*
Nickel	375
Selenium	89
Zinc	2500

*The cumulative limit for molybdenum has not been established at the time of permit issuance

5. Pathogen and Vector Attraction Reduction

5.1 Biosolids shall be processed, treated, or be incorporated or injected into the soil to meet one of the vector attraction reduction requirements in Minnesota Rules, pt. 7041.1400.

5.2 Biosolids shall be processed or treated by one of the alternatives in Minnesota Rules, pt. 7041.1300 to meet the Class A or Class B standards for the reduction of pathogens. When Class B biosolids are applied to the land, the site restrictions in Minnesota Rules, pt. 7041.1300 must also be met.

Chapter 9. Biosolids Land Application

5. Pathogen and Vector Attraction Reduction

5.3 The minimum duration between application and harvest, grazing or public access to areas where Class B biosolids have been applied to the land is as follows:

a. 14 months for food crops whose harvested parts may touch the soil/biosolids mixture (such as melons, squash, tomatoes, etc.), when biosolids are surface applied, incorporated or injected.

b. 20 months or 38 months depending on the application method for food crops whose harvested parts grow in the soil (such as potatoes, carrots, onions, etc.). The 20 month time period is required when biosolids are surface applied or surface applied and incorporated after they have been on the soil surface for at least four (4) months. The 38 month time period is required when the biosolids are injected or surface applied and incorporated within four (4) months of application.

c. 30 days for feed crops, other food crops (such as field corn, sweet corn, etc.), hay or fiber crops when biosolids are surface applied, incorporated or injected.

d. 30 days for grazing of animals when biosolids are surface applied, incorporated or injected.

e. One year where there is a high potential for public contact with the site, (such as a reclamation site located in populated areas, a construction site located in a city, turf farms, plant nurseries, etc.) and 30 days where there is low potential for public contact (such as agricultural land, forest, a reclamation site located in an unpopulated area, etc.) when biosolids are surface applied, incorporated, or injected.

6. Management Practices

6.1 The management practices for the land application of biosolids are described in detail in Minnesota Rules, pt. 7041.1200 and must be followed unless specified otherwise in a site approval letter or a permit issued by the MPCA.

6.2 Overall management requirements:

a. Biosolids must not be applied to the land if it is likely to adversely affect a threatened or endangered species listed under Section 4 of the Endangered Species Act or its designated critical habitat.

b. Biosolids must not be applied to flooded, frozen or snow covered ground so that the biosolids enter wetlands or other waters of the state.

c. Biosolids must be applied at an agronomic rate unless specified otherwise by the MPCA in a permit.

d. Biosolids shall not be applied within 33 feet of a wetland or waters of the state unless specified otherwise by the MPCA in a permit.

7. Monitoring Requirements

7.1 Representative samples of biosolids applied to the land must be analyzed by methods specified in Minnesota Rule pt. 7041.3200 for the following parameters: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, Kjeldahl nitrogen, ammonia nitrogen, total solids, volatile solids, phosphorus, potassium and pH.

Chapter 9. Biosolids Land Application

7. Monitoring Requirements

7.2 At a minimum, biosolids must be monitored at the frequencies specified in Table 3 for the parameters listed above, and any pathogen or vector attraction reduction requirements in Minnesota Rules, pts. 7041.1300 and 7041.1400 if used to determine compliance with those parts.

Table 3 Minimum Sampling Frequencies

Biosolids Applied* (metric tons/365-day period)	Biosolids Applied* (tons/365-day period)	Frequency (times/365-day period)
>0 but <290	>0 but <320	1
>=290 but <1,500	>=320 but <1,650	4
>=1,500 but <15,000	>=1,650 but <16,500	6
>=15,000	>=16,500	12

* Either the amount of bulk biosolids applied to the land or the amount of biosolids received by a person who prepares biosolids that are sold or given away in a bag or other container for application to the land (dry weight basis).

7.3 Representative samples of biosolids that are transferred to storage units and are stored for more than two years shall be analyzed by methods specified in Minnesota Rule pt. 7041.3200 for each cropping year they are stored for the following parameters: arsenic, cadmium, copper, lead, molybdenum, nickel, selenium, and zinc. Mercury is specifically NOT included in the stored biosolids analysis because of the short holding time [28 days] required between sampling and analysis.

7.4 Increased sampling frequencies are specified for the parameters listed in Table 4. Sampling at a frequency at twice the minimum frequencies in Table 3 is required if concentrations listed in Table 4 are exceeded (based on the average of all analyses made during the previous cropping year).

Table 4 Increased Frequency of Sampling

Parameter (mg/kg dry weight basis)
Arsenic 38
Cadmium 43
Copper 2150
Lead 420
Mercury 28
Molybdenum 38
Nickel 210
Selenium 50
Zinc 3750

8. Records

8.1 The Permittee shall keep records of the information necessary to show compliance with pollutant concentrations and loadings, pathogen reduction requirements, vector attraction reduction requirements and management practices as specified in Minnesota Rules, pt. 7041.1600, as applicable to the quality of biosolids produced.

9. Reporting Requirements

9.1 By December 31 following the end of each cropping year, the Permittee shall submit a Biosolids Annual Report for the land application of biosolids on a form provided by or approved by the MPCA. The report shall include the requirements in Minnesota Rules, part 7041.1700.

Chapter 9. Biosolids Land Application

9. Reporting Requirements

9.2 If, during any cropping year, biosolids were transferred, or not land applied, the Permittee shall submit a Biosolids Annual Report by December 31 following the end of the cropping year. The report shall state that biosolids were not land applied, how much was generated, and where they were transferred to.

9.3 For biosolids that are stored for more than two years, the Biosolids Annual Report must also include the analytical data from the representative sample of the biosolids generated during the cropping year.

9.4 The Permittee shall submit the Biosolids Annual Report to:

Biosolids Coordinator
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

9.5 The Permittee must notify the MPCA in writing when 90 percent or more of any of the cumulative pollutant loading rates listed for any Land Application Sites has been reached for a site.

Chapter 10. Pretreatment

1. Pretreatment - Definitions

1.1 An "Individual Control Mechanism" is a document, such as an agreement or permit, that imposes limitations or requirements on an individual industrial user of the POTW.

1.2 "Significant Industrial User" (SIU) means any industrial user that:

a. discharges 25,000 gallons per day or more of process wastewater;

b. contributes a load of five (5) % or more of the capacity of the POTW; or

c. is designated as significant by the Permittee or the MPCA on the basis that the SIU has a reasonable potential to adversely impact the POTW, or the quality of its effluent or residuals. (Minn. R. 7049.0120, Subp. 24)

2. Pretreatment - Permittee Responsibility to Control Users

2.1 It is the Permittee's responsibility to regulate the discharge from users of its wastewater treatment facility. The Permittee shall prevent any pass through of pollutants or any inhibition or disruption of the Permittee's facility, its treatment processes, or its sludge processes or disposal that contribute to the violation of the conditions of this permit or any federal or state law or regulation limiting the release of pollutants from the POTW. (Minn. R. 7049.0600)

Chapter 10. Pretreatment

2. Pretreatment - Permittee Responsibility to Control Users

2.2 The Permittee shall prohibit the discharge of the following to its wastewater treatment facility:

a. pollutants which create a fire or explosion hazard, including any discharge with a flash point less than 60 degrees C (140 degrees F);

b. pollutants which would cause corrosive structural damage to the POTW, including any waste stream with a pH of less than 5.0;

c. solid or viscous pollutants which would obstruct flow;

d. heat that would inhibit biological activity, including any discharge that would cause the temperature of the waste stream at the POTW treatment plant headworks to exceed 40 degrees C (104 degrees F);

e. pollutants which produce toxic gases, vapors, or fumes that may endanger the health or safety of workers; or

f. any pollutant, including oxygen demanding pollutants such as biochemical oxygen demand, released at a flow rate or pollutant concentration that will cause interference or pass through. (Minn. R. 7049.0140)

2.3 The Permittee shall prohibit new discharges of non-contact cooling waters unless there is no cost effective alternative. Existing discharges of non-contact cooling water to the Permittee's wastewater treatment facility shall be eliminated, where elimination is cost-effective, or where an infiltration/inflow analysis and sewer system evaluation survey indicates the need for such removal.

2.4 If the Permittee accepts trucked-in wastes, the Permittee shall evaluate the trucked in wastes prior to acceptance in the same manner as it monitors sewered wastes. The Permittee shall accept trucked-in wastes only at specifically designated points. (Minn. R. 7049.0140, Subp. 4)

2.5 Pollutant of concern means a pollutant that is or may be discharged by an industrial user that is, or reasonably should be of concern on the basis that it may cause the permittee to violate any permit limits on the release of pollutants. The following pollutants shall be evaluated to determine if they should be pollutants of concern: pollutants limited in this permit, pollutants for which monitoring is required in this permit, pollutants that are likely to cause inhibition of the Permittee's POTW, pollutants which may interfere with sludge disposal, and pollutants for which the Permittee's treatment facility has limited capacity. (Minn. R. 7049.0120, Subp. 13)

3. Control of Significant Industrial Users

3.1 The Permittee shall impose pretreatment requirements on SIUs which will ensure compliance with all applicable effluent limitations and other requirements set forth in this permit or any federal or state law or regulation limiting the release of pollutants from the POTW. These requirements shall be applied to SIUs by means of an individual control mechanism. (Minn. R. 7049.0600)

3.2 The Permittee shall not knowingly enter into an individual control mechanism with any user that would allow the user to contribute an amount or strength of wastewater that would cause violation of any limitation or requirement in the permit, or any applicable federal, state or local law or regulation. (Minn. R. 7049.0600 Subp. 3)

4. Monitoring of Significant Industrial Users

4.1 The Permittee shall obtain from SIUs specific information on the quality and quantity of the SIU's discharges to the Permittee's POTW. Except where specifically requested by the Permittee and approved by the MPCA, this information shall be obtained by means of representative monitoring conducted by the Permittee or by the SIU under requirements imposed by the Permittee in the SIU's individual control mechanism. Monitoring performed to comply with this requirement shall include all pollutants for which the SIU is significant and shall be done at a frequency commensurate with the significance of the SIU. (Minn. R. 7049.0710)

Chapter 10. Pretreatment

5. Reporting and Notification

5.1 If a SIU discharges to the POTW during a given calendar year, the Permittee shall submit a Pretreatment Annual Report for that calendar year, due by January 31 of the following year. The Pretreatment Annual Report shall be submitted on forms provided by the agency or shall provide equivalent information.

The Permittee shall submit the pre-treatment report to the following address:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194 (Minn. R. 7049.0720)

5.2 The Permittee shall notify the MPCA in writing of any:

a. SIU of the Permittee's POTW which has not been previously disclosed to the MPCA;

b. anticipated or actual changes in the volume or quality of discharge by an industrial user that could result in the industrial user becoming an SIU as defined in this chapter; or

c. anticipated or actual changes in the volume or quality of discharges by a SIU that would require changes to the SIU's required local limits.

This notification shall be submitted within 30 days of identifying the IU as a SIU. Where changes are proposed, they must be submitted prior to changes being made. (Minn. R. 7049.0700, Subp. 1)

5.3 Upon notifying the MPCA of a SIU or change in a SIU discharge as required above, the Permittee shall submit the following information on forms provided by the agency or in a comparable format:

a. the identity of the SIU and a description of the SIU's operation and process;

b. a characterization of the SIU's discharge;

c. the required local limits that will be imposed on the SIU;

d. a technical justification of the required local limits; and

e. a plan for monitoring the SIU which is consistent with monitoring requirements in this chapter. (Minn. R. 7049.0700)

5.4 In addition, the Permittee shall, upon request, submit the following to the MPCA for approval:

a. additional information on the SIU, its processes and discharge;

b. a copy of the individual control mechanism used to control the SIU;

c. the Permittee's legal authority to be used for regulating the SIU; and

d. the Permittee's procedures for enforcing the requirements imposed on the SIU. (Minn. R. 7049.0700, Subp. 3)

5.5 The permittee shall notify MPCA of any of its industrial users that may be subject to national categorical pretreatment standards.

Chapter 10. Pretreatment

5. Reporting and Notification

5.6 This permit may be modified in accordance with Minnesota Rules, ch. 7001 to require development of a pretreatment program approvable under the Federal General Pretreatment Regulation (40 CFR 403).

Chapter 11. Total Facility Requirements

1. General Requirements

General Requirements

1.1 Incorporation by Reference. The following applicable federal and state laws are incorporated by reference in this permit, are applicable to the Permittee, and are enforceable parts of this permit: 40 CFR pts. 122.41, 122.42, 136, 403 and 503; Minn. R. pts. 7001, 7041, 7045, 7050, 7052, 7053, 7060, and 7080; and Minn. Stat. Sec. 115 and 116.

1.2 Permittee Responsibility. The Permittee shall perform the actions or conduct the activity authorized by the permit in compliance with the conditions of the permit and, if required, in accordance with the plans and specifications approved by the Agency. (Minn. R. 7001.0150, subp. 3, item E)

1.3 Toxic Discharges Prohibited. Whether or not this permit includes effluent limitations for toxic pollutants, the Permittee shall not discharge a toxic pollutant except according to Code of Federal Regulations, Title 40, sections 400 to 460 and Minnesota Rules 7050, 7052, 7053 and any other applicable MPCA rules. (Minn. R. 7001.1090, subp.1, item A)

1.4 Nuisance Conditions Prohibited. The Permittee's discharge shall not cause any nuisance conditions including, but not limited to: floating solids, scum and visible oil film, acutely toxic conditions to aquatic life, or other adverse impact on the receiving water. (Minn. R. 7050.0210 subp. 2)

1.5 Property Rights. This permit does not convey a property right or an exclusive privilege. (Minn. R. 7001.0150, subp. 3, item C)

1.6 Liability Exemption. In issuing this permit, the state and the MPCA assume no responsibility for damage to persons, property, or the environment caused by the activities of the Permittee in the conduct of its actions, including those activities authorized, directed, or undertaken under this permit. To the extent the state and the MPCA may be liable for the activities of its employees, that liability is explicitly limited to that provided in the Tort Claims Act. (Minn. R. 7001.0150, subp. 3, item O)

1.7 The MPCA's issuance of this permit does not obligate the MPCA to enforce local laws, rules, or plans beyond what is authorized by Minnesota Statutes. (Minn. R. 7001.0150, subp.3, item D)

1.8 Liabilities. The MPCA's issuance of this permit does not release the Permittee from any liability, penalty or duty imposed by Minnesota or federal statutes or rules or local ordinances, except the obligation to obtain the permit. (Minn. R. 7001.0150, subp.3, item A)

1.9 The issuance of this permit does not prevent the future adoption by the MPCA of pollution control rules, standards, or orders more stringent than those now in existence and does not prevent the enforcement of these rules, standards, or orders against the Permittee. (Minn. R. 7001.0150, subp.3, item B)

1.10 Severability. The provisions of this permit are severable, and if any provisions of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected thereby.

1.11 Compliance with Other Rules and Statutes. The Permittee shall comply with all applicable air quality, solid waste, and hazardous waste statutes and rules in the operation and maintenance of the facility.

Chapter 11. Total Facility Requirements

1. General Requirements

1.12 Inspection and Entry. When authorized by Minn. Stat. Sec. 115.04; 115B.17, subd. 4; and 116.091, and upon presentation of proper credentials, the agency, or an authorized employee or agent of the agency, shall be allowed by the Permittee to enter at reasonable times upon the property of the Permittee to examine and copy books, papers, records, or memoranda pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit; and to conduct surveys and investigations, including sampling or monitoring, pertaining to the construction, modification, or operation of the facility covered by the permit or pertaining to the activity covered by the permit. (Minn. R. 7001.0150, subp.3, item I)

1.13 Control Users. The Permittee shall regulate the users of its wastewater treatment facility so as to prevent the introduction of pollutants or materials that may result in the inhibition or disruption of the conveyance system, treatment facility or processes, or disposal system that would contribute to the violation of the conditions of this permit or any federal, state or local law or regulation.

Sampling

1.14 Representative Sampling. Samples and measurements required by this permit shall be conducted as specified in this permit and shall be representative of the discharge or monitored activity. (40 CFR 122.41 (j)(1))

1.15 Additional Sampling. If the Permittee monitors more frequently than required, the results and the frequency of monitoring shall be reported on the Discharge Monitoring Report (DMR) or another MPCA-approved form for that reporting period. (Minn. R. 7001.1090, subp. 1, item E)

1.16 Certified Laboratory. A laboratory certified by the Minnesota Department of Health shall conduct analyses required by this permit. Analyses of dissolved oxygen, pH, temperature and total residual oxidants (chlorine, bromine) do not need to be completed by a certified laboratory but shall comply with manufacturers specifications for equipment calibration and use. (Minn. Stat. Sec. 144.97 through 144.98 and Minn. R. 4740.2010 and 4740.2050 through 4740.2120) (Minn. R. 4740.2010 and 4740.2050 through 2120)

1.17 Sample Preservation and Procedure. Sample preservation and test procedures for the analysis of pollutants shall conform to 40 CFR Part 136 and Minn. R. 7041.3200.

