Table of Contents

I. Project Summary and Overview.

The goal of this project was to evaluate the performance and applicability of a new treatment technology to denitrify wastewater flows in small flow installations (< 200,000 gpd). The technology being tested consists of a recirculating sand/gravel filter (RSF/RGF) followed by a non-vegetated subsurface flow (SSF) constructed wetland. The objective of this technology was to achieve nitrification in the RSF/RGF (where aerobic conditions dominate) and denitrification in the SSF wetland (where anoxic conditions dominate). The advantage of this approach is less process monitoring than typically required with activated sludge reactors modified to achieve denitrification where aerobic and anoxic conditions are alternately created to denitrify the wastewater. In small flow applications, which tend to have high fluctuations in wastewater flow and characteristics, balancing the aerobic and anoxic phases of treatment can be difficult and result in process upsets unless expensive and maintenance intensive process control equipment are installed.

II. Wastewater Characteristics and Flows.

Appendix A contains the summary of sample test results on the RSF influent wastewater. The influent sample point was after primary sedimentation through septic tanks providing a two day detention time at design flow rates and after septic tank effluent screens. The influent waste characteristics showed higher than expected ammonia and total nitrogen and lower than expected CBOD. The high total nitrogen combined with the lower than expected organic strength of this wastewater resulted in higher than anticipated nitrate levels in the waste stream entering the SSF wetland. The impact of these waste characteristics was the necessity to install a methanol feed addition to the waste stream entering the wetland. Methanol is typically the chemical chosen for a supplemental carbon source for denitrification because it has a low cell yield which minimizes biomass accumulation in the wetland.

The sources of waste flows at Black Rock are two motel style buildings each with twenty eight rooms, two cabins with accommodations for ten people each and a dining hall which serves meals to staff and guests. The base flows when there are no guests at the retreat average around 1000 gallons per day. Peak flows approach the design flow of 12,000 gallons per day for this treatment system. The high flow variability at this site is reflected in the minimum to maximum flow ratio in excess of 12:1. The effluent flow records are included in Appendix B. The final effluent sample test results are included in Appendix A.

III. Site Description

Black Rock Retreat is a non-denominational religious retreat center offering lodging in the form of two retreat halls with 28 rooms each as well as several cabins. The retreat is located in Southern Lancaster County in a rural and agricultural setting. The surrounding agricultural activities and site geology have contributed to the elevated nitrate-nitrogen present in the groundwater at this site. Because the background nitrate levels exceed the drinking water standard of 10 mg-l nitrate-N, the Retreat was required to use denitrification technology on new flows created during an expansion project in 1999. The additional flows created during the

expansion were approximately equal to the pre-expansion flow of 6,000 gpd resulting in a total retreat wastewater flow of 12,000 gpd.

IV. Innovative Technology Description.

The RSF/SSF wetland series treatment system was installed at Black Rock Retreat to replace a sequential batch reactor (SBR) package plant system with a design flow of 6,000 gpd, which although configured to accomplish denitrification, was failing to meet total nitrogen effluent limits. After eighteen months of operation without meeting discharge limits for total-N as described in their permit, Black Rock was issued a notice of violation (NOV) by the Department. After several attempts to improve the performance of the SBR without consistent success at meeting the total-N discharge limits of 10 mg/l, it was determined that a process which utilized separate treatment phases to achieve the nitrification and denitrification steps would be more stable in small flow installations than technologies relying on balancing aerobic and anoxic conditions within a single reactor vessel. After reviewing available technologies which would be capable of performing these two steps as independent unit processes in series, it was decided that the combination which would offer the lowest operator input as well as the lowest initial installed cost would be a RSF/SSF wetland system.

Additional advantages of the RSF/wetland technology include low system O&M expenses as well as a very high quality effluent for final disposal. The effluent is very low in CBOD as well as TSS and typically meets stream water discharge levels of fecal coliform bacteria inactivation without incorporating chemical disinfection. Black Rock Retreat employs in-ground disposal beds for final disposal and the low CBOD and TSS should enhance the operating life of the disposal beds compared to either SBR or septic tank effluent. This high quality effluent is achieved with significantly less energy input compared to typical suspended growth processes. The RSF/wetland system is a passive natural treatment system using two 0.5 H.P. RSF dosing pumps operating intermittently to pulse dose the RSF bed with gravity flow to and through the wetland. The wetland effluent is then pumped to a disposal bed dosing tank via another 0.5 H.P. pump, were it is pressure dosed to the disposal beds. A treatment schematic is included in Appendix C.

V. Operating Conditions for the Innovative Technology.

The design basis for the RSF system is a hydraulic loading rate of 5 gpd/ft² and an organic loading rate of 0.008 lb/d- ft². The design basis for the wetland is a two day hydraulic residence time at design flows. The RSF dosing pumps are typically controlled to deliver a dose of 0.11 gpm /ft² for a duration of one to three minutes at twenty to thirty minute intervals. The RSF effluent can flow by gravity or be pressure dosed to the wetland. The carbon source for denitrifying in the wetland is provided by a methanol feed to the wetland influent.

The septic tank effluent at Black Rock Retreat flowed by gravity into a small transfer tank which pumped to the RSF recirculation tanks in ~ 200 gallon batches via pumps controlled by float switches. This arrangement does not provide flow equalization and occasional hydraulic and organic overloads were noticed during process monitoring. During periods of overload, the

RSF effluent would show incomplete nitrification of the waste stream. Providing flow equalization ahead of the RSF recirculation tanks in future designs should minimize the occurrence of these periods of incomplete nitrification.

VI. Monitoring and Sampling Plan for Innovative Technology

The sampling plan involved weekly sample frequency at the following sample locations:

- Screened septic tank effluent (RSF influent) – 2 samples/month for the following parameters:
    1. pH
    2. Temperature
    3. Alkalinity
    4. Ammonia-N
    5. Nitrate-N
    6. Nitrite-N
    7. TKN
    8. CBOD-5 day
    9. TSS
    10. Chloride
    11. Phosphorus-T

- Recirculating Sand Filter effluent for the following parameters and indicated frequency:
    1. pH - weekly
    2. Temperature - weekly
    3. Alkalinity - monthly
    4. Ammonia-N - weekly
    5. Nitrate-N - weekly
    6. Nitrite-N - weekly
    7. TKN - monthly
    8. CBOD-5 day
    9. TSS - monthly
    10. Chloride - monthly
    11. Phosphorus-T – monthly

- Wetland at the 25%, 50% and 75% hydraulic detention time points (weekly)
    1. Ammonia-N
    2. Nitrate-N
    3. Nitrite-N

- Wetland effluent collection tank (weekly)
    1. pH
    2. Temperature
    3. Alkalinity
    4. Ammonia-N

5. Nitrate-N
6. Nitrite-N
7. TKN
8. CBOD-5 day
9. TSS
10. Chloride
11. Phosphorus-T

VII. Analytical Results

Appendix A includes analytical result summaries from the above noted sample points.

VIII. Cost of Technology

The cost categories and approximate amounts for this project are listed below. This design was for a 12,000 gpd treatment system.

- RSF/wetland pumps, controls, piping and liner materials - $22,000
- RSF/wetland media including sand bedding - $12,000
- Excavation of RSF and wetland beds, site work for setting tanks and placing media -$10,000
- Plumbing contract for all piping up to final effluent discharge - $12,000
- Electrical contract to install main breaker, service and electrify pump control panels - $5,000
- Two 6,000 gallon RSF recirculation tanks and one 2,500 gallon final effluent tank - $15,000
- Chemical feed systems - $5,000
- Miscellaneous (meters, valves, materials testing, etc.) - $5,000
- Sample collection and transport - $4,000
- Engineering design, permit application and construction inspection - $10,000
- Total project cost = $100,000

IX. Conclusions

The intent of this project was to evaluate the capability of the RSF/wetland technology to denitrify the wastewater stream at Black Rock Retreat. The test results from Black Rock Retreat as well as those from the installation at Musser's Market (Appendix D) support this technology's capability to achieve that treatment goal although there are several changes proposed to the original design to enhance the performance and reliability of the RSF/wetland system. During the course of the project, several valuable lessons were learned:

- The drinking water pH adjustment chemical had to be changed from caustic soda to soda ash in order to provide adequate alkalinity in the wastewater for the RSF

to fully nitrify the wastewater without excessive pH elevation in the water supply. This change was made August 9th, 2002 after which, the RSF pH was maintained at a more optimum level for nitrification. The availability of alkalinity in the wastewater to permit complete nitrification should always be considered as well as how the alkalinity can be supplemented to the waste stream in the event it is necessary. Both installations of the RSF/wetland system (Musser's and Black Rock) required the addition of soda ash in their drinking water supply to obtain adequate alkalinity for nitrification.

- Although the original intent of the project was to use the septic tank effluent in a by-pass mode to provide the carbon source for denitrification, the high NH3-N:CBOD ratio of this wastewater made this practice impractical. A methanol feed tank and pump were installed and operational March 7th, 2002. The original chemical feed set-up developed vapor lock in the diaphragm pump from off-gassing of the methanol. Various corrective actions were taken in the ensuing months with the result of increasing the pump capacity from 30 gpd to 60 gpd and installing a de-gassing head to prevent the vapor lock. The modified chemical feed system was installed December 3, 2002. After adjusting the pump feed rate, the test results began to show improved denitrification even though the wetland temperatures were approaching 1° C for the months of January and February. The effects of the improved methanol feed rates are slow to show in the final effluent primarily due to the long hydraulic retention time during the low flows Black Rock generates during the winter season and the low water temperature of the wetland. This chemical feed system provided stable results until July 2003 at which time the de-gassing head began to malfunction, presumably due to the methanol causing the check valves to stick periodically. The 80 gpd diaphragm pump was replaced with a 60 gpd peristaltic pump August 13, 2003. The peristaltic pump design seems to be better suited for methanol feed applications than the diaphragm design and will be employed at all future installations.

- The very low winter season flows contributed to the lower than anticipated temperatures measured in the wetland. Future installations would be installed with an 18" to 24" earthen cover to insulate the wetland and improve the denitrification by increasing the wetland temperature to 5- 6° C.

- The flow from the RSF to the wetland at Black Rock Retreat was via gravity. This system does not perform well especially during the winter months when the combination of low flows and cold air temperatures resulted in freezing of the discharge laterals. In addition to the tendency for the distribution laterals to freeze during winter, the low flows made it very difficult to equally split the flow between the two wetland cells and distribute it evenly along the front of each cell. To rectify this situation, the treatment system later installed at Musser's Market used a dosing siphon to dose the RSF effluent under pressure to the wetland. This resulted in a more even distribution of the RSF effluent along the front of the wetland and prevented the biofilm accumulation which

clogged the lines at BRR from getting established. The distribution laterals at Musser's completely drained between doses which prevented any problem with freezing. It is planned that the gravity flow at Black Rock Retreat will be replaced with a low head pumped system to improve the reliability and function of the wetland distribution laterals within the coming calendar year (2004).

- When reviewing the system performance data, the following actions and dates should be considered as they affected the system's operational efficiency:

    1. March 7, 2002 – started methanol feed using 30 gpd diaphragm pump and discontinued septic tank by-pass flow to wetland.
    2. May 1, 2002 – replaced automatic distributing valve (ADV) in RSF dosing plumbing due to malfunction.
    3. October 22, 2002 – installed degassing head on 30 gpd diaphragm pump.
    4. December 3, 2002 – installed 80 gpd diaphragm pump with degassing head to get adequate methanol feed rate.
    5. April 2, 2003 – replaced automatic distributing valve in RSF dosing plumbing due to malfunction. Corrected placement of ADV to allow draining between pump cycles and prevent recurrence of ADV failures.
    6. August 13, 2003 – Replaced 80 gpd diaphragm pump with 60 gpd peristaltic chemical feed pump.

