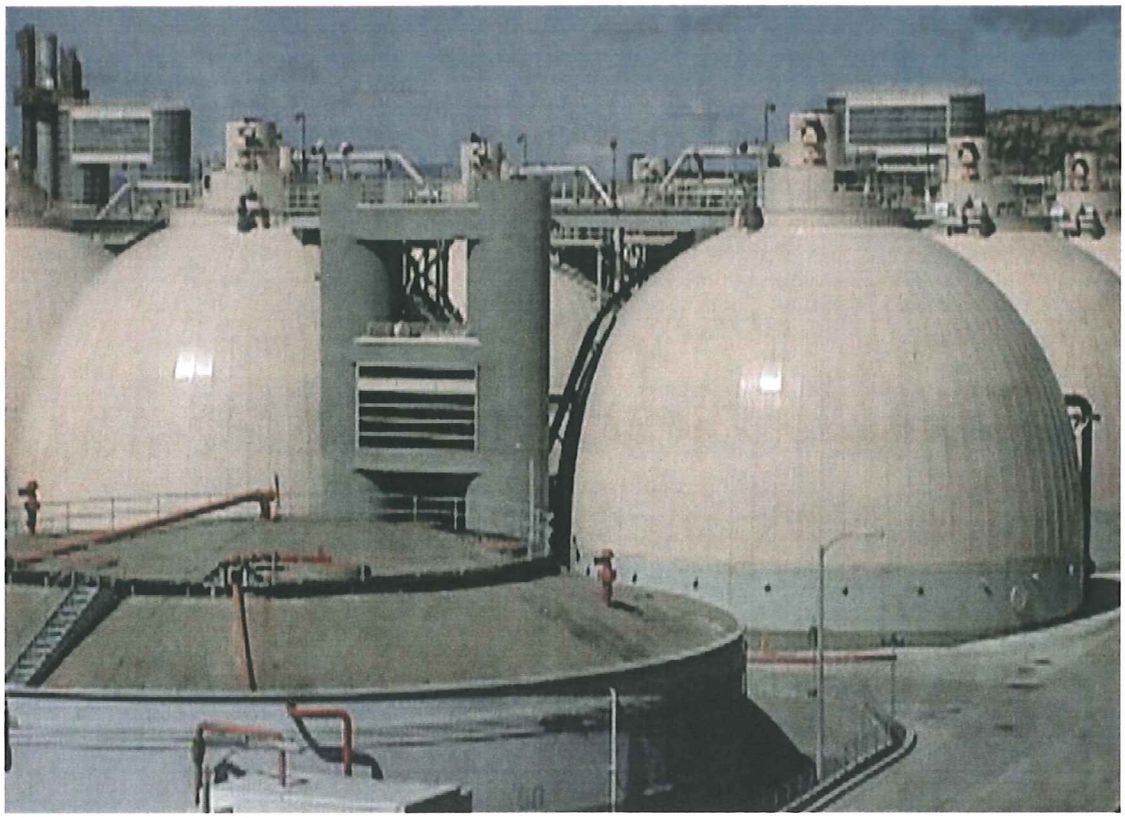
Class A Biosolids

Hyperion Treatment Plant (Phase III)



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The following individuals formed the Class A Certification Task Force and worked diligently to facilitate the operation, testing and analysis as well as review all the data and prepare this report.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Phase III testing at Hyperion Treatment Plant (HTP) (August – September, 2002), demonstrated meeting the Part 503 Alternative 3 Class A pathogen requirements in a continuous single stage process for 90% thermophilic and 10% mesophilic digestion of the plant's total feed sludge of on average 3.0 mgd primary sludge and 0.8 mgd TWAS. The Phase III process contained the following elements:

1. Approximately 90% of the sludge was digested in 15 thermophilic digesters at an average temperature of 130.0 ^{0}F (range 125.8 – 135 ^{0}F) and a mean hydraulic retention time (HRT) of approximately 10.9 days.
2. Approximately 10% of the sludge was digested in 6 mesophilic digesters at an average temperature of 95.3 ^{0}F (range 91.4 – 99.2 ^{0}F) and a mean HRT of approximately 39 days.
3. The digested sludges from mesophilic and thermophilic digesters were mixed in two blending digesters at a mean HRT of 1.3 days and an average temperature of approximately 124.5 ^{0}F (range 121.7 – 128.5 ^{0}F).

Preliminary testing in August, 2002, to determine the effectiveness of insulation of the post-digestion train at HTP, provided the following results:

1. A relatively high temperature of on average 122.7 ^{0}F in silo biosolids was maintained (compared with approximately 107 ^{0}F without insulation).
2. Fecal coliform densities in silo biosolids were below the Class A limit in all of six samples.

Full testing in September, 2002, to demonstrate compliance with Class A pathogen requirements, provided the following results:

1. The Class A limit for fecal coliforms in biosolids at the Truck Loading Facility and the farm was met in 95% (two exceedances) and 88% (one exceedance) of the samples, respectively.
2. The Class A limit for *Salmonella* sp. in farm biosolids was met in all (100%) samples.
3. Helminth ova and enteric viruses were present in primary sludge, but densities of these non-bacterial pathogens in farm biosolids were reduced to below their Class A limits.
4. The one exceedance observed for fecal coliforms in farm biosolids is not significant as an indicator of disinfection efficiency because the Phase III process achieved reduction of all pathogens in primary sludge (*Salmonella* sp., viable helminth ova, enteric viruses) to below the limits for Class A biosolids.
5. Preliminary regrowth tests indicate that the biosolids produced in the Phase III process were less susceptible to reactivation and/or growth of fecal coliforms than was observed during Phase I and Phase II tests.

These results demonstrate that the Phase III process meets the Class A pathogen requirements of Alternative 3 in the Part 503 Biosolids Rule. The results are remarkable and better than at first expected from a continuous process that operates below the target temperature of 131 ^{0}F, receives large amounts of fecal coliforms from the mesophilic digesters, and has a minimum average residence time in the digesters.

1. INTRODUCTION

During August - September, 2002, the digesters were temporarily operated in a single stage continuous process with approximately 90% of the plant's total feed sludge being digested at thermophilic temperatures. The original plan was that Phase III would be a test of a full-scale batch process that was guaranteed to meet the time/temperature requirement of Alternative 1 of 40 CFR 503. However, operational problems delayed the startup of this process. Consequently, Phase III became a full-scale test of a continuous single stage thermophilic anaerobic digestion process.

The Class A Task Force performed preliminary tests during August, 2002, to determine biosolids temperature profiles along the insulated post-digestion train and fecal coliform densities in silo biosolids. Subsequently, the September 2002 tests were conducted to determine the efficiency of disinfection of biosolids with respect to fecal coliforms, *Salmonella* sp., viable helminth ova and enteric viruses. If the Phase III process would meet the Class A pathogen requirements, compliance with the Part 503 Biosolids Rule may be demonstrated using Alternative 3.

