

COST EFFECTIVE CLUSTER TREATMENT AND DISPERSAL SYSTEM TO ACHIEVE TOTAL NITROGEN OF < 10 MG/L IN AN ENVIRONMENTALLY SENSITIVE AREA OF MALIBU, CA

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Introduction

The Malibu Creek Plaza is a shopping plaza consisting of both retail and commercial businesses. Some of the current occupants include: a multi-screen theater, three full serve restaurants, an ice cream parlor, a dry cleaner, a bank, a pet store which also grooms pets, and other retail businesses. It is located in an environmentally sensitive area. Malibu Lagoon is approximately 200 feet south of the site. The Pacific Ocean is approximately 1,400 feet south of the site. Both Malibu Creek and Malibu Lagoon are currently identified as impaired for both nutrients and bacteria in the States 303(d) listing. The septic tanks and leach fields for Malibu Creek Plaza are located in the Malibu Creek Hydrologic Sub-area and overlie the Malibu Valley Groundwater Basin. Figure 1 shows the location of Malibu Creek Plaza.



Figure 1: Site Location for Malibu Creek Plaza

In 1999 the California Regional Water Quality Control Board (CRWCB) and the City of Malibu conducted groundwater and surface water sampling at Malibu Creek Plaza and the nearby area and determined that wastewater discharge from the Plaza causes groundwater pollution, which adversely impacts Malibu Creek and Malibu Lagoon.

Regulatory Requirements

On January 11, 2001, the CRWQCB issued a consent order, which imposed the following requirements on the Malibu Creek Plaza's wastewater system:

Influent Limitations

1. Waste discharged is limited to discharges from commercial and retail business. No water softener regeneration brines or industrial wastewaters shall be discharged.
2. The maximum daily influent flow shall not exceed the design capacity of 42,000 gpd. This flow limitation also applies to effluent discharged to the leach fields.
3. No volatile organic compounds are allowed to be discharged into the system.

Effluent Limitations

The pH of the effluent shall at all times be between 6.5 and 8.5 pH units. The wastewater discharged to the drainfields shall meet the effluent limitations in Table 1.

Table 1: Effluent Standards

Monthly Constituent	Unit	Average	Maximum
BOD ₅	mg/L	30	45
Suspended solids	mg/L	30	45
Turbidity	NTU	10	15
Oil and Grease	mg/L	-	15
TDS	mg/L	-	2,000
Sulfate	mg/L	-	500
Chloride	mg/L	-	500
Total Nitrogen	mg/L	-	10
Fecal Coliform ^(a)	MPN/100 mL	-	200
Enterococcus ^(b)	MPN/100 mL	24	104

(a) The limits for coliform shall apply, prior to discharge of the effluent into the leach fields

(b) The Enterococcus limit is based on geometric mean of at least 5 equally spaced samples in any 30-day period.

Lombardo Associates, Inc. (LAI) was retained to review the existing system and site conditions and design a CRWCB compliant wastewater management system that would be protective of the nearby sensitive environmental receptors.

Existing System

The former septic system at Malibu Creek Plaza was a conventional system consisting of grease traps, septic tanks and gravel drainfields. Three 1,500 gallon grease traps existed. After inspection of existing facilities to determine adequacy, it was determined that the existing grease traps did not have sufficient capacity. The system consisted of ten septic tanks, which provided a total volume of 42,000 gallons. LAI's assessment indicated that the septic tanks did not have adequate capacity for the proposed system and were of questionable quality.

There were eleven drainfields. The total dispersal area for the old system was approximately 30,000 square feet (sf). A site evaluation revealed that there was ponding in the drainfields and that they were in failure.

Proposed System

The Malibu Creek Plaza wastewater management system was designed to collect, treat and disperse the wastewater generated in the Plaza based on a number of factors. The factors determining the design parameters include actual measured water usage, expected flows, water

quality sampling data from the existing system, regulatory requirements, and future expansion requirements.

Figure 2 shows the process flow diagram for the new wastewater system at Malibu Creek Plaza.