- The flow rates at Black Rock Retreat are highly variable and affect the efficiency of the treatment system. The RSF recirculation tanks have adequate capacity to act in a flow equalization capacity which was the original intent. Using the recirculation tanks as flow EQ tanks has the side effect of slugging influent through to the RSF beds. The stoichiometric ratio of dissolved oxygen to ammonia nitrified indicates that on a unit basis, it takes approximately four times the D.O. to nitrify one mg/l NH3 as it does to metabolize one mg/l CBOD. Using the recirculation tanks to equalize the flows at Black Rock Retreat occasionally resulted in RSF effluent D.O. levels of <1 mg/l which resulted in incomplete nitrification prior to the RSF effluent discharging to the wetland. This system's overall performance would be significantly improved with the addition of a conventional flow EQ tank ahead of the recirculation tanks. For the above mentioned reasons, all future installations will include flow EQ equal to 30% - 50% of the maximum daily flow. The higher flow equalization volume (as a percent of maximum daily flow) should be used in installations such as Black Rock where the flow variation is on the order of eight to ten times the maximum flow and the lower EQ volume used when the variation is predicted or known to be on the order of three to four times the maximum flow.

  The Musser's Market system had consistent enough flow rates through the day that flow EQ was not necessary. If the flows at Musser's increase significantly or become more erratic that system may need EQ tanks added in the future as well.

This project proved the value of the recirculating sand filter/wetland technology to achieve a denitrified effluent with very little operator attention due to the separate aerobic (RSF) and anoxic (wetland) processes used. The Musser's Market RSF/wetland system was able to meet its discharge limits without a septic tank by-pass flow or chemical feed until December, 2002 at which time the by-pass flow was started. Prior to starting the by-pass flow, the effluent showed the same fecal coliform inactivation levels noted at Black Rock after discontinuing the by-pass flow there and also had extremely high quality with regard to odor and color. After beginning the by-pass flow at Musser's, the fecal counts and color deteriorated slightly but still were very good.

The high quality effluent this treatment system can produce makes it an excellent candidate for water re-use applications. The very low TSS, CBOD, Color and Odor of the effluent gives it the aesthetic qualities necessary for grey water re-use systems with one such application currently under consideration. The low O&M and initial installation costs of this system make it an attractive option for re-use/reclamation projects for on-lot treatment systems.

X. Acknowledgements

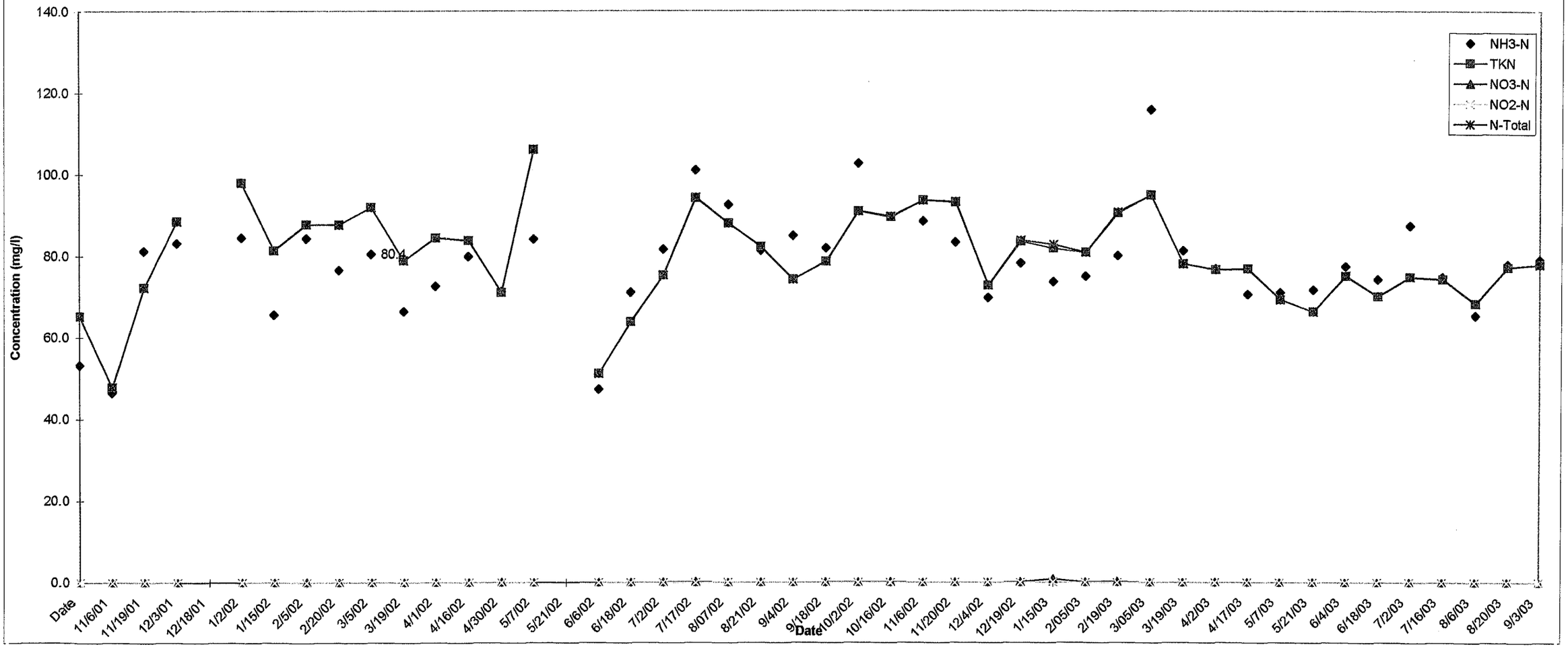
I would like to thank the staff and personnel associated with the new and innovative technology program at PA DEP's Central office as well as Jim Miller and Ed Corriveau of the Southcentral DEP office for recognizing the importance of researching and testing technologies which can achieve the goals of reducing total nitrogen loading into the environment, particularly into the Chesapeake Bay watershed. It is highly unlikely that a demonstration project using this technology would have been constructed without their assistance. I would also like to express my appreciation for the faith the staff and board of Black Rock showed in allowing me to install and optimize the RSF/wetland treatment system at their facility and their cooperation in providing operational assistance for the system. Finally, I would like to thank the folks at ORENCO for their patience and advice in troubleshooting the RSF portion of this treatment system during start-up and the first year of operation.

Appendix A – Analytical Test Results

Raw Water Analytical Results

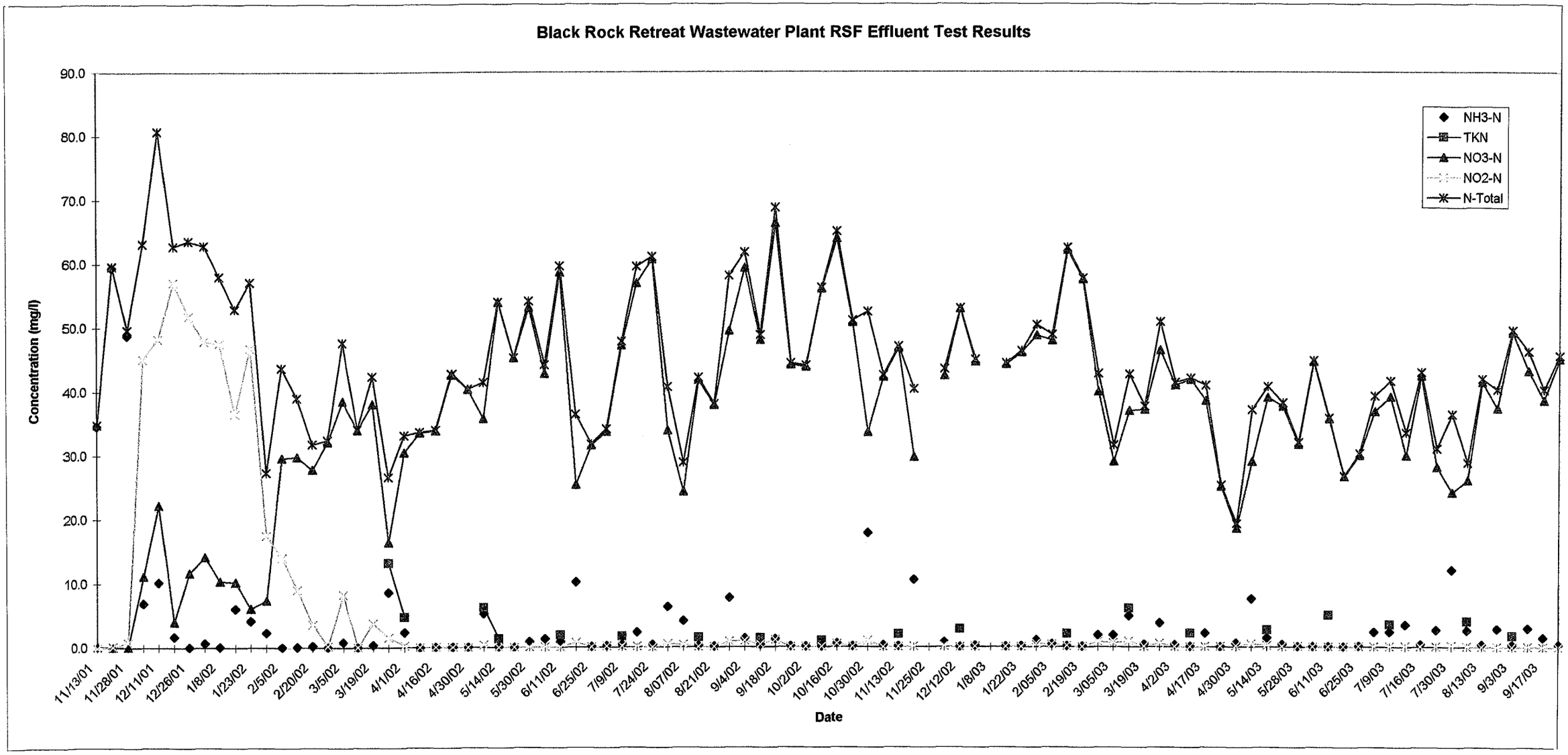
	Black Rock Retreat RSF influent (screened septic tank effluent) sample results											
Date	NH_3-N	TKN	NO3-N	NO2-N	N-Total	CBOD5	SS	pH	Alkalinity	Phosphorus	Chloride	T (deg. C)
11/6/01	53.2	65.2	0.0	0.0	65.3	221	52	6.50	400	18.3	147	18.0
11/19/01	46.5	47.8	0.0	0.0	47.9	99	22	6.85	334	20.0	141	15
12/3/01	81.2	72.2	0.0	0.0	72.3	213	54	6.88	462	21.1	142	14
12/18/01	83.1	88.5	0.0	0.0	88.5	108	20	6.92	420	5.7	149	12
1/2/02								7.20				7
1/15/02	84.5	97.9	0.0	0.0	97.9	?	56	7.41	502	15.3	121	8.0
2/5/02	65.6	81.3	0.0	0.0	81.4	146	4	7.28	374	13.3	156	8.0
2/20/02	84.3	87.6	0.1	0.0	87.7	185	66	7.31	448	17.8	183	10.1
3/5/02	76.5	87.6	0.0	0.0	87.7	217	54	7.24	396	14.4	184	9.0
3/19/02	80.4	91.9	0.0	0.0	92.0	281	46	6.82	462	18.5	197	15.7
4/1/02	66.4	78.8	0.0	0.0	78.9	156	44	7.06	406	14.8	179	13.7
4/16/02	72.6	84.4	0.0	0.0	84.5	170	72	6.95	422	13.1	208	17.7
4/30/02	79.9	83.7	0.0	0.0	83.8	173	44	6.84	454	16.9	226	18.2
5/7/02	71.2	71.0	0.1	0.0	71.1	110	44	7.03	416	10.7	202	19.0
5/21/02	84.1	106.0	0.0	0.0	106.1	112	40	6.80	466	16.2	220	19.0
6/6/02								7.13				20.0
6/18/02	47.3	51.1	0.0	0.0	51.2	60	30	6.87	340	10.4	189	20.2
7/2/02	71.1	63.8	0.0	0.0	63.9	278	24	7.10	436	14.8	205	
7/17/02	81.6	75.2	0.1	0.0	75.3	>82	34	6.99	496	16.9	237	24.5
8/07/02	101.0	94.1	0.2	0.0	94.3	118	32	6.72	450	15.0	209	26.0
8/21/02	92.5	87.9	0.0	0.0	87.9	176	22	6.76	568	16.0	220	26.2
9/4/02	81.3	82.2	0.1	0.0	82.3	<85	36	7.11	534	16.2	232	24.3
9/18/02	84.9	74.2	0.0	0.0	74.2	140	34	7.23	528	13.9	217	22.7
10/2/02	81.9	78.5	0.1	0.0	78.6	67	28	7.28	562	15.8	240	22.9
10/16/02	102.6	90.9	0.1	0.0	91.0	>81	56	7.40	548	16.6	270	18.0
11/6/02		89.5	0.2	0.0	89.7	100	38	7.40	672	16.8	242	12.0
11/20/02	88.5	93.5	0.0	0.0	93.6	131	42	7.40	630	20.3	222	9.0
12/4/02	83.3	93.1	0.1	0.0	93.2	96	40	7.30	636	19.7	268	7.0
12/19/02	69.8	72.7	0.0	0.1	72.8	98	22	7.50	575	18.9	285	4.0
1/15/03	78.2	83.5	0.2	0.0	83.8	76	2	7.30		17.0		3.0
2/05/03	73.7	81.7	0.9	0.1	82.7	136	60	7.30	610	20.0	269	7.0
2/19/03	75.0	80.8	0.1	0.0	80.9	220	50	7.00	584	24.3	272	6.0
3/05/03	80.1	90.5	0.3	0.0	90.8	164	48	7.10	612	19.3	380	13.0
3/19/03	115.9	94.9	0.0	0.0	94.9	220	66	7.60	627	19.8	201	17.0
4/2/03	81.3	78.0	0.0	0.0	78.1	144	48	7.30	605	17.9	189	14.0
4/17/03	76.9	76.6	0.1	0.0	76.7	165	70	7.30	599	21.5	172	17.0
5/7/03	70.5	76.8	0.0	0.0	76.9	192	62	7.10	557	17.5	176	16.0
5/21/03	71.1	69.3	0.0	0.0	69.4	90	32	7.20	604	20.3	198	19.0
6/4/03	71.8	66.3	0.0	0.0	66.4	118	54	7.30	556	18.1	274	14.0
6/18/03	77.5	75.1	0.0	0.0	75.2	225	128	7.00	572	20.1	395	19.0
7/2/03	74.3	70.1	0.0	0.0	70.2	214	44	7.10	531	15.5	166	22.0
7/16/03	87.4	74.8	0.0	0.0	74.9	219	56	7.30	556	18.2	168	24.0
8/6/03	74.9	74.3	0.0	0.0	74.4	300	64	7.10	537	17.1	172	25.0
8/20/03	65.4	68.3	0.0	0.0	68.3	211	48	7.20	512	16.7	180	24.0
9/3/03	77.9	77.2	0.0	0.0	77.3	90	28	7.50	562	16.7	171	23.0
9/17/03	79.1	77.9	0.0	0.0	78.0	142	42	7.50	591	20.5	194	20.0
Average	**77.8**	**79.7**	**0.1**	**0.0**	**81.6**	**160**	**45**	**7.14**	**515**	**17.0**	**211**	**16.1**
Maximum	**115.9**	**106.0**	**0.9**	**0.1**	**106.1**	**300**	**128**	**7.6**	**672.0**	**24.3**	**395.0**	**26.2**
Minimum	**47.3**	**51.1**	**0.0**	**0.0**	**51.2**	**60**	**2**	**6.7**	**340.0**	**5.7**	**121.0**	**3.0**

