State of Vermont

Agency of Natural Resources

SOLID WASTE MANAGEMENT GUIDELINES FOR BENEFICIAL USE OF SEWAGE SLUDGES AND SIMILAR WASTES AND INSTRUCTIONS FOR THE PREPARATION OF FACILITY CERTIFICATION APPLICATIONS

April 2011

Department of Environmental Conservation

Wastewater Management Division

Residuals Management Section

GUIDELINES FOR RESIDUAL WASTE MANAGEMENT
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TABLE OF CONTENTS

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INTRODUCTION

Wastewater treatment sludges and other solid wastes of suitable quality may be eligible for diffuse disposal (land application) on agricultural lands or in forested (silvicultural) areas. Diffuse disposal means that the waste is applied at a controlled rate so that the nutrient value of the waste is used, while the portion without value can be assimilated by the environment. Proper management is the key to environmentally sound reuse of these wastes. The State of Vermont, Department of Environmental Conservation (hereafter referred to as the "Department"), endorses properly managed diffuse disposal of solid wastes.

These guidelines are intended to provide the reader with a summary of the technical elements necessary for proper management of diffuse disposal of sludges and other solid wastes. These wastes can include wastewater treatment plant sludges, septage, wood ash, sludges resulting from the biological treatment of paper manufacturing wastes (short paper fiber). Other wastes may be deemed suitable for diffuse disposal. All of the technical elements should be addressed in the application for certification (See *Application for Certification*, below).

This document is not intended to provide all readers with all the information necessary to evaluate a proposal for diffuse disposal of a waste. The primary audience for these guidelines is comprised of engineers, hydrogeologists, facility operators, and people working in the health and agricultural fields, who will be directly involved in submitting an application for certification and operation of a solid waste management facility. In so targeting the intent of the document, we assume a baseline of knowledge or familiarity with the subject and the ability to consult with other references and persons to make judgments that may not be covered here.

As a case in point, we have chosen to write these guidelines using the management of wastewater treatment plant sludges as the example. This example was chosen because it was believed to be the most conservative. We assume that proper management of wastewater treatment plant sludges would be suitable for all wastes, and logically, the proper management of other wastes will not involve all of the aspects of wastewater treatment plant sludges. **It is the responsibility of the applicant to document the differences if a case is to be made for a variance from the standards contained in these guidelines.** In most cases these differences are apparent. Still, in other cases, the example may not cover all the aspects of some sludges (paper) and the Department may choose to require more information on a case-by-case basis.

Consultants and solid wastes managers are targeted because they make the most use of these guidelines, and must make the decisions about alternatives. At times, other sources may have to be consulted, and the Department will be issuing updates, clarifications, office procedures, etc., as required, or in response to new information and as technical standards are developed.

Hereinafter, wastewater treatment sludge which has been treated to meet the pathogen reduction and vector attraction reduction standards and which has been demonstrated to meet the numerical pollutant standards established in the Rules, shall be referred to as “**biosolids**”.

AUTHORITY

The management of biosolids, septage, and other solid wastes is regulated under the authority of 10 V.S.A. Section 159, the Solid Waste Management Rules, and Chapter 6 of the Environmental Protection Rules.

APPLICATION FOR CERTIFICATION

All solid waste management facilities must be certified in accordance with 10 V.S.A. Chapter 159, and must be shown to be in compliance with the applicable technical standards in the solid waste management rules. The solid waste management rules also describe the administrative process which must take place for all certifications. Essentially, upon application, both public and technical review processes are set in motion. The public review process is detailed in the rules; the technical standards are detailed in these guidelines. Upon receipt of an application, the documentation is reviewed for consistency with both rules and guidelines. Any variances are evaluated case-by-case on their merits.

The guidelines cannot account for all possible means for accomplishing the common goal of proper solid waste management. In many respects the Department staff can be expected to use judgment in interpreting the standards which are included in the guidelines. However, the following standards are to be used as minimum siting criteria for diffuse disposal, though not necessarily for treatment or storage facilities. These standards are contained in the (State of Vermont) Solid Waste Management Plan and Solid Waste Management Rules.

ISOLATION DISTANCES REQUIRED OF SOLID WASTE MANAGEMENT FACILITIES

CATEGORY	FACILITY TYPE			
	Diffuse Disposal		Discrete Disposal	Subchapter 12 facilities
	Injection	Other		
Minimum vertical separation from high seasonal groundwater	3'	3'	6'	n/a
Minimum vertical separation to bedrock	3'	3'	10'	n/a
Minimum distance to waters of the State, including intermittent streams and all larger water bodies	50'	100'	300'	100'
Distance to drinking water source from the waste management boundary	300'	300'	1000'	100'
Distance to property line	25'	50'	300'	50'
Minimum distance from waste management boundary to residences, schools, day care facilities, hospitals, and nursing homes, not owned by the applicant.	100’	100’	1000’	100’

NOTE: the shaded columns pertain to biosolids land application sites.

Injection includes any method that immediately incorporates the waste beneath the surface of the soil, rather than leaving it on the surface.

Note that there are operating standards which appear in the solid waste management rules which indirectly affect siting decisions (e.g., restrictions on grazing, harvesting and feeding crops, winter application, access from a state or federal highway or a Class III or better town highway).

There are many cases where judgment can be exercised. For instance, the rules prohibit winter application and require that the aggregate of facilities must provide for five months biosolids storage capacity in order to accomplish the goal. These guidelines detail design and operating recommendations which should be met in the application for certification, but alternatives to storage may be shown to meet the standard. Examples might include shared storage with an existing facility, use of a wastewater treatment plant, or landfilling for disposal during the winter.

Another example of exercising judgment in applying the solid waste management rules is the requirement that all facilities must be accessible from a state or federal highway or a Class III or better town highway. Land application sites are frequently located in isolated areas that may not be adjacent to state or federal highways or Class III or better town roads. If private land must be crossed to reach the site, the access road must be suitable for equipment to reach the site, and there must be an agreement with the landowner that allows access to the site.

It is important that the applicant document such variances from guideline standards, and in the example given, provide assurance that the variance could be sustained for the certification period. For example, if a septage hauler applies for a certification to treat and land dispose septage, but proposes to use one or more wastewater treatment plants to dispose of septage during the winter, then the issuance of the certificate would depend on an agreement in writing, with all treatment plants involved, which demonstrated that all of the septage could be accepted during the winter, with no storage required. Furthermore, the valid period for the certification would be determined by the length of time specified in the agreement. Therefore, it is in the interest of the applicant, in this example, to maximize the length of the agreement period, in order to minimize the expense of application renewal. Alternatively, if the hauler proposes to cease pumping operations during the winter, the storage requirement would be similarly waived.

