

## APPENDIX 1

Secondary Effluent Treatment Train:  
Overall system influent and effluent nitrogen and COD raw data and mass balances

### Nitrogen Raw Data

Date	Influent Nitrogen Concentrations				Effluent Nitrogen Concentrations			
	NO3+NO2	NO2	NHx	TN	NO3+NO2	NO2	NHx	TN
	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L
19-May-97								
20-May-97	3.3	0.6	27.2	64.2	19.4	0.9	18.5	37.7
21-May-97								
22-May-97	3.5	0.5	41.6	50.2	20.1	0.6	19.3	43.7
23-May-97								
24-May-97								
25-May-97								
26-May-97								
27-May-97	4.0	0.5	40.0	45.3	20.5	0.0	0.0	23.5
28-May-97								
29-May-97	3.4	0.5	43.9	54.0	25.0	0.0	0.7	28.1
30-May-97	2.9	0.3	38.9	45.3	19.1	0.0	0.0	21.5
31-May-97								
1-Jun-97	3.3	0.3	36.4	41.4				
2-Jun-97								
3-Jun-97	2.9	0.4	34.9	40.6	0.6	0.3	0.0	2.6
4-Jun-97								
5-Jun-97								
6-Jun-97	2.7	0.2	28.9	38.1	1.8	0.5	0.0	3.6
7-Jun-97								
8-Jun-97	3.2	0.3	35.6	39.5				
9-Jun-97								
10-Jun-97	2.9	0.2	32.1	35.5	1.8	0.7	10.5	12.3
11-Jun-97								
12-Jun-97	2.9	0.3	36.3	44.2	0.3	0.2	0.2	1.3
13-Jun-97	2.4	0.2	33.2	51.8	0.8	0.5	0.0	3.2
14-Jun-97								
15-Jun-97								
16-Jun-97	2.5	0.3	24.5	29.6				
17-Jun-97	3.0	0.3	25.0	30.8	3.5	0.3	0.0	5.2
18-Jun-97	2.6	0.3	30.1	37.8	0.8	0.5	10.5	13.1
19-Jun-97	3.2	0.4	31.3	43.3	0.4	0.3	17.1	18.9
20-Jun-97	2.9	0.4	28.9	30.7	0.9	0.6	8.9	11.0
21-Jun-97								
22-Jun-97								
23-Jun-97	3.3	0.5	30.3	40.8	0.0	0.0	24.5	24.4
24-Jun-97	3.0	0.6	26.0	29.1	0.0	0.0	19.7	19.7
25-Jun-97	2.9	0.7	24.3	27.5	1.1	0.5	9.0	11.8
26-Jun-97								
27-Jun-97	2.4	0.6	22.1	24.4	0?	0?	0?	1.3?
28-Jun-97								
29-Jun-97								
30-Jun-97	4.6	1.6	57.2	66.9	0.7	0.4	1.4	3.3
1-Jul-97	5.0	2.0	57.6	66.3	1.2	0.3	0.0	2.9
2-Jul-97								
3-Jul-97	4.5	1.4	37.1	46.6	0.0	0.0	0.0	1.3
4-Jul-97								

Table Continued

5-Jul-97								
6-Jul-97								
7-Jul-97	8.2	3.6	27.3	40.5	0.2	0.0	0.0	1.1
8-Jul-97	8.4	4.2	28.6	46.9	0.0	0.0	0.0	0.0
9-Jul-97	10.9	5.7	33.4	52.2	1.7	0.0	0.0	3.2
10-Jul-97	12.3	5.7	40.6	58.4	1.6	0.0	0.0	2.5
11-Jul-97	8.1	3.6	27.6	41.3	0.0	0.0	0.0	0.8
12-Jul-97								
13-Jul-97								
14-Jul-97	10.4	3.5	29.3	46.2	0.0	0.0	0.0	0.8
15-Jul-97	5.8	1.4	28.3	39.6	0.0	0.0	0.0	1.1
16-Jul-97	7.0	2.1	33.6	45.5	0.0	0.0	0.0	1.0
17-Jul-97	7.2	2.4	30.8	39.3	2.8	0.5	29.0	30.3
18-Jul-97	3.8	1.2	32.0	31.7	0.2	0.2	24.9	27.4
19-Jul-97								
20-Jul-97								
21-Jul-97	11.2	3.6	32.0	44.9				
22-Jul-97	9.7	2.8	32.9	45.1	2.0	1.4	0.0	2.8
23-Jul-97								
24-Jul-97	8.2	2.0	27.9	32.6	0.0	0.0	0.0	0.9
25-Jul-97	9.1	1.7	26.2	31.5	0.1	0.0	0.0	0.9
26-Jul-97								
27-Jul-97								
28-Jul-97	10.2	2.9	31.5	43.2	0.0	0.0	0.0	0.9
29-Jul-97	10.7	2.2	34.5	46.9	0.0	0.0	0.0	1.0
30-Jul-97	11.1	2.1	40.3	54.6	0.0	0.0	0.0	1.0
31-Jul-97	12.0	1.9	50.8	64.2	0.0	0.0	0.0	0.9
1-Aug-97	9.2	2.3	43.8	58.9	0.8	0.2	0.0	1.7
2-Aug-97								
3-Aug-97								
4-Aug-97								
5-Aug-97	12.4	6.6	42.0	68.8	5.1	1.5	3.1	9.4
6-Aug-97								
7-Aug-97	10.6	5.5	31.8	49.5	1.9	0.5	0.0	4.0
8-Aug-97								
9-Aug-97								
10-Aug-97								
11-Aug-97	8.8	4.8	26.7	32.8	0.0	0.0	0.0	1.3
12-Aug-97	5.4	3.3	30.9	41.3	0.5	0.0	0.0	1.3
13-Aug-97	3.7	1.4	27.8	33.5	0.0	0.0	0.0	1.1
14-Aug-97	2.1	1.5	28.1	28.7	0.0	0.0	0.0	0.7
15-Aug-97	?	0.8	29.8	33.2	?	0.0	0.0	0.0
16-Aug-97								
17-Aug-97								
18-Aug-97	9.4	4.2	31.2	39.0	3.3	0.4	0.1	4.1
19-Aug-97	5.8	3.2	34.6	37.5	0.6	0.0	0.0	1.7
20-Aug-97	3.2	2.0	30.7	40.4	0.0	0.0	0.0	0.8
21-Aug-97	2.3	1.4	29.9	37.1	0.0	0.0	0.0	1.1
22-Aug-97	2.4	1.4	26.8	35.5	0.0	0.0	0.0	1.1
23-Aug-97								
24-Aug-97								

Table Continued

25-Aug-97	?	?	?	?	?	?	?	?
26-Aug-97	3.8	2.2	25.9	33.3	0.3	0.1	0.0	1.3
27-Aug-97	3.1	2.1	27.2	35.8	0.0	0.0	0.0	1.5
28-Aug-97	1.3	1.0	26.1	32.0	0.0	0.0	6.1	7.3
29-Aug-97	6.2	3.1	26.3	38.1	0.0	0.0	12.0	12.6
30-Aug-97								
31-Aug-97								
1-Sep-97								
2-Sep-97	5.5	3.2	24.1	30.0	0.0	0.0	14.5	14.1
3-Sep-97	5.3	3.1	28.3	35.5	0.0	0.0	19.7	18.3
4-Sep-97	4.1	2.8	39.1	45.8	0.0	0.0	25.5	25.7
5-Sep-97	3.7	1.8	?	35.7	0.0	0.0	?	19.3
6-Sep-97								
7-Sep-97								
8-Sep-97	6.8	4.1	25.4	33.1	0.2	0.0	19.3	17.9
9-Sep-97	6.2	3.3	23.4	31.9	0.0	0.0	20.1	18.2
10-Sep-97	7.3	2.9	25.2	36.4	0.0	0.0	21.5	20.4
11-Sep-97	?	?	?	?	0.0	0.0	16.5	17.2
12-Sep-97	1.4	0.8	22.9	26.9	0.0	0.0	15.7	15.6

### COD Raw Data

Date	Influent COD mg/L	Effluent COD mg/L	Methanol stock solution mL/L	Methanol concentration mg/L	Methanol Theoretical COD mg/L
19-May-97			2	1583	2374
20-May-97	147	103	2	1583	2374
21-May-97			2	1583	2374
22-May-97			2	1583	2374
23-May-97			2	1583	2374
24-May-97			2	1583	2374
25-May-97			2	1583	2374
26-May-97			2	1583	2374
27-May-97	138	179	2	1583	2374
28-May-97			2	1583	2374
29-May-97	139	105	8	6331	9497
30-May-97	158	280?	8	6331	9497
31-May-97			8	6331	9497
1-Jun-97			8	6331	9497
2-Jun-97			8	6331	9497
3-Jun-97	151	288	8	6331	9497
4-Jun-97			8	6331	9497
5-Jun-97	132	293	6	4748	7123
6-Jun-97	128	213	6	4748	7123
7-Jun-97			6	4748	7123
8-Jun-97			6	4748	7123
9-Jun-97			6	4748	7123
10-Jun-97	132	202	6	4748	7123
11-Jun-97			6	4748	7123
12-Jun-97	158?	67	6	4748	7123
13-Jun-97	238	105	6	4748	7123
14-Jun-97			5	3957	5936
15-Jun-97			5	3957	5936
16-Jun-97	203		5	3957	5936
17-Jun-97	184	72	5	3957	5936
18-Jun-97	224	154	5	3957	5936
19-Jun-97	236	176	5	3957	5936
20-Jun-97	280	137	5	3957	5936
21-Jun-97			5	3957	5936
22-Jun-97			5	3957	5936
23-Jun-97	280	106	5	3957	5936
24-Jun-97	232	64	5	3957	5936
25-Jun-97	252	49	5	3957	5936
26-Jun-97			5	3957	5936
27-Jun-97	229	70	5	3957	5936
28-Jun-97			5	3957	5936
29-Jun-97			5	3957	5936
30-Jun-97			5	3957	5936
1-Jul-97	382	71	5	3957	5936
2-Jul-97			5	3957	5936
3-Jul-97	201	52	5	3957	5936
4-Jul-97			5	3957	5936

Table Continued

5-Jul-97			5	3957	5936
6-Jul-97			5	3957	5936
7-Jul-97	205	54	5	3957	5936
8-Jul-97	394	54	5	3957	5936
9-Jul-97	378	81	5	3957	5936
10-Jul-97	208	48	5	3957	5936
11-Jul-97	243	46	5	3957	5936
12-Jul-97	147	65	5	3957	5936
13-Jul-97			5	3957	5936
14-Jul-97	147	55	5	3957	5936
15-Jul-97	160	77	5	3957	5936
16-Jul-97	154	62	5	3957	5936
17-Jul-97	252	396	5	3957	5936
18-Jul-97	154	135	5	3957	5936
19-Jul-97			5	3957	5936
20-Jul-97			5	3957	5936
21-Jul-97			5	3957	5936
22-Jul-97	147	40	5	3957	5936
23-Jul-97			5	3957	5936
24-Jul-97	123	38	5	3957	5936
25-Jul-97	226	42	5	3957	5936
26-Jul-97			5	3957	5936
27-Jul-97			5	3957	5936
28-Jul-97			5	3957	5936
29-Jul-97	119	40	5	3957	5936
30-Jul-97	131	58	5	3957	5936
31-Jul-97			5	3957	5936
1-Aug-97	174	50	5	3957	5936
2-Aug-97			5	3957	5936
3-Aug-97			5	3957	5936
4-Aug-97			5	3957	5936
5-Aug-97	149	104	5	3957	5936
6-Aug-97			5	3957	5936
7-Aug-97	136	60	5	3957	5936
8-Aug-97			5	3957	5936
9-Aug-97			5	3957	5936
10-Aug-97			5	3957	5936
11-Aug-97	80	37	5	3957	5936
12-Aug-97	92	39	5	3957	5936
13-Aug-97	102	43	5	3957	5936
14-Aug-97	99	44	5	3957	5936
15-Aug-97	171	62	5	3957	5936
16-Aug-97			5	3957	5936
17-Aug-97			5	3957	5936
18-Aug-97	163	68	5	3957	5936
19-Aug-97	214	54	5	3957	5936
20-Aug-97	235	50	5	3957	5936
21-Aug-97	180	54	5	3957	5936
22-Aug-97	176	49	5	3957	5936
23-Aug-97			5	3957	5936
24-Aug-97			5	3957	5936

Table Continued

25-Aug-97	234	106	5	3957	5936
26-Aug-97	185	84	5	3957	5936
27-Aug-97	?	50	5	3957	5936
28-Aug-97	197	82	5	3957	5936
29-Aug-97	172	60	5	3957	5936
30-Aug-97			5	3957	5936
31-Aug-97			5	3957	5936
1-Sep-97			5	3957	5936
2-Sep-97	143	61	5	3957	5936
3-Sep-97	124	56	5	3957	5936
4-Sep-97	119	61	5	3957	5936
5-Sep-97	125	78	5	3957	5936
6-Sep-97			5	3957	5936
7-Sep-97			5	3957	5936
8-Sep-97	122	108	5	3957	5936
9-Sep-97	120	171	5	3957	5936
10-Sep-97	98	84	5	3957	5936
11-Sep-97	114	89	5	3957	5936
12-Sep-97	133	215	5	3957	5936

### Nitrogen Mass Balances

Date	Influent NO3+NO2 mg/day	Influent NHx mg/day	Influent "TKN" mg/day	Effluent NO3+NO2 mg/day	Effluent NH4 mg/day	Effluent "SKN" mg/day	Bioavailable "TKN" mg-N/day	MLVSS mg/L	Aerobic biomass mg	VSS growth mgVSS/day	Specific growth rate mgVSS/mgMLVSS-day
20-May-97	333	2742	6139	1956	1865	1865					
22-May-97	348	4133	4636	1997	1918	2345					
27-May-97	409	4090	4223	2096	0	310					
29-May-97	356	4619	5318	2625	74	329					
30-May-97	301	3974	4334	1953	0	249					
1-Jun-97	332	3668	3845	0	0	0					
3-Jun-97	301	3569	3846	58	0	211	3635	1607	28917	8227	#DIV/0!
5-Jun-97	0	0	0	0	0	0	0	2190	39420	11375	0.170
6-Jun-97	269	2917	3570	181	0	179	3392	2600	46800	13239	0.166
8-Jun-97	314	3539	3610	0	0	0	3610	1573	28305	8099	#DIV/0!
10-Jun-97	299	3280	3331	189	1075	1075	3331	1840	33120	9405	0.167
12-Jun-97	300	3766	4283	28	18	102	4199	1585	28530	8084	0.167
13-Jun-97	253	3536	5267	85	0	258	5009	1280	23040	6538	0.167
16-Jun-97	260	2570	2850	0	0	0	2850	1710	30780	8775	0.168
17-Jun-97	302	2523	2801	354	0	174	2627	1113	20034	5678	0.167
18-Jun-97	262	2993	3492	81	1045	1223	3314	980	17640	5080	0.169
19-Jun-97	318	3108	3982	43	1698	1833	3847	1330	23940	5743	0.141
20-Jun-97	286	2875	2875	93	881	1003	2754	1860	33480	2534	0.045
23-Jun-97	320	2971	3679	0	2403	2403	3679	2540	45720	11157	0.144
24-Jun-97	293	2543	2561	0	1928	1931	2558	1960	35280	2297	0.038
25-Jun-97	295	2484	2516	116	916	1086	2346	2620	47160	1399	0.017
27-Jun-97	234	2181	2181	#VALUE!	#VALUE!	#VALUE!	#VALUE!	2120	38160	3832	0.059
30-Jun-97	473	5925	6461	68	144	277	6329	4100	73800	20843	0.166
1-Jul-97	519	5971	6357	127	0	177	6179	3740	67320	19049	0.166
3-Jul-97	443	3685	4187	0	0	128	4059	3430	61740	17573	0.167
7-Jul-97	824	2756	3256	21	0	88	3168	3180	57240	16182	0.166
8-Jul-97	842	2880	3889	0	0	0	3889	2840	51120	14601	0.168
9-Jul-97	1083	3323	4103	168	0	149	3953	3400	61200	17338	0.167
10-Jul-97	1226	4033	4580	164	0	88	4493	2820	50760	14235	0.165
11-Jul-97	811	2780	3356	0	0	85	3271	2900	52200	14851	0.167
14-Jul-97	1052	2951	3600	0	0	79	3521	2340	42120	8819	0.123
15-Jul-97	869	4285	5111	0	0	171	4940	2720	48960	13818	0.166
16-Jul-97	1045	5032	5775	0	0	154	5620	2340	42120	12008	0.168
17-Jul-97	1126	4784	4988	438	4507	4507	4988	1720	30960	2115	0.040
18-Jul-97	575	4844	4844	34	3766	4103	4508	1780	32040	1362	0.025
21-Jul-97	1666	4740	4991	0	0	0	4991	3410	61380	17275	0.166
22-Jul-97	1428	4829	5195	295	0	119	5076	3130	56340	15948	0.167

Table Continued

24-Jul-97	1225	4171	4171	0	0	133	4038	3030	54540	15585	0.168
25-Jul-97	1383	3993	3993	9	0	130	3863	2990	53820	15180	0.166
28-Jul-97	1591	4897	5120	0	0	134	4986	3470	62460	23028	0.217
29-Jul-97	1658	5369	5636	0	0	159	5477	2560	46080	12974	0.166
30-Jul-97	1627	5913	6390	0	0	140	6250	2580	46440	13258	0.168
31-Jul-97	1835	7754	7966	0	0	143	7822	2640	47520	13071	0.162
1-Aug-97	1425	6815	7739	130	0	140	7598	2720	48960	13656	0.164
5-Aug-97	2366	7976	10713	965	587	826	10475	2260	40680	10790	0.156
7-Aug-97	1978	5945	7296	347	0	406	6890	2340	42120	11615	0.162
11-Aug-97	1640	4996	4996	0	0	245	4751	2470	44460	12215	0.162
12-Aug-97	1018	5788	6711	93	0	157	6554	2240	40320	12450	0.182
13-Aug-97	696	5197	5575	0	0	198	5376	2100	37800	19886	0.309
14-Aug-97	400	5251	5251	0	0	131	5120	2260	40680	11122	0.161
15-Aug-97	#VALUE!	5584	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	2740	49320	13921	0.166
18-Aug-97	1754	5833	5833	619	22	154	5702	2200	39600	11847	0.176
19-Aug-97	1065	6383	6383	117	0	198	6185	2940	52920	14787	0.164
20-Aug-97	588	5659	6860	8	0	139	6721	3070	55260	15582	0.166
21-Aug-97	428	5506	6412	0	0	203	6210	2800	50400	14266	0.167
22-Aug-97	443	5008	6206	0	0	212	5994	2820	50760	14359	0.166
25-Aug-97	1408	4686	6093	17	0	0	6093	3420	61560	17291	0.165
26-Aug-97	717	4925	5605	57	0	195	5410	2850	51300	17508	0.201
27-Aug-97	583	5176	6222	0	0	278	5945	2230	40140	11072	0.162
28-Aug-97	239	4880	5759	0	1140	1365	5535	1950	35100	6502	0.109
29-Aug-97	1166	4929	5959	0	2239	2362	5836	2270	40860	11419	0.164
2-Sep-97	1014	4469	4562	0	2692	2692	4562	2720	48960	13675	0.164
3-Sep-97	993	5298	5647	0	3688	3688	5647	2420	43560	12032	0.162
4-Sep-97	763	7212	7678	0	4700	4744	7634	1870	33660	9491	0.166
5-Sep-97	687	5431	5994	0	3448	3619	5824	1590	28620	7825	0.161
8-Sep-97	1277	4746	4919	39	3620	3620	4919	493	8874	1973	0.131
9-Sep-97	1151	4375	4822	0	3766	3766	4822	1610	28980	10072	0.204
10-Sep-97	1344	4643	5373	0	3956	3956	5373	1570	28260	12111	0.252
11-Sep-97	1031	4274	5008	0	3093	3218	4883	2540	45720	12790	0.165
12-Sep-97	254	4261	4744	0	2920	2920	4744	2280	41040	3979	0.057

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	mg-N growth	TKN oxidized	Overall observed	Overall observed	Nitrification	Denitrification
	(12% of VSS growth)	mg-N/day	Specific Nfication rate mgTKN/mgVSS/day	Specific DeNfication rate mgNOx/mgVSS/day	F:M mgTKN/mg Aerobic-VSS/day	F:M mgTKN/mg Anoxic-VSS/day
20-May-97						
22-May-97						
27-May-97						
29-May-97						
30-May-97						
1-Jun-97						
3-Jun-97	987	2648	0.092	0.221		
5-Jun-97	1365	-1365	-0.035	-0.076		
6-Jun-97	1589	1803	0.039	0.089		
8-Jun-97	972	2638	0.093	0.230		
10-Jun-97	1129	1128	0.034	0.082		
12-Jun-97	970	3211	0.113	0.269	0.15	0.32
13-Jun-97	785	4224	0.183	0.421	0.23	0.48
16-Jun-97	1053	1797	0.058	0.147	0.09	0.20
17-Jun-97	681	1946	0.097	0.208	0.14	0.30
18-Jun-97	610	1659	0.094	0.230	0.20	0.42
19-Jun-97	689	1460	0.061	0.160	0.17	0.35
20-Jun-97	304	1569	0.047	0.116	0.09	0.18
23-Jun-97	1339	-63	-0.001	0.012	0.08	0.17
24-Jun-97	276	354	0.010	0.040	0.07	0.15
25-Jun-97	168	1262	0.027	0.067	0.05	0.11
27-Jun-97	460	#VALUE!	#VALUE!	#VALUE!	0.06	0.12
30-Jun-97	2501	3684	0.050	0.122	0.09	0.19
1-Jul-97	2286	3893	0.058	0.140	0.09	0.20
3-Jul-97	2109	1950	0.032	0.086	0.07	0.14
7-Jul-97	1942	1226	0.021	0.078	0.06	0.12
8-Jul-97	1752	2137	0.042	0.129	0.08	0.16
9-Jul-97	2081	1873	0.031	0.100	0.07	0.14
10-Jul-97	1708	2785	0.055	0.167	0.09	0.19
11-Jul-97	1782	1489	0.029	0.097	0.06	0.14
14-Jul-97	1058	2463	0.058	0.184	0.09	0.18
15-Jul-97	1658	3282	0.067	0.187	0.10	0.22
16-Jul-97	1441	4180	0.099	0.274	0.14	0.29
17-Jul-97	254	227	0.007	0.065	0.16	0.34
18-Jul-97	163	578	0.018	0.077	0.15	0.32
21-Jul-97	2073	2918	0.048	0.165	0.08	0.17
22-Jul-97	1914	3162	0.056	0.168	0.09	0.20

Table Continued

24-Jul-97	1870	2167	0.040	0.137	0.08	0.16
25-Jul-97	1822	2041	0.038	0.140	0.07	0.16
28-Jul-97	2763	2223	0.036	0.135	0.08	0.17
29-Jul-97	1557	3921	0.085	0.267	0.12	0.26
30-Jul-97	1591	4660	0.100	0.299	0.14	0.29
31-Jul-97	1569	6254	0.132	0.375	0.17	0.35
1-Aug-97	1639	5960	0.122	0.327	0.16	0.33
5-Aug-97	1295	8593	0.211	0.542	0.26	0.56
7-Aug-97	1394	5497	0.131	0.373	0.17	0.37
11-Aug-97	1466	3285	0.074	0.244	0.11	0.24
12-Aug-97	1494	5060	0.125	0.327	0.17	0.35
13-Aug-97	2386	2990	0.079	0.215	0.15	0.31
14-Aug-97	1335	3785	0.093	0.227	0.13	0.27
15-Aug-97	1671	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
18-Aug-97	1422	4257	0.108	0.300	0.15	0.31
19-Aug-97	1774	4411	0.083	0.223	0.12	0.26
20-Aug-97	1870	4851	0.088	0.217	0.12	0.26
21-Aug-97	1712	4498	0.089	0.216	0.13	0.27
22-Aug-97	1723	4271	0.084	0.205	0.12	0.26
25-Aug-97	2075	4018	0.065	0.194	0.10	0.21
26-Aug-97	2101	3309	0.064	0.171	0.11	0.23
27-Aug-97	1329	4616	0.115	0.286	0.16	0.33
28-Aug-97	780	3614	0.103	0.242	0.16	0.35
29-Aug-97	1370	2227	0.054	0.183	0.15	0.31
2-Sep-97	1641	230	0.005	0.056	0.09	0.20
3-Sep-97	1444	515	0.012	0.076	0.13	0.27
4-Sep-97	1139	1795	0.053	0.168	0.23	0.48
5-Sep-97	939	1436	0.050	0.164	0.21	0.44
8-Sep-97	237	1062	0.120	0.572	0.55	1.17
9-Sep-97	1209	-153	-0.005	0.076	0.17	0.35
10-Sep-97	1453	-36	-0.001	0.102	0.19	0.40
11-Sep-97	1535	256	0.006	0.062	0.11	0.23
12-Sep-97	477	1347	0.033	0.086	0.12	0.24

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

**COD Mass Balances**

Date	Influent COD inf mg/day	Effluent COD eff mg/day	Methanol COD added mg/day	Bioavailable CODin/TKNin (C:N ratio) mgCOD/mgTKN-N
10-Jun-97	13496	20652	42052	10.5
12-Jun-97	16381	6947	42052	12.0
13-Jun-97	25361	11189	41539	10.6
16-Jun-97	21339	0	35043	19.8
17-Jun-97	18547	7258	34188	16.2
18-Jun-97	22257	15301	35043	12.0
19-Jun-97	23449	17487	34616	10.2
20-Jun-97	27821	13612	35043	17.1
23-Jun-97	27418	10380	34188	13.9
24-Jun-97	22717	6267	34188	19.8
25-Jun-97	25764	5010	32479	21.2
27-Jun-97	22589	6905	32479	22.1
1-Jul-97	39606	7361	34188	10.5
3-Jul-97	19971	5167	34616	11.8
7-Jul-97	20664	5443	34188	15.2
8-Jul-97	39715	5443	34188	17.6
9-Jul-97	37558	8048	35043	15.7
10-Jul-97	20667	4769	35043	11.1
11-Jul-97	24494	4637	35043	16.4
12-Jul-97	14818	6552	34188	no TKN data
14-Jul-97	14818	5544	35043	12.3
15-Jul-97	24192	11642	51283	12.5
16-Jul-97	23063	9285	50428	11.1
17-Jul-97	39191	61586	51283	5.8
18-Jul-97	23285	20412	51283	11.2
22-Jul-97	21591	5875	51283	12.9
24-Jul-97	18420	5691	50855	15.2
25-Jul-97	34497	6411	51283	19.9
29-Jul-97	18507	6221	51283	11.3
30-Jul-97	19241	8519	51283	9.7
1-Aug-97	27060	7776	52137	9.2
5-Aug-97	22743	15875	51283	5.4
7-Aug-97	25459	11232	52137	9.1
11-Aug-97	14976	6926	51283	11.9
12-Aug-97	17222	7301	52137	9.2
13-Aug-97	19094	8050	52137	11.3
14-Aug-97	18533	8237	52137	11.9
15-Aug-97	32011	11606	52565	#VALUE!
18-Aug-97	30514	12730	51283	11.8

Table Continued

19-Aug-97	39444	9953	51283	12.7
20-Aug-97	43315	9216	51283	12.4
21-Aug-97	33178	9953	52137	11.8
22-Aug-97	32947	9173	51283	12.1
25-Aug-97	43805	19843	49573	12.1
26-Aug-97	35165	15967	52992	12.9
27-Aug-97	#VALUE!	9504	51283	#VALUE!
28-Aug-97	36878	15350	49573	12.3
29-Aug-97	32198	11232	51283	12.1
2-Sep-97	26564	11331	51283	14.6
3-Sep-97	23213	10483	50428	11.2
4-Sep-97	21934	11244	50428	8.0
5-Sep-97	23400	14602	51283	10.0
8-Sep-97	22838	20218	51283	11.0
9-Sep-97	22464	32011	51283	8.7
10-Sep-97	18063	15483	51283	10.0
11-Sep-97	21341	16661	51283	11.2
12-Sep-97	24706	39938	54274	8.2

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

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**NOTE:** Indicates system upset.

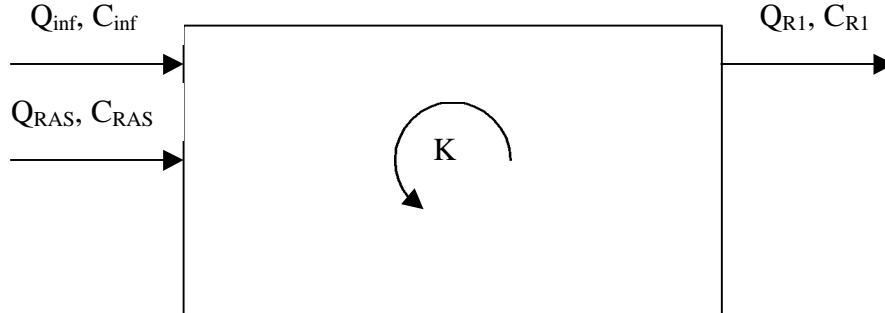
**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

## APPENDIX 2

Secondary Effluent Treatment Train:  
Main aerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Main Aerobic Reactor (R1) of the Secondary Effluent Treatment Train



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{R1}$  = Flow rate exiting the main aerobic reactor (R1) =  $Q_{inf} + Q_{RAS}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g., Nitrogen assimilation,  $NO_x$  production, COD consumption, etc.)

$$\text{Total loading to main aerobic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{RAS} \times C_{RAS})$$

$C_{in}$  = Concentration of the constituent of interest entering the main aerobic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{RAS}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{inf} + Q_{RAS}} \right)$$

$$C_{out} = C_{R1} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
29-May-97	29.1	1.2	2.6	33.6	100
5-Jun-97					60
12-Jun-97	21.0	0.8	0.0	24.8	57
17-Jun-97	15.5	1.8	4.3	21.3	80
19-Jun-97	5.8	1.1	21.9	28.9	94
24-Jun-97	1.3	0.5	22.8	23.8	64
8-Jul-97	20.8	1.1	0.0	25.0	92
10-Jul-97	29.5	0.5	0.0	30.9	46
11-Jul-97	20.0	0.2	0.0	22.3	
15-Jul-97	18.3	3.5	1.4	21.0	75
17-Jul-97	2.0	0.6	30.9	29.7	385
24-Jul-97	20.3	4.4	0.0	22.1	47
29-Jul-97	25.4	2.3	0.0	26.5	46
31-Jul-97	21.6	2.3	5.3	28.8	
7-Aug-97	20.4	0.9	0.0	24.3	62
12-Aug-97	19.7	0.2	0.0	20.8	37
14-Aug-97	11.3	0.2	0.0	18.3	44
19-Aug-97	21.5	0.2	0.0	23.8	62
21-Aug-97	20.0	0.0	0.0	19.6	48
28-Aug-97	10.2	8.9	8.6	19.6	81
4-Sep-97	3.3	2.3	29.7	31.0	71
9-Sep-97	1.2	0.6	21.9	22.9	86
10-Sep-97	0.6	0.5	22.9	21.5	111
11-Sep-97	0.6	0.2	20.1	20.0	169
12-Sep-97	0.5	0.3	18.8	18.7	97

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxout-NOxin mg-N/day	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	TNin-TNout mg-N/day	"TKN" in mg-N/day	"SKN" out mg-N/day
29-May-97	2046	5028	2983	4666	456	4210	7575	5806	1769	5529	778
5-Jun-97	0	0	0	0	0	0	0	0	0	0	0
12-Jun-97	317	3518	3202	3777	0	3777	4663	4157	506	4346	639
17-Jun-97	534	2590	2056	2523	722	1801	3450	3561	-112	2915	971
19-Jun-97	346	964	617	4228	3606	622	5537	4770	767	5191	3806
24-Jun-97	293	216	-76	3819	3708	111	4131	3868	263	3838	3708
8-Jul-97	<b>842</b>	<b>3417</b>	<b>2575</b>	<b>2880</b>	<b>0</b>	<b>2880</b>	<b>4731</b>	<b>4104</b>	<b>627</b>	<b>3889</b>	<b>687</b>
10-Jul-97	<b>1326</b>	<b>4717</b>	<b>3391</b>	<b>4033</b>	<b>0</b>	<b>4033</b>	<b>5960</b>	<b>4934</b>	<b>1025</b>	<b>4634</b>	<b>217</b>
15-Jul-97	869	4569	3699	4285	349	3936	6091	5241	849	5221	673
17-Jul-97	1402	514	-888	7622	7836	-215	9077	7517	1560	7675	7836
24-Jul-97	1225	5000	3775	4171	0	4171	4962	5432	-470	4171	432
29-Jul-97	1658	6463	4805	5369	0	5369	7395	6754	641	5737	291
31-Jul-97	1835	5375	3540	7754	1330	6424	9892	7185	2707	8057	1810
7-Aug-97	2159	5813	3654	5945	0	5945	9668	6934	2733	7508	1121
12-Aug-97	1067	5617	4550	5788	0	5788	7861	5930	1930	6793	313
14-Aug-97	400	3190	2791	5251	0	5251	5441	5154	287	5251	1963
19-Aug-97	1127	6060	4933	6383	0	6383	7087	6723	364	6383	663
21-Aug-97	428	5688	5260	5506	0	5506	6951	5594	1357	6523	0
28-Aug-97	239	2879	2641	5459	2424	3035	6691	5523	1167	6452	2644
4-Sep-97	763	922	159	9636	8305	1331	10888	8666	2222	10125	8305
9-Sep-97	1151	345	-806	6316	6215	101	7729	6508	1222	6578	6215
10-Sep-97	1344	167	-1177	6713	6416	297	8688	6032	2656	7344	6416
11-Sep-97	1031	165	-866	5891	5720	172	7722	5702	2020	6692	5720
12-Sep-97	254	163	-92	6072	5649	423	6794	5637	1157	6539	5649

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	TKN <sub>in</sub> -SKN <sub>out</sub> mg-N/day	N growth mg-N/day	MINIMUM		minimum observed specific	Temp oC
			TKN oxidized	Aerobic Biomass mg of VSS	nitrification rate mgTKN/mgVSS/day	
29-May-97	4752		4752			
5-Jun-97	0	1365	-1365	39420	0.0	23.5
12-Jun-97	3707	970	2737	28530	0.096	24.5
17-Jun-97	1944	681	1263	20034	0.063	23.2
19-Jun-97	1385	689	696	23940	0.029	28.0
24-Jun-97	130	276	-146	35280	-0.004	25.8
8-Jul-97	<b>3202</b>	<b>1752</b>	<b>1450</b>	<b>51120</b>	<b>0.028</b>	<b>26.0</b>
10-Jul-97	<b>4417</b>	<b>1708</b>	<b>2709</b>	<b>50760</b>	<b>0.053</b>	<b>27.0</b>
15-Jul-97	4549	1658	2890	48960	0.059	30.0
17-Jul-97	-162	254	-415	30960	-0.013	26.4
24-Jul-97	3738	1870	1868	54540	0.034	27.9
29-Jul-97	5446	1557	3889	46080	0.084	28.8
31-Jul-97	6247	1569	4678	47520	0.098	22.6
7-Aug-97	6387	1394	4993	42120	0.119	27.2
12-Aug-97	6480	1494	4986	40320	0.124	29.7
14-Aug-97	3288	1335	1953	40680	0.048	30.4
19-Aug-97	5720	1774	3945	52920	0.075	29.0
21-Aug-97	6523	1712	4811	50400	0.095	27.2
28-Aug-97	3808	780	3028	35100	0.095	41.0
4-Sep-97	1819	1139	680	33660	0.034	43.8
9-Sep-97	363	1209	-846	28980	-0.012	47.1
10-Sep-97	928	1453	-526	28260	0.003	46.8
11-Sep-97	972	1535	-563	45720	0.002	46.0
12-Sep-97	890	477	413	41040	0.015	23.3

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

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**NOTE:** Indicates system upset.