Black Rock Retreat Wastewater Plant RSF Influent Test Results



RSF effluent test results

	RSF Effluent Chemical Analyses											
Date	NH3-N	TKN	NO3-N	NO2-N	N-Total	CBOD5	SS	pH	T (deg. C)	Alkalinity	Phosphorus	Chloride
11/6/01	34.6		0.2	0.0	34.8	7.1	22.0	7.58	13.0	314	8	138
11/13/01	59.4		0.0	0.2	59.6			7.72	13.5			
11/19/01	48.8		0.1	0.8	49.7			7.50	13.5			
11/28/01	6.9		11.2	45.1	63.2			6.38	12.7			
12/3/01	10.2		22.3	48.2	80.7	2.8	6.0	6.33	13.2	102	15	131
12/11/01	1.7		4.0	57.1	62.7			5.98	11.3			
12/18/01	0.1		11.7	51.8	63.6			5.98	10.3			
12/26/01	0.7		14.3	47.9	62.9			6.14	7.8			
1/2/02	0.1		10.4	47.5	58.0			6.71	6.1			
1/8/02	6.1		10.3	36.5	52.9			6.59	6.3			
1/15/02	4.2		6.2	46.8	57.2			6.25	6.6			
1/23/02	2.4		7.4	17.5	27.4			6.56	6.7			
1/29/02	0.1		29.6	14.1	43.7			6.30	7.8			
2/5/02	0.1		29.8	9.0	39.0	4.6	2.0	6.70	7.5	40	13	132
2/11/02	0.3		27.9	3.7	31.8			6.77	7.6			
2/20/02	0.1		32.1	0.3	32.5			6.60	8.0			
2/26/02	0.9		38.5	8.3	47.7			6.14	9.4			
3/5/02	0.0		34.0	0.1	34.1	0.2	8.0	6.40	9.5	32	12	172
3/12/02	0.4		38.1	3.8	42.4			5.42	9.7			
3/19/02	8.7	13.2	16.4	1.6	26.7			6.36	10.1			
3/27/02	2.4	4.7	30.5	0.3	33.2			6.70	10.3			
4/1/02	0.0		33.6	0.1	33.7	1.7	4.0	6.30	12.5	56	16	162
4/8/02	0.1		33.9	0.0	34.0			6.42	11.8			
4/16/02	0.1		42.6	0.1	42.8			6.40	15.4			
4/23/02	0.1		40.3	0.0	40.4			6.44	15.2			
4/30/02	5.3	6.2	35.8	0.4	41.5	5.9	2.0	6.37	14.8	72	15	201
5/7/02	0.1	1.3	53.9	0.0	54.0	1.2	6.0	6.12	16.2	28	13	188
5/14/02	0.0		45.3	0.0	45.3			6.06	17.0			
5/21/02	0.9		53.2	0.1	54.2			5.34	15.3			
5/30/02	1.3		42.8	0.1	44.2			6.19	19.2			
6/6/02	0.9	1.9	58.7	0.1	59.6	0.7	6.0	5.38	21.1	6	15	191
6/11/02	10.2		25.5	0.8	36.4			6.33	20.7			
6/18/02	0.1		31.6	0.0	31.8			6.61	20.1			
6/25/02	0.2		33.7	0.2	34.1			6.80	22.7			
7/2/02	0.4	1.7	47.2	0.2	47.8	1.9	2.0			28	13	191
7/9/02	2.4		57.0	0.2	59.6			5.13	23.9			
7/17/02	0.4		60.7	0.0	61.1			5.13	23.6			
7/24/02	6.3		33.9	0.5	40.7			6.30	24.9			
7/31/02	4.1		24.4	0.5	28.9			6.07	26.2			
8/07/02	0.3	1.5	41.8	0.1	42.2	1.5	6.0	5.67	25.9	44	16	208
8/14/02	0.1		37.9	0.1	38.1			6.03	25.2			
8/21/02	7.7		49.5	0.9	58.1			6.49	26.2			
8/28/02	1.4		59.4	1.1	61.8			6.30	23.3			
9/4/02	0.4	1.4	48.0	0.4	48.8	?	6.0	6.54	23.9	74	16	155
9/11/02	1.3		66.3	1.2	68.8			6.11	22.5			
9/18/02	0.2		44.2	0.1	44.4			6.55	22.7			
9/25/02	0.1		43.8	0.1	44.0			6.55	22.4			
10/2/02	0.1	1.0	56.0	0.1	56.2	6.6	2.0	6.68	21.1	60	15	209
10/9/02	0.6		63.9	0.5	65.1			6.50	18.0			
10/16/02	0.2		50.8	0.1	51.1			6.70	16.0			
10/23/02	17.8		33.6	1.0	52.4			6.70	15.0			
10/30/02	0.3		42.2	0.0	42.6			7.00	12.0			
11/6/02	0.2	2.0	46.8	0.1	47.1	12.9		6.90	10.0	140	17	228
11/13/02	10.5		29.7	0.1	40.3			7.00	11.0			
11/20/02								7.20	7.0			
11/25/02	0.8		42.5	0.2	43.5			6.70	9.0			
12/4/02	0.1	2.8	52.9	0.0	53.0	5.6		7.10	4.0	110	18	
12/12/02	0.2		44.6	0.1	45.0							
12/19/02								7.00	1.0			
1/8/03	0.1		44.2	0.1	44.4			7.00	1.0			
1/15/03	0.2		46.1	0.1	46.3			7.10	0.0			
1/22/03	1.1		48.7	0.6	50.4			6.60	1.0			
1/29/03	0.5		48.0	0.5	48.9			6.80	4.0			
2/05/03	0.2	2.1	62.1	0.2	62.5	1.8		7.20	6.0	121	19	215
2/12/03	0.1		57.5	0.1	57.7			7.20	5.0			
2/19/03	1.9		40.0	0.9	42.8			7.00	5.0			
2/26/03	1.9		29.0	0.7	31.6			7.00	6.0			
3/05/03	4.9	6.0	36.9	0.9	42.7	6.6	6.0	6.90	7.0	172	19	365
3/12/03	0.4		37.1	0.1	37.7			7.00	7.0			
3/19/03	3.8		46.5	0.6	50.9			6.90	13.0			
3/26/03	0.4		41.0	0.1	41.4			6.80	15.0			
4/2/03	0.2	2.2	41.8	0.1	42.1			7.00	14.0	132	20	174
4/9/03	2.2		38.6	0.2	41.0			7.10	11.0			
4/17/03	0.0		25.2	0.1	25.3			7.40	16.0			
4/23/03	0.6		18.5	0.2	19.3			7.50	14.0			
4/30/03	7.6		29.1	0.5	37.1			6.66	14.0			
5/7/03	1.5	2.7	39.1	0.3	40.8			7.00	14.0	160	18	178
5/14/03	0.4		37.7	0.1	38.2			7.00	14.0			
5/21/03	0.1		31.7	0.2	32.0			7.00	15.0			
5/28/03	0.1		44.6	0.1	44.8			6.85	14.0			
6/4/03	0.1	5.0	35.7	0.0	35.9			7.10	14.0	123	19	207
6/11/03	0.1		26.6	0.0	26.7			7.20	16.0			
6/18/03	0.2		30.0	0.1	30.3			7.10	18.0			
6/25/03	2.4		36.9	0.1	39.3			6.90	18.0			
7/2/03	2.4	3.5	39.1	0.1	41.6		6.0	6.90	22.0	146	17	168
7/9/03	3.4		29.9	0.2	33.6			6.50	25.0			
7/16/03	0.4		42.5	0.1	43.0			7.00	23.0			
7/23/03	2.7		28.2	0.1	31.0			6.80	22.0			
7/30/03	12.0		24.1	0.2	36.4			6.80	24.0			
8/6/03	2.6	4.0	26.1	0.1	28.9	2.5	2.0	6.50	24.0	187	16	148
8/13/03	0.4		41.5	0.1	42.0			6.50	24.0			
8/20/03	2.8		37.4	0.1	40.3							
9/3/03	0.3	1.8	49.2	0.0	49.6	3.4	14.0	7.00	22.0	102	17	155
9/10/03	3.0		43.3	0.1	46.3			7.10	21.0			
9/17/03	1.6		38.6	0.1	40.3			7.20	20.0			
9/24/03	0.5		45.1	0.1	45.6			6.60	18.0			
Ave.	3.6	3.5	35.9	5.3	44.7	4.1	6.0	6.6	14.0	98	16	190
count	87.0	17.0	87.0	87.0	87.0	16.0	14.0	87.0	87.0	20	20	19


Black Rock Retreat Wastewater Plant RSF Effluent Test Results
Concentration (mg/l)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
NH3-N
TKN
NO3-N
NO2-N
N-Total
11/13/01
11/28/01
12/11/01
12/26/01
1/8/02
1/23/02
2/5/02
2/20/02
3/5/02
3/19/02
4/1/02
4/16/02
4/30/02
5/14/02
5/30/02
6/11/02
6/25/02
7/9/02
7/24/02
8/07/02
8/21/02
9/4/02
9/18/02
10/2/02
10/16/02
10/30/02
11/13/02
11/25/02
12/12/02
1/8/03
1/22/03
2/05/03
2/19/03
3/05/03
3/19/03
4/2/03
4/17/03
4/30/03
5/14/03
5/28/03
6/11/03
6/25/03
7/9/03
7/16/03
7/30/03
8/13/03
9/3/03
9/17/03
Date