The main objective of Phase III was to demonstrate:

1. The reduction of fecal coliforms, *Salmonella* sp., viable helminth ova and enteric viruses in a single stage continuous process employing thermophilic anaerobic digestion.
2. The compliance with Class A pathogen requirements in biosolids at the Truck Loading Facility and the farm.
3. The efficiency of insulation of the post-digestion train by determining temperature profiles and by conducting regrowth tests with biosolids from the Truck Loading Facility and the farm.

Summary of previous tests, Phases I and II: Phase I and Phase II tests were done in October/November, 2001, and February/March, 2002, respectively, with designated thermophilic digesters and a post-digestion train designated to the thermophilic digesters.

Thermophilic digestion was performed in battery D1 with six egg-shaped digesters, which were isolated from mesophilic operations at the plant. A two-stage batch process was employed according to Alternative 1 of the Part 503 Biosolids Rule, section 503.32. The first stage was continuous at a mean HRT of 13 days and an average temperature of 136.2 ^{0}F in Phase I and 135.8 ^{0}F in Phase II. The second stage batch operation (guaranteed holding of 13 hours in Phase I and 24 hours in Phase II) was at 130.0 ^{0}F in Phase I and 128.3 ^{0}F in Phase II.

The two-stage batch digestion process effectively reduced fecal coliforms and *Salmonella* sp. to below the EPA limits for Class A biosolids. *Salmonella* sp. in biosolids remained below the EPA limit of 3 MPN/4 g dry wt at all sampling locations in the post-digestion train and at the farm. Fecal coliforms in biosolids remained below the EPA limit of 1000 MPN/g dry wt at all sampling locations in the post-digestion train, except in biosolids at the Truck Loading Facility where densities of $1.1x10^4$ to $>5.5x10^5$ (Phase I) and $5.6x10^5$ to $3.0x10^6$ MPN/g dry wt (Phase II) were found. Likewise, Phase II tests demonstrated elevated densities of fecal coliforms in biosolids at the farm. Temperature profiling along the post-digestion train demonstrated a large drop of the temperature, resulting in an average biosolids temperature in the truck at the Truck Loading Facility of 107 ^{0}F (Phase I) and 106 ^{0}F (Phase II). The temperature drop occurred mainly between the centrifuge and the silo, and it was identified as a probable cause that facilitated the re-occurrence of fecal coliform in biosolids at the Truck Loading Facility and the farm.

From Phase I and Phase II testing, it was recommended to include insulation of the post-digestion train and to proceed with Phase III testing as soon as the insulation would be implemented and the plant would be in thermophilic operation.

2. MATERIALS AND METHODS

Process description: During August and September, 2002, HTP temporarily employed seventeen out of twenty egg-shaped digesters (three were out of service) for thermophilic anaerobic digestion and six conventional low digesters for mesophilic anaerobic digestion (Figure 1). The egg-shaped digesters are grouped in three independently operated batteries with six or eight digesters (Batteries D1, D2 and E, respectively). Each digester has a capacity of approximately 2.5 million gallons and an internal draft-tube mixing system. The low digesters, each also with a volume of 2.5 million gallons, are grouped in Battery C. Two digesters in Battery E were used as blending tanks for digested sludges (both mesophilic and thermophilic) before transport to screening and dewatering.

The plant's total feed sludge consisted of about 3.0 mgd of primary sludge and 0.8 mgd of thickened waste activated sludge. The ratio of sludge feeding rates to the thermophilic and the mesophilic digesters was 90:10. All digesters were operated with continuous feed and draw. The mean hydraulic retention time (HRT) in thermophilic digesters was 10.9 days and the digesters were heated by steam injection. The mean HRT in the mesophilic digesters was 39 days at an average temperature of 95 – 96 ^{0}F. After digestion, the mesophilically and thermophilically digested sludges were mixed in two blending digesters at an average HRT of 1.3 days. The blending digesters were not heated. Digester temperatures are presented in Section 3.1.

Post-digestion processing was according to the following steps. Digested sludge was first pumped from the blending tanks to the Digester Screening Facility for removal of hair, fibers, rags, grits and other impurities that may cause potential plugging problems. Screened sludge was then transported to a wetwell by gravity flow. Diluted polymer solution was injected downstream from the wetwell and mixed with digested sludge through an in-line static mixer before transport to the dewatering centrifuge. The centrifuge biosolids (= wetcake) with approximately 30% total solids was then pumped to the silos for storage at the Truck Loading Facility and loading onto the trucks. Truck loading takes place once a day from 11:00 pm to approximately 12:30 pm the next day.

Procedures: Tables 1 and 2 provide sampling schedules for Phase III August and September testing, respectively. All analyses were performed according to requirements of the Part 503 Biosolids Rule:

1. Fecal coliform: Parts 9221-B and 9221-E in "*Standard Methods for the Examination of Water and Wastewater*", 18th edition (APHA, 1992). Analysis by EMD.
2. *Salmonella* sp.: Kenner and Clark (1974). Analysis of split samples by BioVir and EMD.
3. Viable helminth ova: EPA (1987). Analysis by BioVir.
4. Enteric viruses: D 4994-89 (ASTM, 1992). Analysis by BioVir.
5. Total solids: Part 2540-G in "*Standard Methods for the Examination of Water and Wastewater*", 18th edition (APHA, 1992). Analysis by EMD.

HTP has eight silos at the Truck Loading Facility for storage of biosolids. The objective of the September 2002 sampling protocol was to sample from different silos in order to determine whether differences would exist between silos. On each sampling day, one truck at the Truck Loading Facility was designated for subsequent sampling at the farm.

Samples from primary sludge, biosolids from the truck in the Truck Loading Facility and biosolids from the farm were collected in sterile bottles and bags. Before each use, the shovel for

biosolids sampling was thoroughly disinfected with 70% ethanol and allowed to dry. Personnel used clean gloves at all sampling activities and, in addition, protective gear (overall, goggles, respirator) during sampling in the Truck Loading Facility. At each sampling event, the sample temperature was measured with a digital thermometer and an additional grab sample was taken for total solids analysis. Samples taken at HTP were immediately transported to the laboratory and they did not require preservation. Samples from the farm were stored in cooled boxes and transported to the laboratory within 5 hours. All *Salmonella* samples were split for separate analysis by Environmental Monitoring Division (EMD) at HTP and BioVir Laboratories, Benicia, CA (commercial, certified laboratory). Samples for helminth ova and enteric viruses (primary sludge, farm biosolids) were only collected during Phase III in September and were stored at required temperatures until final composition and analysis by BioVir Laboratories.

Temperature measurements: The focus of August 2002 test was on temperature measurements including the determination of profiles along the post-digestion train:

1. Temperatures in the digesters were continuously measured by two sensors located at mid-height of each digester, and subsequently transmitted to HTP Control Room (Control Room temperatures). Values reported herein (Table 3) are the average of the two sensors over one day (done during August and September, 2002).
2. Digester outflow temperatures were measured by inserting a digital temperature probe into samples from the digester outflow (herein referred to as field measurements). These were done to verify Control Room temperatures.
3. Temperature profiling along the post-digestion train was done by inserting a digital temperature probe into biosolids grab samples from centrifuges and silos, or directly by inserting the probe (mounted on a pole) in the biosolids process stream at the centrifuges and silos.