**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	delNOx mg-N/L	NHx in mg-N/L	NHx out mg-N/L	delNHx mg-N/L	TNin mg-N/L	TNout mg-N/L	delTN mg-N/L	"TKN" in mg-N/L	"SKN" out mg-N/L	del"TKN" mg-N/L
29-May-97	11.8	29.1	17.3	27.0	2.6	24.4	43.8	33.6	10.2	32.0	4.5	27.5
5-Jun-97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Jun-97	1.9	21.0	19.1	22.5	0.0	22.5	27.8	24.8	3.0	25.9	3.8	22.1
17-Jun-97	3.2	15.5	12.3	15.1	4.3	10.8	20.7	21.3	-0.7	17.5	5.8	11.6
19-Jun-97	2.1	5.8	3.7	25.6	21.9	3.8	33.6	28.9	4.7	31.5	23.1	8.4
24-Jun-97	1.8	1.3	-0.5	23.5	22.8	0.7	25.4	23.8	1.6	23.6	22.8	0.8
8-Jul-97	<b>5.1</b>	<b>20.8</b>	<b>15.7</b>	<b>17.5</b>	<b>0.0</b>	<b>17.5</b>	<b>28.8</b>	<b>25.0</b>	<b>3.8</b>	<b>23.7</b>	<b>4.2</b>	<b>19.5</b>
10-Jul-97	<b>8.3</b>	<b>29.5</b>	<b>21.2</b>	<b>25.2</b>	<b>0.0</b>	<b>25.2</b>	<b>37.3</b>	<b>30.9</b>	<b>6.4</b>	<b>29.0</b>	<b>1.4</b>	<b>27.6</b>
15-Jul-97	3.5	18.3	14.9	17.2	1.4	15.8	24.4	21.0	3.4	21.0	2.7	18.3
17-Jul-97	5.5	2.0	-3.5	30.1	30.9	-0.8	35.8	29.7	6.2	30.3	30.9	-0.6
24-Jul-97	5.0	20.3	15.3	16.9	0.0	16.9	20.2	22.1	-1.9	16.9	1.8	15.2
29-Jul-97	6.5	25.4	18.9	21.1	0.0	21.1	29.0	26.5	2.5	22.5	1.1	21.4
31-Jul-97	7.4	21.6	14.2	31.1	5.3	25.8	39.7	28.8	10.9	32.3	7.3	25.1
7-Aug-97	7.6	20.4	12.8	20.9	0.0	20.9	33.9	24.3	9.6	26.3	3.9	22.4
12-Aug-97	3.7	19.7	16.0	20.3	0.0	20.3	27.6	20.8	6.8	23.8	1.1	22.7
14-Aug-97	1.4	11.3	9.9	18.6	0.0	18.6	19.3	18.3	1.0	18.6	7.0	11.6
19-Aug-97	4.0	21.5	17.5	22.6	0.0	22.6	25.1	23.8	1.3	22.6	2.4	20.3
21-Aug-97	1.5	20.0	18.4	19.3	0.0	19.3	24.4	19.6	4.8	22.9	0.0	22.9
28-Aug-97	0.8	10.2	9.4	19.3	8.6	10.8	23.7	19.6	4.1	22.9	9.4	13.5
4-Sep-97	2.7	3.3	0.6	34.5	29.7	4.8	39.0	31.0	8.0	36.2	29.7	6.5
9-Sep-97	4.1	1.2	-2.8	22.3	21.9	0.4	27.2	22.9	4.3	23.2	21.9	1.3
10-Sep-97	4.8	0.6	-4.2	23.9	22.9	1.1	30.9	21.5	9.5	26.2	22.9	3.3
11-Sep-97	3.6	0.6	-3.0	20.7	20.1	0.6	27.1	20.0	7.1	23.5	20.1	3.4
12-Sep-97	0.8	0.5	-0.3	20.2	18.8	1.4	22.6	18.7	3.8	21.7	18.8	3.0

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**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L
29-May-97	21718	17280	4438	126	100
5-Jun-97	32461	10066	22396	193	60
12-Jun-97	20675	9562	11112	123	57
17-Jun-97	23316	13363	9953	140	80
19-Jun-97	34980	15499	19482	212	94
24-Jun-97	26865	10414	16451	165	64
8-Jul-97	<b>43137</b>	<b>15103</b>	<b>28034</b>	<b>263</b>	<b>92</b>
10-Jul-97	<b>23570</b>	<b>7353</b>	<b>16217</b>	<b>147</b>	<b>46</b>
15-Jul-97	31732	18684	13048	127	75
17-Jul-97	77967	97574	-19607	308	385
24-Jul-97	22087	11573	10513	90	47
29-Jul-97	22481	11724	10757	88	46
7-Aug-97	31334	17677	13657	110	62
12-Aug-97	21041	10549	10492	74	37
14-Aug-97	22715	12419	10296	80	44
19-Aug-97	44732	17499	27233	158	62
21-Aug-97	38621	13686	24935	135	48
28-Aug-97	44672	22861	21810	158	81
4-Sep-97	27732	19835	7897	99	71
9-Sep-97	38962	24396	14566	137	86
10-Sep-97	26168	31169	-5001	93	111
11-Sep-97	30056	48185	-18130	105	169
12-Sep-97	49474	29193	20281	164	97

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**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

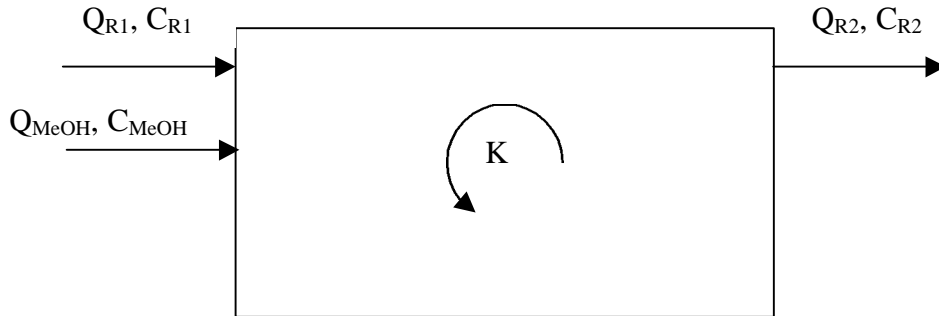
**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### APPENDIX 3

Secondary Effluent Treatment Train:  
Anoxic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Anoxic Reactor (R2) of the Secondary Effluent Treatment Train



$Q_{R1}$  = Flow rate exiting the main aerobic reactor (R1) =  $Q_{inf} + Q_{RAS}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$Q_{MeOH}$  = Flow rate of the methanol addition (L/day)

$C_{MeOH}$  = Concentration of COD in the methanol stream (C assumed to be zero for all other constituents) (mg/L)

$Q_{R2}$  = Flow rate exiting the anoxic reactor (R2) =  $Q_{inf} + Q_{RAS} + Q_{MeOH}$  (L/day)

$C_{R2}$  = Concentration of the constituent of interest exiting R2 = the concentration measured in R2 (mg/L)

K = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anoxic reactor (mg/day)} = (Q_{R1} \times C_{R1}) + (Q_{MeOH} \times C_{MeOH})$$

$C_{in}$  = Concentration of the constituent of interest entering the anoxic reactor (mg/L)

$$= \left( C_{R1} \times \frac{Q_{R1}}{Q_{R1} + Q_{MeOH}} \right) + \left( C_{MeOH} \times \frac{Q_{MeOH}}{Q_{R1} + Q_{MeOH}} \right)$$

$$C_{out} = C_{R2} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
29-May-97	24.8	0.0	3.0	30.4	174
5-Jun-97					336
12-Jun-97	4.3	2.2	0.0	5.6	192
17-Jun-97	3.8	1.5	3.1	7.7	106
19-Jun-97	0.4	0.3	20.5	21.4	222
24-Jun-97	0.0	0.0	22.0	21.6	198
8-Jul-97	0.6	0.4	0.0	1.7	176
10-Jul-97	1.7	1.4	0.0	2.3	93
15-Jul-97	0.0	0.0	0.0	1.2	191
17-Jul-97	2.1	0.6	30.7	30.3	434
24-Jul-97	0.0	0.0	0.0	1.1	192
29-Jul-97	0.0	0.0	0.0	0.9	100
31-Jul-97	0.0	0.0	3.3	3.7	
7-Aug-97	3.7	0.8	0.0	5.6	137
12-Aug-97	1.2	0.4	0.0	2.1	87
14-Aug-97	0.0	0.0	0.0	0.6	124
19-Aug-97	0.5	0.3	0.0	1.5	114
21-Aug-97	0.4	0.1	0.0	1.4	127
28-Aug-97	0.3	0.2	8.8	9.8	182
4-Sep-97	0.1	0.0	28.2	27.7	192
9-Sep-97	0.0	0.1	22.4	20.2	236
10-Sep-97	0.0	0.0	23.6	22.1	224
11-Sep-97	0.0	0.0	20.0	19.8	207
12-Sep-97	0.0	0.0	17.2	16.9	381

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	Observed specific denitrification rate mgNOx-N/mgVSS/day	Percent Denitrification	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day
29-May-97	5028	4287	741	#DIV/0!	14.7	456	511	-55
5-Jun-97	0	0	0	0.000	#DIV/0!	0	0	0
12-Jun-97	3518	719	2799	0.216	79.6	0	0	0
17-Jun-97	2590	632	1958	0.216	75.6	722	519	202
19-Jun-97	964	60	904	0.083	93.8	3606	3375	231
24-Jun-97	216	0	216	0.014	100.0	3708	3580	129
8-Jul-97	<b>3417</b>	<b>95</b>	<b>3322</b>	<b>0.143</b>	<b>97.2</b>	<b>0</b>	<b>0</b>	<b>0</b>
10-Jul-97	<b>4717</b>	<b>267</b>	<b>4451</b>	<b>0.193</b>	<b>94.3</b>	<b>0</b>	<b>0</b>	<b>0</b>
15-Jul-97	4569	0	4569	0.206	100.0	349	0	349
17-Jul-97	514	544	-30	-0.002	-5.9	7836	7776	61
24-Jul-97	5000	0	5000	0.202	100.0	0	0	0
29-Jul-97	6463	0	6463	0.309	100.0	0	0	0
31-Jul-97	5375	0	5375	0.249	100.0	1330	815	516
7-Aug-97	5813	1057	4756	0.249	81.8	0	0	0
12-Aug-97	5617	350	5267	0.288	93.8	0	0	0
14-Aug-97	3190	0	3190	0.173	100.0	0	0	0
19-Aug-97	6060	150	5910	0.246	97.5	0	0	0
21-Aug-97	5688	113	5575	0.244	98.0	0	0	0
28-Aug-97	2879	82	2798	0.176	97.2	2424	2481	-56
4-Sep-97	922	21	901	0.059	97.8	8305	7867	439
9-Sep-97	345	0	345	0.026	100.0	6215	6354	-139
10-Sep-97	167	0	167	0.013	100.0	6416	6621	-205
11-Sep-97	165	0	165	0.008	100.0	5720	5702	17
12-Sep-97	163	0	163	0.009	100.0	5649	5161	488

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**NOTE:** Indicates infestation of grazers (sludge worms).

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	TNin mg-N/day	TNout mg-N/day	TNin - TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg/day	Temp. °C
29-May-97	5806	5253	553	778	966	19.8
5-Jun-97	0	0	0	0	0	22.5
12-Jun-97	4157	938	3219	639	219	25.0
17-Jun-97	3561	1286	2275	971	654	22.9
19-Jun-97	4770	3522	1248	3806	3462	28.0
24-Jun-97	3868	3513	355	3708	3580	25.0
8-Jul-97	<b>4104</b>	<b>273</b>	<b>3831</b>	<b>687</b>	<b>178</b>	<b>25.7</b>
10-Jul-97	<b>4934</b>	<b>371</b>	<b>4563</b>	<b>217</b>	<b>104</b>	<b>27.4</b>
15-Jul-97	5241	304	4938	673	304	28.7
17-Jul-97	7517	7679	-162	7836	7776	26.2
24-Jul-97	5432	266	5166	432	266	27.2
29-Jul-97	6754	217	6538	291	217	28.7
31-Jul-97	7185	919	6265	1810	919	22.0
7-Aug-97	6934	1585	5349	1121	528	26.6
12-Aug-97	5930	607	5323	313	257	28.5
14-Aug-97	5154	155	4998	1963	155	29.3
19-Aug-97	6723	418	6305	663	268	28.2
21-Aug-97	5594	405	5189	0	291	26.7
28-Aug-97	5523	2772	2752	2644	2690	35.6
4-Sep-97	8666	7727	939	8305	7867	35.3
9-Sep-97	6508	5739	769	6215	6354	44.5
10-Sep-97	6032	6203	-171	6416	6621	43.2
11-Sep-97	5702	5631	71	5720	5702	39.8
12-Sep-97	5637	5083	554	5649	5161	24.2

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### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	NOxin - NOxout mg-N/L	NHx in mg-N/L	NHx out mg-N/L	delNHx mg-N/L	TNin mg-N/L	TNout mg-N/L	TNin-TNout mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L	SKNin-SKNout mg-N/L
29-May-97	29.1	24.8	4.3	2.6	3.0	-0.3	33.6	30.4	3.2	4.5	5.6	-1.1
5-Jun-97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12-Jun-97	21.0	4.3	16.7	0.0	0.0	0.0	24.8	5.6	19.2	3.8	1.3	2.5
17-Jun-97	15.5	3.8	11.7	4.3	3.1	1.2	21.3	7.7	13.6	5.8	3.9	1.9
19-Jun-97	5.8	0.4	5.5	21.9	20.5	1.4	28.9	21.4	7.6	23.1	21.0	2.1
24-Jun-97	1.3	0.0	1.3	22.8	22.0	0.8	23.8	21.6	2.2	22.8	22.0	0.8
8-Jul-97	<b>20.8</b>	<b>0.6</b>	<b>20.2</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>25.0</b>	<b>1.7</b>	<b>23.3</b>	<b>4.2</b>	<b>1.1</b>	<b>3.1</b>
10-Jul-97	<b>29.5</b>	<b>1.7</b>	<b>27.8</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>30.9</b>	<b>2.3</b>	<b>28.6</b>	<b>1.4</b>	<b>0.7</b>	<b>0.7</b>
15-Jul-97	18.3	0.0	18.3	1.4	0.0	1.4	21.0	1.2	19.8	2.7	1.2	1.5
17-Jul-97	2.0	2.1	-0.1	30.9	30.7	0.2	29.7	30.3	-0.6	30.9	30.7	0.2
24-Jul-97	20.3	0.0	20.3	0.0	0.0	0.0	22.1	1.1	21.0	1.8	1.1	0.7
29-Jul-97	25.4	0.0	25.4	0.0	0.0	0.0	26.5	0.9	25.7	1.1	0.9	0.3
31-Jul-97	21.6	0.0	21.6	5.3	3.3	2.1	28.8	3.7	25.2	7.3	3.7	3.6
7-Aug-97	20.4	3.7	16.7	0.0	0.0	0.0	24.3	5.6	18.8	3.9	1.9	2.1
12-Aug-97	19.7	1.2	18.5	0.0	0.0	0.0	20.8	2.1	18.7	1.1	0.9	0.2
14-Aug-97	11.3	0.0	11.3	0.0	0.0	0.0	18.3	0.6	17.7	7.0	0.6	6.4
19-Aug-97	21.5	0.5	20.9	0.0	0.0	0.0	23.8	1.5	22.3	2.4	1.0	1.4
21-Aug-97	20.0	0.4	19.6	0.0	0.0	0.0	19.6	1.4	18.2	0.0	1.0	-1.0
28-Aug-97	10.2	0.3	9.9	8.6	8.8	-0.2	19.6	9.8	9.8	9.4	9.5	-0.2
4-Sep-97	3.3	0.1	3.2	29.7	28.2	1.6	31.0	27.7	3.4	29.7	28.2	1.6
9-Sep-97	1.2	0.0	1.2	21.9	22.4	-0.5	22.9	20.2	2.7	21.9	22.4	-0.5
10-Sep-97	0.6	0.0	0.6	22.9	23.6	-0.7	21.5	22.1	-0.6	22.9	23.6	-0.7
11-Sep-97	0.6	0.0	0.6	20.1	20.0	0.1	20.0	19.8	0.3	20.1	20.0	0.1
12-Sep-97	0.5	0.0	0.5	18.8	17.2	1.6	18.7	16.9	1.8	18.8	17.2	1.6

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### COD Mass Balances

Date	CODin from R1 mg/day	COD out mg/day	COD added (MeOH) mg/day	TOTAL COD in mg/day	COD in mg/L	COD out mg/L
29-May-97	17280	31094	#VALUE!	#VALUE!	100	174
5-Jun-97	10066	58327	41539	51605	60	336
12-Jun-97	9562	33343	42052	51614	57	192
17-Jun-97	13363	18317	34188	47552	80	106
19-Jun-97	15499	37898	34616	50115	94	222
24-Jun-97	10414	33359	34188	44603	64	198
8-Jul-97	<b>15103</b>	<b>29906</b>	<b>34188</b>	<b>49291</b>	<b>92</b>	<b>176</b>
10-Jul-97	<b>7353</b>	<b>15414</b>	<b>35043</b>	<b>42396</b>	<b>46</b>	<b>93</b>
15-Jul-97	18684	49232	51283	69967	75	191
17-Jul-97	97574	113743	51283	148857	385	434
24-Jul-97	11573	48923	50855	62429	47	192
29-Jul-97	11724	26352	51283	63007	46	100
7-Aug-97	17677	40265	52137	69815	62	137
12-Aug-97	10549	25570	52137	62687	37	87
14-Aug-97	12419	36087	52137	64556	44	124
19-Aug-97	17499	33160	51283	68782	62	114
21-Aug-97	13686	37326	52137	65823	48	127
28-Aug-97	22861	52888	49573	72435	81	182
4-Sep-97	19835	55268	50428	70263	71	192
9-Sep-97	24396	68988	51283	75679	86	236
10-Sep-97	31169	64835	51283	82452	111	224
11-Sep-97	48185	60808	51283	99468	169	207
12-Sep-97	29193	118150	54274	83467	97	381

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APPENDIX 4

Secondary Effluent Treatment Train:  
Biosolids data and calculations

Date	MLSS			Final Effluent (ETSS) (mg/L)	MLVSS		Theoretical Wastage (L)	Manual Wastage (L)	Actual SRT (days)
	Main aerobic reactor (R1) (mg/L)	Anoxic reactor (R2) (mg/L)	Reaeration reactor (R3) (mg/L)		Main aerobic reactor (R1) (mg/L)				
19-May-97								0.0	
20-May-97								0.0	
21-May-97								0.0	
22-May-97	645							0.0	
23-May-97	3120							0.0	
24-May-97	2450			830		-42.5		0.0	0.9
25-May-97	1360			45		1.9		0.0	9.3
26-May-97								0.0	
27-May-97	2160			20		4.2		4.0	6.2
28-May-97	2720			12		4.7		4.6	6.1
29-May-97	3865	2000	2050	13		4.8		4.7	6.1
30-May-97	2310			8		4.8		0.0	86.2
31-May-97	2570			25		4.2		6.5	4.1
1-Jun-97	2370			24		4.1		6.5	4.1
2-Jun-97	2350	2170	1880	79		1.8		4.8	3.7
3-Jun-97	1890			10		4.6		4.6	6.0
4-Jun-97	2580	2470	2560	17	2150	4.5		4.5	6.0
5-Jun-97	2620			17	2190	4.5		4.5	5.9
6-Jun-97	3010			21	2600	4.4		4.4	6.0
7-Jun-97	2255			26	1895	4.0		4.0	5.9
8-Jun-97	1850			27		3.7		3.7	5.9
9-Jun-97	1930	1860	2000	19		4.2		4.2	6.0
10-Jun-97	2150			32	1840	3.6		3.6	6.0
11-Jun-97	2020	1920	1980	16	1710	4.3		4.3	6.0
12-Jun-97	1855			9	1585	4.6		4.6	6.0
13-Jun-97	1460			23	1280	3.5		3.5	5.9
14-Jun-97	1347			140	1145	-5.2		0.0	3.1
15-Jun-97	2050			86	1750	0.7		0.0	6.9
16-Jun-97	2030	2180	1910	14	1710	4.4		4.4	6.0
17-Jun-97	1267			16	1113	3.9		3.9	5.9
18-Jun-97	1170	1180	1380	20	980	3.5		3.5	5.9
19-Jun-97	1620			68	1330	1.0		0.0	7.3
20-Jun-97	2260			30	1860	3.8		0.0	23.2
21-Jun-97	2670			36	2180	3.8		0.0	22.8
22-Jun-97	2640			15	2180	4.6		0.0	54.2
23-Jun-97	3010	3320	3010	61	2540	3.2		2.4	7.0
24-Jun-97	2370			28	1960	4.0		0.0	26.8
25-Jun-97	3130	3350	3650	16	2620	4.6			58.2
26-Jun-97	2840			8	2345	4.8			104.8
27-Jun-97	2530			46	2120	3.4		0.0	17.2
28-Jun-97	2210			22	1850	4.2		<b>0.0</b>	31.4
29-Jun-97	4680			29	3920	4.5		0.0	49.2
30-Jun-97	4940	4490	4620	13	4100	4.8		4.8	6.0
1-Jul-97	4430			8	3740	4.9		4.9	6.0
2-Jul-97	4430	4210	4570	28	3790	4.5		4.5	6.0
3-Jul-97	4470			18	3430	4.7		4.7	6.0
4-Jul-97	3580			4	3020	5.0		5.0	6.0

Table Continued

26-Aug-97	3210			18	2850	4.0	5.1	4.9
27-Aug-97	2410	2250	2340	29	2230	2.9	2.9	5.9
28-Aug-97	2150			14	1950	3.9	2.2	9.0
29-Aug-97	2520			15	2270	4.0	4.0	6.0
30-Aug-97	1770			35	1590	1.3	0.0	8.1
31-Aug-97	1450			77	1340	-5.2	0.0	3.1
1-Sep-97								
2-Sep-97	2990			18	2720	4.0	4.0	6.0
3-Sep-97	2660	2560	2630	45	2420	2.0	2.0	5.9
4-Sep-97	2090			20	1870	3.4	3.4	5.9
5-Sep-97	1730			21	1590	2.8	2.8	6.0
6-Sep-97	1330			16	1260	2.9	2.9	6.0
7-Sep-97	1030			28	1010	0.1	0.0	6.1
8-Sep-97	527	559	464	12	493	0.7	0.0	6.9
9-Sep-97	1830			63	1610	-1.4	0.0	4.7
10-Sep-97	1760	1700	1760	77	1570	-3.1	0.0	3.8
11-Sep-97	2870			29	2540	3.2	3.2	6.0
12-Sep-97	2510			25	2280	3.3	0.0	16.4

**NOTE:** Cells indicate days when sludge was added from other reactors.

Days of sludge addition	Volume and type of sludge added
28-Jun-97	Added 2.8 L of Primary MLSS
18-Jul-97	Added 2.2 L of Primary MLSS
19-Jul-97	Added 1.6 L of Primary MLSS
20-Jul-97	Added 2 L of Primary MLSS
31-Aug-97	Added 1.5 L of Primary + 0.38 L of Heated Primary MLSS
8-Sep-97	Added 2.3 L of Primary + 1.0 L of Heated Primary MLSS

APPENDIX 5

Secondary Effluent Treatment Train:  
Flow rate data

Date	Flow Rates				
	Influent mL/min	Phosphoric acid addition mL/min	Alkalinity addition mL/min	Methanol addition mL/min	Return Activated Sludge (RAS) mL/min
19-May-97	70	0.8	1.8	3.5	45
20-May-97	70	0.7	1.7	4.2	45
21-May-97	72	0.8	1.7	4.4	44
22-May-97	69	0.8	1.1	4.3	44
23-May-97	68	0.8	1.1	4.1	43
24-May-97	68				
25-May-97	69	1.1			
26-May-97	69				
27-May-97	71			4.1	48
28-May-97	71	1.7	0.8	3.9	
29-May-97	73			4.1	47
30-May-97	71	1.0	1.1	4.0	46
31-May-97	67			4.0	
1-Jun-97	70			4.0	46
2-Jun-97	70	0.8	1.1	4.1	
3-Jun-97	71			3.9	45
4-Jun-97	70	1.2	1.3	4.0	
5-Jun-97	72			4.1	45
6-Jun-97	70	1.1	1.3		
7-Jun-97	69	1.1	1.2	4.0	44
8-Jun-97	69		0.8		
9-Jun-97	69	1.0	0.7	4.0	
10-Jun-97	71			4.1	45
11-Jun-97	71	1.1	0.8	4.1	45
12-Jun-97	72	0.5		4.1	45
13-Jun-97	74	0.5	0.4	4.1	45
14-Jun-97	65	0.5	0.3	4.1	45
15-Jun-97	73				45
16-Jun-97	73	0.3	0.3	4.1	
17-Jun-97	70			4.0	46
18-Jun-97	69	0.5	0.3	4.1	
19-Jun-97	69			4.1	46
20-Jun-97	69	0.5	0.3	4.1	46
21-Jun-97	69			4.1	46
22-Jun-97	69			4.1	46
23-Jun-97	68	0.4	0.8	4.0	
24-Jun-97	68			4.0	45
25-Jun-97	71	0.6	0.8	3.8	
26-Jun-97	72			3.8	46
27-Jun-97	69	0.6	0.7	3.8	45
28-Jun-97	70	0.6	0.8	3.9	45
29-Jun-97	69		0.9	3.8	
30-Jun-97	72	0.6	0.8	4.5	
1-Jul-97	72			4.0	45
2-Jul-97	69	0.5	0.9	4.2	
3-Jul-97	69	0.5	0.9	4.1	46
4-Jul-97	70	0.5	0.8	4.1	46

Table Continued

5-Jul-97	69			4.1	46
6-Jul-97	68			4.2	60-45
7-Jul-97	70	0.4	0.5	4.0	
8-Jul-97	70			4.0	44
9-Jul-97	69	0.5	0.8	4.1	
10-Jul-97	69			4.1	42
11-Jul-97	70	0.5	0.8	4.1	45
12-Jul-97	70	0-.55	0.8	4.0	45
13-Jul-97	70	0.6	1.3	4.1	45
14-Jul-97	70			4.1	45
15-Jul-97	105	0.5	1.3	6.0	68
16-Jul-97	104			5.9	68
17-Jul-97	108	0.6		6.0	
18-Jul-97	105		0.3	6.0	68
19-Jul-97	107			5.9	69
20-Jul-97	102	0.6	1.3	5.9	68
21-Jul-97	103	0.6	1.3	6.0	
22-Jul-97	102			6.0	67
23-Jul-97	106	0.7	1.2	6.0	
24-Jul-97	104	0.7	1.2	6.0	67
25-Jul-97	106	0.7	1.1	6.0	68
26-Jul-97	106			5.8-6.0	69
27-Jul-97	106			6.0	69
28-Jul-97	108	0.5	1.2	6.0	
29-Jul-97	108			6.0	69
30-Jul-97	102	0.8	1.3	6.0	68
31-Jul-97	106	0.5	1.2	6.0	67
1-Aug-97	108	0-.85	1.3	6.1	62
2-Aug-97	103		1.2	6.1	66
3-Aug-97	102			6.1	67
4-Aug-97	106	0.9	0.0	6.0	
5-Aug-97	106		0.0	6.0	68
6-Aug-97	132	1.0	0.0	6.0	66
7-Aug-97	130		0.0	6.1	68
8-Aug-97	132	2.0	0.0	6.0	68
9-Aug-97	130	1.7	0.0	6.0	66
10-Aug-97	130		0.0	6.1	67
11-Aug-97	130	1.6	0.0	6.0	
12-Aug-97	130		0.0	6.1	68
13-Aug-97	130	1.6	0.0	6.1	
14-Aug-97	130		0.0	6.1	66
15-Aug-97	130	1.7-0.8	0.0	6.2	66
16-Aug-97	130		0.0	6.0	67
17-Aug-97	130		0.0	6.2-6.0	67
18-Aug-97	130	0.8	0.0	6.0	
19-Aug-97	128		0.0	6.0	68
20-Aug-97	128	0.8	0.0	6.0	
21-Aug-97	128		0.0	6.1	70
22-Aug-97	130	0.8	0.0	6.0	68
23-Aug-97	130		0.0	5.9	66
24-Aug-97	130		0.0	5.6-6.1	66
25-Aug-97	130	0.8	0.0	5.8	

Table Continued

26-Aug-97	132		0.0	6.2	70
27-Aug-97	132	0.9	0.0	6.0	
28-Aug-97	130		0.0	5.8	66
29-Aug-97	130	0.9	0.0	6.0	69
30-Aug-97	132		0.0	6.0	68
31-Aug-97	130		0.0		68
1-Sep-97	130		0.0		
2-Sep-97	129		0.0	6.0	68
3-Sep-97	130	0.9	0.0	5.9	
4-Sep-97	128		0.0	5.9	66
5-Sep-97	130	1.2	0.0	6.0	70
6-Sep-97	130		0.0	6.2	67
7-Sep-97	130		0.0	6.2	67
8-Sep-97	130	1.1	0.0	6.0	
9-Sep-97	130		0.0	6.0	67
10-Sep-97	128	1.1	0.0	6.0	
11-Sep-97	130		0.0	6.0	68
12-Sep-97	129	1.3	0.0	6.35-6.2	80

**NOTE:** Ranges listed for flow rates signify that the flow was adjusted from the first value to the second.

**NOTE:** Grey cells indicate the flow rate was adjusted from the initial measured flow rate to the indicated flow rate. The flow rate shown is the one used for any related calculation.