25% wetland sample results

25% Wetland Chemical Analyses (mg/l)							
Date	NH3-N	TKN	NO3-N	NO2-N	N-Total	T (deg. C)	pH
11/6/01	28.4		0.0	0.0	28.5	12.6	7.09
11/13/01	52.3		0.0	0.0	52.4	11.1	7.31
11/19/01	59.3		0.0	0.0	59.4	11.7	7.38
11/28/01	36.2		1.1	6.4	43.7	11.2	7.51
12/3/01	31.5		8.6	21.6	61.6	11.2	7.04
12/11/01	24.0		10.8	23.6	58.4	9.7	7.08
12/18/01	15.0		7.6	33.7	56.3	9.3	6.82
12/26/01	8.6		13.7	32.4	54.7	5.6	6.76
1/2/02	23.1		2.0	2.3	27.4	3.9	7.43
1/8/02	10.6		20.2	17.7	48.5	3.9	6.75
1/15/02	20.4		17.1	14.0	51.5	5.5	6.97
1/23/02	10.7		21.5	20.3	52.5	4.5	6.63
1/29/02	14.7		17.3	11.3	43.2	6.9	6.62
2/5/02	19.8		12.2	8.4	40.4	6.0	6.90
2/11/02	17.8		16.8	8.3	42.8	7.7	6.87
2/20/02	9.3		29.9	2.7	41.8	6.4	6.81
2/26/02	9.2		25.7	12.0	46.9	7.7	6.69
3/5/02	24.7		7.9	0.3	32.9	8.3	6.80
3/12/02	15.6		3.2	15.5	34.2	9.5	6.89
3/19/02	5.7		10.7	0.0	16.4	9.1	6.72
3/27/02	2.3		0.1	0.0	2.4	8.8	6.92
4/1/02	3.2		8.9	0.0	12.2	11.1	6.78
4/8/02	5.0		5.9	0.0	10.9	9.5	6.72
4/16/02	8.8		12.6	0.0	21.4	16.4	6.78
4/23/02	7.7		9.3	0.0	17.1	13.8	6.77
4/30/02	2.6		15.4	0.0	18.0	12.7	6.83
5/7/02	4.1		0.0	0.0	4.1	16.5	6.85
5/14/02	3.3		0.1	0.1	3.5	17.0	6.99
5/21/02	2.2		3.9	0.4	6.4	14.7	7.28
5/30/02	17.0		0.1	0.0	17.1	19.4	6.87
6/6/02	18.3		0.1	0.2	18.5	21.5	6.89
6/11/02	10.2		6.6	0.1	16.9	21.2	6.64
6/18/02	3.1		3.1	0.0	6.3	19.8	7.01
6/25/02	3.4		5.1	0.1	8.5	22.7	6.80
7/2/02	2.9		5.8	0.8	9.5		
7/9/02	3.1		16.0	2.0	21.1	24.5	6.70
7/17/02	1.3		17.3	1.4	20.1	23.6	6.65
7/24/02	6.2		12.4	2.8	21.5	25.2	6.79
7/31/02	6.3		1.7	0.8	8.7	26.0	6.56
8/07/02	1.3		5.2	0.6	7.0	25.8	6.84
8/14/02	0.9		23.4	4.4	28.7	26.0	6.67
8/21/02	11.6		0.3	2.1	14.1	26.7	7.07
8/28/02	4.1		6.7	7.7	18.6	24.8	7.22
9/4/02	5.6		18.2	6.3	30.1	23.1	7.06
9/11/02	1.0		29.1	3.9	34.1	22.8	7.04
9/18/02	0.3		2.1	2.2	4.6	22.7	7.26
9/25/02	1.8		0.0	0.0	1.9	21.3	7.24
10/2/02	3.9		0.4	0.0	4.3	21.0	7.49
10/9/02	1.2		5.6	4.9	11.7	16.0	7.20
10/16/02	6.5		17.6	0.3	24.3	14.0	7.00
10/23/02	1.9		9.3	1.4	12.6	12.0	6.90
10/30/02	3.7		1.7	0.0	5.4	8.0	7.10
11/6/02	0.4		6.3	0.0	6.7	5.0	7.00
11/13/02	0.8		3.6	0.0	4.4	6.0	7.10
11/20/02					0.0	4.0	7.20
11/25/02	1.0		20.1	1.6	22.7	7.0	7.00
12/4/02	1.3		13.9	0.1	15.3	0.0	7.00
12/12/02	1.7		1.4	2.7	5.8	0.0	7.10
12/19/02	0.6		6.2	2.0	8.7	-1.0	7.10
1/8/03	1.0		2.3	0.9	4.2	-1.0	7.30
1/15/03	0.4		4.4	1.0	5.9	0.0	7.30
1/22/03	0.3		5.5	0.9	6.7	1.0	7.40
1/29/03	0.2		2.7	0.4	3.3	1.0	7.30
2/05/03	0.2		1.1	0.2	1.5	0.5	7.10
2/12/03	0.7		0.1	0.1	0.8	2.0	7.10
2/19/03	1.2		0.5	0.4	2.1	2.0	7.00
2/26/03	0.7		3.1	0.4	4.3	4.0	7.40
3/05/03	1.3		6.2	0.1	7.5	5.0	7.40
3/12/03	2.5		5.3	0.2	7.9	5.0	7.40
3/19/03	3.6		4.1	0.1	7.8	13.0	7.00
3/26/03	2.7		7.2	0.3	10.2	15.0	7.00
4/2/03	3.2		1.8	0.1	5.1	14.0	7.20
4/9/03	0.5		0.1	0.0	0.5	11.0	7.30
4/17/03	3.9		0.0	0.0	4.0	14.0	7.20
4/23/03	6.0		0.0	0.0	6.0	15.0	7.10
4/30/03	1.1		0.1	0.0	1.2	15.0	7.30
5/7/03	0.2		1.1	0.7	1.9	13.0	7.30
5/14/03	3.1		0.1	0.0	3.1	13.0	7.30
5/21/03	2.7		0.4	0.0	3.1	13.0	7.50
5/28/03	0.8		16.2	3.9	20.9	13.0	7.20
6/4/03	1.0		0.0	0.1	1.1	12.0	7.50
6/11/03	5.4		0.1	0.0	5.4	17.0	7.30
6/18/03	0.4		0.1	0.3	0.7	18.0	7.70
6/25/03	0.6		0.0	0.0	0.7	20.0	7.20
7/2/03	0.2		0.0	0.0	0.3	23.0	7.30
7/9/03	5.3		0.0	0.0	5.3	23.0	7.10
7/16/03	4.1		0.1	0.0	4.2	24.0	7.60
7/23/03	4.0		4.2	0.1	8.3	23.0	7.30
7/30/03	12.0		0.8	0.2	12.9	24.0	7.10
8/6/03	5.6		0.0	0.0	5.7	24.0	7.10
8/13/03	5.6		0.0	0.0	5.7	24.0	7.10
8/20/03	6.9		3.0	1.6	11.5	24.0	7.50
9/3/03	10.5		0.2	0.0	10.7	22.0	7.50
9/10/03	4.3		1.9	0.0	6.2	20.0	7.40
9/17/03	4.3		0.9	1.4	6.6	19.0	7.40
9/24/03	1.2		10.7	1.0	12.9	19.0	7.30

50% Wetland Test Results

	50% Wetland Chemical Analyses (mg/l)					
Date	NH3-N	NO3-N	NO2-N	N-Total	T (deg. C)	pH
11/6/01	11.2	5.3	0.3	16.8	11.4	6.73
11/13/01	48.3	0.0	0.0	48.4	10.4	7.31
11/19/01	60.0	0.0	0.0	60.1	10.9	7.40
11/28/01	38.7	0.4	3.4	42.4	10.8	7.49
12/3/01	25.0	14.1	26.9	65.9	11.7	7.00
12/11/01	19.9	2.7	29.7	52.3	8.9	6.95
12/18/01	10.8	34.6	7.7	53.1	8.8	6.78
12/26/01	10.3	6.7	23.2	40.2	6.1	6.86
1/2/02	15.8	4.9	17.5	38.2	3.1	7.15
1/8/02	8.6	16.3	11.4	36.4	2.4	6.98
1/15/02	6.9	13.1	6.9	26.9	4.0	6.70
1/23/02	10.4	13.1	14.5	38.0	3.9	6.73
1/29/02	8.4	13.9	10.5	32.7	5.5	6.58
2/5/02	21.6	13.3	6.0	40.9	5.7	6.90
2/11/02	10.9	27.5	3.7	42.1	6.8	6.80
2/20/02	10.3	23.7	2.1	36.2	5.5	6.80
2/26/02	12.4	28.3	3.1	43.7	7.4	6.88
3/5/02	22.9	8.9	0.7	32.5	7.5	6.75
3/12/02	18.9	9.1	4.0	32.0	8.8	6.73
3/19/02	6.5	9.1	0.1	15.6	9.3	6.74
3/27/02	3.8	0.0	0.0	3.8	8.1	6.77
4/1/02	3.7	3.6	0.0	7.3	10.4	7.11
4/8/02	2.6	3.1	0.0	5.7	8.2	6.98
4/16/02	7.4	12.3	0.0	19.8	15.5	6.79
4/23/02	4.3	7.4	0.1	11.7	13.7	6.76
4/30/02	5.5	11.4	0.0	16.9	13.2	6.58
5/7/02	7.6	0.0	0.0	7.6	16.0	6.81
5/14/02	1.8	0.1	0.1	1.9	16.5	6.76
5/21/02	2.2	0.3	0.1	2.6	14.8	7.09
5/30/02	16.5	0.0	0.0	16.6	19.1	6.80
6/6/02	18.3	0.0	0.0	18.4	21.2	6.91
6/11/02	20.8	0.1	0.1	21.0	21.2	6.77
6/18/02	3.6	0.5	0.0	4.1	19.7	7.09
6/25/02	6.0	0.8	0.1	6.8	22.7	6.86
7/2/02	1.6	4.4	0.3	6.3		
7/9/02	4.1	10.0	1.5	15.5	24.3	6.72
7/17/02	2.7	26.1	1.0	29.7	23.6	6.47
7/24/02	3.5	22.4	1.7	27.5	25.2	6.74
7/31/02	3.6	8.1	3.3	15.0	25.7	6.62
8/07/02	2.0	0.7	0.1	2.7	25.2	6.81
8/14/02	0.8	24.3	4.1	29.2	25.7	6.67
8/21/02	1.7	8.0	10.7	20.3	26.3	7.08
8/28/02	2.0	25.1	2.9	30.0	23.3	7.20
9/4/02	3.9	19.9	6.7	30.5	23.0	7.07
9/11/02	4.1	28.4	5.7	38.2	22.1	6.94
9/18/02	0.7	3.7	3.9	8.3	22.5	7.25
9/25/02	1.7	0.4	0.0	2.1	21.2	7.33
10/2/02	0.8	1.7	1.7	4.1	20.3	7.52
10/9/02	0.9	2.1	5.9	8.9	16.0	7.40
10/16/02	5.4	12.3	1.6	19.3	13.0	6.90
10/23/02	0.9	16.3	1.0	18.2	11.0	7.00
10/30/02	0.4	2.5	0.0	2.9	7.0	7.20
11/6/02	0.1	8.0	0.0	8.1	5.0	7.00
11/13/02	0.4	3.9	0.0	4.3	6.0	7.10
11/20/02				0.0	4.0	7.20
11/25/02	0.2	7.3	1.7	9.1	5.0	7.10
12/4/02	1.7	15.1	0.0	16.8	2.0	7.00
12/12/02	1.0	0.4	8.5	9.9	0.0	7.10
12/19/02	0.6	5.2	2.6	8.4	-1.0	7.10
1/8/03	0.6	4.1	0.3	5.1	-1.0	7.20
1/15/03	0.5	4.1	0.1	4.7	0.0	7.20
1/22/03	0.1	0.4	0.0	0.5	1.0	7.10
1/29/03	0.1	3.8	0.0	4.0	1.0	7.40
2/05/03	0.1	1.5	0.0	1.6	1.0	7.20
2/12/03	0.2	0.4	0.0	0.5	1.0	7.10
2/19/03	0.8	0.4	0.1	1.3	2.0	7.10
2/26/03	1.1	1.2	0.0	2.4	1.0	7.30
3/05/03	2.7	3.8	0.2	6.7	5.0	7.20
3/12/03	5.3	0.1	0.0	5.4	4.0	7.30
3/19/03	7.8	3.7	0.1	11.5	12.0	7.20
3/26/03	6.2	4.6	0.3	11.0	15.0	7.10
4/2/03	2.4	0.7	0.1	3.1	8.0	7.10
4/9/03	0.1	0.0	0.0	0.2	9.0	7.70
4/17/03	2.1	0.0	0.0	2.1	14.0	7.20
4/23/03	1.7	0.0	0.0	1.8	14.0	7.10
4/30/03	3.9	0.0	0.0	3.9	13.0	7.20
5/7/03	4.0	0.0	0.0	4.1	13.0	7.20
5/14/03	4.7	0.1	0.0	4.8	13.0	7.20
5/21/03	2.3	0.2	0.1	2.6	13.0	7.70
5/28/03	0.2	7.9	3.8	11.9	12.0	7.39
6/4/03	3.4	0.2	0.0	3.6	12.0	7.50
6/11/03	1.3	0.1	0.0	1.5	16.0	7.30
6/18/03	2.5	0.2	0.0	2.8	18.0	7.30
6/25/03	0.9	0.1	0.0	1.1	18.0	7.20

