QUALITY ASSURANCE PROJECT PLAN

WESTERN MONMOUTH UTILITIES AUTHORITY REED BED SLUDGE STUDY

Rutgers Environmental Research Clinic

February 29, 2008

REVISED March 10, 2008

REVISED March 28, 2008

QUALITY ASSURANCE PROJECT PLAN

WESTERN MONMOUTH UTILITIES AUTHORITY REED BED SLUDGE STUDY

Applicant:

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1. Project Name: Western Monmouth Utilities Authority (WMUA) Reed Bed Sludge Study

   Requested By: Michael Dimino, Executive Director
   Western Monmouth Utilities Authority

2. This project has been initiated by the Western Monmouth Utilities Authority (WMUA) to collect data needed to demonstrate mortality of *Phragmites australis* rhizome biomass in WMUA reed bed sludge residues. Data will also be collected to evaluate whether the USEPA criteria for pathogen kill are met.

3. Date Project Requested: January 23, 2008

4. Date Project Initiated: February 1, 2008

5. Project Officer: Beth Ravit, Ph.D.
   Rutgers Environmental Research Clinic
   Rutgers University

6. QA Officer: Peter F. Strom, Ph.D.
   Department of Environmental Sciences
   Rutgers University

7. Project Description:

A. Objective and Scope

The use of *Phragmites australis* (*Phragmites*) to dewater and remove nutrients is a common practice in wastewater treatment reed bed systems (Toet et al., 2005, Kuusemets & Löhmus 2005). For over a decade Western Monmouth Utilities Authority (WMUA) has utilized *Phragmites* reed beds to de-water their anaerobically digested sewage sludge. These reed beds are now full to capacity and the residual material remaining in the beds needs to be disposed of so the beds can contain additional newly digested sludge material. The presence of live *Phragmites'* rhizomes precludes the material being categorized as acceptable for land application under current NJDEP Class B land use disposal standards.

This project has been initiated by the WMUA to determine the feasibility of treating their reed bed sludge to meet the highest possible USEPA/NJDEP designated class for disposal/reuse of this material. Land application of sewage sludge is regulated by USEPA as detailed in Title 40 of the Code of Federal Regulations, Part 503 (http://www.epa.gov/owm/mtb/biosolids/sludge.pdf). Federal regulatory criteria are based on the presence of pollutants, pathogens, or attractiveness to disease vectors. Working in conjunction with the WMUA, NJDEP, and Reed Bed Systems, Inc., Rutgers

will design and implement field experiments at the WMUA site to evaluate treatment options to kill the *Phragmites'* rhizomes. Rutgers will also evaluate the potential to demonstrate pathogen mortality in WMUA reed bed sludge by meeting the USEPA composting temperature criteria for pathogen kill.

Operators of reed bed facilities have anecdotally reported that piles of reed bed treated sludge containing *Phragmites* rhizomes appear to self-heat (compost) when covered with plastic tarps, and that over time the *Phragmites* biomass is killed (Jack Emory, *personal communications*). The technique of composting is also used to kill pathogens found in sewage sludge residues (Pourcher et al. 2005). Our strategy is to utilize successfully demonstrated composting methods (Finstein et al. 1986, Finstein et al. 1987) to achieve the dual objectives of killing both *Phragmites* rhizomes and pathogens of concern that might be residing in the WMUA reed bed sludge. We believe that these two objectives can possibly be achieved simultaneously, and we will begin the experiments by demonstrating 100% mortality of *Phragmites* rhizomes and documenting the environmental parameters under which this goal is achieved. Our second objective is to meet the USEPA composting requirements for pathogen destruction under aerated static pile methods (55 ^{0}C for 3 consecutive days followed by 40 ^{0}C for an additional 14 consecutive days; average temperature 45 ^{0}C or over during the 14 days). We seek to demonstrate to the NJDEP that in meeting these parameters, the WMUA's treated reed bed residues could be disposed of as Class B or Class A material. Throughout the experimental process we will communicate with the NJDEP to review our experimental data and to verify experimental compliance with the Approved Work Plan.

Specific goals of the research are to:

1. Develop protocols acceptable to the NJDEP that demonstrate *Phragmites* mortality,
2. Design and implement experiments to determine the efficacy of composting WMUA reed bed sludge material to kill *Phragmites* rhizomes,
3. Determine the environmental conditions that achieve maximum efficiency of the composting treatment through testing various environmental parameters such as organic matter content, carbon:nitrogen ratio, insulating materials, bulking material content, moisture content, temperature, and ventilation,
4. Develop protocols acceptable to the NJDEP that demonstrate the absence of pathogens of concern,
5. Determine the efficacy of using the *Phragmites* treatment process to kill pathogens of concern in the residual material, and
6. Identify any factors related to the composting treatment that would affect the NJDEP classification determination for disposal of the treated material.

