

Performance Analysis of Anaerobic Digestion Systems
At Two Dairy Farms in Northeastern Wisconsin

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*This project was funded by the Focus on Energy program.

ACKNOWLEDGEMENTS

- Focus on Energy for providing funding for this project
- Operators and workers at Green Valley Dairy and Suring Community Dairy for their assistance during sampling
- Staff at Badger Laboratories for analyzing the samples

ABSTRACT

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This study compared the performance of anaerobic digestion systems of two dairy farms in the northeastern Wisconsin. Both systems were similar in that they were mesophilic, completely mixed systems. Green Valley Dairy in Krakow, Wisconsin, is a 2,500 cattle dairy farm with a dual tank system. Suring Community Dairy in Suring, Wisconsin, is a 1,000 cattle dairy farm with a single tank system. The two farms were analyzed using an established protocol to determine the performance of each anaerobic digestion system. The farms were compared on twelve parameters including pathogens, total solids, volatile solids, chemical oxygen demand, and soluble chemical oxygen demand. They were also compared on the amount of biogas generated per pound of volatile solids destruction, chemical oxygen demand destruction, and soluble chemical oxygen demand destruction. The two digesters produced nearly equal results for total solids destruction (30%-32%), volatile solids destruction (35%-37%), nutrient balance, and pathogen destruction (98% for fecal coliform and 93% for fecal streptococcus). The Green Valley digester performed significantly better than the Suring Community Dairy digester in terms of chemical oxygen demand destruction (39% versus 27%) and soluble chemical oxygen demand destruction (52% versus 36%). The Green Valley digester also had significantly less VFAs in the effluent (500 mg/l versus 1152 mg/l), which would indicate that the anaerobic digestion system is functioning efficiently in converting VFAs to biogas. The Green Valley digester outperformed the Suring Community Dairy digester in terms of biogas produced per pound of VS destruction (69% higher), per pound of COD destruction (19% higher) and per pound of SCOD destruction (58% higher). The Green Valley digester produced 15.91 cubic feet of biogas per pound of volatile solids destroyed. Suring Community Dairy produced 9.44 cubic feet of biogas per pound of volatile solids destroyed.

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Introduction

The management of dairy manure has become a major issue in recent years, particularly in northeastern Wisconsin. There are many reasons for this including larger dairy farms with higher waste volumes, agricultural runoff issues, odor concerns, pathogen concerns, and urban sprawl onto agricultural lands. Even though there are fewer farms in Wisconsin today than in the past, the farms are becoming much larger. Urban sprawl is also rapidly consuming agricultural lands, bringing more people into contact with farms and raising concern over odors pathogens associated with manure. Farms that fertilize with manure find less land available, leading to the potential over-application of manure. This may cause runoff into local waterways and groundwater contamination. Anaerobic digestion of dairy manure is seen as a good way to address many of these concerns. In particular, the odor and pathogens are greatly reduced after digestion. Additionally, the biogas produced during anaerobic digestion can be burned in an internal combustion engine to produce electricity for either on-site use or can be sold to the local utility, while the solids can be separated and used for bedding or other value-added products.

There are still questions about the performance of anaerobic digestion systems on dairy farms. This study evaluated the efficacy of two similar anaerobic digestion systems installed on two different dairy farms in northeastern Wisconsin. Digester performance is evaluated in terms of biogas production and reductions in certain parameters including total solids, volatile solids, chemical oxygen demand, and pathogens.

Locations of the Anaerobic Digesters to be Evaluated

Two farms were willing participants in this study. One of the dairy farms in the study was Green Valley Dairy in Krakow, Wisconsin. Krakow is located in Shawano County in northeastern Wisconsin. Green Valley Dairy has roughly 2,500 head of cattle on the farm, with an average of 2,200 in milk production. Green Valley Dairy had a mesophilic, dual tank, above ground, complete mix anaerobic digester system. The biogas produced is utilized in a Caterpillar 3512 reciprocating engine, creating electricity that was sold to WE Energies. The excess heat was used as space heating and to heat the manure in an external heat exchanger. The digested manure was separated by two FANTM separators, with the liquid fraction going to the lagoon, and the solid fraction going to a storage area for use as bedding at Green Valley Dairy or sold to other dairies in the areas. Influent and effluent from the anaerobic digestion system was collected and analyzed for this study.

The second farm was Suring Community Dairy in Suring, Wisconsin. Suring is located in Oconto County in northeastern Wisconsin. Suring Community Dairy had roughly 1,000 cattle, with an average of 800 in production. The anaerobic digester at Suring was a mesophilic, single tank, above ground, complete mix system. The biogas produced in the digester was burned in a dual fuel (diesel) reciprocating engine. Excess heat from the engine was used to heat the digester and for space heating. The digested manure is separated by a WEDA screw press and a PTI screw press separator. The liquid fraction went to the lagoon for storage and eventual land application, and the solids were used as bedding and were also sold. Influent and effluent from the anaerobic digestion system was collected and analyzed for this study.

Methods and Materials

The study was performed in accordance to a set protocol written by Dr. John Martin. The protocol “A Protocol for Quantifying and Reporting the Performance of Anaerobic Digestion Systems for Livestock Manures” (2007) was written to provide farm operators and system developers a standard approach for quantifying the performance of their systems and to support claims in order to receive acceptance as credible. The study consisted of 24 total sampling episodes over a ten month period. The parameters that were analyzed are shown in Table 1.

Table 1
Parameters Analyzed from Manure Samples

Parameter
Total solids
Total volatile solids
Chemical oxygen demand
Soluble chemical oxygen demand
Total volatile acids
Total Kjeldahl nitrogen
Ammonia nitrogen
Total phosphorus
Soluble phosphorus
Fecal coliform
Fecal streptococcus
pH

Sampling at both facilities was scheduled to be done on a bi-weekly basis. That changed toward the end of the study due to unforeseen complications at each farm, so weekly sampling was then required at the end of the study. Each sample was a composite sample of five gallons collected over a one hour period. Subsamples of one liter and 100 milliliters were then taken from the composite sample for analysis. The 100 milliliter sample was for pathogen testing while the one liter sample was for the balance of the parameters shown in Table 1. Staff from

Badger Laboratories of Neenah, Wisconsin, picked up the eight sample bottles at the University of Wisconsin – Green Bay the day after sampling and the samples were then analyzed in accordance with the EPA and Standard Methods.

Although influent and effluent samples were collected at each farm, the sample collection was performed differently at each farm due to the design constraints for each anaerobic digestion system. The influent was collected from the manure collection pit at each farm and in a similar fashion at both farms. The manure pit at Green Valley Dairy had three pumps which constantly agitate the manure. Suring Community Dairy had two pumps that operate every other hour, but there was a switch that could be used to manually operate the pumps in order to create agitation within the pit. Due to the consistent agitation at the time of sampling, it was determined that samples from different depths would not be necessary. Therefore, a sampling device was constructed to reach down into the manure pit to extract the manure samples. Two, 15 foot, retractable metallic golf ball retrieving devices were purchased for use as part of the sampling device. One gallon plastic containers with a 4" x 6" opening cut into the top to allow manure collection were then attached to the ends of the golf ball retrievers with duct tape and cable ties to keep the plastic containers affixed to the retriever. There was one sampling device dedicated for use at each farm. During sampling, the retriever was extended down to the manure, dipped under until full, and brought back up where it was emptied into a five gallon bucket. This was done a number of times over a one hour interval until there were five gallons of manure. The sample was then stirred with a five gallon paint stir stick to ensure adequate mixing and eliminate the settling of solids. While stirring, a 0.5 liter measuring cup was lowered into the manure and filled, with the contents being transferred to the one liter bottle. This was performed twice to fill the one liter sample bottle. The measuring cup was then filled partially, with the

contents being poured into the 100 milliliter bottle. The temperature of the influent was measured with an alcohol thermometer and recorded. The samples were then placed on ice in a cooler as soon as they were obtained.

The effluent collection and sampling was different at each farm due to the design of the system and where sampling locations were available. Suring Community Dairy had a valve on the outside of the digester, which provided an easy access point for effluent sampling. This was a composite, five gallon sample collected over a one hour time span. The valve was opened and effluent was allowed to empty into a bucket for a few seconds. Approximately one gallon was then collected and transferred to the five gallon bucket, with this process being repeated until the composite, five gallon sample was collected. The manure was stirred in the same manner as the influent, and the one liter and 100 milliliter samples were then collected and placed on ice in a cooler as soon as they were obtained.

Green Valley Dairy had a more complicated method of sample collection. They did not have any sample ports on the digester like at Suring Community. Therefore, samples were collected with a different technique. At Green Valley Dairy, the effluent flowed from the digester into a building that housed the FANTM separators, with the sampling location found just before the manure goes to the FANTM separators. The samples were taken from a 500 gallon tank with a small hole in the top that was approximately one foot in diameter, which can be seen in Figure 1.

Figure 1. Effluent Sampling Point at Green Valley Dairy



As shown in Figure 1, the tank was located on the upper level of the building very near the roof. The roof was slanted and the tank was tight against the ceiling, giving roughly 12 inches of head space above the tank to work with to gather samples. The manure tank was approximately five feet high, and the manure level fluctuated within the tank. There was a manual switch that activated a pump which filled the tank. There were a few instances when pumping was required to fill the tank in order to obtain samples. The sample device developed for this sampling point consisted of an 18 inch piece of lumber with a one gallon plastic bucket bolted onto the wood. The sampling device was lowered by hand through the hole in the tank and down to the level of the manure, where it was then filled and transferred to a five gallon bucket. This was another composite, five gallon sample. The composite sample was then stirred with a paint stick, and samples were withdrawn in the same manner as the other samples. A one liter bottle and a 100 milliliter bottle were filled, just as the influent samples. The temperatures were measured and recorded, and the samples were placed on ice in a cooler.

Statistical Analysis

All results were analyzed according to the protocol referenced previously. Data sets were analyzed on the differences observed between the influent and effluent. The differences were analyzed for outliers by using Dixon's method. An outlier is any observation that appears to be inconsistent with the rest of the data. Dixon's method, according to Snedecor and Cochran (1983) is a test used to identify outliers and hidden outliers within a data set. The test is designed for use on a small data set of 3 to 25 data points. The data is ordered and tests are performed on the high and low values. The numbers are compared to a table and if the value is higher than the

value in the table, the value is an outlier and should not be included in further data analysis. The

equations are as follows:

$$\frac{X_n - X_{n-2}}{X_n - X_3} \quad (1)$$

$$\frac{X_3 - X_1}{X_{n-2} - X_1} \quad (2)$$

where X_n represents the sample number.

Once all outliers were found, they were then removed from the data set. The subsequent data was then statistically analyzed using a t-test for paired means in Microsoft Excel. The differences were determined to be statistically significant at the $P < 0.05$ level according to the protocol.

Results

Green Valley Dairy

There were a total of 24 sampling events through June 26, 2008, with results provided from Badger Laboratories. Results were not obtained for January 31, 2008, due to engine failure and subsequent issues with sampling areas. Results were also not obtained for March 13, 2008, and March 27, 2008, because maintenance was being performed on the influent manure pit and the effluent tank was empty. Both times, personnel from Green Valley Dairy were unavailable to assist in obtaining samples. Table 2 presents the results for Green Valley Dairy and represents the averages for each parameter for all sampling through June 26, 2008. All data has been statistically analyzed and any potential outliers have been excluded from analysis. The average operating temperature of the two digester tanks was 38.28°C (101°F).

Table 2. Results for Green Valley Dairy

Parameter	Average Influent	Average Effluent	Units	Destruction or Change	Pounds Removed per Day
Total solids	7.26	4.93	%	32.16%	15,578
Total volatile solids	85.43	79.39	%	36.96%	15,184
Chemical oxygen demand	52,710	32,295	mg/L	38.73%	13,621
Soluble chemical oxygen demand	16,044	8,175	mg/L	49.05%	5,251
Total volatile acids	3,370	500	mg/L	85.16%	1,915
Total Kjeldahl nitrogen	2,768	2,563	mg/L	7.41%	137
Ammonia nitrogen	1,132	1,297	mg/L	12.72% *	-110
Total phosphorus	379	310	mg/L	18.21%	47
Soluble phosphorus	222	184	mg/L	17.12%	25
Fecal coliform	1,991,848	29,684	CFU/g	98.51%	
Fecal streptococcus	2,249,432	158,007	CFU/g	92.98%	
pH	7.73	7.68		0.67%	

Note: * signifies an increase in levels

Figure 2 shows the recorded digester temperatures. It should be noted that some dates are missing due to mechanical error in the measuring equipment.

