REPORT OF RESULTS
Grease Cap Reduction Trial
Beef Packing Plant

1. Summary

The purpose of this report is to present the results of a field trial of the effectiveness of biological treatment of an anaerobic lagoon grease cap augmented by EcoZyme™ Bio-organic Catalyst (BOC) product manufactured by Neozyme International, Inc. Worldwide Environmental Technologies Corporation (Wheaton, IL) developed the treatment process, utilizing indigenous microorganisms from the activated sludge in an on-site wastewater treatment plant along with the ECO-ZYME™ product, nutrients, and air. This report discusses the existing conditions at the plant, the experimental design of the trial, operation of the trial, and results. Significant results include:

- Reductions in grease cap volume of 66.6%,
- Short reaction time of 14 days,
- Remaining grease cap mass is significantly more liquid, and most is pumpable,
- Results achieved *in situ* without major increases in organic loading of underlying water.

2. Existing Conditions

The subject facility (owner and location withheld by request) is a beef slaughter and hide tanning plant with a capacity of about 3,000 head per day. The wastewater treatment facility (see Figure 1) receives an average of 2.26 MGD of wastewater at an average of about 2,900 mg/L BOD_5. The waste water treatment facility utilizes two, 7 million-gallon, primary anaerobic treatment lagoons, each with surface dimensions of 300 feet by 300 feet. The primary lagoons achieve an average of 80% BOD_5 removal, and have a solid grease cap estimated to average five feet in depth. The floating cap is more solid and deeper near the inlet pipes and thinner near the outlets. The grease cap has an Oil & Grease (FOG) content ranging between 21.2% (212,000 ppm) up to 40.7% (407,000 ppm). Total Solids vary between 52.2% and 59.0%. An odor control system utilizing a chlorine-based reagent is now in operation. This system sprays the reagent through a system of fogging nozzles across the surface of the primary anaerobic lagoons.

Water from the primary anaerobic lagoons flows to a mixed anoxic basin followed by an activated sludge type treatment process and chlorine contact before discharge to a river under an NPDES Permit. The treatment facility includes two identical aeration basins that utilize fine-bubble air diffusers. Sludge is returned to the anoxic basin or wasted to facultative settling ponds for stabilization prior to land application. An additional waste water flow of about 2.0 MGD from the tannery wastewater pre-treatment system and supernatant from the sludge settling ponds also enters the treatment plant at the anoxic basin (tannery waste water does not enter the primary anaerobic lagoons). The tannery waste water first passes through a bar screen, flow equalization basins and primary settling tank before discharging to the anoxic basin. Thickened tannery sludge is dewatered in belt filter presses for land application.

3. Trial Objective and Design

The purpose of the Trial was to demonstrate the magnitude of the reduction in total volume of the grease cap that could be achieved using this process, and tile extent to which tile remaining mass could be liquefied. The trial was designed to simulate a treatment that would take place *in situ,* that is, without moving the grease cap mass out of tile anaerobic lagoons. The treatment process was developed based upon successful applications of tile BOC technology in the removal of grease caps in wastewater lift stations and in anaerobic digesters at municipal waste water treatment plants. An additional objective of tile Trial was to determine if solubilization of the grease cap by the treatment would increase tile BOD_5 in the underlying water in the lagoon.

ECO-ZYME™ has demonstrated tile ability to solubilize grease caps and accelerate the microbial breakdown of tile oil and grease components. Typical bovine fat consists of a number of saturated fatty acids (myristic, palmitic, stearic and others) and unsaturated fatty acids (principally oleic and linoleic) all in the form of a glyceride. The fat is hydrolyzed by the BOC yielding fatty acids and glycerol, which are further broken down in a stepwise fashion into lower molecular weight compounds. These compounds become more liquid and miscible with water, and are presented to tile microbial flora in a more easily digestible form, thereby accelerating the microbial digestion (assuming the presence of adequate amounts of nutrients and oxygen).