In addition to monitoring and analyzing environmental parameters related to the composting process, *Phragmites* and pathogen mortality, data will also be collected that characterizes the quality of the reed bed sludge before and after the composting treatment process, including analyses of metals (As, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Zn, K) and volatile solids. These analyses will be conducted by QC Laboratories, the NJDEP

certified laboratory utilized by WMUA. QC Laboratories will also conduct independent bacterial analyses to verify the Rutgers pathogen test results.

B. Data Usage

The data collected in accordance with the Quality Assurance Project Plan (QAPP) will demonstrate the level of *Phragmites australis* and pathogen mortality in WMUA reed bed sludge residues. The data will provide the NJDEP with evidence to determine whether composting of WMUA reed bed sludge is an acceptable method to produce material suitable for a Class B or Class A disposal designation.

C. Experimental and Monitoring Design and Rational

1. Phragmites Rhizome Mortality Experiments

To determine conditions that result in *Phragmites* rhizome mortality a number of experiments will be conducted in the Rutgers University laboratories and greenhouse.

- Experiment 1: Live Control: Conditions Favorable to Phragmites Shoot Growth
  To verify that under our experimental conditions *Phragmites australis* can regenerate from portions of rhizomes, a Live Control will be established. Rhizomes and sludge collected from the undisturbed reed beds will be planted in 8" round pots that are perforated on the sides and bottom to allow free flow of irrigation water. The soil will be a commercial potting medium purchased at Home Depot, and the two materials will be mixed on 50% w/w basis. After planting the rhizomes will be watered on a weekly basis and placed in direct sunlight in a Rutgers University greenhouse. ***Formation of new shoot biomass will confirm rhizome survival and reproduction capability.***

- Experiment 2: Killed Control – Temperature Destruction
  To verify the death of *Phragmites* rhizomes and inability of the plant to produce new biomass under our experimental conditions, a Killed Control will be established. Rhizomes and sludge collected from the undisturbed reed beds will be placed in an autoclave for a period of one hour at 120 ^{0}C. After autoclaving the material will be planted and treated as the Live Control. In the very unlikely event that growth occurs, autoclaving will be repeated at a higher temperature and/or a longer duration until no shoot growth is observed. ***The absence of the formation of shoot biomass will demonstrate rhizome mortality and inability to reproduce.***

- Experiment 3: Mortality Temperature Lower Limit Experiment
  The autoclave Experiment 2 will be repeated at lower temperatures and/or shorter lengths of times using an appropriate incubator until the material exhibits the formation of new shoot biomass after heating. ***The highest temperature under which the plant can survive and produce new shoot biomass will be defined as the upper temperature that the plant can survive without 100% mortality occurring.***

- Experiment 4: Time Course Composting Experiment

  At time periods of Day 0, 3 months, 6 months, and 9 months after the outdoor composting experiments (described below) begin at the WMUA site, samples consisting of rhizomes and sludge material will be collected from the various composting treatments. This material will be planted in the potting soil medium, watered on a weekly basis, and the pots placed in full sunlight in a Rutgers University greenhouse. Killed controls will be maintained at all time points. ***The absence of the formation of shoot biomass will demonstrate rhizome mortality.***

- Replication: All experimental treatments and controls will consist of a minimum of three (3) replicated samples.

2. Composting Experiments

To determine the possibility of heating reed bed sludge material at the WMUA facility to a minimum of 55 ^{o}C as a method to destroy *Phragmites* rhizomes and demonstrate pathogen destruction, a number of experiments will be conducted.

- Experiment 5. Amendments to Accelerate Temperature Increases

  Initial on site examination of the WMUA reed bed sludge material, and a preliminary laboratory characterization of its organic content, suggest that the material already may be sufficiently stabilized so that substantial self-heating does not occur. To test this hypothesis and to determine possible amendments that will promote a sufficient increase in the sludge temperature, a laboratory experiment testing different amendments will be conducted at Rutgers University. The choice of the amendments (leaves and aboveground reed bed plant material, saw dust, WMUA freshly digested sewage sludge, and WMUA undigested sewage sludge) was based on composition, economy, and availability. The benchtop experiments will be established in 3.8 L reactors. Above ground biomass will be finely ground before addition to the reactors. In the initial experiments the leaves, above ground biomass, and saw dust will be added to the reactors on a 50% v/v basis; sludge material will be added on a 5% w/w basis. The temperature and weight of the reactor materials will be monitored daily. Once temperature changes in the reactors occur, the mixture(s) exhibiting the greatest increase in temperature and the greatest reduction in weight will be determined. Subsequently additional benchtop experiments will be conducted using the most efficient amendment(s) to determine the optimal proportions to be added to the reed bed sludge material.

Prior to commencement of Experiment 6, results of the additives tested in Experiment 5 will be reviewed with WMUA and NJDEP to ascertain that any recommended amendments are appropriate material(s) to add into the WMUA reed bed sludge. Protocols to deal with the unlikely production of nuisance odors will be implemented on site before the experiments commence (see discussion below). The actual number of windrow piles and the amount of reed bed sludge material to be composted in the on-site tests will be agreed with WMUA and NJDEP prior to initiating the field experiments.