## APPENDIX 6

Primary Effluent Treatment Train:  
Overall system influent and effluent nitrogen and COD raw data and mass balances

### Nitrogen Raw Data

Date	Influent Nitrogen Concentrations				Effluent Nitrogen Concentrations			
	NO3+NO2	NO2	NHx	TN	NO3+NO2	NO2	NHx	TN
	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L
19-May-97								
20-May-97	0.7	0.6	51.5	65.7	20.5	1.1	4.9	28.7
21-May-97								
22-May-97	1.9	0.8	42.4	49.8	5.1	0.0	17.3	26.3
23-May-97								
24-May-97								
25-May-97								
26-May-97								
27-May-97	2.9	1.5	39.3	46.0				
28-May-97	3.2	2.2	41.7	46.9	5.7	0.1	19.9	25.5
29-May-97	2.5	1.9	39.5	43.0				
30-May-97	2.5	1.4	38.5	41.0	1.8	0.2	20.3	22.8
31-May-97								
1-Jun-97								
2-Jun-97	6.4	2.3	39.1	43.2	15.0	0.0	1.4	18.2
3-Jun-97								
4-Jun-97	4.2	1.5	40.0	43.9	6.2	0.0	1.6	8.5
5-Jun-97								
6-Jun-97	0.7	0.6	31.4	39.0	7.3	0.0	0.0	8.6
7-Jun-97								
8-Jun-97								
9-Jun-97	1.3	1.0	39.3	38.8	6.0	0.0	0.0	6.3
10-Jun-97								
11-Jun-97	0.0	0.0	42.7	44.3	6.7	0.0	0.0	8.6
12-Jun-97								
13-Jun-97	0.0	0.1	35.1	55.2	5.4	0.0	0.0	9.5
14-Jun-97								
15-Jun-97								
16-Jun-97	2.6	0.5	29.7	29.6	5.0	0.0	0.0	6.6
17-Jun-97	9.7	1.0	31.6	49.7	6.2	0.0	0.0	8.2
18-Jun-97	4.7	1.7	33.0	48.3	10.2	0.0	0.0	12.7
19-Jun-97	5.7	1.3	32.5	50.1	15.3	0.1	1.9	18.8
20-Jun-97	0.9	0.9	29.3	31.3	14.3	0.1	0.0	16.5
21-Jun-97								
22-Jun-97								
23-Jun-97	1.2	1.3	33.4	41.4	7.1	0.1	0.0	9.4
24-Jun-97	3.7	4.4	25.3	37.0	4.8	0.2	1.4	7.5
25-Jun-97	3.2	2.0	25.1	29.1	3.0	0.3	3.3	7.1
26-Jun-97	?	?	?	?	6.0	0.0	0.0	7.8
27-Jun-97	5.7	5.6	28.0	31.7	7.9	0.9	0.0	10.3
28-Jun-97								
29-Jun-97								
30-Jun-97	19.9	15.7	55.8	81.1	14.1	2.5	4.1	19.9
1-Jul-97	16.2	14.1	60.8	78.6	10.0	0.5	2.5	14.3
2-Jul-97	13.1	11.5	56.1	72.0	5.5	0.3	5.4	12.4
3-Jul-97	6.7	5.0	32.5	42.3	6.0	0.1	0.0	7.9
4-Jul-97								

Table Continued

5-Jul-97								
6-Jul-97								
7-Jul-97	7.0	5.2	31.7	44.2	6.1	0.0	0.0	7.5
8-Jul-97								
9-Jul-97	9.1	5.2	37.5	52.9	0.3	0.2	29.5	28.5
10-Jul-97								
11-Jul-97	4.7	3.5	32.6	40.0	2.5	0.6	8.1	11.2
12-Jul-97								
13-Jul-97								
14-Jul-97	3.6	1.5	31.2	43.2	5.2	0.1	0.0	6.3
15-Jul-97								
16-Jul-97	3.5	1.7	35.5	40.8	5.9	0.7	0.0	7.0
17-Jul-97	2.2	0.8	38.2	40.7	6.4	0.5	0.0	8.0
18-Jul-97	1.6	1.3	36.6	40.3	7.0	0.3	0.0	9.1
19-Jul-97								
20-Jul-97								
21-Jul-97	7.5	3.9	37.5	41.9	7.4	0.1	1.1	9.1
22-Jul-97	9.6	4.6	37.3	42.8	6.6	0.2	0.0	7.7
23-Jul-97	6.1	3.4	35.5	39.3	4.6	0.0	0.0	5.6
24-Jul-97								
25-Jul-97	5.4	4.4	29.6	35.3	6.6	0.1	0.4	7.6
26-Jul-97								
27-Jul-97								
28-Jul-97	4.9	4.8	35.6	39.8	6.4	0.3	1.2	7.9
29-Jul-97								
30-Jul-97	11.5	3.0	51.2	51.9	5.9	0.5	15.7	19.4
31-Jul-97								
1-Aug-97	4.2	3.8	55.8	51.1	6.9	0.8	24.1	27.3
2-Aug-97								
3-Aug-97								
4-Aug-97	12.4	8.8	39.8	48.8	11.6	0.9	0.0	13.8
5-Aug-97	8.4	?	48.0	56.2	7.6	2.3	3.0	11.3
6-Aug-97								
7-Aug-97	?	?	?	?	3.1	0.2	0.0	5.7
8-Aug-97	10.3	7.7	30.9	43.5	5.2	0.2	0.0	6.1
9-Aug-97								
10-Aug-97								
11-Aug-97	12.2	10.3	29.0	41.2	4.3	0.3	0.0	5.6
12-Aug-97								
13-Aug-97	9.0	3.7	26.4	37.9	0.0	0.0	21.0	19.6
14-Aug-97	2.5	3.1	31.8	37.1	0.8	0.3	12.5	13.2
15-Aug-97	?	3.8	30.3	37.8	?	0.9	9.9	11.7
16-Aug-97								
17-Aug-97								
18-Aug-97	12.1	8.4	30.7	41.7	2.7	0.7	18.8	18.4
19-Aug-97	4.7	2.4	37.2	50.0	4.5	1.1	1.3	6.9
20-Aug-97	4.0	2.9	30.3	33.4	4.8	0.5	1.5	6.8
21-Aug-97	1.4	1.2	31.3	37.5	5.5	0.0	0.0	7.5
22-Aug-97	2.2	1.8	26.8	36.6	3.4	0.3	0.0	5.3
23-Aug-97								
24-Aug-97								

Table Continued

25-Aug-97	?	?	?	?	?	?	?	?
26-Aug-97	5.8	4.3	30.7	38.0	3.6	0.1	1.1	5.7
27-Aug-97	3.1	2.7	29.4	35.6	2.9	0.0	0.0	4.3
28-Aug-97	4.7	3.9	27.6	36.0	2.2	0.1	0.0	3.9
29-Aug-97	8.4	3.8	27.6	41.0	2.6	0.7	0.0	4.7
30-Aug-97								
31-Aug-97								
1-Sep-97								
2-Sep-97	4.0	3.0	25.9	33.1	1.9	1.1	2.4	5.2
3-Sep-97	5.1	4.8	32.7	37.5	4.9	1.1	1.4	6.8
4-Sep-97	1.2	1.0	35.8	40.2	4.1	0.2	1.4	7.0
5-Sep-97	4.8	3.1	?	37.4	3.7	0.2	?	6.3

**NOTE:** Soluble data for nutrients in reactors and effluent starting 6/10/97. Total (solid+soluble) for influent. All previous data (6/9/97 and earlier) reports total values for influent, reactors, and effluent. Only data from 6/10/97 on is used for calculations and Figures.

**COD Raw Data**

Date	Influent COD mg/L	Effluent COD mg/L	Methanol stock solution mL/L	Methanol concentration mg/L	Methanol Theoretical COD mg/L
19-May-97			0	0	0
20-May-97	890	700	0	0	0
21-May-97			0	0	0
22-May-97			0	0	0
23-May-97			0	0	0
24-May-97			0	0	0
25-May-97			0	0	0
26-May-97	628		0	0	0
27-May-97			0	0	0
28-May-97	571	123	0	0	0
29-May-97	626		0	0	0
30-May-97	697	144	0	0	0
31-May-97			0	0	0
1-Jun-97			0	0	0
2-Jun-97	634	59	0	0	0
3-Jun-97			0	0	0
4-Jun-97	680	163	0	0	0
5-Jun-97			0	0	0
6-Jun-97	680	87	0	0	0
7-Jun-97			0	0	0
8-Jun-97			0	0	0
9-Jun-97		71?	0	0	0
10-Jun-97			0	0	0
11-Jun-97	651	44	0	0	0
12-Jun-97	646		0	0	0
13-Jun-97	663	66	0	0	0
14-Jun-97			0	0	0
15-Jun-97			0	0	0
16-Jun-97	488	58	0	0	0
17-Jun-97	705	78	0	0	0
18-Jun-97	593	60	0	0	0
19-Jun-97	668	55	0	0	0
20-Jun-97	600	56	0	0	0
21-Jun-97			0	0	0
22-Jun-97			0	0	0
23-Jun-97	628	54	0	0	0
24-Jun-97	531	50	1.0	791	1187
25-Jun-97	520	42	1.0	791	1187
26-Jun-97	542	55	1.0	791	1187
27-Jun-97	570	55	1.0	791	1187
28-Jun-97			1.0	791	1187
29-Jun-97			1.0	791	1187
30-Jun-97	571	44	1.0	791	1187
1-Jul-97	590	71	1.0	791	1187
2-Jul-97	634	59	1.0	791	1187
3-Jul-97	523	48	1.0	791	1187
4-Jul-97			0	0	0

Table Continued

5-Jul-97	450		0	0	0
6-Jul-97	635		0	0	0
7-Jul-97	540	51	0	0	0
8-Jul-97			0	0	0
9-Jul-97	628	110	0	0	0
10-Jul-97			0	0	0
11-Jul-97	630	86	0	0	0
12-Jul-97			0	0	0
13-Jul-97			0	0	0
14-Jul-97	503	33	0	0	0
15-Jul-97			0	0	0
16-Jul-97	545	56	0	0	0
17-Jul-97	452	44	0	0	0
18-Jul-97	453	54	0	0	0
19-Jul-97			0	0	0
20-Jul-97			0	0	0
21-Jul-97	480	44	0	0	0
22-Jul-97	551	48	0	0	0
23-Jul-97	540	55	0	0	0
24-Jul-97			0	0	0
25-Jul-97	415	39	0	0	0
26-Jul-97			0	0	0
27-Jul-97			0	0	0
28-Jul-97			0	0	0
29-Jul-97			0	0	0
30-Jul-97	565	54	0	0	0
31-Jul-97			0	0	0
1-Aug-97	600	63	0	0	0
2-Aug-97			0	0	0
3-Aug-97			0	0	0
4-Aug-97	413	46	0	0	0
5-Aug-97	484	54	0	0	0
6-Aug-97			0	0	0
7-Aug-97	no sample	74	0	0	0
8-Aug-97	565	37	0	0	0
9-Aug-97			0	0	0
10-Aug-97			0	0	0
11-Aug-97	500	32	0	0	0
12-Aug-97			0	0	0
13-Aug-97	1090	80	0	0	0
14-Aug-97	760	54	0	0	0
15-Aug-97	663	54	0	0	0
16-Aug-97			0	0	0
17-Aug-97			0	0	0
18-Aug-97	611	62	0	0	0
19-Aug-97	663	62	0	0	0
20-Aug-97	648	54	0	0	0
21-Aug-97	570	49	0	0	0
22-Aug-97	571	49	0	0	0
23-Aug-97			0	0	0
24-Aug-97			0	0	0

25-Aug-97	611	63	0	0	0
26-Aug-97	657	46	5.0	3957	5936
27-Aug-97	?	40	5.0	3957	5936
28-Aug-97	686	46	5.0	3957	5936
29-Aug-97	566	47	5.0	3957	5936
30-Aug-97			5.0	3957	5936
31-Aug-97			5.0	3957	5936
1-Sep-97			5.0	3957	5936
2-Sep-97	520	50	5.0	3957	5936
3-Sep-97	520	44	5.0	3957	5936
4-Sep-97	497	41	5.0	3957	5936
5-Sep-97	553	66	5.0	3957	5936

**NOTE:** Soluble data for nutrients in reactors and effluent starting 6/10/97. Total (solid+soluble) for influent. All previous data (6/9/97 and earlier) reports total values for influent, reactors, and effluent. Only data from 6/10/97 on is used for calculations and Figures.

**Nitrogen Mass Balances**

Date	Influent NO3+NO2 mg/day	Influent NHx mg/day	Influent "TKN" mg/day	Effluent NO3+NO2 mg/day	Effluent NHx mg/day	Effluent "TKN" mg/day	bioavailable TKN	Aerobic MLVSS mg/L	Aerobic biomass	VSS growth mgVSS/day
28-May-97	323	4207	4406	575	2005	2005	4406	2480	67952	8309
29-May-97	258	4041	4141	no data	no data	#VALUE!	#VALUE!	2188	59951	7312
30-May-97	245	3769	3769	180	1991	2048	3712	1712	46909	5735
2-Jun-97	673	4107	4107	1577	145	341	3911	4656	127574	15479
4-Jun-97	414	3978	3978	617	156	229	3906	4944	135466	16480
6-Jun-97	70	3256	3977	757	0	136	3841	4736	129766	27060
9-Jun-97	132	3963	3963	603	0	35	3928	4060	111244	13372
11-Jun-97	0	4670	4845	736	0	209	4636	3730	102202	12258
13-Jun-97	0	4246	6673	655	0	492	6181	4315	118231	14524
16-Jun-97	247	2819	2819	472	0	154	2665	5330	146042	17510
17-Jun-97	1001	3279	4154	638	0	215	3940	5020	137548	16750
18-Jun-97	538	3754	4957	1165	0	282	4674	3600	98640	12228
19-Jun-97	584	3327	4535	1560	193	357	4372	4980	136452	16613
20-Jun-97	89	2956	3065	1437	0	228	2837	4260	116724	15399
23-Jun-97	126	3419	4109	726	0	232	3877	4980	136452	16889
24-Jun-97	369	2550	3363	486	144	265	3243	5020	137548	16810
25-Jun-97	308	2421	2500	289	321	394	2427	5950	163030	19754
27-Jun-97	574	2820	2820	791	0	250	2570	3790	103846	12660
30-Jun-97	2096	5860	6432	1479	432	613	6252	2700	73980	8948
1-Jul-97	1707	6396	6552	1049	266	450	6368	5500	150700	18482
2-Jul-97	1533	6545	6864	647	628	799	6693	6160	168784	20643
3-Jul-97	689	3371	3699	617	0	197	3503	4030	110422	12186
7-Jul-97	981	4425	5189	857	0	190	4999	3430	93982	11412
9-Jul-97	1267	5244	6118	38	4118	4118	6118	1730	47402	4156
11-Jul-97	643	4502	4892	350	1123	1195	4820	3385	92749	11174
14-Jul-97	506	4355	5529	729	0	144	5384	3260	89324	10794
16-Jul-97	497	5004	5263	829	0	160	5103	2720	74528	8928
17-Jul-97	311	5384	5430	897	0	233	5197	3440	94256	11554
18-Jul-97	227	5053	5343	972	0	286	5057	3630	99462	12071
21-Jul-97	1036	5190	5190	1020	147	242	5094	3690	101106	12327
22-Jul-97	1324	5152	5152	919	0	143	5009	4390	120286	14678
23-Jul-97	837	4850	4850	629	0	133	4717	5580	152892	18400

Table Continued

25-Jul-97	766	4175	4208	929	52	142	4118	3090	84666	69
28-Jul-97	674	4923	4923	884	165	205	4882	4090	112066	2012
30-Jul-97	1931	8628	8628	995	2650	2650	8628	3940	107956	13023
1-Aug-97	742	9878	9878	1220	4262	4262	9878	4800	131520	15931
4-Aug-97	2214	7101	7101	2073	0	391	6710	3370	92338	7378
5-Aug-97	1515	8638	8638	1361	531	675	8495	3120	85488	10477
8-Aug-97	1801	5429	5841	920	0	157	5683	3430	93982	11299
11-Aug-97	2108	5018	5018	746	0	220	4798	4660	127684	15304
13-Aug-97	1573	4591	5024	0	3666	3666	5024	4100	112340	13494
14-Aug-97	427	5502	5988	137	2167	2167	5988	3760	103024	12510
15-Aug-97	#VALUE!	5060	#VALUE!	#VALUE!	1657	#VALUE!	#VALUE!	5480	150152	27608
18-Aug-97	2127	5390	5390	471	3303	3303	5390	3990	109326	13464
19-Aug-97	819	6528	7969	796	223	414	7778	3830	104942	13075
20-Aug-97	544	4141	4141	656	198	272	4067	4540	124396	14960
21-Aug-97	185	4282	4945	757	0	275	4670	4430	121382	14824
22-Aug-97	295	3666	4709	467	0	261	4448	3530	96722	11764
25-Aug-97	339	3854	4233	635	0	0	4233	4990	136726	16398
26-Aug-97	822	4328	4544	512	148	285	4407	4520	123848	22554
27-Aug-97	440	4109	4526	408	0	197	4329	4700	128780	15825
28-Aug-97	634	3695	4191	295	0	226	3965	3270	89598	10868
29-Aug-97	1122	3700	4364	344	0	286	4079	2800	76720	9147
2-Sep-97	550	3543	3974	258	331	456	3849	5180	141932	17237
3-Sep-97	695	4479	4479	666	193	264	4408	7600	208240	25304
4-Sep-97	167	4843	5276	551	184	393	5067	4350	119190	14520
5-Sep-97	663	#VALUE!	#VALUE!	512	170	364	#VALUE!	4710	129054	15695

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	Specific growth rate	mg-N growth	TKN oxidized	Overall observed	Overall observed	Nitrification	Denitrification
	mgVSS/mgMLVSS-day	mg-N/day	mg-N/day	Specific Nfication rate mgTKN/mgVSS/day	Specific DeNfication rate mgNOx/mgVSS/day	F:M loading mgTKN/mgVSS/day	F:M loading mgTKN/mgVSS/day
28-May-97	0.156	997	1404	0.021	0.055	0.065	0.209
29-May-97	0.171	877	#VALUE!	#VALUE!	#VALUE!	0.069	0.223
30-May-97	0.227	688	1033	0.022	0.075	0.080	0.259
2-Jun-97	0.068	1858	1909	0.015	0.025	0.032	0.104
4-Jun-97	0.084	1978	1772	0.013	0.037	0.029	0.095
6-Jun-97	0.143	3247	594	0.005	-0.002	0.031	0.099
9-Jun-97	0.083	1605	2324	0.021	0.054	0.036	0.115
11-Jun-97	0.082	1471	3165	0.031	0.077	0.047	0.153
13-Jun-97	0.084	1743	4438	0.038	0.103	0.056	0.182
16-Jun-97	0.082	2101	564	0.004	0.007	0.019	0.062
17-Jun-97	0.084	2010	1930	0.014	0.054	0.030	0.097
18-Jun-97	0.085	1467	3207	0.033	0.084	0.050	0.162
19-Jun-97	0.084	1994	2185	0.016	0.029	0.033	0.107
20-Jun-97	0.091	1848	989	0.008	-0.010	0.026	0.085
23-Jun-97	0.085	2027	1850	0.014	0.030	0.030	0.097
24-Jun-97	0.084	2017	1081	0.008	0.023	0.024	0.079
25-Jun-97	0.083	2370	-265	-0.002	-0.005	0.015	0.049
27-Jun-97	0.084	1519	1051	0.010	0.026	0.027	0.088
30-Jun-97	0.083	1074	4746	0.064	0.234	0.087	0.280
1-Jul-97	0.084	2218	3884	0.026	0.097	0.043	0.140
2-Jul-97	0.084	2477	3589	0.021	0.085	0.041	0.131
3-Jul-97	0.076	1462	2040	0.018	0.062	0.034	0.108
7-Jul-97	0.083	1369	3629	0.039	0.129	0.055	0.178
9-Jul-97	0.060	499	1501	0.032	0.186	0.129	0.416
11-Jul-97	0.083	1341	2357	0.025	0.092	0.053	0.170
14-Jul-97	0.083	1295	4089	0.046	0.140	0.062	0.200
16-Jul-97	0.082	1071	4032	0.054	0.160	0.071	0.228
17-Jul-97	0.084	1387	3810	0.040	0.110	0.058	0.186
18-Jul-97	0.083	1449	3609	0.036	0.093	0.054	0.173
21-Jul-97	0.084	1479	3468	0.034	0.111	0.051	0.165
22-Jul-97	0.084	1761	3248	0.027	0.098	0.043	0.138
23-Jul-97	0.083	2208	2509	0.016	0.057	0.032	0.102

Table Continued

25-Jul-97	0.001	8	4058	0.048	0.148	0.050	0.160
28-Jul-97	0.012	241	4476	0.040	0.123	0.044	0.142
30-Jul-97	0.0828	1563	4415	0.041	0.160	0.080	0.258
1-Aug-97	0.0832	1912	3705	0.028	0.079	0.075	0.242
4-Aug-97	0.0549	885	5825	0.063	0.208	0.077	0.248
5-Aug-97	0.084	1257	6706	0.078	0.259	0.101	0.326
8-Aug-97	0.083	1356	4328	0.046	0.179	0.062	0.200
11-Aug-97	0.082	1837	2961	0.023	0.109	0.039	0.127
13-Aug-97	0.082	1619	-261	-0.002	0.038	0.045	0.144
14-Aug-97	0.083	1501	2319	0.023	0.082	0.058	0.187
15-Aug-97	0.126	3313	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
18-Aug-97	0.085	1616	471	0.004	0.063	0.049	0.159
19-Aug-97	0.086	1569	5986	0.057	0.185	0.076	0.245
20-Aug-97	0.083	1795	2074	0.017	0.051	0.033	0.107
21-Aug-97	0.084	1779	2891	0.024	0.062	0.041	0.131
22-Aug-97	0.084	1412	3037	0.031	0.095	0.049	0.157
25-Aug-97	0.082	1968	2265	0.017	0.046	0.031	0.100
26-Aug-97	0.125	2706	1553	0.013	0.048	0.037	0.118
27-Aug-97	0.084	1899	2430	0.019	0.062	0.035	0.113
28-Aug-97	0.083	1304	2661	0.030	0.108	0.047	0.151
29-Aug-97	0.082	1098	2981	0.039	0.158	0.057	0.183
2-Sep-97	0.083	2068	1449	0.010	0.040	0.028	0.090
3-Sep-97	0.083	3036	1179	0.006	0.019	0.022	0.069
4-Sep-97	0.084	1742	3140	0.026	0.075	0.044	0.143
5-Sep-97	0.084	1883	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	Influent COD inf mg/day	Effluent COD eff mg/day	Methanol COD added mg/day	Bioavailable CODin/TKNin (C:N ratio) mgCOD/mgTKN
28-May-97	57557	12398	0	
29-May-97	64002	0	0	
30-May-97	68250	14100	0	
2-Jun-97	66646	6202	0	
4-Jun-97	67565	16196	0	
6-Jun-97	70502	9020	0	
11-Jun-97	71245	4815	0	16.9
12-Jun-97	65117	no data	0	#VALUE!
13-Jun-97	80196	7983	0	11.7
16-Jun-97	46380	5512	0	15.3
17-Jun-97	73094	8087	0	16.5
18-Jun-97	67460	6826	0	13.0
19-Jun-97	68296	5623	0	15.0
20-Jun-97	60480	5645	0	19.3
23-Jun-97	64207	5521	0	15.1
24-Jun-97	53525	5040	3590	16.8
25-Jun-97	50170	4052	3419	23.5
26-Jun-97	54634	5544	3419	
27-Jun-97	57456	5544	3590	21.6
30-Jun-97	60024	4625	3590	10.1
1-Jul-97	62021	7464	3590	9.5
2-Jul-97	73950	6882	3590	11.6
3-Jul-97	54225	4977	3590	15.1
5-Jul-97	57672	no data	0	no TKN data
6-Jul-97	85039	no data	0	no TKN data
7-Jul-97	75427	7124	0	13.7
9-Jul-97	87719	15365	0	36.2
11-Jul-97	87091	11889	0	20.3
14-Jul-97	70259	4609	0	12.2
16-Jul-97	76910	7903	0	13.5
17-Jul-97	63786	6209	0	11.1
18-Jul-97	62623	7465	0	10.9
21-Jul-97	66355	6083	0	12.2
22-Jul-97	76170	6636	0	13.9
23-Jul-97	73872	7524	0	14.1
25-Jul-97	58266	5476	0	13.0
30-Jul-97	95191	9098	0	14.4
1-Aug-97	106272	11159	0	16.9
4-Aug-97	73745	8214	0	9.8
5-Aug-97	87120	9720	0	9.7
7-Aug-97	#VALUE!	13427	0	no TKN data
8-Aug-97	99259	6500	0	16.3
11-Aug-97	86400	5530	0	16.9

Table Continued

13-Aug-97	189922	13939	0	129.6
14-Aug-97	131328	9331	0	31.9
15-Aug-97	110748	9020	0	#VALUE!
18-Aug-97	107340	10892	0	46.2
19-Aug-97	116476	10892	0	14.0
20-Aug-97	88646	7387	0	21.0
21-Aug-97	77976	6703	0	15.3
22-Aug-97	78113	6703	0	16.1
25-Aug-97	85344	8800	0	18.1
26-Aug-97	92716	6492	41026	29.9
27-Aug-97	no data	5587	41026	#VALUE!
28-Aug-97	91869	6160	38462	31.3
29-Aug-97	75799	6294	27351	23.7
2-Sep-97	71136	6840	28205	26.3
3-Sep-97	71136	6019	28205	22.1
4-Sep-97	67274	5550	28205	18.4
5-Sep-97	76447	9124	30770	#VALUE!

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

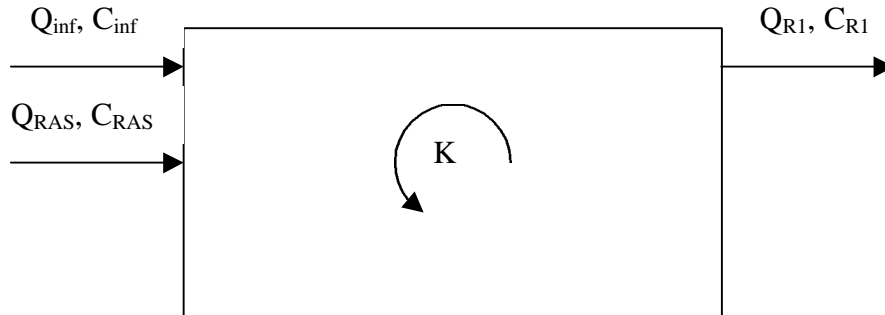
**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

## APPENDIX 7

Primary Effluent Treatment Train:  
Anaerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Anaerobic Reactor (R1) of the Primary Effluent Treatment Train



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{R1}$  = Flow rate exiting the anaerobic reactor (R1) =  $Q_{inf} + Q_{RAS}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anaerobic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{RAS} \times C_{RAS})$$

$C_{in}$  = Concentration of the constituent of interest entering the anaerobic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{RAS}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{inf} + Q_{RAS}} \right)$$

$C_{out} = C_{R1}$  (mg/L)

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	0.0	0.0	28.9	31.5	840
4-Jun-97	0.0	0.0	21.7	22.3	
11-Jun-97	0.0	0.0	23.1	25.0	186
18-Jun-97	0.4	0.0	16.9	19.9	166
23-Jun-97	0.0	0.0	15.4	17.0	160
25-Jun-97	0.0	0.0	13.5	14.6	131
30-Jun-97	0.0	0.0	35.5	31.1	159
2-Jul-97	0.6	0.0	28.0	27.7	169
14-Jul-97	0.0	0.0	18.6	20.1	344
21-Jul-97	0.0	0.0	23.1	20.5	175
23-Jul-97	0.0	0.0	11.7	11.9	150
30-Jul-97	0.0	0.0	41.9	40.8	187
4-Aug-97	0.4	0.0	26.5	25.2	174
7-Aug-97	0.0	0.0	12.1	12.9	202
13-Aug-97	0.0	0.0	28.3	24.9	237
18-Aug-97	0.1	0.0	25.8	24.8	197
20-Aug-97	0.0	0.0	20.3	18.9	188
27-Aug-97	0.1	0.0	17.6	19.9	331
3-Sep-97	0.0	0.0	19.4	18.2	474

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	NHx in mg-N/day	NHx out mg-N/day	TNin mg-N/day	TNout mg-N/day	"TKN" in mg-N/day	"SKN" out mg-N/day
28-May-97	700	0	700	5525	4831	6418	5262	5718	5262
4-Jun-97	835	0	835	4085	3620	4940	3717	4105	3717
11-Jun-97	474	0	474	4670	4163	5454	4493	4980	4493
18-Jun-97	1202	70	1131	3754	3019	6319	3553	5117	3483
23-Jun-97	601	0	601	3419	2607	4862	2873	4261	2873
25-Jun-97	502	0	502	2636	2176	3266	2358	2765	2358
30-Jun-97	3038	0	3038	6136	6104	9861	5357	6823	6104
2-Jul-97	1900	107	1793	6901	5121	9218	5058	7318	5121
14-Jul-97	979	0	979	4355	4279	6601	4624	5622	4624
21-Jul-97	1716	0	1716	5287	5311	6635	4712	5287	5311
23-Jul-97	1248	0	1248	4850	2652	5868	2688	4850	2688
30-Jul-97	2578	0	2578	10349	11645	10854	11345	10349	11645
<b>4-Aug-97</b>	<b>3534</b>	<b>118</b>	<b>3416</b>	<b>7101</b>	<b>7758</b>	<b>10291</b>	<b>7375</b>	<b>7101</b>	<b>7758</b>
7-Aug-97	#VALUE!	0	#VALUE!	#VALUE!	3575	#VALUE!	3839	#VALUE!	3839
13-Aug-97	1573	0	1573	7015	8188	8855	7213	7282	8188
18-Aug-97	2440	17	2423	7583	7554	9467	7258	7583	7554
20-Aug-97	<b>985</b>	<b>5</b>	<b>981</b>	<b>4275</b>	<b>4646</b>	<b>5198</b>	<b>4334</b>	<b>4275</b>	<b>4646</b>
27-Aug-97	717	15	702	4109	4126	5377	4680	4660	4665
3-Sep-97	1158	0	1158	4613	4488	5769	4229	4613	4488

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"TKN" in mg-N/L	"SKN" out mg-N/L
28-May-97	4.2	0.0	33.1	28.9	38.4	31.5	34.2	31.5
4-Jun-97	5.0	0.0	24.5	21.7	29.6	22.3	24.6	22.3
11-Jun-97	2.6	0.0	25.9	23.1	30.3	25.0	27.7	25.0
18-Jun-97	6.7	0.4	21.0	16.9	35.4	19.9	28.7	19.5
23-Jun-97	3.6	0.0	20.2	15.4	28.7	17.0	25.2	17.0
25-Jun-97	3.1	0.0	16.3	13.5	20.3	14.6	17.1	14.6
30-Jun-97	17.7	0.0	35.7	35.5	57.3	31.1	39.6	35.5
2-Jul-97	10.4	0.6	37.7	28.0	50.4	27.7	40.0	28.0
14-Jul-97	4.2	0.0	18.9	18.6	28.7	20.1	24.4	20.1
21-Jul-97	7.4	0.0	22.9	23.1	28.8	20.5	22.9	23.1
23-Jul-97	5.5	0.0	21.5	11.7	26.0	11.9	21.5	11.9
30-Jul-97	9.3	0.0	37.2	41.9	39.1	40.8	37.2	41.9
<b>4-Aug-97</b>	<b>12.1</b>	<b>0.4</b>	<b>24.3</b>	<b>26.5</b>	<b>35.2</b>	<b>25.2</b>	<b>24.3</b>	<b>26.5</b>
7-Aug-97	#VALUE!	0.0	#VALUE!	12.1	#VALUE!	12.9	#VALUE!	12.9
13-Aug-97	5.4	0.0	24.2	28.3	30.6	24.9	25.2	28.3
18-Aug-97	8.3	0.1	25.9	25.8	32.4	24.8	25.9	25.8
20-Aug-97	<b>4.3</b>	<b>0.0</b>	<b>18.7</b>	<b>20.3</b>	<b>22.7</b>	<b>18.9</b>	<b>18.7</b>	<b>20.3</b>
27-Aug-97	3.1	0.1	17.5	17.6	22.9	19.9	19.9	19.9
3-Sep-97	5.0	0.0	19.9	19.4	24.9	18.2	19.9	19.4

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	CODin mg/day	COD out mg/day	COD in mg/L	COD out mg/L
28-May-97	65704	140314	393	840
11-Jun-97	74350	33480	413	186
18-Jun-97	71348	29641	400	166
23-Jun-97	67823	27072	401	160
25-Jun-97	52891	21128	328	131
30-Jun-97	62970	27361	366	159
2-Jul-97	77858	30907	426	169
14-Jul-97	73253	79258	318	344
21-Jul-97	70410	40320	306	175
23-Jul-97	78782	33912	348	150
30-Jul-97	101101	51971	364	187
<b>4-Aug-97</b>	<b>78978</b>	<b>50864</b>	<b>270</b>	<b>174</b>
7-Aug-97	#VALUE!	59921	#VALUE!	202
13-Aug-97	199138	68597	688	237
18-Aug-97	114572	57587	392	197
20-Aug-97	93623	43044	409	188
27-Aug-97	#VALUE!	77692	#VALUE!	331
3-Sep-97	75318	109892	325	474

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**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

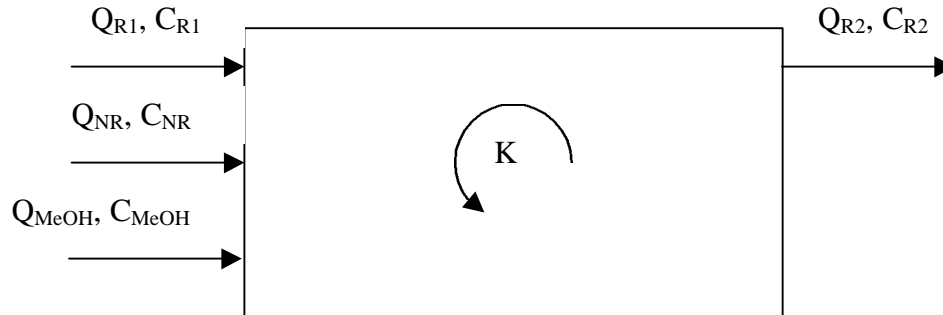
**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

## APPENDIX 8

Primary Effluent Treatment Train:  
Anoxic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Anoxic Reactor (R2) of the Primary Effluent Treatment Train



$Q_{R1}$  = Flow rate exiting the anaerobic reactor (R1) =  $Q_{inf} + Q_{RAS}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$Q_{NR}$  = Nitrate recirculation flow rate (L/day)

$C_{NR}$  = Nitrate recirculation concentration of the constituent of interest = aerobic reactor (R3) concentration (mg/L)

$Q_{MeOH}$  = Flow rate of the methanol addition (L/day)

$C_{MeOH}$  = Concentration of COD in the methanol stream (C assumed to be zero for all other constituents) (mg/L)

$Q_{R2}$  = Flow rate exiting the anoxic reactor (R2) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R2}$  = Concentration of the constituent of interest exiting R2 = the concentration measured in R2 (mg/L)

K = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anoxic reactor (mg/day)} = (Q_{R1} \times C_{R1}) + (Q_{NR} \times C_{NR}) + (Q_{MeOH} \times C_{MeOH})$$

$C_{in}$  = Concentration of the constituent of interest entering the anoxic reactor (mg/L)

$$= \left( C_{R1} \times \frac{Q_{R1}}{Q_{R1} + Q_{NR} + Q_{MeOH}} \right) + \left( C_{NR} \times \frac{Q_{NR}}{Q_{R1} + Q_{NR} + Q_{MeOH}} \right) + \left( C_{MeOH} \times \frac{Q_{MeOH}}{Q_{R1} + Q_{NR} + Q_{MeOH}} \right)$$

$$C_{out} = C_{R2} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	0.0	0.0	18.2	19.9	145
4-Jun-97	0.0	0.0	7.8	9.6	
11-Jun-97	0.0	0.0	7.1	10.1	60
18-Jun-97	0.0	0.0	18.3	21.3	171
23-Jun-97	0.0	0.0	6.1	7.3	72
25-Jun-97	0.0	0.0	4.7	5.6	66
30-Jun-97	5.5	1.2	14.8	20.6	70
2-Jul-97	9.3	0.2	4.9	16.3	49
14-Jul-97	0.0	0.0	8.6	9.9	98
21-Jul-97	0.0	0.0	9.4	9.5	72
23-Jul-97	0.0	0.0	6.6	7.2	84
30-Jul-97	0.0	0.0	29.0	26.4	98
4-Aug-97	1.3	0.0	10.7	11.6	58
7-Aug-97	0.0	0.0	4.2	5.4	100
13-Aug-97	0.0	0.0	23.1	21.3	118
18-Aug-97	0.0	0.0	17.2	17.4	95
20-Aug-97	0.0	0.0	20.1	19.8	76
27-Aug-97	0.0	0.0	7.1	8.1	100
3-Sep-97	0.0	0.0	7.6	7.6	69

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	Percent Denitrification	Observed specific	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg/day
					denitrification rate mgNOx-N/mgVSS/day							
28-May-97	1944	0	1944	100.0	0.092	6230	5883	347	8714	6432	6770	548
4-Jun-97	1363	0	1363	100.0	0.033	3620	2924	696	5455	3590	4092	666
11-Jun-97	1798	0	1798	100.0	0.057	4163	3048	1115	6758	4336	4960	1287
18-Jun-97	4073	0	4073	100.0	0.133	3019	7840	-4821	8109	9153	4035	1313
23-Jun-97	1836	0	1836	100.0	0.043	2607	2531	77	5120	3066	3284	535
25-Jun-97	626	0	626	100.0	0.012	2176	1926	250	3331	2331	2705	405
30-Jun-97	4446	2369	2077	46.7	0.090	6678	6353	325	10852	8838	6678	2485
2-Jul-97	5178	4596	582	11.2	0.011	5121	2449	2671	11114	8073	5936	5624
14-Jul-97	1936	0	1936	100.0	0.070	4279	4959	-681	6936	5714	5000	755
21-Jul-97	2936	0	2936	100.0	0.094	5311	5529	-218	7951	5593	5311	65
23-Jul-97	2297	0	2297	100.0	0.048	2652	3784	-1132	5281	4136	2984	351
30-Jul-97	2476	0	2476	100.0	0.074	20029	19947	82	21229	18120	20029	0
<b>4-Aug-97</b>	<b>5550</b>	<b>964</b>	<b>4587</b>	<b>82.6</b>	<b>0.160</b>	<b>7758</b>	<b>7796</b>	<b>-37</b>	<b>13542</b>	<b>8436</b>	<b>7992</b>	<b>640</b>
7-Aug-97	1361	0	1361	100.0	0.042	3575	3046	529	5942	3927	4581	882
13-Aug-97	0	0	0	No NOx in	0.000	16299	16717	-419	14962	15457	16299	0
18-Aug-97	2340	23	2317	99.0	0.068	12684	12830	-146	14666	12949	12684	119
20-Aug-97	<b>1606</b>	<b>14</b>	<b>1592</b>	<b>99.1</b>	<b>0.041</b>	<b>4646</b>	<b>11641</b>	<b>-6996</b>	<b>6392</b>	<b>11473</b>	<b>4786</b>	<b>0</b>
27-Aug-97	650	14	636	97.8	0.016	4126	4223	-96	5868	4835	5218	613
3-Sep-97	1834	0	1834	100.0	0.028	4488	4504	-15	6612	4522	4778	18

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**NOTE:** Indicates non-steady state (transitional) day.