The treatment took place in a 275-gallon (1,041 L) plastic tank supplied by the owner placed inside a building adjacent to the anaerobic lagoons. One 4-inch and two 1 ½ inch circular openings in the top of the tank was used to apply the treatment, mix and install the air lance (see Figure 2). A sample of the grease cap was placed into the tank, and then anaerobic lagoon effluent water was pumped into the tank until the levels reached the 220-gallon mark (29 inches above the base). The measured initial quantities are listed below.

Grease Cap Depth:	16 in. (41 cm)
Grease Cap Volume:	140 gal. (530 L)
Water Depth:	13 in. (33 cm)
Water Volume:	114 gal. (431 L)

The grease cap sample was taken by shovel from the surface of the West lagoon at one location. The water sample was taken from the discharge of the anaerobic lagoon effluent pump.

4. Trial Operation

After taking baseline samples of tile grease cap and water (using a small, submersible pump), one gallon of activated sludge from the treatment plant was distributed across the surface of the grease cap to assure an adequate starting bacterial population because the chlorine-based reagent in odor control system may have significantly reduced bacterial populations in the grease cap. The treatment also included the addition of the ECO-ZYME™ BOC product, nutrients, and dilution water. The BOC and nutrients were mixed with the dilution water and sprayed over the surface of the grease cap with a hand sprayer, then mixed into the grease cap mass using the air lance or pipe probe. The amounts and timing of the treatment are shown below.

Day	BOC (ml)	Nutrients* (g)	Dilution Water (L)
1	652	0	14
2	326	25	7
3	326	25	7
4	326	25	7
5	0	0	0
6	0	0	0
7	326	25	7
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
Totals	**1956**	**100**	**42**

The BOC amount was established to be about 3,700 parts per million by volume of the grease cap sample (a total of 1,956 ml). The BOC was applied in a mixture with dilution water and nutrients over several days as shown. In addition, the tank received air through a horizontal air lance that bubbled air at 20 standard cubic feet per hour (SCFH) through the grease cap mass.

After the baseline samples were taken, additional samples of the grease cap and water were taken at 24-hour intervals for the first three to four days after the start of treatment. Additional samples were taken at seven and fourteen days after starting the treatment. The owner's on-site laboratory analyzed all samples. The grease cap samples were analyzed for %Total Solids, % Moisture, and % Oil &. Grease. The water samples were analyzed for these same constituents plus BOD_5 and Total Suspended Solids (TSS). In addition, the thickness of the grease cap was measured during the first several days after the treatment started and again after fourteen days. Measurements were taken by using a probe to feel the resistance of the bottom of the grease cap mass. Observations of grease cap liquidity were also recorded at the time the depth measurements and lab samples were taken.

5. Results

The laboratory results along with the grease cap depth measurements are shown on the attached table. The following are the key results.

a. Grease Cap Reduction

The treatment accomplished significant reductions in the volume of the grease cap. Figure 3 shows the percent reduction from the starting depth over the 14-day treatment period. The total reduction was 66.6%. It should also be noted that the reduction appears to show a continuing downward trend. These trends indicate that more reduction may be possible over a longer treatment period with the BOC product. The treatment also significantly reduced the mass of Oil & Grease compounds. By combining the grease cap volume reduction with the %Oil & Grease laboratory results (wt. %), total reductions of the mass of Oil & Grease can be calculated. Total mass reduction of 71% is indicated by the data.

b. Grease Cap Liquefaction

The remaining grease cap mass was significantly more liquid at the end of the treatment period. Observations of the liquidity during grease cap sampling indicate a much more liquid, pumpable mass. Samples taken in the first three to four days could be successfully obtained by coring with a sampling tube, and retained the cylindrical shape in the sample jars. At seven days, the coring method of sampling the grease cap case was no longer possible because the mass was too liquid. The laboratory data shows generally increasing % Moisture and decreasing %Total Solids over the treatment period, but these changes do not completely explain the extent of liquefaction. It is likely that as the grease cap was reduced, the remaining Oil & Grease became more liquid due to breakdown by the BOC into lower molecular weight "oily" compounds. These compounds would likely not volatize during the drying required to determine %Total Solids, and therefore would be counted as "solids".