❖ Experiment 6. Onsite Composting Experiments

Based on the results obtained in the laboratory amendment experiments, field composting experiments will be established at the WMUA facility. The reed bed sludge material will be mixed with the amendment(s) found to optimally increase temperature during the laboratory experiments. Windrows approximately 6 feet high x 14 feet wide x 20 feet long (Fig. 1, Appendix I) will be constructed within the existing reed bed structures. Windrows will be sampled over the time course of the experiment. The compost piles will be built in the form of a trapezoid shape and materials will be place loosely to allow sufficient oxygen to pass through the system to avoid compaction, reduce the possibility of the system becoming anaerobic, and reduce the possibility of overheating (Strom & Finstein 1994). It is anticipated that an aeration system will be required to force air into some of the composting piles as a means of dissipating heat build up and to maintain aerobic conditions. This aeration system will be constructed using 4" perforated flexible pipe laid underneath the composting pile itself and connected to a small blower that will be regulated by the temperature within the composting pile (Fig. 2, Appendix I). The pile's initial moisture content will be adjusted to at least 50% wet weight to provide optimum moisture conditions for the composting bacteria (Strom & Finstein 1994). Initial pH will be determined and if necessary, adjusted to maintain the pH at neutral conditions; amendments may include the addition of granulated limestone to raise acidic pH (Strom & Finstein 1994). Monitoring of the piles will be conducted at weekly intervals for individual experiments expected to last 12 weeks, over a period of 9 months. Since the success of the composting process is dependent on heat generated by microbial metabolic activity, factors will be monitored that have a direct effect on heat generation, including oxygen content, moisture content, C:N ratio and pH. Temperature readings will be monitored at one foot, three feet and five feet heights on both sides of the pile (Fig. 3, Appendix I), and at depths of one foot, three feet, and five feet from the pile surface. After sampling locations reach a temperature of 55 ^{o}C, an MPN test will be conducted. Sludge and rhizome material samples will be obtained from a windrow pile on Day 0 and Month 3 and at other time intervals as appropriate (shorter or longer periods if the compost is "cured" after the active phase). These samples will be used in the *Phragmites* mortality Experiment 4 tests (see above) and the pathogen mortality Experiment 8 tests (see below).

❖ Experiment 7. Onsite Tarp Experiment

To determine the beneficial effects of covering reed bed sludge material with a black plastic tarp an experiment will be conducted in the WMUA onsite reed beds. A pile of sludge material will be constructed in a trapezoid shaped windrow (Fig. 1, Appendix II) with dimensions as described in Experiment 6 above. This pile will be completely covered with a black plastic tarp to prevent sunlight reaching the *Phragmites* biomass and to potentially enhance heat build up within the pile. No aeration system will be installed. The windrow will be sampled every 12 weeks over a 9 month period. The sampled material will be used in the *Phragmites* mortality Experiment 4 tests (see above) and the pathogen mortality Experiment 8 tests (see below).

3. Pathogen Mortality Experiments

The USEPA requirements for sewage sludge to be eligible for disposal as class A or B material are based on the presence or absence of pathogenic bacteria [Section 503.32 (a) and 503.33 (b) of 40 CFR Part 503)]. Class A designation requires complete destruction of pathogens, while class B mandates only significant reduction of pathogens (USEPA 1994). It has been shown that during the disinfection or sanitization step of composting, pathogenic bacteria and indicators belonging to enteric and coliform groups are completely destroyed when temperatures rise to 50-70ºC (Pietronave et al. 2004). The USEPA has ruled that pathogen destruction is achieved when compost attains a temperature of greater than 55ºC for at least 3 days (USEPA 1997). To verify the destruction of pathogens during the Composting Experiments described above, the following experiments will be conducted (we note that under USEPA rules Class A pathogen reduction is "proven" by meeting the temperature requirements as set forth in [Section 503.32 (a) and 503.33 (b) of 40 CFR Part 503)]).

- Experiment 8. Most Probable Number (MPN) Fecal Coliform Estimates

  To determine the presence and number of living fecal coliform bacteria per gram of dry weight sludge, Rutgers will conduct MPN tests on both Day 0 when the Composting Experiments begin, and again after the temperature of the pile is maintained at 55 ºC for three days. The tests will be conducted using the Method 9221E fecal coliform test as described in *Standard Methods for the Examination of Water and Waste Water* (American Public Health Association 1998). The MPN tests will be performed on samples obtained from: 1) the sludge material in the compost pile; 2) the sludge material from the compost pile to which fecal coliform bacteria have been added (positive control to validate the method); and 3) the sludge material from the composted pile after autoclaving (negative control). The MPN test will consist of three steps – Presumptive Test, Confirmed Test, and Completion Test (Fig. 4, Appendix I).