1.18 Equipment Calibration: Flow meters, pumps, flumes, lift stations or other flow monitoring equipment used for purposes of determining compliance with permit shall be checked and/or calibrated for accuracy at least twice annually. (Minn. R. 7001.0150, subp. 2, items B and C)

1.19 Maintain Records. The Permittee shall keep the records required by this permit for at least three years, including any calculations, original recordings from automatic monitoring instruments, and laboratory sheets. The Permittee shall extend these record retention periods upon request of the MPCA. The Permittee shall maintain records for each sample and measurement. The records shall include the following information (Minn. R. 7001.0150, subp. 2, item C):

a. The exact place, date, and time of the sample or measurement;

b. The date of analysis;

c. The name of the person who performed the sample collection, measurement, analysis, or calculation; and

d. The analytical techniques, procedures and methods used; and

e. The results of the analysis.

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1.20 Completing Reports. The Permittee shall submit the results of the required sampling and monitoring activities on the forms provided, specified, or approved by the MPCA. The information shall be recorded in the specified areas on those forms and in the units specified. (Minn. R. 7001.1090, subp. 1, item D; Minn. R. 7001.0150, subp. 2, item B)

Required forms may include:

DMR Supplemental Form
Individual values for each sample and measurement must be recorded on the DMR Supplemental Form which, if required, will be provided by the MPCA. DMR Supplemental Forms shall be submitted with the appropriate DMRs. You may design and use your own supplemental form; however it must be approved by the MPCA. Note: Required summary information MUST also be recorded on the DMR. Summary information that is submitted ONLY on the DMR Supplemental Form does not comply with the reporting requirements.

1.21 Submitting Reports. DMRs and DMR Supplemental Forms shall be submitted to:

MPCA
Attn: Discharge Monitoring Reports
520 Lafayette Road North
St. Paul, Minnesota 55155-4194.

DMRs and DMR Supplemental Formss shall be postmarked by the 21st day of the month following the sampling period or as otherwise specified in this permit. A DMR shall be submitted for each required station even if no discharge occurred during the reporting period. (Minn. R. 7001.0150, subps. 2.B and 3.H)

Other reports required by this permit shall be postmarked by the date specified in the permit to:

MPCA
Attn: WQ Submittals Center
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

1.22 Incomplete or Incorrect Reports. The Permittee shall immediately submit an amended report or DMR to the MPCA upon discovery by the Permittee or notification by the MPCA that it has submitted an incomplete or incorrect report or DMR. The amended report or DMR shall contain the missing or corrected data along with a cover letter explaining the circumstances of the incomplete or incorrect report. (Minn. R. 7001.0150 subp. 3, item G)

1.23 Required Signatures. All DMRs, forms, reports, and other documents submitted to the MPCA shall be signed by the Permittee or the duly authorized representative of the Permittee. Minn. R. 7001.0150, subp. 2, item D. The person or persons that sign the DMRs, forms, reports or other documents must certify that he or she understands and complies with the certification requirements of Minn. R. 7001.0070 and 7001.0540, including the penalties for submitting false information. Technical documents, such as design drawings and specifications and engineering studies required to be submitted as part of a permit application or by permit conditions, must be certified by a registered professional engineer. (Minn. R. 7001.0540)

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1.24 Detection Level. The Permittee shall report monitoring results below the reporting limit (RL) of a particular instrument as "<" the value of the RL. For example, if an instrument has a RL of 0.1 mg/L and a parameter is not detected at a value of 0.1 mg/L or greater, the concentration shall be reported as "<0.1 mg/L." "Non-detected," "undetected," "below detection limit," and "zero" are unacceptable reporting results, and are permit reporting violations. (Minn. R. 7001.0150, subp. 2, item B)

Where sample values are less than the level of detection and the permit requires reporting of an average, the Permittee shall calculate the average as follows:

a. If one or more values are greater than the level of detection, substitute zero for all nondetectable values to use in the average calculation.

b. If all values are below the level of detection, report the averages as "<" the corresponding level of detection.

c. Where one or more sample values are less than the level of detection, and the permit requires reporting of a mass, usually expressed as kg/day, the Permittee shall substitute zero for all nondetectable values. (Minn. R. 7001.0150, subp. 2, item B)

1.25 Records. The Permittee shall, when requested by the Agency, submit within a reasonable time the information and reports that are relevant to the control of pollution regarding the construction, modification, or operation of the facility covered by the permit or regarding the conduct of the activity covered by the permit. (Minn. R. 7001.0150, subp. 3, item H)

1.26 Confidential Information. Except for data determined to be confidential according to Minn. Stat. Sec. 116.075, subd. 2, all reports required by this permit shall be available for public inspection. Effluent data shall not be considered confidential. To request the Agency maintain data as confidential, the Permittee must follow Minn. R. 7000.1300.

Noncompliance and Enforcement

1.27 Subject to Enforcement Action and Penalties. Noncompliance with a term or condition of this permit subjects the Permittee to penalties provided by federal and state law set forth in section 309 of the Clean Water Act; United States Code, title 33, section 1319, as amended; and in Minn. Stat. Sec. 115.071 and 116.072, including monetary penalties, imprisonment, or both. (Minn. R. 7001.1090, subp. 1, item B)

1.28 Criminal Activity. The Permittee may not knowingly make a false statement, representation, or certification in a record or other document submitted to the Agency. A person who falsifies a report or document submitted to the Agency, or tampers with, or knowingly renders inaccurate a monitoring device or method required to be maintained under this permit is subject to criminal and civil penalties provided by federal and state law. (Minn. R. 7001.0150, subp.3, item G., 7001.1090, subps. 1, items G and H and Minn. Stat. Sec. 609.671)

1.29 Noncompliance Defense. It shall not be a defense for the 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. (40 CFR 122.41(c))

1.30 Effluent Violations. If sampling by the Permittee indicates a violation of any discharge limitation specified in this permit, the Permittee shall immediately make every effort to verify the violation by collecting additional samples, if appropriate, investigate the cause of the violation, and take action to prevent future violations. Violations that are determined to pose a threat to human health or a drinking water supply, or represent a significant risk to the environment shall be immediately reported to the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area). In addition, you may also contact the MPCA during business hours. Otherwise the violations and the results of any additional sampling shall be recorded on the next appropriate DMR or report.

Chapter 11. Total Facility Requirements

1. General Requirements

1.31 Unauthorized Releases of Wastewater Prohibited. Except for conditions specifically described in Minn. R. 7001.1090, subp. 1, items J and K, all unauthorized bypasses, overflows, discharges, spills, or other releases of wastewater or materials to the environment, whether intentional or not, are prohibited. However, the MPCA will consider the Permittee's compliance with permit requirements, frequency of release, quantity, type, location, and other relevant factors when determining appropriate action. (40 CFR 122.41 and Minn. Stat. Sec 115.061)

1.32 Discovery of a release. Upon discovery of a release, the Permittee shall:

a. Take all reasonable steps to immediately end the release.

b. Notify the Minnesota Department of Public Safety Duty Officer at 1(800)422-0798 (toll free) or (651)649-5451 (metro area) immediately upon discovery of the release. In addition, you may also contact the MPCA during business hours at 1(800) 657-3864.

c. Recover as rapidly and as thoroughly as possible all substances and materials released or immediately take other action as may be reasonably possible to minimize or abate pollution to waters of the state or potential impacts to human health caused thereby. If the released materials or substances cannot be immediately or completely recovered, the Permittee shall contact the MPCA. If directed by the MPCA, the Permittee shall consult with other local, state or federal agencies (such as the Minnesota Department of Natural Resources and/or the Wetland Conservation Act authority) for implementation of additional clean-up or remediation activities in wetland or other sensitive areas.

d. Collect representative samples of the release. The Permittee shall sample the release for parameters of concern immediately following discovery of the release. The Permittee may contact the MPCA during business hours to discuss the sampling parameters and protocol. In addition, Fecal Coliform Bacteria samples shall be collected where it is determined by the Permittee that the release contains or may contain sewage. If the release cannot be immediately stopped, the Permittee shall consult with MPCA regarding additional sampling requirements. Samples shall be collected at least, but not limited to, two times per week for as long as the release continues.

e. Submit the sampling results as directed by the MPCA. At a minimum, the results shall be submitted to the MPCA with the next DMR.

1.33 Upset Defense. In the event of temporary noncompliance by the Permittee with an applicable effluent limitation resulting from an upset at the Permittee's facility due to factors beyond the control of the Permittee, the Permittee has an affirmative defense to an enforcement action brought by the Agency as a result of the noncompliance if the Permittee demonstrates by a preponderance of competent evidence:

a. The specific cause of the upset;

b. That the upset was unintentional;

c. That the upset resulted from factors beyond the reasonable control of the Permittee and did not result from operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or increases in production which are beyond the design capability of the treatment facilities;

d. That at the time of the upset the facility was being properly operated;

e. That the Permittee properly notified the Commissioner of the upset in accordance with Minn. R. 7001.1090, subp. 1, item I; and

f. That the Permittee implemented the remedial measures required by Minn. R. 7001.0150, subp. 3, item J.

Chapter 11. Total Facility Requirements

1. General Requirements

Operation and Maintenance

1.34 The Permittee shall at all times properly operate and maintain the facilities and systems of treatment and control, and the appurtenances related to them which are installed or used by the Permittee to achieve compliance with the conditions of the permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. The Permittee shall install and maintain appropriate backup or auxiliary facilities if they are necessary to achieve compliance with the conditions of the permit and, for all permits other than hazardous waste facility permits, if these backup or auxiliary facilities are technically and economically feasible Minn. R. 7001.0150. subp. 3, item F.

1.35 In the event of a reduction or loss of effective treatment of wastewater at the facility, the Permittee shall control production or curtail its discharges to the extent necessary to maintain compliance with the terms and conditions of this permit. The Permittee shall continue this control or curtailment until the wastewater treatment facility has been restored or until an alternative method of treatment is provided. (Minn. R. 7001.1090, subp. 1, item C)

1.36 Solids Management. The Permittee shall properly store, transport, and dispose of biosolids, septage, sediments, residual solids, filter backwash, screenings, oil, grease, and other substances so that pollutants do not enter surface waters or ground waters of the state. Solids should be disposed of in accordance with local, state and federal requirements. (40 CFR 503 and Minn. R. 7041 and applicable federal and state solid waste rules)

1.37 Scheduled Maintenance. The Permittee shall schedule maintenance of the treatment works during non-critical water quality periods to prevent degradation of water quality, except where emergency maintenance is required to prevent a condition that would be detrimental to water quality or human health. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

1.38 Control Tests. In-plant control tests shall be conducted at a frequency adequate to ensure compliance with the conditions of this permit. (Minn. R. 7001.0150. subp. 3, item F and Minn. R. 7001.0150. subp. 2, item B)

Changes to the Facility or Permit

1.39 Permit Modifications. No person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the Agency has issued a written permit for the facility or activity. (Minn. R. 7001.0030)

Permittees that propose to make a change to the facility or discharge that requires a permit modification must follow Minn. R. 7001.0190. If the Permittee cannot determine whether a permit modification is needed, the Permittee must contact the MPCA prior to any action. It is recommended that the application for permit modification be submitted to the MPCA at least 180 days prior to the planned change.

1.40 Construction. No construction shall begin until the Permittee receives written approval of plans and specifications from the MPCA (Minn. Stat. Sec. 115.03(f)).

Plans, specifications and MPCA approval are not necessary when maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent. For instance, a broken pipe, lift station pump, aerator, or blower can be replaced with the same design-sized equipment without MPCA approval.

If the proposed construction is not expressly authorized by this permit, it may require a permit modification. If the construction project requires an Environmental Assessment Worksheet under Minn. R. 4410, no construction shall begin until a negative declaration is issued and all approvals are received or implemented.

Chapter 11. Total Facility Requirements

1. General Requirements

1.41 Report Changes. The Permittee shall give advance notice as soon as possible to the MPCA of any substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit. (Minn. R. 7001.0150, subp. 3, item M)

1.42 Chemical Additives. The Permittee shall receive prior written approval from the MPCA before increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge.

The Permittee shall request approval for an increased or new use of a chemical additive at least 60 days, or as soon as possible, before the proposed increased or new use.

This written request shall include at least the following information for the proposed additive:

a. The process for which the additive will be used;
b. Material Safety Data Sheet (MSDS) which shall include aquatic toxicity, human health, and environmental fate information for the proposed additive;
c. A complete product use and instruction label;
d. The commercial and chemical names and Chemical Abstract Survey (CAS) number for all ingredients in the additive (If the MSDS does not include information on chemical composition, including percentages for each ingredient totaling to 100%, the Permittee shall contact the supplier to have this information provided); and
e. The proposed method of application, application frequency, concentration, and daily average and maximum rates of use.

Upon review of the information submitted regarding the proposed chemical additive, the MPCA may require additional information be submitted for consideration. This permit may be modified to restrict the use or discharge of a chemical additive and include additional influent and effluent monitoring requirements.

Approval for the use of an additive shall not justify the exceedance of any effluent limitation nor shall it be used as a defense against pollutant levels in the discharge causing or contributing to the violation of a water quality standard. (Minn. R. 7001.0170)

1.43 MPCA Initiated Permit Modification, Suspension, or Revocation. The MPCA may modify or revoke and reissue this permit pursuant to Minn. R. 7001.0170. The MPCA may revoke without reissuance this permit pursuant to Minn. R. 7001.0180.

1.44 TMDL Impacts. Facilities that discharge to an impaired surface water, watershed or drainage basin may be required to comply with additional permits or permit requirements, including additional restriction or relaxation of limits and monitoring as authorized by the CWA 303(d)(4)(A) and 40 CFR 122.44.l.2.i., necessary to ensure consistency with the assumptions and requirements of any applicable US EPA approved wasteload allocations resulting from Total Maximum Daily Load (TMDL) studies.

1.45 Permit Transfer. The permit is not transferable to any person without the express written approval of the Agency after compliance with the requirements of Minn. R. 7001.0190. A person to whom the permit has been transferred shall comply with the conditions of the permit. (Minn. R., 7001.0150, subp. 3, item N)

Chapter 11. Total Facility Requirements

1. General Requirements

1.46 Facility Closure. The Permittee is responsible for closure and postclosure care of the facility. The Permittee shall notify the MPCA of a significant reduction or cessation of the activities described in this permit at least 180 days before the reduction or cessation. The MPCA may require the Permittee to provide to the MPCA a facility Closure Plan for approval.

Facility closure that could result in a potential long-term water quality concern, such as the ongoing discharge of wastewater to surface or ground water, may require a permit modification or reissuance.

The MPCA may require the Permittee to establish and maintain financial assurance to ensure performance of certain obligations under this permit, including closure, postclosure care and remedial action at the facility. If financial assurance is required, the amount and type of financial assurance, and proposed modifications to previously MPCA-approved financial assurance, shall be approved by the MPCA. (Minn. Stat. Sec. 116.07, subd. 4)

1.47 Permit Reissuance. If the Permittee desires to continue permit coverage beyond the date of permit expiration, the Permittee shall submit an application for reissuance at least 180 days before permit expiration. If the Permittee does not intend to continue the activities authorized by this permit after the expiration date of this permit, the Permittee shall notify the MPCA in writing at least 180 days before permit expiration.