c. Changes in Underlying Water

Due to sampling difficulties and laboratory methods, the results of the analysis of the underlying water are inconclusive. The laboratory data indicate a general decrease in TSS. The laboratory data also indicate a general increase in BOD_5, but the extent of the increase is unclear due to many samples being reported as "Greater Than". The laboratory reported that these samples were *out* of the expected range and therefore not sufficiently diluted. The data are characterized by considerable variations up and down during the treatment period. These variations are likely due to sampling error brought about by the use of the submersible pump. The pump inlet would often be "blinded" after pushing through the grease cap, requiring it to be pulled up, or shaken in the tank to get sufficient flow for the samples. These actions disturbed the solids in the grease cap mass and settled solids, putting more solids in suspension in the sampled water than would exist in the undisturbed tank.

Although inconclusive as to the precise magnitude of changes, the data support the conclusion that biological consumption, not solubilization, was the principle mechanism in the reduction of the Oil & Grease component of the grease cap. If all of the Oil & Grease mass that was removed by the treatment had been solubilized and converted into BOD_5 in the underlying water by the BOC (i.e., no biological consumption), a BOD_5 increase of over 250,000 mg/L would have resulted.

6. Conclusions

Biological treatment augmented by the ECO-ZYME™ Bio-organic Catalyst can achieve significant volume and mass reductions of grease caps (66.6% and 71% respectively) within a relatively short time period (two weeks). The treatment can also liquefy the grease cap so that most is pumpable. This treatment can be undertaken with the grease cap in place on the surface of the anaerobic lagoon without major increases in the BOD_5 concentration of the underlying water.

It is likely that a full-scale treatment of the grease cap in the lagoons could achieve even better results than these small trials because of the following test limitations.

a. Inadequate Mixing

The ability to mix and break up large "chunks" of grease in the test tank was limited due to the small tank openings available. In the field, mechanical or other methods would be employed to break up and thoroughly mix the grease solids with the BOC, nutrients and microorganisms, resulting in faster and more complete reduction.

b. Limited Air Distribution

The small openings in the test tank also limited the ability to distribute the air adequately throughout the grease cap mass. Because the principle mechanism is biological consumption, oxygen availability may have been a limiting factor. In a full-scale application, air can be supplied in accordance with reaction kinetics calculations, and diffusers can be arranged to provide more complete distribution.

c. Static Test Tanks

The tests were conducted with a simplified, static model of the anaerobic lagoon system. In the actual lagoon there is a constant influent/effluent flow that will dilute any solubilized Oil & Grease; and anaerobic microorganisms exist that would be available to consume any additional BOD_5. It is likely that the full-scale treatment of the lagoon would take place in sections, rather than the entire lagoon at once. As such, increases in BOD_5 shown in the test tanks cannot necessarily be predicted to occur in the lagoon effluent, and would likely be much less.