**Nitrogen Mass Balances**

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L
28-May-97	6.0	0.0	19.3	18.2	27.0	19.9	21.0	19.9
4-Jun-97	3.7	0.0	9.7	7.8	14.6	9.6	11.0	9.6
11-Jun-97	4.2	0.0	9.7	7.1	15.7	10.1	11.5	10.1
18-Jun-97	9.5	0.0	7.0	18.3	18.9	21.3	9.4	21.3
23-Jun-97	4.4	0.0	6.2	6.1	12.2	7.3	7.9	7.3
25-Jun-97	1.5	0.0	5.3	4.7	8.1	5.6	6.5	5.6
30-Jun-97	10.4	5.5	15.6	14.8	25.3	20.6	15.6	15.1
2-Jul-97	10.4	9.3	10.3	4.9	22.4	16.3	11.9	7.0
14-Jul-97	3.4	0.0	7.4	8.6	12.0	9.9	8.7	9.9
21-Jul-97	5.0	0.0	9.0	9.4	13.5	9.5	9.0	9.5
23-Jul-97	4.0	0.0	4.6	6.6	9.2	7.2	5.2	7.2
30-Jul-97	3.6	0.0	29.2	29.0	30.9	26.4	29.2	29.0
<b>4-Aug-97</b>	<b>7.6</b>	<b>1.3</b>	<b>10.7</b>	<b>10.7</b>	<b>18.6</b>	<b>11.6</b>	<b>11.0</b>	<b>10.7</b>
7-Aug-97	1.9	0.0	4.9	4.2	8.2	5.4	6.3	5.4
13-Aug-97	0.0	0.0	22.5	23.1	20.7	21.3	22.5	23.1
18-Aug-97	3.1	0.0	17.0	17.2	19.7	17.4	17.0	17.3
20-Aug-97	<b>2.8</b>	<b>0.0</b>	<b>8.0</b>	<b>20.1</b>	<b>11.0</b>	<b>19.8</b>	<b>8.3</b>	<b>20.1</b>
27-Aug-97	1.1	0.0	6.9	7.1	9.9	8.1	8.8	8.1
3-Sep-97	3.1	0.0	7.6	7.6	11.2	7.6	8.1	7.6

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### COD Mass Balances

Date	CODin mg/day	COD out mg/day	COD added (MeOH) mg/day	TOTAL COD in mg/day	COD in mg/L	COD out mg/L
28-May-97	161464	46771	0	161464	501	145
11-Jun-97	43502	25834	0	43502	101	60
18-Jun-97	45677	73380	0	45677	106	171
23-Jun-97	41521	30119	0	41521	99	72
25-Jun-97	30956	27467	3419	34375	74	66
30-Jun-97	39151	30200	3590	42741	91	70
2-Jul-97	45975	24491	3590	49565	92	49
14-Jul-97	94810	56448	0	94810	165	98
21-Jul-97	57105	42301	0	57105	97	72
23-Jul-97	54207	48384	0	54207	94	84
30-Jul-97	69147	67314	0	69147	101	98
<b>4-Aug-97</b>	<b>70433</b>	<b>42178</b>	<b>0</b>	<b>70433</b>	<b>97</b>	<b>58</b>
7-Aug-97	91889	72864	0	91889	126	100
13-Aug-97	99474	85470	0	99474	137	118
18-Aug-97	78906	70862	0	78906	106	95
20-Aug-97	58091	43995	0	58091	100	76
27-Aug-97	100012	60163	41026	141038	166	100
3-Sep-97	126452	41165	28205	154658	212	69

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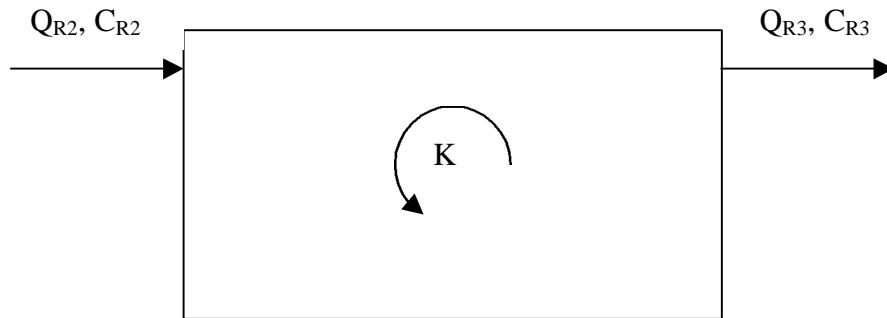
**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

## APPENDIX 9

Primary Effluent Treatment Train:  
Aerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Aerobic Reactor (R3) of the Primary Effluent Treatment Train



$Q_{R2}$  = Flow rate exiting the anoxic reactor (R2) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R2}$  = Concentration of the constituent of interest exiting R2 = the concentration measured in R2 (mg/L)

$Q_{R3}$  = Flow rate exiting the aerobic reactor (R3) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R3}$  = Concentration of the constituent of interest exiting R3 = the concentration measured in R3 (mg/L)

$K$  = Reaction term (e.g., Nitrogen assimilation,  $NO_x$  production, COD consumption, etc.)

Total loading to aerobic reactor (mg/day) =  $Q_{R2} \times C_{R2}$

$C_{in}$  = Concentration of the constituent of interest entering the aerobic reactor =  $C_{R2}$  (mg/L)

$C_{out}$  =  $C_{R3}$  (mg/L)

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	12.5	0.1	9.0	22.2	136
4-Jun-97	6.6	0.0	0.0	8.4	
11-Jun-97	7.2	0.0	0.0	9.0	40
18-Jun-97	16.0	0.0	0.0	18.2	64
23-Jun-97	7.4	0.0	0.0	9.0	58
25-Jun-97	2.5	0.0	0.0	3.9	39
30-Jun-97	17.3	3.3	2.2	21.4	46
2-Jul-97	16.2	0.0	0.0	19.3	48
14-Jul-97	5.6	0.1	0.0	6.7	45
21-Jul-97	8.2	0.2	0.0	9.1	47
23-Jul-97	6.6	0.0	0.0	7.4	58
30-Jul-97	6.1	0.3	20.5	24.2	42
4-Aug-97	12.5	1.0	0.0	14.2	45
7-Aug-97	3.2	0.0	0.0	4.9	74
13-Aug-97	0.0	0.0	18.7	17.8	71
18-Aug-97	5.1	0.8	11.3	16.3	47
20-Aug-97	4.6	0.3	0.0	5.9	43
27-Aug-97	1.8	0.0	0.0	3.3	62
3-Sep-97	5.1	1.0	0.0	6.6	46

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxout-NOxin mg-N/day	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	TNin-TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg-N/day	SKNin-SKNout mg-N/day
28-May-97	0	4032	4032	5883	2903	2980	6432	7161	-729	6432	3129	3303
4-Jun-97	0	2468	2468	2924	0	2924	3590	3148	442	3590	680	2910
11-Jun-97	0	3089	3089	3048	0	3048	4336	3892	443	4336	803	3532
18-Jun-97	0	6856	6856	7840	0	7840	9153	7801	1352	9153	945	8208
23-Jun-97	0	3083	3083	2531	0	2531	3066	3773	-707	3066	690	2376
25-Jun-97	0	1026	1026	1926	0	1926	2331	1595	736	2331	569	1762
30-Jun-97	2369	7431	5062	6353	960	5394	8838	9185	-347	6468	1754	4715
2-Jul-97	4596	8024	3428	2449	0	2449	8073	9583	-1510	3477	1559	1918
14-Jul-97	0	3227	3227	4959	0	4959	5714	3853	1860	5714	626	5088
21-Jul-97	0	4830	4830	5529	0	5529	5593	5329	264	5593	499	5094
23-Jul-97	0	3780	3780	3784	0	3784	4136	4268	-132	4136	488	3648
30-Jul-97	0	4158	4158	19947	14081	5866	18120	16602	1518	19947	14081	5866
<b>4-Aug-97</b>	<b>964</b>	<b>9083</b>	<b>8120</b>	<b>7796</b>	<b>0</b>	<b>7796</b>	<b>8436</b>	<b>10312</b>	<b>-1876</b>	<b>7796</b>	<b>1228</b>	<b>6567</b>
7-Aug-97	0	2296	2296	3046	0	3046	3927	3548	379	3927	1253	2675
13-Aug-97	0	0	0	16717	13509	3209	15457	12907	2550	16717	13509	3209
18-Aug-97	23	3820	3797	12830	8436	4393	12949	12181	768	12926	8436	4490
20-Aug-97	<b>14</b>	<b>2649</b>	<b>2635</b>	<b>11641</b>	<b>0</b>	<b>11641</b>	<b>11473</b>	<b>3404</b>	<b>8070</b>	<b>11641</b>	<b>755</b>	<b>10886</b>
27-Aug-97	14	1048	1034	4223	0	4223	4835	1963	2872	4821	914	3907
3-Sep-97	0	3015	3015	4504	0	4504	4522	3918	604	4522	903	3619

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### Nitrogen Mass Balances

Date	MINIMUM			Minimum observed specific nitrification rate mgAvail.TKN/mgVSS/day	Observed specific NOx production rate mgNOx-N/mgVSS/day
	N growth mg-N/day	TKN oxidized mg-N/day	Aerobic Biomass mg of VSS		
28-May-97	997	2306	67952	0.034	0.059
4-Jun-97	1978	932	133438	0.007	0.018
11-Jun-97	1471	2061	102202	0.020	0.030
18-Jun-97	1467	6740	98640	0.068	0.070
23-Jun-97	2027	349	136452	0.003	0.023
25-Jun-97	2370	-609	163030	-0.004	0.006
30-Jun-97	1074	3641	73980	0.049	0.068
2-Jul-97	2477	-559	168784	-0.003	0.020
14-Jul-97	1295	3793	89324	0.042	0.036
21-Jul-97	1479	3615	101106	0.036	0.048
23-Jul-97	2208	1440	152892	0.009	0.025
30-Jul-97	1563	4303	107956	0.040	0.039
<b>4-Aug-97</b>	<b>885</b>	<b>5682</b>	<b>92338</b>	<b>0.062</b>	<b>0.088</b>
7-Aug-97	1515	1159	103298	0.011	0.022
13-Aug-97	1619	1589	112340	0.014	0.000
18-Aug-97	1616	2874	109326	0.026	0.035
20-Aug-97	<b>1795</b>	<b>9091</b>	<b>124396</b>	<b>0.073</b>	<b>0.021</b>
27-Aug-97	1899	2008	128780	0.016	0.008
3-Sep-97	3036	582	208240	0.003	0.014

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**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg/L	NOx out mg/L	delNOx mg/L	NHx in mg/L	NHx out mg/L	delNHx mg/L	TNin mg/L	TNout mg/L	delTN mg/L	"SKN" in mg/L	"SKN" out mg/L	del"TKN" mg/L
28-May-97	0.0	12.5	12.5	18.2	9.0	9.2	19.9	22.2	-2.3	19.9	9.7	10.2
4-Jun-97	0.0	6.6	6.6	7.8	0.0	7.8	9.6	8.4	1.2	9.6	1.8	7.8
11-Jun-97	0.0	7.2	7.2	7.1	0.0	7.1	10.1	9.0	1.0	10.1	1.9	8.2
18-Jun-97	0.0	16.0	16.0	18.3	0.0	18.3	21.3	18.2	3.2	21.3	2.2	19.1
23-Jun-97	0.0	7.4	7.4	6.1	0.0	6.1	7.3	9.0	-1.7	7.3	1.7	5.7
25-Jun-97	0.0	2.5	2.5	4.7	0.0	4.7	5.6	3.9	1.8	5.6	1.4	4.3
30-Jun-97	5.5	17.3	11.8	14.8	2.2	12.6	20.6	21.4	-0.8	15.1	4.1	11.0
2-Jul-97	9.3	16.2	6.9	4.9	0.0	4.9	16.3	19.3	-3.0	7.0	3.1	3.9
14-Jul-97	0.0	5.6	5.6	8.6	0.0	8.6	9.9	6.7	3.2	9.9	1.1	8.8
21-Jul-97	0.0	8.2	8.2	9.4	0.0	9.4	9.5	9.1	0.4	9.5	0.8	8.7
23-Jul-97	0.0	6.6	6.6	6.6	0.0	6.6	7.2	7.4	-0.2	7.2	0.8	6.3
30-Jul-97	0.0	6.1	6.1	29.0	20.5	8.5	26.4	24.2	2.2	29.0	20.5	8.5
<b>4-Aug-97</b>	<b>1.3</b>	<b>12.5</b>	<b>11.2</b>	<b>10.7</b>	<b>0.0</b>	<b>10.7</b>	<b>11.6</b>	<b>14.2</b>	<b>-2.6</b>	<b>10.7</b>	<b>1.7</b>	<b>9.0</b>
7-Aug-97	0.0	3.2	3.2	4.2	0.0	4.2	5.4	4.9	0.5	5.4	1.7	3.7
13-Aug-97	0.0	0.0	0.0	23.1	18.7	4.4	21.3	17.8	3.5	23.1	18.7	4.4
18-Aug-97	0.0	5.1	5.1	17.2	11.3	5.9	17.4	16.3	1.0	17.3	11.3	6.0
20-Aug-97	<b>0.0</b>	<b>4.6</b>	<b>4.6</b>	<b>20.1</b>	<b>0.0</b>	<b>20.1</b>	<b>19.8</b>	<b>5.9</b>	<b>13.9</b>	<b>20.1</b>	<b>1.3</b>	<b>18.8</b>
27-Aug-97	0.0	1.8	1.7	7.1	0.0	7.1	8.1	3.3	4.8	8.1	1.5	6.6
3-Sep-97	0.0	5.1	5.1	7.6	0.0	7.6	7.6	6.6	1.0	7.6	1.5	6.1

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

**COD Mass Balances**

Date	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L
28-May-97	46771	0	46771	145	136
11-Jun-97	25834	17222	8611	60	40
18-Jun-97	73380	27464	45916	171	64
23-Jun-97	30119	24263	5856	72	58
25-Jun-97	27467	16230	11236	66	39
30-Jun-97	30200	19846	10354	70	46
2-Jul-97	24491	23992	500	49	48
14-Jul-97	56448	25920	30528	98	45
21-Jul-97	42301	27613	14688	72	47
23-Jul-97	48384	33408	14976	84	58
30-Jul-97	67314	28849	38465	98	42
<b>4-Aug-97</b>	<b>42178</b>	<b>32724</b>	<b>9454</b>	<b>58</b>	<b>45</b>
7-Aug-97	72864	53919	18945	100	74
13-Aug-97	85470	51427	34043	118	71
18-Aug-97	70862	35058	35804	95	47
20-Aug-97	43995	24892	19103	76	43
27-Aug-97	60163	37301	22862	100	62
3-Sep-97	41165	27443	13722	69	46

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values were used for steady state calculations because of lack of data.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 10

Primary Effluent Treatment Train:  
Biosolids data and calculations

Date	MLSS			Final Effluent (ETSS) (mg/L)	MLVSS			Actual SRT (days)
	Anaerobic reactor (R1) (mg/L)	Anoxic reactor (R2) (mg/L)	Aerobic reactor (R3) (mg/L)		Aerobic reactor (R1) (mg/L)	Theoretical Wastage (L)	Manual Wastage (L)	
19-May-97							0.0	
20-May-97							0.0	
21-May-97							1.5	
22-May-97			3650				0.0	
23-May-97			4030				0.0	
24-May-97			3590	140.0			0.0	
25-May-97			2180	38.0			0.0	
26-May-97							0.0	
27-May-97			4130	25.0		2.8	2.6	12.5
28-May-97			3100	20.0		2.7	2.7	11.9
29-May-97			2735	14.5		2.8	2.8	11.9
30-May-97			2140	26.0		2.2	2.2	11.9
31-May-97			6030	16.5		3.1	3.1	12.0
1-Jun-97			5630	8.0		3.2	3.2	12.0
2-Jun-97	4940	5470	5820	6.9		3.2	3.2	12.0
3-Jun-97			4820	3.6	3856	3.3	3.2	12.2
4-Jun-97	5590	5980	6180	17.0	4870	3.1	3.1	12.0
5-Jun-97			6760	152.0	5350	1.2	1.2	11.8
6-Jun-97			5920	14.0	4736	3.1	3.1	12.0
7-Jun-97			5670	13.5	4460	3.1	3.1	12.0
8-Jun-97			5420	15.0	4336	3.1	3.1	12.0
9-Jun-97	4220	4950	5080	14.8	4060	3.0	3.0	12.1
10-Jun-97			4940	14.6	4020	3.0	3.0	12.1
11-Jun-97	3350	4270	4700	8.0	3730	3.1	3.1	12.2
12-Jun-97			5290	18.5	4200	3.0	3.0	11.9
13-Jun-97			5415	13.7	4315	3.1	3.1	12.0
14-Jun-97			6540	19.3	5232	3.0	3.0	12.0
15-Jun-97			5890	23.0	4690	2.9	3.0	12.0
16-Jun-97	5910	6740	6800	20.4	5330	3.0	3.0	12.1
17-Jun-97			6250	20.3	5020	3.0	3.0	12.0
18-Jun-97	5540	10960	4580	20.8	3600	2.9	2.9	12.0
19-Jun-97			6300	17.0	4980	3.1	3.1	12.0
20-Jun-97			5380	16.8	4260	3.0	3.3	11.0
21-Jun-97			6950	28.0	5450	2.9	2.9	11.9
22-Jun-97			5420	14.0	4270	3.1	3.1	12.0
23-Jun-97	5960	6410	6460	50.0	4980	2.6	2.6	11.8
24-Jun-97			6420	22.2	5020	3.0	3.0	11.9
25-Jun-97	6810	7350	7690	25.5	5950	3.0	3.0	12.0
26-Jun-97			6120	8.8	4720	3.2	3.2	12.0
27-Jun-97			4810	17.2	3790	3.0	3.0	11.9
28-Jun-97			4730	24.0	3630	2.8	2.8	12.0
29-Jun-97			4040	16.7	3160	2.9	2.9	12.0
30-Jun-97	5690	3900	3480	10.4	2700	3.0	3.0	12.0
1-Jul-97			7000	24.0	5500	3.0	3.0	11.9
2-Jul-97	1120	6780	7820	10.8	6160	3.2	3.2	11.9
3-Jul-97			5220	44.0	4030	2.5	2.2	13.2
4-Jul-97			5640	45.3	4450	2.2	2.2	11.9

Table Continued

5-Jul-97			4460	11.3	3550	3.0	3.0	12.0
6-Jul-97			5780	11.5	4530	3.1	3.1	12.0
7-Jul-97	3990	4280	4350	13.3	3430	2.9	2.9	12.0
8-Jul-97			2890	100.0	2190	-1.7	0.0	8.1
9-Jul-97	1530	1540	2250	38.7	1730	0.9	0.0	16.6
10-Jul-97			2770	2.3	2210	3.2	3.2	12.0
11-Jul-97			4275	12.4	3385	2.9	2.9	12.1
12-Jul-97			4300	1.4	3440	3.3	3.3	11.9
13-Jul-97			3740	3.4	2940	3.2	3.2	12.0
14-Jul-97	1280	3310	4030	3.2	3260	3.2	3.2	12.1
15-Jul-97			4770	12.0	3950	3.0	3.0	12.0
16-Jul-97	2650	3210	3300	6.6	2720	3.0	3.0	12.2
17-Jul-97			4110	22.1	3440	2.6	2.6	11.9
18-Jul-97			4410	4.0	3630	3.2	3.2	12.0
19-Jul-97			5450	3.4	4470	3.2	3.2	12.1
20-Jul-97			4540	10.4	3740	3.0	3.0	12.0
21-Jul-97	4860	6900	4480	7.8	3690	3.1	3.1	11.9
22-Jul-97			5290	20.8	4390	2.8	2.8	11.9
23-Jul-97	7070	6490	6740	4.8	5580	3.2	3.2	12.1
24-Jul-97			3920	4.0	3240	3.2	0.0	278.5
25-Jul-97			3780	0.6	3090	3.3	0.0	1790.4
26-Jul-97			4680	2.2	3740	3.3	3.3	12.0
27-Jul-97			3800	2.6	3140	3.2	3.2	12.1
28-Jul-97	5000	4290	4890	17.4	4090	2.8	0.0	81.1
29-Jul-97			3910	9.8	3190	2.9	2.9	11.9
30-Jul-97	3680	4280	4760	5.8	3940	3.1	3.1	12.1
31-Jul-97			2870	21.9	2380	2.0	2.0	11.9
1-Aug-97			5770	15.6	4800	2.9	2.8	12.0
2-Aug-97			3880	26.9	3190	2.1	2.1	12.0
3-Aug-97			4280	25.8	3500	2.3	2.3	12.0
4-Aug-97	3740	3740	4000	13.2	3370	2.7	1.6	18.2
5-Aug-97			3620	7.2	3120	3.0	3.0	11.9
6-Aug-97	4010	4460	4420	9.4	3770	2.9	3.0	11.8
7-Aug-97			4550	18.8	3770	2.6	2.6	11.9
8-Aug-97			4160	4.6	3430	3.1	3.1	12.1
9-Aug-97			3230	18.8	2710	2.3	2.3	11.9
10-Aug-97			4530	6.0	3750	3.1	3.1	12.0
11-Aug-97	5850	5200	5630	6.0	4660	3.1	3.1	12.1
12-Aug-97			6290	28.4	4620	2.6	2.6	11.8
13-Aug-97	4490	5040	5570	22.1	4100	2.6	2.6	12.1
14-Aug-97			4400	4.0	3760	3.2	3.2	12.0
15-Aug-97			6540	5.4	5480	3.2	4.9	7.9
16-Aug-97			6500	9.2	5450	3.1	3.1	11.9
17-Aug-97			3970	3.6	3270	3.2	3.2	11.9
18-Aug-97	4630	5180	5630	12.0	3990	3.0	3.0	11.8
19-Aug-97			4500	10.6	3830	2.9	3.0	11.7
20-Aug-97	2750	4750	5460	3.8	4540	3.2	3.2	12.1
21-Aug-97			5310	1.8	4430	3.3	3.3	11.9
22-Aug-97			4200	1.0	3530	3.3	3.3	12.0
23-Aug-97			4890	5.4	4110	3.2	3.2	12.0
24-Aug-97			4390	4.6	3670	3.2	3.2	12.0
25-Aug-97	4880	5140	5840	3.6	4990	3.2	3.2	12.1

Table Continued

26-Aug-97			5340	3.4	4520	3.2	4.9	8.0
27-Aug-97	4280	5080	5520	6.6	4700	3.2	3.2	11.9
28-Aug-97			3820	7.8	3270	3.0	3.1	12.0
29-Aug-97			3260	34.0	2800	1.9	1.9	11.9
30-Aug-97			3120	134.0	2680	-2.9	0.0	6.6
31-Aug-97			3600	46.7	3040	1.5	1.5	11.9
1-Sep-97							1.5	
2-Sep-97			6010	10.0	5180	3.1	3.1	12.0
3-Sep-97	5420	6430	8880	11.0	7600	3.2	3.2	12.0
4-Sep-97			5120	9.0	4350	3.1	3.1	12.0
5-Sep-97			5610	7.8	4710	3.1	3.1	12.0
6-Sep-97			4550	8.0	3880	3.1	3.1	11.9
7-Sep-97			2920	11.3	2510	2.8	2.8	12.0
8-Sep-97	7060	3310	2270	31.2	1930	1.4	2.3	9.4
9-Sep-97			6520	36.8	5470	2.6	2.6	11.8
10-Sep-97	7520	5880	5090	22.0	4300	2.7	2.8	11.8
11-Sep-97			5480	9.3	4580	3.1	3.1	12.0
12-Sep-97			6350	10.6	5410	3.1	3.1	12.0

**NOTE:** Indicates the MLVSS was not determined directly and was estimated to be 80% of the MLSS.

**NOTE:** Indicates a spill occurred and the amount of biomass wasted (as well as the SRT) are thus estimated.

APPENDIX 11

Primary Effluent Treatment Train:  
Flow rate data

Date	Influent mL/min	Phosphoric acid addition mL/min	Alkalinity addition mL/min	Methanol addition mL/min	Return Activated Sludge (RAS) mL/min	Nitrate Recirculation (NR) mL/min
19-May-97	67	0.0	1.8	0	50	110
20-May-97	69	0.7	1.6	0	55	114
21-May-97	70	0.8	1.7-1.1	0	68	120-109
22-May-97	70	0.8	1.1	0	47	112
23-May-97	71	0.8	1.4	0	48	110
24-May-97	70			0		
25-May-97	72	1.1		0		
26-May-97				0		
27-May-97	67	1.5		0	46	108
28-May-97	70	1.1	1.1	0		
29-May-97	71			0	45	109
30-May-97	68	1.0	1.2	0	48	110
31-May-97	69			0	47	
1-Jun-97	67			0	47	
2-Jun-97	73	0.9	1.0	0		
3-Jun-97	68			0	47	110
4-Jun-97	69	1.2	1.2	0		143-170
5-Jun-97	67	1.2	1.2	0	46	160
6-Jun-97	72	1.1	1.2	0	45	162-165
7-Jun-97	67	1.0	1.2	0	47	162-172
8-Jun-97	66		0.8	0	46	174
9-Jun-97	70	0.8	0.7	0		
10-Jun-97	72		0.7	0	47	178
11-Jun-97	74	0-1.1	0.8	0	49-43	174
12-Jun-97	70	0.5	0.8	0	45	174
13-Jun-97	69	0.5	0.3	0	45	176
14-Jun-97	70	0.6	0.3	0	46	178
15-Jun-97	69		0.3	0	45	178
16-Jun-97	66	0.5	0.3	0		
17-Jun-97	72		0.3	0	45	174
18-Jun-97	70	0.5	0.3	0		
19-Jun-97	71		0.3	0	46	173
20-Jun-97	70	0.5	0.3	0	46	172
21-Jun-97	69		0.3	0	46	175
22-Jun-97	72		0.3	0	47	173
23-Jun-97	71	0.4	0.8	0		
24-Jun-97	70		0.8	2.1	45	175
25-Jun-97	67	0.6	0.7	2.0		
26-Jun-97	70		0.0	2.0	42	172
27-Jun-97	70	0.6	0.0	2.1	47	176
28-Jun-97	72	0.6	0.0	2.0	47	178
29-Jun-97	70		0.0	2.0	47	
30-Jun-97	73	0.6	0.0	2.1		215
1-Jul-97	73		0.0	2.1	46	218
2-Jul-97	81	0.5	0.0	2.1		
3-Jul-97	81	0.5	0.0	0	63	243

Table Continued

4-Jul-97	96	0.5	0.0	0	62	180-242
5-Jul-97	99		0.0	0	63	172-245
6-Jul-97	96		0.0	0	64	285-244
7-Jul-97	97	0.5	0.0	0		
8-Jul-97	99		0.0	0	66	240
9-Jul-97	97	0.5	0.0	0	68-64	228-242
10-Jul-97	96		0.0	0	64	220-242
11-Jul-97	96	0.5	0.0	0	64	250
12-Jul-97	97	0-7	0.0	0	63	0-250
13-Jul-97	97		0.0	0	63	260-240
14-Jul-97	97	0.6	0.0	0		
15-Jul-97	98		0.0	0	68	240
16-Jul-97	98	0.5	0.0	0	63	245
17-Jul-97	98		0.0	0	66	249
18-Jul-97	96	0.6	0.0	0	62	248
19-Jul-97	98		0.0	0	64	247
20-Jul-97	99	0.6	0.0	0	64	248
21-Jul-97	96		0.0	0		
22-Jul-97	96		0.0	0	62	243
23-Jul-97	95	0.7	0.0	0		
24-Jul-97	98	0.6	0.0	0	63	135-242
25-Jul-97	98	0.7	0.0	0	64	238
26-Jul-97	98		0.0	0	64	234-241
27-Jul-97	98		0.0	0	67-64	235-243
28-Jul-97	96	0.5	0.0	0		
29-Jul-97	122		0.0	0	80	304
30-Jul-97	120	0.9	0.0	0	76	284-296
31-Jul-97	122		0.0	0	78	292-300
1-Aug-97	123	0.8	0.0	0	75	302
2-Aug-97	122		0.0	0	79	300
3-Aug-97	124		0.0	0	79	295-302
4-Aug-97	124	0.9	0.0	0		
5-Aug-97	125		0.0	0	80	301
6-Aug-97	126	1.0	0.0	0	79	295
7-Aug-97	126		0.0	0	80	300
8-Aug-97	122		0.0	0	80	300
9-Aug-97	124	1.7	0.0	0	78	297
10-Aug-97	124		0.0	0	79	305
11-Aug-97	120	1.6	0.0	0		
12-Aug-97	120		0.0	0	80	302
13-Aug-97	121	1.6	0.0	0		
14-Aug-97	120		0.0	0	80	305
15-Aug-97	122		0.0	0	80	310
16-Aug-97	123		0.0	0	80	315
17-Aug-97	122		0.0	0	83-81	315
18-Aug-97	122	0.8	0.0	0		
19-Aug-97	122		0.0	0	64	243
20-Aug-97	95	0.8	0.0	0		
21-Aug-97	95		0.0	0	65	244
22-Aug-97	95	0.8	0.0	0	65	243
23-Aug-97	98		0.0	0	62	248
24-Aug-97	96		0.0	0	66	250

Table Continued

25-Aug-97	97	0.8	0.0	0		
26-Aug-97	98		0.0	4.8	66	250
27-Aug-97	97	0.9	0.0	4.8		
28-Aug-97	96	0.9	0.0	4.5	65	254
29-Aug-97	98	0.9	0.0	3.2	62	256
30-Aug-97	98		0.0	3.2	62	256
31-Aug-97	97		0.0	3.2	63	256
1-Sep-97			0.0	3.2		
2-Sep-97	95		0.0	3.3	66	250
3-Sep-97	95	0.9	0.0	3.3		
4-Sep-97	94		0.0	3.3	65	250
5-Sep-97	96	1.2	0.0	3.6	64	250
6-Sep-97	98		0.0	3.0	63	256
7-Sep-97	95		0.0	3.2	63	256
8-Sep-97	98	1.1	0.0	3.2		
9-Sep-97	96		0.0	3.2	66	250
10-Sep-97	95	1.1	0.0	3.2		
11-Sep-97	95		0.0	3.2	68	250
12-Sep-97	95	1.3	0.0	3.2	61	248

**NOTE:** Ranges listed for flow rates signify that the flow was adjusted from the first value to the second.

**NOTE:** Grey cells indicate the flow rate was adjusted from the initial measured flow rate to the indicated flow rate. The flow rate shown is the one used for any related calculation.