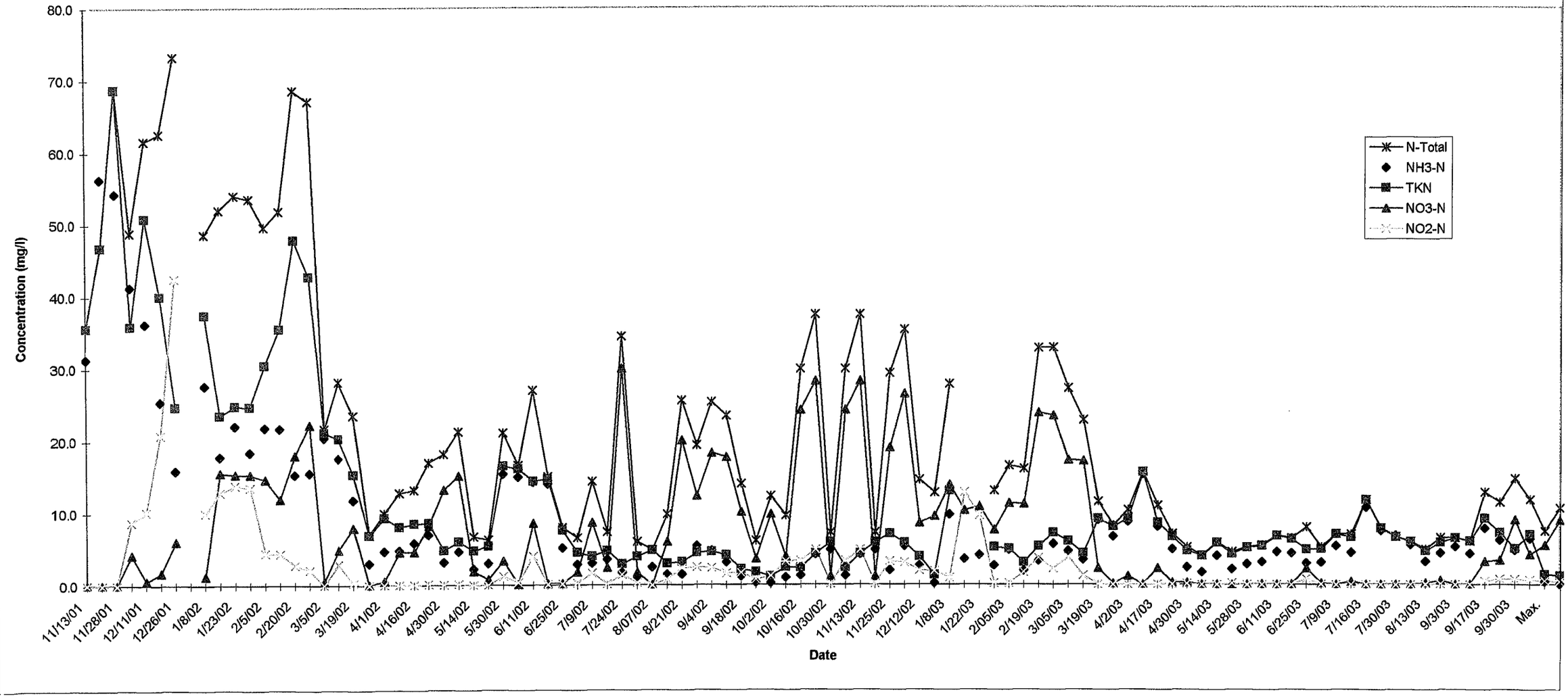
75% Wetland Test Results

	75% Wetland Chemical Analyses (mg/l)					
Date	NH3-N	NO3-N	NO2-N	N-Total	pH	T (deg. C)
11/6/01	1.7	6.5	0.1	8.4	6.27	11.5
11/13/01	28.8	2.7	0.0	31.5	7.06	9.2
11/19/01	28.6	1.5	0.2	30.3	7.10	8.9
11/28/01	30.1	1.3	2.2	33.6	7.27	10.1
12/3/01	21.1	9.9	23.0	53.9	7.24	10.5
12/11/01	16.7	1.9	17.1	35.7	7.02	8.7
12/18/01	8.7	4.0	17.1	29.8	6.79	7.7
12/26/01	8.4	6.4	27.5	42.3	6.88	5.6
1/2/02					6.85	1.8
1/8/02	6.3	5.6	7.9	19.7	6.88	1.2
1/15/02	3.6	9.5	5.3	18.4	6.52	3.3
1/23/02	3.8	8.6	6.4	18.8	6.48	3.0
1/29/02	3.1	9.8	6.3	19.3	6.40	4.7
2/5/02	11.6	10.2	3.0	24.8	6.93	4.7
2/11/02	3.0	16.4	1.0	20.3	6.71	5.5
2/20/02	4.5	23.9	0.5	28.9	6.72	4.8
2/26/02	6.1	20.4	1.0	27.4	6.76	6.6
3/5/02	11.3	10.4	0.3	22.0	6.80	6.1
3/12/02	13.5	5.0	3.0	21.5	6.70	7.9
3/19/02	3.8	4.5	0.0	8.3	6.74	7.7
3/27/02	1.3	0.0	0.0	1.3	6.81	7.7
4/1/02	1.0	2.6	0.0	3.6	7.02	9.7
4/8/02	1.8	2.5	0.0	4.4	6.85	8.1
4/16/02	3.0	2.7	0.0	5.8	6.94	15.0
4/23/02	1.4	0.7	0.2	2.2	6.70	13.1
4/30/02	0.6	3.0	0.0	3.6	6.47	12.2
5/7/02	0.8	0.1	0.6	1.5	6.53	15.5
5/14/02	0.7	0.0	0.0	0.8	6.37	16.0
5/21/02	1.5	0.0	0.0	1.6	6.70	14.3
5/30/02	9.0	0.4	0.1	9.5	6.77	19.4
6/6/02	7.8	0.0	0.0	7.8	6.83	21.1
6/11/02	8.6	5.4	3.3	17.3	6.51	21.1
6/18/02	5.2	0.6	0.2	5.9	6.83	19.7
6/25/02	5.1	0.2	0.1	5.3	6.88	22.7
7/2/02	1.9	0.7	0.1	2.7		
7/9/02	3.6	4.5	1.4	9.4	6.70	24.4
7/17/02	2.8	18.6	1.4	22.7	6.57	23.5
7/24/02	1.2	18.7	0.6	20.5	6.53	24.3
7/31/02	1.7	5.0	1.9	8.5	6.67	25.5
8/07/02	1.6	0.3	0.0	1.9	6.77	25.5
8/14/02	0.9	15.8	2.4	19.1	6.72	25.6
8/21/02	0.6	1.9	3.5	6.0	7.11	26.4
8/28/02	1.7	15.4	1.7	18.7	7.11	23.9
9/4/02	1.5	16.3	3.9	21.7	7.07	22.2
9/11/02	1.2	11.0	4.7	17.0	7.16	21.8
9/18/02	0.8	2.8	0.6	4.2	7.31	22.5
9/25/02	0.4	0.5	0.0	0.9	7.54	20.8
10/2/02	0.2	0.9	1.5	2.6	7.53	20.0
10/9/02	0.7	0.4	1.0	2.2	7.20	15.0
10/16/02	0.4	8.2	1.3	9.9	6.90	13.0
10/23/02	1.7	14.3	2.6	18.6	7.00	12.0
10/30/02	0.0	3.8	0.0	3.8	7.20	7.0
11/6/02	1.0	2.5	0.0	3.4	7.00	5.0
11/13/02	0.3	3.2	0.0	3.5	7.10	6.0
11/20/02					7.20	4.0
11/25/02	0.1	7.2	0.5	7.7	7.10	4.0
12/4/02	2.7	8.9	0.0	11.6	7.00	1.0
12/12/02	0.4	2.2	2.4	5.0	7.10	0.0
12/19/02	0.5	4.2	2.7	7.4	7.10	-1.0
1/8/03	0.3	3.0	0.3	3.6	7.20	-2.0
1/15/03	0.1	0.2	0.0	0.4	7.10	0.0
1/22/03	0.1	0.3	0.0	0.3	7.10	1.0
1/29/03	0.2	4.2	0.0	4.5	7.40	1.0
2/05/03	0.1	0.7	0.0	0.8	7.20	2.0
2/12/03	0.1	0.4	0.0	0.5	7.10	1.0
2/19/03	0.2	0.2	0.0	0.4	7.00	1.0
2/26/03	1.3	0.3	0.0	1.6	7.30	1.0
3/05/03	1.4	0.1	0.0	1.6	7.30	3.0
3/12/03	4.0	0.2	0.0	4.2	7.40	3.0
3/19/03	6.1	3.7	0.1	9.9	7.30	11.0
3/26/03	5.4	0.4	0.0	5.9	7.00	14.0
4/2/03	1.8	0.1	0.0	1.9	7.20	10.0
4/9/03	0.3	0.1	0.0	0.4	7.70	9.0
4/17/03	1.9	0.1	0.0	2.1	7.20	13.0
4/23/03	1.6	0.1	0.0	1.8	7.30	14.0
4/30/03	1.0	0.0	0.0	1.1	7.30	14.0
5/7/03	2.2	0.0	0.0	2.2	7.20	11.0
5/14/03	1.8	0.1	0.0	1.9	7.20	13.0
5/21/03	1.9	0.3	0.3	2.5	7.70	12.0
5/28/03	0.9	1.6	3.1	5.6	7.27	12.0
6/4/03	1.2	0.7	0.0	2.0	7.50	12.0
6/11/03	0.6	0.9	0.5	2.0	7.30	16.0
6/18/03	1.4	0.4	0.0	1.8	7.60	17.0
6/25/03	1.0	0.3	0.0	1.3	7.10	19.0