If the Permittee has submitted a timely application for permit reissuance, the Permittee may continue to conduct the activities authorized by this permit, in compliance with the requirements of this permit, until the MPCA takes final action on the application, unless the MPCA determines any of the following (Minn. R. 7001.0040 and 7001.0160):

a. The Permittee is not in substantial compliance with the requirements of this permit, or with a stipulation agreement or compliance schedule designed to bring the Permittee into compliance with this permit;

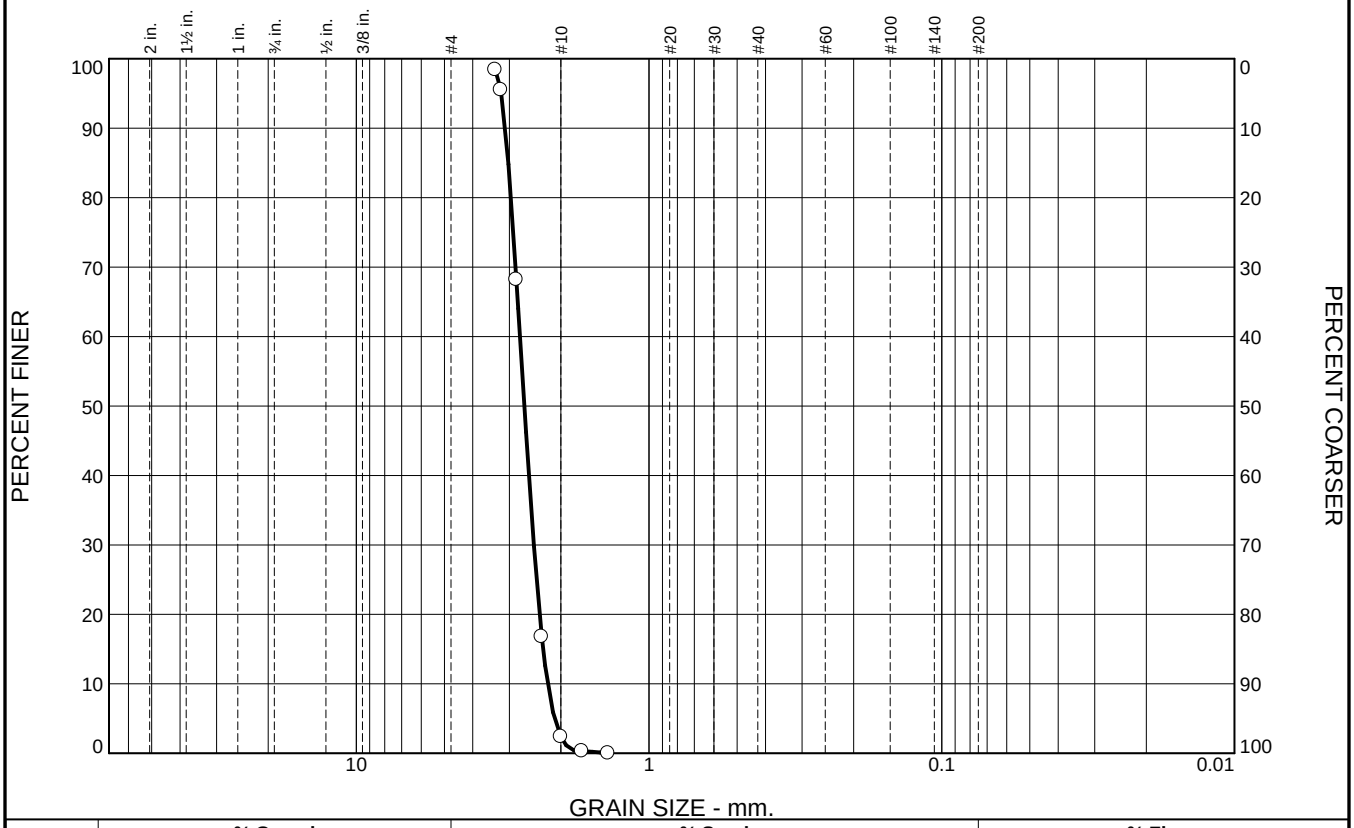
b. The MPCA, as a result of an action or failure to act by the Permittee, has been unable to take final action on the application on or before the expiration date of the permit;

c. The Permittee has submitted an application with major deficiencies or has failed to properly supplement the application in a timely manner after being informed of deficiencies.

APPENDIX B

Particle Size Distribution Report, Typical Sieve Analysis

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
				2.4	0.0	0.0	0.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#6	98.4		
1/8"	95.5		
#7	68.2		
#8	16.8		
#10	2.4		
#12	0.3		
#14	0.0		

* (no specification provided)

Material Description

FILTER SAND 6/9 MESH, UC < 1.35
(1/8" x #10 as substitute)

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.0940 D_{85}= 3.0227 D_{60}= 2.7599
D_{50}= 2.6661 D_{30}= 2.4746 D_{15}= 2.3002
D_{10}= 2.2190 C_u= 1.24 C_c= 1.00

Classification

USCS= AASHTO=

Remarks

TYPICAL SIEVE ANALYSIS

Date: 2014

RED FLINT SAND & GRAVEL, LLC.
Eau Claire, Wisconsin

Client:
Project: TYPICAL SIEVE ANALYSIS

Project No: **Figure**

APPENDIX C

MicroC 2000 Material Safety Data Sheets

Material Safety Data Sheet

MicroC 2000

ENVIRONMENTAL OPERATING SOLUTIONS, INC.

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: MicroC 2000™ **Publication Date:** June 1, 2014

Product Code: NA **Replaces:** January 9, 2012

Product Use: A reducing agent for biological processes

Supplier Information:

Environmental Operating Solutions, Inc
160 MacArthur Blvd., Unit 6
Bourne, MA 02532

Phone: 508-743-8440
Fax: 508-743-8443
Website: www.eosenvironmental.com

EMERGENCY TELEPHONE NUMBER: **CHEMTREC** **800-424-9300**

2. HAZARDS IDENTIFICATION

OSHA Regulatory Status: This product is considered not hazardous under 29 CFR 1910.1200

Hazard Statement: CAUTION !
High mist concentrations may cause irritation of the skin, eyes, throat and respiratory tract.
Classification Category: Inhalation (Dust/Mist) -Category 4
Target Organs: Lungs, Kidneys

Precautionary Statement:
Avoid breathing dust/mist. Use with adequate ventilation. If inhaled, remove person to fresh air.

Potential Health Effects

Routes of Exposure	Ingestion, inhalation, skin contact, eye contact
Eyes	May cause slight irritation
Skin	May cause slight irritation
Inhalation	High mist concentrations may cause irritation of respiratory tract.
Ingestion	May be harmful if swallowed in large quantities

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS #	% by Weight
Glycerin; glycerol	56-81-5	70-74%
Water	7732-18-5	22-26%
Sodium Chloride	647-14-5	4-6%
Methanol	67-56-1	< 1%

4. FIRST AID MEASURES

Eye Contact	Immediately flush eyes thoroughly with plenty of water for 15 minutes and consult a physician immediately.
Skin Contact	Remove contaminated clothing and wash affected area with water and soap. Consult physician if irritation develops
Inhalation	Remove individual to fresh air. Seek medical attention if breathing problems persist
Ingestion	Do not induce vomiting. Rinse mouth thoroughly. Seek medical attention.
General Advice	If individual feels unwell following the exposure to the product consult a physician immediately. Present this Safety Data Sheet to the doctor in attendance
Note to physician	Treat patient symptomatically

5. FIRE FIGHTING MEASURES

Flammability Summary (OSHA and NFPA)	Non-flammable Material
Protection of Firefighters:	Wear suitable protective equipment. Wear self contained breathing apparatus if necessary
Extinguishing Media	Use equipment appropriate to the main source of the fire. Water spray, alcohol foam, dry chemical or CO2. Water or alcohol foam may cause frothing
Specific hazards arising from the chemical	Carbon oxides

6. ACCIDENTAL RELEASE MEASURES

Personal Protection for Spills	Keep unnecessary personnel away from spill. Use personal protective equipment. Ventilate area of leak or spill. Avoid breathing vapors and mist.
Methods for Containment	Eliminate all sources of ignition. Stop flow of material if safe to do so. Dike spilled material. Absorb spill with inert absorbent material. Sand, earth and vermiculite are suitable absorbent materials.
Environmental Precautions	Prevent further leakage. Contain spill if safe to do so. Do not let product enter storm drains if possible.

7. HANDLING AND STORAGE

Precautions for Safe Handling	See other relevant sections of this SDS. Avoid contact with skin and eyes. Avoid breathing mist. Use with adequate ventilation. Do not handle and store near open flames, high heat or sources of ignition.
Storage	Keep containers closed when not in use. Minimize evaporative losses. Keep away from ignition sources.
Incompatible Materials for Storage	None known

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Component	Concentration in Product	ACGIH TLV	OSHA TABLE Z-1 Limits for Air Contaminants	NIOSH
Glycerin CAS No: 56-81-5	70-74% w/w	Form: Glycerin Mist TWA: 10 mg/m3	Form: Total Dust PEL: 15 mg/m3 Form: Respirable Fraction PEL: 5 mg/m3	Insufficient Data on Glycerin Mist
Methanol CAS No: 67-56-1	< 1 % w/w	TWA: 260 mg/m3	PEL: 260 mg/m3	TWA: 260 mg/m3

Engineering Controls — Use proper equipment and storage conditions to control airborne levels below recommended exposure limits.

Personal Protective Equipment

Eye Protection: — Use normal eye protection practices such as safety glasses with side shields. Use chemical goggles if risk of splashing is high.

Skin Protection — Handle with chemical resistant gloves. Dispose of contaminated gloves after use. Nitrile gloves recommended.

Respiratory Protection — If workers could be exposed to concentrations above the exposure limits in Section 8, use a full face respirator with multipurpose combination cartridges.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid	**Flash Point**	None to Boil (ASTM D93)
Color	Light brown	**Boiling Point**	Not determined
Odor	Musty – Sweet Odor	**Evaporation Rate**	Not determined
Odor Threshold	Not determined	**UEL/LEL**	Not determined
		Flammability (solid, gas)	Not determined
pH	4.00-11.00	**Vapor Pressure**	Not determined
Solubility in Water	Highly soluble in water	**Vapor Density**	Not determined
		Relative Density	Not Determined
Bulk Density	10.22 lbs/gal	**Partition Coefficient**	Not determined
Specific gravity	1.225@ 20°C	**Autoignition Temperatures**	
		Decomposition	
Viscosity	45 cPs @ 20C	**Temperature**	Not determined

10. STABILITY AND REACTIVITY

Reactivity	Avoid contact with oxidizing agents (e.g. nitric acid, peroxides, chromates)
Chemical Stability	Stable under normal storage conditions
Possibility of hazardous reactions	None known
Conditions to Avoid	Heat, flames, sparks. Contact with oxidizing agents
Incompatible Materials	None known
Hazardous Decomposition Products	Oxides of carbon under high heat

11. TOXICOLOGY

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Eye Contact	The components in this product may result in mild eye irritation from contact with liquid or vapors. Symptoms include redness, swelling, watering.
Skin Contact	The components in this product may result in mild skin irritation. Symptoms include redness, itching, burning, dermatitis.
Inhalation	Breathing high mist concentrations may be harmful. Inhalation can cause irritation of the throat and lungs.
Ingestion	Ingestion of this product may result in nausea, vomiting and diarrhea. Aspiration into the lungs can cause damage and inflammation to the lungs.
Target Organs	Lungs, Kidneys
Prolonged Exposure	Symptoms include nausea, headache, vomiting

Glycerin; Glycerol CAS No. 56-81-5

Acute Toxicity	Dermal LD50 = > 10,000 mg/kg (Rabbit) Inhalation LC50 = > 570 mg/m^3 1 hr (Rat) Oral LD50 = 12,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

Methanol 67-56-1

Acute Toxicity	Dermal LD50 = 15,800 mg/kg (Rabbit) Inhalation LC50 = 64,000 mg/m^3 4 hr (Rat) Oral LD50 = 5,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

12. ECOLOGICAL INFORMATION

Ecotoxicity	Glycerin: 96 hr LC50: 51,000-57,000 mg/L (Rainbow Trout), > 5000 mg/L Goldfish Methanol: 96 hr LC50: > 15,400-29,400 mg/L (Fish)
Persistence and degradability	No data available
Bioaccumulative potential	No data available
Mobility in soil	No data available
Other adverse effects	No data available

13. DISPOSAL CONSIDERATIONS

This product as supplied is not classified as a RCRA hazardous waste according to 40 CFR 261. However it should be fully characterized prior to disposal as contamination with other materials may subject it to hazardous waste regulations. RCRA requires the user of the product to determine whether the product meets RCRA criteria for hazardous waste. Always consult with local, state and federal regulations prior to disposal.

14. TRANSPORTATION INFORMATION

US Domestic DOT	Not Regulated
Shipping Name	Glycerin; Glycerol
IMDG	Not dangerous goods
IATA	Not dangerous goods
Marine pollutant	No

15. REGULATORY INFORMATION

United States

Toxic Substances Control Act

The components of this product are listed on the TSCA Inventory of Existing Chemical Substances

Section 302 (EHS) TPQ	Not applicable
Section 304 (EHS) TPQ	Not applicable

SARA Section 311/312 Hazard Categories

Acute - YES (glycerin mist)
Chronic – NO
Physical - None
Pressure Hazard - NO
Fire Hazard - NO

SARA Section 313

This product may contain trace amounts of a chemical that is subject to reporting requirements of SARA

Methanol CAS # 67-56-1 Typical % Weight in Product 0.0-0.10%

CERCLA

This product may contain trace amounts of a chemical that is subject to reporting requirements of CERCLA

Methanol RQ # 5,000. Typical % Weight in Product 0.0-0.10%

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3): None

State Right to Know Regulations

Chemical Name: Glycerin

California – Proposition 65	Not applicable
Massachusetts Right to Know	Glycerin
Minnesota Hazardous Substances List	Glycerin mist
New Jersey Right to Know	None
Pennsylvania Right to Know	Glycerin
Rhode Island Right to Know	Glycerin

16. ADDITIONAL INFORMATION

Hazard Summary

	NFPA	HMIS
Health Hazard	1	1
Flammability	1	1
Reactivity	0	0
Specific Hazard	None	None

MSDS REVISION STATUS: June 1, 2014| Replaces January 9, 2012

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS MSDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS MSDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

APPENDIX D

Fremont RLT 4710 Material Safety Data Sheets

FREMONT
WATER SOLUTIONS

June 1, 2015

Dear Valued Customer:

The OSHA Hazard Communication System (HCS) was modified in 2012 to align its provisions with the Globally Harmonized System (GHS). Material Safety Data Sheets (MSDS) will be replaced by Safety Data Sheets (SDS) under the HazCom 2012 Standard. Both product labeling and SDS will require specific and standardized changes under HazCom 2012.

As your chemical vendor. Fremont Industries is required to utilize GHS compliant labeling on our products shipped to you and to provide you with GHS compliant Safety Data Sheets (SDS) on and following June 1, 2015. Please note that exceptions to this enforcement date include shipment of distributed products (December 1, 2015 compliance date) and compounded chemical products (enforcement date extended for an undetermined period).

Please find enclosed SDS and/or MSDS pertaining to Fremont products you have purchased on or after June 1, 2015. If you have received MSDS, you will be provided with SDS for the related products as soon as they are available.

Please direct any questions or concerns related to Fremont product SDS or requests for Fremont product SDS to: sds@fremontind.com.

Thank you for your recent order and for your continued choice of Fremont Industries as your partner for your water management needs.

Sincerely,

Bruce Busch
V.P., Research & Development

BB/as
Enclosure(s)

CORPORATE OFFICE
Fremont Industries, Inc.
P.O. Box 67 · 4400 Valley Ind. Blvd. N.
Shakopee, MN 55379-0067 · 952.445.4121

ISO 9001 CERTIFIED

REGIONAL OFFICE
Fremont Industries, Inc.
1358 S. Enterprise Street
Olathe, KS 66061-5357 · 913.962.7676

FREMONT
WATER SOLUTIONS

FREMONT RLT 4710 Return Line Treatment

Safety Data Sheet

Prepared according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Revision date: 02/01/2015 Supersedes: 11/10/2010

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Trade name : FREMONT RLT 4710 Return Line Treatment

Product form : Mixtures

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Water treatment.

1.3. Details of the supplier of the safety data sheet

FREMONT INDUSTRIES, INC.
4400 Valley Industrial Blvd. N.
P.O. Box 67
Shakopee, MN 55379-0067

1.4. Emergency telephone number

Emergency number : (952) 445-4121
CHEMTREC: (800) 424-9300

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (GHS-US)

Not classified

2.2. Label elements

GHS-US labeling

No labeling applicable

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS-US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable

3.2. Mixtures

Name	Product identifier	%
Contains no hazardous ingredients at levels requiring disclosure by the OSHA Hazard Communication Standard (29 CFR 1910.1200).		100

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : If exposed or concerned, get medical attention/advice. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before re-use. Never give anything to an unconscious person.

First-aid measures after inhalation : IF INHALED: Remove to fresh air and keep at rest in a comfortable position for breathing.

First-aid measures after skin contact : IF ON SKIN (or clothing): Remove affected clothing and wash all exposed skin with water for at least 15 minutes.

First-aid measures after eye contact : IF IN EYES: Immediately flush with plenty of water for at least 15 minutes. Remove contact lenses if present and easy to do so. Continue rinsing.