## APPENDIX 12

Heated Primary Effluent Treatment Train:  
Overall system influent and effluent nitrogen and COD raw data and mass balances

**Nitrogen Raw Data**

Date	Influent Nutrient Concentrations				Effluent Nutrient Concentrations			
	NO3+NO2	NO2	NHx	TN	NO3+NO2	NO2	NHx	TN
	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L
27-May-97	0.0	0.0	10.0	13.1	0.0	0.0	18.0	21.7
28-May-97								
29-May-97	0.0	0.0	7.5	8.5	0.0	0.0	4.1	5.8
30-May-97	0.0	0.0	6.2	7.4	0.0	0.0	2.3	4.2
31-May-97								
1-Jun-97								
2-Jun-97								
3-Jun-97	0.0	0.0	6.2	7.0	1.5	1.3	1.9	4.0
4-Jun-97								
5-Jun-97								
6-Jun-97	0.0	0.0	4.8	7.0	3.0	2.4	0.0	3.9
7-Jun-97								
8-Jun-97								
9-Jun-97								
10-Jun-97	0.0	0.0	11.9	14.2	7.5	4.2	0.0	8.2
11-Jun-97								
12-Jun-97	0.0	0.1	11.5	13.5	8.3	5.4	0.0	9.7
13-Jun-97	0.0	0.1	9.4	16.7	9.4	7.1	0.0	13.5
14-Jun-97								
15-Jun-97								
16-Jun-97								
17-Jun-97	0.0	0.3	8.3	4.52?	0.3	0.1	0.0	1.4
18-Jun-97								
19-Jun-97	0.0	0.2	9.2	12.2	0.2	0.0	0.0	1.9
20-Jun-97	0.0	0.2	3.9	6.1	0.2	0.0	2.1	3.5
21-Jun-97								
22-Jun-97								
23-Jun-97	0.0	0.0	3.7	6.6	0.4	0.3	2.8	4.3
24-Jun-97								
25-Jun-97								
26-Jun-97	0.0	0.0	4.7	4.3	0.0	0.0	0.0	0.0
27-Jun-97	0.0	0.1	8.6	9.5	0.2	0.0	0.0	1.1
28-Jun-97								
29-Jun-97								
30-Jun-97								
1-Jul-97	0.0	0.0	10.7	12.4	3.4	3.6	5.8	10.6
2-Jul-97								
3-Jul-97	0.0	0.0	8.6	10.4	6.1	6.3	0.0	7.2
4-Jul-97								
5-Jul-97								
6-Jul-97								
7-Jul-97								
8-Jul-97	0.0	0.1	11.0	12.0	2.7	1.0	0.0	3.8
9-Jul-97								
10-Jul-97	0.0	0.0	9.3	10.6	4.5	0.4	0.0	5.9
11-Jul-97								
12-Jul-97								

Table Continued

13-Jul-97								
14-Jul-97								
15-Jul-97	0.0	0.0	8.7	10.8	4.9	0.1	0.0	6.0
16-Jul-97								
17-Jul-97								
18-Jul-97	0.0	0.1	9.1	10.0	2.1	0.5	1.1	3.9
19-Jul-97								
20-Jul-97								
21-Jul-97								
22-Jul-97	0.0	0.0	12.3	12.9	6.9	0.1	0.0	7.4
23-Jul-97								
24-Jul-97	0.0	0.0	23.5	22.9	11.0	0.1	0.0	11.3
25-Jul-97	0.0	0.0	28.3	26.1	17.0	0.0	0.0	17.2
26-Jul-97								
27-Jul-97								
28-Jul-97								
29-Jul-97	0.0	0.0	27.0	26.4	20.8	0.1	0.0	21.0
30-Jul-97								
31-Jul-97	0.0	0.0	29.3	26.9	20.5	0.0	2.8	24.9
1-Aug-97	0.0	0.0	24.9	21.8	20.6	0.0	3.3	24.6
2-Aug-97								
3-Aug-97								
4-Aug-97								
5-Aug-97								
6-Aug-97								
7-Aug-97	?	?	?	?	9.8	0.2	19.6	29.8
8-Aug-97	10.3	7.7	30.9	43.5	8.9	0.2	15.5	24.6
9-Aug-97								
10-Aug-97								
11-Aug-97								
12-Aug-97	3.7	2.3	34.1	41.1	15.6	0.4	4.8	23.0
13-Aug-97								
14-Aug-97	2.5	3.1	31.8	37.1	9.3	0.1	4.9	15.3
15-Aug-97	?	3.8	30.3	37.8	?	0.0	3.9	16.9
16-Aug-97								
17-Aug-97								
18-Aug-97								
19-Aug-97	4.7	2.4	37.2	50.0	5.2	0.9	14.2	20.7
20-Aug-97								
21-Aug-97	1.4	1.2	31.3	37.5	19.0	1.0	5.3	25.0
22-Aug-97	2.2	1.8	26.8	36.6	15.5	0.4	6.1	23.9
23-Aug-97								
24-Aug-97								
25-Aug-97	2.4	2.7	27.6	32.7	22.4	0.4	0.0	27.3
26-Aug-97	5.8	4.3	30.7	38.0	23.3	0.3	0.0	26.0
27-Aug-97	3.1	2.7	29.4	35.6	17.3	0.5	0.0	19.2
28-Aug-97	4.7	3.9	27.6	36.0	10.3	0.3	0.0	12.4
29-Aug-97	8.4	3.8	27.6	41.0	5.8	0.3	0.0	7.5
30-Aug-97								
31-Aug-97								
1-Sep-97								
2-Sep-97	4.0	3.0	25.9	33.1	3.7	0.0	0.0	5.2

Table Continued

3-Sep-97	5.1	4.8	32.7	37.5	5.7	0.0	0.0	6.6
4-Sep-97	1.2	1.0	35.8	40.2	8.3	0.0	0.0	9.8
5-Sep-97	4.8	3.1	?	37.4	5.3	0.0	?	7.0
6-Sep-97								
7-Sep-97								
8-Sep-97	8.1	7.4	23.1	35.1	5.0	0.0	0.0	6.0
9-Sep-97	8.1	5.2	25.1	37.3	3.8	0.0	0.0	4.8
10-Sep-97	12.0	5.2	25.5	41.5	3.9	0.0	0.0	5.4
11-Sep-97	no sample	no sample	no sample	no sample	3.1	0.0	0.0	4.5
12-Sep-97	0.5	0.4	24.1	29.7	3.0	0.0	0.0	4.2

**COD Raw Data**

Date	Influent COD mg/L	Effluent COD mg/L
27-May-97	356	136
28-May-97		
29-May-97	408	262
30-May-97	351	167
31-May-97		
1-Jun-97		
2-Jun-97		
3-Jun-97	482	80
4-Jun-97		
5-Jun-97	488	160
6-Jun-97	596	87
7-Jun-97		
8-Jun-97		
9-Jun-97		
10-Jun-97	436	42
11-Jun-97		
12-Jun-97	368	51
13-Jun-97	312	65
14-Jun-97		
15-Jun-97		
16-Jun-97		
17-Jun-97	1984	566
18-Jun-97		
19-Jun-97	960	411
20-Jun-97	832	400
21-Jun-97		
22-Jun-97		
23-Jun-97		
24-Jun-97	272	82
25-Jun-97	1313	329
26-Jun-97		
27-Jun-97	1147	326
28-Jun-97		
29-Jun-97		
30-Jun-97		
1-Jul-97	412	131
2-Jul-97		
3-Jul-97	354	85
4-Jul-97		
5-Jul-97		
6-Jul-97		
7-Jul-97		
8-Jul-97	548	167
9-Jul-97		
10-Jul-97	377	122
11-Jul-97		
12-Jul-97		

Table Continued

13-Jul-97		
14-Jul-97		
15-Jul-97	351	67
16-Jul-97		
17-Jul-97		
18-Jul-97	423	67
19-Jul-97		
20-Jul-97		
21-Jul-97		
22-Jul-97	213	47
23-Jul-97		
24-Jul-97	341	40
25-Jul-97	275	48
26-Jul-97		
27-Jul-97		
28-Jul-97		
29-Jul-97	350	42
30-Jul-97		
31-Jul-97		
1-Aug-97	194	42
2-Aug-97		
3-Aug-97		
4-Aug-97		
5-Aug-97		
6-Aug-97		
7-Aug-97	no sample	80
8-Aug-97	565	50
9-Aug-97		
10-Aug-97		
11-Aug-97		
12-Aug-97	579	45
13-Aug-97		
14-Aug-97	760	40
15-Aug-97	663	50
16-Aug-97		
17-Aug-97		
18-Aug-97		
19-Aug-97	663	81
20-Aug-97		
21-Aug-97	570	52
22-Aug-97	571	46
23-Aug-97		
24-Aug-97		
25-Aug-97	611	59
26-Aug-97	657	50
27-Aug-97	?	50
28-Aug-97	686	42
29-Aug-97	566	45
30-Aug-97		
31-Aug-97		
1-Sep-97		
2-Sep-97	520	46

Table Continued

3-Sep-97	520	50
4-Sep-97	497	38
5-Sep-97	553	55
6-Sep-97		
7-Sep-97		
8-Sep-97	699	64
9-Sep-97	700	58
10-Sep-97	660	62
11-Sep-97	631	54
12-Sep-97	711	66

### Nitrogen Mass Balances

Date	Influent NO3+NO2 mg/day	Influent NHx mg/day	Influent "TKN" mg/day	Effluent NO3+NO2 mg/day	Effluent NHx mg/day	Effluent "SKN" mg/day	Bioavailable TKN (mg/day)	Aerobic MLVSS mg/L	Aerobic biomass (mg)	VSS growth mgVSS/day	Specific growth rate mgVSS/mgMLVSS-day
27-May-97	0	605	792	0	1089	1309	572	5246	69242	11651	0.168
29-May-97	0	454	512	0	246	349	409	2324	30677	7706	0.251
30-May-97	0	366	438	0	136	248	326	5154	68037	14603	0.215
3-Jun-97	0	349	391	82	108	143	356	4349	57409	9590	0.167
6-Jun-97	0	293	422	179	0	55	367	5440	71808	12261	0.171
10-Jun-97	0	721	861	451	0	42	818	4580	60456	10271	0.170
12-Jun-97	0	696	813	500	0	87	726	3545	46794	52307	1.118
13-Jun-97	0	580	1031	580	0	254	777	3495	46134	7714	0.167
17-Jun-97	0	492	#VALUE!	19	0	63	#VALUE!	4000	52800	8495	0.161
19-Jun-97	0	576	765	13	0	109	657	4180	55176	13864	0.251
20-Jun-97	0	240	375	15	131	204	302	3560	46992	11664	0.248
23-Jun-97	0	220	391	26	163	226	328	1240	16368	4018	0.245
26-Jun-97	0	266	266	0	0	0	266	1525	20130	2098	0.104
27-Jun-97	0	496	548	10	0	52	495	510	6732	669	0.099
1-Jul-97	0	430	502	135	232	291	442	2090	27588	6987	0.253
3-Jul-97	0	347	418	248	0	42	375	1320	17424	4417	0.254
8-Jul-97	0	444	483	109	0	44	440	1500	19800	4976	0.251
10-Jul-97	0	377	429	180	0	57	372	1320	17424	1855	0.106
15-Jul-97	0	350	434	198	0	43	391	1560	20592	2597	0.126
18-Jul-97	0	391	433	91	49	80	402	690	9108	2259	0.248
22-Jul-97	0	494	519	278	0	21	497	860	11352	1339	0.118
24-Jul-97	0	932	932	435	0	12	921	1170	15444	1272	0.082
25-Jul-97	1	1141	1141	685	0	7	1134	1350	17820	2189	0.123
29-Jul-97	0	1087	1087	837	0	8	1080	910	12012	874	0.073
31-Jul-97	0	1180	1180	826	114	176	1117	1860	24552	2981	0.121
1-Aug-97	0	1005	1005	830	134	161	978	1830	24156	2973	0.123
7-Aug-97	#VALUE!	#VALUE!	#VALUE!	396	789	804	#VALUE!	1040	13728	-2088	-0.152
8-Aug-97	413	1246	1341	357	626	634	1332	1520	20064	-3005	-0.150
12-Aug-97	147	1374	1510	630	194	296	1407	2010	26532	3483	0.131
14-Aug-97	100	1284	1397	377	198	241	1354	2900	38280	4685	0.122
15-Aug-97	#VALUE!	1243	#VALUE!	#VALUE!	158	#VALUE!	#VALUE!	2500	33000	4172	0.126
19-Aug-97	188	1498	1829	212	573	624	1778	1430	18876	569	0.030

Table Continued

21-Aug-97	54	1262	1458	768	214	238	1433	3270	43164	3578	0.083
22-Aug-97	84	1042	1338	604	236	324	1251	2990	39468	3410	0.086
25-Aug-97	98	1112	1222	905	0	196	1026	3780	49896	4088	0.082
26-Aug-97	227	1192	1252	906	0	107	1145	3790	50028	4132	0.083
27-Aug-97	122	1144	1260	674	0	72	1188	3490	46068	5105	0.085
28-Aug-97	181	1053	1194	392	0	83	1112	3420	45144	4918	0.084
29-Aug-97	338	1114	1314	232	0	72	1242	2890	38148	4138	0.083
2-Sep-97	162	1044	1171	148	0	60	1112	2440	32208	3450	0.082
3-Sep-97	198	1273	1273	223	0	34	1239	2140	28248	3050	0.083
4-Sep-97	50	1443	1572	334	0	62	1509	1890	24948	2773	0.085
5-Sep-97	187	#VALUE!	#VALUE!	204	0	68	#VALUE!	1540	20328	2221	0.084
8-Sep-97	337	965	1131	210	0	40	1090	2000	26400	2717	0.079
9-Sep-97	316	977	1135	148	0	40	1096	2090	27588	2962	0.082
10-Sep-97	467	991	1147	154	0	55	1091	2040	26928	2807	0.080
11-Sep-97	#VALUE!	#VALUE!	#VALUE!	118	0	51	#VALUE!	1890	24948	2662	0.082
12-Sep-97	19	990	1200	122	0	50	1149	1920	25344	2838	0.086

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

Date	Nitrogen Mass Balances				
	mg-N growth	TKN oxidized	Overall observed	Overall observed	Nitrification
	mg-N/day	mg-N/day	Specific Nfication rate mgTKN/mgVSS/day	Specific DeNfication rate mgNOx/mgVSS/day	F:M mgTKN/mg Aerobic-VSS/day
27-May-97	1398	-1915	-0.028	n/a	0.011
29-May-97	925	-762	-0.025	n/a	0.017
30-May-97	1752	-1563	-0.023	n/a	0.006
3-Jun-97	1151	-903	-0.016	n/a	0.007
6-Jun-97	1471	-1104	-0.015	n/a	0.006
10-Jun-97	1232	-414	-0.007	n/a	0.014
12-Jun-97	6277	-5550	-0.119	n/a	0.017
13-Jun-97	926	-149	-0.003	n/a	0.022
17-Jun-97	1019	#VALUE!	#VALUE!	n/a	#VALUE!
19-Jun-97	1664	-1007	-0.018	n/a	0.014
20-Jun-97	1400	-1229	-0.026	n/a	0.008
23-Jun-97	482	-317	-0.019	n/a	0.024
26-Jun-97	252	14	0.001	n/a	0.013
27-Jun-97	80	415	0.062	n/a	0.081
1-Jul-97	838	-628	-0.023	n/a	0.018
3-Jul-97	530	-155	-0.009	n/a	0.024
8-Jul-97	597	-158	-0.008	n/a	0.024
10-Jul-97	223	149	0.009	n/a	0.025
15-Jul-97	312	79	0.004	n/a	0.021
18-Jul-97	271	83	0.009	n/a	0.048
22-Jul-97	161	337	0.030	n/a	0.046
24-Jul-97	153	768	0.050	n/a	0.060
25-Jul-97	263	871	0.049	n/a	0.064
29-Jul-97	105	975	0.081	n/a	0.091
31-Jul-97	358	646	0.026	n/a	0.048
1-Aug-97	357	487	0.020	n/a	0.042
7-Aug-97	-251	#VALUE!	#VALUE!	n/a	#VALUE!
8-Aug-97	-361	1067	0.053	n/a	0.067
12-Aug-97	418	796	0.030	n/a	0.057
14-Aug-97	562	594	0.016	n/a	0.036
15-Aug-97	501	#VALUE!	#VALUE!	n/a	#VALUE!
19-Aug-97	68	1136	0.060	n/a	0.097

Table Continued

21-Aug-97	429	790	0.018	n/a	0.034
22-Aug-97	409	606	0.015	n/a	0.034
25-Aug-97	491	535	0.011	n/a	0.024
26-Aug-97	496	650	0.013	n/a	0.025
27-Aug-97	613	575	0.012	-0.036	0.027
28-Aug-97	590	521	0.012	-0.012	0.026
29-Aug-97	497	746	0.020	0.014	0.034
2-Sep-97	414	698	0.022	0.008	0.036
3-Sep-97	366	873	0.031	0.005	0.045
4-Sep-97	333	1176	0.047	-0.027	0.063
5-Sep-97	266	#VALUE!	#VALUE!	#VALUE!	#VALUE!
8-Sep-97	326	764	0.029	0.025	0.043
9-Sep-97	355	740	0.027	0.028	0.041
10-Sep-97	337	755	0.028	0.047	0.043
11-Sep-97	319	#VALUE!	#VALUE!	#VALUE!	#VALUE!
12-Sep-97	341	809	0.032	-0.004	0.047

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balance

Date	Influent COD inf mg/day	Effluent COD eff mg/day
27-May-97	21531	8225
29-May-97	24676	15846
30-May-97	20723	9860
3-Jun-97	27069	4493
5-Jun-97	29514	9677
6-Jun-97	36046	5262
10-Jun-97	26369	2540
12-Jun-97	22257	3084
13-Jun-97	19319	4025
17-Jun-97	117135	33417
19-Jun-97	60134	25745
20-Jun-97	51517	24768
24-Jun-97	15667	4723
25-Jun-97	75629	18950
27-Jun-97	66067	18778
1-Jul-97	16612	5282
3-Jul-97	14273	3427
8-Jul-97	22095	6733
10-Jul-97	15201	4919
15-Jul-97	14152	2701
18-Jul-97	18274	2894
22-Jul-97	8588	1895
24-Jul-97	13504	1584
25-Jul-97	11088	1935
29-Jul-97	14112	1693
1-Aug-97	7822	1693
7-Aug-97	#VALUE!	3226
8-Aug-97	22781	2016
12-Aug-97	23345	1814
14-Aug-97	30643	1613
15-Aug-97	27210	2052
19-Aug-97	26732	3266
21-Aug-97	22982	2097
22-Aug-97	22200	1788
25-Aug-97	24636	2379
26-Aug-97	25544	1944
27-Aug-97	#VALUE!	1944
28-Aug-97	26178	1603
29-Aug-97	22821	1814
2-Sep-97	20966	1855
3-Sep-97	20218	1944
4-Sep-97	20039	1532
5-Sep-97	21501	2138
8-Sep-97	29190	2673
9-Sep-97	27216	2255
10-Sep-97	25661	2411
11-Sep-97	23625	2022
12-Sep-97	29179	2709

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

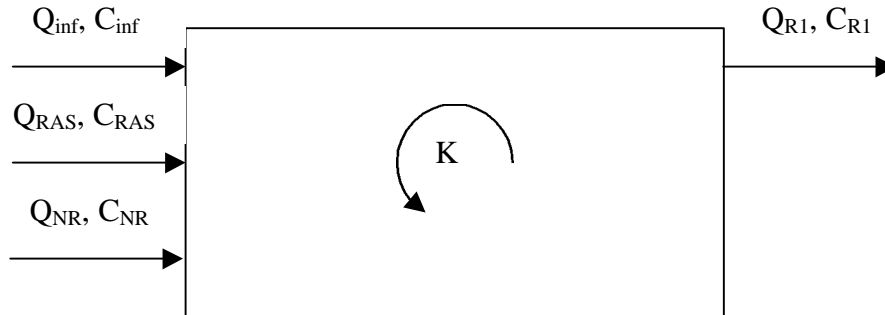
**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 13

Heated Primary Effluent Treatment Train:  
Anoxic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Anoxic Reactor (R1) of the Heated Primary Effluent MLE Treatment Train



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{NR}$  = Nitrate recirculation flow rate (L/day)

$C_{NR}$  = Nitrate recirculation concentration of the constituent of interest = aerobic reactor (R2) concentration (mg/L)

$Q_{R1}$  = Flow rate exiting the anoxic reactor (R1) =  $Q_{inf} + Q_{RAS} + Q_{NR}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anoxic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{RAS} \times C_{RAS}) + (Q_{NR} \times C_{NR})$$

$C_{in}$  = Concentration of the constituent of interest entering the anoxic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right) + \left( C_{NR} \times \frac{Q_{NR}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right)$$

$$C_{out} = C_{R1} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
27-Aug-97					
28-Aug-97					
29-Aug-97					
30-Aug-97					
31-Aug-97					
1-Sep-97					
2-Sep-97					
3-Sep-97					
4-Sep-97	5.7	1.8	3.0	9.3	58
5-Sep-97					
6-Sep-97					
7-Sep-97					
8-Sep-97					
9-Sep-97					
10-Sep-97					
11-Sep-97	2.0	0.0	0.0	4.1	91
12-Sep-97					

**Nitrogen Mass Balances**

Date	NOx in mg/day	NOx out mg/day	NHx in mg/day	NHx out mg/day	TNin mg/day	TNout mg/day	"TKN" in mg/day	"SKN" out mg/day	TKNin - SKNout TKNin-TKNout
12-Jun-97									
19-Jun-97									
26-Jun-97									
10-Jul-97									
18-Jul-97									
24-Jul-97									
31-Jul-97									
14-Aug-97									
21-Aug-97									
28-Aug-97									
4-Sep-97	1756	1411	1443	736	3610	2292	1854	882	972
11-Sep-97	#VALUE!	236	#VALUE!	0	#VALUE!	497	#VALUE!	261	#VALUE!

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Data within the boxes were used for steady state determinations.

**Nitrogen Mass Balances**

Date	NOx in mg/L	NOx out mg/L	NHx in mg/L	NHx out mg/L	TNin mg/L	TN out mg/L	"TKN" in mg/L	"SKN" out mg/L
12-Jun-97								
19-Jun-97								
26-Jun-97								
10-Jul-97								
18-Jul-97								
24-Jul-97								
31-Jul-97								
14-Aug-97								
21-Aug-97								
28-Aug-97								
4-Sep-97	7.1	5.7	5.9	3.0	53.1	9.3	46.0	3.6
11-Sep-97	#VALUE!	2.0	#VALUE!	0.0	#VALUE!	4.1	#VALUE!	2.2

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Data within the boxes were used for steady state determinations.

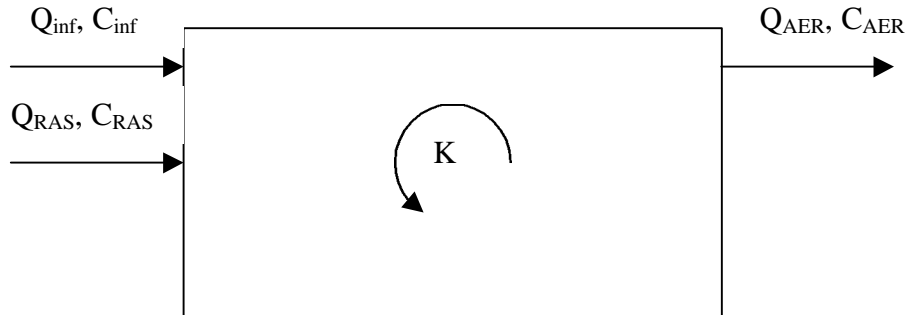
**COD Mass Balances**

Date	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L	CODin-CODout mg/L
12-Jun-97						
19-Jun-97						
25-Jun-97						
10-Jul-97						
18-Jul-97						
24-Jul-97						
14-Aug-97						
21-Aug-97						
28-Aug-97						
4-Sep-97	28483	14282	14201	116	58	58
11-Sep-97	28135	11007	17127	233	91	142

## APPENDIX 14

Heated Primary Effluent Treatment Train:  
Aerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Fully Aerobic Reactor of the Heated Primary Effluent Treatment Train



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{AER}$  = Flow rate exiting the aerobic reactor (AER) =  $Q_{inf} + Q_{RAS}$  (L/day)

$C_{AER}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g., Nitrogen assimilation,  $NO_x$  production, COD consumption, etc.)

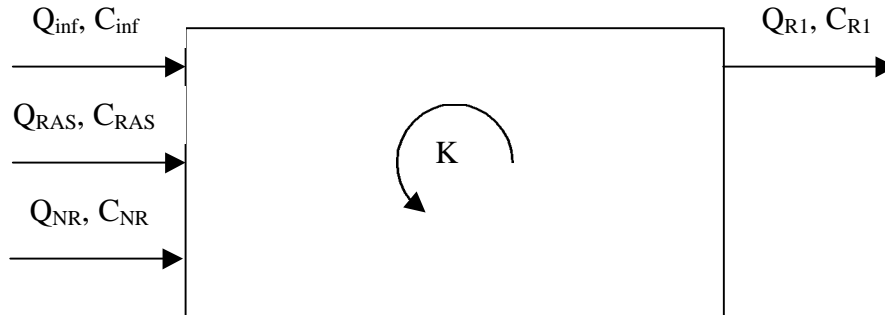
$$\text{Total loading to aerobic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{RAS} \times C_{RAS})$$

$C_{in}$  = Concentration of the constituent of interest entering the aerobic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{RAS}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{inf} + Q_{RAS}} \right)$$

$C_{out} = C_{AER}$  (mg/L)

Performing a Mass Balance on the Anoxic Reactor (R1) of the Heated Primary Effluent MLE Treatment Train



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{NR}$  = Nitrate recirculation flow rate (L/day)

$C_{NR}$  = Nitrate recirculation concentration of the constituent of interest = aerobic reactor (R2) concentration (mg/L)

$Q_{R1}$  = Flow rate exiting the anoxic reactor (R1) =  $Q_{inf} + Q_{RAS} + Q_{NR}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anoxic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{RAS} \times C_{RAS}) + (Q_{NR} \times C_{NR})$$

$C_{in}$  = Concentration of the constituent of interest entering the anoxic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right) + \left( C_{NR} \times \frac{Q_{NR}}{Q_{inf} + Q_{RAS} + Q_{NR}} \right)$$

$$C_{out} = C_{R1} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
29-May-97	0.0	0.0	3.1	4.7	151
5-Jun-97					89
12-Jun-97	9.2	6.6	0.0	10.7	56
19-Jun-97	0.3	0.1	2.9	4.2	283
25-Jun-97					486
26-Jun-97	0.0	0.0	0.0	0.0	
10-Jul-97	3.9	0.5	0.0	5.1	118
18-Jul-97	1.8	0.5	1.2	3.9	68
24-Jul-97	11.2	0.8	0.0	12.2	50
31-Jul-97	19.8	0.0	4.0	24.9	
14-Aug-97	11.2	0.2	2.9	16.4	58
21-Aug-97	22.0	1.0	2.0	24.7	50
28-Aug-97	8.9	0.2	0.0	11.9	44
4-Sep-97	8.3	0.1	0.0	9.5	43
11-Sep-97	3.1	0.0	0.0	4.6	79

**Aerobic Reactor Daily Temperature Data**

Date	Temperature in 1st baffle of aerobic reactor (°C)	Temperature in 3rd baffle of aerobic reactor (°C)
20-May-97		33.0
21-May-97		31.0
22-May-97		29.0
23-May-97		36.2
24-May-97		35.5
25-May-97		35.5
26-May-97		
27-May-97		32.2
28-May-97		33.4
29-May-97	29.9	33.5
30-May-97	32.7	35.7
31-May-97	33.9	36.1
1-Jun-97	33.1	39.3
2-Jun-97		34.9
3-Jun-97		32.9
4-Jun-97		35.0
5-Jun-97	34.5	37.0
6-Jun-97	31.5	34.5
7-Jun-97	31.9	34.7
8-Jun-97	34.1	36.8
9-Jun-97		34.5
10-Jun-97		37.5
11-Jun-97		37.9
12-Jun-97		39.5
13-Jun-97	35.3	38.9
14-Jun-97	33.7	37.7
15-Jun-97	35.8	38.6
16-Jun-97		
17-Jun-97		
18-Jun-97		
19-Jun-97		
20-Jun-97	38.7	41.0
21-Jun-97	39.4	41.2
22-Jun-97	38.6	41.1
23-Jun-97		
24-Jun-97		
25-Jun-97		
26-Jun-97		
27-Jun-97		
28-Jun-97	39.5	42.0
29-Jun-97	39.0	41.5
30-Jun-97		
1-Jul-97		
2-Jul-97		
3-Jul-97	38.9	41.4
4-Jul-97	39.9	42.1

Table Continued

5-Jul-97	39.4	42.0
6-Jul-97	38.7	41.2
7-Jul-97		41.0
8-Jul-97		40.6
9-Jul-97	38.6	40.8
10-Jul-97	38.6	41.4
11-Jul-97	39.1	42.9
12-Jul-97	39.5	43.0
13-Jul-97	41.2	44.5
14-Jul-97		
15-Jul-97		43.3
16-Jul-97		43.9
17-Jul-97		
18-Jul-97	40.4	43.4
19-Jul-97	40.9	43.6
20-Jul-97	39.4	42.5
21-Jul-97		44.0
22-Jul-97		43.2
23-Jul-97	40.5	43.8
24-Jul-97		43.6
25-Jul-97	39.7	43.4
26-Jul-97	41.5	44.7
27-Jul-97	42.9	45.9
28-Jul-97		46.5
29-Jul-97		45.5
30-Jul-97		45.7
31-Jul-97	41.9	
1-Aug-97	44.0	
2-Aug-97	42.5	45.7
3-Aug-97	43.0	47.0
4-Aug-97		48.7
5-Aug-97		46.8
6-Aug-97		45.5
7-Aug-97	39.8	45.7
8-Aug-97	39.3	45.1
9-Aug-97	40.4	45.8
10-Aug-97	40.3	45.7
11-Aug-97		44.3
12-Aug-97		43.8
13-Aug-97		44.0
14-Aug-97		43.2
15-Aug-97		46.0
16-Aug-97	41.9	47.0
17-Aug-97	41.8	45.3
18-Aug-97		46.3
19-Aug-97		46.3
20-Aug-97	40.6	45.1
21-Aug-97	41.5	46.4
22-Aug-97	41.1	47.2
23-Aug-97	40.7	47.3
24-Aug-97	40.2	47.0
25-Aug-97		44.7

Table Continued

26-Aug-97		45.8
27-Aug-97	36.1	41.7
28-Aug-97	36.6	41.9
29-Aug-97	37.3	42.3
30-Aug-97	37.2	42.6
31-Aug-97	39.7	47.0
1-Sep-97		
2-Sep-97		42.3
3-Sep-97	35.9	39.5
4-Sep-97	33.2	38.3
5-Sep-97	36.2	39.9
6-Sep-97	39.1	39.8
7-Sep-97	37.1	41.3
8-Sep-97		42.0
9-Sep-97		41.7
10-Sep-97		41.0
11-Sep-97		43.2
12-Sep-97		40.8