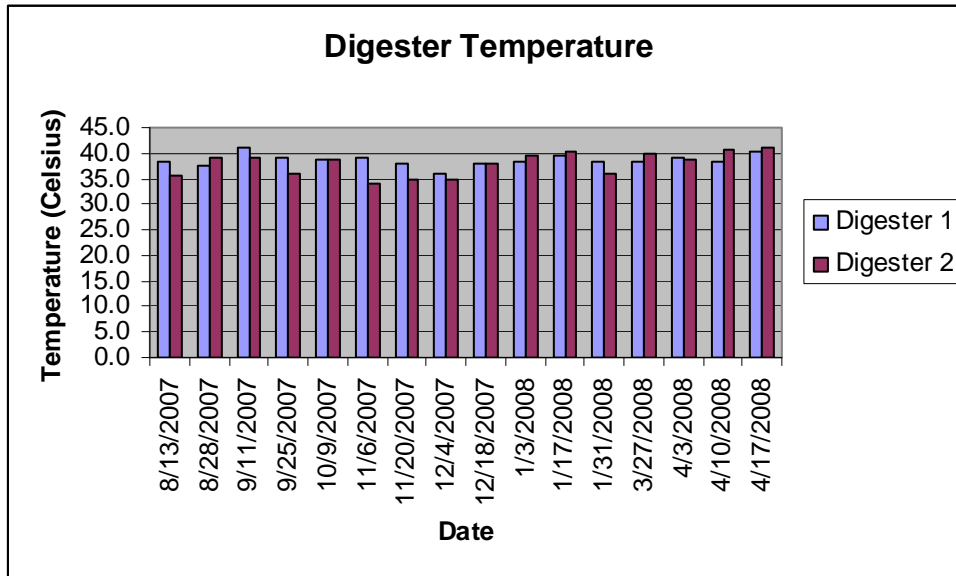


Figure 2. Recorded Digester Temperatures for Green Valley Dairy

Manure flow to the digesters was estimated at 56 gallons per minute, or 80,000 gallons per day, based on information provided by Green Valley Dairy. There is a gas flow meter to the engine that measures both current gas consumption and cumulative gas consumption. Green Valley Dairy does not have a meter to measure the entire gas production, which poses a problem because any excess gas that is flared or is lost to the pressure relief valves is not measured.

The data presented here is from August 13, 2007, through June 26, 2008. There is a period of time from January 31, 2008, March 25, 2008, where the engine generator was offline at Green Valley due to mechanical failure. While the engine was offline, the biogas was flared to the atmosphere to prevent emissions of methane. The amount of biogas produced during this time was measured by the gas meter. During this time period, the digester produced an average of 241,614 cubic feet of biogas per day, or 168 cubic feet of biogas per minute. The total biogas production was 77,075,000 cubic feet since the first measurement on August 13, 2007.

Engine hours were recorded during each sampling period, except for August 13, 2007, when the information was not available. Since August 13, 2007, the engine operated for 5,592 hours and produced 2,771,743 kilowatt hours, with electrical production numbers obtained from WE Energies. There were 7,656 hours during the duration of the sampling period. The capacity factor of the engine was 73% during the entire period, but was greatly reduced because of one major event when the engine was inoperable for 63 days or 1,512 hours. Exclusion of this 63 day time period from the overall calculations results in a capacity factor of 91%.

Suring Community Dairy

There were a total of 24 potential sampling events through June 26, 2008, with results provided from Badger Laboratories. Samples were not obtained on December 18, 2007, due to a ruptured inner biogas membrane leading to construction work on the digester. Samples were not obtained on January 31, 2008, and February 27, 2008, due to the effluent sample port being inaccessible due to ice. Table 3 presents the results for Suring Community Dairy. The numbers presented are averages for each parameter, and represent data through the June 26, 2008, sampling episode. All data has been statistically analyzed and any outliers have been excluded from the analysis. The average operating temperature of the digester tank was 34.86°C (94.75°F). Figure 3 shows the recorded digester temperatures. Some data is missing due to computer failure, which did not allow for measurements to be made.

Table 3. Results from Suring Community Dairy

Parameter	Average Influent	Average Effluent	Units	Destruction or Change	Pounds Removed per Day
Total solids	7.79	5.39	%	30.81%	4,437
Total volatile solids	82.7	77.3	%	35.36%	4,214
Chemical oxygen demand	53,894	39,499	mg/L	26.71%	2,661
Soluble chemical oxygen demand	19,525	12,110	mg/L	37.97%	1,371
Total volatile acids	4,167	1,152	mg/L	72.35%	57
Total Kjeldahl nitrogen	3,458	3,561	mg/L	2.89% *	-19
Ammonia nitrogen	1,391	1,874	mg/L	25.77% *	-89
Total phosphorus	447	386	mg/L	13.65%	11
Soluble phosphorus	233	205	mg/L	12.02%	5
Fecal coliform	1,718,818	33,250	CFU/g	98.07%	
Fecal streptococcus	1,059,882	80,795	CFU/g	92.38%	
pH	7.56	7.80		3.08% *	

Note: * signifies an increase in levels

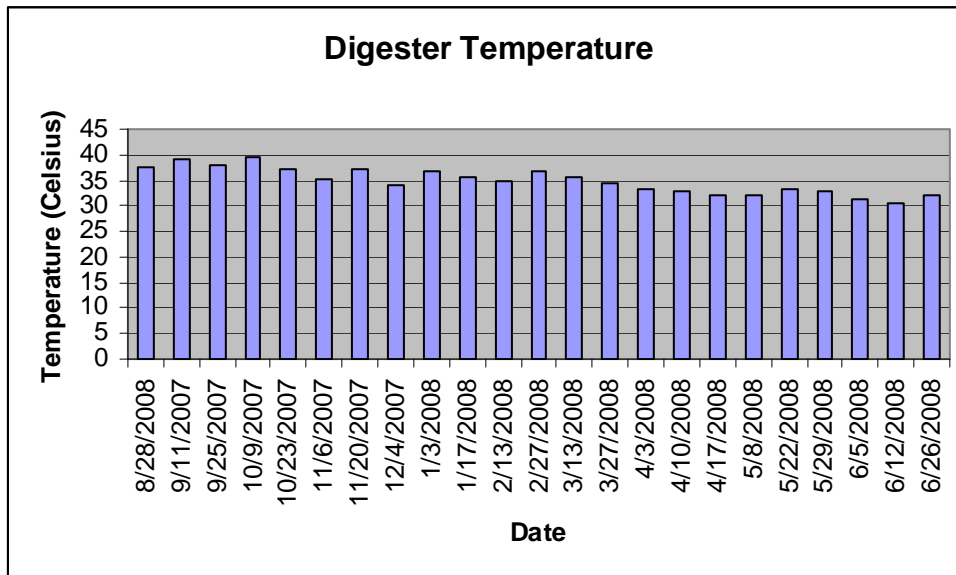


Figure 3. Recorded Digester Temperatures for Suring Community Dairy

Data on engine hours, biogas consumption, and electrical generation were also obtained for the same time period. This data includes information from January 31, 2008, and February 27, 2008, but not from December 18, 2007. Although the sample port was frozen on two of the days, the data regarding biogas consumption and electricity generation was still accessible.

Suring Community Dairy had a computer that monitored multiple parameters, including instantaneous biogas production and composition. There was no cumulative biogas production meter. Suring Community Dairy does not have a flare to burn excess gas; if necessary, excess gas is vented through pressure relief valves.

The digester produced 12,698,580 cubic feet of biogas during the study period. This was calculated based on the total hours during the study period and the biogas produced, which averaged 51.65 cubic feet per minute. Since August 13, 2007, the engine operated for 4,098 hours out of a potential total of 7,656 hours, which equates to a capacity factor of 53.5% and resulted in the production of 767,180 kilowatt hours of electricity. The digester was primarily operated during peak times for electrical rates, as it was indicated by the operator that it was not cost effective to operate the engine generator during off-peak hours. It should be noted that the biogas at Suring Community Dairy is mixed with diesel fuel in the engine so the entire electrical generation cannot be attributed to biogas. This will be explained in more detail later in this report. It should also be noted that the operator indicated that small amounts of biogas may be lost through the pressure relief valves. It was estimated by the operator that this might be about 2% of the total biogas produced; however, this was not included in the overall calculations for biogas production.

Data Analysis

Green Valley Dairy

The manure flow rate to the digester was estimated at 80,000 gallons per day. This approximation comes from an employee at Green Valley. Using this flow rate, the destruction of certain parameters can be calculated in pounds. All data presented here had any outliers removed for the statistical analysis. Tables 4, 5, and 6 show the data for volatile solids destruction, chemical oxygen demand destruction, and soluble chemical oxygen demand destruction.

The biogas composition at Green Valley Dairy is relatively unknown. One biogas sample was taken from the farm and analyzed at the University of Wisconsin-Green Bay. The methane content was found to be at 53.6%, and the carbon dioxide content was 43.8%. This was determined using a gas chromatograph according to ASTM standards and plotted in Excel.

Table 4. Volatile Solids Destruction.

Date	Volatile Solids (%)			VS Influent	VS Effluent	Amount VS Removed
	Influent	Effluent	Change of Total Solids	pounds/day	pounds/day	pounds/day
8/13/2007	86.3	76.0	50.68%	28,790	14,198	14,592
8/28/2007	78.0	72.3	64.84%	30,184	10,612	19,572
9/11/2007	84.5	81.7	41.00%	33,263	19,624	13,640
9/25/2007	86.7	80.7	37.38%	31,815	19,922	11,894
10/9/2007	86.3	82.3	28.88%	33,972	24,161	9,811
10/23/2007	86.8	77.6	59.71%	41,118	16,568	24,550
11/6/2007	86.8	81.4	35.45%	44,593	28,784	15,809
11/20/2007	86.3	83.2	19.89%	40,881	32,752	8,130
12/4/2007	87.4	82.8	33.05%	43,735	29,279	14,456
12/18/2007	86.7	76.3	51.11%	46,855	22,908	23,947
1/3/2008	86.1	80.0	30.31%	48,255	33,627	14,628
1/17/2008	84.9	80.6	37.11%	45,316	28,501	16,815
2/13/2008	84.0	80.2	29.00%	43,715	31,035	12,679
2/27/2008	85.3	83.6	18.70%	50,083	40,718	9,365
4/3/2008	84.4	81.0	37.51%	48,428	30,264	18,164
4/17/2008	85.2	78.4	30.99%	50,024	34,524	15,500
5/8/2008	84.5	79.1	30.96%	45,103	31,138	13,965
5/22/2008	96.1	79.0	44.80%	44,883	24,773	20,109
5/29/2008	83.1	78.1	37.77%	41,029	25,533	15,496
6/5/2008	84.0	77.0	38.89%	38,671	23,632	15,039
6/12/2008	84.4	77.5	43.95%	43,360	24,303	19,057
6/19/2008	84.2	78.0	41.37%	44,381	26,021	18,360
6/26/2008	82.9	79.1	10.84%	33,740	30,082	3,658
Average	85.43	79.39	36.96%	41,400	26,216	15,184

Table 5. Chemical Oxygen Demand Destruction.

Date	COD						
	Influent		Effluent		Amount Destroyed		
	mg/L	pounds	mg/L	pounds	mg/L	pounds	%
8/13/2007	26,275	17,531	17,200	11,476	9,075	6,055	34.54
8/28/2007	35,300	23,552	14,900	9,941	20,400	13,611	57.79
9/11/2007	35,250	23,519	13,750	9,174	21,500	14,345	60.99
9/25/2007	36,400	24,286	23,300	15,546	13,100	8,740	35.99
10/9/2007	21,100	14,078	17,500	11,676	3,600	2,402	17.06
10/23/2007	59,950	39,999	24,950	16,647	35,000	23,352	58.38
11/6/2007	67,925	45,320	35,048	23,384	32,877	21,936	48.40
11/20/2007	57,117	38,108	49,921	33,307	7,196	4,801	12.60
12/4/2007	64,612	43,109	50,888	33,952	13,724	9,157	21.24
12/18/2007	72,816	48,583	34,952	23,320	37,864	25,263	52.00
1/3/2008	70,050	46,737	34,109	22,758	35,941	23,980	51.31
1/17/2008	61,167	40,811	41,855	27,926	19,312	12,885	31.57
2/13/2008	61,597	41,098	57,178	38,149	4,419	2,948	7.17
2/27/2008	49,790	33,220	35,142	23,447	14,648	9,773	29.42
4/3/2008	62,192	41,495	48,028	32,044	14,164	9,450	22.77
4/10/2008	37,570	25,067	40,000	26,688	-2,430	-1,621	-6.47
4/17/2008	61,545	41,063	36,045	24,049	25,500	17,014	41.43
5/8/2008	53,333	35,584	27,800	18,548	25,533	17,036	47.87
5/22/2008	41,346	27,586	26,880	17,934	14,466	9,652	34.99
5/29/2008	62,626	41,784	31,281	20,871	31,345	20,913	50.05
6/5/2008	67,000	44,702	27,961	18,656	39,039	26,047	58.27
6/12/2008	47,165	31,468	26,683	17,803	20,482	13,666	43.43
6/19/2008	65,135	43,458	28,596	19,079	36,539	24,379	56.10
6/26/2008	47,778	31,877	31,122	20,765	16,656	11,113	34.86
Average	52,710	35,168	32,295	21,547	20,415	13,621	38.73

Table 6. Soluble Chemical Oxygen Demand Destruction.