First-aid measures after ingestion : IF SWALLOWED: rinse mouth thoroughly. Do not induce vomiting without advice from poison control center or medical professional. Get medical attention if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries	: Not expected to present a significant hazard under anticipated conditions of normal use.
Symptoms/injuries after inhalation	: May cause respiratory irritation.
Symptoms/injuries after skin contact	: May cause skin irritation.
Symptoms/injuries after eye contact	: Direct contact with the eyes is likely to be irritating.
Symptoms/injuries after ingestion	: May cause gastrointestinal irritation.

4.3. Indication of any immediate medical attention and special treatment needed

No additional information available

SECTION 5: Firefighting measures

5.1. Extinguishing media

suitable extinguishing media : Water spray. Carbon dioxide. Foam. Dry powder.

5.2. Special hazards arising from the substance or mixture

Fire hazard	: Product is not flammable.
Explosion hazard	: Product is not explosive.
Reactivity	: No dangerous reactions known under normal conditions of use.

5.3. Advice for firefighters

Firefighting instructions	: Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Do not dispose of fire-fighting water in the environment. Prevent human exposure to fire, fumes, smoke and products of combustion
Protection during firefighting	: Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Evacuate area. Keep upwind. Ventilate area. Spill should be handled by trained clean-up crews properly equipped with respiratory equipment and full chemical protective gear (see Section 8).

6.1.1. For non-emergency personnel

Protective equipment	: Wear Protective equipment as described in Section 8.
Emergency procedures	: Evacuate unnecessary personnel.

6.1.2. For emergency responders

Protective equipment : Wear suitable protective clothing, gloves and eye or face protection. Approved supplied-air respirator, in case of emergency.

6.2. Environmental precautions

Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters. Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

For containment	: Contain any spills with dikes or absorbents to prevent migration and entry into sewers or streams.
Methods for cleaning up	: Soak up spills with inert solids, such as clay or diatomaceous earth as soon as possible. Place in a suitable container for disposal in accordance with the waste regulations (see Section 13). Wash spill area thoroughly with plenty of soap and water.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Do not handle until all safety precautions have been read and understood. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work Provide good ventilation in process area to prevent formation of vapor. Do not breathe mists. Keep away from sources of ignition - No smoking.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions	: Keep only in the original container in a cool, well ventilated place away from : Heat sources. Keep container closed when not in use.
Incompatible materials	: Strong oxidizers.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

No data available

8.2. Exposure controls

Appropriate engineering controls : Provide adequate general and local exhaust ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Use explosion-proof equipment with flammable materials. Ensure adequate ventilation, especially in confined areas.

Personal protective equipment : Gloves. Protective goggles.

Hand protection : Use gloves chemically resistant to this material when prolonged or repeated contact could occur. Gloves should be classified under Standard EN 374 or ASTM F1296. Suggested glove materials are: Neoprene, Nitrile/butadiene rubber, Polyethylene, Ethyl vinyl alcohol laminate, PVC or vinyl. . Suitable gloves for this specific application can be recommended by the glove supplier.

Eye protection : Use eye protection suitable to the environment. Avoid direct contact with eyes.

Skin and body protection : Wear long sleeves, and chemically impervious PPE/coveralls to minimize bodily exposure.

Respiratory protection : Use NIOSH-approved dust/particulate respirator. Where vapor, mist, or dust exceed PELs or other applicable OELs, use NIOSH-approved respiratory protective equipment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance	: Clear.
Color	: colorless.
Odor	: odorless.
Odor Threshold	: No data available
pH	: 5.7 (neat)
Relative evaporation rate (butyl acetate=1)	: No data available
Melting point	: No data available
Freezing point	: No data available
Boiling point	: 100 °C
Flash point	: not flammable (T.C.C.)
Self ignition temperature	: No data available
Decomposition temperature	: No data available
Flammability (solid, gas)	: No data available
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: 1.16
Solubility	: Complete solubility in water.
Log Pow	: No data available
Log Kow	: No data available
Viscosity, kinematic	: No data available
Viscosity, dynamic	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available
Explosive limits	: No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

No dangerous reactions known under normal conditions of use.

10.2. Chemical stability

Stable under recommended handling and storage conditions (see section 7).

10.3. Possibility of hazardous reactions

None known.

10.4. Conditions to avoid

Sparks. Heat. Open flame.

10.5. Incompatible materials

Oxidizing agent.

10.6. Hazardous decomposition products

Thermal decomposition generates : Carbon oxides (CO, CO2). Nitrogen oxides.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity	: Not classified
Skin corrosion/irritation	: Not classified pH: 5.7 (neat)
Serious eye damage/irritation	: Not classified pH: 5.7 (neat)
Respiratory or skin sensitization	: Not classified
Germ cell mutagenicity	: Not classified
Carcinogenicity	: Not classified
Reproductive toxicity	: Not classified
Specific target organ toxicity (single exposure)	: Not classified
Specific target organ toxicity (repeated exposure)	: Not classified
Aspiration hazard	: Not classified
Symptoms/injuries after inhalation	: May cause respiratory irritation.
Symptoms/injuries after skin contact	: May cause skin irritation.
Symptoms/injuries after eye contact	: Direct contact with the eyes is likely to be irritating.
Symptoms/injuries after ingestion	: May cause a light irritation of the linings of the mouth, throat, and gastrointestinal tract. Not expected to be toxic.
Chronic symptoms	: No data available.

SECTION 12: Ecological information

12.1. Toxicity

No additional information available

12.2. Persistence and degradability

No additional information available

12.3. Bioaccumulative potential

No additional information available

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste treatment methods	: Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.
Waste disposal recommendations	: Dispose in a safe manner in accordance with local/national regulations. Do not allow the product to be released into the environment.

SECTION 14: Transport information

In accordance with ADR / RID / IMDG / IATA

14.1. UN number

Not applicable

14.2. UN proper shipping name

Not applicable

14.3. Additional information

Other information : No supplementary information available.

Overland transport

No additional information available

Transport by sea

No additional information available

Air transport

No additional information available

SECTION 15: Regulatory information

15.1. US Federal regulations

FREMONT RLT 4710 Return Line Treatment	
All chemical substances in this product are listed in the EPA (Environmental Protection Agency) TSCA (Toxic Substances Control Act) Inventory	
SARA Section 311/312 Hazard Classes	None

15.2. International regulations

CANADA

No additional information available

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Classification according to Directive 67/548/EEC or 1999/45/EC

Not classified

15.2.2. National regulations

No additional information available

15.3. US State regulations

No additional information available

SECTION 16: Other information

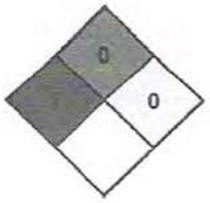
Indication of changes : Revision - September 2013 - New SDS Created. This sheet has been revised completely (changes were not marked).

Other information : Author: JAH.

NFPA health hazard : 1 - Exposure could cause irritation but only minor residual injury even if no treatment is given.

NFPA fire hazard : 0 - Materials that will not burn.

NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health	: 1
Flammability	: 0
Physical	: 0
Personal Protection	:

FREMONT'S PRODUCTS ARE SOLD "AS IS." FREMONT MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WITH RESPECT TO ITS PRODUCTS OR RELATED SERVICES. ALL SUCH EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE SPECIFICALLY DISCLAIMED.

APPENDIX E

LEOPOLD ELIMI-NITE®
DENITRIFICATION SYSTEM PROPOSAL

Proposal Number: I16320 **July 12, 2016**

Windom, MN - WWTP

elimi•NITE®

Denitrification System

Proposal Prepared for
Windom, MN

Xylem Water Solutions USA, Inc — 227 South Division Street — Zelienople, PA 16063
Phone (724) 452-6300 — Fax (724) 453-2122

Table of Contents

1. elimi-NITE Denitrification System General Process Description

The elimi-NITE Denitrification System is an attached growth, microbiological process. This gravity, downflow, packed-bed denitrification system is physically identical to a deep-bed downflow sand filter. Denitrifying microorganisms attach to the filter media, which provides the support system for their growth. A carbon source such as methanol, acetic acid, molasses, etc. is added upstream of the packed-bed filter and a nitrified influent is filtered through the media. The packed-bed filter system is well suited for denitrification because it provides the necessary hydraulic detention time for the biological reaction to take place. The filter media is composed of a coarse, hard, predominately siliceous material. This media can filter out solids and serve as a support system for the denitrifying microorganisms. The downflow packed-bed system eliminates the requirement for downstream filtration or clarification required of other denitrification systems.

As denitrification occurs, nitrogen gas accumulates in the filter media, which increases the headloss over the headloss due to the accumulation of solids. The nitrogen gas bubbles are periodically released from the media by taking the filter off line and applying backwash water for a few minutes. This process is called the nitrogen release cycle or filter bumping. The frequency of the nitrogen release cycle is a function of both nitrate removal and a minimum acceptable time between cycles, typically less than one hour. Usually a filter needs to be bumped once every four to eight hours, again depending on the nitrogen loading rate. The bumps are usually set on a time basis. After a bump the headloss in the filter is reduced or recovered. However, when the liquid level in the filter reaches a designated high level, signifying that the bumps are not effective in reducing headloss, a full backwash is performed on the filter.

The elimi-NITE Denitrification System is comprised of the following basic principles:

- A packed deep-bed layer of sand for biomass attachment and retention of suspended solids
- A Leopold Universal® Type S® Filter System for distribution of air and water for superior backwashing of the elimi-NITE filter module.
- A complete chemical feed system of the carbon source for denitrification (future)
- Automated backwash sequence and controls optimized for each applications requirement utilizing Leopold FilterWorx™ Control System.

The full backwash consists of the following sequence:

- Influent and effluent valves are closed
- Waste valve is opened
- Blower is started
- Air isolation valve is opened, vent valve is closed and air only wash for approximately one minute
- Backwash pump is started
- Backwash isolation valve is opened and air/water backwash for approximately 15 minutes
- Air isolation valve is closed, vent valve is open and the blower is stopped

- Water only backwash continues for approximately 5 minutes to purge air from the filter
- Backwash isolation valve is closed and the backwash pump is stopped
- Waste valve is closed
- Influent and effluent valves are opened

Gases such as nitrogen or dissolved oxygen will build-up high levels in the filter and cause air binding. In this case the filters are water-only "bumped." The bump consists of isolating the filters from the influent flow, closing the effluent valve, starting the backwash pump, opening the backwash valve, opening the waste valve (optional if the water depth stays below the effluent launder) and backwashing the filter for approximately 2-5 minutes. This reversal of flow allows the built-up gases to escape the filter. The filter is then put back on-line. The bumps can be programmed to occur either on time or on level and are site specific.

2. Design Criteria

The elimi-NITE Denitrification System described here-in is a wastewater treatment system designed for the removal of nitrate-nitrogen.

The elimi-NITE Denitrification System that shall be furnished and installed is described in Section 3 - Scope of Supply.

The system has been designed based on Leopold's standard specifications using the following criteria:

Option	Plant Flow	MGD
1	Avg.	0.5
2	Avg.	1.0
3	Avg.	1.5
4	Avg.	2.0
5	Avg.	2.5

Note: Please define the following parameters to help optimize the denitrification process.

The elimi-NITE Denitrification System is based on treating the influent the filters with the following characteristics:

Influent Parameter	mg/L	Given	Assumed
Total Suspended Solids (TSS)	25	-----	X
Nitrates	60.0	X	-----
Minimum Water Temperature (°C)	10	-----	X

The elimi-NITE Denitrification System is designed to achieve the following monthly average effluent quality:

Effluent Parameters	mg/L	Given	Assumed
Total Suspended Solids (TSS)	<5.0	-----	X
Nitrates	<10.0	-----	X

The external carbon source for the elimi-NITE Denitrification System that will be provided by others is methanol.

If Phosphorous removal is required, the phosphorous must be in an insoluble form. This may require the use of coagulants upstream of the Filtration System.

Elimi-NITE Denitrification System Design Criteria

Total number of filters	**Option 1**	Two (2)
	Option 2	Two (2)
	Option 3	Three (3)
	Option 4	Four (4)
	Option 5	Four (4)

Individual filter sizing

Option 1	
Area	144 ft^2
Length	16’-0”
Width	9’-0"
Media Depth	72”
Media volume	864 ft^3
Option 2-4	
Area	288 ft^2
Length	24’-0”
Width	12’-0"
Media Depth	72”
Media volume	1728 ft^3
Option 5	
Area	336 ft^2
Length	28’-0”
Width	12’-0"
Media Depth	72”
Media volume	2016 ft^3

Media Type

Coarse Silica Sand	1/8” x No. 12 – 72”

Loading Rates	**Filter Loading Rate**	**with one in backwash**
At 0.5 MGD (Option 1)	1.21 gpm/ft^2	2.41 gpm/ft^2
At 1.0 MGD (Option 2)	1.21 gpm/ft^2	2.41 gpm/ft^2
At 1.5 MGD (Option 3)	1.21 gpm/ft^2	1.81 gpm/ft^2
At 2.0 MGD (Option 4)	1.21 gpm/ft^2	1.61 gpm/ft^2

At 2.5 MGD (Option 5)	1.29 gpm/ft^2	1.72 gpm/ft^2

Backwash Rates

Design concurrent water rate	6 gpm/ft^2
Design concurrent air rate	5 scfm/ft^2
Design high water rate	6 gpm/ft^2

Designed Driving Head 8'-0"

Air Scour Blowers

Total Number	Two (2)
Number in standby	One (1)

Backwash Pumps

Total Number	Two (2)
Number in standby	One (1)

Mudwell Pumps

Total Number	Two (2)
Number in standby	One (1)

3. Scope of Supply

Xylem Water Solutions USA, Inc. will supply only the items specifically detailed within this proposal.

3.1 Filter Internals

Complete elimi-NITE filters will be provided for each flow option utilizing a front flume arrangement including:

Leopold Universal® Type S® Underdrain of the Dual/Parallel Lateral type, manufactured from corrosion resistant, high-density polyethylene supplied with necessary "O"-rings and carbon steel "L" anchor rods.

I.M.S® 1000 MEDIA RETAINER will be furnished. The scope includes molded thermoplastic I.M.S® 1000 media retainer factory installed onto the proposed underdrain block prior to shipment.

Air Header Assemblies shall be manufactured from schedule 5, type 304 stainless steel pipe. The air header pipe shall run the width of the filter cell. The air header shall commence with a flange approximately 6" inside the filter cell. Mating flange and hardware is to be supplied by others. The air header pipe will have J-risers to provide air to each of the individual filter laterals.

Curved Weir Plates that shall be installed on top of the concrete troughs in the filters. The weirs shall be 1/8" thick and be constructed of type 304 stainless steel. They will be run the length of the concrete troughs. The weir plates shall include the required type 304 mounting hardware.

3.2 Media

Coarse Silica Sand – 72" Depth Per Filter For Each Flow Option

Effective Size: 1/8" x No. 12

3.3 FilterWorx™ Control System

CONTROLS WILL BE PROVIDED FOR EACH FLOW OPTION. QUANTITY OF PANELS AND LEVEL TRANSMITTERS WILL VARY BETWEEN FLOW OPTIONS.

Leopold model AFC-5000 Filter Control Panels. The panels shall be housed in a NEMA 4X rated, 304 stainless steel enclosure. The panel shall include provisions for the automatic, semi-automatic, and manual control of the filtration and backwashing operations. Logic functions shall be performed by an Allen Bradley Compact Logix Series PLC. Manual operation shall be independent of the PLC. Operator interface shall be via an Allen Bradley Panelview Plus 1000 touchscreen and Square D type ZB4 selector switches, pushbuttons and pilot lights.

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Siemens Hydroranger 200 Ultrasonic filter level transmitters

One (1) **Siemens Hydroranger 200 Clearwell Level Transmitter**

One (1) **Siemens Hydroranger 200 Mudwell Level Transmitter**

Two (2) **Hach Nitratax Sensors and SC200 Controllers (One Influent& One Effluent)**

One (1) **Siemens 5100W magnetic flow meter for filter influent**

One (1) Lot **Spare Equipment** consisting of:

One (1) PLC DI module
One (1) PLC DO module
One (1) PLC AI module
One (1) PLC AO module
Two (2) of each type of relay, selector switch, pushbutton, and pilot light used.