3. RESULTS AND DISCUSSION

3.1 Digester temperatures

Table 3 shows the temperatures measured in individual digesters during Phase III.

In August, 2002, the average temperature in thermophilic digesters was 130.0 ^{0}F with a range of 126 to 135 ^{0}F. Temperatures in individual digesters were relatively constant over time (maximum fluctuation of 4 ^{0}F over 4 days). No data were available on temperatures in mesophilic digesters and blending digesters.

In September, 2002, the average temperature in thermophilic digesters slightly declined from 131.4 ^{0}F on September 4, to a low of 128.1 ^{0}F on September 12, after which the average temperature increased to a maximum of 131.7 ^{0}F on September 19 (Table 3). The overall average over this period was 130.0 ^{0}F, with individual thermophilic digester temperatures in the range of 125.8 to 135 ^{0}F. The daily average temperature in mesophilic digesters was relatively constant and remained between 94.8 and 96.8^{0}F with an average of 95.3 ^{0}F. The temperature in the blending digesters was in the range of 121.7 to 128.5 ^{0}F with an overall average of 124.5^{0}F.

3.2 Fecal coliforms at Truck Loading Facility, August 2002

Table 4 demonstrates that all biosolids samples at the Truck Loading Facility contained fecal coliforms in densities of less than 690/g dry wt, with most samples having a density of less than 66 MPN/g dry wt. Sample temperatures in truck biosolids ranged from 118 to 127.3 ^{0}F with an average of 122.8 ^{0}F. It should be noted that evaporative cooling during collection of the grab samples may have caused a slight decrease of temperature.

3.3 Indicator and pathogens in primary sludge, September 2002

Densities of *Salmonella* sp. in primary sludge were on average 14.6 and 31.7 MPN/4 g dry wt as determined by EMD and BioVir Laboratories, respectively (Table 5). Fecal coliforms were not determined. Extensive sampling during Phases I and II has shown that the fecal coliform density in primary sludge is consistently in the range of $10^7 - 10^8$ MPN/g dry wt. The September 2002 tests included analyses of non-bacterial pathogens, which were both present in primary sludge. The density of helminth ova in composited samples was 1 ovum/4 g dry wt. The density of enteric viruses in composited samples was 69 PFU/4 g dry wt.

3.4 Indicator and pathogens at Truck Loading Facility, September 2002

Individual temperatures in biosolids at the Truck Loading Facility ranged from 118.5 to 129.8 ^{0}F, with an overall average temperature of 124.4 ^{0}F (Table 5).

Over 15 days of testing, 30 out of 32 samples complied with the fecal coliform Class A limit of 1000 MPN/g dry wt (Table 5). Approximately 75% of the samples contained densities at least 10 times below the limit, with 58% of the samples being at least 100 times under the limit.

3.5 Indicator and pathogens at the farm, September 2002

The average biosolids temperature at the farm was 124.7 ^{0}F with a range 120.9 to 127.1^{0}F (Table 5). Because average temperatures at the farm and the Truck Loading Facility were the same, it can be concluded that no cooling during biosolids transport occurred.

For 7 out of 8 samples (88% of the samples), the fecal coliform density in farm biosolids was less than 25 MPN/g dry wt, that is, at least 40 times less than the limit for Class A biosolids. One exceedance at the farm was observed on September 12, 2002.

Salmonella sp. densities in biosolids at the farm were always less than 1.6 MPN/4 g dry wt (Table 5). It also important to note that the split analysis by EMD and BioVir gave approximately the same results. Future *Salmonella* sp. analyses can therefore be done by EMD, but at a lower cost and faster.

Farm biosolids were collected for analysis of helminth ova and enteric viruses in composited samples by BioVir Laboratories. The density of viable helminth ova was <1 ovum/4 g dry wt and the density of enteric viruses was less than 1 PFU/4 g dry wt.

3.6 Regrowth tests, September 2002

Two regrowth tests were performed with biosolids collected from the Truck Loading Facility and the farm on September 18, 2002. Fecal coliform densities in these samples at the time of collection were less than 10 MPN/g dry wt (Figure 2). Subsequent storage of these samples at approximately 75^{0}F did not result in an increase of the fecal coliform density over a period of at least 140 hours. These results are in strong contrast to previous findings during Phases I and II where it was observed that fecal densities initially were high and increased during further storage. This may indicate that the configuration of the Phase III process in combination with insulation of the post-digestion train produces biosolids that are less susceptible to reactivation and/or growth of fecal coliforms after digestion.

4. CONCLUSIONS

The main conclusions of Phase III testing of the single stage continuous process are:

1. With the exception of two exceedances at the Truck Loading Facility and one exceedance at the farm, HTP was in compliance with the Class A requirements for fecal coliforms.
2. Farm biosolids were always in compliance with the Class A requirements for *Salmonella* sp.
3. Helminth ova and enteric viruses were present in primary sludge, but these non-bacterial pathogens were below the Class A limit in farm biosolids.
4. The one exceedance of the fecal coliform (indicator) density in farm biosolids does not appear to be related to the reduction of pathogens because all pathogens in farm biosolids were always below the Class A limits.
5. The Phase III disinfection results demonstrate compliance with the Class A limits for and pathogens in biosolids at the farm as required in all Alternatives.
6. The Phase III disinfection results demonstrate reduction of helminth ova and enteric viruses to below the Class A limits as required in Alternative 3 of the Part 503 Biosolids Rule.
7. Insulation of the post-digestion train is effective in maintaining a high temperature in biosolids, which probably contributes to preventing the regrowth of fecal coliforms in biosolids at the Truck Loading Facility and the farm.
8. Preliminary regrowth tests indicate that the biosolids produced in the Phase III process are less susceptible to reactivation and/or growth of fecal coliforms than was observed during Phase I and Phase II tests.

These results are remarkable and better than at first expected from a continuous process that operates a few degrees below the target temperature of 131^0F, receives large amounts of fecal coliforms from the first stage mesophilic digesters, and has a minimum average residence time in the digesters.

On a few occasions, non-compliance was observed regarding fecal coliforms in biosolids at the Truck Loading Facility and the farm. These could be related to occasions of relatively low biosolids temperatures. This may be prevented with relatively little effort by better controlling the temperature.

Conclusions regarding the August 2002 temperature studies are provided in Appendix 1, Section 6.

5. RECOMMENDATIONS

It is recommended:

1. Proceed with Phase IV and the full conversion of HTP to a two-stage batch process for thermophilic anaerobic digestion.
2. Proceed with Phase IV testing starting on October 10, 2002, and containing two weeks sampling of primary sludge and biosolids at the farm to demonstrate compliance with the Class A pathogen requirements under Alternative 1.