  - The Presumptive Test will be done first to see if there is gas production due to lactose fermentation after the sample is incubated in lauryl tryptose broth media. The production of gas indicates the probable presence of coliform bacteria. Each sample will be added to the lactose broth, incubated at 35ºC for two days, and then observed for positive or negative results based on the presence or absence of gas bubbles in the tube. The presence of gas bubble will be considered a **positive** presumptive test.
  - The Confirmed Test will be conducted on the positive samples from the presumptive test. Positive samples will be transferred to a more selective EC medium to test for fecal coliform, incubated for 2 days, and re-examined for the presence of gas in the tubes. Production of gas is a **positive** confirmation of the presumptive test results.
  - The Completed Test will isolate single colonies from samples exhibiting gas production in the Confirmed Test. Eosine-Methylene Blue (EMB) agar plates will be streaked with 10% of all positive confirmed samples, plates will be incubated at 35 ºC for 1 day, and the plates will then be

examined. The presence of green, metallic colonies is a **positive** result, denoting the presence of fecal coliform bacteria. Microscopic examination will also be conducted.

- The dry weight of the sludge will be determined by oven drying the composted sludge to a constant weight and then calculating the proportion of dry material in a gram of composted sludge.

USEPA has determined that the acceptable level of fecal coliform in finished compost is less than 1,000 MPN per gram of solids (on a dry weight basis). Using a 5-tube MPN table (Meynell & Meynell 1970), an MPN number for each sample will be determined. The MPN numbers obtained after composting the WMUA sludge will be compared to the USEPA standards to determine if the sample meets USEPA requirements for destruction of pathogens. To confirm the results of Rutgers pathogen experiments, QC Laboratories (certified by NJDEP to perform fecal coliform and salmonella bacteria analyses) will test the composted material for the presence of both fecal coliform and salmonella.

❖ Experiment 9. Pathogen Destruction versus Rhizome Mortality

The MPN tests described in Experiment 8 above will be conducted on the samples used in the *Phragmites* rhizome mortality tests as described in Experiment 4.

❖ Replication: All experimental treatments and controls will consist of a minimum of three (3) replicated samples. Fecal Coliform test results obtained in the Rutgers experiments will be compared with fecal coliform results from replicate samples that will be analyzed at QC Laboratories, the NJDEP certified laboratory utilized by WMUA.

Summary of Experimental Design

Experiment	Frequency	Parameters	# Replicates	Positive Result
Rhizome mortality	12 samples per composting treatment	*Phragmites* mortality	3 per sample	No *Phragmites* shoot growth
Rhizome survival temperature	As required to determine upper survival temperature	*Phragmites* mortality	3 per test	New *Phragmites* shoot growth
Rhizome Live Control	All rhizome mortality tests	Experimental conditions	3 per experiment	New *Phragmites* shoot growth
Rhizome Killed Control	All rhizome mortality tests	Experimental conditions	3 per experiment	No *Phragmites* shoot growth
Temperature increasing amendments	As required to determine amendments required	Increase in temperature	1/amendment initially 3/amendment to verify results	Temperature minimum of 40 ^{o}C in benchtop reactors
Windrow composting piles	12 samples per composting treatment	*Phragmites* mortality Pathogen destruction	3 per treatment for each test	No *Phragmites* shoot growth MPN less than 1000/g dry wt
Tarp pile	4 sample events	*Phragmites* mortality Pathogen destruction	3 per sample event	No *Phragmites* shoot growth MPN less than 1000/g dry wt
MPN coliform tests	8 sample events As required based on # of treatments	MPN estimate Positive ID of fecal coliform bacteria	3 per sample event	MPN less than 1000/g dry wt

D. Monitoring Parameters

Compost samples will be obtained by Rutgers University from multiple locations within the composting mass as described in USEPA 833-B-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989) (Appendix II). Compost grab samples will be collected using graduated glass cylinders; multiple samples will be composited by mixing well in a plastic pail to obtain a more representative sample.

As described in USEPA 833-B-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989) fecal coliform sample material will be collected in glass jars, immediately placed on ice, and will be maintained at a temperate of 4 ^{o}C for transport to the laboratory for processing. Fecal coliform sample holding time will not exceed 6 hours.

Most probable number (MPN) will be calculated using the Most Probable Number 5-Tube per Dilution method for detection of fecal coliform bacteria as described by the American Public Health Association (APHA) (Appendix II).

QC Laboratories (NJDEP certification number PA166) will perform analyses to characterize the presence of fecal coliform and salmonella bacteria, various metals, VOCs, and solids post-composting treatment according to their approved Standard Operating Procedures (SOPs) (Appendix II).

E. Parameter Table

Sampling equipment will be maintained as described in USEPA 833-B-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989). Sample containers, preservation techniques, and holding times will be in accordance with USEPA 833-B-89-100 Sludge Sampling and Analysis Document Guidance (1989). QC Laboratories will provide appropriate containers for all analysis conducted by their laboratories. Methods and test procedures are included in Appendix II. Any deviations from the test procedures and/or preservation methods and holding times will be reported to the NJDEP Office of Quality Assurance and will be noted in the final report from the laboratory.