Soluble COD							
Date	Influent		Effluent		Amount Destroyed		
	mg/L	pounds	mg/L	pounds	mg/L	pounds	%
8/13/2007	13922	9289	8746	5835	5,176	3,453	37.18
8/28/2007	18089	12069	9287	6196	8,802	5,873	48.66
9/11/2007	17159	11448	7782	5192	9,377	6,256	54.65
9/25/2007	11702	7808	4451	2970	7,251	4,838	61.96
10/9/2007	12457	8311	5790	3863	6,667	4,448	53.52
10/23/2007	9218	6150	2470	1648	6,748	4,502	73.20
11/6/2007	19773	13193	9745	6502	10,028	6,691	50.72
11/20/2007	15168	10120	8284	5527	6,884	4,593	45.39
12/4/2007	15741	10502	7031	4691	8,710	5,811	55.33
12/18/2007	12990	8667	9486	6329	3,504	2,338	26.97
1/3/2008	15890	10602	5904	3939	9,986	6,663	62.84
1/17/2008	16063	10717	7549	5037	8,514	5,681	53.00
2/13/2008	15723	10490	7331	4891	8,392	5,599	53.37
4/3/2008	20263	13519	10359	6912	9,904	6,608	48.88
4/10/2008	19705	13147	10763	7181	8,942	5,966	45.38
4/17/2008	19843	13239	10401	6940	9,442	6,300	47.58
5/8/2008	20193	13473	10693	7134	9,500	6,338	47.05
5/22/2008	15757	10513	10000	6672	5,757	3,841	36.54
5/29/2008	17189	11469	6512	4345	10,677	7,124	62.12
6/5/2008	15077	10059	9104	6074	5,973	3,985	39.62
6/12/2008	14930	9961	8889	5931	6,041	4,031	40.46
6/26/2008	16124	10758	9270	6185	6,854	4,573	42.51
Average	16,044	10,705	8,175	5,454	7,870	5,251	49.05

Suring Community Dairy

Unfortunately, all of the information required for this study was not provided by Suring Community Dairy, and therefore, some conclusions cannot be effectively determined. Flow rates and data for Suring Community Dairy are not available, but some estimates may be used. The manure flow to the digester can be estimated at 22,165 gallons per day. This number was calculated using estimates of manure flow provided by the farm. It was stated that 2/3 of the time the digester feeding rate is 96,000 liters per day, and the other 1/3 of the time it is fed 60,000 liters per day. This results in an average of 84,004 liters per day or 22,165 gallons per day. Using this flow value, the destruction of certain parameters can be calculated in pounds. Tables 7, 8, and 9 show the data for volatile solids destruction, chemical oxygen demand destruction, and soluble chemical oxygen demand destruction, respectively.

Table 7. Suring Community Dairy Volatile Solids Destruction.

Date	Volatile Solids (%)			VS Influent	VS Effluent	Amount VS Removed
	Influent	Effluent	Change of Total Solids	pounds/day	pounds/day	pounds/day
8/13/2007	84.0	75.0	48.46%	10,818	5,575	5,243
8/28/2007	85.0	87.0	38.01%	11,117	6,892	4,225
9/11/2007	83.0	76.0	50.53%	11,689	5,783	5,906
9/25/2007	85.0	78.0	41.14%	11,195	6,590	4,605
10/9/2007	85.0	79.0	44.64%	12,615	6,983	5,631
10/23/2007	83.6	79.4	30.42%	13,290	9,247	4,044
11/6/2007	83.0	77.5	21.30%	10,740	8,453	2,288
11/20/2007	84.1	78.6	34.58%	12,437	8,137	4,300
12/4/2007	84.3	80.4	19.89%	11,688	9,363	2,324
1/3/2008	84.6	77.2	46.26%	14,075	7,564	6,511
1/17/2008	82.0	76.0	18.90%	9,701	7,867	1,834
2/13/2008	83.0	74.6	20.23%	12,274	9,791	2,483
3/13/2008	83.3	77.9	36.13%	12,627	8,064	4,563
3/27/2008	83.0	77.8	40.45%	13,042	7,766	5,275
4/3/2008	81.1	77.6	26.60%	10,944	8,033	2,911
4/10/2008	80.5	77.1	30.56%	11,905	8,266	3,638
4/17/2008	81.9	77.1	39.40%	13,172	7,981	5,190
5/8/2008	80.5	74.1	37.41%	11,161	6,986	4,175
5/22/2008	81.9	76.2	29.88%	10,446	7,325	3,122
5/29/2008	80.0	75.5	36.70%	12,127	7,676	4,450
6/12/2008	81.1	75.9	37.98%	12,443	7,717	4,726
6/26/2008	79.4	72.2	42.23%	12,476	7,207	5,269
Average:	82.70	77.26	35.36%	11,908	7,694	4,214

Table 8. Suring Community Dairy Chemical Oxygen Demand Destruction.

COD							
Date	Influent		Effluent		Amount Destroyed		
	mg/L	pounds	mg/L	pounds	mg/L	pounds	%
8/13/2007	63,175	11,678	24,175	4,469	39,000	7,209	61.73
8/28/2007	45,300	8,374	21,250	3,928	24,050	4,446	53.09
9/11/2007	58,600	10,833	28,050	5,185	30,550	5,647	52.13
9/25/2007	43,250	7,995	17,500	3,235	25,750	4,760	59.54
10/9/2007	44,900	8,300	26,150	4,834	18,750	3,466	41.76
10/23/2007	67,550	12,487	51,700	9,557	15,850	2,930	23.46
11/6/2007	54,286	10,035	46,948	8,679	7,338	1,356	13.52
11/20/2007	68,952	12,746	48,786	9,018	20,166	3,728	29.25
12/4/2007	62,350	11,526	61,518	11,372	832	154	1.33
1/3/2008	65,748	12,154	40,175	7,427	25,573	4,727	38.90
1/17/2008	60,000	11,091	52,361	9,679	7,639	1,412	12.73
2/13/2008	65,043	12,024	54,237	10,026	10,806	1,998	16.61
3/13/2008	64,286	11,884	46,587	8,612	17,699	3,272	27.53
3/27/2008	58,818	10,873	44,575	8,240	14,243	2,633	24.22
4/3/2008	59,419	10,984	41,852	7,737	17,567	3,247	29.56
4/10/2008	74,811	13,829	53,163	9,828	21,648	4,002	28.94
4/17/2008	65,760	12,156	53,595	9,907	12,165	2,249	18.50
5/8/2008	50,000	9,243	42,804	7,913	7,196	1,330	14.39
5/22/2008	41,215	7,619	29,805	5,510	11,410	2,109	27.68
5/29/2008	54,476	10,070	33,729	6,235	20,747	3,835	38.08
6/5/2008	14,764	2,729	28,616	5,290	-13,852	-2,561	48.41
6/12/2008	17,172	3,174	24,781	4,581	-7,609	-1,407	30.70
6/19/2008	19,048	3,521	36,152	6,683	-17,104	-3,162	47.31
6/26/2008	74,531	13,778	39,478	7,298	35,053	6,480	47.03
Average:	53,894	9,963	39,499	7,302	14,394	2,661	26.71

Table 9. Suring Community Dairy Soluble Chemical Oxygen Demand Destruction.

Soluble COD							
Date	Influent		Effluent		Difference		
	mg/L	pounds	mg/L	pounds	mg/L	pounds	%
8/13/2007	21,875	4,044	11,978	2,217	9,897	1,827	45.24
8/28/2007	17,877	3,305	13,153	2,434	4,724	870	26.43
9/11/2007	23,283	4,304	11,458	2,121	11,825	2,183	50.79
9/25/2007	12,435	2,299	11,102	2,055	1,333	244	10.72
10/9/2007	20,948	3,872	12,185	2,255	8,763	1,617	41.83
10/23/2007	12,994	2,402	8,175	1,513	4,819	889	37.09
11/6/2007	23,030	4,257	15,108	2,796	7,922	1,461	34.40
11/20/2007	20,860	3,856	9,942	1,840	10,918	2,016	52.34
12/4/2007	19,475	3,600	11,835	2,190	7,640	1,410	39.23
1/3/2008	23,266	4,301	13,918	2,576	9,348	1,725	40.18
1/17/2008	14,824	2,740	13,080	2,421	1,744	319	11.76
2/13/2008	28,933	5,348	13,996	2,590	14,937	2,758	51.63
3/13/2008	15,314	2,831	9,376	1,735	5,938	1,096	38.77
3/27/2008	19,661	3,634	12,410	2,297	7,251	1,338	36.88
4/3/2008	24,847	4,593	14,900	2,758	9,947	1,835	40.03
4/10/2008	21,903	4,049	14,960	2,769	6,943	1,280	31.70
4/17/2008	21,747	4,020	14,867	2,752	6,880	1,269	31.64
5/8/2008	17,966	3,321	10,837	2,006	7,129	1,315	39.68
5/22/2008	16,791	3,104	11,583	2,144	5,208	960	31.02
5/29/2008	20,404	3,772	12,949	2,397	7,455	1,375	36.54
6/5/2008	13,209	2,442	11,796	2,183	1,413	259	10.70
6/12/2008	12,099	2,237	3,840	711	8,259	1,526	68.26
6/26/2008	25,327	4,682	15,090	2,793	10,237	1,889	40.42
Average:	19,525	3,609	12,110	2,241	7,414	1,368	37.97

The total amount of electricity produced during the time period from August 13, 2007, to June 26, 2008 was 767,180 kWh. During this time period, the engine at Suring Community Dairy operated for a total of 4,098 hours and has consumed 12,698,580 cubic feet of biogas with an average methane content of 55.7%. This was calculated by multiplying the average biogas flow to the engine in cubic feet per hour by the engine hours run. Again, as noted previously, it was estimated that an additional 2% of the biogas may be lost through the pressure relief valves but this was not included in the calculations.

During this same time period, the engine has consumed 7,235 gallons of diesel fuel. This was calculated by taking the average liters of diesel consumed per hour, multiplying this value by the engine hours, and converting to gallons. After calculating the corresponding BTU contents of methane and diesel fuel, the amount of electricity produced from the methane at Suring Community Dairy was found to be 673,038 kilowatt hours. Table 10 is a summary of the biogas and diesel consumed, and electricity generated at Suring Community Dairy. Table 11 is a breakdown of how much electricity is produced by the biogas.

Table 10. Suring Community Dairy Biogas, Diesel, and Electricity Data.

Average biogas consumption ft ³ /min	Total biogas consumed ft ³	Average diesel consumed L/hr	Total diesel consumed gallons	Electricity generated kWh	Average methane content of biogas %	Total amount of methane in biogas ft ³
51.65	12,698,580	6.74	7,298.37	767,180	55.67%	7,068,876

Table 11. Energy Content of Biogas and Diesel, and the Associated Electrical Generation at Suring Community Dairy.

BTU content of methane * 1 ft ³	BTU content of diesel * 1 gallon	Energy of consumed methane BTU	Energy of diesel consumed BTU	Total Energy Consumed BTU	Amount from methane %	Electricity from methane kWh	Electricity from diesel kWh
1,026	139,000	7,252,666,698	1,014,473,893	8,267,140,592	87.73	673,038	94,142

*Source: Energy Information Administration 2007

Biogas Production and Parameter Destruction Comparison

The following section compares the amount of biogas production relative to the destruction of volatile solids, chemical oxygen demand, and soluble chemical oxygen demand. Tables 12, 13, and 14 show the amounts of gas produced at Green Valley and Suring per pound of volatile solids destruction, chemical oxygen demand destruction, and soluble chemical oxygen demand destruction, respectively.

Table 12. Amount of Biogas Produced per Pound of Volatile Solids Destruction.

<i>Green Valley</i>				<i>Suring</i>			
Average gas flow ft ³ /day	Average VS reduction Pounds/day	Amount of gas produced per pound VS reduced ft ³ /lb	Amount of methane per pound VS reduced ft ³ /lb	Average gas flow ft ³ /day	Average VS reduction pounds/day	Amount of gas produced per pound VS reduced ft ³ /lb	Amount of methane per pound VS reduced ft ³ /lb
241,614	15,184	15.91	8.53	39,807	4,214	9.44	5.25

Table 13. Amount of Biogas Produced per Pound of Chemical Oxygen Demand Destruction.

<i>Green Valley</i>				<i>Suring</i>			
Average gas flow ft ³ /day	Average COD reduction Pounds/day	Amount of gas produced per pound COD reduced ft ³ /lb	Amount of methane per pound COD reduced ft ³ /lb	Average gas flow ft ³ /day	Average COD reduction pounds/day	Amount of gas produced per pound COD reduced ft ³ /lb	Amount of methane per pound COD reduced ft ³ /lb
241,614	13,621	17.74	9.51	39,807	2,661	14.96	8.33

Table 14. Amount of Biogas Produced per Pound of Soluble Chemical Oxygen Demand Destruction.

