Case Study:

Boy Scouts of America upgrades water recycling system to reduce Nitrogen

Northern Tier High Adventure Base @ Ely, MN uses Biowater Technology carrier elements for Nitrification & Denitrification.

Superior National Forest—3,900,000 acres, Northern Minnesota of which ~1,000,000 acres of Woods & Waters is set aside as the pristine *Boundary Waters Canoe Area*

Problem Statement

- **The sensitive ecosystem of the area necessitated upgrade to the base camps wastewater treatment and recycling system. Boy Scouts of America and the Minnesota Pollution Control Agency had come to a mutual understanding that the water recycling system had to be upgraded to reduce nitrogen emitted from the water recycling system.**

Wastewater system addition designed to Total Nitrogen (TN) limit of 10 mg/l prior to soil absorption

Existing components:

- **Two 6,000-gallon septic tanks in series for solids settling.**
- **Two 4,000-gallon equalization tanks to equalize the flows over a 24-hour period.**
- **Equalization lift station with two pumps that pump to the west end of the wetland treatment cell.**
- **Wetland treatment cell that provides biological treatment of the wastewater.**

Lift & dosing tanks & pumps for Trench & At-Grade soil absorption & disposal system consisting of approximately 20 trenches & 6 At-Grades of varying lengths.

Modified Treatment Design Details

- **The existing wastewater treatment system needed a robust fixed film biological addition that treats variable flows and nitrogen loads from cold artificial wetland water prior to soil disposal.**
- **The Smart-Treat® MBBR treatment system was approved by the Minnesota regulatory agency (MPCA). The Biowater Technology BWT-X biofilm carrier elements provide sufficient biological surface area to accomplish the treatment goal.**

Northern Tier WWTP
Nitrification/Denitrification Design Details

- Ave CBOD to MBBR: 11,000 GPD x 25 mg/l CBOD = 2.29 lbs. CBOD/day
- Ave Nitrogen to MBBR: 11,000 GPD x 100 mg/l TN= 9.1 Lbs. N/day
- MBBR Reactor Size: Reactor 1 = 6,000 Reactor 1-51% fill=416 cu ft.
- Reactor 2/3 = 4,800 combo
  - Reactor 2 3,000 anoxic 49% fill=200 cu ft.
  - Reactor 3- 1,800 Post-aerobic 29.6% fill=69 cu ft.
- Clarifier Size 4,200 gallon
- Aeration Reactor 1-200 CFM
- Reactor 3-38 CFM
- Anoxic Mixer Reactor 2- 1.0 HP 1750 RPM
- Media 685 cubic feet

Addition to Northern Tier WWTP to Accomplish Cold Water Nitrogen Removal

- **2,000-gallon pump tank and heater – heat the wastewater to 7.2 C during the winter months and pump the effluent to the nitrification tank.**
- **6,000-gallon nitrification MBBR Reactor– BWT-X media and aeration.**
- **4,800-gallon denitrification MBBR – Two-compartment tank contains media, a mixer & carbon addition to facilitate growth of denitrifying bacteria. The mixer promotes optimal conditions for denitrifying bacteria while maintaining anoxic conditions. The polishing reactor is aeration & biomedia.**
- **4,200-gallon clarifier tank – This single compartment tank will allow for sludge that develops in the denitrification/polishing process to be settled and liquids to be decanted to the existing trench dosing station.**
- **Control Building - New electrical control panel, chemical feed equipment, chemical storage and emergency eyewash. The chemical feed system provides alkalinity (30% sodium hydroxide) to the aerobic nitrifying reactor and carbon (Micro-C) to the anoxic reactor. A blower provides oxygen to aerobic & polishing reactors.**

Northern Tier Nitrogen Removal System
(copied from facilities plan document)