Final Effluent Analytical Results

	Black Rock Retreat final effluent sample results												
Date	NH3-N	TKN	NO3-N	NO2-N	N-Total	CBOD5	SS	Fecal Col.	pH	T (deg. C)	Alkalinity	Phosphorus	Chloride
11/13/01	31.3	35.6	0.0	0.0	35.7	12.3	22.0	1800	7.37	10.7	310	8.5	140
11/19/01	56.3	46.8	0.0	0.0	46.9	10.2	2.0	1200	7.45	10.2	386	10.6	146
11/28/01	54.3	68.7	0.1	0.0	68.8	4.3	12.0	200	7.47	9.7	382	9.1	143
12/3/01	41.3	35.9	4.3	8.8	48.9	4.0	12.0	380	7.60	10.5	296	12.4	137
12/11/01	36.2	50.8	0.6	10.1	61.5	4.4	16.0	220	7.40	9.6	298	15.9	138
12/18/01	25.4	40.0	1.8	20.8	62.5	6.8	18.0	20	7.33	8.3	220	16.6	126
12/26/01	15.9	24.7	6.1	42.5	73.3	5.2	18.0	20	7.24	6.7	166	15.5	130
1/2/02									7.12	5.7			
1/8/02	27.6	37.4	1.2	10.0	48.6	8.2	2.0	11000	7.35	4.0	264	13.2	134
1/15/02	17.8	23.5	15.6	12.9	52.0	7.5	6.0	5100	7.00	4.4	172	9.7	114
1/23/02	22.1	24.8	15.4	13.9	54.0	4.7	12.0	4800	6.99	4.3	198	11.8	100
1/29/02	18.4	24.7	15.3	13.5	53.5	4.2	44.0	1000	6.94	5.0	162	13.1	113
2/5/02	21.8	30.5	14.7	4.5	49.6	6.4	2.0	4700	7.17	5.4	190	13.4	127
2/11/02	21.7	35.5	11.9	4.4	51.8	5.9	6.0	4000	7.08	4.7	202	12.3	140
2/20/02	15.3	47.8	17.9	2.8	68.6	5.2	30.0	1000	7.03	4.8	152	11.5	154
2/26/02	15.5	42.7	22.2	2.1	67.0	4.8	6.0	2500	7.13	6.4	158	12.1	161
3/5/02	20.4	21.1	0.5	0.0	21.7	6.2	12.0	1200	7.04	6.1	200	12.0	194
3/12/02	17.6	20.3	4.9	2.9	28.2	72.0	2.0	3400	6.88	8.0	176	11.4	166
3/19/02	11.8	15.3	7.9	0.3	23.5	9.9	2.0	600	6.93	8.2	146	12.6	169
3/27/02	3.0	6.9	0.0	0.0	7.0	35.8	40.0	3900	6.91	8.0	172	15.3	168
4/1/02	4.7	9.4	0.6	0.1	10.0	14.5	44.0	360	7.02	8.8	186	16.5	164
4/8/02	4.8	8.1	4.6	0.1	12.8	2.7	6.0		6.97	8.5	172	15.2	160
4/16/02	5.9	8.5	4.6	0.1	13.2	8.2	2.0	120	7.05	11.1	182	14.7	178
4/23/02	7.0	8.6	8.2	0.1	17.0	2.6	2.0		6.97	13.9	180	15.3	181
4/30/02	3.2	4.8	13.2	0.1	18.2	2.7	2.0	20	6.95	12.7	140	14.5	201
5/7/02	4.7	6.0	15.1	0.2	21.3	2.3	14.0	40	6.87	13.9	128	14.2	186
5/14/02	2.2	4.8	1.9	0.0	6.7	14.3	44.0		6.92	15.0	170	10.5	194
5/21/02	3.1	5.4	0.8	0.1	6.3	5.4	2.0	20	7.00	15.0	178	10.2	174
5/30/02	15.4	16.5	3.3	1.3	21.1	3.8	6.0		7.01	16.5	238	10.7	200
6/6/02	15.0	16.1	0.1	0.4	16.6	2.7	8.0	760	7.01	18.5	234	15.1	182
6/11/02	14.3	14.4	8.6	4.0	27.0	4.6	2.0		6.82	19.4	178	10.1	181
6/18/02	14.0	14.7	0.2	0.1	15.1	1.4	4.0	<20	7.00	19.2	240	11.8	184
6/25/02	5.2	7.6	0.2	0.1	8.0	2.4	2.0		7.02	22.6	208	10.8	144
7/2/02	2.9	4.5	1.8	0.3	6.6	1.9	2.0	<10			182	13.2	173
7/9/02	3.0	4.0	8.7	1.7	14.4	2.6	2.0		6.81	23.0	162	14.6	190
7/17/02	3.6	4.8	2.4	0.2	7.4	1.1	2.0	<20	6.77	22.3	126	13.4	243
7/24/02	1.8	3.0	30.0	1.5	34.5	1.6	4.0		6.62	23.6	90	13.5	174
7/31/02	1.2	4.0	1.7	0.4	6.0	1.8	2.0		6.82	25.0	186	14.8	194
8/07/02	2.5	4.8	0.1	0.0	4.9	2.8	16.0	480	6.85	24.1	196	15.2	195
8/14/02	1.5	3.0	6.0	0.8	9.8	1.8	12.0		7.03	23.6	166	14.1	212
8/21/02	1.4	3.2	20.0	2.3	25.5	1.5	12.0		6.91	25.3	144	14.3	218
8/28/02	5.4	4.5	12.4	2.5	19.4	1.8	12.0		7.09	23.8	230	18.2	261
9/4/02	4.8	4.6	18.3	2.4	25.3	1.5	2.0	<20	7.17	22.5	194	16.4	197
9/11/02	3.2	4.1	17.7	1.7	23.4	1.8	2.0		7.23	20.8	190	13.6	196
9/18/02	1.2	2.2	10.1	1.7	14.0	1.6	2.0		7.35	21.2	216	12.7	201
9/25/02	0.3	1.8	3.6	0.8	6.2	1.6	2.0		7.42	20.9	234	13.0	231
10/2/02	0.3	1.2	9.8	1.3	12.3	0.8	4.0	<20	7.42	20.0	196	12.0	207
10/9/02	1.0	2.4	3.9	3.3	9.6	1.4	6.0		7.50	17.0	226	12.8	244
10/16/02	1.3	2.4	24.2	3.3	29.9	2.1	2.0		7.10	15.0	134	13.9	198
10/23/02	4.2	4.4	28.2	4.9	37.5	1.7	2.0	480	7.10	14.0	132	13.4	216
10/30/02	4.9	5.9	1.2	0.2	7.3	2.2	10.0		7.30	10.0	244	15.0	253
11/6/02	2.0	7.0	19.0	3.3	29.3	2.6	8.0		7.00	8.0	196	11.4	223
11/13/02	5.4	5.8	26.4	3.1	35.3	0.7	2.0		7.10	8.0	230	19.9	235
11/20/02	2.7	3.9	8.6	2.0	14.5	1.9	4.0		7.20	6.0	260	16.2	185
11/25/02	0.2	1.4	9.5	1.9	12.8	0.8	4.0		7.20	7.0	208	16.8	170
12/4/02	9.7	13.0	13.8	1.0	27.8	0.9	2.0		7.20	5.0	286	16.9	224
12/12/02	3.6		10.3	12.8					7.10	2.0			
12/19/02	4.1		10.8	9.6					7.30	2.0			
1/8/03	2.7	5.2	7.6	0.2	13.0				7.30	0.0			
1/15/03	4.8	5.0	11.3	0.2	16.5				7.30	0.0			
1/22/03	2.0	3.1	11.2	1.8	16.1				7.50	3.0			
1/29/03	3.3	5.3	23.8	3.7	32.8				7.30	4.0			
2/05/03	5.6	7.2	23.4	2.2	32.8	7.3	8.0		7.30	5.0	237	17.8	218
2/12/03	4.7	6.1	17.3	3.9	27.2	2.1	6.0		7.40	4.0	235	5.5	244
2/19/03	3.5	4.3	17.2	1.3	22.8	3.1	2.0		7.00	5.0	243	17.4	237
2/26/03	9.0	9.1	2.3	0.1	11.5	2.9	4.0		7.20	4.0	286	16.7	209
3/05/03	6.7	8.0	0.1	0.0	8.2	5.9	2.0		7.50	5.0	287	17.1	275
3/12/03	8.8	9.1	1.2	0.0	10.4	2.2	16.0		7.30	5.0	280	15.2	321
3/19/03	15.3	15.6	0.0	0.0	15.7	25.9	30.0		7.40	7.0	358	15.4	265
3/26/03	8.0	8.6	2.3	0.1	11.0	2.4	2.0		7.30	10.0	295	16.8	191
4/2/03	4.9	6.7	0.3	0.1	7.05	3.7	2.0		7.50	12.0	294	19.1	173
4/9/03	2.4	4.7	0.3	0.2	5.19	2.8	4.0		7.50	9.0	291	18.1	171
4/17/03	1.7	4.0	0.1	0.0	4.07	19.0	8.0		7.50	10.0	309	18.8	169
4/23/03	4.0	5.8	0.0	0.0	5.85	7.4	18.0		7.40	13.0	323	20.6	170
4/30/03	2.2	4.3	0.0	0.2	4.57	4.7	10.0		7.50	16.0	314	18.8	166
5/7/03	2.9	5.2	0.0	0.0	5.20	3.3	14.0		7.40	12.0	321	18.7	185
5/14/03	3.2	5.4	0.1	0.0	5.48	3.9	24.0		7.50	12.0	314	19.2	192
5/21/03	4.6	6.8	0.1	0.0	6.86	4.6	4.0		7.50	12.0	314	1.8	170
5/28/03	4.4	6.3	0.1	0.0	6.46	2.6	6.0		7.25	12.0	302	18.5	205
6/4/03	3.0	4.9	2.3	0.8	7.97	2.7	4.0		7.50	12.0	264	17.5	227
6/11/03	3.1	4.9	0.2	0.1	5.20	2.8	2.0		7.50	14.0	255	12.9	164
6/18/03	5.4	7.0	0.0	0.0	7.07	3.8	10.0		7.10	15.0	277	17.6	306
6/25/03	4.5	6.6	0.4	0.0	7.00	3.8	12.0	40	7.20	17.0	238	12.8	142
7/2/03	10.7	11.7	0.0	0.0	11.76	6.2	14.0		7.20	20.0	314	15.3	169
7/9/03	7.5	7.8	0.0	0.0	7.89	3.6	12.0	40	7.20	21.0	318	16.8	209
7/10/03	6.9	6.6	0.0	0.0	6.68	4.1	12.0		7.50		311	15.9	203
7/16/03	5.6	6.0	0.0	0.0	6.04	2.8		<20	7.40	22.0	311	17.3	158
7/23/03	3.2	4.7	0.2	0.0	4.91	3.9	6.0	20	7.40	21.0	301	16.5	165
7/30/03	4.4	5.8	0.6	0.1	6.53	4.4	14.0	200	7.50	23.0	302	13.9	158
8/6/03	5.3	6.5	0.0	0.0	6.52	1.5	2.0	<20	7.30	23.0	299	17.6	159
8/13/03	4.3	6.0	0.0	0.0	6.05	3.3	8.0	<20	7.20	23.0	295	16.4	157
8/20/03	7.8	9.2	3.2	0.5	12.82	3.8	16.0	20	7.50	23.0	265	11.2	153
9/3/03	6.2	7.2	3.4	0.8	11.45	1.6	10.0	<20	7.50	22.0	257	15.0	134
9/10/03	4.8	5.0	9.0	0.7	14.71	1.1	8.0	160	7.50	20.0	233	13.5	173
9/17/03	6.4	6.9	4.2	0.7	11.76	1.5	4.0	<20	7.50	18.0	250	14.4	150
9/24/03	0.4	1.4	5.5	0.5	7.45	1.1	4.0	<20	7.30	18.0	159	11.7	95
9/30/03	0.1	1.3	8.9	0.4	10.63	0.9	4.0	<20	7.60	16.0	182	11.8	105
Ave.	8.7	11.7	6.9	2.5	20.8	5.3	9.2	*166	7.21	12.8	232.7	14.3	182.8
Max.	56.3	68.7	30.0	42.5	73.3	72.0	44.0	11000.0	7.60	25.3	386.0	20.6	321.0
Min.	0.1	1.2	0.0	0.0	4.1	0.7	2.0	20.0	6.62	0.0	90.0	1.8	95.1
Count	96	94	96	96	94	90	89	45	96	95	90	90	90
								*Geo. Mean					