<i>Green Valley</i>				<i>Suring</i>			
Average gas flow ft ³ /day	Average SCOD reduction Pounds/day	Amount of gas produced per pound of SCOD reduced ft ³ /lb	Amount of methane per pound SCOD reduced ft ³ /lb	Average gas flow ft ³ /day	Average SCOD reduction pounds/day	Amount of gas produced per pound of SCOD reduced ft ³ /lb	Amount of methane per pound SCOD reduced ft ³ /lb
241,614	5,251	46.02	24.67	39,807	1,368	29.10	16.21

According to these results, Green Valley produced 15.91 cubic feet of biogas per pound of volatile solids removed, 17.74 cubic feet of biogas per pound of chemical oxygen demand destroyed, and 46.02 cubic feet of biogas per pound of soluble chemical oxygen demand destroyed. Assuming the methane content of the biogas at Green Valley Dairy is 53.6%, the digester is producing 8.53 cubic feet of methane per pound of volatile solids destroyed, 9.51

cubic feet per pound of chemical oxygen demand destroyed, and 24.67 cubic feet per pound of soluble chemical oxygen demand destroyed.

Suring produced 9.44 cubic feet of biogas per pound of volatile solids removed, 14.96 cubic feet of biogas per pound of chemical oxygen demand destroyed, and 29.10 cubic feet of biogas per pound of soluble chemical oxygen demand destroyed. With an average methane content of 55.67% the digester is producing 5.25 cubic feet of methane per pound of volatile solids destroyed, 8.33 cubic feet per pound of chemical oxygen demand destroyed, and 16.21 cubic feet per pound of soluble chemical oxygen demand destroyed.

Conclusions

Based on the analysis of sampling data for a one year period at Green Valley Dairy and Suring Community Dairy, the following conclusions can be made regarding the operation and performance of these anaerobic digestion systems:

1. The two digesters produced nearly equal results for total solids destruction (30%-32%), volatile solids destruction (35%-37%), nutrient balance, and pathogen destruction (98% for fecal coliform and 93% for fecal streptococcus).
2. The Green Valley digester performed significantly better than the Suring Community Dairy digester in terms of chemical oxygen demand destruction (39% versus 27%) and soluble chemical oxygen demand destruction (52% versus 36%). The Green Valley digester also had significantly less VFAs in the effluent (500 mg/l versus 1152 mg/l), which would indicate that the anaerobic digestion system is functioning efficiently in converting VFAs to biogas. For most municipal anaerobic digesters, VFA levels in the effluent below 250 mg/l would be expected.
3. As related to Item 2, the Green Valley digester outperformed the Suring Community Dairy digester in terms of biogas produced per pound of VS destruction (68% higher), per pound of COD destruction (19% higher) and per pound of SCOD destruction (54% higher). It should be noted that some biogas was being released through the pressure relief valves at Suring Community Dairy, which was not measurable and therefore not included in the calculations.
4. The Green Valley digester produced 15.91 cubic feet of biogas per pound of volatile solids destroyed, which is in the generally accepted range of 12-18 cubic feet of biogas per pound of solids destroyed. Suring Community Dairy produced 9.44 cubic feet of biogas per pound of volatile solids destroyed, which would be below the normally accepted range, but as noted previously did have higher levels of VFAs in the effluent that had not been converted to biogas in the digester.
5. The Green Valley digester had a higher capacity factor (73% to 54%) even considering the fact that there was a major mechanical failure during the monitoring period. Without this major interruption, the capacity factor at Green Valley would have been approximately 90%. However, it should be noted that Suring Community Dairy only runs the engine during peak times, as it was indicated by the operator that it was not cost-effective to run the engine during off-peak hours, which is likely related to the fact that diesel fuel is used in conjunction with the biogas to run the engine.

References

Badger Laboratories and Engineering. 2008. Quality Assurance Manual.

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Appendix A

Raw Data

Total Solids Content Comparison

Total Solids (%)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	5.0	2.8	44.00%	7.0	4.0	42.86%
8/28/2007	5.8	2.2	62.07%	7.1	4.3	39.44%
9/11/2007	5.9	3.6	38.98%	7.6	4.1	46.05%
9/25/2007	5.5	3.7	32.73%	7.1	4.6	35.21%
10/9/2007	5.9	4.4	25.42%	8.0	4.8	40.00%
10/23/2007	7.1	3.2	54.93%	8.6	6.3	26.74%
11/6/2007	7.7	5.3	31.17%	7.0	5.9	15.71%
11/20/2007	7.1	5.9	16.90%	8.0	5.6	30.00%
12/4/2007	7.5	5.3	29.33%	7.5	6.3	16.00%
12/18/2007	8.1	4.5	44.44%			
1/3/2008	8.4	6.3	25.00%	9	5.3	41.11%
1/17/2008	8	5.3	33.75%	6.4	5.6	12.50%
1/31/2008						
2/13/2008	7.8	5.8	25.64%	8	7.1	11.25%
2/27/2008	8.8	7.3	17.05%			
3/13/2008				8.2	5.6	31.71%
3/27/2008				8.5	5.4	36.47%
4/3/2008	8.6	5.6	34.88%	7.3	5.6	23.29%
4/10/2008	8.2	9	8.89%	8	5.8	27.50%
4/17/2008	8.8	6.6	25.00%	8.7	5.6	35.63%
5/8/2008	8	5.9	26.25%	7.5	5.1	32.00%
5/22/2008	7	4.7	32.86%	6.9	5.2	24.64%
5/29/2008	7.4	4.9	33.78%	8.2	5.5	32.93%
6/5/2008	6.9	4.6	33.33%	2.6	5.2	50.00%*
6/12/2008	7.7	4.7	38.96%	8.3	5.5	33.73%
6/19/2008	7.9	5	36.71%	2.3	5.6	58.93%*
6/26/2008	6.1	5.7	6.56%	8.5	5.4	36.47%
Average	7.3	5.1	30.19%	7.35	5.39	26.60%

Note: * signifies an increase in numbers

Volatile Solids Comparison

Date	Volatile Solids (%)					
	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	86.3	76.0	50.68%	84	75	48.46%
8/28/2007	78.0	72.3	64.84%	85	87	38.01%
9/11/2007	84.5	81.7	41.00%	83	76	50.53%
9/25/2007	86.7	80.7	37.38%	85	78	41.14%
10/9/2007	86.3	82.3	28.88%	85	79	44.64%
10/23/2007	86.8	77.6	59.71%	83.6	79.4	30.42%
11/6/2007	86.8	81.4	35.45%	83	77.5	21.30%
11/20/2007	86.3	83.2	19.89%	84.1	78.6	34.58%
12/4/2007	87.4	82.8	33.05%	84.3	80.4	19.89%
12/18/2007	86.7	76.3	51.11%			
1/3/2008	86.1	80	30.31%	84.6	77.2	46.26%
1/17/2008	84.9	80.6	37.11%	82	76	18.90%
1/31/2008						
2/13/2008	84	80.2	29.00%	83	74.6	20.23%
2/27/2008	85.3	83.6	18.70%			
3/13/2008				83.3	77.9	36.13%
3/27/2008				83	77.8	40.45%
4/3/2008	84.4	81	37.51%	81.1	77.6	26.60%
4/10/2008	85.1	82.6	-6.53%	80.5	77.1	30.56%
4/17/2008	85.2	78.4	30.99%	81.9	77.1	39.40%
5/8/2008	84.5	79.1	30.96%	80.5	74.1	37.41%
5/22/2008	96.1	79	44.80%	81.9	76.2	29.88%
5/29/2008	83.1	78.1	37.77%	80	75.5	36.70%
6/5/2008	84	77	38.89%	72.2	75.1	-108.03%*
6/12/2008	84.4	77.5	43.95%	81.1	75.9	37.98%
6/19/2008	84.2	78	41.37%	66.3	75.5	-177.26%*
6/26/2008	82.9	79.1	10.84%	79.4	72.2	42.23%
Average	85.42	79.52	35.01%	81.58	77.10	30.64%

Note: * signifies an increase in numbers

Fecal Coliform Numbers

Fecal Coliform (CFU/g)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	22750000	31500	99.86%	1260000	22750	98.19%
8/28/2007	2275000	18750	99.18%	1850000	28500	98.46%
9/11/2007	3300000	74000	97.76%	1725000	41000	97.62%
9/25/2007	3775000	32000	99.15%	2425000	27000	98.89%
10/9/2007	1875000	22500	98.80%	1100000	21000	98.09%
10/23/2007	1625000	24000	98.52%	925000	42500	95.41%
11/6/2007	2400000	28750	98.80%	3025000	30750	98.98%
11/20/2007	3275000	58000	98.23%	3000000	27500	99.08%
12/4/2007	1000000	17750	98.23%	1950000	17750	99.09%
12/18/2007	575000	23000	96.00%			
1/3/2008	225000	5200	97.69%	40000	2250	94.38%
1/17/2008	887500	11875	98.66%	6875	11000	37.50%*
1/31/2008						
2/13/2008	762500	23250	96.95%	800000	17000	97.88%
2/27/2008	925000	13500	98.54%			
3/13/2008				450000	10750	97.61%
3/27/2008				950000	13375	98.59%
4/3/2008	1550000	29500	98.10%	1115000	14625	98.69%
4/10/2008	3825000	34500	99.10%	4025000	31500	99.22%
4/17/2008	4250000	59500	98.60%	1350000	56000	95.85%
5/8/2008	1850000	28000	98.49%	40000	77000	48.05%*
5/22/2008	1500000	27150	98.19%	3250000	58000	98.22%
5/29/2008	1500000	35000	97.67%	3812500	55500	98.54%
6/5/2008	1125000	20000	98.22%	2225000	27000	98.79%
6/12/2008	2362500	27000	98.86%	5250000	60750	98.84%
6/19/2008	2900000	49000	98.31%	17250	87500	80.29%*
6/26/2008	2050000	20500	99.00%	660000	17000	97.42%
Average	2856771	29759	98.96%	1718818	33250	98.07%

Note: * Signifies an increase in numbers

Fecal Streptococcus Numbers

Fecal Streptococcus (CFU/g)						
Date	<i>Green Valley</i>			<i>Suring</i>		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	1287500	41150	96.80%	860000	19500	97.73%
8/28/2007	1730000	18750	98.92%	1850000	80250	95.66%
9/11/2007	2687500	74000	97.25%	1250000	42500	96.60%
9/25/2007	4100000	188000	95.41%	1300000	55500	95.73%
10/9/2007	2225000	8500	99.62%	3125000	79000	97.47%
10/23/2007	3250000	120000	96.31%	3350000	45000	98.66%
11/6/2007	2675000	182500	93.18%	750000	36500	95.13%
11/20/2007	2275000	162500	92.86%	1137500	42500	96.26%
12/4/2007	1650000	187500	88.64%	1100000	69500	93.68%
12/18/2007	2375000	180000	92.42%			
1/3/2008	2275000	145000	93.63%	1200000	63000	94.75%
1/17/2008	3375000	208750	93.81%	36500	99000	63.13%*
1/31/2008						
2/13/2008	1875000	127500	93.20%	1425000	127000	91.09%
2/27/2008	2000000	155000	92.25%			
3/13/2008				1350000	147500	89.07%
3/27/2008				1700000	135000	92.06%
4/3/2008	2825000	288750	89.78%	1325000	133000	89.96%
4/10/2008	3000000	390000	87.00%	762500	120000	84.26%
4/17/2008	4250000	36250	99.15%	175000	86000	50.86%
5/8/2008	2525000	247500	90.20%	12500	26000	51.92%*
5/22/2008	1125000	142500	87.33%	1560000	26000	98.33%
5/29/2008	4100000	385000	90.61%	3162500	82500	97.39%
6/5/2008	1775000	110000	93.80%	625000	130000	79.20%
6/12/2008	300000	41250	86.25%	1125000	115000	89.78%
6/19/2008	575000	34500	94.00%	25900	118750	78.19%*
6/26/2008	1212500	56250	95.36%	397500	60000	84.91%
Average	2311146	147131	93.63%	1233538	80792	93.45%