3.4 Automatic Valves

Under this section we propose to furnish the following 150 lb. Class flanged butterfly valves conforming to AWWA C-504. The valves shall be flanged with EDPM seats, 316 stainless steel shafts and cast iron bodies per ASTM A126. Shaft seals should be self-compensating split V-type or O-ring packing made of BUNA-N per AWWA C-504 Class B. The valves shall be supplied with the listed electric operators. Actuators shall be Rotork IQT / IQTM as specified. **AMOUNT PROVIDED (FOR EACH FUNCTION) WILL EQUAL THE NUMBER OF FILTERS FOR EACH FLOW OPTION.**

Function	Service
Influent	open/close
Effluent	open/close
BW Inlet	open/close
BW Waste	open/close
Air Inlet	open/close
Air Vent	open/close

3.5 Pumps (FOR ALL FLOW OPTIONS)

Two (2) **Submersible Backwash Pumps**. The pumps shall be rated for the correct backwash flow an estimated 30 feet of head. Accessories shall include a 50' cable, leakage sensor, discharge connection and hardware, guide bar brackets and stainless steel lift chains. The pump motor shall 60 Hz , 460v, 3 phase and have a cast iron housing, volute and impeller. Also included shall be a manual isolation butterfly valve and an air cushioned swing check valve. **The stainless steel guide bars shall be supplied by the contractor.**

Two (2) **Submersible Mudwell Pumps**. The pumps shall be rated for the correct waste flow at an estimated 30 feet of head. Accessories shall include a 50' cable, leakage sensor, discharge connection and hardware, guide bar brackets and stainless steel lift chains. The pump motor shall be 60 Hz , 460v, 3 phase and have a cast iron housing, volute and impeller. Also included shall be a manual isolation butterfly valve and an air cushioned swing check valve. **The stainless steel guide bars shall be supplied by the contractor.**

3.6 Blowers and Appurtenances (FOR ALL FLOW OPTIONS)

Two (2) **Positive Displacement Blower Packages** The blower packages shall be capable of supplying air to the filters during backwash. Included with the blower package are TEFC motor, silencer, filter, pressure relief valve, flexible connections, pressure gauges, temperature gauges, discharge check valve and discharge butterfly valve. The blower shall have a 460 volts, 3 phase, 60 hertz, TEFC motor. An acoustical enclosure will be included.

3.7 Chemical Feed System (FOR ALL FLOW OPTIONS)

Two (2) **Positive Displacement Diaphragm Pumps**, hydraulically actuated, capable of supplying the influent with the required methanol to denitrify. The pumps will

come with an explosion proof DC motor. Accessories shall include a backpressure valve, pulsation dampener, and pressure relief valve for each discharge line.

One (1) **Carbon Steel Methanol Storage Tank,** designed to meet API 650 Appendix J. The tank shall come equipped with a fill adapter, vents, mechanical gauge, ladder, signage, level indicator, and leak detector. The exterior of the tank shall be shipped factory primed. Finish coats shall be provided and applied by the on-site contractor.

One (1) **Methanol Control Panel,** to be housed in a NEMA 4X rated, 304 stainless steel, wall-mounted enclosure. The panel shall include provisions for control of the methanol feed pumps. The panel shall also include a digital indicator for methanol tank level. Logic functions shall be performed by an Allen Bradley Micro Logix series system. Interface with the Filter Control Panels shall be via a 4 – 20 mA signal.

4. Installation and Instruction Services

The services of a qualified Leopold technical representative to instruct the Contractor's personnel about the proper installation technique of the mechanical **filter equipment** will be provided for a period of six (6) days (8 hr/day) on site plus four (4) days travel time to and from the job-site in two (2) trips.

The services of a qualified Leopold technical representative for **filter control system startup and operator training** will be provided for a period of nine (9) days (8 hr/day) on site plus six (6) days travel time to and from the job-site in three (3) trips.

Additional services may be obtained at the current prevailing rate plus living and travel expenses.

Should our service representative be scheduled and arrive on site at the time requested by the contractor/purchaser and the equipment is not ready, our standard per diem rate, plus travel and living expenses will apply.

5. Clarifications and Qualifications

MEDIA:

Submittals:

Materials meet and/or exceed American Water Works Association Standard B100 (latest revision) for Filtering Material. Typical samples and/or test reports detailing the physical and chemical characteristics of the filtering material will be provided for review and approval as required by the specification. If independent testing is required per specification, test reports of the actual material produced will be submitted for approval prior to release for shipment.

Packaging and Placement of Materials:

Material will be packaged in semi-bulk containers, "Super Bags," with lifting sleeves and bottom discharge spout, containing approximately 2,000 to 4,000 pounds per sack.

Quantities:

Quantities indicated above are Xylem Water Solutions USA, Inc best calculations of the quantity requirements. Loss of gravel due to storage or handling is not covered by this proposal.

FILTER MEDIA WARRANTY (if applicable): SELLER warrants that its filter media products will meet the standards established by the latest edition of AWWA (American Water Works Association) B100. SELLER shall be responsible for verifying that the filter media meets or exceeds the AWWA B100 Standard at the point of sale. Testing shall be by an independent laboratory, which regularly performs testing of filter media. BUYER shall notify Xylem Water Solutions USA, Inc. immediately upon discovery of any defective product. The SELLER shall have the right to inspect said product and BUYER shall, if requested, return the defective product to the SELLER with transportation prepaid. NO LIABILITY IS ASSUMED BY THE SELLER UNDER ANY CIRCUMSTANCES FOR LABOR, MATERIAL OR OTHER COSTS ASSOCIATED WITH THE REMOVAL OR REPLACEMENT OF MEDIA UNLESS PREVIOUSLY APPROVED IN WRITING BY AN AUTHORIZED EMPLOYEE OF THE SELLER.

ITEMS NOT INCLUDED

The following items, while not comprehensive, are not included in the elimi-NITE Denitrification System:

- Receiving, unloading, storing, and proper installation of supplied equipment and materials.
- Concrete for filter, building/architectural work and engineering thereof.
- Grout between and under the underdrain laterals in filters.
- Platforms, ladders, or walkways.
- Lubricants for mechanical equipment.
- Interconnecting piping, piping supports, and wall sleeves/pipes including flanges, bolts, nuts, and gaskets.
- Instrument air pipe, isolation valves, tubing, and engineering thereof.
- Electrical starters, circuit breakers, motor control center, conduit, and interconnecting wiring and engineering thereof, and 480 VAC, 3 phase, 60 HZ power.

- Water supply/disposal for flushing of filter internals, media installation or backwash testing.

- Lab services for performance guarantee testing.

6. Production Schedule

Submittal of PID's and mechanical drawings for approval 6 to 8 weeks after receipt of purchase order.

Submittal of EIC drawings for approval 6 to 8 weeks after receipt of purchase order.

Delivery of fabricated items and filter media 14 to 16 weeks after drawing approval.

7. Pricing Information

BASIS of PRICING:

Any items and/or accessories not specifically called out in this quotation must be construed as being furnished by others.

This quotation is considered firm for 90 days. Orders received more than 90 days after the date of this quotation is reviewed by Xylem Water Solutions USA, Inc before acceptance and is subject to changes in prices or delivery depending on conditions existing at the time of entry. Quoted prices are firm for delivery within 12 months from the delivery date stipulated in the plans & specifications or mutually agreed upon by Xylem Water Solutions USA, Inc. and Purchase Order issuer at time of order placement.

We do not include any applicable taxes.

Orders resulting from this quotation should be addresses to Xylem Water Solutions USA, Inc. 227 S. Division St., Zelienople, PA, 16063, USA.

We propose to furnish the material described in this document for **a total budget selling price of $_____,** FCA factory with full freight allowed to the job site.

For final pricing and further information pertaining to the equipment contained in this proposal, please contact our area representative, who is:

Vessco, Inc.
8217 Upland Circle
Chanhassen, MN 55317
Phone: 952-941-2678
Fax: 952-941-0796

Attention: Clark Corbett

Payment terms:

10% net 30 days upon initial submittal of mechanical, electrical and I/C drawings for approval
80% net 30 days from the date of the respective shipments of the products
5% installation of the Leopold equipment, NTE 150 days after shipment
5% start-up/training on the Leopold equipment, NTE 180 days after shipment

Respectfully submitted,

Xylem Water Solutions USA, Inc

Wayne Steen

Sr. Sales Engineer

Attachment: Terms of Quotation

T&C'S FOR PROPOSAL

1. Agreement, Integration and Conflict of Terms. These terms and conditions, together with any special conditions expressly incorporated thereto in the quotation or sales form, are to govern any sale between the Seller and Buyer. The Seller shall mean the applicable affiliate of Xylem Inc. that is party to the Agreement ("Seller"). The Buyer shall mean the entity that is party to the Agreement with Seller. This writing is an offer or counteroffer by Seller to sell the goods and/or services set forth on the quotation or sales form subject to these terms and conditions and is expressly made conditional on Buyer's assent to these terms and conditions. Acceptance by Buyer is expressly limited to these terms and conditions. Any additional or different terms and conditions contained in Buyer's purchase order or other communication shall not be effective or binding upon Seller unless specifically agreed to in writing by Seller; Seller hereby objects to any such conditions, and the failure of Seller to object to specific provisions contained in any purchase order or other communication from Buyer shall not be construed as a waiver of these terms and conditions nor an acceptance of any such provisions. Neither Seller's commencement of performance nor delivery shall be deemed or construed as acceptance of Buyer's additional or different terms and conditions. Buyer agrees that these terms and conditions, together with any accompanying quotation and any special conditions or limited process guarantees or documents referred to or included within the quotation and expressly made a part of this agreement, (e.g., drawings, illustrations, specifications, or diagrams), is the complete and final agreement between Buyer and the Seller ("Agreement"). This Agreement supersedes all prior negotiations, representations, or agreements, either written or oral, between the parties and, further, can only be altered, modified or amended with the express written consent of Seller.

2. Quotation, Withdrawal, Expiration. Quotes are valid for thirty (30) calendar days from the date of issuance unless otherwise provided therein. Seller reserves the right to cancel or withdraw the quotation at any time with or without notice or cause prior to acceptance by Buyer. There is no Agreement if any conditions specified within the quotation ***or*** sales form are not completed by Buyer to Seller's satisfaction within thirty (30) calendar days of Seller's acknowledgement in writing of an order. Seller nevertheless reserves its right to accept any contractual documents received from Buyer after this 30-day period.

3. Prices. Prices apply to the specific quantities stated on the quotation or sales form. Unless otherwise agreed to in writing by Seller, all prices are FCA; Origin (as defined in accordance with the latest version of Incoterms), and do not include transportation costs or charges relating to transportation unless otherwise specified. Prices include standard packing according to Seller's specifications for delivery. All costs and taxes for special packing requested by Buyer, including packing for exports, shall be paid by Buyer as an additional charge. Prices are subject to change without notice.

4. Taxes. The price for the goods does not include any applicable sales, use, excise, GST, VAT, or similar tax, duties or levies. Buyer shall have the responsibility for the payment of such taxes if applicable.

5. Payment Terms. Seller reserves the right to require payment in advance or C.O.D. and otherwise modify credit terms should Buyer's credit standing not meet Seller's acceptance. Unless different payment terms are expressly set forth in the quotation or sales form or order acknowledgment or Sales Policy Manual, goods will be invoiced upon shipment. Payment shall be made in U.S. Dollars. Payment in full is due within thirty (30) days from the invoice date. In the event payment is not made when due, Buyer agrees to pay Seller a service or finance charge of the lesser of (i) one and one-half percent (1.5%) per month (18% per annum), or (ii) the highest rate permitted by applicable law, on the unpaid balance of the invoice from and after the invoice due date. Buyer is responsible for all costs and expenses associated with any checks returned due to insufficient funds. All credit sales are subject to prior approval of Seller's credit department. Export shipments will require payment prior to shipment or an appropriate Letter of Credit. If, during the performance of the contract with Buyer, the financial responsibility or condition of Buyer is such that Seller in good faith deems itself insecure, or if Buyer becomes insolvent, or if a material change in the ownership of Buyer occurs, or if Buyer fails to make any payments in accordance with the terms of its contract with Seller, then, in any such event, Seller is not obligated to continue performance under the contract and may stop goods in transit and defer or decline to make delivery of goods, except upon receipt of satisfactory security or cash payments in advance, or Seller may terminate the order upon written notice to Buyer without further obligation to Buyer whatsoever. If Buyer fails to make payments or fails to furnish security satisfactory to Seller, then Seller shall also have the right to enforce payment to the full contract price of the work completed and in process. Upon default by Buyer in payment when due, Buyer shall immediately pay to Seller the entire unpaid amounts for any and all shipments made to Buyer irrespective of the terms of said shipment and whether said shipments are made pursuant to this Agreement or any other contract of sale between Seller and Buyer, and Seller may withhold all subsequent shipments until the full amount is settled. Acceptance by Seller of less than full payment shall not be a waiver of any of its rights hereunder. Buyer shall not assign or transfer this Agreement or any interest in it, or monies payable under it, without the written consent of Seller and any assignment made without such consent shall be null and void.

6. Delivery, Risk of Loss. Delivery dates are estimates, and time is not of the essence. All shipments will be made FCA; Origin, unless otherwise specified. Seller shall not be responsible to Buyer for any loss, whether direct, indirect, incidental or consequential in nature, including without limitation loss of profits, arising out of or relating to any failure of the goods to be delivered by the specified delivery date. In the absence of specific instructions, Seller will select the carrier. Upon delivery to the common carrier, title and the risk of loss for the material shall pass to Buyer. Buyer shall reimburse Seller for the additional cost of its performance resulting from inaccurate or lack of delivery instructions, or by any act or omission on Buyer's part. Any such additional cost may include, but is not limited to, storage, insurance, protection, re-inspection and delivery expenses. Buyer further agrees that any payment due on delivery shall be made on delivery into storage as though goods had been delivered in accordance with the order.

Buyer grants to Seller a continuing security interest in and a lien upon the products and the proceeds thereof (including insurance proceeds), as security for the payment of all such amounts and the performance by Buyer of all of its obligations to Seller pursuant to the order and all such other sales, and Buyer shall have no right to sell, encumber or dispose of the products. Buyer shall execute any and all financing statements and other documents and instruments and do and perform any and all other acts and things which Seller may consider necessary, desirable or appropriate to establish, perfect or protect Seller's title, security interest and lien. In addition,

Buyer authorizes Seller and its agents and employees to execute any and all such documents and instruments and do and perform any and all such acts and things, at Buyer's expense, in Buyer's name and on its behalf. Such documents and instruments may also be filed without the signature of Buyer to the extent permitted by law.

7. Warranty. For goods sold by Seller to Buyer that are used by Buyer for personal, family or household purposes, Seller warrants the goods to Buyer on the terms of Seller's limited warranty available on Seller's website. For goods sold by Seller to Buyer for any other purpose, Seller warrants that the goods sold to Buyer hereunder (with the exception of membranes, seals, gaskets, elastomer materials, coatings and other "wear parts" or consumables all of which are not warranted except as otherwise provided in the quotation or sales form) will be (i) be built in accordance with the specifications referred to in the quotation or sales form, if such specifications are expressly made a part of this Agreement, and (ii) free from defects in material and workmanship for a period of one (1) year from the date of installation or eighteen (18) months from the date of shipment (which date of shipment shall not be greater than thirty (30) days after receipt of notice that the goods are ready to ship), whichever shall occur first, unless an alternate period of time is provided by law or is specified in the product documentation from Xylem (the "Warranty").

Except as otherwise provided by law, Seller shall, at its option and at no cost to Buyer, either repair or replace any product which fails to conform with the Warranty; provided, however, that under either option, Seller shall not be obligated to remove the defective product or install the replaced or repaired product and Buyer shall be responsible for all other costs, including, but not limited to, service costs, shipping fees and expenses. Seller shall have complete discretion as to the method or means of repair or replacement. Buyer's failure to comply with Seller's repair or replacement directions shall constitute a waiver of its rights and render all warranties void. Any parts repaired or replaced under the Warranty are warranted only for the balance of the warranty period on the parts that were repaired or replaced. The Warranty is conditioned on Buyer giving written notice to Seller of any defects in material or workmanship of warranted goods within ten (10) days of the date when any defects are first manifest. Seller shall have no warranty obligations to Buyer with respect to any product or parts of a product that: (a) have been repaired by third parties other than Seller or without Seller's written approval; (b) have been subject to misuse, misapplication, neglect, alteration, accident, or physical damage; (c) have been used in a manner contrary to Seller's instructions for installation, operation and maintenance; (d) have been damaged from ordinary wear and tear, corrosion, or chemical attack; (e) have been damaged due to abnormal conditions, vibration, failure to properly prime, or operation without flow; (f) have been damaged due to a defective power supply or improper electrical protection; or (g) have been damaged resulting from the use of accessory equipment not sold by Seller or not approved by Seller in connection with products supplied by Seller hereunder. In any case of products not manufactured by Seller, there is no warranty from Seller; however, Seller will extend to Buyer any warranty received from Seller's supplier of such products.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, GUARANTEES, CONDITIONS OR TERMS OF WHATEVER NATURE RELATING TO THE GOODS PROVIDED HEREUNDER, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND EXCLUDED. EXCEPT AS OTHERWISE PROVIDED BY LAW, BUYER'S EXCLUSIVE REMEDY AND SELLER'S

AGGREGATE LIABILITY FOR BREACH OF ANY OF THE FOREGOING WARRANTIES ARE LIMITED TO REPAIRING OR REPLACING THE PRODUCT AND SHALL IN ALL CASES BE LIMITED TO THE AMOUNT PAID BY THE BUYER HEREUNDER. IN NO EVENT IS SELLER LIABLE FOR ANY OTHER FORM OF DAMAGES, WHETHER DIRECT, INDIRECT, LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY OR LOSS OF REPUTATION.