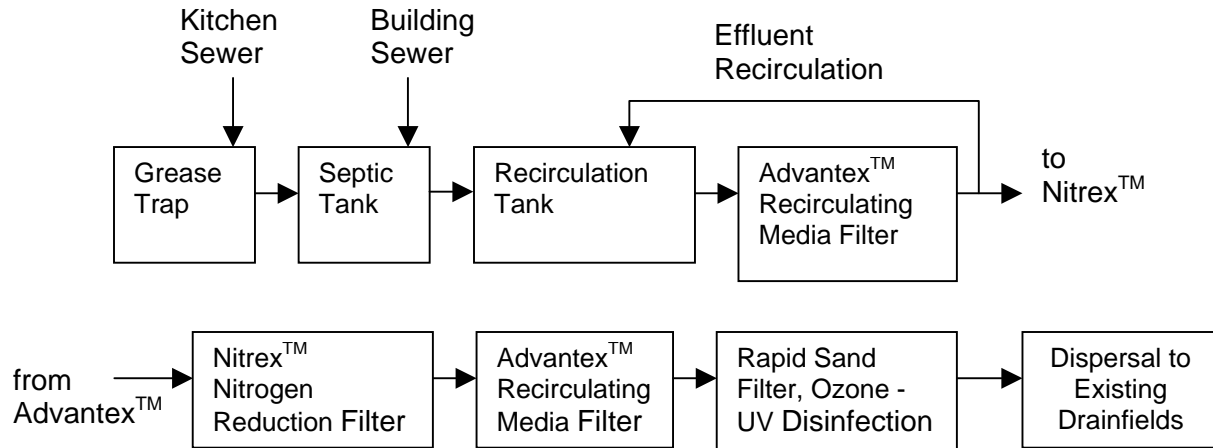


Figure 2: Process Flow Diagram

The treatment system was designed to treat existing flows and will be expanded as additional capacity is needed. The treatment system’s modular design is conducive to this design approach. The Malibu Creek Plaza wastewater system design flows are:

Base flow	12,000 gpd
Peak flow and growth allowance	<u>4,000 gpd</u>
	16,000 gpd

Based upon information provided by BioSolutions, the system’s operator, wastewater characteristics for Malibu Creek Plaza (*i.e.*, septic tank effluent as septic tanks are part of treatment process) are presented in Table 2. Samples were collected from 2001 through 2003. The septic tank effluent wastewater quality data was used to design the treatment system. Tank 2 serves the North portion of the Plaza (office/retail) and Tank 5 serves the South portion of the Plaza. The BOD₅ data for Tank 5 is substantially higher than that for Tank 2. LAI is of the opinion that Tank 2 is more representative of the wastewater quality from the retail/office units and Tank 5 is more representative of the septic tank effluent quality from restaurants. A flow weighted average of the BOD₅ load from each tank was used in the design of the wastewater treatment system.

Table 2: Septic Tank Effluent Wastewater Characteristics

Wastewater Characteristics	Tank 2			Tank 5		
	Mean	Min	Max	Mean	Min	Max
pH (s.u.)	7	6	8	6	6	8
TSS (mg/L)	63	9	382	220	54	1363
BOD ₅ (mg/L)	143	22	352	453	137	2059
Oil & Grease (mg/L)	21	5	103	24	5	63
Total Nitrogen (mg/L)	31	1	54	47	2	147

Source: BioSolutions, Inc. 2001-2003

Headworks

In the absence of regulations governing grease trap sizing in L.A. County, LAI used the following criteria to size the grease traps for Malibu Plaza:

- 50% of the estimated L.A. County design flows as kitchen flow (i.e. Massachusetts regulations are approximately 43%).
- 15 gpd per seat was used to determine the kitchen flow rate in accordance with Massachusetts regulations for the other restaurant units.

A hydraulic residence time (HRT) factor of 3-days for the grease traps, the minimum required by the Advantex™ Biofilter treatment system manufacturer, was employed. A total volume of 22,000 gallons is provided for the grease traps.

The septic tanks were sized based on design flows with a HRT of 3-days for those serving office and retail units and 4-days for those serving restaurant units. The HRT employed is the minimum HRT required by the Advantex™ Biofilter system manufacturer for system design. A total volume of 51,000 gallons capacity was provided for septic tanks.

Flow Equalization Tank

A 16,000 gallon equalization tank has been provided to dampen the variations in wastewater flows and strengths. The equalization tank was sized based on an analysis of daily wastewater generation. On a daily basis the treatment plant actual wastewater flow using the peak period of May to July 2004 water use data was approximately 14,000 gallons, with 16,000 gallons of equalization.