Note: * signifies an increase in numbers

Chemical Oxygen Demand Comparison

COD (mg/L)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	26275	17200	34.54%	63175	24175	61.73%
8/28/2007	35300	14900	57.79%	45300	21250	53.09%
9/11/2007	35250	13750	60.99%	58600	28050	52.13%
9/25/2007	36400	23300	35.99%	43250	17500	59.54%
10/9/2007	21100	17500	17.06%	44900	26150	41.76%
10/23/2007	59950	24950	58.38%	67550	51700	23.46%
11/6/2007	67925	35048	48.40%	54286	46948	13.52%
11/20/2007	57117	49921	12.60%	68952	48786	29.25%
12/4/2007	64612	50888	21.24%	62350	61518	1.33%
12/18/2007	72816	34952	52.00%			
1/3/2008	70050	34109	51.31%	65748	40175	38.90%
1/17/2008	61167	41855	31.57%	60000	52361	12.73%
1/31/2008						
2/13/2008	61597	57178	7.17%	65043	54237	16.61%
2/27/2008	49790	35142	29.42%			
3/13/2008				64286	46587	27.53%
3/27/2008				58818	44575	24.22%
4/3/2008	62192	48028	22.77%	59419	41852	29.56%
4/10/2008	37570	40000	6.08%	74811	53163	28.94%
4/17/2008	61545	36045	41.43%	65760	53595	18.50%
5/8/2008	53333	27800	47.87%	50000	42804	14.39%
5/22/2008	41346	26880	34.99%	41215	29805	27.68%
5/29/2008	62626	31281	50.05%	54476	33729	38.08%
6/5/2008	67000	27961	58.27%	14764	28616	48.41%*
6/12/2008	47165	26683	43.43%	17172	24781	30.70%*
6/19/2008	65135	28596	56.10%	19048	36152	47.31%*
6/26/2008	47778	31122	34.86%	74531	39478	47.03%
Average	52710	32295	38.73%	53894	39499	26.71%

Note: * signifies an increase in numbers

Soluble Chemical Oxygen Demand Comparison

Soluble COD (mg/L)						
Date	<i>Green Valley</i>			<i>Suring</i>		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	13922	8746	37.18%	21875	11978	45.24%
8/28/2007	18089	9287	48.66%	17877	13153	26.43%
9/11/2007	17159	7782	54.65%	23283	11458	50.79%
9/25/2007	11702	4451	61.96%	12435	11102	10.72%
10/9/2007	12457	5790	53.52%	20948	12185	41.83%
10/23/2007	9218	2470	73.20%	12994	8175	37.09%
11/6/2007	19773	9745	50.72%	23030	15108	34.40%
11/20/2007	15168	8284	45.39%	20860	9942	52.34%
12/4/2007	15741	7031	55.33%	19475	11835	39.23%
12/18/2007	12990	9486	26.97%			
1/3/2008	15890	5904	62.84%	23266	13918	40.18%
1/17/2008	16063	7549	53.00%	14824	13080	11.76%
1/31/2008						
2/13/2008	15723	7331	53.37%	28933	13996	51.63%
2/27/2008	20882	5447	73.92%			
3/13/2008				15314	9376	38.77%
3/27/2008				19661	12410	36.88%
4/3/2008	20263	10359	48.88%	24847	14900	40.03%
4/10/2008	19705	10763	45.38%	21903	14960	31.70%
4/17/2008	19843	10401	47.58%	21747	14867	31.64%
5/8/2008	20193	10693	47.05%	17966	10837	39.68%
5/22/2008	15757	10000	36.54%	16791	11583	31.02%
5/29/2008	17189	6512	62.12%	20404	12949	36.54%
6/5/2008	15077	9104	39.62%	13209	11796	10.70%
6/12/2008	14930	8889	40.46%	12099	3840	68.26%
6/19/2008	16076	2687	83.29%	5788	14131	59.04%*
6/26/2008	16124	9270	42.51%	25327	15090	40.42%
Average	16247	7833	51.79%	18952	12195	35.66%

Note: * signifies an increase in numbers

Volatile Fatty Acids Comparison

Volatile Fatty Acids (mg/L)						
Date	<i>Green Valley</i>			<i>Suring</i>		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	1392	252	81.90%	3708	948	74.43%
8/28/2007	1620	204	87.41%	3696	2852	22.84%
9/11/2007	2412	120	95.02%	5076	1884	62.88%
9/25/2007	2088	336	83.91%	4320	1800	58.33%
10/9/2007	2292	132	94.24%	4416	1044	76.36%
10/23/2007	5304	252	95.25%	4140	2340	43.48%
11/6/2007	2844	216	92.41%	3816	1860	51.26%
11/20/2007	3264	324	90.07%	5532	816	85.25%
12/4/2007	3000	372	87.60%	4896	984	79.90%
12/18/2007	4872	396	91.87%			
1/3/2008	3300	408	87.64%	4344	660	84.81%
1/17/2008	3504	276	92.12%	3180	312	90.19%
1/31/2008						
2/13/2008	4320	324	92.50%	3744	276	92.63%
2/27/2008	1608	516	67.91%			
3/13/2008				4860	300	93.83%
3/27/2008				4992	108	97.84%
4/3/2008	5376	192	96.43%	4416	1128	74.46%
4/10/2008	2640	900	65.91%	3912	1140	70.86%
4/17/2008	4752	2316	51.26%	5700	1116	80.42%
5/8/2008	4476	1416	68.36%	4152	936	77.46%
5/22/2008	4356	312	92.84%	4620	756	83.64%
5/29/2008	3684	432	88.27%	4152	996	76.01%
6/5/2008	3204	720	77.53%	3480	1104	68.28%
6/12/2008	3360	396	88.21%	4200	1272	69.71%
6/19/2008	3192	552	82.71%	2100	1620	22.86%
6/26/2008	4008	636	84.13%	2544	1404	44.81%
Average	3370	500	85.16%	4167	1152	72.34%

Total Kjeldahl Nitrogen Comparison

Total Kjeldahl Nitrogen (mg/L)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	1780	1500	15.73%	2940	2400	18.37%
8/28/2007	2000	1498	25.10%	2700	2635	2.41%
9/11/2007	2410	1615	32.99%	3205	2736	14.63%
9/25/2007	1955	2185*	10.53%	3000	3035*	1.15%
10/9/2007	2125	2030	4.47%	3220	2750	14.60%
10/23/2007	2933	2100	28.40%	4045	3525	12.86%
11/6/2007	2855	2560	10.33%	3495	3465	0.86%
11/20/2007	2730	2195	19.60%	3170	2490	21.45%
12/4/2007	2536	1414	44.24%	1228	3084*	60.18%
12/18/2007	3050	2575	15.57%			
1/3/2008	3230	3032	6.13%	4690	4787*	2.03%
1/17/2008	3193	3053	4.38%	3173	3860*	17.80%
1/31/2008						
2/13/2008	3167	2535	19.96%	3640	3855*	5.58%
2/27/2008	3853	3720	3.45%			
3/13/2008				3750	4060*	7.64%
3/27/2008				3820	3955*	3.41%
4/3/2008	3013	3750*	19.65%	3880	3800	2.06%
4/10/2008	2990	2985	0.17%	3790	4005*	5.37%
4/17/2008	2610	2845*	8.26%	3830	4225*	9.35%
5/8/2008	2860	2740	4.20%	3570	3865*	7.63%
5/22/2008	2890	2845	1.56%	3113	3820*	18.51%
5/29/2008	3020	2965	1.82%	3900	3705	5.00%
6/5/2008	2747	2890*	4.95%	2080	3575*	41.82%
6/12/2008	2735	2840*	3.70%	4593	3825	16.72%
6/19/2008	3093	2793	9.70%	1880	3833*	50.95%
6/26/2008	2667	2850*	6.42%	4040	3705	8.29%
Average	2768	2563	7.42%	3365	3541	4.99%

Note: * signifies an increase in numbers

Ammonia Nitrogen Comparison

Ammonia Nitrogen (mg/L)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	595	743*	19.92%	1002	1528*	34.42%
8/28/2007	726	810*	10.37%	1084	1584*	31.57%
9/11/2007	587	383	34.75%	741	819*	9.52%
9/25/2007	689	996*	30.82%	1132	1412*	19.83%
10/9/2007	588	586	0.34%	938	1198*	21.70%
10/23/2007	1001	962	3.90%	1408	1729*	18.57%
11/6/2007	634	670*	5.37%	956	1431*	33.19%
11/20/2007	1263	1364*	7.40%	1658	1815*	8.65%
12/4/2007	1126	1531*	26.45%	1518	2012*	24.55%
12/18/2007	1362	1453*	6.26%			
1/3/2008	1356	1226	9.59%	1914	2117*	9.59%
1/17/2008	1365	1415*	3.53%	1554	2505*	37.96%
1/31/2008						
2/13/2008	1832	1580	13.76%	1652	2492*	33.71%
2/27/2008	1627	1828*	11.00%			
3/13/2008				1433	1932*	25.83%
3/27/2008				1352	1475*	8.34%
4/3/2008	1308	1473*	11.20%	1632	2242*	27.21%
4/10/2008	1192	1587*	24.89%	1567	2118*	26.02%
4/17/2008	1247	1635*	23.73%	1702	2252*	24.42%
5/8/2008	1187	1622*	26.82%	1405	2300*	38.91%
5/22/2008	1425	1595*	10.66%	1558	2137*	27.09%
5/29/2008	1482	1520*	2.50%	1957	2085*	6.14%
6/5/2008	1230	1460*	15.75%	1232	1263*	2.45%
6/12/2008	1417	1463*	3.14%	1590	2280*	30.26%
6/19/2008	1068	1622*	34.16%	922	2118*	56.47%
6/26/2008	863	1602*	46.13%	1478	2142*	31.00%
Average	1132	1297*	12.71%	1391	1874*	25.79%

Note: * signifies an increase in numbers

Total Phosphorus Comparison

Total Phosphorus (mg/L)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	320	160	50.00%	320	240	25.00%
8/28/2007	310	208	32.90%	340	393*	13.49%
9/11/2007	270	180	33.33%	385	232	39.74%
9/25/2007	225	290*	22.41%	340	315	7.35%
10/9/2007	225	190	15.56%	335	240	28.36%
10/23/2007	333	205	38.44%	415	425*	2.35%
11/6/2007	400	265	33.75%	365	405*	9.88%
11/20/2007	420	340	19.05%	540	305	43.52%
12/4/2007	590	525	11.02%	910	470	48.35%
12/18/2007	370	325	12.16%			
1/3/2008	450	388	13.78%	585	367	37.26%
1/17/2008	487	393	19.30%	393	350	10.94%
1/31/2008						
2/13/2008	587	400	31.86%	547	505	7.68%
2/27/2008	413	415*	0.48%			
3/13/2008				440	448*	1.79%
3/27/2008				607	390	35.75%
4/3/2008	493	400	18.86%	525	415	20.95%
4/10/2008	460	385	16.30%	473	390	17.55%
4/17/2008	373	375*	0.53%	560	760*	26.32%
5/8/2008	433	350	19.17%	453	345	23.84%
5/22/2008	260	250	3.85%	380	320	15.79%
5/29/2008	313	340*	7.94%	460	395	14.13%
6/5/2008	293	260	11.26%	160	315*	49.21%
6/12/2008	305	253	17.05%	547	405	25.96%
6/19/2008	313	253	19.17%	205	420*	51.19%
6/26/2008	460	280	39.13%	453	405	10.60%
Average	379	310	18.38%	447	386	13.81%

Note: * signifies an increase in numbers

Dissolved Phosphorus Comparison

Dissolved Phosphorus (mg/L)						
Date	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	81	109*	25.69%	206	126	38.83%
8/28/2007	108	120*	10.00%	148	120	18.92%
9/11/2007	245	144	41.22%	211	149	29.38%
9/25/2007	153	187*	18.18%	183	174	4.92%
10/9/2007	173	164	5.20%	199	174	12.56%
10/23/2007	301	191	36.54%	248	200	19.35%
11/6/2007	322	269	16.46%	214	275*	22.18%
11/20/2007	271	224	17.34%	289	189	34.60%
12/4/2007	240	228	5.00%	281	206	26.69%
12/18/2007	268	204	23.88%			
1/3/2008	250	192	23.20%	336	230	31.55%
1/17/2008	267	221	17.23%	257	243	5.45%
1/31/2008						
2/13/2008	275	181	34.18%	403	255	36.72%
2/27/2008	306	224	26.80%			
3/13/2008				286	270	5.59%
3/27/2008				247	257*	3.89%
4/3/2008	273	191	30.04%	264	260	1.52%
4/10/2008	193	169	12.44%	214	226	5.31%
4/17/2008	239	177	25.94%	206	227	9.25%
5/8/2008	232	188	18.97%	264	175	33.71%
5/22/2008	221	223*	0.90%	241	214	11.20%
5/29/2008	199	165	17.09%	202	192	4.95%
6/5/2008	170	151	11.18%	101	173*	41.62%
6/12/2008	187	160	14.44%	223	170	23.77%
6/19/2008	221	170	23.08%	108	212	49.06%
6/26/2008	124	174	28.74%	265	206	22.26%
Average	222	184	16.79%	233	205	12.03%