8. Inspection. Buyer shall have the right to inspect the goods upon their receipt. When delivery is to Buyer's site or to a project site ("Site"), Buyer shall notify Seller in writing of any nonconformity of the goods with this Agreement within three (3) days from receipt by Buyer. For all other deliveries, Buyer shall notify Seller in writing of any nonconformity with this Agreement within fourteen (14) days from receipt by Buyer. Failure to give such applicable notice shall constitute a waiver of Buyer's right to inspect and/or reject the goods for nonconformity and shall be equivalent to an irrevocable acceptance of the goods by Buyer. Claims for loss of or damage to goods in transit must be made to the carrier, and not to Seller.

9. Seller's Limitation of Liability. EXCEPT AS OTHERWISE PROVIDED BY LAW, IN NO EVENT SHALL SELLER'S LIABILITY UNDER THIS AGREEMENT EXCEED THE AMOUNT PAID BY BUYER UNDER THIS AGREEMENT. SELLER SHALL HAVE NO LIABILITY FOR LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY, LOSS OF REPUTATION, INDIRECT, CONSEQUENTIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES.

10. Force Majeure. Seller may cancel or suspend this Agreement and Seller shall have no liability for any failure to deliver or perform, or for any delay in delivering or performing any obligations, due to acts or omissions of Buyer and/or its contractors, or due to circumstances beyond Seller's reasonable control, including but not limited to acts of God, fire, flood or other natural disasters, war and civil disturbance, riot, acts of governments, terrorism, disease, currency restrictions, labor shortages or disputes, unavailability of materials, fuel, power, energy or transportation facilities, failures of suppliers or subcontractors to effect deliveries, in which case the time for performance shall be extended in an amount equal to the excused period, provided that Seller shall have, as soon as reasonably practicable after it has actual knowledge of the beginning of any excusable delay, notified Buyer of such delay, of the reason therefor and of the probable duration and consequence thereof. Seller shall use its best efforts to eliminate the cause of the delay, interruption or cessation and to resume performance of its obligations hereunder with the least possible delay.

11. Cancellation. Except as otherwise provided in this Agreement, no order may be cancelled on special or made-to-order goods or unless otherwise requested in writing by either party and accepted in writing by the other. In the event of a cancellation by Buyer, Buyer shall, within thirty (30) days of such cancellation, pay Seller a cancellation fee, which shall include all costs and expenses incurred by Seller prior to the receipt of the request for cancellation including, but not limited to, all commitments to its suppliers, subcontractors and others, all fully burdened labor and overhead expended by Seller, plus a reasonable profit charge." Return of goods shall be in

accordance with Seller's most current Return Materials Authorization and subject to a minimum fifteen percent (15%) restocking fee.

Notwithstanding anything to the contrary herein, in the event of the commencement by or against Buyer of any voluntary or involuntary proceedings in bankruptcy or insolvency, or in the event Buyer shall be adjusted bankrupt, make a general assignment for the benefit of its creditors, or if a receiver shall be appointed on account of Buyer's insolvency, or if Buyer fails to make payment when due under this Agreement, or in the event Buyer does not correct or, if immediate correction is not possible, commence and diligently continue action to correct any default of Buyer to comply with any of the provisions or requirements of this Agreement within ten (10) calendar days after being notified in writing of such default by Seller, Seller may, by written notice to Buyer, without prejudice to any other rights or remedies which Seller may have, terminate its further performance of this Agreement. In the event of such termination, Seller shall be entitled to receive payment as if Buyer has cancelled the Agreement as per the preceding paragraph. Seller may nevertheless elect to complete its performance of this Agreement by any means it chooses. Buyer agrees to be responsible for any additional costs incurred by Seller in so doing. Upon termination of this Agreement, the rights, obligations and liabilities of the parties which shall have arisen or been incurred under this Agreement prior to its termination shall survive such termination.

12. Drawings. All drawings are the property of Seller. Seller does not supply detailed or shop working drawings of the goods; however, Seller will supply necessary installation drawings. The drawings and bulletin illustrations submitted with Seller's quotation show general type, arrangement and approximate dimensions of the goods to be furnished for Buyer's information only and Seller makes no representation or warranty regarding their accuracy. Unless expressly stated to the contrary within the quotation or sales form, all drawings, illustrations, specifications or diagrams form no part of this Agreement. Seller reserves the right to alter such details in design or arrangement of its goods which, in its judgment, constitute an improvement in construction, application or operation. All engineering information necessary for installation of the goods shall be forwarded by Seller to Buyer to upon Buyer's acceptance of this Agreement. After Buyer's acceptance of this Agreement, any changes in the type of goods, the arrangement of the goods, or application of the goods requested by Buyer will be made at Buyer's expense. Instructions necessary for installation, operating and maintenance will be supplied when the goods are shipped.

13. Proprietary Information, Injunction. Seller's designs, illustrations, drawings, specifications, technical data, catalogues, "know-how", economic or other business or manufacturing information (collectively "Proprietary Information") disclosed to Buyer shall be deemed proprietary and confidential to Seller. Buyer agrees not to disclose, use, or reproduce any Proprietary Information without first having obtained Seller's express written consent. Buyer's agreement to refrain from disclosing, using or reproducing Proprietary Information shall survive completion of the work under this Agreement. Buyer acknowledges that its improper disclosure of Proprietary Information to any third party will result in Seller's suffering irreparable harm. Seller may seek injunctive or equitable relief to prevent Buyer's unauthorized disclosure.

14. Installation and Start-up. Unless otherwise agreed to in writing by Seller, installation shall be the sole responsibility of Buyer. Where start-up service is required with respect to the goods purchased hereunder, it must be performed by Seller's authorized personnel or agents; otherwise, the Warranty is void. In the event Buyer has engaged Seller to provide an engineer for start-up

supervision, such engineer will function in a supervisory capacity only and Seller shall have no responsibility for the quality of workmanship of the installation. In any event, Buyer understands and agrees that it shall furnish, at Buyer's expense, all necessary foundations, supplies, labor and facilities that might be required to install and operate the goods.

15. Specifications. Changes in specifications requested by Buyer are subject to approval in writing by Seller. In the event such changes are approved, the price for the goods and the delivery schedule shall be changed to reflect such changes.

16. Buyer Warranty. Buyer warrants the accuracy of any and all information relating to the details of its operating conditions, including temperatures, pressures, and where applicable, the nature of all hazardous materials. Seller can justifiably rely upon the accuracy of Buyer's information in its performance. Should Buyer's information prove inaccurate, Buyer agrees to reimburse Seller for any losses, liabilities, damages and expenses that Seller may have incurred as a result of any inaccurate information provided by Buyer to Seller.

17. Minimum Order. Seller reserves the right to refuse to process any order that does not meet quantity requirements that Seller may establish for any given product or group of products.

18. Quality Levels. Prices are based on quality levels commensurate with normal processing. If a different quality level is required, Buyer must specify its requirements, as approved in writing by Seller, and pay any additional costs that may be applicable.

19. Product Recalls. In cases where Buyer purchases for resale, Buyer shall take all reasonable steps (including, without limitation, those measures prescribed by the seller): (a) to ensure that all customers of the Buyer and authorised repairers who own or use affected products are advised of every applicable recall campaign of which the Buyer is notified by the Seller; (b) to ensure that modifications notified to Buyer by Seller by means of service campaigns, recall campaigns, service programmes or otherwise are made with respect to any products sold or serviced by Buyer to its customers or authorized repairers. The reimbursement of Buyer for parts and labor used in making those modifications shall be as set forth in the campaign or program instructions. Without the prior consent of the Seller, the Buyer shall not disclose to any third party the information contained in service campaign, recall campaign or service programme literature. Should Buyer fail to perform any of the actions required under this section, Seller shall have the right to obtain names and address of the Buyer's customers and shall be entitled to get into direct contact which such customers.

19. GOVERNING LAW. THE TERMS OF THIS AGREEMENT AND ALL RIGHTS AND OBLIGATIONS HEREUNDER SHALL BE GOVERNED BY THE LAWS OF THE STATE OF SELLER'S OFFICE TO WHICH THIS ORDER HAS BEEN SUBMITTED (WITHOUT REFERENCE TO PRINCIPLES OF CONFLICTS OF LAWS). THE RIGHTS AND OBLIGATIONS OF THE PARTIES HEREUNDER SHALL NOT BE GOVERNED BY THE 1980 U.N. CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

20. Titles. The section titles are for reference only, and shall not limit or restrict the interpretation or construction of this Agreement.

21. Waiver. Seller's failure to insist, in any one or more instances, upon Buyer's performance of this Agreement, or to exercise any rights conferred, shall not constitute a waiver or relinquishment of any such right or right to insist upon Buyer's performance in any other regard.

22. Severability. The partial or complete invalidity of any one or more provisions of this Agreement shall not affect the validity or continuing force and effect of any other.

AGREEMENT TO PURCHASE: BUYER agrees to purchase the equipment and services herein in accordance with the terms and conditions set forth above.

_____
(BUYER)

BY:_____

_____

_____

_____, 20 _____

ACCEPTANCE:SELLERhereby accepts BUYER'S offer to purchase.

Xylem Water Solutions USA, Inc.

BY:_____

_____

_____

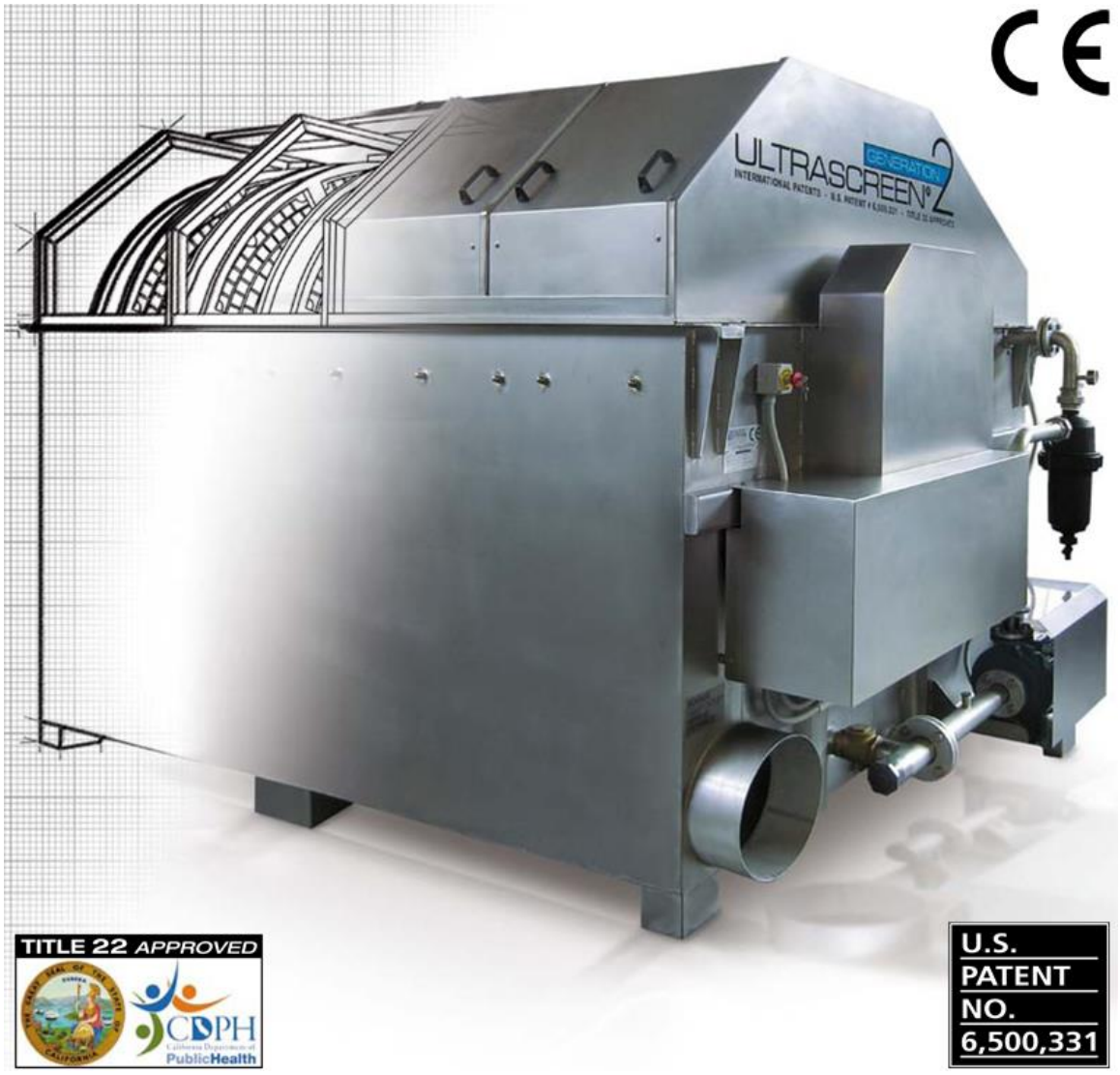
_____, 20 _____

APPENDIX F

LEOPOLD® ULTRASCREEN®
DISK FILTER SYSTEM PROPOSAL

I16320 REV02 **October 26, 2016**

Windom, MN
Leopold® Ultrascreen® Disk Filter System



Xylem Water Solutions Zelienople LLC
227 South Division Street — Zelienople, PA 16063
Phone (724) 452-6300 — Fax (724) 453-2122
www.fbleopold.com

Table of Contents

1. General System Description

The Leopold® Ultrascreen® Disk Filter uses dynamic-tangential filtration to physically remove solids from wastewater. The filtering disks are constructed using a woven 316 stainless steel mesh as the filtration medium. Dynamic-tangential filtration is a unique, patented concept that uses the combination of constant disk rotation and influent flow pattern to create a situation where water passes across the disks tangentially, rather than orthogonally. This reduces the effective openings of the stainless steel mesh and allows for very efficient separation of micro particles contained in the influent water. The efficiency achieved with tangential filtration allows the system to handle total suspended solids (TSS) upsets up to 150 mg/L and leads to a smaller overall footprint for the system and filtration rates of up to 16 gpm per square foot of disk area.

The filtering disks work in pairs. The influent water enters between a pair of disks and water passes outward across the disks. The filtered water then flows by gravity into a common collection well and exits the unit though the outlet pipe.

As water passes across the rotating disks, solids accumulate on the disk surface, which creates headloss. This causes the water level between the pairs of disks to increase. When the water reaches a certain level, a level sensor activates an automatic spray wash cleaning sequence. Each disk has its own spray header to ensure efficient disk cleaning. The spray wash waste water (backwash reject) from each set of disks is collected in a common channel and then purged from the unit through a stainless steel drain valve. The reject water is typically returned to the headworks of the plant for continued treatment.

The Ultrascreen offers the lowest possible total cost of ownership. The robust, all stainless steel construction of the filtering disks means less changing of the filtering elements; typically the disks are effective for at least five years. None of the mechanical bearings within the tank are submerged, which drastically increases bearing lifespan. The above ground installation allows for a simple, “plug and play” startup process and easy access to the unit internals when maintenance is required.

Optimizing the performance of the system is possible because disk rotation frequency, wash cycle timing, and water level in the feed zone are all adjustable. Process adjustments like these are not possible with other static disk filter systems. The Ultrascreen is therefore the right choice for all types of treatment plants and operating conditions.

2. Design Criteria

The disk filtration system described here-in is a treatment system designed for the physical removal of solids. This system that shall be furnished and installed is described in Section 3 - Scope of Supply. The system has been designed based on the engineer's drawings and specifications using the following criteria:

The below design parameters are based on the flow of 1.5 MGD. In the pricing section of this proposal we included the cost for 0.50, 1.00, 1.50, 2.00 and 2.50 MGD options. All of the options are for one Ultrascreen unit capable of handling the flows.