### Nitrogen Mass Balances

Date	NOx in mg/day	NOx out mg/day	NOxout-NOxin mg/day	NHx in mg/day	NHx out mg/day	NHxin-NHxout mg/day	TNin mg/day	TNout mg/day	TNin-TNout mg/day
29-May-97	0.0	0.0	0.0	670.4	352.7	317.8	819.1	529.0	290.1
<u>12-Jun-97</u>	452.0	1064.7	612.7	695.5	0.0	695.5	1344.2	1236.1	108.1
19-Jun-97	11.8	38.6	26.8	575.7	346.6	229.1	875.8	504.4	371.4
26-Jun-97	0.0	0.0	0.0	266.2	0.0	266.2	238.7	0.0	238.7
10-Jul-97	532.8	629.9	97.1	376.6	0.0	376.6	1130.2	816.8	313.4
<u>18-Jul-97</u>	256.7	303.5	46.9	529.3	200.4	328.9	915.6	640.9	274.7
24-Jul-97	1392.3	1864.4	472.2	932.2	0.0	932.2	2336.2	2022.5	313.8
31-Jul-97	1622.4	2362.9	740.5	1403.5	473.3	930.2	3053.5	2976.0	77.5
14-Aug-97	880.0	1387.5	507.5	1693.9	352.9	1340.9	2777.0	2031.0	746.1
21-Aug-97	1644.7	2722.0	1077.4	1704.7	245.2	1459.5	3595.8	3056.4	539.5
<b>28-Aug-97</b>	<b>1037.7</b>	<b>1087.8</b>	<b>50.1</b>	<b>1052.8</b>	<b>0.0</b>	<b>1052.8</b>	<b>2413.1</b>	<b>1448.0</b>	<b>965.1</b>
4-Sep-97	1410.7	2039.4	628.7	736.3	0.0	736.3	2292.5	2349.1	-56.6
11-Sep-97	236.2	379.8	143.6	0.0	0.0	0.0	497.1	555.2	-58.1

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	"TKN" in mg/day	"SKN" out mg/day	TKN <sub>in</sub> -SKN <sub>out</sub> mg/day	N growth mg-N/day	MINIMUM		Minimum observed specific nitrification rate mgTKN/mgVSS/day
					TKN oxidized	Aerobic Biomass mg of VSS	
29-May-97	819.1	529.0	290.1	924.8	-634.7	30677	-0.021
12-Jun-97	892.3	171.4	720.8	6276.8	-5556.0	46794	-0.119
19-Jun-97	864.0	465.8	398.3	1663.7	-1265.4	55176	-0.023
26-Jun-97	266.2	0.0	266.2	251.7	14.5	20130	0.001
10-Jul-97	597.4	186.9	410.5	222.7	187.9	17424	0.011
18-Jul-97	658.9	337.3	321.6	271.1	50.5	9108	0.006
24-Jul-97	944.0	158.0	786.0	152.6	633.3	15444	0.041
31-Jul-97	1431.1	613.1	818.0	357.8	460.2	24552	0.019
14-Aug-97	1897.0	643.5	1253.6	562.2	691.4	38280	0.018
21-Aug-97	1951.2	334.4	1616.8	429.3	1187.5	43164	0.028
<b>28-Aug-97</b>	<b>1375.4</b>	<b>360.2</b>	<b>1015.2</b>	<b>590.2</b>	<b>425.0</b>	<b>45144</b>	<b>0.009</b>
4-Sep-97	881.8	309.8	572.0	332.8	239.2	24948	0.010
11-Sep-97	260.9	175.4	85.5	319.5	-233.9	24948	-0.009

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	delNOx mg-N/L	NHx in mg-N/L	NHx out mg-N/L	delNHx mg-N/L	TNin mg-N/L	TNout mg-N/L	delTN mg-N/L	"TKN" in mg-N/L	"SKN" out mg-N/L	del"TKN" mg-N/L
29-May-97	0.0	0.0	0.0	5.9	3.1	2.8	7.2	4.7	2.6	7.2	4.7	2.6
12-Jun-97	3.9	9.2	5.3	6.0	0.0	6.0	11.7	10.7	0.9	7.7	1.5	6.3
19-Jun-97	0.1	0.3	0.2	4.8	2.9	1.9	7.3	4.2	3.1	7.2	3.9	3.3
26-Jun-97	0.0	0.0	0.0	2.1	0.0	2.1	1.9	0.0	1.9	2.1	0.0	2.1
10-Jul-97	3.3	3.9	0.6	2.4	0.0	2.4	7.1	5.1	2.0	3.7	1.2	2.6
18-Jul-97	1.5	1.8	0.3	3.2	1.2	2.0	5.5	3.9	1.7	4.0	2.0	1.9
24-Jul-97	8.4	11.2	2.8	5.6	0.0	5.6	14.0	12.2	1.9	5.7	0.9	4.7
31-Jul-97	13.6	19.8	6.2	11.7	4.0	7.8	25.5	24.9	0.6	12.0	5.1	6.8
14-Aug-97	7.1	11.2	4.1	13.7	2.9	10.8	22.4	16.4	6.0	15.3	5.2	10.1
21-Aug-97	13.3	22.0	8.7	13.8	2.0	11.8	29.0	24.7	4.4	15.8	2.7	13.1
<b>28-Aug-97</b>	<b>8.5</b>	<b>8.9</b>	<b>0.4</b>	<b>8.7</b>	<b>0.0</b>	<b>8.7</b>	<b>19.8</b>	<b>11.9</b>	<b>7.9</b>	<b>11.3</b>	<b>3.0</b>	<b>8.3</b>
4-Sep-97	5.7	8.3	2.6	3.0	0.0	3.0	9.3	9.5	-0.2	3.6	1.3	2.3
11-Sep-97	2.0	3.1	1.2	0.0	0.0	0.0	4.1	4.6	-0.5	2.2	1.5	0.7

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L
<u>12-Jun-97</u>	25047	6451	18596	217	56
19-Jun-97	83512	33824	49688	699	283
25-Jun-97	98369	61586	36783	776	486
10-Jul-97	29782	18861	10921	186	118
<u>18-Jul-97</u>	26474	11261	15214	160	68
24-Jul-97	18572	8316	10256	112	50
14-Aug-97	33984	7183	26801	274	58
21-Aug-97	27325	6192	21133	221	50
<b>28-Aug-97</b>	<b>29686</b>	<b>5354</b>	<b>24332</b>	<b>244</b>	<b>44</b>
4-Sep-97	14282	10588	3694	58	43
11-Sep-97	11007	19339	-8332	91	79

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 15

Heated Primary Effluent Treatment Train:  
Clarifier temperature and DO data and nitrogen mass balances

**Data**

Date	Clarifier Temp. (°C)	Clarifier DO (mg/L)
27-Jul-97	40.7	2.1
3-Aug-97	37.5	1.5
6-Aug-97	38.8	0.8
7-Aug-97	37.3	0.5
9-Aug-97	37.3	0.1
16-Aug-97	40.5	0.1
20-Aug-97	39.1	0.1
21-Aug-97	38.8	0.1
23-Aug-97	36.3	0.5
24-Aug-97	36.9	0.7
<b>AVERAGE</b>	<b>38.3</b>	<b>0.6</b>

26-Aug-97	Configured system to Anoxic-Aerobic on 8/26/97	
27-Aug-97	36.6	0.6
28-Aug-97	35.9	0.9
29-Aug-97	36.7	0.4
31-Aug-97	37.0	0.7
3-Sep-97	36.6	1.8
4-Sep-97	33.6	1.7
5-Sep-97	34.5	0.8
6-Sep-97	34.0	0.9
7-Sep-97	35.0	0.8
<b>AVERAGE</b>	<b>35.5</b>	<b>0.9</b>

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NHx in mg-N/day	NHx out mg-N/day	TN in mg-N/day	TN out mg-N/day	"SKN" in mg-N/day	"SKN" out mg-N/day
<u>29-May-97</u>	0	0	353	463	529	656	529.0	656.4
<u>12-Jun-97</u>	1065	952	0	0	1236	1117	171.4	165.9
19-Jun-97	39	25	347	0	504	232	465.8	207.1
26-Jun-97	0	0	0	0	0	0	0.0	0.0
10-Jul-97	630	713	0	0	817	938	186.9	225.7
<u>18-Jul-97</u>	304	347	200	187	641	652	337.3	305.2
24-Jul-97	1864	1827	0	0	2022	1876	158.0	48.7
31-Jul-97	2363	2448	473	337	2976	2971	613.1	522.9
14-Aug-97	1388	1157	353	608	2031	1898	643.5	741.3
21-Aug-97	2722	2358	245	656	3056	3090	334.4	731.9
<b>28-Aug-97</b>	1088	1249	0	0	1448	1512	360.2	263.8
4-Sep-97	2039	1015	0	0	2349	1204	309.8	189.0
11-Sep-97	380	380	0	0	555	546	175.4	165.6

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	NHx out mg-N/L	TNin mg-N/L	TN out mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L
<u>29-May-97</u>	0.0	0.0	4.1	4.7	5.8	4.7	5.8
<u>12-Jun-97</u>	9.2	8.3	0.0	10.7	9.7	1.5	1.4
19-Jun-97	0.3	0.2	0.0	4.2	1.9	3.9	1.7
26-Jun-97	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10-Jul-97	3.9	4.5	0.0	5.1	5.9	1.2	1.4
<u>18-Jul-97</u>	1.8	2.1	1.1	3.9	3.9	2.0	1.8
24-Jul-97	11.2	11.0	0.0	12.2	11.3	0.9	0.3
31-Jul-97	19.8	20.5	2.8	24.9	24.9	5.1	4.4
<u>14-Aug-97</u>	11.2	9.3	4.9	16.4	15.3	5.2	6.0
21-Aug-97	22.0	19.0	5.3	24.7	25.0	2.7	5.9
<b>28-Aug-97</b>	8.9	10.3	0.0	11.9	12.4	3.0	2.2
4-Sep-97	8.3	8.3	0.0	9.5	9.8	1.3	1.5
11-Sep-97	3.1	3.1	0.0	4.6	4.5	1.5	1.4

**NOTE:**          Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:**          Samples were not filtered until June 10.

**NOTE:**          Bold values are not valid because no data from the anoxic reactor was collected.

**NOTE:**          Data within the boxes were used for steady state determinations.

**NOTE:**          Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:**          Indicates non-steady state (transitional) day.

APPENDIX 16

Heated Primary Effluent Treatment Train:  
Biosolids data and calculations

Date	MLSS Anoxic reactor (R1) (mg/L)	Aerobic reactor (R2) (mg/L)	Final Effluent (ETSS) (mg/L)	MLVSS Aerobic reactor (R2) (mg/L)	Theoretical Wastage (L)	Manual Wastage (L)	Actual SRT (days)
20-May-97							
21-May-97							
22-May-97		2890				0.0	
23-May-97		5950				0.0	
24-May-97		1620	140			0.0	
25-May-97		5450	45			0.0	
26-May-97							
27-May-97		6320	44		1.8	1.8	5.9
28-May-97		4510	364		-2.7	0.0	2.8
29-May-97		2800	60		0.9	2.0	4.0
30-May-97		6210	298		-0.7	0.0	4.7
31-May-97		6590	386		-1.3	0.0	3.8
1-Jun-97		6150	24		2.0	2.0	6.0
2-Jun-97		6340	21		2.0	2.0	6.0
3-Jun-97		5240	21		2.0	2.0	6.0
4-Jun-97		6710	19	5380	2.0	2.0	6.0
5-Jun-97		7010	230	5760	0.2	0.2	6.0
6-Jun-97		6620	21	5440	2.2	2.1	6.4
7-Jun-97		5515	38	4520	1.8	1.8	6.0
8-Jun-97		5180	128		0.8	0.8	5.9
9-Jun-97		5570	14	4570	2.1	2.1	6.0
10-Jun-97		5510	13	4580	2.1	2.1	5.9
11-Jun-97		4720	10	3860	2.1	2.1	5.9
12-Jun-97		4300	1042	3545	-16.4	0.0	0.9
13-Jun-97		4200	10	3495	2.1	2.1	6.0
14-Jun-97		2940	22		1.8	1.8	6.0
15-Jun-97		2310	296	1880	-6.6	0.0	1.7
16-Jun-97		4370	44	3600	1.6	1.6	5.9
17-Jun-97		4630	162	4000	0.1	0.1	6.0
18-Jun-97		5510	103	4670	2.2	2.2	4.0
19-Jun-97		4860	52	4180	2.7	2.7	4.0
20-Jun-97		4140	42	3560	2.7	2.7	4.0
21-Jun-97		2970	372	2560	-5.1	1.6	1.4
22-Jun-97		2540	616	2160	-15.7	0.0	0.9
23-Jun-97		1460	82	1240	0.0	0.0	4.0
24-Jun-97		2520	64	2050	1.9	1.9	3.9
25-Jun-97		1890	56	1560	1.6	1.6	4.0
26-Jun-97		1775	45	1525	1.9	0.0	9.3
27-Jun-97		580	46	510	-1.4	<b>-3.0</b>	8.4
28-Jun-97		3320	33	2710	2.9	0.0	32.9
29-Jun-97		3040	74	2490	2.4	0.0	13.7
30-Jun-97		2870	72	2370	2.4	2.4	3.9
1-Jul-97		2520	71	2090	2.2	2.2	3.9
2-Jul-97		2070	180	1760	-0.2	0.0	3.8
3-Jul-97		1590	132	1320	-0.1	0.0	3.9
4-Jul-97		1530	128	1310	-0.1	0.0	3.9
5-Jul-97		1290	212	1120	-3.8	0.0	2.0

Table Continued

6-Jul-97	1640	112	1330	0.6	0.0	4.9
7-Jul-97	2250	39	1860	2.7	2.6	4.0
8-Jul-97	1980	19	1500	2.9	2.9	4.0
9-Jul-97	1700	88	1330	1.3	0.0	6.3
10-Jul-97	1590	16	1320	1.3	1.0	9.4
11-Jul-97	1020	27	885	0.6	0.0	12.4
12-Jul-97	1450	3	1230	1.6	1.0	12.1
13-Jul-97	1640	19	1380	1.2	1.2	8.0
14-Jul-97	1690	24	1420	1.1	1.1	7.9
15-Jul-97	1880	14	1560	1.4	1.4	7.9
16-Jul-97	2110	15	1770	1.4	1.4	8.0
17-Jul-97	930	no data	730	no data	0.0	no data
18-Jul-97	810	63	690	-1.9	0.0	3.9
19-Jul-97	1000	39	890	0.1	0.0	8.4
20-Jul-97	1150	62	1030	-0.5	0.0	6.2
21-Jul-97	1200	29	950	0.7	0.0	13.7
22-Jul-97	1000	40	860	0.0	0.0	8.2
23-Jul-97	810	36	680	-0.2	0.0	7.3
24-Jul-97	1350	39	1170	0.5	0.0	11.6
25-Jul-97	1620	53	1350	0.3	0.3	8.1
26-Jul-97	1510	286	1250	-7.4	0.0	1.7
27-Jul-97	1450	78	1260	-0.5	0.0	6.1
28-Jul-97	1950	69	1660	0.2	0.0	9.3
29-Jul-97	1190	20	910	1.0	0.2	14.6
30-Jul-97	670	86	580	-4.0	0.0	2.6
31-Jul-97	2270	61	1860	0.6	0.5	8.3
1-Aug-97	2160	78	1830	0.2	0.2	8.0
2-Aug-97	1880	49	1630	0.6	1.0	6.5
3-Aug-97	1820	84	1500	-0.2	0.0	7.4
4-Aug-97	1410	32	1200	0.8	0.0	14.6
5-Aug-97	1187	22	1080	0.9	0.0	18.0
6-Aug-97	1060	8	930	1.4	0.0	44.5
7-Aug-97	1210	18	1040	1.1	-2.6	-6.6
8-Aug-97	1860	6	1520	1.5	-2.1	-6.7
9-Aug-97	2600	6	2120	1.6	1.6	8.0
10-Aug-97	2470	7	2050	1.5	1.5	8.1
11-Aug-97	2510	24	2040	1.3	1.3	7.8
12-Aug-97	3180	26	2010	1.3	1.3	8.1
13-Aug-97	3720	27	2450	1.4	1.4	7.8
14-Aug-97	3450	10	2900	1.5	1.5	8.2
15-Aug-97	2790	12	2500	1.5	1.5	7.8
16-Aug-97	3400	12	2870	1.5	1.5	8.0
17-Aug-97	2870	30	2420	1.2	1.3	7.9
18-Aug-97	3950	23	2540	1.4	1.4	8.1
19-Aug-97	1790	17	1430	1.3	0.0	34.5
20-Aug-97	3990	9	3280	1.6	1.6	7.8
21-Aug-97	3970	9	3270	1.0	1.0	12.1
22-Aug-97	3640	13	2990	1.0	1.0	11.6
23-Aug-97	4570	11	3770	1.0	1.0	12.0
24-Aug-97	4760	9	3890	1.0	1.0	12.3
25-Aug-97	4480	9	3780	1.0	1.0	12.2
26-Aug-97	4640	11	3790	1.3	1.0	12.1

27-Aug-97	4470	4100	7	3490	1.4	1.4	11.7
28-Aug-97		4140	5	3420	1.4	1.4	12.0
29-Aug-97		3450	9	2890	1.3	1.3	12.0
30-Aug-97		3150	40	2580	0.9	0.9	11.9
31-Aug-97		2750	4	2340	1.4	1.4	12.0
1-Sep-97					no data	1.4	no data
2-Sep-97		2850	16	2440	1.2	1.2	12.1
3-Sep-97	2310	2480	23	2140	1.1	1.1	12.0
4-Sep-97		2230	4	1890	1.4	1.4	11.7
5-Sep-97		1870	2	1540	1.4	1.4	11.9
6-Sep-97		2200	3	1900	1.4	1.4	11.8
7-Sep-97		2180	3	1810	1.4	1.4	11.8
8-Sep-97	2280	2380	21	2000	1.1	1.0	12.6
9-Sep-97		2530	8	2090	1.3	1.3	12.1
10-Sep-97	2300	2440	5	2040	1.4	1.3	12.5
11-Sep-97		2260	7	1890	1.3	1.3	12.2
12-Sep-97		2260	4	1920	1.4	1.4	11.6

**NOTE:** Indicates a spill occurred and the amount of biomass wasted (as well as the SRT) are thus estimated.  
**NOTE:** Cells indicate days when sludge was added from other reactors.

Days of sludge addition	Volume and type of sludge added
27-Jun-97	Added 3.0 L of Primary MLSS
7-Aug-97	Added 2.6 L of Primary MLSS
8-Aug-97	Added 2.1 L of Primary MLSS

APPENDIX 17

Heated Primary Effluent Treatment Train:  
Flow rate data

Date	Flow Rates		Nitrate Recirculation (NR) mL/min
	Influent mL/min	Return Activated Sludge (RAS) mL/min	
20-May-97	55.0	37.0	
21-May-97	52-40	35-23	
22-May-97	56.0	35.0	
23-May-97	56 - 39.5	40.0	
24-May-97	37.5-40.7		
25-May-97	41.0	37.0	
26-May-97			
27-May-97	42.0	36.0	
28-May-97	40.0		
29-May-97	42.0	37.0	
30-May-97	41.0	35.0	
31-May-97	41.0	34-39	
1-Jun-97	40.5	39.0	
2-Jun-97	40.0	39.0	
3-Jun-97	39.0	39.0	
4-Jun-97	41.5		
5-Jun-97	42.0	38.0	
6-Jun-97			
7-Jun-97	41.0	38.0	
8-Jun-97	41.0	38.5	
9-Jun-97	42.0		
10-Jun-97	42.0	38.0	
11-Jun-97	42.0	38.5	
12-Jun-97	42.0	38.0	
13-Jun-97	43.0	38.5	
14-Jun-97	40.0	38.0	
15-Jun-97	43.0	39.0	
16-Jun-97	43.0		
17-Jun-97	41.0	38.0	
18-Jun-97	43.0	40.0	
19-Jun-97	43.5	39.5	
20-Jun-97	43.0	40.0	
21-Jun-97	43.0	40.0	
22-Jun-97	43.5	40.0	
23-Jun-97	41.0		
24-Jun-97	40.0	48.0	
25-Jun-97	40.0		
26-Jun-97	39.0	48.0	
27-Jun-97	40.0	48.0	
28-Jun-97	28.0	48.0	
29-Jun-97	27.5	47.5	
30-Jun-97	27.0		
1-Jul-97	28.0	47.0	
2-Jul-97	28.0		
3-Jul-97	28.0	46.0	
4-Jul-97	28.0	46.5	
5-Jul-97	27.5	45.5	

Table Continued

6-Jul-97	27.5	82.0	
7-Jul-97	28.0		
8-Jul-97	28.0	83.0	
9-Jul-97	28.0		
10-Jul-97	28.0	83.0	
11-Jul-97	28.0	83.0	
12-Jul-97	28.0	81.0	
13-Jul-97	28.0	82.0	
14-Jul-97	28.0		
15-Jul-97	28.0	82.0	
16-Jul-97	28.0		
17-Jul-97	30.0	84.0	
18-Jul-97	30.0	85.0	
19-Jul-97	28.0	88.0	
20-Jul-97	27.5	86.0	
21-Jul-97	28.0		
22-Jul-97	28.0		
23-Jul-97	28.0		
24-Jul-97	27.5	88.0	
25-Jul-97	28.0	88.0	
26-Jul-97	28.0	87.0	
27-Jul-97	28.0	88.0	
28-Jul-97	28.0	56.0	
29-Jul-97	28.0	56.0	
30-Jul-97	28.0		
31-Jul-97	28.0	55.0	
1-Aug-97	28.0	55.0	
2-Aug-97	27.0	55.0	
3-Aug-97	27.0	52-56	
4-Aug-97	28.0	57.0	
5-Aug-97	28.0	58.0	
6-Aug-97	28.0	58.0	
7-Aug-97	28.0	58.0	
8-Aug-97	28.0	58.0	
9-Aug-97	28.0	58.5	
10-Aug-97	28.0	58.0	
11-Aug-97	28.0		
12-Aug-97	28.0	58.0	
13-Aug-97	29.0		
14-Aug-97	28.0	58.0	
15-Aug-97	28.5	57.0	
16-Aug-97	29.0	59.0	
17-Aug-97	28.0	58.0	
18-Aug-97	28.0		
19-Aug-97	28.0	58.0	
20-Aug-97	28.0		
21-Aug-97	28.0	58.0	
22-Aug-97	27.0	56.0	
23-Aug-97	28.5	50-58	
24-Aug-97	27.0	57.0	
25-Aug-97	28.0		
26-Aug-97	27.0	58.0	82.0

Table Continued

27-Aug-97	27.0		84.0
28-Aug-97	26.5	58.0	79-84
29-Aug-97	28.0	59.0	84.0
30-Aug-97	30.0	57.0	68-88
31-Aug-97	28.0	57.0	0-89
1-Sep-97			
2-Sep-97	28.0	57.0	86.0
3-Sep-97	27.0		
4-Sep-97	28.0	57.0	86.0
5-Sep-97	27.0	55.0	87.0
6-Sep-97	27.5	55.0	86.0
7-Sep-97	29.0	59.0	85.0
8-Sep-97	29.0		
9-Sep-97	27.0	58.0	86.0
10-Sep-97	27.0		
11-Sep-97	26.0	58.0	86.0
12-Sep-97	28.5	57.0	86.0

**NOTE:** Ranges listed for flow rates signify that the flow was adjusted from the first value to the second.

**NOTE:** Grey cells indicate the flow rate was adjusted from the initial measured flow rate to the indicated flow rate. The flow rate shown is the one used for any related calculation.

## APPENDIX 18

High Ammonia Side Stream Treatment Train:  
Overall system influent and effluent nitrogen and COD raw data and mass balances

### Nitrogen Raw Data

Date	Influent Nutrient Concentrations				Effluent Nutrient Concentrations			
	NO3+NO2	NO2	NHx	TN	NO3+NO2	NO2	NHx	TN
	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L	mg-N/L
20-May-97	17.0		166.0		0.0		30.0	
21-May-97	5.0		140.0					
22-May-97					0.0	0.3	82.7	90.8
23-May-97								
24-May-97								
25-May-97								
26-May-97								
27-May-97	7.0		166.0					
28-May-97	0.0	0.0	109.9	125.7	0.4	0.0	112.0	115.4
29-May-97								
30-May-97	0.0	0.0	110.0	117.2	2.7	0.0	98.9	103.3
31-May-97								
1-Jun-97								
2-Jun-97	0.0	0.0	121.9	125.4	2.1	1.0	105.2	109.1
3-Jun-97								
4-Jun-97	0.0	0.0	127.4	114.2	9.4	3.0	99.1	107.8
5-Jun-97								
6-Jun-97	0.0	0.0	107.7	141.4	22.4	2.8	46.1	76.5
7-Jun-97								
8-Jun-97								
9-Jun-97	0.0	0.0	134.9	141.2	31.5	4.9	54.0	74.9
10-Jun-97	0.0	0.0	130.6	146.6	28.8	4.6	52.8	79.7
11-Jun-97	0.0	0.0	136.0	146.9	25.9	4.0	48.8	76.3
12-Jun-97	0.0	0.0	134.6	143.5	27.0	1.8	40.4	66.9
13-Jun-97	0.0	0.0	134.3	179.9	27.3	1.5	40.9	85.5
14-Jun-97								
15-Jun-97								
16-Jun-97	0.0	0.0	113.0	138.2	39.4	0.6	26.7	68.8
17-Jun-97								
18-Jun-97	0.0	0.0	104.4	112.9	36.7	0.4	17.7	55.4
19-Jun-97								
20-Jun-97	0.0	0.0	101.8	119.7	30.3	0.3	13.5	46.0
21-Jun-97								
22-Jun-97								
23-Jun-97	0.0	0.1	108.6	125.2	40.5	0.6	6.1	51.2
24-Jun-97								
25-Jun-97	0.0	0.0	92.2	100.4	43.5	3.7	8.8	55.7
26-Jun-97								
27-Jun-97	0.0	0.0	71.7	79.2	38.4	0.3	1.0	44.7
28-Jun-97								
29-Jun-97								
30-Jun-97	0.0	0.1	188.9	192.0	67.8	2.6	47.9	119.8
1-Jul-97								
2-Jul-97	0.0	0.1	194.4	182.6	77.9	2.5	45.3	129.9

Table Continued

3-Jul-97								
4-Jul-97								
5-Jul-97								
6-Jul-97								
7-Jul-97	0.0	0.0	109.9	110.7	64.6	5.3	0.0	70.8
8-Jul-97								
9-Jul-97	0.0	0.0	106.3	108.7	?	?	?	?
10-Jul-97								
11-Jul-97	0.0	0.0	166.8	157.2	43.6	9.7	24.3	70.8
12-Jul-97								
13-Jul-97								
14-Jul-97	0.0	0.0	127.2	134.0	57.6	1.6	6.3	66.6
15-Jul-97								
16-Jul-97	0.0	0.1	121.3	132.4	41.4	2.4	0.0	47.1
17-Jul-97								
18-Jul-97	0.0	0.1	127.9	132.2	0.3	0.0	61.0	56.3
19-Jul-97								
20-Jul-97								
21-Jul-97	0.0	0.1	128.7	126.8	16.9	9.9	36.6	54.0
22-Jul-97								
23-Jul-97	0.0	0.0	126.4	120.1	22.6	7.8	4.3	27.7
24-Jul-97								
25-Jul-97	0.0	0.1	120.7	?	25.5	3.3	3.3	29.6
26-Jul-97								
27-Jul-97								
28-Jul-97	0.0	0.0	143.0	133.0	34.5	0.8	0.0	38.1
29-Jul-97								
30-Jul-97	0.0	0.0	138.6	130.4	29.3	1.0	1.4	32.2
31-Jul-97								
1-Aug-97	0.0	0.0	149.9	145.4	36.8	1.7	3.2	43.8
2-Aug-97								
3-Aug-97								
4-Aug-97	0.0	0.0	135.8	131.3	47.2	0.3	0.0	49.7
5-Aug-97								
6-Aug-97	0.3	0.1	175.9	172.2	44.8	1.0	5.5	29.2
7-Aug-97								
8-Aug-97	0.0	0.0	133.0	133.3	48.4	1.7	4.6	59.9
9-Aug-97								
10-Aug-97								
11-Aug-97	0.0	0.0	120.3	111.7	25.8	0.3	0.0	31.5
12-Aug-97								
13-Aug-97	0.0	0.0	115.7	109.5	19.8	0.5	0.0	23.3
14-Aug-97								
15-Aug-97	?	0.0	111.1	107.5	?	0.6	0.0	19.0
16-Aug-97								
17-Aug-97								
18-Aug-97	0.1	0.1	109.1	112.8	15.1	0.6	0.7	17.9
19-Aug-97								
20-Aug-97	0.0	0.1	103.7	106.9	11.7	1.3	11.3	23.1

Table Continued

21-Aug-97	0.1	0.1	106.0	108.1	13.2	1.2	0.0	15.0
22-Aug-97	0.0	0.0	103.2	118.8	6.2	1.2	2.9	11.5
23-Aug-97								
24-Aug-97								
25-Aug-97	?	?	?	?	?	?	?	?
26-Aug-97	0.1	0.1	103.4	104.6	15.0	0.2	0.0	16.5
27-Aug-97	0.1	0.0	100.9	103.6	13.0	0.2	0.0	14.8
28-Aug-97	0.0	0.0	96.9	96.6	6.8	0.1	1.1	9.6
29-Aug-97	0.0	0.0	88.8	97.1	9.0	0.2	0.0	11.7
30-Aug-97								
31-Aug-97								
1-Sep-97								
2-Sep-97	0.0	0.0	99.6	95.0	9.0	1.0	1.6	12.6
3-Sep-97	0.0	0.0	101.8	108.1	6.8	0.1	1.1	9.3
4-Sep-97	0.0	0.0	105.2	109.6	11.2	0.9	2.7	15.4
5-Sep-97	0.0	0.0	?	111.6	11.8	0.2	?	15.2
6-Sep-97								
7-Sep-97								
8-Sep-97	0.0	0.0	101.6	108.4	11.3	0.0	0.0	13.5
9-Sep-97	0.0	0.0	97.3	98.0	8.2	0.1	1.7	10.5
10-Sep-97	0.0	0.0	162.4	156.2	20.6	0.4	7.8	30.1
11-Sep-97	0.0	0.0	181.4	130.5	22.6	0.0	11.4	33.8
12-Sep-97	0.0	0.0	208.8	203.1	20.4	1.1	28.4	51.7

**NOTE:** Soluble data for nutrients in reactors and effluent starting 6/10/97. Total (solid+soluble) for influent. All previous data (6/9/97 and earlier) reports total values for influent, reactors, and effluent. Only data from 6/10/97 on is used for calculations and Figures.