GUIDELINES FOR DIFFUSE DISPOSAL OF WASTEWATER TREATMENT FACILITY BIOSOLIDS

I) Treatment Criteria

A) Pathogen Reduction

1) PSRP (Process to *Significantly* Reduce Pathogens) is required of pathogenic wastes before land application. Refer to Appendix A, Parts A and C, which list the approved PSRP processes and pathogen reduction demonstrations, as defined in 40 CFR Part 503.32 and accepted by the State of Vermont. Solid waste facility management plans must include a basis of design that demonstrates that PSRP criteria will be met throughout the design period. The basis of design must include an estimate of the waste quantity to be generated during the design year.

2) PFRP (Process to *Further* Reduce Pathogens) is not required for diffuse land application of pathogenic wastes, but methods that achieve PFRP go beyond PSRP and therefore satisfy the requirement for pathogen reduction. PFRP is, however, required for wastes to be considered compost, co-compost, or any other product derived from biosolids which are intended to be eligible for final management by general distribution to the public. Refer to Appendix A, Parts B and C, which lists the approved PFRP processes and pathogen reduction demonstrations, as defined in 40 CFR Part 503.32 and accepted by the State of Vermont.

B) Vector Attraction Reduction and Reduction of Deleterious Character

1) Prior to management via application to the land or by release of a product derived from a residual waste to the general public, the material must meet one of the Vector Attraction Reduction standards established at 40 CFR Part 503.33. Refer to Appendix A, Part D, which lists the approved vector attraction reduction processes and demonstrations, as defined in 40 CFR Part 503.33 and accepted by the State of Vermont.

2) Ideally, a residual waste final product should not contain plastic or rubber items or other non-biodegradable objects. Such articles should be prevented from entering, or be removed from, the influent wastewater or residual waste, by educating sewer users, or by screening or other appropriate means. Any non-biodegradable objects removed from influent wastewater or residual waste should be disposed of by landfilling or other appropriate means, in accordance with applicable solid waste rules.

3) Control objectionable odors such that they cannot be detected beyond the property line of any treatment area (per Vermont Air Pollution Control Regulations, §5-241). Additional steps beyond pathogen reduction may be necessary to meet this requirement. Examples include, but are not limited to, liming, masking agents, other chemical additions, injection or

incorporation. The Department will require a curing cycle for all compost and co-compost during which the material must return to normal ambient temperature such that active composting has ceased.

II) Storage Criteria

A) Stockpiles

A stockpile is defined here as a pile of non-fluid or dewatered residual waste placed directly on soil. A storage bunker with a concrete floor, walls and a leachate control system is classified in these guidelines as a storage tank. **The Department does not allow the long term storage of residual wastes in stockpiles.** The Department will allow short term staging of residual wastes in the field prior to their being applied to the land, however this activity must be limited to approximately two weeks or less duration.

B) Lagoons

A lagoon is defined here as a designed reservoir, typically earthen walls with a clay or synthetic liner, for the temporary storage of residual waste, usually in liquid form.

1) Site Design Criteria

a) Site Location Restrictions

The following areas are unsuitable for lagoons. Areas described in items i) through vi), plus item viii), are specifically prohibited by the Vermont solid waste rules §6-502 for all solid waste facilities.

i) Class I and Class II Ground Water Areas.

ii) A significant wetland area, as designated by the Vermont Water Resources Board.

iii) A National Wildlife Refuge, as designated by the United States Fish and Wildlife Service.

iv) A wildlife management area, as designated by the Vermont Agency of Natural Resources.

v) A threatened or endangered species habitat area, as designated by the Vermont Agency of Natural Resources.

vi) A watershed for a Class A stream or stream segment, as designated by the Vermont Water Resources Board.

vii) Within a one-hundred year flood plain, as designated by the United States Army Corps of Engineers or the Vermont Department of Environmental Conservation.

viii) Within five-hundred feet of an Outstanding Natural Resource Water, as provided for in Water Quality Standards and as designated by the Vermont Water Resources Board.

ix) Other sensitive or unique areas of historical, archaeological or ecological importance.

b) Site Location Standards

Standards i) through iii) below are taken from the Vermont solid waste rules §6-503.

i) The facility shall not *"result in an unreasonable visual impact for anyone off site of the facility."*

ii) The facility shall not *"unreasonably increase the level of noise detectable by persons off site of the facility."*

iii) The facility must be *"accessible from a state or federal highway or a Class III or better town highway."*

iv) The land area on which a lagoon is to be constructed, including all land within fifty feet of the planned outer limit of the lagoon berm, should have a natural slope (prior to construction) of eight percent or less. The intent of this standard is to reduce the possibility of physical damage to the lagoon, due to erosion.

v) The permeability of the native soil beneath a lagoon liner should not exceed six inches per hour.

c) Minimum Isolation and Separation Distances recommended, as measured horizontally from the closest edge of the required liner, or vertically from the underside of the liner are the same minimum distances as:

i) Vertical distance to seasonal high water table: 3'

ii) Vertical distance to bedrock (or impervious soil layer): 3'

iii) To surface waters, including intermittent drainage ways: 100'

iv) To drinking water supplies: 300'

v) To property lines, or to right-of-way lines for public highways or private driveways: 50'

vi) To occupied dwellings or public buildings: 300', except at wastewater treatment facilities.

2) Design Standards

a) Minimum Total Storage Capacity

Total waste storage capacity for all storage facilities combined, including lagoons, must, by rule, be at least five months at the expected waste generation rate. Storage capacity for six months is recommended. The storage capacity requirement may be offset by demonstrating the capability to otherwise dispose of the wastes at times when diffuse disposal is prohibited.

b) Freeboard

Design a lagoon such that a minimum of one foot of freeboard is available in the design year, after precipitation and evaporation have been taken into account.

c) Control of Surface Runoff

Design a lagoon site such that surface runoff from outside the site will not enter the lagoon.

d) Liners

Line the entire bottom and sides of a lagoon with either synthetic material or clay, as described below.

i) Synthetic materials:

A synthetic liner should be at least 30 mils thick and should be physically and chemically compatible with the material stored in a lagoon. All exposed portions of a UV-degradable liner should be covered in order to prevent degradation. The liner must be anchored to the side edge of the lagoon. The liner material must have a permeability of 1/1,000,000 cm/sec or less.

ii) Clay:

The material in a clay liner must have an in-situ permeability of 1/1,000,000 cm/sec or less. A clay liner must be at least two feet thick.

e) Groundwater Monitoring Wells

A minimum of three wells, one up-gradient and two down-gradient, are normally recommended. Fewer wells may be adequate if preliminary design work has defined groundwater flow direction. Design and location of wells should be appropriate for site conditions. Submit proposed well locations to the Residuals Management Section prior to well installation. The primary function of monitoring wells around lagoons is to serve as early leak detection devices, and they should be designed and located accordingly.

f) Odor Control

Select and design a lagoon site so as to minimize odors detectable at the boundary of the site. Careful site selection is an especially important means of preventing odor complaints, but other measures may be appropriate. Provision for adding and mixing odor control agents such as lime may be desirable, for example.

g) Control of Public Access

Surround a lagoon with a sturdy permanent fence with a lockable gate designed to prevent public access. If a lagoon is not part of a larger facility (such as a wastewater treatment plant), post durable, waterproof warning signs containing language such as "Restricted Access: Processed Sewage Sludge Storage Area, Town of ____________".