Recirculation Tanks

A recirculation tank was used to mix the recycled effluent from the Advantex™ biofilters with the influent to the biofilters. The mixing helps promote denitrification. The recirculation tank provides 1 day HRT. A 20,000 four-compartment tank was installed. The first two compartments are for recirculation and are 12,000 and 4,000 gallons respectively. The other two compartments are 2,000 gallons each and serves as pump chambers.

Advantex™ Biofilters

The Advantex™ biofilters were sized both on a hydraulic and mass loading rate.

The areal hydraulic application rate to the Advantex™ filters is 10 gallons per day per square foot (gpd/sf) for restaurant facilities and 25 gpd/sf for office/retail facilities as specified by the manufacturer. The flow weighted loading rate was calculated to be 1,300 gpd per AX-100 pod (i.e. 13 gpd / sf), which reflects that restaurant facilities account for the majority of the wastewater generated. Thus, for a design flow of 16,000 gpd, 12 pods were required on a hydraulic loading rate.

The Advantex™ treatment system was also sized based on a design BOD loading rate of 0.04 ppd/ft², with the constraint of an average hydraulic loading rate less than 25 gpm/ft². Sampling data showed that the typical BOD concentration of septic tank effluent for the restaurants and similar commercial tenants was 453 mg/L. The average BOD concentration for offices/retail tenants was 143 mg/L. A flow-weighted average resulted in an Advantex™ influent wastewater BOD concentration of 404 mg/L. Using this concentration with a design flow of 16,000 gpd, an average BOD loading rate of 54 ppd was calculated. Using the Advantex™ AX-100 units with a treatment

area of 100 ft² each, a total of 14 units were needed to treat septic tank effluent from the plaza based on the mass loading. The BOD loading rate governed the final design.

Fourteen (14) Advantex™ AX-100 Biofilters were installed for BOD, TSS and NH₄ removal. The Advantex™ Biofilters are recirculating media filters with part of the Biofilter effluent returned to the recirculation tank. Recycling to the recirculation tank was assumed to provide approximately 50 percent denitrification.

Two of the Advantex™ AX-100 pods are used to polish the effluent from the Nitrex™ units before disinfection.

Nitrex™ Filters

The Nitrex™ component of the wastewater system was sized based on LAI's previous experience with Nitrex™ systems and consultation with the technology patent holder. Five (5) Nitrex™ Filters (anoxic bioreactors), each in a 15,000-gallon tank, follow the Advantex™ Biofilters for nitrogen reduction. A pumping station receives the effluent from the Nitrex™ Filters. All pump stations, are watertight with alarms should excess water enter the system or pumps fail.

Disinfection System

The proposed disinfection system is an ozone and ultra-violet (UV) light disinfection system. It was sized by the required flow rate and effluent requirements. For Malibu Plaza a system with a 12 gpm flow rate was employed. Disinfection is achieved by passing the treated wastewater from the Nitrex™ through a rapid sand filter, then through an ozone treatment unit, and finally through UV chambers before discharging to the drainfields. Redundant disinfection units were used due to the environmental sensitivity of the site.

Drainfields

New drainfields were installed at 2.47 gpm / ft². There are three drainfields, measuring 2,160 square feet each, for a total capacity of 16,000 gpd.

Performance

The system was installed and has been operational since July 2007. Table 3 shows the performance summary for the system. Table 4 presents the complete water quality data collected.

