Wastewater Effluent Total Nitrogen of 3 mg/l with Cost Effective, Low Maintenance Cluster Treatment System

Pio Lombardo, P.E.
Lombardo Associates, Inc.
49 Edge Hill Road, Newton, MA 02467
617-964-2924
Pio@LombardoAssociates.com

ABSTRACT

Excessive nitrogen levels pose a threat to the ecological health of water resources in the United States due to excessive algal growth that causes ecological decline. The Nitrex™ denitrification filter is a low cost, low maintenance, long lasting easily installed solution that requires no chemical addition equipment and is maintenance free for many years after the installation. Over the past ten years, numerous installations have been completed in various applications such as for single-family residential, commercial (e.g., shopping center, hotel, mixed office use), campground, public school and large wastewater treatment systems. Overall average removal rates of 97%+ for nitrate (NO_3^-) have been attained, achieving nitrate NO_3^- - N effluent quality of 0.1 mg/l. The paper will present performance summaries for projects utilizing the Nitrex™ Nitrogen Removal Technology.

Keywords: nitrogen removal, wastewater, decentralized systems

INTRODUCTION

Excessive nitrogen levels pose a threat to the ecological health of water resources in the United States due to excessive algal growth that causes ecological decline. Nitrogen has been identified in the nutrient-related declines of shellfish and aquatic plant life in the Chesapeake Bay, Florida coastal areas, and Cape Cod; the hypoxic "dead zone" in the Gulf of Mexico, and Long Island Sound. Nitrogen loads to watersheds result predominantly from inadequate wastewater treatment, stormwater runoff, agricultural or domestic fertilizers and atmospheric deposition, with the relative contributions varying among watersheds.

In many watersheds, nitrogen from wastewater contributes 40% to 80% of total nitrogen loads. Due to concerns about eutrophication and public health limits for nitrate in drinking water, many states, including Connecticut, Massachusetts, Indiana, Arizona, parts of California, and Oregon, require wastewater nitrogen removal in water supply recharge and ecologically sensitive areas.

Septic system effluent will be increasingly subject to stringent nitrogen limits as total maximum daily load (TMDL) studies are completed and corrective actions required. When faced with the need to remove nitrogen from wastewater, communities with septic systems have two options: construct sewers and centralized treatment facilities or implement reliable technologies for removing nitrogen from septic tank effluent on an individual or cluster/communal/neighborhood system basis or with groundwater treatment.

The Nitrex™ technology can be used as an alternative to conventional centralized options. The Nitrex™ denitrification filter easily meets the most stringent nitrate regulatory criteria. The Nitrex™ filter is a low cost, low maintenance, long lasting easily, installed solution that requires no chemical addition equipment and is maintenance free for many years after the installation.

The Nitrex™ system also has been used in Massachusetts, Rhode Island and Canada for in-situ passive groundwater nitrate removal in coastal areas and water supply aquifers, achieving nitrate-nitrogen removal to <0.1 mg/l. The Nitrex™ Groundwater Treatment System has been independently evaluated at the Woods Hole Marine Biological Laboratory and the University of Rhode Island, confirming these treatment capabilities. In some areas, this system can be used in lieu of wastewater treatment with costs projected at 20% to 30% of the cost of conventional sewering.

PROJECT SUMMARIES

Mashpee, MA

The Mashpee, MA Main Street Village, in Mashpee, Cape Cod, MA, which has 24 housing units and small commercial space, was created with a 5,226 gpd design flow, community-sized wastewater treatment

system. The wastewater system is located in a defined nitrogen sensitive area, a Zone II of a public water supply well. Zone II areas are contributing to a water supply well.

Table 1. Mashpee, MA Total Nitrogen Data

Date	Septic Tank Effluent Total Nitrogen (mg/l)	Nitrex™ Tank Effluent Total Nitrogen (mg/l)
10-May-06	57.6	5
16-Jun-06	58	<7.0(1)
26-Jul-06	48.6	2.6
17-Aug-06	75.6	< 3.0
14-Sep-06	67.28	2.15
17-Oct-06	62.29	1.6
20-Nov-06	47	2.08
12-Dec-06	51	4.1
30-Jan-07	63	3.26
28-Feb-07	14(2)	6.27
3-Apr-07	39	2.6
26-Apr-07	44	2.64
16-May-07	43	3.55
26-Jun-07	70	3.9
25-Jul-07	73.6	6.05(1)
25-Jul-07	29	2.66
24-Sep-07	45	2.5
22-Oct-07	47	2.28
28-Jan-08	40	4.92
Period of Record Average	51.3	3.59
12 Month Rolling Average	46.6	3.73

(1) Due to insufficient nitrification of pretreatment system.

(2) High pH due to inappropriate wastewater discharge caused low total nitrogen.

The development is served with Town water and the entire Wastewater System includes a wastewater collection system, septic tank, and Recirculating Media Biofilter followed by a Nitrex™ Filter to reduce effluent total nitrogen prior to discharge to a drainfield. Permit effluent requirements are TN must be < 10 mg/l. The Wastewater System became operational in March 2006.