3) Operating Standards

a) Maintain records of daily volumes added or removed.

b) Control objectionable odors such that they cannot be detected beyond the property line of any storage facility (per Vermont Air Pollution Control Regulations, 5-241).

c) Maintain restriction of public access.

d) Maximum duration of storage: Remove the entire contents of a lagoon at least once per year. At that time, inspect the lagoon and make repairs as necessary.

e) Maintain the berm of a lagoon, in order to prevent liner breach.

4) Monitoring Standards

a) Groundwater Testing

Test groundwater at each monitoring well, for the parameters listed in Appendix D, Part II, prior to initial certification and at least twice per year (spring and fall) thereafter, until site closure, or as indicated by test results.

b) Soil Testing

Test at least one composite soil sample, for the parameters listed in Appendix D, Part III, from the area to be surrounded by a lagoon berm, prior to construction and after closure of the lagoon.

c) Sampling, Preservation and Analytical Methods

Use the appropriate methods described in Appendix D.

5) Reporting Standards

a) On a quarterly basis, send all laboratory test results to the Residuals Management Section.

b) On a quarterly basis, report monthly volumes added to and removed from lagoons, as well as total remaining storage capacity at the end of each quarter.

c) Format - To report storage volumes, use appropriate standard forms supplied by the Residuals Management Section.

6) Recordkeeping Standards

a) Items to be kept on record:

i) Certified Solid Waste Management Plan

ii) Certification

iii) Laboratory Reports

iv) Copies of all correspondence relating to waste treatment, storage and disposal, including reports to the Agency

v) Written records of all complaints and of actions taken to resolve those complaints

b) Store all records in a secure, dry place for at least three years. This is a requirement of the solid waste rules §6-701.

7) Site Closure Standards

a) Remove lagoon and its contents.

b) Restore site to an acceptable condition. Proposals will be evaluated on a case-by-case basis, but generally site should be restored to original contours, or as approved by the site owner and the Department.

c) Continue applicable monitoring if previous monitoring data indicates a need. The schedule and parameters of any additional monitoring will be determined on a case-by-case basis.

C) Above-Ground Storage Tanks

A storage tank is defined here as a designed structure with permanent, impermeable floor and walls, typically constructed of materials such as concrete, steel, or plastic. A storage tank is used to contain residual waste in fluid or non-fluid form. Under this definition, a residual waste storage bunker with a concrete floor would typically be classified as a storage tank (although not necessarily an above-ground tank).

An above-ground storage tank is defined here as a storage tank in which no portion of the contained residual waste lies below the final (post-construction) ground elevations at the tank walls. If only a portion of the tank walls is visible, then the tank would typically be considered below-ground rather than above-ground.

1) Site Design Criteria

a) Site Location Restrictions

The following areas are unsuitable for above- ground storage tanks. Areas described in items i) through vi), plus item viii), are specifically prohibited by the Vermont solid waste rules §6-502) for all solid waste facilities.

i) Class I and Class II Ground Water Areas.

ii) A significant wetland area, as designated by the Vermont Water Resources Board.

iii) A National Wildlife Refuge, as designated by the United States Fish and Wildlife Service.

iv) A wildlife management area, as designated by the Vermont Agency of Natural Resources.

v) A threatened or endangered species habitat area, as designated by the Vermont Agency of Natural Resources.

vi) A watershed for a Class A stream or stream segment, as designated by the Vermont Water Resources Board.

vii) Flood Plains/Floodways

aa) If an above-ground storage tank is not located at a wastewater treatment facility, it shall not be located within a one-hundred year flood plain, as designated by the United States Army Corps of Engineers or the Vermont Department of Environmental Conservation.

ab) If an above-ground storage tank is located at a wastewater treatment facility, it shall not be located within the floodway portion of a one-hundred year flood plain.

viii) Within five-hundred feet of an Outstanding Natural Resource Water, as provided for in Water Quality Standards and as designated by the Vermont Water Resources Board.

ix) Other sensitive or unique areas of historical, archaeological or ecological importance.

b) Site Location Standards

Standards i) through iii) below are taken from the Vermont solid waste rules §6-503.

i) The facility shall not *"result in an unreasonable visual impact for anyone off site of the facility."*

ii) The facility shall not *"unreasonably increase the level of noise detectable by persons off site of the facility."*

iii) The facility must be *"accessible from a state or federal highway or a Class III or better town highway."*

iv) The permeability of the native soil beneath an above-ground storage tank should not exceed six inches per hour, except at wastewater treatment facilities.

c) Minimum Isolation and Separation Distances recommended, as measured from the closest tank wall or from the underside of the tank floor slab:

i) Vertical distance to seasonal high water table: 3'

ii) Vertical distance to bedrock (or impervious soil layer): 3'

iii) To surface waters, including intermittent drainage ways: 100'

iv) To drinking water supplies: 300'

v) To property lines, or to right-of-way lines for public highways or private driveways: 50'

vi) To occupied dwellings or public buildings: 300', except at wastewater treatment facilities.

2) Design Standards

a) Minimum Total Storage Capacity

Total waste storage capacity for all storage facilities combined, including storage tanks, must, by rule, be at least five months at the expected waste generation rate. Storage capacity for six months is recommended. The storage capacity requirement may be offset by demonstrating the capability to otherwise dispose of the wastes at times when diffuse disposal is prohibited.

b) Freeboard

Design a storage tank such that a minimum of two feet of freeboard is available in the design year. If a tank is used to store waste in fluid form, and is not covered, precipitation and evaporation must be taken into account.

c) Surface Water Protection

If an above-ground storage tank site is used to store waste in fluid form, design the site such that, should the entire contents of a full tank accidentally escape from that tank, waste will not enter a surface water or intermittent drainage way, or cross a property line or right-of-way line.

d) Flood Protection

If an above-ground storage tank site is located within a one-hundred year flood plain (but outside the floodway) at a wastewater treatment facility, that storage site, including structures and electrical and mechanical equipment, should be protected from physical damage by a one hundred year flood.

In addition, design above-ground tanks to prevent flood waters from entering the tanks, to the maximum extent feasible.

e) Groundwater Protection

Design a storage tank site so as to prevent contamination of groundwater.

i) If an above-ground storage tank site is used to store waste in fluid form, provide facilities for convenient measurement of the fluid level of each tank.

ii) If an above-ground storage tank site is used to store waste in non-fluid or dewatered form, provide facilities for collection, storage and removal of precipitation, as applicable.

iii) If an above-ground storage tank is NOT located at a wastewater treatment facility, install groundwater monitoring wells.