Table 3: Malibu Creek Plaza Performance Summary

	Constituent	BOD ₅	Total Suspended Solids	Turbidity	Oil & Grease	TDS	Sulfate	Chloride	Total Nitrogen	Organic Nitrogen	NH ₄ - N	NO ₂	NO ₃	Fecal Coliform(a)	Enterococcus (b)	Total Coliform	Flow @ Sampling Date	Average Monthly Flow	Temp.	
	Units	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	MPN/100 ml	gpd	gpd	°F	
Malibu Creek Plaza Effluent Standards	Average	30	30	10	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	
	Max	45	45	15	15	2,000	500.0	500	10.00	-	-	-	-	200	104	-	-	-	-	
Title 22 Unrestricted Reuse Requirements	Average			2												2.2				
	Max			10												23				
Sampling Location	Date	Days from Start - Up																		
DF-1	07/16/07	0	839	40	34				8.29	8.18	0.07	0.02	0.02					16,643	21,982	
DF-1	07/26/07	10	164	36	19	9	620	6.1	189	11.47	0.00	11.40	0.02	0.05				12,215	21,982	
July 2007 Avg.			502	38	26	9	620	6.1	189	9.88	4.09	5.74	0.02	0.04				14,429	21,982	
DF-1	08/09/07	24	137	10	49				4.07	0.00	3.92	<0.02	0.15					15,476	15,244	
DD-1	08/16/07	31	70	10	12	<5	940	23.4	228	3.39	2.68	0.67	<0.02	0.04				13,395	15,244	
DF-1	08/23/07	38	57	37	38				6.49	3.13	3.32	<0.02	0.04					11,325	15,244	
DD-1	08/30/07	45	19	35	3.5				3.00	2.54	0.32	<0.02	0.14					10,825	15,244	
Aug. 2007 Avg.			71	23	25.6	<5	940	23.4	228	4.24	2.09	2.06	<0.02	0.09				12,755	15,244	
DD-1	09/04/07	50	11	6	3.0				4.13	3.10	0.75	0.12	0.16					11,234	11,778	
DD-1	09/07/07	53	<5	<5	2.1				9.95	3.12	1.38	2.77	2.68					9,849	11,778	
DD-1	09/11/07	57	<5	<5	1.7				4.96	2.28	0.85	0.36	1.47					10,930	11,778	
DD-1	09/18/07	64	6	<5	1.0	<5	596	66.4	241	5.29	1.96	0.53	<0.02	2.80	<2	<1	<2	12,009	11,778	
DD-1	09/25/07	71	<5	<5	1.0		584		4.60	1.65	0.22	<0.02	2.73	<2	<1	<2	10,668	11,778		
Sept. 2007 Avg.¹			<6	5	1.8	<5	590	66.4	241	4.75	2.42	0.75	<0.66	1.97	<2	<1	<2	10,938	11,778	82
DD-1	10/02/07	78	6	<5	1.5		644		3.99	1.94	0.50	<0.02	1.55					13,531	20,425	
DD-1	10/11/07	87	12	<5	1.8		636		4.14	2.40	0.45	<0.02	1.29					10,266	20,425	
DD-1	10/16/07	92	8	<5	0.4		652		3.87	1.10	0.27	<0.02	2.50	<2	<1	<2	13,386	20,425		
DD-1	10/25/07	101	6	<5	1.2	<5	432	89.9	90	7.80	1.50	0.34	<0.02	5.96	2	<1	2	11,713	20,425	
DD-1	10/30/07	106	<5	<5	0.5		496		3.75	1.03	0.14	<0.02	2.58	<2	<1	<2	16,160	20,425		
Oct. 2007 Avg.²			<7	5	1.1	<5	572	89.9	90	3.94	1.59	0.34	<0.02	2.78	<2	<1	<2	13,011	20,425	81
DD-1	11/01/07	108	<5	<5	1.0		512		3.31	1.38	<0.01	<0.02	1.93					10,936	11,692	
DD-1	11/15/07	122	<5	<5	0.7	<5	540	59.0	212	3.14	0.08	0.79	<0.02	2.27				14,014	11,692	
Nov. 2007 Avg.			<5	<5	0.9	<5	526	59.0	212	3.23	0.73	<0.79	<0.02	2.10	0	0	0	12,475	11,692	80
DD-1	12/06/07	143	12	9	1.8	<5	688	62.1	270	3.57	1.67	0.47	<0.02	1.43	2	<1	8	10,834	11,692	
Dec. 2007 Avg.			12	9	1.8	<5	688	62.1	270	3.57	1.67	0.47	<0.02	1.43	2	<1	8	10,834	9,519	80
DD-2	01/17/08	185	6	<5	1.1	<5	604	49.8	162	4.73	1.37	0.06	<0.02	3.30	<2	<1	50	9,982	9,725	
Jan. 2008 Avg.			6	5	1.1	<5	604	49.8	162	4.73	1.37	0.06	<0.02	3.30	<2	<1	50	9,982	9,725	
Average from 9/1/07 on			<8	6	1.3	<5	596	65	195	4.04	1.56	0.48	<0.18	2.31	<2	<1	<4	11,448	11,802	81

¹The Sept TN Average does not include the September 7 sampling data, as the TN for this date was high due to start-up conditions.

²The Oct TN Average does not include the October 25 sampling data, as the TN for this date was high due to Operational Issues.

(a) The limits for coliform shall apply, prior to discharge of the effluent into the leach fields.

(b) The enterococcus limit is geometric mean of at least 5 equally spaced samples in any 30-day period.