FIGURE 1

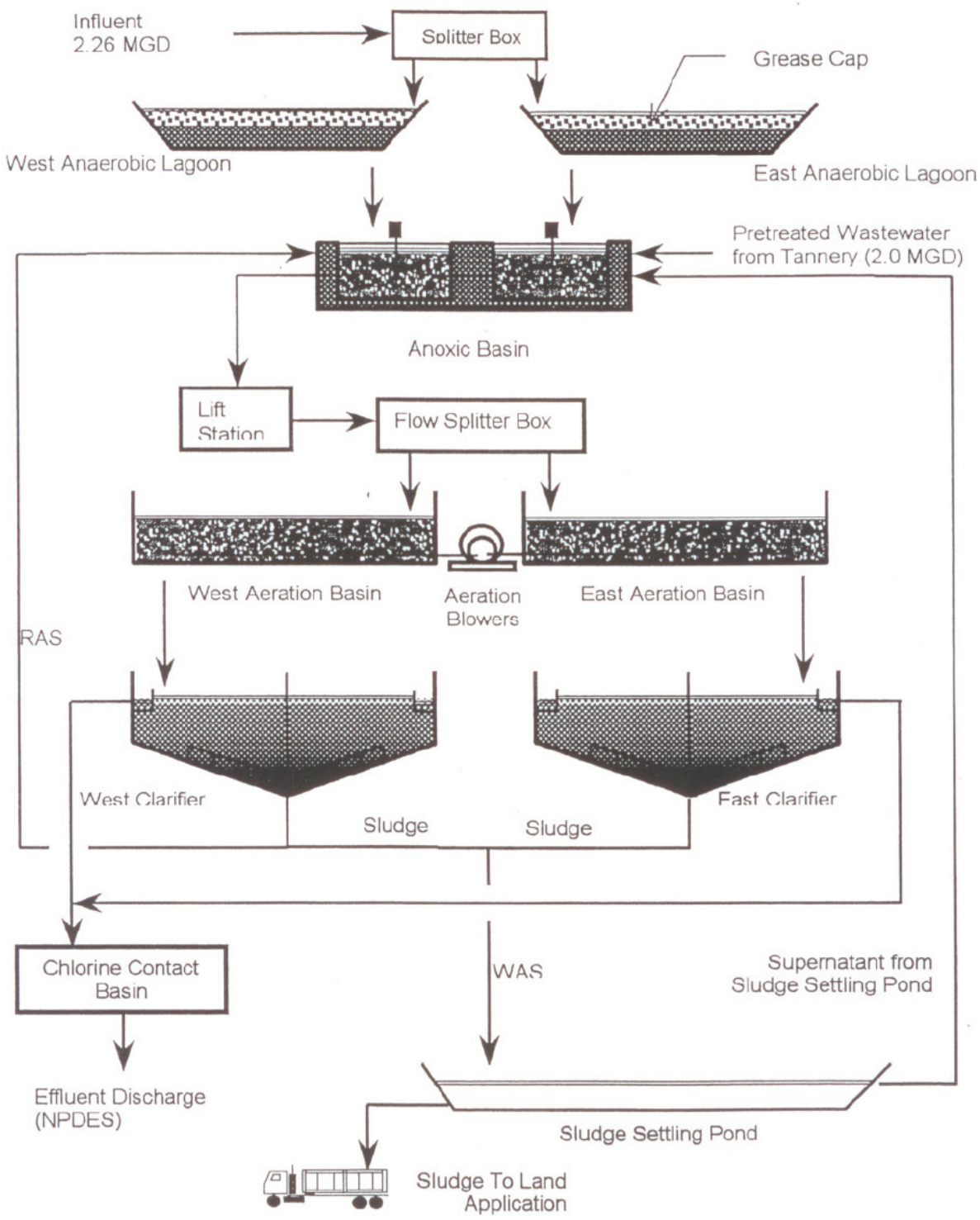