A minimum of three wells, one up-gradient and two down-gradient, are normally recommended. Fewer wells may be adequate if preliminary design work has defined groundwater flow direction. Design and location of wells should be appropriate for site conditions. Submit proposed well locations to the Residuals Management Section prior to well installation.

f) Corrosion Control

Storage tank design should address corrosion control. Tank materials and construction should be compatible with the waste stored and should resist degradation due to soil and weather conditions.

g) Odor Control

Provision for adding odor control agents such as lime or air, as applicable, is desirable at a storage tank site. Depending on site conditions, covering and odor control devices may be needed.

h) Solids Control

If a tank is used to store waste in fluid form, provide mixing equipment to prevent separation of solids and provide a more uniform feed to further processing facilities or final disposal. Decanting systems, to increase solids concentration, and flushing water, to clean out tanks, are also recommended.

i) Control of Public Access

Design a storage tank site to prevent unauthorized personnel from climbing tank walls or entering tanks. If the storage site is not part of a larger facility (such as a wastewater treatment plant), post durable, waterproof warning signs containing language such as "Restricted Access: Processed Sewage Sludge Storage Area, Town of ____________".

3) Operating Requirements

a) Maintain records of daily volumes added or removed.

b) Control objectionable odors such that they cannot be detected beyond the property line of any storage facility (per Vermont Air Pollution Control Regulations, §5-241).

c) Maintain restriction of public access.

d) Maintain secondary containment facilities, as applicable, in order to protect surface water and groundwater.

4) Monitoring Standards

a) Will be determined by the Department on a case-by-case basis. Testing of leachate, if any, may be required prior to acceptance of leachate by a wastewater treatment plant.

5) Reporting Standards

a) On a quarterly basis, send all laboratory test reports to the Residuals Management Section.

b) On a quarterly basis, report monthly volumes added to and removed from above-ground storage tanks, as well as total volumes remaining in storage at end of quarter.

c) To report storage volumes, use appropriate standard forms supplied by the Residuals Management Section.

6) Recordkeeping Standards

a) Items to be kept on record:

i) Certified Solid Waste Management Plan

ii) Certification

iii) Laboratory Reports

iv) Copies of all correspondence relating to waste treatment, storage and disposal, including reports to the Agency

v) Written records of all complaints and of actions taken to resolve those complaints

b) Store all records in a secure, dry place for at least three years. This is a requirement of the solid waste rules §6-701.

7) Site Closure Standards

a) Remove each storage tank and its contents.

b) Restore site to an acceptable condition. Proposals will be evaluated on a case-by-case basis, but generally site should be restored to original contours, or as approved by the site owner and the Department.

c) Continue applicable monitoring if previous monitoring data indicate a need. The schedule and parameters of any additional monitoring will be determined on a case-by-case basis.

D) Below-Ground Storage Tanks

A storage tank is defined here as a designed structure with permanent, impermeable floor and walls, typically constructed of materials such as concrete, steel, or plastic. A storage tank is used to contain residual waste in fluid or non-fluid form. Under this definition, a residual waste storage bunker with a concrete floor would typically be classified as a storage tank (although not necessarily a below-ground tank).

A below-ground tank is defined here as a storage tank in which at least some portion of the contained residual waste lies below the final (post-construction) ground elevations at the tank walls. If only a portion of the tank walls is visible, then the tank would typically be considered below-ground rather than above-ground.

1) Site Design Criteria

a) Site Location Restrictions

The following areas are unsuitable for below-ground storage tanks. Areas described in items i) through vi), plus item viii), are specifically prohibited by the Vermont solid waste rules §6-502 for all solid waste facilities.

i) Class I and Class II Ground Water Areas.

ii) A significant wetland area, as designated by the Vermont Water Resources Board.

iii) A National Wildlife Refuge, as designated by the United States Fish and Wildlife Service.

iv) A wildlife management area, as designated by the Vermont Agency of Natural Resources.

v) A threatened or endangered species habitat area, as designated by the Vermont Agency of Natural Resources.

vi) A watershed for a Class A stream or stream segment, as designated by the Vermont Water Resources Board.

vii) Flood Plains/Floodways

aa) If a below-ground storage tank is not located at a wastewater treatment facility, it should not be located within a one-hundred year flood plain, as designated by the United States Army Corps of Engineers or the Vermont Department of Environmental Conservation.

ab) If a below-ground storage tank is located at a wastewater treatment facility, it may not be located within the floodway portion of a one-hundred year flood plain.

viii) Within five-hundred feet of an Outstanding Natural Resource Water, as provided for in Water Quality Standards and as designated by the Vermont Water Resources Board.

ix) Other sensitive or unique areas of historical, archaeological or ecological importance.

b) Site Location Standards

Standards i) through iii) below are taken from the Vermont solid waste rules §6-503.

i) The facility shall not *"result in an unreasonable visual impact for anyone off site of the facility."*

ii) The facility shall not *"unreasonably increase the level of noise detectable by persons off site of the facility."*

iii) The facility must be *"accessible from a state or federal highway or a Class III or better town highway."*

iv) The permeability of the native soil surrounding a below-ground storage tank should not exceed six inches per hour, except at wastewater treatment facilities.

c) Minimum Isolation and Separation Distances recommended, as measured from the closest tank wall or from the underside of the tank floor slab:

i) Vertical distance to seasonal high water table: 3'

ii) Vertical distance to bedrock (or impervious soil layer): 3'

iii) To surface waters, including intermittent drainage ways: 100'

iv) To drinking water supplies: 300'

v) To property lines, or to right-of-way lines for public highways or private driveways: 50'

vi) To occupied dwellings or public buildings: 300', except at wastewater treatment facilities.

2) Design Standards

a) Minimum Total Storage Capacity

Total waste storage capacity for all storage facilities combined, including storage tanks, must, by rule, be at least five months at the expected waste generation rate. Storage capacity for six months is recommended. The storage capacity requirement may be offset by demonstrating the capability to otherwise dispose of the wastes at times when diffuse disposal is prohibited.

b) Freeboard

Design a storage tank such that a minimum of two feet of freeboard is available in the design year. If a tank is used to store waste in fluid form, and is not covered, precipitation and evaporation must be taken into account.

c) Surface Water Protection

If a partially exposed below-ground storage tank is used to store waste in fluid form, design the site such that, should the entire contents of a full tank accidentally escape, waste will not enter a surface water or intermittent drainage way, or cross a property line or right-of-way line, at or above ground elevation. This standard does not apply to completely buried tanks.

d) Flood Protection

If a below-ground storage tank site is located within a one-hundred year flood plain (but outside the floodway) at a wastewater treatment facility, that storage site, including structures and electrical and mechanical equipment, should be protected from physical damage by a one hundred year flood.

In addition, design below-ground tanks to prevent flood waters from entering the tanks, to the maximum extent feasible.

e) Groundwater Protection

Design a storage tank site so as to prevent contamination of groundwater.

i) If a below-ground storage tank site is used to store waste in fluid form, provide facilities for convenient measurement of the fluid level of each tank.

ii) If a below-ground storage tank site is used to store waste in non-fluid or dewatered form, provide facilities for collection, storage and removal of precipitation, as applicable.

iii) If a below-ground storage tank is NOT located at a wastewater treatment facility, or if storage tanks are completely buried, install groundwater monitoring wells.