F. Operational Protocols

ODOR CONTROL

The WMUA facility is located near a residential area. Aerobic composting is not expected to produce offensive odors. One exception is that for materials with a very low C/N ratio, an ammonia odor can result. While unlikely, should a composting pile become anaerobic, the potential exists that the outdoor composting experiments could result in generation of other odors. Should odors be produced during the WMUA composting experiments, the following procedures will be followed to prevent them from becoming a nuisance to the surrounding community. ***Note that an important aspect of this phased approach is that potential odor problems are detected and corrected before they impact nearby residences.***

- Monitoring: The most effective method to prevent odor problems is to prevent odorous compounds from being formed in or released from the piles. Regular monitoring of the composting pile can help catch any potential problem before the odor can spread off-site. Should an odor be noticed, an immediate response to correct the problem can prevent further anaerobic conditions from occurring and/or prompt action can prevent odor release. To this end, a representative of WMUA will check the pile(s) each morning to determine that the aeration system and temperature probes are operational and that no odors are detectable beyond any that have historically been associated with the site, and that have been found to be non-problematic. Should any monitoring equipment malfunction, the temperature exceed 65 ^{o}C, or an atypical odor be detected, Rutgers will be immediately notified.

- Response to Initial Odor Formation: Should anaerobic conditions occur, odor formation proceeds in a predictable pattern. The first odor noticed has a vinegary smell due to the formation of acetic acid. This is soon followed by a sour-sweet smell, as the acetic and similar fatty acids combine with the ethanol and similar alcohols to produce esters. Should such odors be present during a daily pile inspection, WMUA personnel will spread granulated limestone (garden "lime") on the surface of the composting pile and notify Rutgers immediately. The lime raises the pH, so that the volatile acetic acid is converted to nonvolatile acetate, which remains in the pile. Lime will be housed on site for this purpose.
- Response to Ammonia Odor: A low ratio of available carbon:nitrogen, combined with a pH level that is too high, can result in the production of an ammonia smell. Addition of a readily available C source and/or acidic material to the composting pile will halt the release of ammonia. Should an ammonia odor be detected, WMUA will add dry or partially composted leaves to the composting pile and notify Rutgers immediately. A source of readily available leaves or leaf compost will be identified for this purpose.
- Response to Hydrogen Sulfide and Related Odors: A hydrogen sulfide (rotten egg) odor indicates that the composting pile has become more severely anaerobic. This is typically caused by conditions that are either too wet, or when there is insufficient aeration of the composting pile for a prolonged period. This is unlikely to occur with the WMUA reed bed material because it has previously been stabilized through extended biodegradation in the beds. If a hydrogen sulfide smell is detected and determined to be due to a saturated composting pile, a dry bulking agent such as leaves will be added. If aeration of the pile is insufficient, the piles will re-mixed and the air flow system will be investigated. If necessary smaller piles will be formed.
- Amine Odors: Amines can be produced if the pile is allowed to go anaerobic and also becomes acidic. However, like ammonia, amines become volatile only at higher pH values. In the unlikely event amine odors are detected, they will be controlled by steps such as those described above to ensure aerobic conditions and neutral pH.
- Removal of Malodorous Composting Material: Should an odor problem occur that cannot be eliminated by the measures described above, the odorous material will be removed from the WMUA site. We will identify an off-site location that can accept such material and provide NJDEP with this information prior to commencing the outdoor composting experiments.

Based upon the results of the composting field experiments, Rutgers University will design operational protocols to achieve mortality of *Phragmites* rhizomes and pathogens in WMUA reed bed sludge material. These design parameters will be tested by WMUA at the conclusion of this experiment. Successful replication of the Rutgers experimental results will indicate the feasibility of utilizing these protocols to produce a Class B or Class A material.

G. Disposition Options

Should the experiments and WMUA implementation result in mortality of *Phragmites* rhizomes contained in the reed bed sludge residue, the composted product will be considered to meet the criteria required for designation as Class B disposal material. Should the proposed experiments and WMUA implementation result in: 1) the mortality of *Phragmites* rhizomes contained in the reed bed sludge residue; and 2) the sludge maintaining a temperature of 55 ^{o}C for a minimum of three days, the composted product will be considered to meet the criteria required for designation as Class A disposal material.

Prior to commencing the outdoor composting treatments, we will identify and provide to NJDEP a description of the disposal of the material(s) resulting from the WMUA on site experiments.

References Cited

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11. USEPA. 1994. Land Application of Sewage Sludge. Guide for land applicators on the requirements of the federal standards for the use or disposal of sewage sludge 40 CFR part 503. http://www.epa.gov/owm/mtb/biosolids/sludge.pdf.

8. Schedule*

*Schedule is subject to NJDEP final approval of QAPP.