**COD Raw Data**

Date	Influent COD mg/L	Effluent COD mg/L	Methanol stock solution mL/L	Methanol concentration mg/L	Methanol Theoretical COD mg/L
20-May-97			0	0	0
21-May-97		4120	0	0	0
22-May-97			0	0	0
23-May-97			0	0	0
24-May-97			0	0	0
25-May-97			0	0	0
26-May-97			0	0	0
27-May-97			0	0	0
28-May-97	304	154	0	0	0
29-May-97			0	0	0
30-May-97	330	72	0	0	0
31-May-97			0	0	0
1-Jun-97			0	0	0
2-Jun-97	245	71	0	0	0
3-Jun-97			0	0	0
4-Jun-97	332	86	0	0	0
5-Jun-97	370	46	0	0	0
6-Jun-97	380	55	0	0	0
7-Jun-97			0	0	0
8-Jun-97			0	0	0
9-Jun-97	400	46	0	0	0
10-Jun-97	490	44	0	0	0
11-Jun-97	367	36	0	0	0
12-Jun-97	487	37	0	0	0
13-Jun-97	488	42	0	0	0
14-Jun-97			0	0	0
15-Jun-97			0	0	0
16-Jun-97	417	39	0	0	0
17-Jun-97			0	0	0
18-Jun-97	400	56	0	0	0
19-Jun-97			0	0	0
20-Jun-97	807	64	0	0	0
21-Jun-97			0	0	0
22-Jun-97			0	0	0
23-Jun-97	700	42	0	0	0
24-Jun-97			0	0	0
25-Jun-97	587	57	0	0	0
26-Jun-97			0	0	0
27-Jun-97	296	46	0	0	0
28-Jun-97			0	0	0
29-Jun-97			0	0	0
30-Jun-97	350	38	0	0	0
1-Jul-97			0	0	0
2-Jul-97	380	48	0	0	0

Table Continued

3-Jul-97			0	0	0
4-Jul-97			0	0	0
5-Jul-97			0	0	0
6-Jul-97			0	0	0
7-Jul-97	480	32	0	0	0
8-Jul-97			0	0	0
9-Jul-97	355	13	0	0	0
10-Jul-97			0	0	0
11-Jul-97	487	53	0	0	0
12-Jul-97			0	0	0
13-Jul-97			0	0	0
14-Jul-97	663	43	0	0	0
15-Jul-97			0	0	0
16-Jul-97	1293	46	0	0	0
17-Jul-97			1.0	791.4	1187
18-Jul-97	1047	79	1.0	791.4	1187
19-Jul-97			1.0	791.4	1187
20-Jul-97			1.0	791.4	1187
21-Jul-97	444	48	1.0	791.4	1187
22-Jul-97			1.0	791.4	1187
23-Jul-97	676	39	1.0	791.4	1187
24-Jul-97			1.0	791.4	1187
25-Jul-97	412	33	1.0	791.4	1187
26-Jul-97			1.0	791.4	1187
27-Jul-97			1.0	791.4	1187
28-Jul-97			1.0	791.4	1187
29-Jul-97			1.0	791.4	1187
30-Jul-97	372	42	1.0	791.4	1187
31-Jul-97			1.0	791.4	1187
1-Aug-97	412	42	1.0	791.4	1187
2-Aug-97			1.0	791.4	1187
3-Aug-97			1.0	791.4	1187
4-Aug-97	269	34	1.0	791.4	1187
5-Aug-97			1.0	791.4	1187
6-Aug-97	418	26	1.0	791.4	1187
7-Aug-97			1.0	791.4	1187
8-Aug-97	408	44	2.0	1582.8	2374
9-Aug-97			2.0	1582.8	2374
10-Aug-97			2.0	1582.8	2374
11-Aug-97	216	23	2.0	1582.8	2374
12-Aug-97			2.0	1582.8	2374
13-Aug-97	292	42	2.0	1582.8	2374
14-Aug-97			2.0	1582.8	2374
15-Aug-97	231	30	2.0	1582.8	2374
16-Aug-97			2.0	1582.8	2374
17-Aug-97			2.0	1582.8	2374
18-Aug-97	416	27	2.0	1582.8	2374
19-Aug-97			2.0	1582.8	2374
20-Aug-97	530	30	2.0	1582.8	2374

Table Continued

21-Aug-97	433	38	2.0	1582.8	2374
22-Aug-97	404	37	2.0	1582.8	2374
23-Aug-97			2.0	1582.8	2374
24-Aug-97			2.0	1582.8	2374
25-Aug-97	396	42	2.0	1582.8	2374
26-Aug-97	475	38	2.0	1582.8	2374
27-Aug-97	352	36	2.0	1582.8	2374
28-Aug-97	404	27	2.0	1582.8	2374
29-Aug-97	408	27	2.0	1582.8	2374
30-Aug-97			2.0	1582.8	2374
31-Aug-97			2.0	1582.8	2374
1-Sep-97			2.0	1582.8	2374
2-Sep-97	328	43	2.0	1582.8	2374
3-Sep-97	292	29	2.0	1582.8	2374
4-Sep-97	292	27	2.0	1582.8	2374
5-Sep-97	261	40	2.0	1582.8	2374
6-Sep-97			2.0	1582.8	2374
7-Sep-97			2.0	1582.8	2374
8-Sep-97	551	55	2.0	1582.8	2374
9-Sep-97	750	42	2.0	1582.8	2374
10-Sep-97	720	48	2.0	1582.8	2374
11-Sep-97	676	44	2.0	1582.8	2374
12-Sep-97	481	50	2.0	1582.8	2374

### Nitrogen Mass Balances

Date	Influent NO3+NO2 mg-N/day	Influent NHx mg-N/day	Influent "TKN" mg-N/day	Effluent NO3+NO2 mg-N/day	Effluent NHx mg-N/day	Effluent "TKN" mg-N/day	bioavailable TKN mg-N/day	Aerobic MLVSS mg/L	Aerobic biomass mg	VSS growth mgVSS/day	Specific growth rate mgVSS/mgMLVSS-day
28-May-97	0	4904	5611	20	5000	5133	5477	3144	56592	5565	
30-May-97	0	4751	5064	115	4272	4347	4989	2280	41040	4029	
2-Jun-97	0	5440	5598	95	4697	4774	5521	1328	23904	2736	
4-Jun-97	0	5594	5594	415	4351	4351	5594	3880	69840	878	
6-Jun-97	0	3645	4783	758	1559	1829	4513	4270	76860	7479	
9-Jun-97	0	5244	5490	1225	2100	2100	5490	3990	71820	7125	
10-Jun-97	0	5077	5701	1118	2052	2052	5701	3620	65160	6259	0.054
11-Jun-97	0	4896	5289	934	1758	1812	5235	3260	58680	5821	0.056
12-Jun-97	0	5039	5371	1009	1511	1511	5371	3130	56340	5471	0.055
13-Jun-97	0	4003	5362	814	1218	1734	4847	3170	57060	5679	0.056
16-Jun-97	0	2360	2885	823	557	613	2830	2490	44820	4417	0.055
18-Jun-97	0	3156	3414	1111	536	566	3385	2920	52560	342	0.004
20-Jun-97	0	3006	3534	895	398	464	3468	2410	43380	213	0.003
23-Jun-97	0	3283	3787	1226	184	324	3647	2670	48060	1452	0.017
25-Jun-97	0	2656	2891	1253	255	352	2794	2530	45540	3827	0.047
27-Jun-97	0	2066	2280	1107	30	181	2129	2290	41220	392	0.005
30-Jun-97	0	5713	5806	2050	1449	1573	5682	1830	32940	281	0.005
2-Jul-97	0	5879	5879	2357	1371	1572	5678	2330	41940	4922	0.066
7-Jul-97	0	3165	3187	1859	0	181	3006	1940	34920	2540	0.041
9-Jul-97	0	3214	3287	#VALUE!	#VALUE!	#VALUE!	#VALUE!	1450	26100	368	0.008
11-Jul-97	0	5045	5045	1318	734	823	4955	1000	18000	-4027	-0.126
14-Jul-97	0	3664	3859	1658	182	259	3782	2030	36540	2736	0.042
16-Jul-97	0	3581	3908	1222	0	168	3739	1410	25380	255	0.006
18-Jul-97	0	3683	3808	8	1755	1755	3808	2180	39240	-1811	-0.026
21-Jul-97	0	3705	3705	487	1054	1068	3691	3440	61920	4446	0.040
23-Jul-97	0	3641	3641	652	123	147	3617	3290	59220	4446	0.042
25-Jul-97	1	3477	#VALUE!	733	96	120	#VALUE!	2850	51300	3796	0.042
28-Jul-97	0	4120	4120	993	0	103	4016	2860	51480	3745	0.041
30-Jul-97	0	3992	3992	843	40	85	3947	2430	43740	3174	0.041
1-Aug-97	0	4317	4317	1060	91	201	4207	1520	27360	2006	0.041
4-Aug-97	0	3910	3910	1360	0	71	3839	2580	46440	3322	0.040
6-Aug-97	10	5066	5066	1292	158	158	5066	2260	40680	2789	0.039

Table Continued

8-Aug-97	0	3829	3838	1395	131	331	3639	2360	42480	3144	0.042
11-Aug-97	0	3463	3463	744	0	163	3300	2000	36000	2660	0.042
13-Aug-97	0	3331	3331	570	0	101	3230	960	17280	1490	0.049
15-Aug-97	#VALUE!	3278	#VALUE!	#VALUE!	0	#VALUE!	#VALUE!	1350	24300	120	0.003
18-Aug-97	2	4399	4547	608	30	114	4464	1400	25200	1364	0.030
20-Aug-97	0	3733	3848	420	407	412	3843	2060	37080	2691	0.041
21-Aug-97	4	4121	4199	514	0	67	4132	1610	28980	330	0.006
22-Aug-97	0	3715	4275	224	104	189	4190	1930	34740	2175	0.040
26-Aug-97	5	3871	3913	561	0	56	3857	2080	37440	2314	0.040
27-Aug-97	4	3634	3724	466	0	65	3659	3040	54720	3554	0.042
28-Aug-97	0	3488	3488	245	38	101	3425	1840	33120	2090	0.041
29-Aug-97	0	3198	3496	326	0	96	3400	2690	48420	#VALUE!	#VALUE!
2-Sep-97	0	4302	4302	389	68	154	4216	2680	48240	3051	0.041
3-Sep-97	0	4250	4512	285	45	103	4454	2860	51480	3336	0.042
4-Sep-97	0	4243	4421	452	110	169	4361	2850	51300	3354	0.042
5-Sep-97	0	6061	6429	680	0	193	6236	3100	55800	3733	0.043
8-Sep-97	0	5706	6085	633	0	126	5959	2580	46440	2919	0.035
9-Sep-97	0	5607	5643	471	98	136	5605	2850	51300	3154	0.035
10-Sep-97	0	8885	8885	1126	427	520	8793	3150	56700	3632	0.036
11-Sep-97	0	10712	10712	1337	671	671	10712	2910	52380	3288	0.035
12-Sep-97	0	12177	12177	1191	1656	1822	12011	4060	73080	4711	0.036

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**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	mg-N growth	TKN oxidized	Specific Nfication rate	Specific DeNfication rate	Nitrification	Denitrification
	mg-N/day	mg-N/day	mgTKN/mgVSS/day	mgNOx/mgVSS/day	F:M loading mgTKN/mgVSS/day	F:M loading mgTKN/mgVSS/day
28-May-97	668	-190	-0.003	-0.008	0.10	0.22
30-May-97	483	233	0.006	0.007	0.12	0.28
2-Jun-97	328	496	0.021	0.038	0.23	0.53
4-Jun-97	105	1138	0.016	0.023	0.08	0.18
6-Jun-97	897	2057	0.027	0.038	0.06	0.14
9-Jun-97	855	2535	0.035	0.041	0.08	0.17
10-Jun-97	751	2898	0.044	0.061	0.09	0.20
11-Jun-97	698	2779	0.047	0.071	0.09	0.20
12-Jun-97	656	3203	0.057	0.088	0.10	0.21
13-Jun-97	681	2947	0.052	0.084	0.09	0.21
16-Jun-97	530	1742	0.039	0.046	0.06	0.14
18-Jun-97	41	2807	0.053	0.073	0.06	0.15
20-Jun-97	26	3044	0.070	0.112	0.08	0.18
23-Jun-97	174	3289	0.068	0.097	0.08	0.18
25-Jun-97	459	2080	0.046	0.041	0.06	0.14
27-Jun-97	47	2052	0.050	0.052	0.06	0.12
30-Jun-97	34	4200	0.127	0.147	0.18	0.40
2-Jul-97	591	3716	0.089	0.073	0.14	0.32
7-Jul-97	305	2701	0.077	0.054	0.09	0.21
9-Jul-97	44	#VALUE!	#VALUE!	#VALUE!	0.13	0.28
11-Jul-97	-483	4705	0.261	0.423	0.28	0.63
14-Jul-97	328	3271	0.090	0.099	0.11	0.24
16-Jul-97	31	3709	0.146	0.220	0.15	0.35
18-Jul-97	-217	2270	0.058	0.130	0.10	0.22
21-Jul-97	534	2104	0.034	0.059	0.06	0.13
23-Jul-97	533	2961	0.050	0.088	0.06	0.14
25-Jul-97	456	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
28-Jul-97	449	3567	0.069	0.112	0.08	0.18
30-Jul-97	381	3526	0.081	0.138	0.09	0.21
1-Aug-97	241	3876	0.142	0.232	0.16	0.36
4-Aug-97	399	3440	0.074	0.101	0.08	0.19
6-Aug-97	335	4574	0.112	0.182	0.12	0.28

Table Continued

8-Aug-97	377	3131	0.074	0.092	0.09	0.20
11-Aug-97	319	2981	0.083	0.140	0.10	0.22
13-Aug-97	179	3051	0.177	0.323	0.19	0.43
15-Aug-97	14	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
18-Aug-97	164	4270	0.169	0.327	0.18	0.41
20-Aug-97	323	3113	0.084	0.163	0.10	0.23
21-Aug-97	40	4092	0.141	0.278	0.14	0.33
22-Aug-97	261	3825	0.110	0.466	0.12	0.55
26-Aug-97	278	3580	0.096	0.363	0.10	0.47
27-Aug-97	426	3233	0.059	0.228	0.07	0.31
28-Aug-97	251	3136	0.095	0.393	0.11	0.47
29-Aug-97	#VALUE!	#VALUE!	#VALUE!	#VALUE!	0.07	0.32
2-Sep-97	366	3782	0.078	0.316	0.09	0.40
3-Sep-97	400	4008	0.078	0.325	0.09	0.39
4-Sep-97	403	3849	0.075	0.298	0.09	0.39
5-Sep-97	448	5789	0.104	0.412	0.12	0.52
8-Sep-97	350	5609	0.121	0.482	0.13	0.59
9-Sep-97	378	5129	0.100	0.409	0.11	0.50
10-Sep-97	436	7929	0.140	0.540	0.16	0.71
11-Sep-97	395	9646	0.184	0.714	0.20	0.92
12-Sep-97	565	9790	0.134	0.530	0.17	0.75

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**NOTE:** Indicates system upset.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	Influent COD inf mg/day	Effluent COD eff mg/day	Methanol COD added mg/day	Bioavailable CODin/TKNin (C:N ratio) mgCOD/mgTKN
10-Jun-97	19051	1711	0	3.0
11-Jun-97	13212	1296	0	2.3
12-Jun-97	18233	1385	0	3.1
13-Jun-97	14546	1252	0	2.7
16-Jun-97	8707	814	0	2.8
18-Jun-97	12096	1693	0	3.1
20-Jun-97	23823	1889	0	6.3
23-Jun-97	21168	1270	0	5.5
25-Jun-97	16906	1642	0	5.5
27-Jun-97	8525	1325	0	3.4
30-Jun-97	10584	1149	0	1.7
2-Jul-97	11491	1452	0	1.8
7-Jul-97	13824	922	0	4.3
9-Jul-97	10735	393	0	#VALUE!
11-Jul-97	14727	1603	0	2.6
14-Jul-97	19094	1238	0	4.7
16-Jul-97	38169	1358	0	9.8
18-Jul-97	30154	2275	6838	9.1
21-Jul-97	12787	1382	6838	4.9
23-Jul-97	19469	1123	6838	7.0
25-Jul-97	11866	950	6838	#VALUE!
30-Jul-97	10714	1210	6838	4.1
1-Aug-97	11866	1210	6838	4.2
4-Aug-97	7747	979	6838	3.5
6-Aug-97	12038	749	6838	3.6
8-Aug-97	11750	1267	13675	6.6
11-Aug-97	6221	662	11966	5.3
13-Aug-97	8410	1210	12992	6.3
15-Aug-97	6819	886	15727	#VALUE!
18-Aug-97	16773	1089	17094	7.3
20-Aug-97	19080	1080	17094	9.1
21-Aug-97	16835	1477	17778	8.0
22-Aug-97	14544	1332	18120	7.5
25-Aug-97	14256	1512	17094	7.0
26-Aug-97	17784	1423	17094	8.7
27-Aug-97	12672	1296	17094	7.8
28-Aug-97	14544	972	17094	9.0
29-Aug-97	14688	972	17094	9.1
2-Sep-97	14170	1858	19487	7.5
3-Sep-97	12194	1211	19487	6.8
4-Sep-97	11773	1089	18462	6.7
5-Sep-97	15034	2304	18462	5.0
8-Sep-97	30944	3089	26325	9.1
9-Sep-97	43200	2442	26325	12.0
10-Sep-97	39398	2627	26325	7.2
11-Sep-97	39911	2598	26325	5.9
12-Sep-97	28052	2916	26325	4.3

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates system upset.

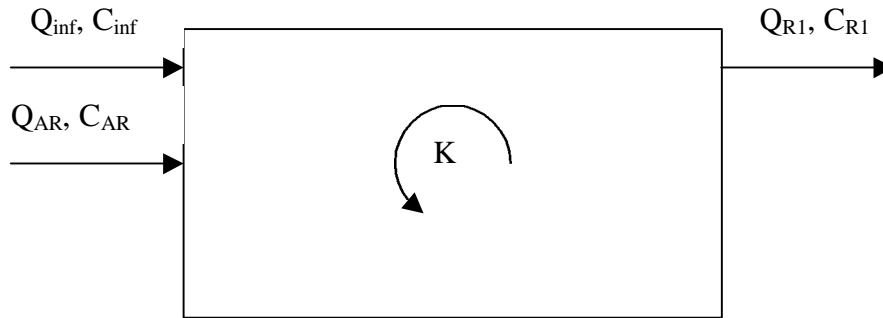
**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 19

High Ammonia Side Stream Treatment Train:  
Anaerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Anaerobic Reactor (R1) of the High Ammonia Side Stream  
MUCT Treatment Train

(NOTE: Mass balances for A2/O treatment of the high ammonia side stream are identical to those for A2/O treatment of the primary effluent)



$Q_{inf}$  = Influent flow rate (L/day)

$C_{inf}$  = Influent concentration of the constituent of interest (e.g., COD,  $NH_x-N$ , etc.) (mg/L)

$Q_{AR}$  = Anoxic recirculation (AR) flow rate (L/day)

$C_{AR}$  = Anoxic recirculation (AR) concentration of the constituent of interest  
= first anoxic reactor (R2) concentration (mg/L)

$Q_{R1}$  = Flow rate exiting the anaerobic reactor (R1) =  $Q_{inf} + Q_{AR}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$K$  = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to anaerobic reactor (mg/day)} = (Q_{inf} \times C_{inf}) + (Q_{AR} \times C_{AR})$$

$C_{in}$  = Concentration of the constituent of interest entering the anaerobic reactor (mg/L)

$$= \left( C_{inf} \times \frac{Q_{inf}}{Q_{inf} + Q_{AR}} \right) + \left( C_{AR} \times \frac{Q_{AR}}{Q_{inf} + Q_{AR}} \right)$$

$$C_{out} = C_{R1} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	0.0	0.0	108.5	114.3	288
4-Jun-97	0.0	0.1	118.6	123.1	278
11-Jun-97	0.0	0.0	97.3	103.0	154
18-Jun-97	0.1	0.0	73.9	75.9	166
25-Jun-97	0.3	0.0	69.8	73.8	143
2-Jul-97	7.3	0.2	135.2	140.0	70
16-Jul-97	0.2	0.0	74.1	72.1	237
23-Jul-97	0.0	0.0	79.6	81.4	170
30-Jul-97	0.0	0.0	85.4	80.8	98
6-Aug-97	0.2	0.0	108.4	107.4	60
13-Aug-97	0.0	0.0	71.7	69.1	68
20-Aug-97	0.0	0.0	74.1	75.1	196
<b>22-Aug-97 Switched configuration to A2O Friday night (8/22/97)</b>					
27-Aug-97	0.0	0.0	43.6	45.1	104
3-Sep-97	0.0	0.0	29.6	28.9	53
10-Sep-97	0.2	0.0	74.6	75.8	96
11-Sep-97	0.0	0.0	152.0	158.4	106
12-Sep-97	1.9	0.0	88.4	91.3	107

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	NHx in mg-N/day	NHx out mg-N/day	TNin mg-N/day	TNout mg-N/day	"TKN" in mg-N/day	"SKN" out mg-N/day
28-May-97	0	0	0	12362	12187	13353	12835	13353	12835
4-Jun-97	0	0	0	13184	13240	12653	13732	13184	13732
11-Jun-97	0	0	0	10845	10225	11662	10823	11662	10823
18-Jun-97	0	12	-12	7495	7451	7986	7654	7986	7641
25-Jun-97	0	30	-30	6753	6934	7130	7332	7130	7302
2-Jul-97	1416	737	679	14164	13627	15189	14115	14164	13627
16-Jul-97	0	29	-29	9119	8912	9930	8667	9930	8912
23-Jul-97	0	0	0	8063	7796	8127	7970	8127	7970
30-Jul-97	68	0	68	8460	8236	8053	7797	8460	8236
6-Aug-97	543	24	519	11097	10612	11422	10517	11097	10612
13-Aug-97	0	0	0	7084	7017	6877	6761	7084	7017
20-Aug-97	0	0	0	8782	9072	9275	9197	9275	9197

: Entering and Exiting at rate(Feed+RAS)

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	NHx in mg-N/day	NHx out mg-N/day	TNin mg-N/day	TNout mg-N/day	"TKN" in mg-N/day	"SKN" out mg-N/day
27-Aug-97	489	0	489	3634	3198	4281	3314	3791	3314
3-Sep-97	295	0	295	4297	2514	4914	2457	4619	2514
10-Sep-97	1215	23	1192	9347	8482	10321	8625	9347	8602
11-Sep-97	1370	0	1370	11399	18162	9752	18930	11399	18930
12-Sep-97	1220	220	1001	13874	10436	14931	10775	13874	10555

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**Nitrogen Mass Balances**

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"TKN" in mg-N/L	"SKN" out mg-N/L
28-May-97	0.0	0.0	110.1	108.5	118.9	114.3	118.9	114.3
4-Jun-97	0.0	0.0	118.1	118.6	113.4	123.1	118.1	123.1
11-Jun-97	0.0	0.0	103.2	97.3	110.9	103.0	110.9	103.0
18-Jun-97	0.0	0.1	74.4	73.9	79.2	75.9	79.2	75.8
25-Jun-97	0.0	0.3	68.0	69.8	71.8	73.8	71.8	73.5
2-Jul-97	14.0	7.3	140.5	135.2	150.7	140.0	140.5	135.2
16-Jul-97	0.0	0.2	75.8	74.1	82.6	72.1	82.6	74.1
23-Jul-97	0.0	0.0	82.3	79.6	83.0	81.4	83.0	81.4
30-Jul-97	0.7	0.0	87.7	85.4	83.5	80.8	87.7	85.4
6-Aug-97	5.5	0.2	113.3	108.4	116.7	107.4	113.3	108.4
13-Aug-97	0.0	0.0	72.3	71.7	70.2	69.1	72.3	71.7
20-Aug-97	0.0	0.0	71.8	74.1	75.8	75.1	75.8	75.1

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"TKN" in mg-N/L	"SKN" out mg-N/L
27-Aug-97	6.7	0.0	49.5	43.6	58.3	45.1	51.6	45.1
3-Sep-97	3.5	0.0	50.6	29.6	57.8	28.9	54.4	29.6
10-Sep-97	10.7	0.2	82.2	74.6	90.7	75.8	82.2	75.6
11-Sep-97	11.5	0.0	95.4	152.0	81.6	158.4	95.4	158.4
12-Sep-97	10.3	1.9	117.5	88.4	126.5	91.3	117.5	89.4

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**COD Mass Balances**

Date	CODin mg/day	COD out mg/day	COD in mg/L	COD out mg/L
28-May-97	31167	32348	277	288
4-Jun-97	14581	31025	131	278
11-Jun-97	19778	16188	188	154
18-Jun-97	19152	16733	190	166
25-Jun-97	23538	14208	237	143
2-Jul-97	15725	7056	156	70
16-Jul-97	51505	28497	428	237
23-Jul-97	27832	16646	284	170
30-Jul-97	15180	9455	157	98
6-Aug-97	15494	5875	158	60
13-Aug-97	12557	6659	128	68
20-Aug-97	31867	23990	260	196

Date	COD in mg/day	COD out mg/day	COD in mg/L	COD out mg/L
27-Aug-97	14020	7638	191	104
3-Sep-97	13447	4503	158	53
10-Sep-97	42232	10921	371	96
11-Sep-97	42572	12669	356	106
12-Sep-97	31040	12635	263	107

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

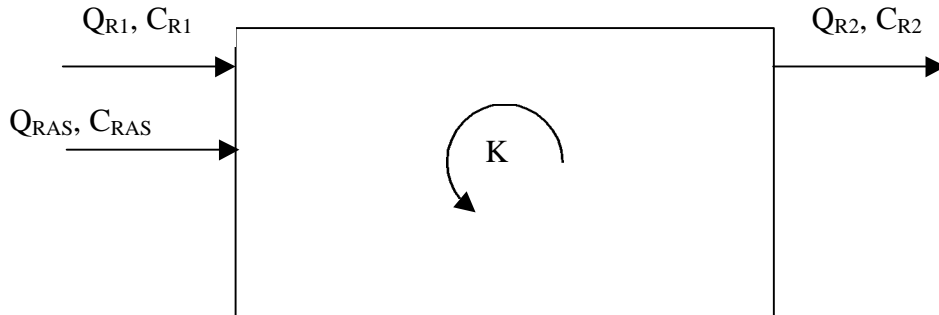
**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 20

High Ammonia Side Stream Treatment Train:  
Anaerobic reactor #1 nitrogen and COD raw data and mass balances

Performing a Mass Balance on the First Anoxic Reactor (R2) of the High Ammonia Side Stream MUCT Treatment Train

(NOTE: Mass balances for A2/O treatment of the high ammonia side stream are identical to those for A2/O treatment of the primary effluent)



$Q_{R1}$  = Flow rate exiting the anaerobic reactor (R1) =  $Q_{inf} + Q_{AR}$  (L/day)

$C_{R1}$  = Concentration of the constituent of interest exiting R1 = the concentration measured in R1 (mg/L)

$Q_{RAS}$  = RAS flow rate (L/day)

$C_{RAS}$  = RAS concentration of the constituent of interest = final effluent concentration (mg/L)

$Q_{R2}$  = Flow rate exiting the first anoxic reactor (R2) =  $Q_{inf} + Q_{AR} + Q_{RAS}$  (L/day)

$C_{R2}$  = Concentration of the constituent of interest exiting R2 = the concentration measured in R2 (mg/L)

$K$  = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to first anoxic reactor (mg/day)} = (Q_{R1} \times C_{R1}) + (Q_{RAS} \times C_{RAS})$$

$C_{in}$  = Concentration of the constituent of interest entering the first anoxic reactor (mg/L)

$$= \left( C_{R1} \times \frac{Q_{R1}}{Q_{R1} + Q_{RAS}} \right) + \left( C_{RAS} \times \frac{Q_{RAS}}{Q_{R1} + Q_{RAS}} \right)$$

$$C_{out} = C_{R2} \text{ (mg/L)}$$

### Nitrogen and COD Raw Data

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	0.0	0.0	110.2	114.4	260
4-Jun-97	0.0	0.0	112.1	112.9	
11-Jun-97	0.0	0.0	86.1	92.2	95
18-Jun-97	0.0	0.0	61.5	64.8	100
25-Jun-97	0.0	0.0	58.1	60.1	94
2-Jul-97	20.1	0.1	117.4	137.0	60
16-Jul-97	0.0	0.0	61.0	66.4	147
23-Jul-97	0.0	0.0	64.0	67.5	121
30-Jul-97	1.0	0.2	66.0	63.5	66
6-Aug-97	7.7	0.2	87.3	93.5	50
13-Aug-97	0.0	0.0	54.3	53.9	60
20-Aug-97	0.0	0.0	58.4	62.8	148
22-Aug-97	Switched configuration to A2O Friday night (8/22/97)				

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	NHx in mg-N/day	NHx out mg-N/day	TNin mg-N/day	TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg-N/day
28-May-97	14	0	14	12187	15867	12835	16474	12821	16474
4-Jun-97	449	0	449	13240	17844	13732	17958	13283	17958
11-Jun-97	859	0	859	10225	11898	10823	12744	10225	12744
18-Jun-97	1017	0	1017	7451	7882	7654	8303	7451	8303
25-Jun-97	1283	0	1283	6934	7442	7806	7700	6934	7700
2-Jul-97	2869	2572	298	13670	15049	14459	17558	13670	15049
16-Jul-97	1192	0	1192	8912	9053	8667	9845	8912	9845
23-Jul-97	652	0	652	7796	8108	7970	8557	7796	8557
30-Jul-97	822	125	697	8236	8223	7797	7908	8236	8223
6-Aug-97	1445	1000	445	10612	11309	10517	12119	10612	11309
13-Aug-97	599	0	599	7017	6958	6761	6904	7017	6958
20-Aug-97	420	0	420	9072	9257	9197	9949	9072	9949

Switched configuration to A2O Friday night (8/22/97)

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**Nitrogen Mass Balances**

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L
28-May-97	0.1	0.0	109.3	110.2	114.5	114.4	114.4	114.4
4-Jun-97	2.8	0.0	112.8	112.1	118.5	112.9	115.7	112.9
11-Jun-97	6.2	0.0	85.7	86.1	96.6	92.2	90.4	92.2
18-Jun-97	7.9	0.0	61.9	61.5	71.6	64.8	63.6	64.8
25-Jun-97	10.0	0.0	56.1	58.1	69.7	60.1	59.7	60.1
2-Jul-97	22.4	20.1	116.0	117.4	137.9	137.0	116.0	117.4
16-Jul-97	8.0	0.0	60.1	61.0	67.4	66.4	60.1	66.4
23-Jul-97	5.1	0.0	62.5	64.0	69.2	67.5	64.1	67.5
30-Jul-97	6.6	1.0	66.4	66.0	69.9	63.5	66.4	66.0
6-Aug-97	11.2	7.7	83.2	87.3	88.3	93.5	83.2	87.3
13-Aug-97	4.7	0.0	54.8	54.3	58.3	53.9	54.8	54.3
20-Aug-97	2.7	0.0	59.8	58.4	63.3	62.8	60.7	62.8

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**COD Mass Balances**

Date	CODin mg/day	COD out mg/day	COD in mg/L	COD out mg/L
28-May-97	37227	37440		
4-Jun-97	35112	no data	221	no data
11-Jun-97	17381	13133	126	95
18-Jun-97	18265	12816	143	100
25-Jun-97	15850	12047	124	94
2-Jul-97	8369	7690	65	60
16-Jul-97	29789	21803	201	147
23-Jul-97	17770	15333	140	121
30-Jul-97	10634	8221	85	66
6-Aug-97	6699	6480	52	50
13-Aug-97	7929	7690	62	60
20-Aug-97	25070	23443	158	148

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

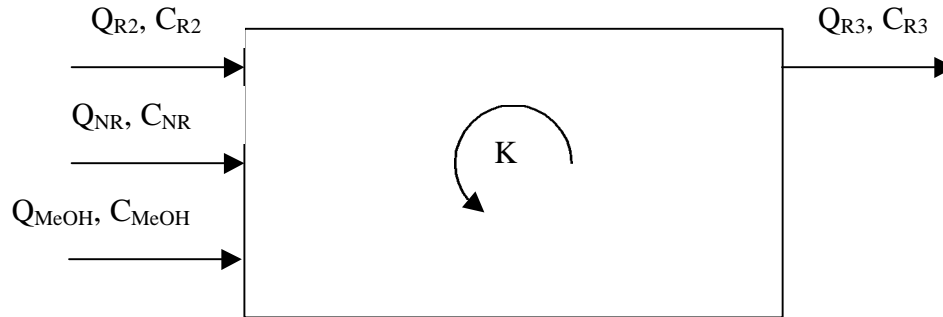
**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 21

High Ammonia Side Stream Treatment Train:  
Anaerobic reactor #2 nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Second Anoxic Reactor (R3) of the High Ammonia Side Stream MUCT Treatment Train

(NOTE: Mass balances for A2/O treatment of the high ammonia side stream are identical to those for A2/O treatment of the primary effluent)



$Q_{R2}$  = Flow rate entering the second anoxic reactor (R3) from the first anoxic reactor (R2)

$$= Q_{inf} + Q_{RAS} \text{ (L/day)}$$

$C_{R2}$  = Concentration of the constituent of interest exiting R2 = the concentration measured in R2 (mg/L)

$Q_{NR}$  = Nitrate recirculation flow rate (L/day)

$C_{NR}$  = Nitrate recirculation concentration of the constituent of interest = aerobic reactor (R4) concentration (mg/L)

$Q_{MeOH}$  = Flow rate of the methanol addition (L/day)

$C_{MeOH}$  = Concentration of COD in the methanol stream (C assumed to be zero for all other constituents) (mg/L)

$Q_{R3}$  = Flow rate exiting the second anoxic reactor (R3) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R3}$  = Concentration of the constituent of interest exiting R3 = the concentration measured in R3 (mg/L)

K = Reaction term (e.g.,  $NO_x$  consumption, COD consumption, etc.)

$$\text{Total loading to second anoxic reactor (mg/day)} = (Q_{R2} \times C_{R2}) + (Q_{NR} \times C_{NR}) + (Q_{MeOH} \times C_{MeOH})$$

$C_{in}$  = Concentration of the constituent of interest entering the anoxic reactor (mg/L)

$$= \left( C_{R2} \times \frac{Q_{R2}}{Q_{R2} + Q_{NR} + Q_{MeOH}} \right) + \left( C_{NR} \times \frac{Q_{NR}}{Q_{R2} + Q_{NR} + Q_{MeOH}} \right) + \left( C_{MeOH} \times \frac{Q_{MeOH}}{Q_{R2} + Q_{NR} + Q_{MeOH}} \right)$$

$$C_{out} = C_{R3} \text{ (mg/L)}$$

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	0.0	0.0	107.7	111.0	170
4-Jun-97	0.0	0.0	101.3	101.0	195
11-Jun-97	11.8	0.1	59.9	74.9	38
18-Jun-97	11.5	0.0	36.9	48.8	56
25-Jun-97	10.8	0.0	40.6	52.8	65
2-Jul-97	56.6	0.4	74.9	134.9	50
16-Jul-97	13.4	0.2	28.0	43.4	69
23-Jul-97	0.4	0.2	26.0	24.0	43
30-Jul-97	10.3	0.2	28.0	37.5	52
6-Aug-97	24.2	0.2	41.5	72.2	51
13-Aug-97	7.1	0.3	22.9	28.4	86
20-Aug-97	0.1	0.1	23.7	21.9	99
<b>22-Aug-97 Switched configuration to A2O Friday night (8/22/97)</b>					
27-Aug-97	0.0	0.0	17.1	18.1	135
3-Sep-97	0.0	0.0	8.5	8.5	63
10-Sep-97	2.9	0.0	39.7	43.5	80
11-Sep-97	5.6	0.0	47.1	?	191
12-Sep-97	5.8	0.0	58.3	61.8	173

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	Percent Denitrification	Observed specific	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg/day
					denitrification rate mgNOx-N/mgVSS/day							
28-May-97	152	0	152	100.0	0.012	14999	15355	-356	15295	15820	15142	15820
4-Jun-97	1306	0	1306	100.0	0.084	16574	16550	24	17160	16511	16574	16550
11-Jun-97	2280	1643	638	28.0	0.049	9357	8367	990	12199	10463	9919	8821
18-Jun-97	2390	1473	916	38.3	0.078	4719	4727	-7	7411	6254	5021	4781
25-Jun-97	2798	1373	1425	50.9	0.141	4288	5145	-857	7335	6684	4537	5311
2-Jul-97	8333	8145	188	2.3	0.020	10753	10786	-32	19660	19418	11327	11273
16-Jul-97	3351	1905	1446	43.1	0.256	3750	3986	-236	7758	6181	4407	4276
23-Jul-97	2055	54	2001	97.4	0.152	3685	3630	55	6136	3351	4081	3630
30-Jul-97	2723	1433	1290	47.4	0.133	4092	3896	195	6783	5214	4092	3896
6-Aug-97	4365	3479	887	20.3	0.098	6358	5972	387	11398	10400	7033	6921
13-Aug-97	2095	1026	1069	51.0	0.278	3205	3333	-128	5707	4123	3612	3333
20-Aug-97	2089	17	2072	99.2	0.251	4208	4235	-28	6894	3909	4805	4235