A minimum of three wells, one up-gradient and two down-gradient, are normally recommended. Fewer wells may be adequate if preliminary design work has defined groundwater flow direction. Design and location of wells should be appropriate for site conditions. Submit proposed well locations to the Residuals Management Section prior to well installation.

f) Corrosion Control

Design of a below-ground storage tank site should address corrosion control. Tank materials and construction should be compatible with the waste stored and should resist degradation due to soil and weather conditions. Cathodic protection of metallic tanks may be needed, for example.

g) Pre-Installation Inspection

Prefabricated tanks to be partially or completely buried should be inspected by the Department prior to installation, to assure adequate protection of groundwater.

h) Odor Control

Provision for adding odor control agents such as lime or air, as applicable, is desirable at a storage tank site. Depending on site conditions, covering and odor control devices may be needed.

i) Solids Control

If a tank is used to store waste in fluid form, provide mixing equipment to prevent separation of solids and provide a more uniform feed to further processing facilities or final disposal. Decanting systems, to increase solids concentration, and flushing water, to clean out tanks, are also recommended, where feasible.

j) Control of Public Access

Design a storage tank site to prevent unauthorized personnel from climbing tank walls or entering tanks. If the storage site is not part of a larger facility (such as a wastewater treatment plant), post durable, waterproof warning signs containing language such as "Restricted Access: Processed Sewage Sludge Storage Area, Town of ____________".

3) Operating Requirements

a) Maintain records of daily volumes added or removed.

b) Control objectionable odors such that they cannot be detected beyond the property line of any storage facility (per Vermont Air Pollution Control Regulations, §5-241).

c) Maintain restriction of public access.

d) Maintain secondary containment facilities, as applicable, in order to protect surface water and groundwater.

4) Monitoring Standards

a) Will be determined by the Department on a case-by-case basis. Testing of leachate, if any, may be required prior to acceptance of leachate by a wastewater treatment plant.

5) Reporting Standards

a) On a quarterly basis, send all laboratory test reports to the Residuals Management Section.

b) On a quarterly basis, report monthly volumes added to and removed from below-ground storage tanks, as well as total remaining storage capacity at the end of each quarter.

c) To report storage volumes, use appropriate standard forms supplied by the Residuals Management Section.

6) Recordkeeping Standards

a) Items to be kept on record:

i) Certified Solid Waste Management Plan

ii) Certification

iii) Laboratory Reports

iv) Copies of all correspondence relating to waste treatment, storage and disposal, including reports to the Agency

v) Written records of all complaints and of actions taken to resolve those complaints

b) Store all records in a secure, dry place for at least three years. This is a requirement of the solid waste rules §6-701.

7) Site Closure Standards

a) Remove contents of each storage tank. Remove each tank or fill it with uncontaminated soil.

b) Restore site to an acceptable condition. Proposals will be evaluated on a case-by-case basis, but generally site should be restored to original contours, or as approved by the site owner and the Department.

c) Continue applicable monitoring if previous monitoring data indicate a need. The schedule and parameters of any additional monitoring will be determined on a case-by-case basis.

III) Diffuse Disposal Criteria

A) Site Design Criteria

1) Site Location Restrictions

The following areas are unsuitable for diffuse disposal of residual waste. Areas described in items a) through l) are specifically prohibited by the Vermont solid waste rules §6-502 for all solid waste facilities related to residual waste management.

a) In the case of discrete disposal facilities, in the Green Mountain National Forest except for a one half (0.5) mile corridor drawn from the center line of the right of way of each Federal and secondary highway or as approved by the National Forest Service. This prohibition does not apply to diffuse disposal facilities;

b) Class I and Class II Groundwater Areas;

c) Class I and Class II wetlands and their associated buffer zones, as defined in the Vermont Wetlands Rules, unless a Conditional Use Determination has been issued by the Agency;

d) Class III wetlands, as defined by the Vermont Wetlands Rules, unless a Water Quality Certification has been issued pursuant to 40 CFR Part 401, or has been waived by the Agency;

e) A National Wildlife Refuge as designated by the United States Fish and Wildlife Service;

f) A wildlife management area as designated by the Agency;

g) A threatened or endangered species habitat area as designated by the Agency, except for diffuse disposal facilities;

h) A watershed for a Class A Waters, as designated by the Vermont Water Resources Board or the Natural Resources Board;

i) In the case of diffuse disposal facilities, within the floodway;

j) Within five hundred (500) feet of an Outstanding Resource Waters as designated by the Vermont Water Resources Board or the Natural Resources Board. This criterion does not apply to previously certified subchapter 12 facilities where there is no expansion of the facility beyond the previously certified waste management boundary;

k) In cases of diffuse disposal facilities, within Zone 1 or 2 of an approved Public Water Supply Source Protection Area, except that the Secretary may, on a case-by-case basis, make a determination that a diffuse disposal facility may be sited in Zone 2 of an approved surface water Public Water Supply Source Protection Area.

l) Other sensitive or unique areas of historical, archaeological or ecological importance.

m) Any area where the slope exceeds fifteen percent on agricultural sites, and twenty five percent on silvicultural sites, unless otherwise approved by the Department.

n) Places of public assembly, unless the waste has been treated by a Process to *Further* Reduce Pathogens (PFRP).

2) Site Location Standards

A diffuse disposal site must also meet the following applicable standards, which are taken from the Vermont solid waste rules §6-503.

a) The facility shall not *"result in an unreasonable visual impact for anyone off site of the facility."*

b) The facility shall not *"unreasonably increase the level of noise detectable by persons off site of the facility."*

c) The facility must be *"accessible from a state or federal highway or a Class III or better town highway."*

3) Minimum Isolation and Separation Distances, as measured horizontally or vertically from the closest application zone boundary.

a) Waste Application by Subsurface Injection (or other means that incorporates waste into the soil at the time of application, rather than leaving the waste on the surface)

Items i) through vi) below are established by solid waste rule §6-503.

i) Vertical distance to water table, at time of incorporation, from bottom of zone of incorporation: 3'

ii) Vertical distance to bedrock (or other impervious strata), from bottom of zone of incorporation: 3'

iii) To surface waters, including intermittent drainage ways: 50'

iv) To drinking water supplies: 300'

v) To property lines (or to right-of-way lines for public highways or private driveways): 25'

vi) To occupied dwellings or public buildings: 100'

vii) To public recreational facilities (trails, campgrounds, picnic areas, etc): 300'

b) Waste Application by Methods Other Than Immediate Incorporation

Items i) through vi) below are established by solid waste rule §6-503 (also, see the table on page 5 of these guidelines).

i) Vertical distance to water table, at time of incorporation, from bottom of zone of incorporation: 3'

ii) Vertical distance to bedrock (or other impervious strata), from bottom of zone of incorporation: 3'

iii) To surface waters, including intermittent drainage ways: 100'

iv) To drinking water supplies: 300'

v) To property lines (or to right-of-way lines for public highways or private driveways): 50'

vi) To occupied dwellings or public buildings: 300'

vii) To public recreational facilities (trails, campgrounds, picnic areas, etc): 300'

4) Site Characterization, Investigation

Sites meeting the location, isolation and separation restrictions require additional work to determine their suitability. A soil scientist, geologist, hydrogeologist or other professional experienced in evaluation of sites for waste treatment or disposal shall assess site suitability and make appropriate recommendations on site use. The type of information that should be collected, prepared and assessed for the recommendation typically includes, but is not limited to:

a) Topographic map - showing the total land parcel, as well as the boundary of actual use at a scale of 1:24000. The map must include a bar scale so that distances can be determined if the map is photo enlarged or reduced in scale.

b) Site map

Two site maps should be developed and submitted.