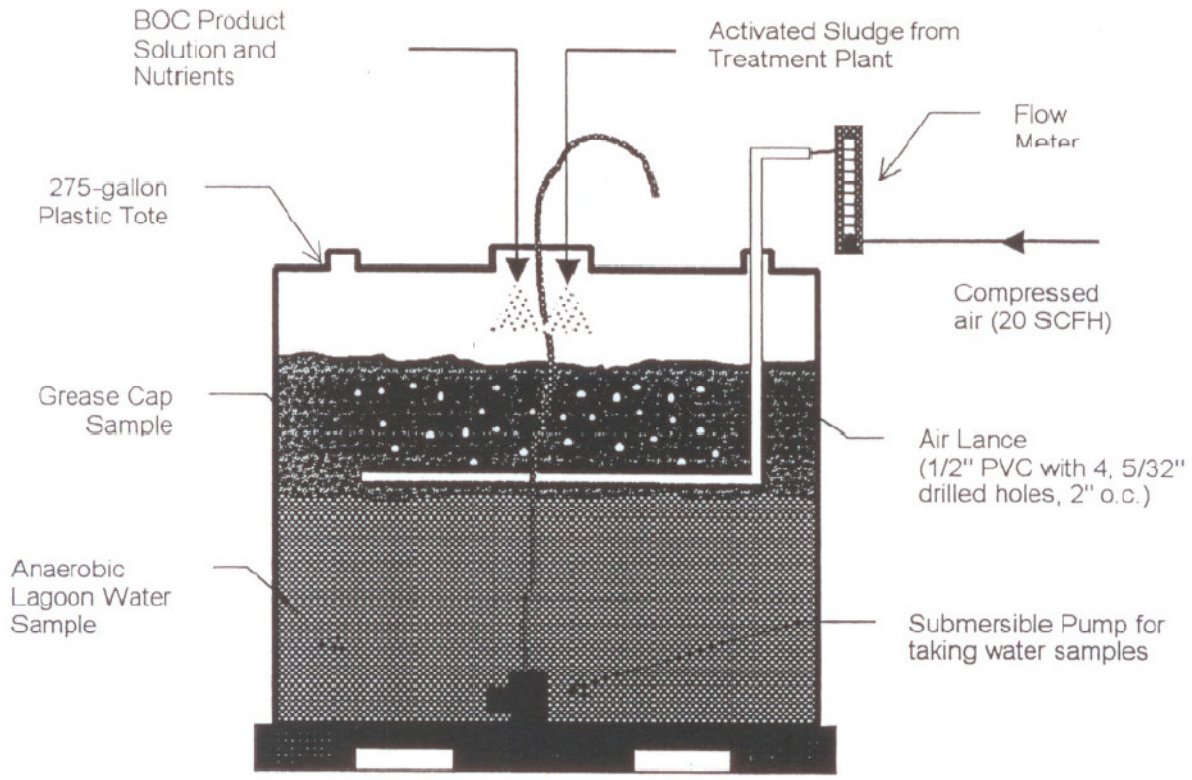