System Design		
Number of Units	Two (2)	*Advised*
Model Number	Leopold Ultrascreen Model UL 1604	*Advised*
Model Layout	Config A	*Advised*
Material of Construction	AISI 304SS	*Advised*
Filtration Surface Area per Unit	177 square feet	*Advised*
Total Filtration Surface Area	353 square feet	*Advised*

Design Specifications		
Average Daily Flow (ADF)	1.5 MGD	*Given*
Peak Daily Flow (PDF)	1.5 MGD	*Given*
Average Influent TSS	30 mg/L	*Given*
Maximum Influent TSS	30 mg/L	*Given*
Required Effluent TSS	< 5 mg/L	*Calculated*

Loading Rates at Average Conditions		
Hydraulic Loading Rate (all online)	3 gpm/sf	*Calculated*
Hydraulic Loading Rate (one offline)	5.9 gpm/sf	*Calculated*
TSS Loading Rate (one unit online)	2.13 lb/day per square foot	*Calculated*
TSS Removal Rate (@ 10 mg/L effluent)	1.42 lb/day per square foot	*Calculated*

Loading Rates at Peak Conditions		
Hydraulic Loading Rate (all online)	3 gpm/sf	*Calculated*
Hydraulic Loading Rate (one offline)	5.9 gpm/sf	*Calculated*
TSS Loading Rate (one unit online)	2.13 lb/day per square foot	*Calculated*
TSS Removal Rate (@ 10 mg/L effluent)	1.42 lb/day per square foot	*Calculated*

Washing Information (meets Title 22 standards) – One Unit Offline		
Wash Time % @ Average Conditions	22%	*Calculated*
Wash Time % @ Peak Conditions	22%	*Calculated*
Nozzles per Unit	144	*Calculated*
Wash Pump Flowrate @ 50 psi	128 gpm	*Calculated*
Average Daily Backwash Reject	**2.7% of forward flow**	***Calculated***

3. Scope of Supply

Xylem Water Solutions Zelienople LLC will supply only the items specifically detailed within this proposal. Use proposal drawings I16320.90.1 as reference.

*** Two (2) Leopold ® UltraScreen® Gen2 Microfilter module UL 1604 (Configuration A)**

- Built in AISI 304 stainless steel
- AISI 304 stainless steel covers
- AISI 304 stainless steel flange connection points
- Removable filtering sectors AISI 316L SS (woven mesh - 20 micron)
- Motorgear equipped with variable speed drive
- Mechanical safety guards complying with Machinery Directive 2006/42/EC
- Equipped with inlet and outlet sample ports
- Each unit contains the following:
    * Five (5) Level Sensors (by mounting elevation from low to high):
        - Disk Motor Stop Level
        - Disk Motor Start Level
        - Wash Pump Stop Level
        - Wash Pump Start Level
        - Overflow Operation Level
    * One (1) Spray Wash System with the following components:
        - Centrifugal Wash Pump
        - Pump Discharge Valve (Manual Ball Valve)
        - Pump Discharge Pressure Gauge
        - Pump Discharge Check Valve
        - Washing Circuit Straining Filter Assembly
    * One (1) Control Panel with the following components & displays:
        - Main Power Switch
        - Main Power On Indication (White)
        - Disk Motor High Temp Alarm Indication (Yellow)
        - Wash Pump Motor High Temp Alarm Indication (Yellow)
        - Backwash Reject Valve Open Indication (Green)
        - Currently Operating in Overflow Indication (Red)
        - Clogged Washing Strainer Alarm Indication (Red)
        - Alarm Reset Pushbutton
        - Washing Method Selector Switch (Pump - Off - System)
        - Disk Motor Selector Switch (Manual - Off - Auto)
        - Wash Pump Operation Selector Switch (Manual - Off - Auto)
        - Backwash Reject Valve Selector Switch (Open - Close - Auto)
        - Digital Display
        - Filtering Disk Speed Control Keypad

*** Lot of Spare Parts**

- One (1) Lateral Gasket
- Two (2) Filtering Screen Sectors
- One (1) Flange Support
- Four (4) Washing Nozzles
- One (1) Chain Kit

- One (1) Nut Driver Tool (for gasket replacement)
- One (1) Cartridge of Bearing Grease

*** Field Service**

- 4 days onsite (8 hr/day) in 1 separate trip

*** Container Packaging & Freight to Windom, MN**

- Includes all maintenance, processing, and customs fees

Items Not Included

The following items, while not comprehensive, are not included in this waste Water Filtration System:

- Receiving, unloading, and storing of supplied equipment and materials.
- Concrete for filter, building/architectural work and engineering thereof.
- Positioning and installation of tanks.
- Platforms, ladders, or walkways.
- Manual Butterfly Valves for Influent and Effluent
- Lubricants for mechanical equipment.
- Interconnecting piping, piping supports, and wall sleeves/pipes including flanges, bolts, nuts, and gaskets.
- Electrical starters, circuit breakers, motor control center, conduit, and interconnecting wiring and engineering thereof.
- Costs associated with any necessary startup and/or commissioning tests.

4. Pricing

Any items and/or accessories not specifically called out in this quotation must be construed as being furnished by others.

This quotation is considered firm for 90 days. Orders received more than 90 days after the date of this quotation is reviewed by Xylem Water Solutions Zelienople LLC before acceptance and is subject to changes in prices or delivery depending on conditions existing at the time of entry. Quoted prices are firm for delivery within 12 months from the delivery date stipulated in the plans & specifications or mutually agreed upon by Xylem Water Solutions Zelienople LLC and Purchase Order issuer at time of order placement.

It is the user's responsibility to ensure that recommendations and materials selections will be satisfactory for the intended environment and service; and it is the user's responsibility to determine the applicability and suitability of recommendations offered for the service and operating conditions under its control. End user's should satisfy themselves as to the applicability of service test data and suitability of any material for the proposed end use. The user assumes the entire risk related to use of materials, and each user bears full responsibility for making its own determination as to the suitability of materials, products, design, recommendations, or advice for its own particular use. The end user must identify and perform all necessary tests and analyses to ensure that materials or products will be safe and suitable for use under end-use service conditions. This may include in-situ corrosion testing and evaluation of materials coupons to determine suitability of materials under consideration prior to selection. We do not include any applicable taxes.

Orders resulting from this quotation should be addresses to Xylem Water Solutions Zelienople LLC, 227 S. Division St., Zelienople, PA, 16063, USA.

Leopold Ultrascreen System **Budget Price**

Flow (MGD)	Disk Filter Unit	Quantity	Price (USD)
0.50	UL 1602	2	$268,768
1.00	UL 1603	2	$313,276
1.50	UL 1604	2	$377,241
2.00	UL 1605	2	$431,933
2.50	UL 1606	2	$475,180

For final pricing and information please contact our local representative:

Vescco, Inc.
8217 Upland Circle
Chanhassen, MN 55317
Phone : 952-941-2678
Attn : Clark Corbett
Email : dcorbett@vessco.com

Respectfully,

Bruce Wolfe
Xylem Water Solutions Zelienople LLC
Senior Sales Engineer

5. Commercial Terms and Conditions

1. Agreement, Integration and Conflict of Terms. These terms and conditions, together with any special conditions expressly incorporated thereto in the quotation or sales form, are to govern any sale between the Seller and Buyer. The Seller shall mean the applicable affiliate of Xylem Inc. that is party to the Agreement ("Seller"). The Buyer shall mean the entity that is party to the Agreement with Seller. This writing is an offer or counteroffer by Seller to sell the goods and/or services set forth on the quotation or sales form subject to these terms and conditions and is expressly made conditional on Buyer's assent to these terms and conditions. Acceptance by Buyer is expressly limited to these terms and conditions. Any additional or different terms and conditions contained in Buyer's purchase order or other communication shall not be effective or binding upon Seller unless specifically agreed to in writing by Seller; Seller hereby objects to any such conditions, and the failure of Seller to object to specific provisions contained in any purchase order or other communication from Buyer shall not be construed as a waiver of these terms and conditions nor an acceptance of any such provisions. Neither Seller's commencement of performance nor delivery shall be deemed or construed as acceptance of Buyer's additional or different terms and conditions. Buyer agrees that these terms and conditions, together with any accompanying quotation and any special conditions or limited process guarantees or documents referred to or included within the quotation and expressly made a part of this agreement, (e.g., drawings, illustrations, specifications, or diagrams), is the complete and final agreement between Buyer and the Seller ("Agreement"). This Agreement supersedes all prior negotiations, representations, or agreements, either written or oral, between the parties and, further, can only be altered, modified or amended with the express written consent of Seller.

2. Quotation, Withdrawal, Expiration. Quotes are valid for thirty (30) calendar days from the date of issuance unless otherwise provided therein. Seller reserves the right to cancel or withdraw the quotation at any time with or without notice or cause prior to acceptance by Buyer. There is no Agreement if any conditions specified within the quotation ***or*** sales form are not completed by Buyer to Seller's satisfaction within thirty (30) calendar days of Seller's acknowledgement in writing of an order. Seller nevertheless reserves its right to accept any contractual documents received from Buyer after this 30-day period.

3. Prices. Prices apply to the specific quantities stated on the quotation or sales form. Unless otherwise agreed to in writing by Seller, all prices are FCA; Origin (as defined in accordance with the latest version of Incoterms), and do not include transportation costs or charges relating to transportation unless otherwise specified. Prices include standard packing according to Seller's specifications for delivery. All costs and taxes for special packing requested by Buyer, including packing for exports, shall be paid by Buyer as an additional charge. Prices are subject to change without notice.

4. Taxes. The price for the goods does not include any applicable sales, use, excise, GST, VAT, or similar tax, duties or levies. Buyer shall have the responsibility for the payment of such taxes if applicable.

5. Payment Terms. Seller reserves the right to require payment in advance or C.O.D. and otherwise modify credit terms should Buyer's credit standing not meet Seller's acceptance. Unless different payment terms are expressly set forth in the quotation or sales form or order acknowledgment or Sales Policy Manual, goods will be invoiced upon shipment. Payment shall be made in U.S. Dollars. Payment in full is due within thirty (30) days from the invoice date. In the event payment is not made when due, Buyer agrees to pay Seller a service or finance charge of the lesser of (i) one and one-half percent (1.5%) per month (18% per annum), or (ii) the highest rate permitted by applicable law, on the unpaid balance of the invoice from and after the invoice due date. Buyer is responsible for all costs and expenses associated with any checks returned due to insufficient funds. All credit sales are subject to prior approval of Seller's credit department. Export shipments will require payment prior to shipment or an appropriate Letter of Credit. If, during the performance of the contract with Buyer, the financial responsibility or condition of Buyer is such that Seller in good faith deems itself insecure, or if Buyer becomes insolvent, or if a material change in the ownership of Buyer occurs, or if Buyer fails to make any payments in accordance with the terms of its contract with Seller, then, in any such event, Seller is not obligated to continue performance under the contract and may stop goods in transit and defer or decline to make delivery of goods, except upon receipt of satisfactory security or cash payments in advance, or Seller may terminate the order upon written notice to Buyer without further obligation to Buyer whatsoever. If Buyer fails to make payments or fails to furnish security satisfactory to Seller, then Seller shall also have the right to enforce payment to the full contract price of the work completed and in process. Upon default by Buyer in payment when due, Buyer shall immediately pay to Seller the entire unpaid amounts for any and all shipments made to Buyer irrespective of the terms of said shipment and whether said shipments are made pursuant to this Agreement or any other contract of sale between Seller and Buyer, and Seller may withhold all subsequent shipments until the full amount is settled. Acceptance by Seller of less than full payment shall not be a waiver of any of its rights hereunder. Buyer shall not assign or transfer this Agreement or any interest in it, or monies payable under it, without the written consent of Seller and any assignment made without such consent shall be null and void.

6. Delivery, Risk of Loss. Delivery dates are estimates, and time is not of the essence. All shipments will be made FCA; Origin, unless otherwise specified. Seller shall not be responsible to Buyer for any loss, whether direct, indirect, incidental or consequential in nature, including without limitation loss of profits, arising out of or relating to any failure of the goods to be delivered by the specified delivery date. In the absence of specific instructions, Seller will select the carrier. Upon delivery to the common carrier, title and the risk of loss for the material shall pass to Buyer. Buyer shall reimburse Seller for the additional cost of its performance resulting from inaccurate or lack of delivery instructions, or by

any act or omission on Buyer's part. Any such additional cost may include, but is not limited to, storage, insurance, protection, re-inspection and delivery expenses. Buyer further agrees that any payment due on delivery shall be made on delivery into storage as though goods had been delivered in accordance with the order.

Buyer grants to Seller a continuing security interest in and a lien upon the products and the proceeds thereof (including insurance proceeds), as security for the payment of all such amounts and the performance by Buyer of all of its obligations to Seller pursuant to the order and all such other sales, and Buyer shall have no right to sell, encumber or dispose of the products. Buyer shall execute any and all financing statements and other documents and instruments and do and perform any and all other acts and things which Seller may consider necessary, desirable or appropriate to establish, perfect or protect Seller's title, security interest and lien. In addition, Buyer authorizes Seller and its agents and employees to execute any and all such documents and instruments and do and perform any and all such acts and things, at Buyer's expense, in Buyer's name and on its behalf. Such documents and instruments may also be filed without the signature of Buyer to the extent permitted by law.

7. Warranty. For goods sold by Seller to Buyer that are used by Buyer for personal, family or household purposes, Seller warrants the goods to Buyer on the terms of Seller's limited warranty available on Seller's website. For goods sold by Seller to Buyer for any other purpose, Seller warrants that the goods sold to Buyer hereunder (with the exception of membranes, seals, gaskets, elastomer materials, coatings and other "wear parts" or consumables all of which are not warranted except as otherwise provided in the quotation or sales form) will be (i) be built in accordance with the specifications referred to in the quotation or sales form, if such specifications are expressly made a part of this Agreement, and (ii) free from defects in material and workmanship for a period of one (1) year from the date of installation or eighteen (18) months from the date of shipment (which date of shipment shall not be greater than thirty (30) days after receipt of notice that the goods are ready to ship), whichever shall occur first, unless an alternate period of time is provided by law or is specified in the product documentation from Xylem (the "Warranty").

Except as otherwise provided by law, Seller shall, at its option and at no cost to Buyer, either repair or replace any product which fails to conform with the Warranty; provided, however, that under either option, Seller shall not be obligated to remove the defective product or install the replaced or repaired product and Buyer shall be responsible for all other costs, including, but not limited to, service costs, shipping fees and expenses. Seller shall have complete discretion as to the method or means of repair or replacement. Buyer's failure to comply with Seller's repair or replacement directions shall constitute a waiver of its rights and render all warranties void. Any parts repaired or replaced under the Warranty are warranted only for the balance of the warranty period on the parts that were repaired or replaced. The Warranty is conditioned on Buyer giving written notice to Seller of any defects in material or workmanship of warranted goods within ten (10) days of the date when any defects are first manifest. Seller shall have no warranty obligations to Buyer with respect to any product or parts of a product that: (a) have been repaired by third parties other than Seller or without Seller's written approval; (b) have been subject to misuse, misapplication, neglect, alteration, accident, or physical damage; (c) have been used in a manner contrary to Seller's instructions for installation, operation and maintenance; (d) have been damaged from ordinary wear and tear, corrosion, or chemical attack; (e) have been damaged due to abnormal conditions, vibration, failure to properly prime, or operation without flow; (f) have been damaged due to a defective power supply or improper electrical protection; or (g) have been damaged resulting from the use of accessory equipment not sold by Seller or not approved by Seller in connection with products supplied by Seller hereunder. In any case of products not manufactured by Seller, there is no warranty from Seller; however, Seller will extend to Buyer any warranty received from Seller's supplier of such products.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, GUARANTEES, CONDITIONS OR TERMS OF WHATEVER NATURE RELATING TO THE GOODS PROVIDED HEREUNDER, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND EXCLUDED. EXCEPT AS OTHERWISE PROVIDED BY LAW, BUYER'S EXCLUSIVE REMEDY AND SELLER'S AGGREGATE LIABILITY FOR BREACH OF ANY OF THE FOREGOING WARRANTIES ARE LIMITED TO REPAIRING OR REPLACING THE PRODUCT AND SHALL IN ALL CASES BE LIMITED TO THE AMOUNT PAID BY THE BUYER HEREUNDER. IN NO EVENT IS SELLER LIABLE FOR ANY OTHER FORM OF DAMAGES, WHETHER DIRECT, INDIRECT, LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY OR LOSS OF REPUTATION.

8. Inspection. Buyer shall have the right to inspect the goods upon their receipt. When delivery is to Buyer's site or to a project site ("Site"), Buyer shall notify Seller in writing of any nonconformity of the goods with this Agreement within three (3) days from receipt by Buyer. For all other deliveries, Buyer shall notify Seller in writing of any nonconformity with this Agreement within fourteen (14) days from receipt by Buyer. Failure to give such applicable notice shall constitute a waiver of Buyer's right to inspect and/or reject the goods for nonconformity and shall be equivalent to an irrevocable acceptance of the goods by Buyer. Claims for loss of or damage to goods in transit must be made to the carrier, and not to Seller.