On the first, the scale should be 1" = 660' or more detailed, and should show the site in relation to surrounding features within 500' (manmade and natural). The site map should show the usable area, locations of test pits, borings and monitoring wells, direction and percent slope, marshes, ponds, lakes, streams, drainage areas, depressions and bedrock outcrops, roads, houses, other buildings, drinking water supplies, property lines, soil series mapping units, and any other features. The map must include a bar scale so that distances can be determined if the map is photo enlarged or reduced in scale.

The second, also at a scale of 1” = 660’ or more detailed, should show the same information as the first map, except that the locations of test pits and borings, direction and percent slope, and soil series mapping units should not be included.

Basically, this map will serve as a “cleaned-up” version of the first and will be used in the certification document to delineate the site. The map must include a bar scale so that distances can be determined if the map is photo enlarged or reduced in scale.

c) Soil test pits and borings: Minimum standards

i) If the site has been mapped by the United States Department of Agriculture Natural Resource Conservation Service (NRCS) Soil Survey:

aa) NRCS maps distinguish soil types by delineating soil boundaries called mapping units. One soil test pit should be excavated and evaluated for each soil mapping unit present on the disposal site.

ab) One soil boring (by auger) per 2 acres, to supplement soil test pit information.

ii) If the site has NOT been mapped by NRCS: one soil test pit per 3 acres.

iii) For all sites

Logs describing all organic and mineral horizons in a 6' profile (or refusal), for soil test pits, or in a 4' profile (or refusal) for soil borings. Logs should include descriptions of soil color, texture, consistency, structures, mottling (in accordance with National Cooperative Soil Survey standards) and depths to seasonal water table and actual water table, if encountered.

iv) For silvicultural sites where slope exceeds fifteen percent: Double the above soil characterization requirements.

d) Monitor well logs - same information as for test pit logs, plus depth of well casing and length of casing above ground. Include depths to seasonal water table and actual water table.

e) Report of occurrence of rare, threatened or endangered species and natural communities from Vermont Natural Heritage Program (silvicultural sites only).

B) Design Standards

1) Groundwater Monitoring Wells or Soil Lysimeters

A minimum of three monitoring wells or soil lysimeters, one up-gradient and two down-gradient, are normally recommended. Fewer may be adequate if preliminary design work has defined groundwater flow direction. Design and location of wells or lysimeters should be appropriate for site conditions. Submit proposed locations to the Residuals Management Section prior to installation. Refer to Appendix B for more details.

2) Nutrient Management

The disposal site should be designed to make the most feasible use of the waste on an agronomic basis and to ensure adequate reuse of the material. Nutrient values of all applicable residual wastes, animal wastes and commercial fertilizers must be considered during site design. Crop nutrient uptake, hydraulic loading and agricultural management practices must also be considered.

3) Control of Application Rate

Some means of achieving and maintaining appropriate waste application rates should be demonstrated before site use commences. The demonstration may take the form of equipment manufacturer literature, an on-site demonstration or some other appropriate method or methods.

4) Design of Transportation and Application Vehicles

The waste transportation and application vehicles should be designed to prevent spillage, odor and other public nuisances. Each application vehicle should be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion. The spreading valve should be of the "fail-safe" type (self-closing), or an additional manual stand-by valve should be employed to prevent uncontrolled spreading or spillage.

C) Operating Requirements

1) Application Prohibitions

Application of biosolids or other solid waste is prohibited under the conditions below:

a) On frozen, snow covered, or saturated ground. The solid waste rules §6-702 specifically prohibit diffuse disposal of waste on frozen or snow-covered ground.

b) In areas where minimum required isolation and separation distances (as listed under site design criteria above) are NOT met.

c) On soils with a permeability of greater than six inches per hour, unless it can be demonstrated that five inches or more available water capacity is present between the surface (if waste is surface-applied) or the base of the zone of incorporation (if incorporated), and groundwater, bedrock or impervious strata at the time of application. NRCS soil surveys may be used for this purpose, or field testing may be needed.

d) On slopes greater than fifteen percent (twenty-five percent on silvicultural sites), unless otherwise approved by the Department.

e) During periods of significant precipitation, sufficient to cause surface runoff from the application site.

f) On silvicultural sites, during the spring "leaf out" period.

2) Other Operational Responsibilities

a) Before site use commences, determine the maximum allowable annual waste application rate, and minimum required land area, using procedures outlined in Appendix E. Testing of residual waste for total solids, nutrients and metals is required. See Appendix D for guidance on monitoring recommendations. Crop nutrient requirements and sources of nutrients other than residual waste must also be known. Contact the Residuals Management Section for application rate information for silvicultural sites. Calculation of application rate is required by rule §6-702.

b) Recalculate the maximum annual waste application rate prior to each application event. Refer to Appendix E for procedures.

c) Limit cadmium loading to 0.45 pound per acre annually, and 4.5 pounds per acre cumulatively. This is required by rule §6-702. Cadmium loading rates can be determined from waste test results and dry solids loading rates.

d) Before site use commences, and at the end of each certification period, determine the remaining site life based on metals, using records of applications. Refer to Appendix G for procedures.

e) Maintain and operate application vehicles to prevent accidental loss of material and to maintain a reasonably consistent application rate during spreading.

f) Apply waste only during daylight hours.

g) Maintain (water-based) soil pH of an application site between 6.5 and 8.0, in the zone of incorporation, from the time of initial site use to the time of site closure. This is required by rule §6-702, but does not apply to silvicultural sites.

h) Control objectionable odors such that they cannot be detected beyond the property line of any waste application site (per Vermont Air Pollution Control Regulations, §5-241).

i) On one-hundred year flood plains, or on slopes of eight to fifteen percent, either inject waste immediately or incorporate waste within 48 hours by means of plowing, harrowing, etc. Flood plain incorporation is required by rule §6-702.

j) On silvicultural sites, clear understory to permit uniform distribution of waste, if necessary.

k) Control public access to an application site from the time of initial waste application, until at least twelve months following the last application episode. (This is specifically required by the solid waste rules §6-702).

Post signs at access points. If a site is generally accessible (an open field, for example), signs should be posted at intervals of 150 feet or less. Signs should be durable and waterproof and should inform the public about the nature of the site, with language such as "Restricted Access - Processed Sewage Sludge Application For Agricultural Purposes - Town of ____________".