DD-1 = Drainfield Discharge

DF-1 = Disinfection Feed

Table 4: Malibu Creek Plaza Water Quality Data

Malibu Creek Plaza Effluent Standards				Title 22 Unrestricted		DF-1	DF-1	DF-1	DD-1	DF-1	DD-1	DD-1	DD-1	DD-1
Monthly Constituent	Units	Average	Max	Average	Max	7/16/07	7/26/07	8/9/07	8/16/07	8/23/07	8/30/07	9/4/07	9/7/07	9/11/07
BOD ₅	mg/l	30	45			839	164	137	70	57	19	11	<5	<5
Suspended Solids	mg/l	30	45			40	36	10	10	37	35	6	<5	<5
Turbidity	NTU	10	15	2	10	34.1	18.6	48.7	11.8	38.2	3.5	3.0	2.1	1.7
Oil & Grease	mg/l	-	15				9		<5		NM	NM	NM	NM
TDS	mg/l	-	2,000				620		940		NM	NM	NM	NM
Sulfate	mg/l	-	500				6.1		23.4		NM	NM	NM	NM
Chloride	mg/l	-	500				189		228		NM	NM	NM	NM
Total Nitrogen	mg/l	-	10			8.29	11.47	4.1	3.39	6.49	3.0	4.13	9.95	4.96
Fecal Coliform ^(a)	MPN/100 ml	-	200											
Enterococcus ^(b)	MPN/100 ml	24	104											
Total Coliform	MPN/100 ml			2.2	23									
Flow @ Sampling Date	gpd													

(a) The limits for coliform shall apply, prior to discharge of the effluent into the leach fields.

(b) The enterococcus limit is geometric mean of at least 5 equally spaced samples in any 30-day period.

NM = Not Measured

DD-1 = Drainfield Discharge

DF-1 = Disinfection Feed

Malibu Creek Plaza Effluent Standards				Title 22 Unrestricted		DD-1	DD-1	DD-1	DD-1	DD-1	DD-1	DD-1	DD-1	DD-1	DD-1
Monthly Constituent	Units	Average	Max	Average	Max	9/18/07	9/25/07	10/2/07	10/11/07	10/16/07	10/25/07	10/30/07	11/1/07	11/15/07	12/6/07
BOD ₅	mg/l	30	45			6.0	<5	6	12	8	6	<5	<5	<5	12
Suspended Solids	mg/l	30	45			<5	<5	<5	<5	<5	<5	<5	<5	<5	9
Turbidity	NTU	10	15	2	10	1.0	1.0	1.5	1.8	0.4	1.2	0.5	1.0	0.7	1.8
Oil & Grease	mg/l	-	15			<5	NM	NM	NM	0	<5	NM	NM	<5	<5
TDS	mg/l	-	2,000			596	584	644	636	652	432	496	512	540	688
Sulfate	mg/l	-	500			66.4	NM	NM	NM	NM	89.9	NM	NM	59	62.1
Chloride	mg/l	-	500			241	NM	NM	NM	NM	165	NM	NM	212	270
Total Nitrogen	mg/l	-	10			5.29	4.60	3.99	4.14	3.87	7.80	3.75	3.31	3.14	3.57
Fecal Coliform ^(a)	MPN/100 ml	-	200			<2	<2			<2	2	<2			
Enterococcus ^(b)	MPN/100 ml	24	104			<1	<1			<1	<1	<1			
Total Coliform	MPN/100 ml			2.2	23	<2	<2			<2	2	<2			
Flow @ Sampling Date	gpd					12,009	10,668			13,386	11,713	16,160			

Summary

Malibu Creek Plaza is located in an environmentally sensitive area. The former wastewater system was a conventional septic system, which provided little nitrogen or bacteria removal. The CRWQCB determined that the Plaza was the source of groundwater pollution that was adversely affecting Malibu Creek and Malibu Lagoon and issued a consent order requiring upgrade of the wastewater system at the Plaza. LAI designed a decentralized wastewater management system, which employs the Advantex™ recirculating media filter, the Nitrex™ media filter for nitrogen removal and an ozone – UV disinfection system for removal of pathogenic organisms and emerging contaminants, and achieves unrestricted water reuse standards. O&M requirements of the system are monthly visits for sampling and minor maintenance. The Treatment System is continuously monitored via an on-site PLC and telephone/internet connection.