6. APPENDIX 1: ADDITIONAL TEMPERATURE STUDIES

Temperature studies were performed during August, 2002.

Control room temperature versus field measurements: In order to verify temperature measurements in digesters by the sensors, as well as data transmission from these sensors to the field panels and the Control Room, temperatures in digested sludge from the digester outlet were measured with a digital probe (field measurement). Table 6 presents the data obtained on August 8 and 23, 2002. Digested sludge temperatures were on average 1.5 ^{0}F (range –0.7 to 5.3 ^{0}F) lower than the temperatures recorded in the digesters by the sensors. This can possibly be attributed to cooling of digested sludge during sample collection for field measurement. Still, the observed differences are small and they indicate that the digesters are well mixed (uniform temperature) and that the temperature sensors and data transmission to the Control Room are working properly.

Centrifuge versus silo/truck wetcake temperatures: Digested sludge is continuously dewatered in four centrifuges (# 2, 4, 5 and 6; # 1 and 3 are on standby). Temperature profiles along the post-digestion train were determined on August 1 and 7, 2002, by measuring the temperature in the biosolids from each centrifuge and in the wetcake from the corresponding silos to where the biosolids were transported at the time of testing. Measurements at centrifuges and silos were done within two hours; hence, the temperatures recorded in centrifuge and silo biosolids were by approximation from the same batch.

Temperature profiles obtained on August 1, 2002, are presented in Table 7a. They demonstrate some variability in biosolids temperatures from different centrifuges, which may tentatively be attributed to evaporative cooling during sample collection and temperature measurement. The difference between centrifuge and silo biosolids temperatures was very small, which indicates that no cooling occurred after the centrifuge. It also demonstrates that insulation of the post-digestion train was very effective in maintaining a high temperature after centrifugation. Temperature profiles determined on August 7, 2002 (Table 7b), confirm these results and conclusions.

7. REFERENCES

City of Los Angeles reports:

1. Class A Biosolids; Hyperion Treatment Plant (Phase 1). April 12, 2002. City of Los Angeles, Bureaus of Sanitation and Engineering.
2. Class A Biosolids; Hyperion Treatment Plant (Phase II). June 11, 2002. City of Los Angeles, Bureaus of Sanitation and Engineering.

Analytical procedures:

1. APHA (1992). Standard methods for the examination of water and wastewater. 18th edition, American Public Health Association, Washington, D.C.
2. ASTM (1992). Standard Practice for recovery of viruses from wastewater sludges. Annual Book of ASTM Standards: Section 11 – Water and Environment Technology, ASTM, Philadelphia, PA.
3. Kenner, B.A., Clark, H.P. (1974). Detection and enumeration of *Salmonella* and *Pseudomonas aeruginosa*. J. Water Pollution Control Federation 46(9):2163-2171.
4. U.S. EPA (1987). Occurrence of pathogens in distribution and marketing municipal sludges. EPA 600/1-87-014.

ATTACHMENT 1: FIGURES AND TABLES

Figure 1. HTP Single Stage Continuous Digester Operations, August and September 2002

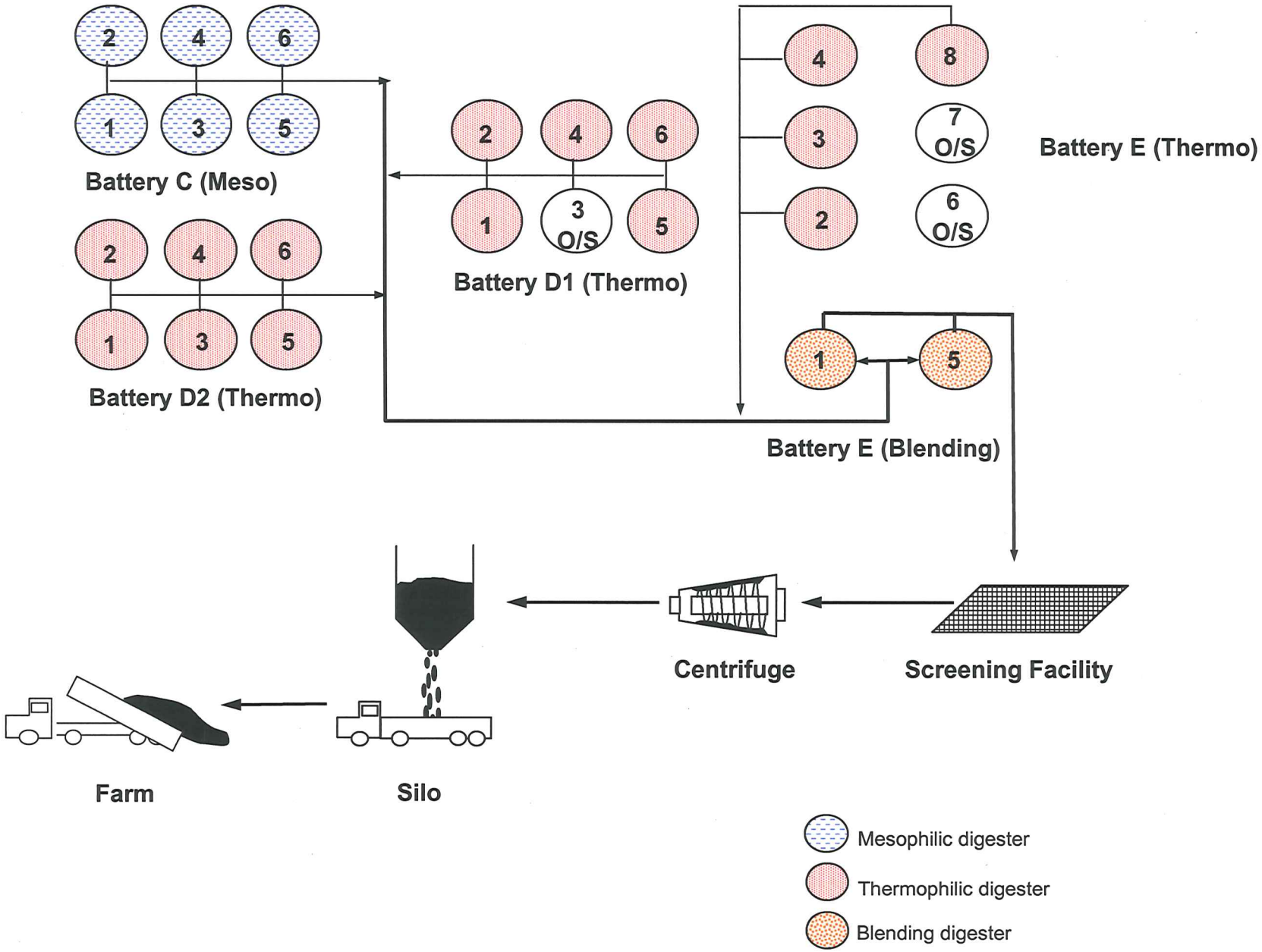

Figure 2. Fecal Coliform Regrowth Tests at 75 °F at Truck Loading Facility (Silo) and Farm, September 18, 2002