3) Control of Impact on Food Chain and Public Exposure

The following restrictions, intended to limit impact on the food chain, are specified by rule §6-702 and 40 CFR 503.32:

a) Food crops with harvested parts that touch the sewage sludge/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of sewage sludge.

b) Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of sewage sludge when the sewage sludge remains on the land surface for four months or longer prior to incorporation into the soil.

c) Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than four months prior to incorporation into the soil.

d) Food crops, feed crops, and fiber crops shall not be harvested for 30 days after application of sewage sludge.

e) Animals shall not be grazed on the land for 30 days after application of sewage sludge.

f) Turf grown on land where sewage sludge is applied shall not be harvested for one year after application of the sewage sludge when the harvested turf is placed on either land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.

g) Public access to land with a high potential for public exposure shall be restricted for one year after application of sewage sludge.

h) Public access to land with a low potential for public exposure shall be restricted for 30 days after application of sewage sludge.

D) Monitoring Requirements

1) Periodic sampling and testing of biosolids or other solid waste, soil, groundwater and plant tissue may be required. The solid waste facility certification will contain the specific requirements. Appendix D contains *recommended* sampling frequencies and parameters and appropriate sample collection and handling methods.

E) Reporting Requirements

1) On a quarterly basis, report all test results to the Residuals Management Section.

2) On a quarterly basis, for each application site, report monthly application volumes and other site management data.

3) Format: Use appropriate standard forms supplied by the Residuals Management Section.

F) Recordkeeping Standards

1) Items to be kept on record:

a) Certified Solid Waste Management Plan.

b) Certification.

c) Laboratory Reports.

d) Copies of all correspondence relating to waste treatment, storage and disposal, including reports to the Department.

e) Written records of all complaints and of actions taken to resolve those complaints.

2) Store all records in a secure, dry place until closure of the facility. This is a requirement of the solid waste rules §6-704.

G) Post Closure Requirements

1) Continue annual groundwater monitoring, for at least two years after the last application of waste, if a site has received seventy-five percent or more of the maximum lifetime loading rate for any potentially toxic element.

2) Continue applicable monitoring if previous monitoring data indicate a need. The schedule and parameters of any additional monitoring will be determined on a case-by-case basis.

3) Comply with all applicable time restrictions on grazing, public access, harvesting, delay of feeding crops to livestock, and use of site for crops that are grown for direct human consumption.

APPENDIX A

PROCESSES TO SIGNIFICANTLY AND FURTHER REDUCE PATHOGENS AND VECTOR ATTRACTION REDUCTION

A. **Processes To Significantly Reduce Pathogens (PSRP)**

PSRP processes treat biosolids to the federal Class B pathogen standards. Class B biosolids may only be managed via land application of agricultural or silvicultural sites that have been specifically authorized for this use under a Solid Waste Management Facility Certification issued by the ANR pursuant to 3 V.S.A. §6605.

1. Aerobic digestion

Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius.

2. Air drying

Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge dries for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius.

3. Anaerobic digestion

Sewage sludge is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35 to 55 degrees Celsius and 60 days at 20 degrees Celsius.

4. Composting

Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius.

5. Lime stabilization

The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours.

B. **Processes to Further Reduce Pathogens (PFRP)**

PFRP processes treat biosolids to the federal Class A pathogen standards. Biosolids which have been demonstrated to meet one of the accepted Class A pathogen reduction standards, which meet one of the accepted vector attraction reduction standards, and which meet the numerical pollutant concentration standards, are no longer classified as a “solid waste” under both the Vermont and federal regulations. Biosolids meeting these three criteria may be marketed and distributed to the public as a commodity and may be applied to the land without the need for site specific authorizations under a Solid Waste Management Facility Certification. The treatment facility which processes the biosolids in order to meet the pathogen and vector attraction reduction standards must, however, be properly authorized under a Solid Waste Management Facility Certification.

1. Composting

Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the sewage sludge is maintained at 55 degrees Celsius or higher for three days.

Using the windrow composting method, the temperature of the sewage sludge is maintained at 55 degrees or higher for 15 days or longer. During the period when the compost is maintained at 55 degrees or higher, there shall be a minimum of five turnings of the windrow.

2. Heat drying

Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10 percent or lower. Either the temperature of the sewage sludge particles exceeds 80 degrees Celsius or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80 degrees Celsius.

3. Heat treatment

Liquid sewage sludge is heated to a temperature of 180 degrees Celsius or higher for 30 minutes.

4. Thermophilic aerobic digestion

Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time of the sewage sludge is 10 days at 55 to 60 degrees Celsius.

5. Beta ray irradiation

Sewage sludge is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius).

6. Gamma ray irradiation

Sewage sludge is irradiated with gamma rays from certain isotopes, such as ^{60}Cobalt and ^{137}Cesium, at dosages of at least 1.0 megarad at room temperature (ca. 20 °Celsius).

7. Pasteurization

The temperature of the sewage sludge is maintained at 70 degrees Celsius or higher for 30 minutes or longer.

8. Other Methods

Other methods or operating conditions may be acceptable for PSRP or PFRP, if it can be demonstrated that pathogens are reduced to an extent equivalent to the reductions achieved by any of the above methods. Contact the Residuals Management Section for information on submittal of an alternative method of achieving PSRP or PFRP.

C. **Federal Pathogen Reduction Standards**

40 CFR 503.32 pathogen reduction demonstrations

Please note that the State of Vermont does not recognize all of the Class A alternatives established in 40 CFR 503.32. Only the following pathogen reduction alternatives are accepted by the State of Vermont. For Class A – Alternative 6 and Class B – Alternative 3, the Department will only accept processes that have received a *national* equivalency determination from USEPA's Pathogen Equivalency Committee.

1. *Sewage sludge—Class A.*

Class A—Alternative 1.

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in the sewage sludge shall be less than three (3) Most Probable Number per four (4) grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10 (b), (c), (e), or (f).

(ii) The temperature of the sewage sludge that is used or disposed shall be maintained at a specific value for a period of time.

(A) When the percent solids of the sewage sludge is seven (7) percent or higher, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (2), except when small particles of sewage sludge are heated by either warmed gases or an immiscible liquid.

$$D = \frac{131,700,000}{10^{0.1400t}} \qquad Eq.(2)$$

Where,

D=time in days.

t=temperature in degrees Celsius.

(B) When the percent solids of the sewage sludge is seven (7) percent or higher and small particles of sewage sludge are heated by either warmed gases or an immiscible liquid, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 15 seconds or longer; and the temperature and time period shall be determined using equation (2).

(C) When the percent solids of the sewage sludge is less than seven (7) percent and the time period is at least 15 seconds, but less than 30 minutes, the temperature and time period shall be determined using equation (2).

(D) When the percent solids of the sewage sludge is less than seven (7) percent; the temperature of the sewage sludge is 50 degrees Celsius or higher; and the time period is 30 minutes or longer, the temperature and time period shall be determined using equation (3).

$$D = \frac{50,070,000}{10^{0.1400t}} \qquad Eq.(3)$$

Where,

D=time in days.

t=temperature in degrees Celsius.