After the start-up period, wastewater effluent TN levels have generally been < 3 mg/l. Effluent BOD and TSS are typically < 15 mg/l and < 5 mg/l, respectively.

Operations and Maintenance requirements consist of permit required monthly visits for treatment system performance sampling. Daily electrical consumption is approximately 5 KWHr, or $0.75/day with electric costs of $0.15/KWHr. Telephone connection allows remote monitoring of flow and notification of alarm conditions. No chemicals and no other utilities are required.

Malibu, CA

The Malibu, CA Nitrex™ wastewater treatment system demonstrates that decentralized distributed wastewater systems can be as effective as centralized facilities in achieving the accepted limit of technology, while treating for emerging contaminants to achieve standards for unrestricted water reuse.

The Malibu Creek Plaza is a shopping plaza consisting of both retail and commercial businesses. It is located in an environmentally sensitive area adjacent to the famous Surfrider Beach in Malibu, California. LAI designed a cost-effective, low maintenance wastewater septic tank effluent collection, treatment and dispersal system that employs a recirculating media filter, the Nitrex™ Nitrogen Removal Technology and an ozone – UV disinfection system for bacteria removal.

Table 2. Malibu Creek Plaza, Malibu, CA Performance Data

	Constituent	BOD_5	Total Suspended Solids	Turbidity	Oil & Grease	TDS	Total Nitrogen	Fecal Coliform	Enterococcus	Total Coliform	Flow @ Sampling Date	Average Monthly Flow
	Units	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	MPN/100 ml	gpd	gpd
Malibu Creek Plaza Effluent Standards	Average	30	30	10.0	-	-	-	-	24			
	Max	45	45	15.0	15	2,000	10.00	200	104			
Title 22 Unrestricted Reuse Requirements	Average			2.0						2.2		
	Max			10.0						23		
Aug. 2007 Avg.		*71*	*23*	*25.55*	*<5*	*940*	*4.24*				*12,755*	*15,244*
Sept. 2007 Avg.		*<6*	*5*	*1.76*	*<5*	*590*	*4.75*	*<2*	*<1*	*<2*	*10,938*	*11,778*
Oct. 2007 Avg.		*<7*	*5*	*1.08*	*<5*	*572*	*3.94*	*<2*	*<1*	*<2*	*13,011*	*20,425*
Nov. 2007 Avg.		*<5*	*<5*	*0.85*	*<5*	*526*	*3.23*				*12,475*	*11,692*
Dec. 2007 Avg.		*12*	*9*	*1.80*	*<5*	*688*	*3.57*	*2*	*<1*	*8*	*10,834*	*9,519*
Jan. 2008 Avg.		*6*	*5*	*1.10*	*<5*	*604*	*4.73*	*<2*	*<1*	*50*	*9,982*	*9,725*
Average from 9/1/07		*<8*	*6*	*1.32*	*<5*	*596*	*4.04*	*<2*	*<1*	*<4*	*11,448*	*11,802*

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The treatment system was designed to treat 16,000 gpd of high strength (85% restaurant wastewater) wastewater-equivalent to 40,000 gpd of residential strength wastewater, approximately 200 houses. The effluent quality is compliant with permit requirements of TN < 10 mg/l, as well as California Title 22 unrestricted water reuse requirements of turbidity < 2 NTU and total coliform < 2.2 MPN/100 ml. The system has been operational since July 2007.

O&M requirements are solely monthly visits. Energy usage is approximately 12.5 KWHr per 1,000 gallons of treated wastewater, with approximately 67% of the energy use attributed to the UV-Ozone disinfection – treatment system. The Malibu System is a cost competitive and lower energy using system than a membrane bioreactor (MBR), which is typically used to achieve these treatment levels. Effluent data is presented in Table 2.

Chinctoteague, VA

LAI designed the Nitrex™ component of the wastewater treatment and disposal system for the seasonally used Landings at Water's Edge site in Chincoteague, VA to reduce total nitrogen to less than 10 mg/l in the effluent after pretreatment by a recirculating peat filter aerobic treatment system. The system is designed for sanitary sewage from a residential development with approximately 15 units. The system has been operational since February 2007 and effluent total nitrogen has been <3 mg/l, see Table 3.

Table 3. Chincoteague, VA Total Nitrogen Data

Date	Nitrex™ Effluent Total Nitrogen mg/l
Detection	
5/24/2007	3.17
6/6/2007	1.10
6/19/2007	0.96
7/11/2007	0.20
9/26/2007	2.05

The results for the Mashpee, MA; Malibu, CA and Chincoteague, VA projects results are similar to those of testing at Massachusetts Alternative Septic System Wastewater Systems Test Center (MASSTC) that shows that the Nitrex™ System achieves TN < 5 mg/l based upon 3 years. The Nitrex™ Filter produced an effluent with an average TN of 4.0 mg/l at MASSTC, as seen in Figure 1, which presents the results of testing on nine different technologies. The Nitrex™ System produced an effluent with an average TN of 2.4 mg/l over 2 years when tested as part of the USEPA funded La Pine, Oregon National On-Site Denitrification Evaluation Project – see website at http://marx.deschutes.org/deq/Performance/RankNitrogen.pdf, with results of the evaluation of 15 technologies presented in Figure 2. Similar Nitrex™ System results have also been obtained at a site in Polson, Montana, tested by the State of Montana.