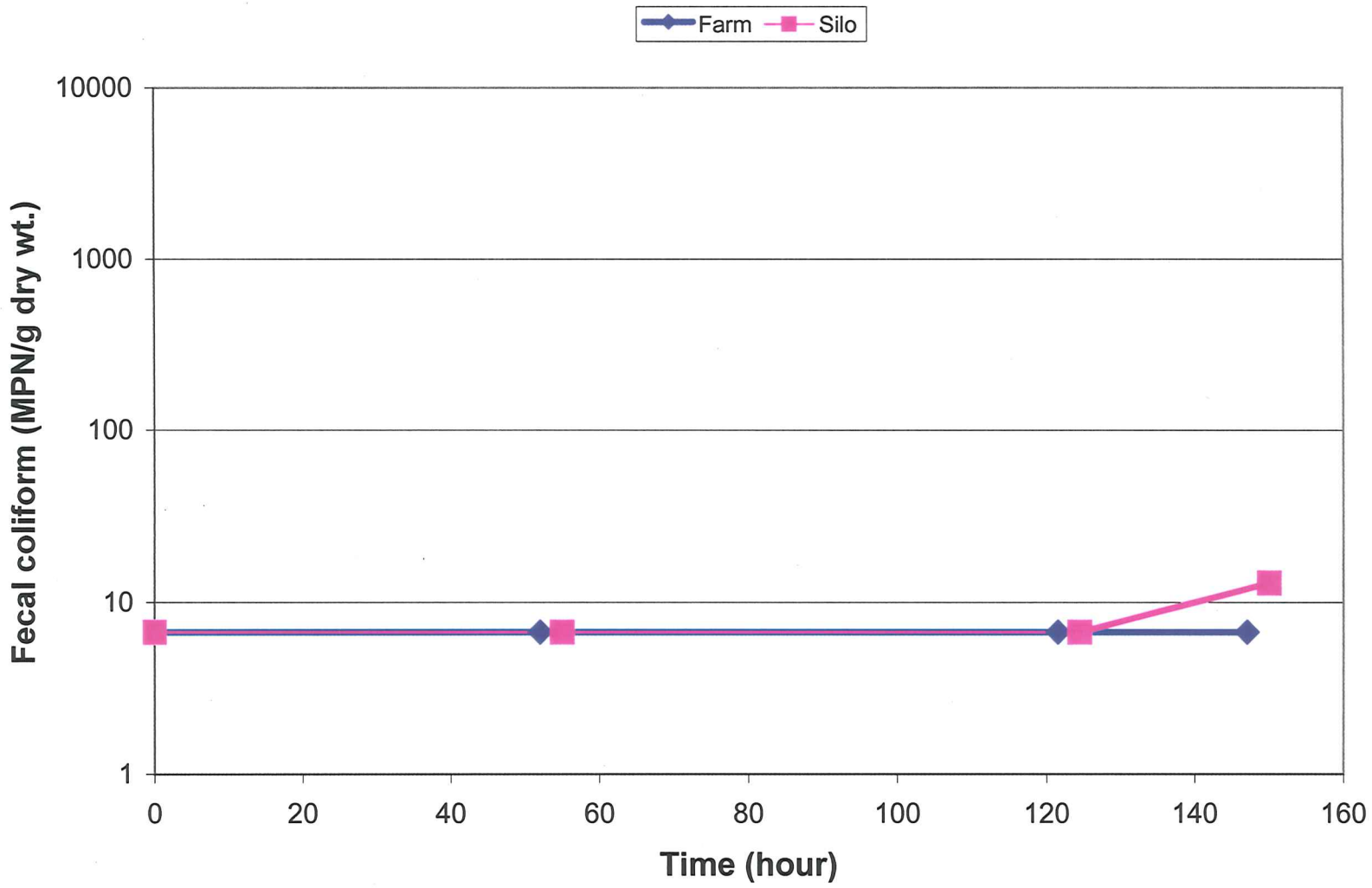

Table 1. Sampling Schedule for Fecal Coliforms, August 2002

Location	8/19 Mon	8/20 Tue	8/21 Wed	8/22 Thu	Sample Container
Silo 1	NS	S	NS	NS	Two sterile 18 oz. plastic bags
Silo 2	S	NS	NS	NS	Two sterile 18 oz. plastic bags
Silo 3	NS	NS	S	S	Two sterile 18 oz. plastic bags
Silo 4	NS	NS	NS	NS	Two sterile 18 oz. plastic bags
Silo 5	NS	S	NS	NS	Two sterile 18 oz. plastic bags
Silo 6	NS	NS	NS	S	Two sterile 18 oz. plastic bags
Silo 7	S	NS	NS	NS	Two sterile 18 oz. plastic bags
Silo 8	NS	NS	NS	NS	Two sterile 18 oz. plastic bags

S = Sample to be collected; NS = No Sample to be collected

2 samples will be collected each day for fecal coliform and total solid analysis

Table 2. Sampling Schedule for Indicators and Pathogens, September 2002

						Week1		Week2				Week3				Sample Containers
Sample Type	Sample	Analysis	Lab	Sampling Time	Sampling Party	9/4 Wed	9/5 Thu	9/9 Mon	9/10 Tue	9/11 Wed	9/12 Thu	9/16 Mon	9/17 Tue	9/18 Wed	9/19 Thu	
Raw Sludge	Primary Sludge	Total solids	EMD	7:00 AM	HTP / Digester	S	S	S	S	S	S	NS	NS	NS	NS	One 500 ml plastic bottle
		Salmonella	EMD/BioVir	7:00 AM		[2]S	[2]S	[2]S	[2]S	[2]S	[2]S	NS	NS	NS	NS	Two 1 L plastic bottles
		Helminth Ova	BioVir	7:00 AM		NS	NS	S	S	S	S	S	S	S	S	One sterile 500 ml plastic bottle
		Enteric Virus	BioVir	7:00 AM		NS	NS	S	S	S	S	S	S	S	S	One sterile 500 ml plastic bottle
Wet Cake	[1]Silo (truck at plant) #1,3,5,7	Total solids	EMD	4:30 AM	WESD / Applied Research HTP / Dewatering	S	NS	S	NS	S	NS	S	NS	S	NS	Four 500 ml plastic bottles (one for each silo)
		Fecal Coliform	EMD	4:30 AM		S	NS	S	NS	S	NS	S	NS	S	NS	Four sterile 18 oz. plastic bags (one for each silo)
	[1]Silo (truck at plant) #2,4,6,8	Total solids	EMD	4:30 AM		NS	S	NS	S	NS	S	NS	S	NS	S	Four 500 ml plastic bottles (one for each silo)
		Fecal Coliform	EMD	4:30 AM		NS	S	NS	S	NS	S	NS	S	NS	S	Four sterile 18 oz. plastic bags (one for each silo)
	[3]Farm	Fecal Coliform	EMD	7:00 AM	WESD / Applied Research	S	S	S	S	S	S	S	S	S	S	One sterile 18 oz. plastic bag
		Salmonella	EMD/BioVir	7:00 AM		NS	NS	[2]S	[2]S	[2]S	[2]S	[2]S	[2]S	[2]S	[2]S	Two 1 L plastic bottles
		Helminth Ova	BioVir	7:00 AM		NS	NS	S	S	S	S	S	S	S	NS	One sterile 500 ml plastic bottle
		Enteric Virus	BioVir	7:00 AM		NS	NS	S	S	S	S	S	S	S	NS	One sterile 500 ml plastic bottle

S = Sample to be collected; NS = No Sample to be collected

[1] Samples will be collected from odd number silos on Monday and Wednesday and even number silos on Tuesday and Thursday.