TASK	**DATE**
Submit QAPP	March 2008
Conduct Field Composting Experiments	April – November 2008
Conduct Benchtop Amendment Studies	April – August 2008
Conduct Benchtop Mortality Experiments	April – October 2008
Submit Data and Summary Report to NJDEP	December 2008
Submit Final Report to NJDEP	February 2009

9. Project Organization and Responsibility

Laboratory Operations:	(Rutgers) (QC Laboratories) (NJDEP)	Sarat Kannepalli Phil Worby
Sampling Operations:	(Rutgers) (WMUA) (NJDEP)	Sarat Kannepalli Rosemary Fillimon
Data Processing/ Data Quality Review	(QA Officer) (Project Manager) (NJDEP)	Peter Strom, Ph.D. Beth Ravit, Ph.D.
Overall QA:	(QA Officer)	Peter Strom, Ph.D.
Overall Coordination:	(Project Manager)	Beth Ravit, Ph.D.

10. Organizational Chart:

Overall Coordination: Beth Ravit, Ph.D. (Rutgers) Overall QA: Peter Strom, Ph.D. (Rutgers)
Data Quality Review/Data Processing: Peter Strom, Ph.D. (Rutgers) Beth Ravit, Ph.D. (Rutgers) (NJDEP)
Sampling QC/Sampling Operations: Peter Strom, Ph.D. (Rutgers) Sarat Kannepalli (Rutgers) Rosemary Fillimon (WMUA) (NJDEP)
Laboratory Operations: Sarat Kannepalli (Rutgers) Phil Worby (QC Laboratories -NJDEP certification #PA166) (NJDEP)

11. Sampling Procedures:

Compost sampling procedures will be in conformance with USEPA 833-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989) or prior written approval from NJDEP.

Bacterial sampling procedures and tests will be in conformance with the American Public Health Association Standard Methods for the Examination of Water and Wastewater. 20th Edition (1998).

Sampling procedures to determine mortality of residual *Phragmites* rhizome material will be as described in Section D above.

Instrumentation used in the collection and analysis of samples will be properly calibrated, in conformance with the manufacturer's instructions, laboratory SOPs and QA manuals.

12. Chain of Custody Procedures:

Chain of Custody procedures will be followed for all samples collected for these experiments. A sample Chain of Custody form is provided in Appendix I. A sample is in one's custody if: 1) it is in one's actual physical possession, 2) it is in one's view after

being in one's physical possession, 3) it is in one's physical possession and then locked up so that no one can tamper with it, and 4) it is kept in a secured area restricted to authorized personal only.

13. Calibration Procedures and Preventative Maintenance:

Calibration and preventative maintenance of laboratory and field equipment will be in accordance with the manufacturer's instructions, American Public Health Association Standard Methods for the Examination of Water and Wastewater (1998), and USEPA 833-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989).

14. Documentation, Data Reduction, and Reporting:

The Project Manager, for a minimum of five years, will keep all data on file, and all applicable data will be included in the summary report to NJDEP. An electronic version of all reports and data will be provided on a CD for the Department's use. All data and reports will be downloadable from the Rutgers web site www.rerc.rutgers.edu.

15. Quality Assurance and Quality Control:

USEPA 833-89-100 POTW Sludge Sampling and Analysis Document Guidance (1989) will be followed for all quality assurance and quality control (QA/QC) practices, including detection limits, quantitation limits, precision, and accuracy. QC Laboratories and Rutgers Environmental Research Clinic will perform data validation. Dr. Beth Ravit will verify the reference/voucher collections prepared by Sarat Kannepelli of Rutgers.

16. Performance and Systems Audits:

All NJDEP certified laboratories participate ***annually in a NJDEP mandated Performance Testing program***. The NJDEP Office of Quality Assurance conducts a performance audit of each laboratory that is certified. The NJDEP Office of Quality Assurance also periodically conducts on-site technical systems audits of each certified laboratory. The findings of these audits, together with the ***NJDEP mandated Performance Testing program***, are used to update each laboratory's certification status.

The NJDEP Office of Quality Assurance periodically conducts field audits of project sampling operations. The Office of Quality Assurance will be contacted during the project to schedule a possible field audit.

17. Corrective Action:

All NJDEP certified laboratories must have a written corrective action procedure which they adhere to in the event that calibration standards, performance evaluation results, blanks, duplicates, spikes, etc. are out of the acceptable range or control limits. If the acceptable results cannot be obtained for the above-mentioned QA/QC samples during

any given day, sample analysis must be repeated for that day with the acceptable QA/QC results. NJDEP will be notified if there are any deviations from the approved work plan.

All signatories of this AQPP will be notified when deviations to the QAPP are made prior to their implementation.

18. Reports:

The summary report will include at a minimum an Introduction, Purpose and Scope, Results and Discussion, Conclusions and Recommendations, and an appendix with data tables. An electronic version of all reports and date will be provided on a CD for the Department's use. The Report and project data will be available electronically at the Rutgers website www.rerc.rutgers.edu.