FIGURE 2



Beef Packing Plant
RESULTS OF GREASE CAP REDUCTION TRIAL
Bio-Organic Catalyst Treatment Results
Grease Cap Depth

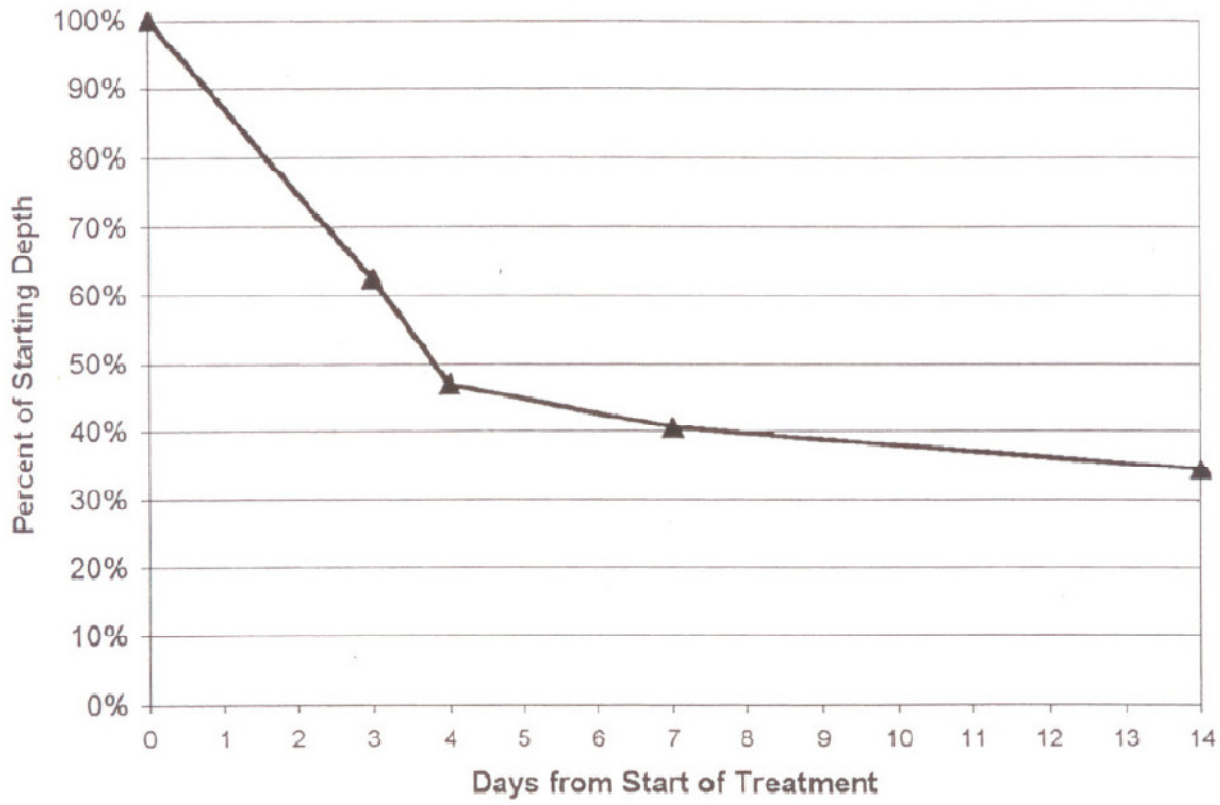


FIGURE 3

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Beef Packing Plant

Results of Grease Cap Reduction Trial

BOC Treatment (6)

Date	Days from Start	Sample Type	Total % Solids	Total % Moisture	(2) % Oil & Grease	TSS (mg/L)	BOD (mg/L)	Grease Cap Depth (inches)	% of Starting Depth	% of Starting Total Solids (5)	% of Starting Oil & Grease (5)
4/24/00 (1)	0	Grease Cap	52.2	47.8	40.7 (3)			16.0	100.0%	100.0%	100.0%
4/25/00	1	Grease Cap	52.3	47.7	31.7						
4/26/00	2	Grease Cap	49.1	50.9	32.4						
4/27/00	3	Grease Cap	43.4	56.7	29.0			10.0	62.5%	52.0%	44.5%
4/28/00	4	Grease Cap	48.4	51.6	22.7			7.5	46.9%	43.5%	26.1%
4/29/00	5	no sample									
4/30/00	6	no sample									
5/1/00	7	Grease Cap	42.0	58.0	29.5			6.5	40.6%	32.7%	29.4%
5/2/00	8	no sample									
5/3/00	9	no sample									
5/4/00	10	no sample									
5/5/00	11	no sample									
5/6/00	12	no sample									
5/7/00	13	no sample									
5/8/00	14	Grease Cap	48.3	51.7	34.2			5.5	34.4%	31.8%	28.9%
4/24/00 (1)	0	Water	0.6	99.4	0.3	3610	1100 (4)				
4/25/00	1	Water	0.4	99.6	0.1	1530	1200 (4)				
4/26/00	2	Water	0.5	99.5	0.2	2220	1200 (4)				
4/27/00	3	Water	0.5	99.5	0.4	2080	1300 (4)				
4/28/00	4	Water	0.5	99.5	0.3	2580	1300 (4)				
4/29/00	5	no sample									
4/30/00	6	no sample									
5/1/00	7	Water	0.2	99.8	0.0	530	2300				
5/2/00	8	no sample									
5/3/00	9	no sample									
5/4/00	10	no sample									
5/5/00	11	no sample									
5/6/00	12	no sample									
5/7/00	13	no sample									
5/8/00	14	Water	0.4	99.6	0.2	2100	2600				

Source: Plant Laboratory, and WETCO measurements

Notes:
(1) Samples taken prior to beginning treatment.
(2) Grease Cap data are averages of three duplicate analyses.
(3) One of three data points removed because it was more than two standard deviations from the mean.
(4) Reported as "greater than" because samples were not diluted sufficiently.
(5) Calculated as percent of starting weight of Total Solids and Oil & Grease
(6) Total of 3,700 ppmv Bio-organic Catalyst (BOC), plus activated sludge, nutrients and air.

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