[2] Duplicate samples will be collected for comparison between EMD and BioVir Lab.

[3] Farm samples will be collected from the designated truck.

Note: Temperature of sample will be measured and recorded.

: These samples will be composited at BioVir Lab for helminth ova or enteric viruses.

Table 3. Digester Temperatures, August and September 2002

Digester	8/19 Mon	8/20 Tue	8/21 Wed	8/22 Thu	9/4 Wed	9/5 Thu	9/9 Mon	9/10 Tue	9/11 Wed	9/12 Thu	9/16 Mon	9/17 Tue	9/18 Wed	9/19 Thu
Stage 1 Mesophilic														
1C					97.8	96.4	99.2	98.2	97.1	96.1	94.6	93.8	93.4	93.1
2C					96.7	96.1	97.7	97.1	96	96.2	95.9	96.7	96.8	96.7
3C					92	91.3	91.5	91.8	92	92	91.8	91.7	91.4	91.2
4C					97.5	97.3	96.4	97.4	97.8	85.5	94.9	94.5	93.9	83.5
5C					97.1	96	97.9	97.6	96.7	96	97.8	97.2	96.1	95.3
6C					96.6	96.2	98.3	97.7	97.2	96.4	96.1	96.3	97.1	98.2
Stage 1 Thermophilic														
1D1	132.3	130.7	131.2	131.5	131.6	132.4	127.8	128.7	129.1	127.2	129.2	128.9	129.4	130.2
2D1	130.6	131.6	132.1	132.1	131.6	132.5	129.4	130	129.9	128.8	131	130.8	133.2	132.2
3D1	Out of service				Out of service									
4D1	132	131	129.2	128.7	132.5	131.5	130	130	130.2	129.1	128.4	129.5	132.9	132.1
5D1	128	128	126.7	126.4	127.9	128.2	128	129	128.6	127.6	125.8	125.9	127.4	128.6
6D1	130	129	129.6	130	132.4	130.7	127	127	127.7	126.5	127.3	127.5	130.3	132.1
1D2	130	129	129	129	132	132	129	129	128	127	126	126	128	129
2D2	130	129	131	131	130	129	129	128	129	127	127	129	131	132
3D2	128	128	131	132	130	130	130	129	130	128	127	128	129	130
4D2	131	129	129	129	134	134	133	131	131	129	128	130	132	134
5D2	131	130	130	130	131	130	129	128	129	127	127	128	130	131
6D2	129	129	129	130	131	128	126	127	129	127	131	131	132	132
2E	133	131	132	132	133	133	133	130	130	128	126	131	131	
3E	131	128	128	129	129	127	129	129	129	127	134	131	132	134
4E	128	126	128	129	133	133	133	133	134	133	134	133	133	132
6E	Out of service				Out of service									
7E														
8E	134	135	132	131	132	130	130	129	130	129	131	132	133	135
Stage 2 Blending Thermophilic and Mesophilic														
1E							124.7	122.9	123.2	122.2	123.8	123.8	124.2	127.1
5E							124.7	125.4	123.3	121.7	126.7	124.2	124.9	128.5

Table 4. Fecal Coliform Counts and Temperatures of Biosolids at Truck Loading Facility, August 2002

Testing date	Silo	Temperature (°F)	Fecal coliform by EMD (MPN/g dry wt.)
8/19/02	2	122.9	<66
	7	123	<66
8/20/02	1	118	690
	5	125.7	56
8/21/2002[a]	3	NA	NA
8/22/02	3	123	26
	6	124	<6.6

[a]Protocols for sampling were not followed on 8-21-02, hence, results are not valid

Table 5. Indicator and Pathogen Counts and Temperatures, September 2002

			Week 1	Week 2			Week 3			
Location	Analysis	Unit	9/4 Wed	9/9 Mon	9/10 Tue	9/11 Wed	9/16 Mon	9/17 Tue	9/18 Wed	9/19 Thu
PS	Salmonella (EMD)	MPN/4g dry wt	35	2.3	16	16				
	Salmonella (BioVir)	MPN/4g dry wt	46.55	39	> 38	36				
	Helminth Ova (BioVir)	ova/4g dry wt		1 (composite sample)						
	Enteric virus (BioVir)	PFU/4g dry wt		69 (composite sample)						
Silo 1	Temperature	°F	123	124.5		123.5a	125.3[a]		123.1	
	Fecal coliform (EMD)	MPN/g dry wt	55	< 6.8		< 6.5	6.6		55	
Silo 2	Temperature	°F			121.5			122.8[a]		124.1[a]
	Fecal coliform (EMD)	MPN/g dry wt			1700			54000		6.5
Silo 3	Temperature	°F	127.6[a]	125.5		125	124.9		124.7[a]	
	Fecal coliform (EMD)	MPN/g dry wt	< 6.5	< 6.6		< 6.7	< 6.6		< 6.7	
Silo 4	Temperature	°F			125.2			126.5		129.8
	Fecal coliform (EMD)	MPN/g dry wt			6.6			420		100
Silo 5	Temperature	°F	NR[b]	126.0		120.5	125.9		123.6	
	Fecal coliform (EMD)	MPN/g dry wt		< 6.6		< 6.6	< 6.8		< 6.7	
Silo 6	Temperature	°F			126.7			125.2		123.6
	Fecal coliform (EMD)	MPN/g dry wt			100			< 6.6		34
Silo 7	Temperature	°F	120.7	119.0[a]		118.5	124.7		123.4	
	Fecal coliform (EMD)	MPN/g dry wt	< 6.5	< 6.7		< 6.5	< 6.6		42	
Silo 8	Temperature	°F			124.4[a]			125.5		123.8
	Fecal coliform (EMD)	MPN/g dry wt			58			< 6.5		6.2
Farm	Temperature	°F	127.1	126.7	126	124	125	120.9	125.9	121.8
	Ambient Temp	°F	77.0	58	63	65	63	58	62.8	62
	Fecal coliform (EMD)	MPN/g dry wt	< 6.5	< 6.7	< 6.8	< 6.5	23	< 6.8	< 6.7	3600
	Salmonella (EMD)	MPN/4g dry wt		< 1.4	< 1.5	< 1.4	< 1.4	1.5	<1.5	<1.4
	Salmonella (BioVir)	MPN/4g dry wt		< 1.6	< 1.7	< 1.7	< 1.7	< 1.6	< 1.7	< 1.8
	Helminth Ova (BioVir)	ova/4g dry wt		<1 (composite sample)						
	Enteric virus (BioVir)	PFU/4g dry wt		<1 (composite sample)						

Notes

[a] Farm sample was collected from truck loaded at indicated silo.