Note: * signifies an increase in numbers

pH Comparison

Date	pH					
	Green Valley			Suring		
	Influent	Effluent	% Change	Influent	Effluent	% Change
8/13/2007	8.1	7.7	4.94%	7.1	7.9*	10.13%
8/28/2007	8.1	7.5	7.41%	7.0	7.6*	7.89%
9/11/2007	8.1	7.4	8.64%	7.1	7.7*	7.79%
9/25/2007	7.3	7.5*	2.67%	7.1	7.6*	6.58%
10/9/2007	7.5	7.6*	1.32%	7.0	7.8*	10.26%
10/23/2007	7.5	7.5	0.00%	6.9	7.7*	10.39%
11/6/2007	7.8	7.6	2.56%	7.5	7.7*	2.60%
11/20/2007	7.8	7.6	2.56%	6.9	7.8*	11.54%
12/4/2007	7.8	7.7	1.28%	7.6	7.8*	2.56%
12/18/2007	8	7.7	3.75%			
1/3/2008	8	7.8	2.50%	8.2	7.9	3.66%
1/17/2008	7.5	7.7*	2.60%	7.9	8*	1.25%
1/31/2008						
2/13/2008	8.1	7.8	3.70%	7.9	8	1.25%
2/27/2008	8	7.8	2.50%			
3/13/2008				7.9	7.8	1.27%
3/27/2008				8	7.9	1.25%
4/3/2008	7.6	7.9*	3.80%	8	8	0.00%
4/10/2008	7.8	7.7	1.28%	8	7.9	1.25%
4/17/2008	7.6	7.7*	1.30%	7.9	7.9	0.00%
5/8/2008	7.7	7.7	0.00%	7.8	7.8	0.00%
5/22/2008	7.8	7.8	0.00%	7.8	7.8	0.00%
5/29/2008	7.9	7.8	1.27%	7.9	7.8	1.27%
6/5/2008	7.5	7.7*	2.60%	8	7.7	3.75%
6/12/2008	7.5	7.7*	2.60%	7.4	7.7*	3.90%
6/19/2008	7.5	7.7*	2.60%	7.3	7.6*	3.95%
6/26/2008	7.1	7.7*	7.79%	7.2	7.8*	7.69%
Average	7.73	7.68	0.70%	7.56	7.80	3.10%

Note: * signifies an increase in numbers

APPENDIX B

STATISTICALLY ANALYZED DATA (OUTLIERS REMOVED)

Chemical Oxygen Demand Comparison with Outliers Removed

COD (mg/L)							
Green Valley Dairy				Suring Community Dairy			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	26,275	17,200	34.54%	8/13/2007	63,175	24,175	61.73%
8/28/2007	35,300	14,900	57.79%	8/28/2007	45,300	21,250	53.09%
9/11/2007	35,250	13,750	60.99%	9/11/2007	58,600	28,050	52.13%
9/25/2007	36,400	23,300	35.99%	9/25/2007	43,250	17,500	59.54%
10/9/2007	21,100	17,500	17.06%	10/9/2007	44,900	26,150	41.76%
10/23/2007	59,950	24,950	58.38%	10/23/2007	67,550	51,700	23.46%
11/6/2007	67,925	35,048	48.40%	11/6/2007	54,286	46,948	13.52%
11/20/2007	57,117	49,921	12.60%	11/20/2007	68,952	48,786	29.25%
12/4/2007	64,612	50,888	21.24%	12/4/2007	62,350	61,518	1.33%
12/18/2007	72,816	34,952	52.00%	1/3/2008	65,748	40,175	38.90%
1/3/2008	70,050	34,109	51.31%	1/17/2008	60,000	52,361	12.73%
1/17/2008	61,167	41,855	31.57%	2/13/2008	65,043	54,237	16.61%
2/13/2008	61,597	57,178	7.17%	3/13/2008	64,286	46,587	27.53%
2/27/2008	49,790	35,142	29.42%	3/27/2008	58,818	44,575	24.22%
4/3/2008	62,192	48,028	22.77%	4/3/2008	59,419	41,852	29.56%
4/10/2008	37,570	40,000	6.08%	4/10/2008	74,811	53,163	28.94%
4/17/2008	61,545	36,045	41.43%	4/17/2008	65,760	53,595	18.50%
5/8/2008	53,333	27,800	47.87%	5/8/2008	50,000	42,804	14.39%
5/22/2008	41,346	26,880	34.99%	5/22/2008	41,215	29,805	27.68%
5/29/2008	62,626	31,281	50.05%	5/29/2008	54,476	33,729	38.08%
6/5/2008	67,000	27,961	58.27%	6/5/2008	14,764	28,616*	48.41%
6/12/2008	47,165	26,683	43.43%	6/12/2008	17,172	24,781*	30.70%
6/19/2008	65,135	28,596	56.10%	6/19/2008	19,048	36,152*	47.31%
6/26/2008	47,778	31,122	34.86%	6/26/2008	74,531	39,478	47.03%
Average	52,710	32,295	38.73%	Average:	53,894	39,499	26.71%

Note: * signifies an increase in numbers

Soluble Chemical Oxygen Demand Comparison with Outliers Removed

Soluble COD (mg/L)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	13922	8746	37.18	8/13/2007	21875	11978	45.24
8/28/2007	18089	9287	48.66	8/28/2007	17877	13153	26.43
9/11/2007	17159	7782	54.65	9/11/2007	23283	11458	50.79
9/25/2007	11702	4451	61.96	9/25/2007	12435	11102	10.72
10/9/2007	12457	5790	53.52	10/9/2007	20948	12185	41.83
10/23/2007	9218	2470	73.20	10/23/2007	12994	8175	37.09
11/6/2007	19773	9745	50.72	11/6/2007	23030	15108	34.40
11/20/2007	15168	8284	45.39	11/20/2007	20860	9942	52.34
12/4/2007	15741	7031	55.33	12/4/2007	19475	11835	39.23
12/18/2007	12990	9486	26.97	1/3/2008	23266	13918	40.18
1/3/2008	15890	5904	62.84	1/17/2008	14824	13080	11.76
1/17/2008	16063	7549	53.00	2/13/2008	28933	13996	51.63
2/13/2008	15723	7331	53.37	3/13/2008	15314	9376	38.77
4/3/2008	20263	10359	48.88	3/27/2008	19661	12410	36.88
4/10/2008	19705	10763	45.38	4/3/2008	24847	14900	40.03
4/17/2008	19843	10401	47.58	4/10/2008	21903	14960	31.70
5/8/2008	20193	10693	47.05	4/17/2008	21747	14867	31.64
5/22/2008	15757	10000	36.54	5/8/2008	17966	10837	39.68
5/29/2008	17189	6512	62.12	5/22/2008	16791	11583	31.02
6/5/2008	15077	9104	39.62	5/29/2008	20404	12949	36.54
6/12/2008	14930	8889	40.46	6/5/2008	13209	11796	10.70
6/26/2008	16124	9270	42.51	6/12/2008	12099	3840	68.26
Average	16,044	8,175	49.05	6/26/2008	25327	15090	40.42
				Average:	19,525	12,110	37.97

Fecal Coliform Comparison with Outliers Removed

Fecal Coliform (CFU/g)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/28/2007	2275000	18750	99.18	8/13/2007	1,260,000	22,750	98.19%
9/11/2007	3300000	74000	97.76	8/28/2007	1,850,000	28,500	98.46%
9/25/2007	3775000	32000	99.15	9/11/2007	1,725,000	41,000	97.62%
10/9/2007	1875000	22500	98.80	9/25/2007	2,425,000	27,000	98.89%
10/23/2007	1625000	24000	98.52	10/9/2007	1,100,000	21,000	98.09%
11/6/2007	2400000	28750	98.80	10/23/2007	925,000	42,500	95.41%
11/20/2007	3275000	58000	98.23	11/6/2007	3,025,000	30,750	98.98%
12/4/2007	1000000	17750	98.23	11/20/2007	3,000,000	27,500	99.08%
12/18/2007	575000	23000	96.00	12/4/2007	1,950,000	17,750	99.09%
1/3/2008	225000	5200	97.69	1/3/2008	40,000	2,250	94.38%
1/17/2008	887500	11875	98.66	1/17/2008	6,875	11,000*	37.50%
2/13/2008	762500	23250	96.95	2/13/2008	800,000	17,000	97.88%
2/27/2008	925000	13500	98.54	3/13/2008	450,000	10,750	97.61%
4/3/2008	1550000	29500	98.10	3/27/2008	950,000	13,375	98.59%
4/10/2008	3825000	34500	99.10	4/3/2008	1,115,000	14,625	98.69%
4/17/2008	4250000	59500	98.60	4/10/2008	4,025,000	31,500	99.22%
5/8/2008	1850000	28000	98.49	4/17/2008	1,350,000	56,000	95.85%
5/22/2008	1500000	27150	98.19	5/8/2008	40,000	77,000*	48.05%
5/29/2008	1500000	35000	97.67	5/22/2008	3,250,000	58,000	98.22%
6/5/2008	1125000	20000	98.22	5/29/2008	3,812,500	55,500	98.54%
6/12/2008	2362500	27000	98.86	6/5/2008	2,225,000	27,000	98.79%
6/19/2008	2900000	49000	98.31	6/12/2008	5,250,000	60,750	98.84%
6/26/2008	2050000	20500	99.00	6/19/2008	17,250	87,500	80.29%
Average	1991848	29684	98.31	6/26/2008	660,000	17,000	97.42%
				Average:	1,718,818	33,250	98.07%

Note: * signifies an increase in numbers

Fecal Streptococcus Comparison with Outliers Removed

Fecal Streptococcus (CFU/g)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	1,287,500	41,150	96.80	8/13/2007	860,000	19,500	97.73%
9/11/2007	2,687,500	74,000	97.25	8/28/2007	1,850,000	80,250	95.66%
9/25/2007	4,100,000	188,000	95.41	9/11/2007	1,250,000	42,500	96.60%
10/9/2007	2,225,000	8,500	99.62	9/25/2007	1,300,000	55,500	95.73%
10/23/2007	3,250,000	120,000	96.31	10/23/2007	3,350,000	45,000	98.66%
11/6/2007	2,675,000	182,500	93.18	11/6/2007	750,000	36,500	95.13%
11/20/2007	2,275,000	162,500	92.86	11/20/2007	1,137,500	42,500	96.26%
12/4/2007	1,650,000	187,500	88.64	12/4/2007	1,100,000	69,500	93.68%
12/18/2007	2,375,000	180,000	92.42	1/3/2008	1,200,000	63,000	94.75%
1/3/2008	2,275,000	145,000	93.63	1/17/2008	36,500	99,000*	63.13%
1/17/2008	3,375,000	208,750	93.81	2/13/2008	1,425,000	127,000	91.09%
2/13/2008	1,875,000	127,500	93.20	3/13/2008	1,350,000	147,500	89.07%
2/27/2008	2,000,000	155,000	92.25	3/27/2008	1,700,000	135,000	92.06%
4/3/2008	2,825,000	288,750	89.78	4/3/2008	1,325,000	133,000	89.96%
4/10/2008	3,000,000	390,000	87.00	4/10/2008	762,500	120,000	84.26%
5/8/2008	2,525,000	247,500	90.20	4/17/2008	175,000	86,000	50.86%
5/22/2008	1,125,000	142,500	87.33	5/8/2008	12,500	26,000*	51.92%
5/29/2008	4,100,000	385,000	90.61	5/22/2008	1,560,000	26,000	98.33%
6/5/2008	1,775,000	110,000	93.80	6/5/2008	625,000	130,000	79.20%
6/12/2008	300,000	41,250	86.25	6/12/2008	1,125,000	115,000	89.78%
6/19/2008	575,000	34,500	94.00	6/19/2008	25,900	118,750*	78.19%
6/26/2008	1,212,500	56,250	95.36	6/26/2008	397,500	60,000	84.91%
Average	2,249,432	158,007	92.98	Average:	1,059,882	80,795	92.38%