Black Rock Retreat Wastewater Plant Final Effluent Test Results



Appendix B – Effluent Flow Records

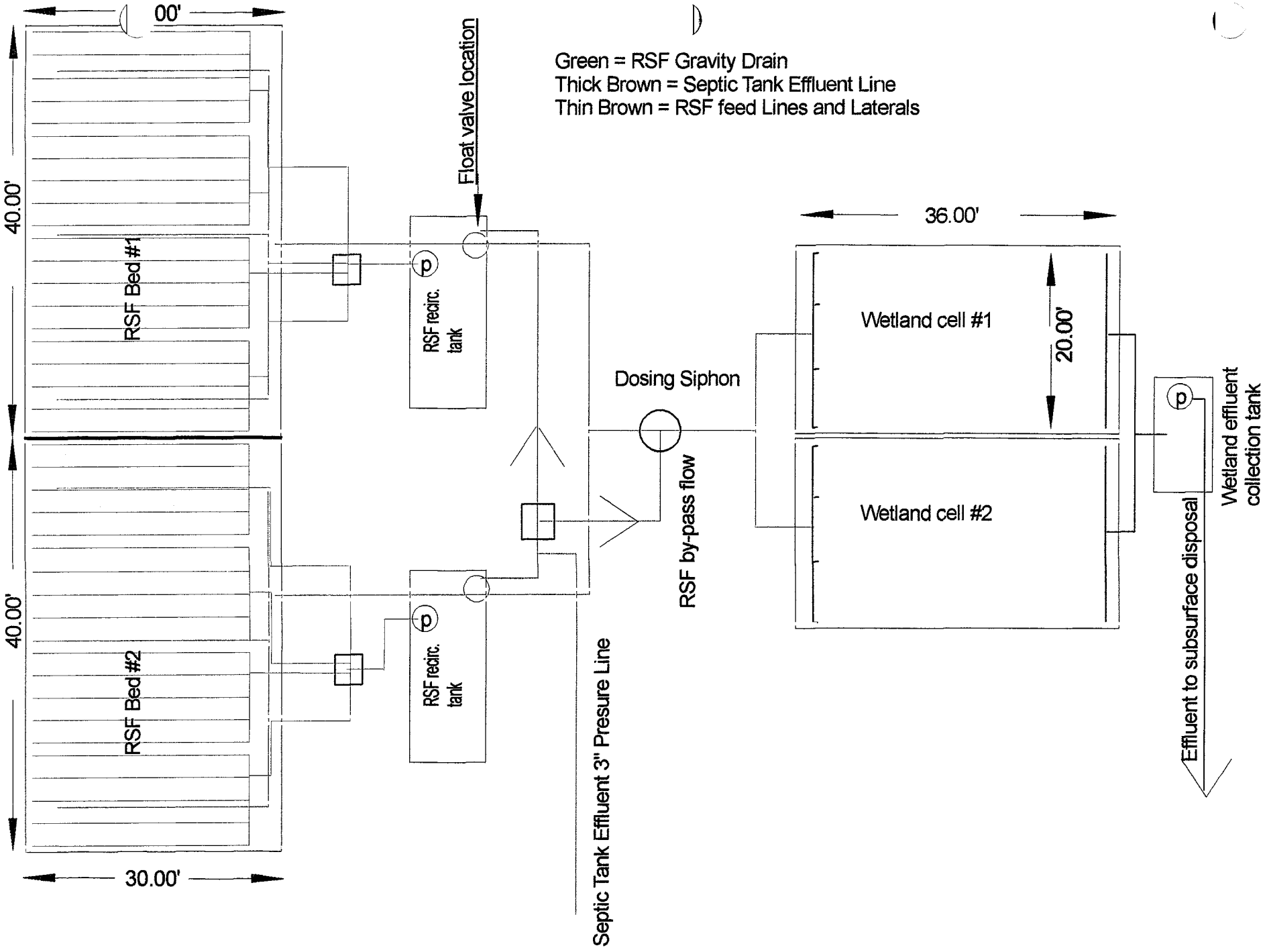
Daily Wetland Effluent Flow Record for Black Rock Retreat

	Jan. '02	Feb. '02	Mar. '02	Apr. '02	May '02	June '02	July '02	Aug. '02	Sep. '02	Oct. '02	Nov. '02	Dec. '02
1	0	6228	6070	2620	5145	6617	2853	8830	6565	1095	4490	2313
2	0	12052	13500	3090	4145	11410	4602	7795	11043	1095	6100	0
3	0	4700	6225	4080	4230	2164	4985	6400	3257	1090	10150	1165
4	3933	1020	0	2135	5570	1075	5685	8780	1090	1095	2350	0
5	4955	0	1035	3120	9300	0	6875	3262	1080	3385	0	1165
6	3925	970	6355	7425	4200	1069	5725	5388	0	7563	2220	1160
7	995	995	12835	7875	2100	13337	3800	4310	1080	2202	2345	7180
8	1960	5013	9400	2065	2080	8000	3966	4290	6570	2195	4545	8345
9	1960	5013	8400	0	4210	1903	6741	3510	3250	4395	3675	2315
10	1955	5013	5085	1640	3170	1904	7853	7215	5380	4400	6100	2315
11	4997	1035	2035	1435	4230	6758	6785	6455	3230	7860	3060	4765
12	8037	1010	2035	1035	7470	1815	6850	4310	3250	7500	3415	6755
13	2953	980	2025	5257	4320	1062	4635	4290	3235	5400	6815	3310
14	978	0	2050	9497	3924	2892	5791	1940	5380	2250	6010	5258
15	995	3720	3061	4151	1077	4866	2829	1150	7575	2200	6885	1470
16	965	7280	5092	3045	1099	4520	3799	2830	5415	3395	7305	0
17	1000	2975	4072	2045	989	2190	2851	4250	4325	4410	10410	1157
18	2925	915	5645	1030	5933	1932	3854	4995	3240	3315	4645	1160
19	5870	95	5715	2040	5443	3847	5784	1025	3255	5560	1255	0
20	2940	985	7365	5290	2198	4011	6431	4100	3215	7795	2200	2325
21	2935	3005	5126	7159	2222	7600	4881	8150	5385	4435	1158	4610
22	1970	4505	5247	4036	3192	5100	6195	6615	8617	4400	3442	4620
23	2000	7780	9000	3120	100	5850	7930	6424	2168	4380	7450	1149
24	995	2910	2560	3080	84	3876	9325	4816	2105	3470	12100	2330
25	4795	3055	1040	4100	4679	3890	8140	2616	1135	4235	2335	3665
26	4795	2965	2060	3000	10774	3908	7966	2552	2155	8695	1165	3665
27	4795	3985	1020	5137	11818	2915	6979	2552	7785	8412	1160	9560
28	1030	1975	3075	9801	4691	3861	7938	5360	5770	3333	1170	12155
29	0		9600	4112	4543	3865	6026	9482	8850	1110	9790	5815
30	1000		5625	5160	2199	5710	9375	8565	3285	3350	1777	2350
31	970		2620		1077		9551	3210		4480		4010
Total	**76628**	**90179**	**154973**	**117580**	**126212**	**127947**	**187000**	**155467**	**128690**	**128500**	**135522**	**106087**
Ave.	**2472**	**3221**	**4999**	**3919**	**4071**	**4265**	**6032**	**5015**	**4290**	**4145**	**4517**	**3422**

Daily Wetland Effluent Flow Record for Black Rock Retreat

	Jan. '03	Feb. '03	Mar. '03	Apr. '03	May '03	June '03	July '03	Aug. '03	Sep. '03	Oct. '03
1	5330	4885	3704	2515	5010	5995	4605	8180	5060	13615
2	2320	10894	10034	3780	6215	1945	5730	6251	5113	3905
3	1175	2361	3717	3770	1245	500	8150	9734	7309	2545
4	10465	2355	2945	1355	10413	4060	8165	9595	4958	8135
5	5510	1085	4890	7855	3727	3550	9345	10100	5970	4980
6	2330	1290	4915	2382	5030	1130	10110	10510	4475	6850
7	0	0	2465	2382	5820	6060	7815	5530	2687	9640
8	1170	4235	7700	6325	4070	11620	9310	5530	3321	4980
9	0	7678	11740	5950	5110	3690	9405	7930	5865	4950
10	1185	4762	2955	5480	6270	2390	8700	12790	6270	4940
11	4805	1205	2470	5205	7390	1165	9850	6650	3757	4730
12	8385	0	1220	9172	2435	0	7060	5767	2808	2675
13	3240	1190	7920	9123	1230	1195	8200	2293	575	6435
14	1170	2385	14730	1300	3960	2450	4630	1150	266	10100
15	0	6025	6368	2550	3280	8306	3685	1125	372	11192
16	75	4760	8932	0	6075	2390	3225	6935	5589	8800
17	2330	2380	5010	1255	8340	2339	4250	11690	7012	2973
18	5855	3585	3730	2225	2320	5855	6610	5665	1469	1980
19	5400	1185	3725	6720	1280	5765	7510	5665	6439	6960
20	2735	4030	4950	8993	0	7205	6550	10845	7550	3000
21	2290	4260	9505	2507	2440	12605	6005	11300	8002	4863
22	2315	12300	7795	1250	1060	7240	6705	11200	6951	980
23	1162	14700	11814	2500	1240	4700	7930	10070	5311	9015
24	1158	3655	3741	1240	1140	5795	7190	12000	6538	3967
25	7137	3650	3790	1245	10575	3480	6245	2480	668	1931
26	3445	3645	1250	6330	3415	4625	6251	1300	680	1959
27	1160	2435	3705	10365	0	7185	7309	1300	760	5960
28	2315	3645	2485	5000	2270	11040	3840	1200	430	7080
29	1163		6475	6260	2310	9370	9975	2555	581	2926
30	0		10365	7520	3685	2285	8795	0	225	2974
31	1167		2775		3685		8315	10365	6275	
Total	**86792**	**114580**	**177820**	**132554**	**121040**	**145935**	**221465**	**207705**	**123286**	**165040**
Ave.	**2800**	**4092**	**5736**	**4418**	**3905**	**4865**	**7144**	**6700**	**3977**	**5501**
Max.	**10465**	**14700**	**14730**	**10365**	**10575**	**12605**	**10110**	**12790**	**8002**	**13615**
Std. dev.	**2629**	**3525**	**3461**	**2937**	**2764**	**3357**	**1956**	**3986**	**2679**	**3117**

Appendix C – Treatment System Block Diagram



Plan view of Musser's Market wastewater treatmtent system (not to scale).

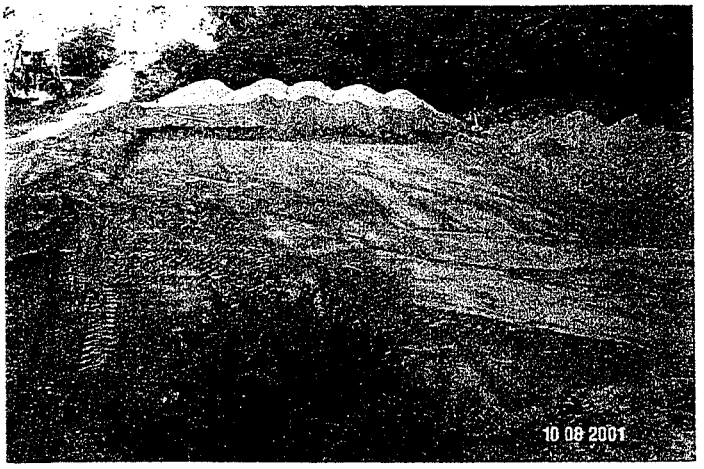
Appendix D – Musser's Market Analytical Results

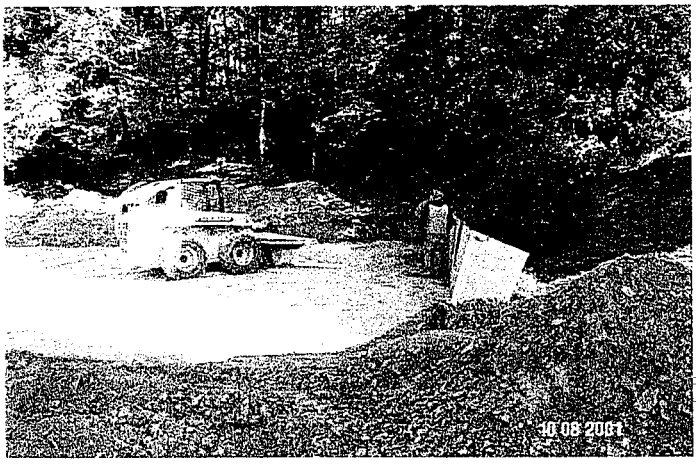
Musser's Market WWTP Influent and Effluent Sample Results