[b] Sample not representative of protocols (silo level low, samples taken from Truck Loading Facility floor)

Table 6. Control Room Temperatures vs. Field Measurements (°F)

Digester	Date	Control Room	Field measurement
3D1	8/8/02	131.1	130.6
3D2	8/8/02	134	134.1
1D1	8/23/02	131.5	130.4
2D1	8/23/02	132.1	130.7
3D1	8/23/02	-	Not in service
4D1	8/23/02	128.7	126.4
5D1	8/23/02	126.4	Not measured
6D1	8/23/02	130	126.8
1D2	8/23/02	129	129.7
2D2	8/23/02	131	131.2
3D2	8/23/02	132	126.7
4D2	8/23/02	129	128.2
5D2	8/23/02	130	128.3
6D2	8/23/02	130	127

Table 7. Temperature Profiles between Centrifuges and Silos

a. August 1, 1:00 - 3:00 pm.

Centrifuge	Wet cake temp (°F)
2	121.7
4	126.5
5	na
6	126.6

Silo	Wet cake temp (°F)
2	124.7
7	127.5

b. August 7, 6:30 - 8:30 am.

Centrifuge	Wet cake temp (°F)
2	124.8
4	124.6
5	126.1
6	127.5

Silo	Wet cake temp (°F)
2	124.6
7	128.1

na: not available

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REPORT OF SAMPLE EVALUATION

AMENDED REPORT

REPORT NO.: S021311A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Sampler:	E. Mathis	Sample Date:	09/04/02
Name of Contact:	Jordan Siplon	Sample Time:	06:55
Sample Source:	Biosolids - Grab	Sample Volume:	1114.1 g
Sample Location:	Primary Sludge	Total Solids:	1.40 %
		Sample ID:	HT43103-1

Sample Received Date: 09/04/02
Sample Received Time: 14:30

ASSAY RESULTS:

1. Salmonella Assay: (SM 18;9260D.1) — 47 MPN / 4 grams total solids.

2. Salmonella Duplicate Assay: (SM 18;9260D.1) — >81 MPN / 4 grams total solids

Analysis Begun Date: 09/04/02 Time: 15:10 Analyst Initials: NK

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REPORT OF SAMPLE EVALUATION

AMENDED REPORT

REPORT NO.: S021327A and S021327B

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Sampler: L. Capota (A), NA (B)

Name of Contact: Siplon (A), Nader Tashakov (B)

Sample Source: Biosolids, Grab

Sample Date: 09/09/02

Sample Received Date: 09/09/02
Sample Received Time: 14:35

ASSAY RESULTS:

1. Salmonella Assay:
(SM 18;9260D.1) Analysis Date Begun: 09/09/02 Time: 15:57 Analyst Initials: NK

BIOVIR ID	SAMPLE ID	SAMPLE LOCATION	SAMPLE TIME	SAMPLE VOLUME	% TOTAL SOLIDS (TS)	SALMONELLA MPN / 4 GRAMS TS
S021327A	HT43136-1	Primary Sludge	07:45	1131.1 g	2.91	39
S021327B	HT43136-6	Farm	07:35	470.6 g	30.0	<1.6

"Less than" results represent the lowest detection limit for this assay.
Note: Total Solids provided by client.

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REPORT OF SAMPLE EVALUATION

AMENDED REPORT

REPORT NO.: S021336A and S021336B

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Sampler: Ashbaugh (A), Nadar Tashakov (B)

Name of Contact: Siplon (A), Nader Tashakov (B)

Sample Source: Biosolids, Grab

Sample Date: 09/10/02

Sample Received Date: 09/10/02
Sample Received Time: 14:45

ASSAY RESULTS:

1. Salmonella Assay:
(SM 18;9260D.1) Analysis Date Begun: 09/10/02 Time: 15:25 Analyst Initials: NK

BIOVIR ID	SAMPLE ID	SAMPLE LOCATION	SAMPLE TIME	SAMPLE VOLUME	% TOTAL SOLIDS (TS)	SALMONELLA MPN / 4 GRAMS TS
S021336A	HT43236-1	Primary Sludge	07:10	1037.6 g	3.04	>38
S021336B	HT43236-6	Farm	07:50	436.5 g	29.3	<1.7

"Less than" results represent the lowest detection limit for this assay.
Note: Total Solids provided by client.

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REPORT OF SAMPLE EVALUATION

AMENDED REPORT

REPORT NO.: S021344A and S021344B

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Sampler: Nader Tashakov (A), E. Mathis (B)

Name of Contact: Nader Tashakov (A), Siplon (B)

Sample Source: Biosolids, Grab

Sample Date: 09/11/02

Sample Received Date: 09/11/02
Sample Received Time: 13:50

ASSAY RESULTS:

1. Salmonella Assay:
(SM 18;9260D.1) Analysis Date Begun: 09/11/02 Time: 14:20 Analyst Initials: NK

BIOVIR ID	SAMPLE ID	SAMPLE LOCATION	SAMPLE TIME	SAMPLE VOLUME	% TOTAL SOLIDS (TS)	SALMONELLA MPN / 4 GRAMS TS
S021344A	HT43239-6	Farm	07:30	436.5 g	30.9	<1.7
S021344A Dup.	HT43239-6	Farm	07:30	436.5 g	30.9	<1.6
S021344B	HT43239-1	Primary Sludge	07:00	1080.1 g	3.13	36

"Less than" results represent the lowest detection level for this assay.
Note: Total Solids provided by client.