Attachments

Appendix I.
Figures
Chain of Custody Form

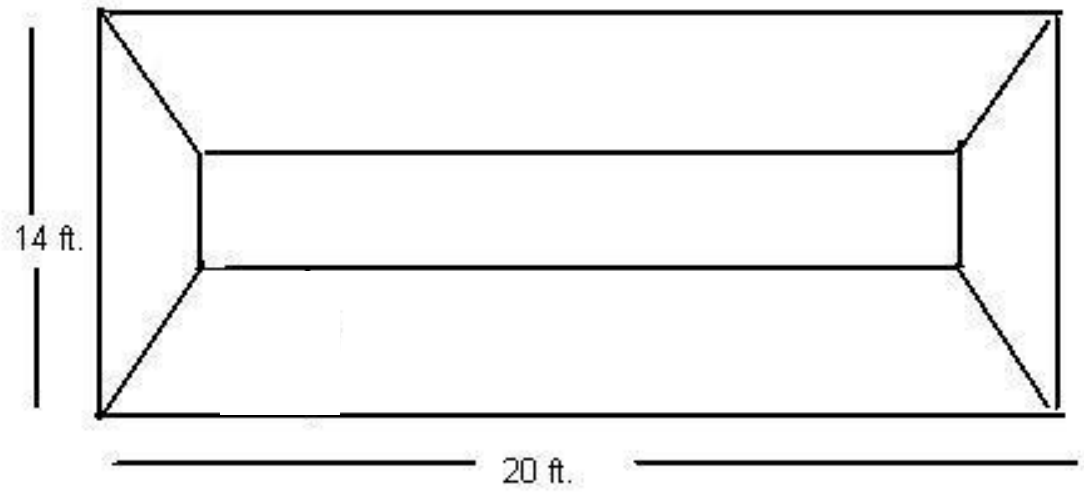

Figure 1. Schematic representation of the proposed windrow compost pile. Initial height will be 6 ft., width at the bottom of the pile will be 14 ft., and at the top of the pile 10 ft. Length given is minimum and all dimensions are approximations.

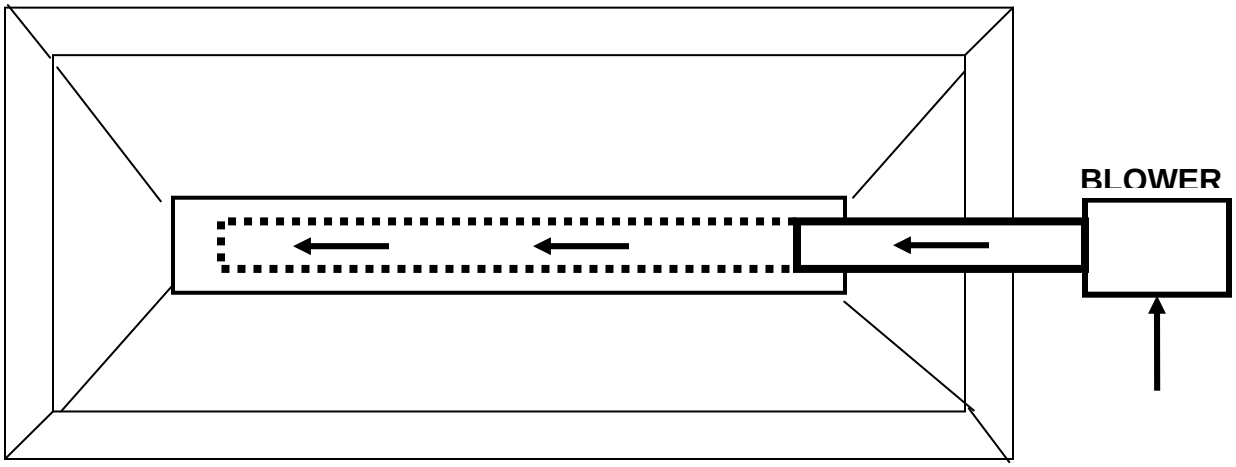

Figure 2. Schematic representation of the proposed aeration system. A perforated pipe placed within the composting pile will be connected to a non-perforated pipe and blower located outside the pile. Arrows indicate the direction of ambient air flow. The blower will be temperature and timer activated.

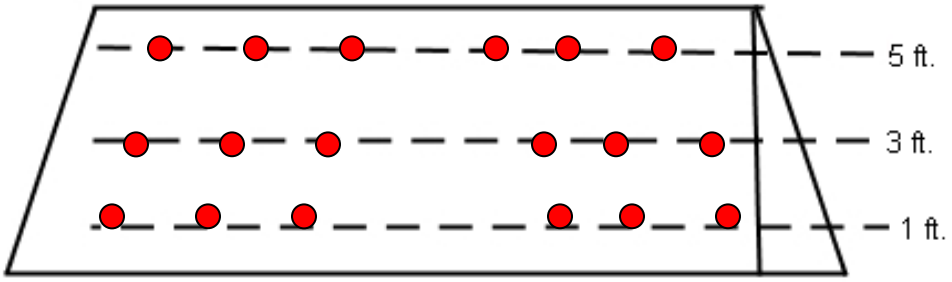

Figure 3. Location of proposed temperature sampling points (on each side of the pile). Depth from the surface of all temperature measurements will be documented to determine the consistency of recorded temperatures throughout the pile.