9. Seller's Limitation of Liability. EXCEPT AS OTHERWISE PROVIDED BY LAW, IN NO EVENT SHALL SELLER'S LIABILITY UNDER THIS AGREEMENT EXCEED THE AMOUNT PAID BY BUYER UNDER THIS AGREEMENT. SELLER SHALL HAVE NO LIABILITY FOR LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY, LOSS OF REPUTATION, INDIRECT, CONSEQUENTIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES.

10. Force Majeure. Seller may cancel or suspend this Agreement and Seller shall have no liability for any failure to deliver or perform, or for any delay in delivering or performing any obligations, due to acts or omissions of Buyer and/or its contractors, or due to circumstances beyond Seller's reasonable control, including but not limited to acts of God, fire, flood or other natural disasters, war and civil disturbance, riot, acts of governments, terrorism, disease, currency restrictions, labor shortages or disputes, unavailability of materials, fuel, power, energy or transportation facilities, failures of suppliers or subcontractors to effect deliveries, in which case the time for performance shall be extended in an amount equal to the excused period, provided that Seller shall have, as soon as reasonably practicable after it has actual knowledge of the beginning of any excusable delay, notified Buyer of such delay, of the reason therefor and of the probable duration and consequence thereof. Seller shall use its best efforts to eliminate the cause of the delay, interruption or cessation and to resume performance of its obligations hereunder with the least possible delay.

11. Cancellation. Except as otherwise provided in this Agreement, no order may be cancelled on special or made-to-order goods or unless otherwise requested in writing by either party and accepted in writing by the other. In the event of a cancellation by Buyer, Buyer shall, within thirty (30) days of such cancellation, pay Seller a cancellation fee, which shall include all costs and expenses incurred by Seller prior to the receipt of the request for cancellation including, but not limited to, all commitments to its suppliers, subcontractors and others, all fully burdened labor and overhead expended by Seller, plus a reasonable profit charge." Return of goods shall be in accordance with Seller's most current Return Materials Authorization and subject to a minimum fifteen percent (15%) restocking fee.

Notwithstanding anything to the contrary herein, in the event of the commencement by or against Buyer of any voluntary or involuntary proceedings in bankruptcy or insolvency, or in the event Buyer shall be adjusted bankrupt, make a general assignment for the benefit of its creditors, or if a receiver shall be appointed on account of Buyer's insolvency, or if Buyer fails to make payment when due under this Agreement, or in the event Buyer does not correct or, if immediate correction is not possible, commence and diligently continue action to correct any default of Buyer to comply with any of the provisions or requirements of this Agreement within ten (10) calendar days after being notified in writing of such default by Seller, Seller may, by written notice to Buyer, without prejudice to any other rights or remedies which Seller may have, terminate its further performance of this Agreement. In the event of such termination, Seller shall be entitled to receive payment as if Buyer has cancelled the Agreement as per the preceding paragraph. Seller may nevertheless elect to complete its performance of this Agreement by any means it chooses. Buyer agrees to be responsible for any additional costs incurred by Seller in so doing. Upon termination of this Agreement, the rights, obligations and liabilities of the parties which shall have arisen or been incurred under this Agreement prior to its termination shall survive such termination.

12. Drawings. All drawings are the property of Seller. Seller does not supply detailed or shop working drawings of the goods; however, Seller will supply necessary installation drawings. The drawings and bulletin illustrations submitted with Seller's quotation show general type, arrangement and approximate dimensions of the goods to be furnished for Buyer's information only and Seller makes no representation or warranty regarding their accuracy. Unless expressly stated to the contrary within the quotation or sales form, all drawings, illustrations, specifications or diagrams form no part of this Agreement. Seller reserves the right to alter such details in design or arrangement of its goods which, in its judgment, constitute an improvement in construction, application or operation. All engineering information necessary for installation of the goods shall be forwarded by Seller to Buyer to upon Buyer's acceptance of this Agreement. After Buyer's acceptance of this Agreement, any changes in the type of goods, the arrangement of the goods, or application of the goods requested by Buyer will be made at Buyer's expense. Instructions necessary for installation, operating and maintenance will be supplied when the goods are shipped.

13. Proprietary Information, Injunction. Seller's designs, illustrations, drawings, specifications, technical data, catalogues, "know-how", economic or other business or manufacturing information (collectively "Proprietary Information") disclosed to Buyer shall be deemed proprietary and confidential to Seller. Buyer agrees not to disclose, use, or reproduce any Proprietary Information without first having obtained Seller's express written consent. Buyer's agreement to refrain from disclosing, using or reproducing Proprietary Information shall survive completion of the work under this Agreement. Buyer acknowledges that its improper disclosure of Proprietary Information to any third party will result in Seller's suffering irreparable harm. Seller may seek injunctive or equitable relief to prevent Buyer's unauthorized disclosure.

14. Installation and Start-up. Unless otherwise agreed to in writing by Seller, installation shall be the sole responsibility of Buyer. Where start-up service is required with respect to the goods purchased hereunder, it must be performed by Seller's authorized personnel or agents; otherwise, the Warranty is void. In the event Buyer has engaged Seller to provide an engineer for start-up supervision, such engineer will function in a supervisory capacity only and Seller shall have no responsibility for the quality of workmanship of the installation. In any event, Buyer understands and agrees that it shall furnish, at Buyer's expense, all necessary foundations, supplies, labor and facilities that might be required to install and operate the goods.

15. Specifications. Changes in specifications requested by Buyer are subject to approval in writing by Seller. In the event such changes are approved, the price for the goods and the delivery schedule shall be changed to reflect such changes.

16. Buyer Warranty. Buyer warrants the accuracy of any and all information relating to the details of its operating conditions, including temperatures, pressures, and where applicable, the nature of all hazardous materials. Seller can justifiably rely upon the accuracy of Buyer's information in its performance. Should Buyer's information prove inaccurate, Buyer agrees to reimburse Seller for any losses, liabilities, damages and expenses that Seller may have incurred as a result of any inaccurate information provided by Buyer to Seller.

17. Minimum Order. Seller reserves the right to refuse to process any order that does not meet quantity requirements that Seller may establish for any given product or group of products.

18. Quality Levels. Prices are based on quality levels commensurate with normal processing. If a different quality level is required, Buyer must specify its requirements, as approved in writing by Seller, and pay any additional costs that may be applicable.

19. Product Recalls. In cases where Buyer purchases for resale, Buyer shall take all reasonable steps (including, without limitation, those measures prescribed by the seller): (a) to ensure that all customers of the Buyer and authorised repairers who own or use affected products are advised of every applicable recall campaign of which the Buyer is notified by the Seller; (b) to ensure that modifications notified to Buyer by Seller by means of service campaigns, recall campaigns, service programmes or otherwise are made with respect to any products sold or serviced by Buyer to its customers or authorized repairers. The reimbursement of Buyer for parts and labor used in making those modifications shall be as set forth in the campaign or program instructions. Without the prior consent of the Seller, the Buyer shall not disclose to any third party the information contained in service campaign, recall campaign or service programme literature. Should Buyer fail to perform any of the actions required under this section, Seller shall have the right to obtain names and address of the Buyer's customers and shall be entitled to get into direct contact which such customers.

19. GOVERNING LAW. THE TERMS OF THIS AGREEMENT AND ALL RIGHTS AND OBLIGATIONS HEREUNDER SHALL BE GOVERNED BY THE LAWS OF THE STATE OF SELLER'S OFFICE TO WHICH THIS ORDER HAS BEEN SUBMITTED (WITHOUT REFERENCE TO PRINCIPLES OF CONFLICTS OF LAWS). THE RIGHTS AND OBLIGATIONS OF THE PARTIES HEREUNDER SHALL NOT BE GOVERNED BY THE 1980 U.N. CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

20. Titles. The section titles are for reference only, and shall not limit or restrict the interpretation or construction of this Agreement.

21. Waiver. Seller's failure to insist, in any one or more instances, upon Buyer's performance of this Agreement, or to exercise any rights conferred, shall not constitute a waiver or relinquishment of any such right or right to insist upon Buyer's performance in any other regard.

22. Severability. The partial or complete invalidity of any one or more provisions of this Agreement shall not affect the validity or continuing force and effect of any other.

AGREEMENT TO PURCHASE: BUYER agrees to purchase the equipment and services herein in accordance with the terms and conditions set forth above.

ACCEPTANCE: SELLER hereby accepts BUYER'S offer to purchase.

_____
(BUYER)

BY:_____

_____

_____

_____, 20 _____

Xylem Water Solutions USA, Inc.

BY:_____

_____

_____

_____, 20 _____

APPENDIX G

RESPONSE TO MPCA'S COMMENTS ON THE DRAFT REPORT PRESENTED ON JULY 29, 2016

1. Section 2. Statement of Problems, Opportunities, and Existing Conditions of the work plan, item (III) includes converting the existing travelling bridge filter to a denitrification filter with external carbon addition. I did not see the conversion of the existing travelling bridge filter covered in the report.

The existing travelling bridge filter media depth is only 11 inches with effective size between 0.55mm and 0.65 mm. During the literature review phase it became apparent that existing travelling bridge filter cannot function as a denitrifying filter. See Tables 2.1 and 2.2 in the report. Therefore no attempt was made use the existing travelling bridge filter as pilot denitrifying filters.

2. Section 2. Statement of Problems, Opportunities, and Existing Conditions of the work plan, Goal 1, Tasks C and D include using three different types of external carbon sources. One project used two external carbon sources while the other used only one. Please clarify why three sources were not used.

With denitrifying filters two different carbon source was piloted. We had hoped to get dry distillers grain from an ethanol facility near Windom to try out as carbon source. However we were not successful in getting this carbon source. We had used two carbon sources Micro C and Glycerin (Fremont 8028) that are most widely used in denitrifying WWTP in US and was available from local chemical suppliers. Moreover midway through the pilot study, PM Beef shut down its operation in Windom and as a result the TKN levels in the influent decreased considerably and reached normal domestic level of around 25 to 35 mg/L. As you may recall one of the reason for selecting Windom WWTP for this pilot study was the high level of TKN in the influent. We attempted to mitigate the situation by addition of an external source of ammonia (Fremont Industries RLT 4710) to the influent to increase the concentration of TKN in the influent. This is a liquid which has to be dosed at precise rate to maintain the desired TKN level. As discussed under Item 9 below, this operation also increased the complexity of the pilot operation produced widely varying results. Because of these unforeseen operation problems, we could not try out more than one carbon source for activated sludge pilot treatment system.
The addition of the external ammonia source added additional complexity to the two-stage activated sludge pilot system and caused several other operational problems because of the low flow (0.4 GPM) at which the pilot treatment system was operated. This required the RAS pumps to operate at 0.6 GPM and the mixed liquor (ML) at 0.4 to 1.6 GPM and required more operator intervention and re-initialization of the pilot treatment process to keep the system going. In the end we ran out of time to try other carbon sources.

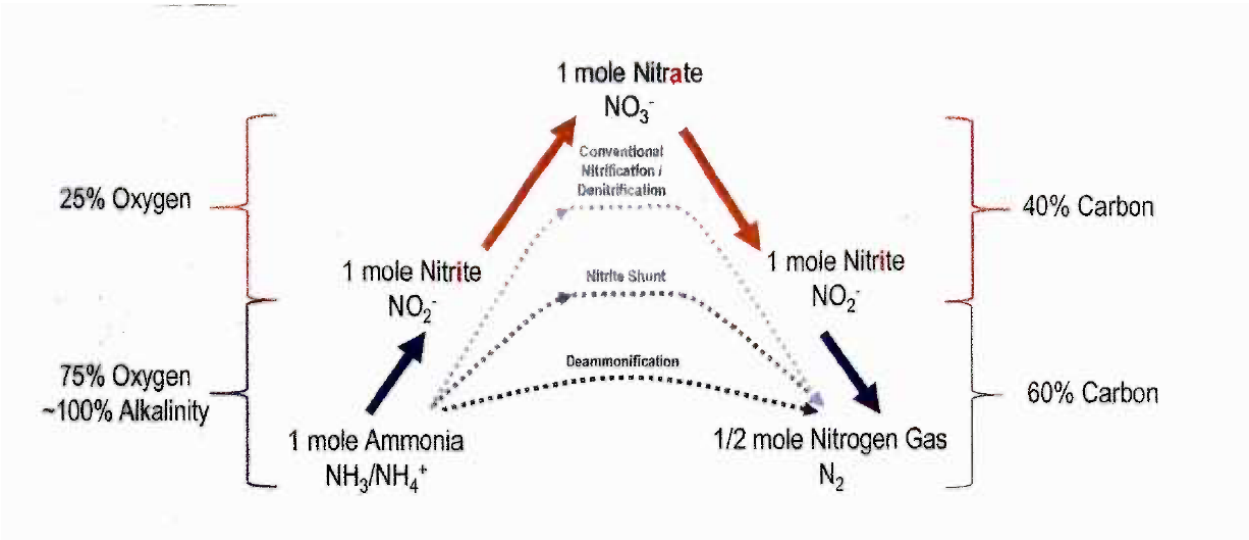
I am not a nitrification/denitrification expert, but it seems to me that there are some conflicting comments in the report when it comes to n/dn.

3. Page 2-2 states that the second step is the conversion of nitrate (NO2) to nitrate (NO3). I believe the first nitrate should be changed to nitrite.

Correct. It will be corrected to nitrite

4. Page 2-3 states that denitrification is the reduction of nitrate to nitrite to nitrogen gas. Shouldn't this be nitrite to nitrate? Also, my understanding is that denitrification does not include nitrite to nitrate, just nitrate to nitrogen gas.

Conventional denitrification follows the path Nitrate--→Nitrite--→Nitrogen gas.
There are other denitrification process as shown in the figure below that can take a different path.



5. Page 2-4 states that denitrification occurs when nitrate (NO3) is reduced, sequentially, to nitrite (NO2). Isn't this backwards?

No. It is correct. See the figure above.

6. Page 4-3 states nitrate +nitrite (NO2+NO3). I believe the NO2 and NO3 should be reversed to match the nitrate +nitrite order.

Yes it should be reversed to match NO2+NO3.

7. Page 5-1 uses the term "path-through". Is this supposed to be pass-through?

It should be pass-through

8. Page 5-2 indicates that the denitrification filter system confirmed the ability to reduce TN to 10 mg/L or less. However, as indicated in Section 2. Statement of Problems, Opportunities, and Existing Conditions and Section 3 Measurable Outcomes of the work plan, the goal was to determine if the city of Windom's facility could achieve a TN limit of 5 mg/L or less. This needs to be clarified.

The work plan was to achieve a TN limit of 5 mg/L or less. However pilot operation did not consistently produce an effluent with a TN less than 5 mg/L. Based on the operational results we are more confident of meeting a TN limit of 10 mg/L instead of a TN limit of 5 mg/L.

9. Page 5-5. The second to last sentence on the page that begins, "Due to the relatively slow..." does not appear to be a complete sentence.

The sentence should be revised as follows:

Due to the relatively slow growth rate of nitrifying bacteria, and the rapid increase in supplemental nitrogen content during the course of the pilot study, it is assumed that the nitrogen feed rate (Fremont RLT 4710)increased too rapidly for the biological system and distribution of organisms to adjust. Therefore, insufficient concentrations of nitrifying bacteria resulted in reduced ammonia conversion and higher effluent ammonia and total nitrogen concentrations during this phase of the pilot study.

10. Page 6-1 mentions that the denitrification filter reduced the TN down to 3 mg/L, but the plot seems to indicate that it was only down to this level for a very short time, not a sustained period. How could this level of treatment be maintained for a sustained period of time?

Yes. We achieved TN level of 3 mg/L only for a short time. What is implied is as low as 3 mg/L. It no way conveys the idea an effluent level of 3 mg/L is sustainable. See the response to the Item 8.

11. Page 6-2 states that 2-stage activated sludge for TN removal is an effective method for reducing nitrogen levels in wastewater effluent. While I don't question this statement, I think the real question is what level of TN can be sustained in the effluent?

Unfortunately we ran into several unforeseen problem with pilot activated sludge operation. Our results were not consistent due to operational problems. You are correct we do not have sufficient data to back this statement

12. Page 6-3 and additional pages include capital cost estimates. Have these cost estimates taken into account the MPCA's reliability criteria?

Costs estimates are revised based on MPCA's reliability criterion, which requires the rated plant capacity (AWW flow) be treated with one unit out of service. The costs were revised to provide at least two denitrification units and preliminary screening or disk filters.