#### R3: Entering and Exiting at rate (Feed+RAS+MLR)

Date	NOx in mg-N/day	NOx out mg-N/day	NOxin-NOxout mg-N/day	Percent Denitrification	denitrification rate mgNOx-N/mgVSS/day	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg/day
3-Sep-97	975	0	975	100.0	0.085	2514	1789	725	2457	1777	2514	1789
10-Sep-97	3849	809	3040	79.0	0.241	8482	11045	-2563	8625	12101	8482	11292
11-Sep-97	4355	1565	2790	64.1	0.240	18162	13220	4942	18930	bad data	18162	#VALUE!
12-Sep-97	3193	1626	1567	49.1	0.096	10436	16449	-6013	10775	17431	10436	16449

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**Nitrogen Mass Balances**

Date	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L
28-May-97	1.1	0.0	105.2	107.7	107.3	111.0	106.2	111.0
4-Jun-97	8.0	0.0	101.4	101.3	105.0	101.0	101.4	101.3
11-Jun-97	16.3	11.8	67.0	59.9	87.3	74.9	71.0	63.1
18-Jun-97	18.6	11.5	36.8	36.9	57.8	48.8	39.2	37.3
25-Jun-97	22.1	10.8	33.8	40.6	57.9	52.8	35.8	41.9
2-Jul-97	57.9	56.6	74.7	74.9	136.5	134.9	78.7	78.3
16-Jul-97	23.5	13.4	26.3	28.0	54.4	43.4	30.9	30.0
23-Jul-97	14.7	0.4	26.4	26.0	43.9	24.0	29.2	26.0
30-Jul-97	19.6	10.3	29.4	28.0	48.8	37.5	29.4	28.0
6-Aug-97	30.3	24.2	44.2	41.5	79.2	72.2	48.8	48.1
13-Aug-97	14.4	7.1	22.0	22.9	39.2	28.4	24.8	22.9
20-Aug-97	11.7	0.1	23.6	23.7	38.6	21.9	26.9	23.7

	NOx in mg-N/L	NOx out mg-N/L	NHx in mg-N/L	NHx out mg-N/L	TNin mg-N/L	TNout mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L
27-Aug-97	9.1	0.0	17.6	17.1	28.3	18.1	19.2	18.1
3-Sep-97	4.6	0.0	12.0	8.5	17.2	8.5	12.6	8.5
10-Sep-97	13.8	2.9	40.3	39.7	54.8	43.5	41.0	40.6
11-Sep-97	15.5	5.6	74.9	47.1	96.1	14.7	80.6	47.1
12-Sep-97	11.3	5.8	61.6	58.3	73.8	61.8	62.5	58.3

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

**COD Mass Balances**

Date	CODin mg/day	COD out mg/day	COD added (MeOH) mg/day	TOTAL COD in mg/day	COD in mg/L	COD out mg/L
28-May-97	32429	24235	0	32429	227	170
4-Jun-97	0	31871	0	0	0	195
11-Jun-97	9530	5308	0	9530	68	38
18-Jun-97	9711	7177	0	9711	76	56
25-Jun-97	8940	8237	0	8940	71	65
2-Jul-97	6826	7200	0	6826	47	50
16-Jul-97	13140	9837	0	13140	92	69
23-Jul-97	9924	6254	6838	16762	68	43
30-Jul-97	7201	7525	6838	14039	50	52
6-Aug-97	6198	7638	6838	13035	41	51
13-Aug-97	5530	12978	12992	18521	37	86
20-Aug-97	14172	18390	17094	31267	76	99

R3: Entering and Exiting at rate (Feed+RAS+MLR)

	CODin mg/day	COD out mg/day	COD added (MeOH) mg/day	TOTAL COD in mg/day	COD in mg/L	COD out mg/L
27-Aug-97	8826	25466	17094	25920	47	135
3-Sep-97	7635	13762	19487	27122	35	63
10-Sep-97	18801	23121	26325	45126	65	80
11-Sep-97	21056	55751	26325	47381	72	191
12-Sep-97	22977	50746	26325	49302	78	173

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

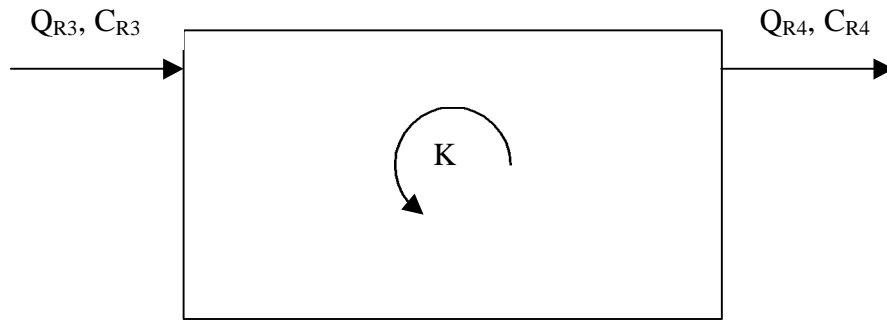
**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 22

High Ammonia Side Stream Treatment Train:  
Aerobic reactor nitrogen and COD raw data and mass balances

Performing a Mass Balance on the Aerobic Reactor (R4) of the High Ammonia Side Stream MUCT Treatment Train

(NOTE: Mass balances for A2/O treatment of the high ammonia side stream are identical to those for A2/O treatment of the primary effluent)



$Q_{R3}$  = Flow rate exiting the second anoxic reactor (R3) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R3}$  = Concentration of the constituent of interest exiting R3 = the concentration measured in R3 (mg/L)

$Q_{R4}$  = Flow rate exiting the aerobic reactor (R4) =  $Q_{inf} + Q_{RAS} + Q_{NR} + Q_{MeOH}$  (L/day)

$C_{R4}$  = Concentration of the constituent of interest exiting R4 = the concentration measured in R4 (mg/L)

$K$  = Reaction term (e.g., Nitrogen assimilation,  $NO_x$  production, COD consumption, etc.)

Total loading to aerobic reactor (mg/day) =  $Q_{R3} \times C_{R3}$

$C_{in}$  = Concentration of the constituent of interest entering the aerobic reactor =  $C_{R3}$  (mg/L)

$C_{out}$  =  $C_{R4}$  (mg/L)

**Nitrogen and COD Raw Data**

Date	NO3+NO2 mg-N/L	NO2 mg-N/L	NHx mg-N/L	TN mg-N/L	COD mg/L
28-May-97	2.3	0.1	99.5	99.1	190
4-Jun-97	18.1	6.9	87.8	95.0	
11-Jun-97	32.3	4.5	48.3	82.6	42
18-Jun-97	33.9	0.5	16.7	52.1	56
25-Jun-97	40.5	5.9	13.7	56.1	51
2-Jul-97	83.1	3.5	46.2	136.2	39
16-Jul-97	39.4	6.2	2.8	46.3	55
23-Jul-97	25.0	7.6	0.0	27.4	36
30-Jul-97	32.5	0.9	4.1	38.6	42
6-Aug-97	46.7	1.1	12.9	68.8	38
13-Aug-97	24.2	1.2	0.0	29.2	23
20-Aug-97	19.6	3.5	0.0	22.3	33
<b>22-Aug-97 Switched configuration to A2O Friday night (8/22/97)</b>					
27-Aug-97	15.2	0.1	0.0	16.8	11
3-Sep-97	7.8	0.0	0.0	9.3	25
10-Sep-97	23.3	0.6	16.5	40.2	48
11-Sep-97	27.0	0.5	17.8	49.9	52
12-Sep-97	18.1	1.3	42.3	61.3	63

### Nitrogen Mass Balances

Date	NOx in mg-N/day	NOx out mg-N/day	NOxout-NOxin mg-N/day	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	TNin-TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg-N/day	SKNin-SKNout mg-N/day
28-May-97	0	328	328	15355	14182	1173	15820	14126	1694	15820	14182	1638
4-Jun-97	0	2965	2965	16550	14347	2203	16511	15527	984	16550	14347	2203
11-Jun-97	1643	4514	2871	8367	6747	1620	10463	11535	-1071	8821	7021	1800
18-Jun-97	1473	4340	2867	4727	2138	2589	6254	6682	-428	4781	2342	2439
25-Jun-97	1373	5130	3757	5145	1730	3415	6684	7104	-419	5311	1974	3337
2-Jul-97	8145	11962	3816	10786	6650	4136	19418	19614	-196	11273	7653	3621
16-Jul-97	1905	5623	3718	3986	392	3594	6181	6602	-421	4276	979	3297
23-Jul-97	54	3497	3443	3630	0	3630	3351	3823	-472	3630	326	3304
30-Jul-97	1433	4513	3080	3896	570	3327	5214	5369	-156	3896	857	3040
6-Aug-97	3479	6722	3243	5972	1863	4108	10400	9901	498	6921	3180	3741
13-Aug-97	1026	3526	2501	3333	0	3333	4123	4253	-129	3333	726	2607
20-Aug-97	17	3501	3484	4235	0	4235	3909	3975	-66	4235	474	3762

R4: Entering and Exiting at rate (Feed+RAS+MLR)

	NOx in mg-N/day	NOx out mg-N/day	NOxout-NOxin mg-N/day	NHx in mg-N/day	NHx out mg-N/day	NHxin-NHxout mg-N/day	TNin mg-N/day	TNout mg-N/day	TNin-TNout mg-N/day	"SKN" in mg-N/day	"SKN" out mg-N/day	SKNin-SKNout mg-N/day
27-Aug-97	0	2760	2760	3108	0	3108	3290	3046	243	3290	287	3003
3-Sep-97	0	1636	1636	1789	0	1789	1777	1957	-181	1789	321	1468
10-Sep-97	809	6477	5668	11045	4580	6464	12101	11184	917	11292	4706	6586
11-Sep-97	1565	7582	6017	13220	4998	8222	bad data	14012	#VALUE!	#VALUE!	6430	bad data
12-Sep-97	1626	5111	3486	16449	11939	4510	17431	17293	138	16449	12181	4267

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	MINIMUM			Minimum observed	Observed specific
	N growth mg-N/day	TKN oxidized mg-N/day	Aerobic Biomass mg of VSS	specific nitrification rate mgAvail.TKN/mgVSS/day	NOx production rate mgNOx-N/mgVSS/day
28-May-97	668	970	56592	0.017	0.006
4-Jun-97	105	2098	69840	0.030	0.042
<u>11-Jun-97</u>	698	1102	58680	0.019	0.049
18-Jun-97	41	2398	52560	0.046	0.055
25-Jun-97	459	2878	45540	0.063	0.082
2-Jul-97	591	3030	41940	0.072	0.091
16-Jul-97	31	3266	25380	0.129	0.146
23-Jul-97	533	2771	59220	0.047	0.058
30-Jul-97	381	2659	43740	0.061	0.070
6-Aug-97	335	3407	40680	0.084	0.080
<u>13-Aug-97</u>	179	2428	17280	0.141	0.145
20-Aug-97	323	3439	37080	0.093	0.094

	N growth mg-N/day	TKN oxidized mg-N/day	Aerobic Biomass mg of VSS	specific nitrification rate mgAvail.TKN/mgVSS/day	NOx production rate mgNOx-N/mgVSS/day
<u>27-Aug-97</u>	426	2576	54720	0.047	0.050
3-Sep-97	400	1068	51480	0.021	0.032
10-Sep-97	436	6150	56700	0.108	0.100
11-Sep-97	395	#VALUE!	52380	#VALUE!	0.115
12-Sep-97	565	3702	73080	0.051	0.048

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### Nitrogen Mass Balances

Date	NOx in mg-N/L	NOx out mg-N/L	delNOx mg-N/L	NHx in mg-N/L	NHx out mg-N/L	delNHx mg-N/L	TNin mg-N/L	TNout mg-N/L	delTN mg-N/L	"SKN" in mg-N/L	"SKN" out mg-N/L	del"SKN" mg-N/L
28-May-97	0.0	2.3	2.3	107.7	99.5	8.2	111.0	99.1	11.9	111.0	99.5	11.5
4-Jun-97	0.0	18.1	18.1	101.3	87.8	13.5	101.0	95.0	6.0	101.3	87.8	13.5
11-Jun-97	11.8	32.3	20.6	59.9	48.3	11.6	74.9	82.6	-7.7	63.1	50.3	12.9
18-Jun-97	11.5	33.9	22.4	36.9	16.7	20.2	48.8	52.1	-3.3	37.3	18.3	19.0
25-Jun-97	10.8	40.5	29.6	40.6	13.7	27.0	52.8	56.1	-3.3	41.9	15.6	26.3
2-Jul-97	56.6	83.1	26.5	74.9	46.2	28.7	134.9	136.2	-1.4	78.3	53.1	25.1
16-Jul-97	13.4	39.4	26.1	28.0	2.8	25.2	43.4	46.3	-3.0	30.0	6.9	23.1
23-Jul-97	0.4	25.0	24.7	26.0	0.0	26.0	24.0	27.4	-3.4	26.0	2.3	23.7
30-Jul-97	10.3	32.5	22.2	28.0	4.1	23.9	37.5	38.6	-1.1	28.0	6.2	21.9
6-Aug-97	24.2	46.7	22.5	41.5	12.9	28.5	72.2	68.8	3.5	48.1	22.1	26.0
13-Aug-97	7.1	24.2	17.2	22.9	0.0	22.9	28.4	29.2	-0.9	22.9	5.0	17.9
20-Aug-97	0.1	19.6	19.5	23.7	0.0	23.7	21.9	22.3	-0.4	23.7	2.7	21.1

	NOx in mg/L	NOx out mg/L	delNOx mg/L	NHx in mg/L	NHx out mg/L	delNHx mg/L	TNin mg/L	TNout mg/L	delTN mg/L	"SKN" in mg/L	"SKN" out mg/L	del"TKN" mg/L
27-Aug-97	0.0	15.2	15.2	17.1	0.0	17.1	18.1	16.8	1.3	18.1	1.6	16.6
3-Sep-97	0.0	7.8	7.8	8.5	0.0	8.5	8.5	9.3	-0.9	8.5	1.5	7.0
10-Sep-97	2.9	23.3	20.4	39.7	16.5	23.3	43.5	40.2	3.3	40.6	16.9	23.7
11-Sep-97	5.6	27.0	21.4	47.1	17.8	29.3	14.7	49.9	-35.2	47.1	22.9	24.2
12-Sep-97	5.8	18.1	12.4	58.3	42.3	16.0	61.8	61.3	0.5	58.3	43.2	15.1

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

### COD Mass Balances

Date	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L
28-May-97	24235	27086	-2851	170	190
4-Jun-97	31871	no data	#VALUE!	195	no data
11-Jun-97	5308	5867	-559	38	42
18-Jun-97	7177	7177	0	56	56
25-Jun-97	8237	6463	1774	65	51
2-Jul-97	7200	5616	1584	50	39
16-Jul-97	9837	7841	1996	69	55
23-Jul-97	6254	5236	1018	43	36
30-Jul-97	7525	6078	1447	52	42
6-Aug-97	7638	5691	1947	51	38
13-Aug-97	12978	3471	9507	86	23
20-Aug-97	18390	6130	12260	99	33

#### R4: Entering and Exiting at rate (Feed+RAS+MLR)

	COD in mg/day	COD out mg/day	CODin-CODout mg/day	COD in mg/L	COD out mg/L
27-Aug-97	25466	2075	23391	135	11
3-Sep-97	13762	5461	8301	63	25
10-Sep-97	23121	13872	9248	80	48
11-Sep-97	55751	15178	40572	191	52
12-Sep-97	50746	18480	32266	173	63

**NOTE:** Underlined dates signify the last day of one of the delineated operation periods.

**NOTE:** Samples were not filtered until June 10.

**NOTE:** Data within the boxes were used for steady state determinations.

**NOTE:** Indicates number is not a reliable value and is not used for any calculation or graph.

**NOTE:** Indicates non-steady state (transitional) day.

APPENDIX 23

High Ammonia Side Stream Treatment Train:  
Biosolids data and calculations

Date	MLSS				Final Effluent (ETSS) (mg/L)	MLVSS			Actual SRT (days)
	Anaerobic reactor (R1) (mg/L)	#1 Anoxic reactor (R2) (mg/L)	#2 Anoxic reactor (R3) (mg/L)	Aerobic reactor (R4) (mg/L)		Aerobic reactor (R4) (mg/L)	Theoretical Wastage (L)	Manual Wastage (L)	
20-May-97								0.0	
21-May-97								0.0	
22-May-97				2450				0.0	
23-May-97				2860				0.0	
24-May-97				2680	80.0			0.0	
25-May-97				2290	119.0			0.0	
26-May-97									
27-May-97				4650	55.0		1.3	1.3	17.7
28-May-97				3930	59.0		1.1	1.1	18.1
29-May-97	2150	3150	3460	3665	67.0		0.9	0.9	18.6
30-May-97				2850	44.0		1.1	1.1	18.1
31-May-97				2570	30.0		1.3	1.1	19.7
1-Jun-97				1610	19.0		1.3	1.3	17.9
2-Jun-97	233	3060	2840	1660	32.0		0.9	1.2	15.5
3-Jun-97				3630	102.0		0.5	0.5	17.8
4-Jun-97				4850	25.0		1.5		
5-Jun-97				6750	47.0		1.4	1.5	17.5
6-Jun-97				5500	16.0	4270	1.7	1.7	18.3
7-Jun-97				5130	17.0	3975	1.6	1.7	18.0
8-Jun-97				4470	24.0		1.6	1.5	18.8
9-Jun-97	2890	5000	5130	4960	11.0	3990	1.7	1.7	17.9
10-Jun-97				4530	15.0	3620	1.6	1.6	18.5
11-Jun-97	3070	4060	4200	4160	21.0	3260	1.6	1.6	18.0
12-Jun-97				3985	5.0	3130	1.7	1.7	18.3
13-Jun-97				3985	60.0	3170	1.3	1.3	17.9
14-Jun-97				3925	10.0	3140	1.7	1.7	18.1
15-Jun-97				3390	11.0	2660	1.7	1.7	18.1
16-Jun-97	2680	3610	3470	3120	11.0	2490	1.7	1.7	18.0
17-Jun-97				3310	13.0	2710	1.7	1.7	17.9
18-Jun-97	2350	3420	3820	3670	14.0	2920	1.7	0.0	275.0

Table Continued

19-Jun-97				3000	8.5	2400	1.7	0.0	382.6
20-Jun-97				2980	9.0	2410	1.7	0.0	358.9
21-Jun-97				3120	5.5	2500	1.7	0.0	614.9
22-Jun-97				3190	8.4	2530	1.7	0.0	411.7
23-Jun-97	2730	3650	3590	3290	60.0	2670	1.2	0.0	58.0
24-Jun-97				3360	10.6	2720	1.7	0.0	335.4
25-Jun-97	1770	3100	3170	3100	166.1	2530	0.2	0.0	20.7
26-Jun-97				2870	6.8	2290	1.7	0.0	469.0
27-Jun-97				2920	17.0	2290	1.6	0.0	190.8
28-Jun-97				2510	62.0	2010	1.1	0.0	45.0
29-Jun-97				2360	6.0	1900	1.7	0.0	437.0
30-Jun-97	1610	2420	2410	2290	11.6	1830	1.6	0.0	208.9
1-Jul-97				2360	38.8	1920	1.3	0.4	34.5
2-Jul-97	1980	2770	2910	2810	85.0	2330	0.5	1.2	14.9
3-Jul-97				2350	9.2	1880	1.2	1.2	24.4
4-Jul-97				1820	8.4	1470	1.2	0.0	234.9
5-Jul-97				1600	16.4	1310	1.0	0.0	108.4
6-Jul-97				2230	6.4	1740	1.2	0.0	387.2
7-Jul-97	1750	2520	2350	2500	9.2	1940	1.2	1.2	24.5
8-Jul-97				1630	11.0	1200	1.1	1.1	24.5
9-Jul-97	268	325	1180	1890	15.2	1450	1.1	0.0	131.6
10-Jul-97				760	10.0	600	0.9	<b>-5.0</b>	<b>-7.0</b>
11-Jul-97				1235	40.2	1000	0.3	<b>-5.0</b>	<b>-8.0</b>
12-Jul-97				2150	8.3	1750	1.2	<b>-3.0</b>	<b>-11.1</b>
13-Jul-97				2680	3.0	2180	1.3	1.3	24.0
14-Jul-97	2060	3100	2710	2460	65.9	2030	0.5	0.6	23.3
15-Jul-97				1870	15.3	1570	1.1	1.1	24.0
16-Jul-97	990	2350	1720	1700	10.8	1410	1.1	0.0	170.6
17-Jul-97				2770	49.0	2250	0.8	0.0	62.8
18-Jul-97				2660	16.0	2180	1.2	<b>-1.0</b>	<b>-38.7</b>
19-Jul-97				3070	9.3	2550	1.2	<b>-1.6</b>	<b>-21.2</b>
20-Jul-97				3170	12.0	2600	1.2	<b>-2.0</b>	<b>-16.9</b>
21-Jul-97	2920	4110	3950	4100	13.8	3440	1.2	1.2	24.7
22-Jul-97				4100	20.8	3420	1.2	1.2	23.8
23-Jul-97	1870	4270	3680	3880	21.6	3290	1.1	1.2	23.5

Table Continued

24-Jul-97				3670	50.4	3110	0.9	1.0	22.9
25-Jul-97				3380	28.7	2850	1.1	1.1	23.8
26-Jul-97				3560	24.5	2930	1.1	1.1	24.6
27-Jul-97				3390	10.8	2850	1.2	1.2	24.7
28-Jul-97	2570	3550	3740	3450	26.0	2860	1.1	1.1	24.3
29-Jul-97				2410	10.0	1960	1.2	1.2	24.3
30-Jul-97				2900	53.4	2430	0.8	0.8	24.1
31-Jul-97				3580	13.4	3080	1.2	1.2	24.5
1-Aug-97				1750	17.8	1520	1.0	1.1	23.8
2-Aug-97				3270	4.8	2780	1.3	1.3	23.9
3-Aug-97				3060	5.0	2540	1.3	1.3	23.8
4-Aug-97	2090	2810	2790	2990	9.8	2580	1.2	1.2	24.7
5-Aug-97				2800	8.2	2380	1.2	1.3	23.2
6-Aug-97	1500	2650	2290	2590	72.0	2260	0.5	0.5	24.6
7-Aug-97				2840	5.6	2430	1.3	1.3	23.5
8-Aug-97	1910	2550	2620	2800	8.4	2360	1.2	1.3	23.9
9-Aug-97				2140	36.2	1820	0.8	0.8	23.7
10-Aug-97				2050	13.2	1740	1.1	1.0	26.8
11-Aug-97	1680	2980	3180	2340	46.0	2000	0.7	0.8	23.4
12-Aug-97				1285	7.6	775	1.2	1.1	25.0
13-Aug-97	1930	2260	2470	1950	23.0	960	1.0	1.0	23.9
14-Aug-97				1640	12.0	1450	1.1	0.5	45.0
15-Aug-97				1570	5.1	1350	1.2	0.0	333.7
16-Aug-97				2380	41.4	2030	0.7	0.0	50.1
17-Aug-97				1490	5.2	1320	1.2	0.8	36.4
18-Aug-97	1160	1200	2270	2450	42.3	1400	0.6	0.0	46.0
19-Aug-97				1550	9.4	1330	1.1	0.0	146.6
20-Aug-97	1650	2780	2590	2390	7.6	2060	1.2	1.2	24.3
21-Aug-97				1820	10.6	1610	1.1	0.0	141.3
22-Aug-97				2170	42.0	1930	0.5	0.5	23.4
23-Aug-97				4040	21.2	3600	1.0	1.0	23.6
24-Aug-97				2880	61.4	2480	0.4	0.4	23.9
25-Aug-97	3410	3480		3960	3.8	3560	1.1	1.3	21.0
26-Aug-97				2370	7.8	2080	1.0	1.0	24.9
27-Aug-97	2730	3020		3360	2.0	3040	1.1	1.2	23.9

Table Continued

28-Aug-97			2040	18.9	1840	0.8	0.8	23.9
29-Aug-97			3050	no sample	2690	#VALUE!	spill	
30-Aug-97			2210	13.3	1950	0.9	spill	
31-Aug-97			2440	130.0	2170	-1.1	0.0	12.6
1-Sep-97						no data	0.0	no data
2-Sep-97			2960	34.0	2680	0.7	0.7	23.4
3-Sep-97			3140	7.4	2860	1.0	1.1	23.8
4-Sep-97			3170	6.8	2850	1.1	1.1	23.6
5-Sep-97			3520	7.0	3100	1.0	1.1	23.1
6-Sep-97			3450	5.2	3130	1.1	1.1	23.6
7-Sep-97			2850	9.0	2590	1.0	1.0	23.7
8-Sep-97	3300	2690	2910	42.0	2580	0.3	0.4	23.1
9-Sep-97			3200	6.6	2850	1.0	1.0	25.0
10-Sep-97	4420	3750	3510	11.0	3150	1.0	1.0	23.9
11-Sep-97			3250	22.8	2910	0.7	0.8	23.8
12-Sep-97			4560	9.6	4060	1.0	1.1	23.9

**NOTE:** Indicates the MLVSS was not determined directly and was estimated to be 80% of the MLSS.

**NOTE:** Indicates a spill occurred and the amount of biomass wasted (as well as the SRT) are thus estimated.

**NOTE:** Cells indicate days when sludge was added from other reactors.

Days of sludge addition	Volume and type of sludge added
10-Jul-97	Added 5.0 L of Secondary MLSS (due to large spill).
11-Jul-97	Added 5.0 L of Secondary MLSS (due to large spill).
12-Jul-97	Added 3.0 L of Secondary MLSS (due to large spill).
18-Jul-97	Added 1.0 L of Primary MLSS.
19-Jul-97	Added 1.6 L of Primary MLSS.
20-Jul-97	Added 2.0 L of Primary MLSS.

APPENDIX 24

High Ammonia Side Stream Treatment Train:  
Flow rate data

Date	Influent mL/min	Methanol addition mL/min	Return Activated Sludge (RAS) mL/min	Nitrate Recirculation (NR) mL/min	Anoxic Recirculation (AR) mL/min
20-May-97	31.0		20.0	50.0	49.0
21-May-97	32.0		21.0	48.0	49.0
22-May-97	32.0		20.0	47.0	49.0
23-May-97	32.0		23.0	59.0	48.0
24-May-97	30.7				
25-May-97	30.7				
26-May-97					
27-May-97	30.0		22.0	46.0	47.0
28-May-97	31.0				
29-May-97	31.0		22.0	50.0	46.0
30-May-97	30.0		22.0	50.0	46.0
31-May-97	31.0		22.5		45.0
1-Jun-97	30.5		21.0		
2-Jun-97	31.0				
3-Jun-97	32.0		23.0	50.0	47.0
4-Jun-97	30.5		33.0		
5-Jun-97	33.0		31.5	49.5	54-48
6-Jun-97	23.5		32.0	49.5	47.5
7-Jun-97	23.0		31.5	49.0	47.0
8-Jun-97	26.0		31.5	50.0	48.0
9-Jun-97	27.0				
10-Jun-97	27.0		23.0	48.0	48.0
11-Jun-97	25.0		23.0	49.0	48.0
12-Jun-97	26.0		23.0	49.0	48.0
13-Jun-97	20.7		23-19	48.5	48.5
14-Jun-97	14.5		19-14	49.5	49.0
15-Jun-97	14.5		14.0		
16-Jun-97	14.5				
17-Jun-97	21.0		19.0	49.0	49.0
18-Jun-97	21.0				
19-Jun-97	20.5		19.5	49.5	49.0
20-Jun-97	20.5		19.5	49.3	49.0
21-Jun-97	20.5		19.0	50.0	50.0
22-Jun-97	20.5		19.5	49.5	49.5
23-Jun-97	21.0				
24-Jun-97	21.0		20.0	48.0	49.0
25-Jun-97	20.0				
26-Jun-97	20.0		20.0	48.0	48.0
27-Jun-97	20.0		19.5	47-60	48.5
28-Jun-97	20.0		19.0	61.0	49.0
29-Jun-97	20.0		18.5	60.0	
30-Jun-97	21.0				
1-Jul-97	21.0		19.0	60.0	49.0
2-Jul-97	21.0				
3-Jul-97	20.0		18.5-20	57.0	48.5

Table Continued

4-Jul-97	20.5		19.7	57.0	48.5
5-Jul-97	20.0		20.0	58.0	48.5
6-Jul-97	20.0		20.0	59.0	48.5
7-Jul-97	20.0				
8-Jul-97	21.0		20.0	59.0	48.0
9-Jul-97	21.0		20.0	58.0	48.5
10-Jul-97	21.0		25.0	60.0	48.0
11-Jul-97	21.0		25.0	59.0	48.0
12-Jul-97	20.5		24.5-19.5	76-61	48.5
13-Jul-97	20.0		19.0	61.0	49.0
14-Jul-97	20.0				
15-Jul-97	20.0		20.0	60.0	48.0
16-Jul-97	20.5		19.5	59.0	63-48.5
17-Jul-97	20.0	4.0	20.0	60.0	49.0
18-Jul-97	20.0	4.0	20.0	58.0	48.0
19-Jul-97	20.5	4.0	20.0	58.5	48.5
20-Jul-97	20.0	3.9	20.0	58.0	47.0
21-Jul-97	20.0	4.0			
22-Jul-97	20.0	4.0	20.0	57.0	48.0
23-Jul-97	20.0				
24-Jul-97	20.0	1.1	20.0	59.0	47.0
25-Jul-97	20.0	4.0	20.0	59.0	46.0
26-Jul-97	20.0	3.9	20.0	60.0	47.0
27-Jul-97	20.5	4.0	19.5	60.0	48.0
28-Jul-97	20.0				
29-Jul-97	20.0		21.0	60.0	48.0
30-Jul-97	20.0	4.0	19.5	57.0	47.0
31-Jul-97	20.0	3.9	20.0	58.0	48.0
1-Aug-97	20.0	4.0	20.0	58.0	47.0
2-Aug-97	19.5	3.9	20.5	59.5	49.0
3-Aug-97	19.5	4.0	20.5	59.0	49.0
4-Aug-97	20.0				
5-Aug-97	19.0		23.0	60.0	48.0
6-Aug-97	20.0		21.0	58.0	48.0
7-Aug-97	21.0		22.0	58.0	48.0
8-Aug-97	20.0		22.0	59.0	48.0
9-Aug-97	21.0	4.1	20.0	58.0	50.5-48.0
10-Aug-97	21.0	3.5	0-19.5	58-60	49.0
11-Aug-97	20.0				
12-Aug-97	21.0	3.8	21.0	60.0	48.0
13-Aug-97	20.0				
14-Aug-97	20.0		23-21	60.0	48.0
15-Aug-97	20.5	4.6	20.0	58-59	47.5
16-Aug-97	25.5	4.1	25.5	76.0	59.0
17-Aug-97	25.5	5.0	25.0	75.0	59.0
18-Aug-97	28.0				
19-Aug-97	25.0	5.0	25.0	74.0	60.0
20-Aug-97	25.0				
21-Aug-97	27.0	5.2	27.0	76.0	58.0

Table Continued

22-Aug-97	25.0	5.3	27.0	76.0	0.0
23-Aug-97	25.0	5.4	26.0	76.0	0.0
24-Aug-97	24.5	0.0	26.0	76.0	0.0
25-Aug-97	25.0	5.0			0.0
26-Aug-97	26.0	5.0	26.0	75.0	0.0
27-Aug-97	25.0				0.0
28-Aug-97	25.0	5.0	25.0	74.0	0.0
29-Aug-97	25.0	5.0	22.0	74.0	0.0
30-Aug-97	29.5	5.0	30.0	86.0	0.0
31-Aug-97	29.0	6.0	29.0	88.0	0.0
1-Sep-97					0.0
2-Sep-97	30.0	5.7	30.0	87.0	0.0
3-Sep-97	29.0				0.0
4-Sep-97	28.0	5.4	30.0	88.0	0.0
5-Sep-97	40.0	5.4	40.0	116.0	0.0
6-Sep-97	39.5	7.4	41.0	114.0	0.0
7-Sep-97	39.5	7.4	41.0	114.0	0.0
8-Sep-97	39.0	7.7			0.0
9-Sep-97	40.0		41.0	114.0	0.0
10-Sep-97	38.0				0.0
11-Sep-97	41.0		42.0	112.0	0.0
12-Sep-97	40.5		41.5	114.0	0.0

**NOTE:** Ranges listed for flow rates signify that the flow was adjusted from the first value to the second.

**NOTE:** Grey cells indicate the flow rate was adjusted from the initial measured flow rate to the indicated flow rate. The flow rate shown is the one used for any related calculation.

## VITA

Andrew Sabalowsky was born in Somerville, New Jersey in November of 1971 and was raised in Long Valley, New Jersey for nearly his entire youth until he left for Virginia Polytechnic Institute and State University in August of 1990. He received his Bachelor of Science degree in Aerospace Engineering with a minor in Philosophy from VPI in May of 1994. Drawn towards what he had learned from translations of texts attributed to Socrates, he began studying Philosophy in the Master's program at VPI starting in the Autumn of 1994. Deciding that academia was a greater hindrance than help in understanding what is Good and the nature of what Is, he withdrew from the program to study and introspect on his own for a year. In the Spring of 1996, he decided it was time for action and thus applied to the graduate program in Environmental Engineering at Virginia Polytechnic Institute and State University, where he enrolled in the Autumn of 1996. Upon completion of the requirements for a Master of Science in Environmental Engineering, Andrew intends to use the skills he has acquired in his continuing pursuit of wisdom and in his contributions to what is Good.