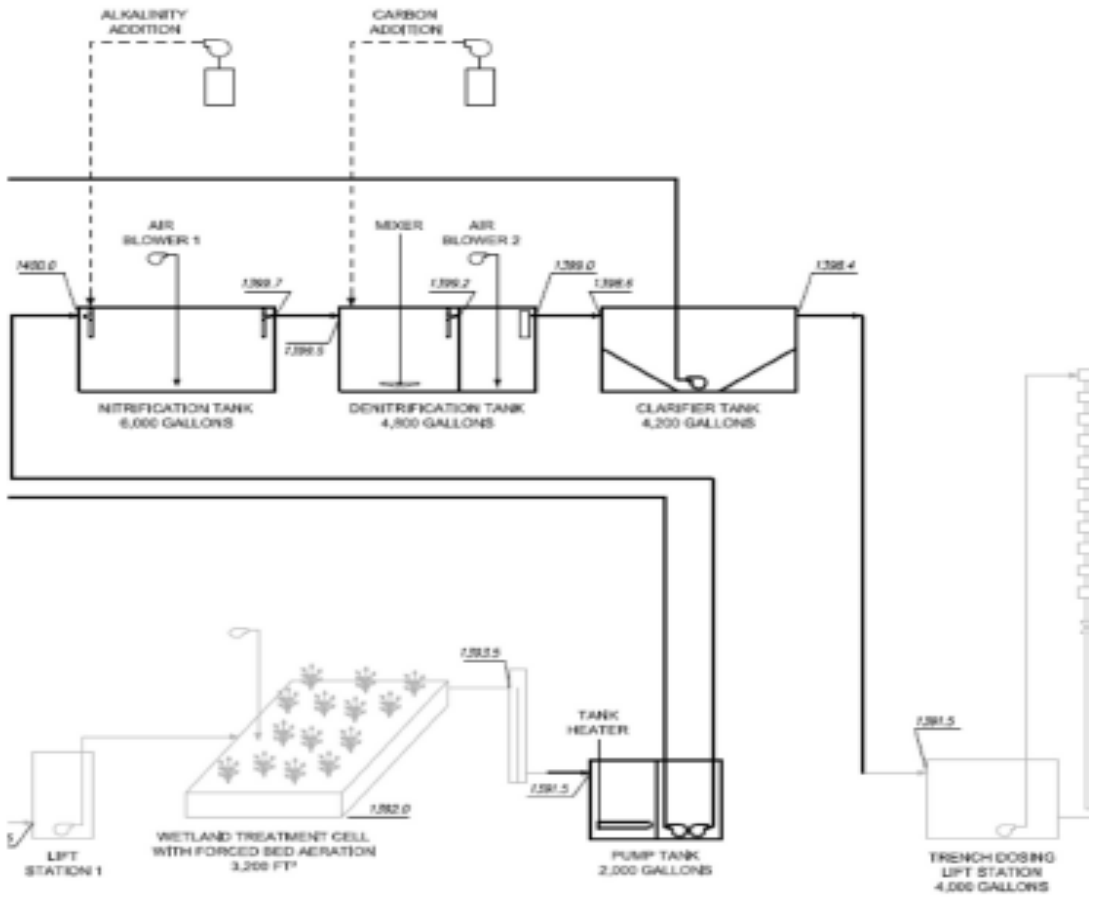

Figure 1: Schematic of Proposed Nitrogen Removal System – Northern Tier

Northern Tier Nitrogen Removal System Results, mg/l

Date	BOD-IN	TSS In	TN-out	BOD-Out	TSS, Out	Comment
Nov –Dec 2019	-	50	11.8	44	20	Start-Up
Dec 26 2019	51	76	3.1	44	10	DN Optimized
Jan 2020	107	216	4.9	39	27	
Feb	140	364	2.6	15	17	
March	68	89	4.0	16	15	
April	18	66	1.8	15	15	
May	-	55	1.8	5	5	
June	55	128	1.5	6	8	
July	116	245	10.5	7	8	High Rain Mo.
August	154	494	2.4	8	4	
Sept	132	568	3.4	8	11	
Averages	**94**	**214**	**3.6-DN Optimized**	**19**	**13**	**Met TN Limit**

Discussion
Northern Tier WWTP Modification

- Multiple grab samples were taken two times per month for most months. It is unfortunate that Total Nitrogen was not analyzed at the influent of the denitrification system equipment addition
- It is assumed that the water heater was used to heat water prior to entrance to the N/DN treatment reactors. Power consumption data is not available. It is assumed that heating of wastewater assisted the biological reactions. However it may not have been necessary to do so, and was employed in design as a safeguard to facilitate adequate treatment.
- Nitrification tank D.O. = 9 mg/L & De-nitrification tank D.O. = 1.1 mg/L
- Chemical addition (Nov 2019 to June 2020):
  - For alkalinity to maintain about 300 PPM, the amount of sodium hydroxide used per 7 days is 2 gallons.
  - The MICRO-C used to adjust BOD is also at 2 gallons per 7 days.

Northern Tier WWTP Modification Summary Nitrification/Denitrification Addition

- **The addition of the MBBR fixed film treatment system achieved target effluent goal of less than 10 mg/l Total Nitrogen**
- **If the Total Nitrogen at the influent to the equipment for nitrogen removal was near design value of 100 mg/l TN, then it could be assumed that the SMART-Treat MBBR achieved over 90% nitrogen reduction**
- **All stakeholders involved with this nitrogen reduction project seem satisfied with the ability of SMART-Treat MBBR to achieve low Total Nitrogen before water is recycled to groundwater within the sensitive Boundary Waters Canoe Area**
- **Thanks to BSA & their maintenance contractor for cooperation.**