	Final effluent sample results (all tests by EPA approved laboratory)									
Date	NH3-N	TKN	NO3-N	NO2-N	N-Total	CBOD5	SS	pH	T (deg. C)	Fecal Col.
8/8/02	3.6	4.4				1.0	1.5	7.03		
8/26/02	1.0	2.1	6.0	0.2	8.3			7.43		0
8/28/02	1.0	1.5	6.8	0.1	8.4			7.66		
9/3/02	1.0	1.8	4.6	0.0	6.41	1.0	19.0	7.58		0
9/9/02	1.0	2.1	4.6	0.0	6.73			7.57	20.8	
10/1/02	1.0	1.7	4.2	0.0	5.95	1.0	7.0	7.40	21.4	1
10/7/02	1.0	1.0	4.2	0.0	5.20			7.63	19.9	
11/01/02	0.2	1.0	1.1	0.0	2.08	9.8	4.0	7.54	13.0	1
11/07/02	0.1	1.2	4.3	0.0	5.48			7.41		
12/3/02	0.3	1.6	12.2	0.0	13.78	1.0	4.0	7.75		0
12/16/02	1.7	7.0	4.5	2.0	13.59			7.70	6.0	
1/2/03	2.5	4.5	15.0	0.2	19.66	16.0	5.0	7.52	5.7	710
1/8/03	1.0	4.8	15.0	0.1	19.86			7.36		
2/25/03	8.3	11.3	23.9	0.0	35.21	20.3	4.0	7.03		222
2/26/02	8.5	14.6	24.1	0.0	38.76					
3/18/03	9.3	10.1	7.4	1.0	18.48	15.8	22.0	7.10	6.0	44
3/26/03	8.0	11.5	8.8	0.0	20.30			7.05		
4/9/03	6.4	8.9	2.1	0.4	11.50	9.5	1.0	6.95		0
4/14/03	2.2	5.1	8.8	0.4	14.28			6.97		
5/14/03	1.0	1.4	4.6	1.1	7.09	26.3	8.0	6.95		9
5/21/03	1.0	2.8	6.7	0.0	9.49			7.00		
6/5/03	1.0	1.0	5.6	0.2	6.80	6.0	2.0			21
6/12/03	0.2	2.2	9.0	0.2	11.34					
7/2/03	0.4	3.7	7.2	0.1	10.97	2.0	4.0			3
7/9/03	1.0	2.1	6.1	0.1	8.29					
8/7/03	1.0	1.9	5.0	0.0	6.90	1.0	1.0	6.88		7
8/14/03	1.0	2.3	5.1	0.2	7.58					
9/4/03	0.4	2.5	3.9	0.2	6.52	1.0	<1	6.89		14
9/11/03	<1	1.3	6.3	0.1	7.77					
10/9/03	<1	1.0	3.0	0.1	4.13	16.0	3.0			17
10/16/03					0.00					
Ave.	2.3	4.0	7.6	0.2	11.8	9.0	6.5	7.30	13.3	*7.2
Note: Started methanol feed 8/1/03										*Geo. Mean

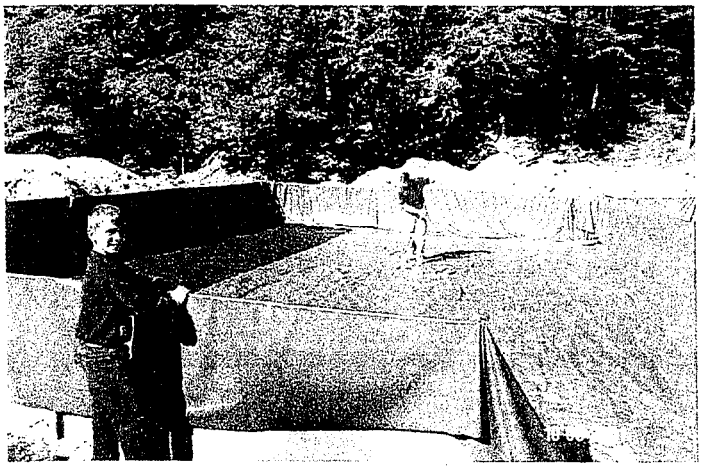
	RSF influent sample results (all tests by EPA approved laboratory)									
Date	NH3-N	TKN	NO3-N	NO2-N	N-Total	CBOD5	SS	pH	T (deg. C)	
8/8/02	74.1	97.2			97.2	761.5	80.0			
8/26/02	58.6	72.9	0.9	0.1	73.9					
9/03/02	55.3	75.9	0.5	0.0	76.5	583.0	128.0	6.50	23.8	
10/01/02	67.1	67.1	4.5	0.0	71.7	788.0	130.0	6.33	22.5	
11/1/02	31.7	40.0	4.8	0.0	44.9	630.2	88.0	6.55	16.5	
12/3/02	74.2	94.1	0.7	0.1	94.9	649.5	76.0	6.95	12.7	
1/2/03	64.7	102.0	0.2	0.5	102.7	634.0	170.0	7.00	9.8	
2/25/03	63.9	74.2	1.2	0.0	75.4	670.0	120.0			
3/18/03	68.3	87.2	1.0	0.0	88.2	680.0	169.9	6.00	14.2	
4/9/03	26.0	39.8	0.5	0.1	40.3	230.0	68.0	6.35	10.8	
5/14/03	74.5	78.5	1.0	0.1	79.6	675.0	118.0			
6/05/03	72.5	78.4	0.1	0.1	78.6	845.0	158.0			
7/2/03	60.7	81.4	1.2	0.0	82.5	748.0	122.0			
8/7/03	47.4	82.7	0.8	0.0	83.5	601.0	142.0			
9/4/03	68.4	85.1	2.4	0.0	87.5	586.4	138.0			
10/9/03	72.7	85.9	1.2	0.0	87.1	571.0	86.0			

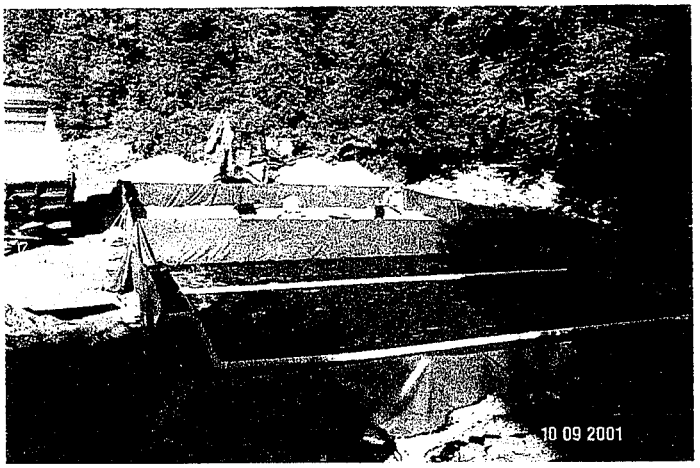
Appendix E – Construction Photographs

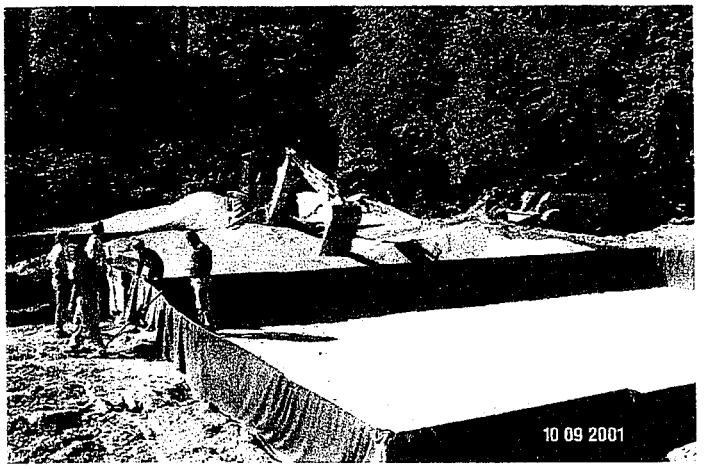

10 08 2001

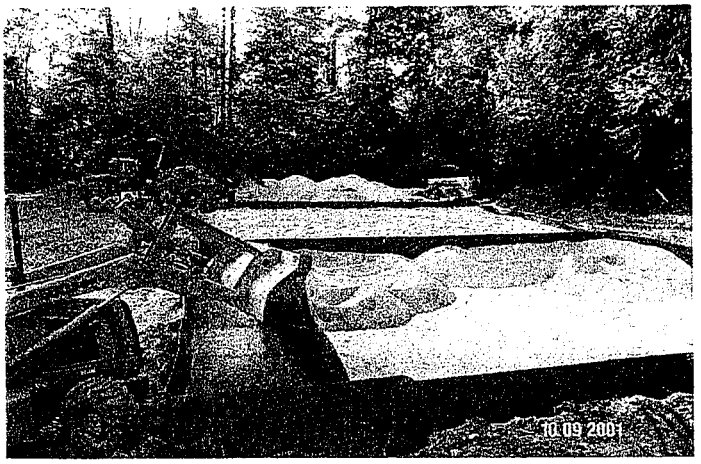

10 08 2001

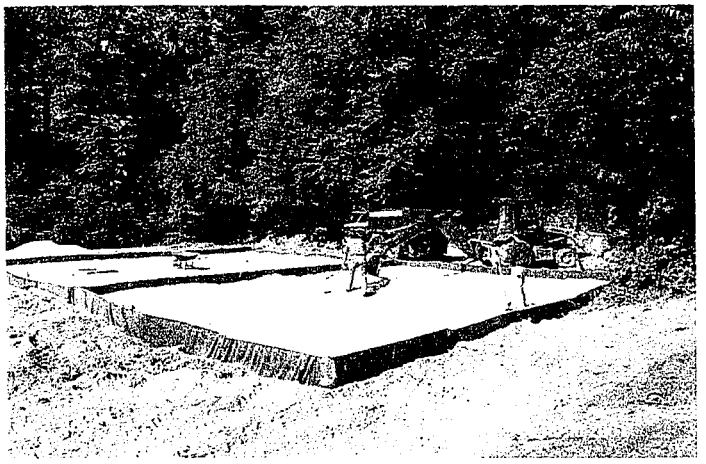

10 08 2001

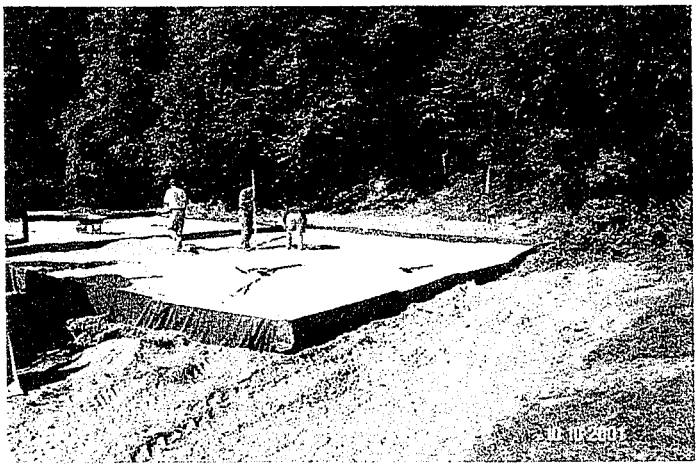


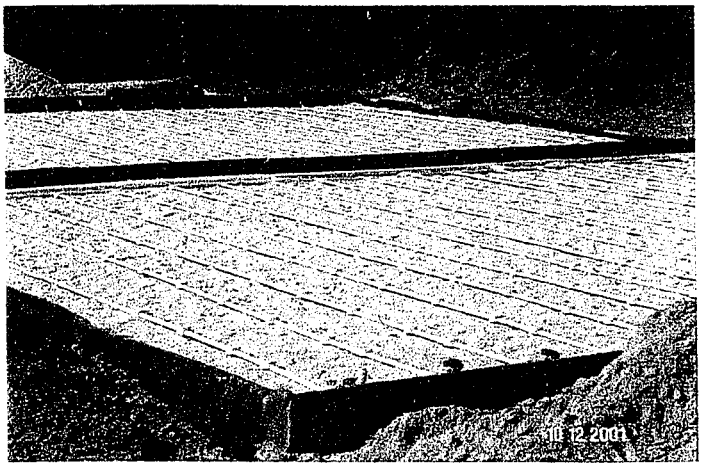

10 09 2001


10 09 2001


10 09 2001




10 10 2001


10 12 2001

Appendix F – Small Flows Quarterly Article