Note: * signifies an increase in numbers

Total Kjeldahl Nitrogen Comparison with Outliers Removed

Total Kjeldahl Nitrogen (mg/L)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	1,780	1,500	15.73%	8/13/2007	2940	2400	18.37
8/28/2007	2,000	1,498	25.10%	8/28/2007	2700	2635	2.41
9/11/2007	2,410	1,615	32.99%	9/11/2007	3205	2736	14.63
9/25/2007	1,955	2,185*	10.53%	9/25/2007	3000	3035	1.15
10/9/2007	2,125	2,030	4.47%	10/9/2007	3220	2750	14.60
10/23/2007	2,933	2,100	28.40%	10/23/2007	4045	3525	12.86
11/6/2007	2,855	2,560	10.33%	11/6/2007	3495	3465	0.86
11/20/2007	2,730	2,195	19.60%	11/20/2007	3170	2490	21.45
12/4/2007	2,536	1,414	44.24%	1/3/2008	4690	4787*	2.03
12/18/2007	3,050	2,575	15.57%	1/17/2008	3173	3860*	17.80
1/3/2008	3,230	3,032	6.13%	2/13/2008	3640	3855*	5.58
1/17/2008	3,193	3,053	4.38%	3/13/2008	3750	4060	7.64
2/13/2008	3,167	2,535	19.96%	3/27/2008	3820	3955*	3.41
2/27/2008	3,853	3,720	3.45%	4/3/2008	3880	3800	2.06
4/3/2008	3,013	3,750*	19.65%	4/10/2008	3790	4005*	5.37
4/10/2008	2,990	2,985	0.17%	4/17/2008	3830	4225*	9.35
4/17/2008	2,610	2,845*	8.26%	5/8/2008	3570	3865*	7.63
5/8/2008	2,860	2,740	4.20%	5/22/2008	3113	3820*	18.51
5/22/2008	2,890	2,845	1.56%	5/29/2008	3900	3705	5.00
5/29/2008	3,020	2,965	1.82%	6/5/2008	2080	3575*	41.82
6/5/2008	2,747	2,890*	4.95%	6/12/2008	4593	3825	16.72
6/12/2008	2,735	2,840*	3.70%	6/19/2008	1880	3833*	50.95
6/19/2008	3,093	2,793	9.70%	6/26/2008	4040	3705	8.29
6/26/2008	2,667	2,850*	6.42%	Average:	3458	3561	2.91
Average	2,768	2,563	7.42%				

Note: * signifies an increase in numbers

Ammonia Nitrogen Comparison with Outliers Removed

Ammonia Nitrogen (mg/L)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	595	743*	19.92%	8/13/2007	1002	1528*	34.42%
8/28/2007	726	810*	10.37%	8/28/2007	1084	1584*	31.57%
9/11/2007	587	383	34.75%	9/11/2007	741	819*	9.52%
9/25/2007	689	996*	30.82%	9/25/2007	1132	1412*	19.83%
10/9/2007	588	586	0.34%	10/9/2007	938	1198*	21.70%
10/23/2007	1,001	962	3.90%	10/23/2007	1408	1729*	18.57%
11/6/2007	634	670*	5.37%	11/6/2007	956	1431*	33.19%
11/20/2007	1,263	1,364*	7.40%	11/20/2007	1658	1815*	8.65%
12/4/2007	1,126	1,531*	26.45%	12/4/2007	1518	2012*	24.55%
12/18/2007	1,362	1,453*	6.26%	1/3/2008	1914	2117*	9.59%
1/3/2008	1,356	1,226	9.59%	1/17/2008	1554	2505*	37.96%
1/17/2008	1,365	1,415*	3.53%	2/13/2008	1652	2492*	33.71%
2/13/2008	1,832	1,580	13.76%	3/13/2008	1433	1932*	25.83%
2/27/2008	1,627	1,828*	11.00%	3/27/2008	1352	1475*	8.34%
4/3/2008	1,308	1,473*	11.20%	4/3/2008	1632	2242*	27.21%
4/10/2008	1,192	1,587*	24.89%	4/10/2008	1567	2118*	26.02%
4/17/2008	1,247	1,635*	23.73%	4/17/2008	1702	2252*	24.42%
5/8/2008	1,187	1,622*	26.82%	5/8/2008	1405	2300*	38.91%
5/22/2008	1,425	1,595*	10.66%	5/22/2008	1558	2137*	27.09%
5/29/2008	1,482	1,520*	2.50%	5/29/2008	1957	2085*	6.14%
6/5/2008	1,230	1,460*	15.75%	6/5/2008	1232	1263*	2.45%
6/12/2008	1,417	1,463*	3.14%	6/12/2008	1590	2280*	30.26%
6/19/2008	1,068	1,622*	34.16%	6/19/2008	922	2118*	56.47%
6/26/2008	863	1,602*	46.13%	6/26/2008	1478	2142*	31.00%
Average	1,132	1,297*	12.71%	Average	1391	1874*	25.79%

Note: * signifies an increase in numbers

Total Phosphorus Comparison with Outliers Removed

Total Phosphorus (mg/L)							
Green Valley Dairy				Suring Community Dairy			
Date	Influent	Effluent	Change	Date	Influent	Effluent	% Change
8/13/2007	320	160	50.00%	8/13/2007	320	240	25.00%
8/28/2007	310	208	32.90%	8/28/2007	340	393*	13.49%
9/11/2007	270	180	33.33%	9/11/2007	385	232	39.74%
9/25/2007	225	290*	22.41%	9/25/2007	340	315	7.35%
10/9/2007	225	190	15.56%	10/9/2007	335	240	28.36%
10/23/2007	333	205	38.44%	10/23/2007	415	425*	2.35%
11/6/2007	400	265	33.75%	11/6/2007	365	405	9.88%
11/20/2007	420	340	19.05%	11/20/2007	540	305	43.52%
12/4/2007	590	525	11.02%	12/4/2007	910	470	48.35%
12/18/2007	370	325	12.16%	1/3/2008	585	367	37.26%
1/3/2008	450	388	13.78%	1/17/2008	393	350	10.94%
1/17/2008	487	393	19.30%	2/13/2008	547	505	7.68%
2/13/2008	587	400	31.86%	3/13/2008	440	448*	1.79%
2/27/2008	413	415*	0.48%	3/27/2008	607	390	35.75%
4/3/2008	493	400	18.86%	4/3/2008	525	415	20.95%
4/10/2008	460	385	16.30%	4/10/2008	473	390	17.55%
4/17/2008	373	375*	0.53%	4/17/2008	560	760*	26.32%
5/8/2008	433	350	19.17%	5/8/2008	453	345	23.84%
5/22/2008	260	250	3.85%	5/22/2008	380	320	15.79%
5/29/2008	313	340*	7.94%	5/29/2008	460	395	14.13%
6/5/2008	293	260	11.26%	6/5/2008	160	315	49.21%
6/12/2008	305	253	17.05%	6/12/2008	547	405	25.96%
6/19/2008	313	253	19.17%	6/19/2008	205	420*	51.19%
6/26/2008	460	280	39.13%	6/26/2008	453	405	10.60%
Average	379	310	18.38%	Average:	447	386	13.81%

Note: * signifies an increase in numbers

Dissolved Phosphorus Comparison with Outliers Removed

Dissolved Phosphorus (mg/L)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	81	109*	25.69%	8/13/2007	206	126	38.83
8/28/2007	108	120*	10.00%	8/28/2007	148	120	18.92
9/11/2007	245	144	41.22%	9/11/2007	211	149	29.38
9/25/2007	153	187*	18.18%	9/25/2007	183	174	4.92
10/9/2007	173	164	5.20%	10/9/2007	199	174	12.56
10/23/2007	301	191	36.54%	10/23/2007	248	200	19.35
11/6/2007	322	269	16.46%	11/6/2007	214	275*	22.18
11/20/2007	271	224	17.34%	11/20/2007	289	189	34.60
12/4/2007	240	228	5.00%	12/4/2007	281	206	26.69
12/18/2007	268	204	23.88%	1/3/2008	336	230	31.55
1/3/2008	250	192	23.20%	1/17/2008	257	243	5.45
1/17/2008	267	221	17.23%	2/13/2008	403	255	36.72
2/13/2008	275	181	34.18%	3/13/2008	286	270	5.59
2/27/2008	306	224	26.80%	3/27/2008	247	257*	3.89
4/3/2008	273	191	30.04%	4/3/2008	264	260	1.52
4/10/2008	193	169	12.44%	4/10/2008	214	226*	5.31
4/17/2008	239	177	25.94%	4/17/2008	206	227*	9.25
5/8/2008	232	188	18.97%	5/8/2008	264	175	33.71
5/22/2008	221	223*	0.90%	5/22/2008	241	214	11.20
5/29/2008	199	165	17.09%	5/29/2008	202	192	4.95
6/5/2008	170	151	11.18%	6/5/2008	101	173*	41.62
6/12/2008	187	160	14.44%	6/12/2008	223	170	23.77
6/19/2008	221	170	23.08%	6/19/2008	108	212*	49.06
6/26/2008	124	174*	28.74%	6/26/2008	265	206	22.26
Average	222	184	16.79%	Average:	233	205	12.03

Note: * signifies an increase in numbers

Total Solids Comparison with Outliers Removed

Total Solids (%)							
Green Valley Dairy				Suring Community Dairy			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	5.0	2.8	44.0%	8/13/2007	7.0	4.0	42.86
8/28/2007	5.8	2.2	62.1%	8/28/2007	7.1	4.3	39.44
9/11/2007	5.9	3.6	39.0%	9/11/2007	7.6	4.1	46.05
9/25/2007	5.5	3.7	32.7%	9/25/2007	7.1	4.6	35.21
10/9/2007	5.9	4.4	25.4%	10/9/2007	8.0	4.8	40.00
10/23/2007	7.1	3.2	54.9%	10/23/2007	8.6	6.3	26.74
11/6/2007	7.7	5.3	31.2%	11/6/2007	7	5.9	15.71
11/20/2007	7.1	5.9	16.9%	11/20/2007	8	5.6	30.00
12/4/2007	7.5	5.3	29.3%	12/4/2007	7.5	6.3	16.00
12/18/2007	8.1	4.5	44.4%	1/3/2008	9	5.3	41.11
1/3/2008	8.4	6.3	25.0%	1/17/2008	6.4	5.6	12.50
1/17/2008	8	5.3	33.8%	2/13/2008	8	7.1	11.25
2/13/2008	7.8	5.8	25.6%	3/13/2008	8.2	5.6	31.71
2/27/2008	8.8	7.3	17.0%	3/27/2008	8.5	5.4	36.47
4/3/2008	8.6	5.6	34.9%	4/3/2008	7.3	5.6	23.29
4/17/2008	8.8	6.6	25.0%	4/10/2008	8	5.8	27.50
5/8/2008	8	5.9	26.3%	4/17/2008	8.7	5.6	35.63
5/22/2008	7	4.7	32.9%	5/8/2008	7.5	5.1	32.00
5/29/2008	7.4	4.9	33.8%	5/22/2008	6.9	5.2	24.64
6/5/2008	6.9	4.6	33.3%	5/29/2008	8.2	5.5	32.93
6/12/2008	7.7	4.7	39.0%	6/12/2008	8.3	5.5	33.73
6/19/2008	7.9	5	36.7%	6/26/2008	8.5	5.4	36.47
6/26/2008	6.1	5.7	6.6%	Average:	7.79	5.39	30.81
Average	7.26	4.93	32.6%				

Volatile Solids Comparison with Outliers Removed

Volatile Solids (%)							
Green Valley Dairy				Suring Community Dairy			
Date	Influent	Effluent	% Change of Total Solids	Date	Influent	Effluent	% Change of Total Solids
8/13/2007	86.3	76	50.68%	8/13/2007	84	75	48.46%
8/28/2007	78	72.3	64.84%	8/28/2007	85	87	38.01%
9/11/2007	84.5	81.7	41.00%	9/11/2007	83	76	50.53%
9/25/2007	86.7	80.7	37.38%	9/25/2007	85	78	41.14%
10/9/2007	86.3	82.3	28.88%	10/9/2007	85	79	44.64%
10/23/2007	86.8	77.6	59.71%	10/23/2007	83.6	79.4	30.42%
11/6/2007	86.8	81.4	35.45%	11/6/2007	83	77.5	21.30%
11/20/2007	86.3	83.2	19.89%	11/20/2007	84.1	78.6	34.58%
12/4/2007	87.4	82.8	33.05%	12/4/2007	84.3	80.4	19.89%
12/18/2007	86.7	76.3	51.11%	1/3/2008	84.6	77.2	46.26%
1/3/2008	86.1	80	30.31%	1/17/2008	82	76	18.90%
1/17/2008	84.9	80.6	37.11%	2/13/2008	83	74.6	20.23%
2/13/2008	84	80.2	29.00%	3/13/2008	83.3	77.9	36.13%
2/27/2008	85.3	83.6	18.70%	3/27/2008	83	77.8	40.45%
4/3/2008	84.4	81	37.51%	4/3/2008	81.1	77.6	26.60%
4/17/2008	85.2	78.4	30.99%	4/10/2008	80.5	77.1	30.56%
5/8/2008	84.5	79.1	30.96%	4/17/2008	81.9	77.1	39.40%
5/22/2008	96.1	79	44.80%	5/8/2008	80.5	74.1	37.41%
5/29/2008	83.1	78.1	37.77%	5/22/2008	81.9	76.2	29.88%
6/5/2008	84	77	38.89%	5/29/2008	80	75.5	36.70%
6/12/2008	84.4	77.5	43.95%	6/12/2008	81.1	75.9	37.98%
6/19/2008	84.2	78	41.37%	6/26/2008	79.4	72.2	42.23%
6/26/2008	82.9	79.1	10.84%	Average:	82.70	77.26	35.36%
Average	85.43	79.39	36.96%				