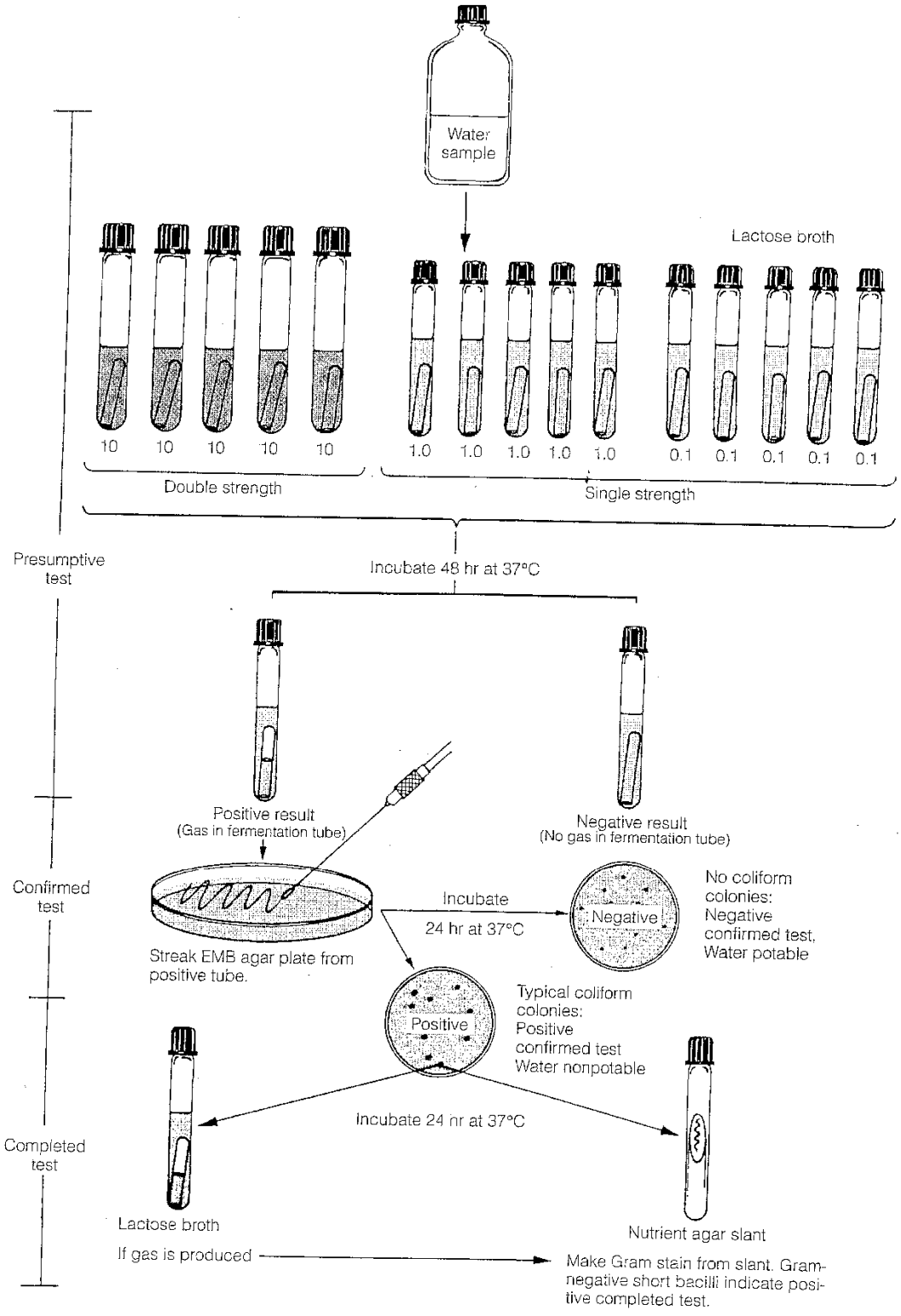

Figure 4. Schematic representation of 5-tube fecal coliform MPN tests (Cappuccino & Sherman 1987). Initial samples that produce gas are incubated in a medium selective for fecal coliform bacteria. A total of 10% of the samples that produce gas in the selective medium are streaked onto EMB agar plates. The formation of green metallic colonies indicates the presence of fecal coliform bacteria.

RUTGERS UNIVERSITY-WESTERN MONMOUTH UTILITIES AUTHORITY REED BED SLUDGE STUDY
CHAIN OF CUSTODY FORM

Sampled by:	**Date:**
Phone:	**Time:**

Lab ID	Sample ID/Location	Date Sampled	Time Sampled	Analysis	NOTES

Relinquished by Sampler	**Date:**	**Received by:**	**Date:**
	Time:		**Time:**
Relinquished by:	**Date:**	**Received by:**	**Date:**
	Time:		**Time:**
Relinquished by:	**Date:**	**Received by:**	**Date:**
	Time:		**Time:**

Appendix II.
Sampling Protocols