Figure 1. MASSTC Wastewater Denitrification System Testing Results.

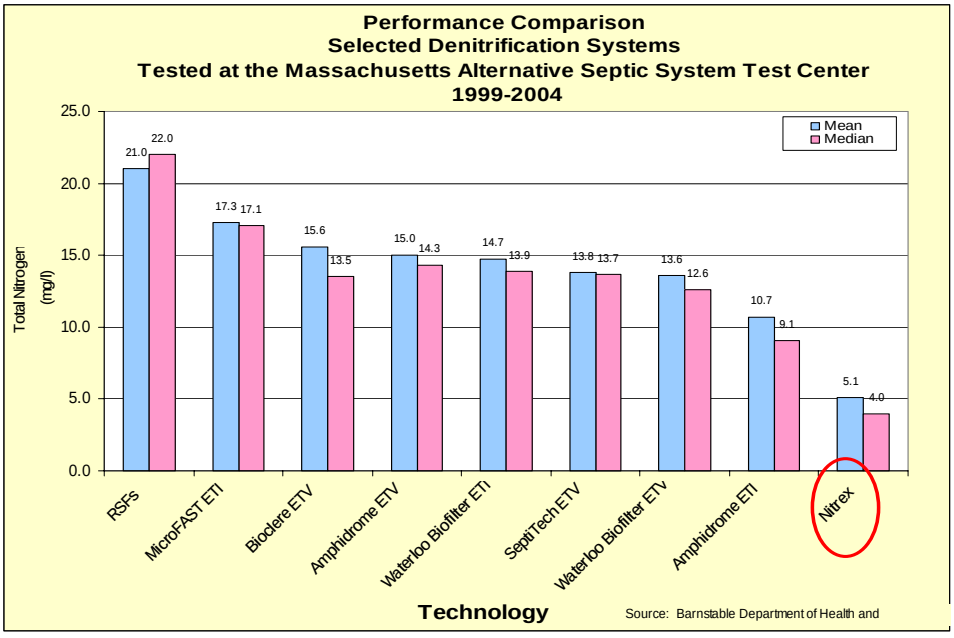
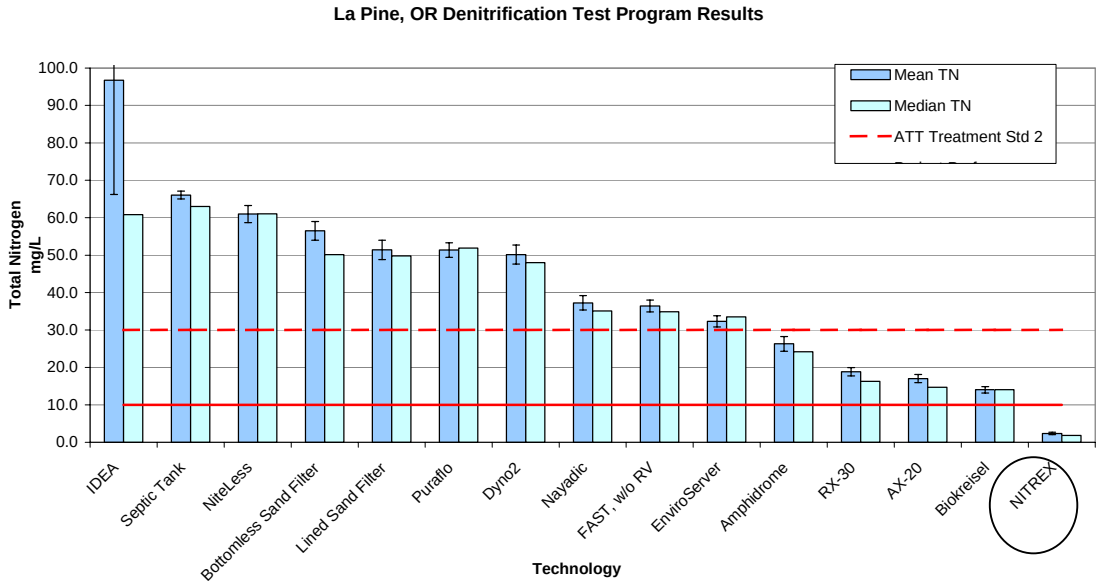


Figure 2. La Pine, Oregon Denitrification Test Program Results.



CONCLUSIONS

The Nitrex™ filter is a slow carbon feed system, which enables heterotrophic denitrification to occur. Media life is expected to be greater than 40 years. The Nitrex™ Filter has been independently tested in the US EPA funded La Pine, OR National On-Site Denitrification Demonstration Project; State of Montana Polson, MT onsite wastewater denitrification systems evaluation project; numerous Canadian installations, as well as being tested at the MASSTC, all with comparable results. The Nitrex™ technology demonstrates that decentralized distributed wastewater systems can be comparable centralized facilities in achieving the accepted limit of technology of TN < 5 mg/l, and is another tool for private and public owners, wastewater planners and engineers in nitrogen sensitive areas.

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