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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021402B

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Contact:	Jordon Siplon	Sample Date:	09/09/02 - 09/19/02
Sample Source:	Primary Sludge, Composite	Sample Time:	07:00 - 07:45
Sample Location:	HTP	Sample ID:	HT43136-1, HT43236-1, HT43239-1, HT43457-1, HT43585, HT43635-5, HT43695-5, HT43769-5

Sample Received Date: 09/13/02 & 09/20/02
Sample Received Time: 10:00 & 10:15

ASSAY RESULTS:

1.	Helminth Ova Assay: (EPA 600/1-87/014)	1 Viable Helminth Ova / 4 grams total solids. Analysis Begun Date: 09/30/02	Time: 11:06	Analyst Initials: DG
2.	Total Solids Assay for Helminth Ova: (SM 18th; 2540B)	3.15% Analysis Begun Date: 09/26/02	Time: 13:50	Analyst Initials: MP
3.	Enteric Virus Assay: (ASTM D 4994-89)	69 PFU / 4 grams total solids. Analysis Begun Date: 09/20/02	Time: 09:30	Analyst Initials: VAL
4.	Total Solids Assay for Enteric Virus: (SM 18th; 2540B)	3.15% Analysis Begun Date: 09/20/02	Time: 16:40	Analyst Initials: MP

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.
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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021402C

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Contact:	Nader Tashakor	Sample Date:	09/09/02 - 09/18/02
Sample Source:	Wet Cake, Composite	Sample Time:	07:30 - 07:35
Sample Location:	Farm	Sample ID:	HT43457-6, HT43769-6

Sample Received Date: 09/13/02 & 09/20/02
Sample Received Time: 10:00 & 10:15

ASSAY RESULTS:

1.	Helminth Ova Assay: (EPA 600/1-87/014)	1 Viable Helminth Ova / 4 grams total solids. Analysis Begun Date: 09/30/02	Time: 11:06	Analyst Initials: DG
2.	Total Solids Assay for Helminth Ova: 30.6% (SM 18th; 2540B)	Analysis Begun Date: 09/26/02	Time: 12:45	Analyst Initials: MP
3.	Enteric Virus Assay: (ASTM D 4994-89)	<1 PFU / 4 grams total solids. Analysis Begun Date: 09/24/02	Time: 16:30	Analyst Initials: VAL
4.	Total Solids Assay for Enteric Virus: 30.3% (SM 18th; 2540B)	Analysis Begun Date: 09/24/02	Time: 08:50	Analyst Initials: MP/KB

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.
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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021402A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Contact:	Nader Tashakor	Sample Date:	09/09/02 - 09/18/02
Sample Source:	Wet Cake, Composite	Sample Time:	07:35 - 07:50
Sample Location:	Farm	Sample ID:	HT43136-6, HT43236, HT43239-6, HT43585-5, HT43635-6, HT43695-6

Sample Received Date: 09/13/02 & 09/20/02
Sample Received Time: 10:00 & 10:15

ASSAY RESULTS:

1.	Helminth Ova Assay: (EPA 600/1-87/014)	<1 Viable Helminth Ova / 4 grams total solids. Analysis Begun Date: 09/30/02	Time: 11:06	Analyst Initials: DG
2.	Total Solids Assay for Helminth Ova: 30.3% (SM 18th; 2540B)	Analysis Begun Date: 09/26/02	Time: 13:15	Analyst Initials: MP
3.	Enteric Virus Assay: (ASTM D 4994-89)	<1 PFU / 4 grams total solids. Analysis Begun Date: 09/20/02	Time: 09:30	Analyst Initials: VAL
4.	Total Solids Assay for Enteric Virus: 36.9% (SM 18th; 2540B)	Analysis Begun Date: 09/20/02	Time: 16:40	Analyst Initials: MP

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.
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11-2-02
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11-8-02

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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021364A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Sampler:	Nader Tashakov	Sample Date:	09/16/02
Name of Contact:	Nader Tashakov	Sample Time:	07:40
Sample Source:	Biosolids - Grab	Sample Volume:	433.7 g
Sample Location:	Farm	Sample ID:	HT43585-5
		Total Solids:	30.4 %

Sample Received Date: 09/16/02
Sample Received Time: 13:15

ASSAY RESULTS:

1. Salmonella Assay: (SM18;9260D.1) <1.7 MPN / 4 grams total solids.

Analysis Begun Date: 09/16/02 Time: 14:10 Analyst Initials: RC

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.

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9-30-02

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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021373A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Sampler:	Nader Tashakov	Sample Date:	09/17/02
Name of Contact:	Nader Tashakov	Sample Time:	07:30
Sample Source:	Biosolids - Grab	Sample Volume:	436.5 g
Sample Location:	Farm	Sample ID:	HT43635-6
		Total Solids:	29.6 %

Sample Received Date: 09/17/02
Sample Received Time: 13:25

ASSAY RESULTS:

1. Salmonella Assay: (SM18;9260D.1) <1.6 MPN / 4 grams total solids.

Analysis Begun Date: 09/17/02 Time: 14:29 Analyst Initials: RC

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.
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9-20-02
COMPLETION DATE

Richard E Darwin
SIGNATURE/DATE
9-30-02

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BioVir Laboratories, Inc.

685 Stone Road, Unit 6 · Benicia, CA 94510 · (707) 747-5906 · 1-800-GIARDIA · FAX (707) 747-1751 · WEB: www.biovir.com

REPORT OF SAMPLE EVALUATION

REPORT NO.: S021386A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Sampler:	Nader Tashakov	Sample Date:	09/18/02
Name of Contact:	Nader Tashakov	Sample Time:	07:30
Sample Source:	Biosolids - Grab	Sample Volume:	425.3 g
Sample Location:	Farm	Sample ID:	HT43695-6
		Total Solids:	29.7 %

Sample Received Date: 09/18/02
Sample Received Time: 13:15

ASSAY RESULTS:

1. Salmonella Assay: (SM18;9260D.1) <1.7 MPN / 4 grams total solids.

Analysis Begun Date: 09/18/02 Time: 14:18 Analyst Initials: RC

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.

COMPANY IS NOT AN INSURER: BioVir Laboratories is not an insurer or guarantor of the quality and/or purity of water, wastewater, biosolid or other material from which the sample was taken. BioVir offers no express or implied warranties whatsoever concerning the quality or purity of any water, wastewater, biosolid or other material which is ultimately consumed, distributed, applied or otherwise disposed.

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REPORT OF SAMPLE EVALUATION

REPORT NO.: S021394A

PAGE NO.: 1 of 1

CLIENT ADDRESS: City of Los Angeles
Environmental Monitoring Division
12000 Vista Del Mar
Playa Del Rey, CA 90293

CLIENT NO.: LOS012

SAMPLE INFORMATION:

Name of Sampler:	Nader Tashakov	Sample Date:	09/19/02
Name of Contact:	Nader Tashakov	Sample Time:	07:30
Sample Source:	Biosolids - Grab	Sample Volume:	464.9 g
Sample Location:	Farm	Sample ID:	HT43769-6
		Total Solids:	30.7 %

Sample Received Date: 09/19/02
Sample Received Time: 13:15

ASSAY RESULTS:

1. Salmonella Assay: <1.8 MPN / 4 grams total solids.
(SM18;9260D.1)

Analysis Begun Date: 09/19/02 Time: 13:50 Analyst Initials: RC

SAMPLE EVALUATION PERFORMANCE CRITERIA: The precise rates of recovery of organisms from environmental samples cannot be determined. BioVir Laboratories has analyzed your sample(s) in accordance with the method described with each analyte above, however, due to inherent limitations of these methods organisms may avoid detection. For additional information regarding the limitations of the method(s) referred to above please call us at 1-800-GIARDIA.

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