Volatile Fatty Acids Comparison with Outliers Removed

Volatile Fatty Acids (mg/L)							
<i>Green Valley Dairy</i>				<i>Suring Community Dairy</i>			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	1,392	252	81.90	8/13/2007	3708	948	74.43
8/28/2007	1,620	204	87.41	8/28/2007	3696	2852	22.84
9/11/2007	2,412	120	95.02	9/11/2007	5076	1884	62.88
9/25/2007	2,088	336	83.91	9/25/2007	4320	1800	58.33
10/9/2007	2,292	132	94.24	10/9/2007	4416	1044	76.36
10/23/2007	5,304	252	95.25	10/23/2007	4140	2340	43.48
11/6/2007	2,844	216	92.41	11/6/2007	3816	1860	51.26
11/20/2007	3,264	324	90.07	11/20/2007	5532	816	85.25
12/4/2007	3,000	372	87.60	12/4/2007	4896	984	79.90
12/18/2007	4,872	396	91.87	1/3/2008	4344	660	84.81
1/3/2008	3,300	408	87.64	1/17/2008	3180	312	90.19
1/17/2008	3,504	276	92.12	2/13/2008	3744	276	92.63
2/13/2008	4,320	324	92.50	3/13/2008	4860	300	93.83
2/27/2008	1,608	516	67.91	3/27/2008	4992	108	97.84
4/3/2008	5,376	192	96.43	4/3/2008	4416	1128	74.46
4/10/2008	2,640	900	65.91	4/10/2008	3912	1140	70.86
4/17/2008	4,752	2,316	51.26	4/17/2008	5700	1116	80.42
5/8/2008	4,476	1,416	68.36	5/8/2008	4152	936	77.46
5/22/2008	4,356	312	92.84	5/22/2008	4620	756	83.64
5/29/2008	3,684	432	88.27	5/29/2008	4152	996	76.01
6/5/2008	3,204	720	77.53	6/5/2008	3480	1104	68.28
6/12/2008	3,360	396	88.21	6/12/2008	4200	1272	69.71
6/19/2008	3,192	552	82.71	6/19/2008	2100	1620	22.86
6/26/2008	4,008	636	84.13	6/26/2008	2544	1404	44.81
Average	3,370	500	85.16	Average:	4167	1152	72.34

pH Comparison with Outliers Removed

pH							
Green Valley Dairy				Suring Community Dairy			
Date	Influent	Effluent	% Change	Date	Influent	Effluent	% Change
8/13/2007	8.1	7.7	4.94	8/13/2007	7.1	7.9	10.13
8/28/2007	8.1	7.5	7.41	8/28/2007	7.0	7.6	7.89
9/11/2007	8.1	7.4	8.64	9/11/2007	7.1	7.7	7.79
9/25/2007	7.3	7.5	2.67	9/25/2007	7.1	7.6	6.58
10/9/2007	7.5	7.6	1.32	10/9/2007	7.0	7.8	10.26
10/23/2007	7.5	7.5	0.00	10/23/2007	6.9	7.7	10.39
11/6/2007	7.8	7.6	2.56	11/6/2007	7.5	7.7	2.60
11/20/2007	7.8	7.6	2.56	11/20/2007	6.9	7.8	11.54
12/4/2007	7.8	7.7	1.28	12/4/2007	7.6	7.8	2.56
12/18/2007	8.0	7.7	3.75	1/3/2008	8.2	7.9	3.66
1/3/2008	8.0	7.8	2.50	1/17/2008	7.9	8	1.25
1/17/2008	7.5	7.7	2.60	2/13/2008	7.9	8	1.25
2/13/2008	8.1	7.8	3.70	3/13/2008	7.9	7.8	1.27
2/27/2008	8.0	7.8	2.50	3/27/2008	8	7.9	1.25
4/3/2008	7.6	7.9	3.80	4/3/2008	8	8	0.00
4/10/2008	7.8	7.7	1.28	4/10/2008	8	7.9	1.25
4/17/2008	7.6	7.7	1.30	4/17/2008	7.9	7.9	0.00
5/8/2008	7.7	7.7	0.00	5/8/2008	7.8	7.8	0.00
5/22/2008	7.8	7.8	0.00	5/22/2008	7.8	7.8	0.00
5/29/2008	7.9	7.8	1.27	5/29/2008	7.9	7.8	1.27
6/5/2008	7.5	7.7	2.60	6/5/2008	8	7.7	3.75
6/12/2008	7.5	7.7	2.60	6/12/2008	7.4	7.7	3.90
6/19/2008	7.5	7.7	2.60	6/19/2008	7.3	7.6	3.95
6/26/2008	7.1	7.7	7.79	6/26/2008	7.2	7.8	7.69
Average	7.73	7.68	0.67	Average:	7.56	7.80	3.10

APPENDIX C

RECORDED DIGESTER OPERATING TEMPERATURES

Green Valley Recorded Digester Temperatures.

Date	Green Valley	
	Digester 1 Celsius	Digester 2 Celsius
8/13/2007	38.5	35.5
8/28/2007	37.6	39.0
9/11/2007	41.1	39.2
9/25/2007	39.1	36.0
10/9/2007	38.6	38.9
11/6/2007	39.2	34.2
11/20/2007	38.1	34.8
12/4/2007	36.1	35.0
12/18/2007	37.8	37.8
1/3/2008	38.2	39.5
1/17/2008	39.4	40.4
1/31/2008	38.3	36.1
3/27/2008	38.3	40.0
4/3/2008	39.3	38.9
4/10/2008	38.3	40.6
4/17/2008	40.3	41.1
Average	38.6	37.9

Recorded Digester Temperatures at Suring Community Dairy

Date	Celsius
8/28/2008	37.5
9/11/2007	39.2
9/25/2007	38
10/9/2007	39.4
10/23/2007	37.2
11/6/2007	35.1
11/20/2007	37.1
12/4/2007	34
1/3/2008	36.7
1/17/2008	35.8
2/13/2008	34.9
2/27/2008	36.6
3/13/2008	35.6
3/27/2008	34.5
4/3/2008	33.1
4/10/2008	32.8
4/17/2008	32.2
5/8/2008	32.1
5/22/2008	33.3
5/29/2008	32.7
6/5/2008	31.5
6/12/2008	30.4
6/26/2008	32.1
Average	34.9

APPENDIX D

BIOGAS CONSUMPTION, ELECTRICITY GENERATION, AND ENGINE HOURS

Green Valley Dairy Gas Consumption, Electricity Production, and Engine Hours.

<i>Green Valley</i>											
Date	Gas Consumption on Date		Gas Recorded on Date		Engine Hours	Hours Run Between Samples	Time Between Samples (hours)	Total Gas Production During Sample Period		Total Engine Hours	Total Electricity Produced During Sample Period
8/13/2007	184	ft ³ /min	32,461,000	ft ³	37,943			77,075,000	ft ³	5,593	2,771,743 kWh
8/28/2007	205	ft ³ /min	36,835,000	ft ³	38,273	330	336				
9/11/2007	170	ft ³ /min	40,498,000	ft ³	38,606	333	336				
9/25/2007	197	ft ³ /min	44,079,000	ft ³	38,937	331	336				
10/9/2007	190	ft ³ /min	47,853,000	ft ³	39,270	334	336				
10/23/2007	183	ft ³ /min	51,685,000	ft ³	39,605	335	336				
11/6/2007	197	ft ³ /min	55,529,000	ft ³	39,930	325	336				
11/20/2007	197	ft ³ /min	59,459,000	ft ³	40,266	336	336				
12/4/2007	296	ft ³ /min	63,155,000	ft ³	40,581	315	336				
12/18/2007	219	ft ³ /min	67,192,000	ft ³	40,916	335	336				
1/3/2008	219	ft ³ /min	71,793,000	ft ³	41,298	382	382				
1/17/2008	315	ft ³ /min	76,484,000	ft ³	41,632	334	336				
1/31/2008		ft ³ /min	*	ft ³			336				
2/13/2008		ft ³ /min	*	ft ³			336				
2/27/2008		ft ³ /min	*	ft ³			336				
3/13/2008		ft ³ /min	*	ft ³			336				
3/27/2008	133	ft ³ /min	91,353,000	ft ³	41,768	136	336				
4/3/2008	141	ft ³ /min	92,761,000	ft ³	41,936	167	168				
4/10/2008	157	ft ³ /min	94,206,000	ft ³	42,096	161	168				
4/17/2008	207	ft ³ /min	95,766,000	ft ³	42,245	149	168				
5/8/2008	181	ft ³ /min	100,256,000	ft ³	42,630	385	336				
5/22/2008	144	ft ³ /min	103,265,000	ft ³	42,955	325	336				
5/29/2008	116	ft ³ /min	104,739,000	ft ³	43,122	166	168				
6/5/2008		ft ³ /min	105,988,000	ft ³	43,284	162	168				

6/12/2008	129	ft ³ /min	106,800,000	ft ³	43,300	16	168	
6/19/2008	221	ft ³ /min	108,138,000	ft ³	43,386	86	168	
6/26/2008	230	ft ³ /min	109,536,000	ft ³	43,535	149	168	
Engine hours for 8/14 are an estimate using the average number of hours run in two weeks.								

Suring Community Dairy Electricity Production, Gas Consumption, and Engine Hours.

<i>Suring</i>														
Date	Cumulative Electricity Recorded on Date		Electricity Produced Between Samples		Gas Consumption Recorded on Date		Gas Consumption in ft ³ /min		Engine Hours	Hours Run Between Samples	Time Between Samples (hours)	Total Electricity Produced		Total Engine Hours
8/13/2007	1,914,540	kWh	N/A	kWh	64	m ³ /hr	37.65	ft ³ /min	11,330	0	0	767,180 kWh		4,098
8/28/2007	1,948,929	kWh	34,389	kWh	64	m ³ /hr	37.65	ft ³ /min	11,504	174	336			
9/11/2007	1,990,573	kWh	41,644	kWh	90	m ³ /hr	52.95	ft ³ /min	11,703	199	336			
9/25/2007	2,032,894	kWh	42,321	kWh	85	m ³ /hr	50.01	ft ³ /min	11,898	195	336			
10/9/2007	2,076,322	kWh	43,428	kWh	87	m ³ /hr	51.19	ft ³ /min	12,098	200	336			
10/23/2007	2,115,777	kWh	39,455	kWh	92	m ³ /hr	54.13	ft ³ /min	12,170	72	336			
11/6/2007	2,151,698	kWh	35,921	kWh	104	m ³ /hr	61.19	ft ³ /min	12,459	289	336			
11/20/2007	2,192,209	kWh	40,511	kWh	107	m ³ /hr	62.95	ft ³ /min	12,677	218	336			
12/4/2007	2,233,581	kWh	41,372	kWh	82	m ³ /hr	48.24	ft ³ /min	12,897	220	336			
12/18/2007						m ³ /hr		ft ³ /min						
1/3/2008	2,251,819	kWh	18,238	kWh	102	m ³ /hr	60.01	ft ³ /min	13,089	192	820			
1/17/2008	2,285,298	kWh	33,479	kWh	121	m ³ /hr	71.19	ft ³ /min	13,254	165	336			
1/31/2008	2,319,123	kWh	33,825	kWh	99	m ³ /hr	58.25	ft ³ /min	13,423	169	336			
2/13/2008	2,357,154	kWh	38,031	kWh	136	m ³ /hr	80.01	ft ³ /min	13,610	187	312			
2/27/2008	2,401,135	kWh	43,981	kWh	102	m ³ /hr	60.01	ft ³ /min	13,848	238	360			
3/13/2008	2,436,491	kWh	35,356	kWh	137	m ³ /hr	80.60	ft ³ /min	14,065	217	336			
3/27/2008	2,463,553	kWh	27,062	kWh	91	m ³ /hr	53.538	ft ³ /min	14,213	148	336			
4/3/2008	2,484,138	kWh	20,585	kWh	94.68	m ³ /hr	55.703	ft ³ /min	14,331	118	168			
4/10/2008	2,504,352	kWh	20,214	kWh	77	m ³ /hr	45.302	ft ³ /min	14,448	117	168			
4/17/2008	2,521,748	kWh	17,396	kWh	85	m ³ /hr	50.008	ft ³ /min	14,552	104	168			
5/8/2008	2,573,908	kWh	52,160	kWh	74	m ³ /hr	43.537	ft ³ /min	14,836	284	336			
5/22/2008	2,609,847	kWh	35,939	kWh	76	m ³ /hr	44.713	ft ³ /min	14,855	19	336			
5/29/2008	2,626,979	kWh	17,132	kWh	49	m ³ /hr	28.828	ft ³ /min	15,122	267	168			

6/5/2008	2,644,586	kWh	17,607	kWh	43		25.298	ft ³ /min	15,165	43	168
6/12/2008		kWh		kWh				ft ³ /min			168
6/19/2008		kWh		kWh				ft ³ /min			168
6/26/2008	2,681,720	kWh	37,134	kWh	52		30.593	ft ³ /min	15,428	263	168