Class A—Alternative 2.

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in the sewage sludge shall be less than three (3) Most Probable Number per four (4) grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10 (b), (c), (e), or (f).

(ii)

(A) The pH of the sewage sludge that is used or disposed shall be raised to above 12.0 S.U. and shall remain above 12 for 72 hours.

(B) The temperature of the sewage sludge shall be above 52 degrees Celsius for 12 hours or longer during the period that the pH of the sewage sludge is above 12.0 S.U.

(C) At the end of the 72 hour period during which the pH of the sewage sludge is above 12.0 S.U., the sewage sludge shall be air dried to achieve a percent solids in the sewage sludge greater than 50 percent.

Class A—Alternative 5.

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella,* sp. bacteria in the sewage sludge shall be less than three (3) Most Probable Number per four (4) grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or given away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), (c), (e), or (f).

(ii) Sewage sludge that is used or disposed shall be treated in one of the Processes to Further Reduce Pathogens described in Appendix A of this part.

Class A—Alternative 6.

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella,* sp. bacteria in the sewage sludge shall be less than three (3) Most Probable Number per four (4) grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or given away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), (c), (e), or (f).

(ii) Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Further Reduce Pathogens, as determined by the permitting authority.

2. *Sewage sludge—Class B.*

Class B—Alternative 1.

(i) Seven (7) representative samples of the sewage sludge that is used or disposed shall be collected.

(ii) The geometric mean of the density of fecal coliform in the samples collected in paragraph (b)(2)(i) of this section shall be less than either 2,000,000 Most Probable Number per gram of total solids (dry weight basis) or 2,000,000 Colony Forming Units per gram of total solids (dry weight basis).

Class B—Alternative 2.

Sewage sludge that is used or disposed shall be treated in one of the Processes to Significantly Reduce Pathogens described in Appendix A of this part.

Class B—Alternative 3.

Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Significantly Reduce Pathogens, as determined by the permitting authority.

3. Domestic Septage

The pH of domestic septage applied to agricultural land, forest, or a reclamation site shall be raised to 12.0 S.U. or higher by alkali addition and, without the addition of more alkali, shall remain at 12.0 S.U. or higher for two hours and the site restrictions in §503.32 (b)(5)(i) through (b)(5)(iv) shall be met.

4. (b)(5) Site use and access restrictions

(i) Food crops with harvested parts that touch the sewage sludge/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of sewage sludge.

(ii) Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of sewage sludge when the sewage sludge remains on the land surface for four (4) months or longer prior to incorporation into the soil.

(iii) Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than four (4) months prior to incorporation into the soil.

(iv) Food crops, feed crops, and fiber crops shall not be harvested for 30 days after application of sewage sludge.

(v) Animals shall not be grazed on the land for 30 days after application of sewage sludge.

(vi) Turf grown on land where sewage sludge is applied shall not be harvested for one (1) year after application of the sewage sludge when the harvested turf is placed on either land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.

(vii) Public access to land with a high potential for public exposure shall be restricted for one (1) year after application of sewage sludge.

(viii) Public access to land with a low potential for public exposure shall be restricted for 30 days after application of sewage sludge.

D. **Vector Attraction Reduction**

1. The mass of volatile solids in the sewage sludge shall be reduced by a minimum of 38 percent (see calculation procedures in “Environmental Regulations and Technology—Control of Pathogens and Vector Attraction in Sewage Sludge”, EPA–625/R–92/013, 1992, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268).

2. When the 38 percent volatile solids reduction requirement in §503.33(b)(1) cannot be met for an anaerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When at the end of the 40 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved.

3. When the 38 percent volatile solids reduction requirement in §503.33(b)(1) cannot be met for an aerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for 30 additional days at 20 degrees Celsius. When at the end of the 30 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 15 percent, vector attraction reduction is achieved.

4. The specific oxygen uptake rate (SOUR) for sewage sludge treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.

5. Sewage sludge shall be treated in an aerobic process for 14 days or longer. During that time, the temperature of the sewage sludge shall be higher than 40 degrees Celsius and the average temperature of the sewage sludge shall be higher than 45 degrees Celsius.

6. The pH of sewage sludge shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours.

7. The percent solids of sewage sludge that does not contain unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials.

8. The percent solids of sewage sludge that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials.

9. Sewage sludge shall be injected below the surface of the land, such that

   a) No significant amount of the sewage sludge shall be present on the land surface within one hour after the sewage sludge is injected, and

   b) When the sewage sludge that is injected below the surface of the land is Class A with respect to pathogens, the sewage sludge shall be injected below the land surface within eight (8) hours after being discharged from the pathogen treatment process.

10. a) Sewage sludge applied to the land surface shall be incorporated into the soil within six (6) hours after application to or placement on the land, unless otherwise specified by the permitting authority.

    b) When sewage sludge that is incorporated into the soil is Class A with respect to pathogens, the sewage sludge shall be applied to or placed on the land within eight (8) hours after being discharged from the pathogen treatment process.

11. The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12.0 S.U. or higher for two hours. This treatment may be conducted concurrently with the lime stabilization process for pathogen reduction listed above.

APPENDIX B

MONITORING WELLS AND LYSIMETERS

Monitoring Wells

Monitoring wells are constructed to provide representative ground water samples. The number of wells needed, and appropriate locations, depend on the location of the water table and the direction of ground water flow. If several aquifers could be affected, a set of monitoring wells is required for each aquifer. The depth of the monitoring wells is dependent on the depth of the aquifer(s) being sampled, and the predicted pathways of potential migrating contaminants. A qualified hydrologist or hydrogeologist should be involved in making these decisions, with decisions based on specific geologic and hydrologic conditions at each site. Consideration should be given to such factors as the following:

·Soil and rock formations existing at the site.

·Direction of ground water flow and anticipated rate of movement.

·Depth of seasonal high water table, and an indication of seasonal variations in ground water depth and direction of movement.

·Nature, extent, and consequences of ground water mounding, which may occur above the naturally occurring water table.

·Depth of impervious layers.

Generally, three or more monitoring wells are required per site, as follows:

·One background well located upgradient, and not affected or contaminated by biosolids application.

·Two or more (depending on site size and hydrogeological factors) wells located downgradient from the site, and used to detect leachate migration.

Often, monitoring wells are installed during the site selection and/or design investigations, after the hired professional has documented site conditions and feels satisfied that guideline criteria have been met. Installation at this time is efficient, and also allows for ample time to collect background samples.

Design of monitoring wells shall be appropriate for site conditions. Important features include an impermeable surface seal (to exclude surface water), plastic piping, a well screen, and appropriate backfill around the well screen. The composition of the materials selected for ground water monitoring well construction and sample collection and storage should be examined for possible contamination and interference with the chemical analysis. For example, galvanized pipe should not be used when testing for trace metals. Inert materials such as ABS or PVC plastic reduce the possibility of erroneous readings. Threaded piping should be used, to avoid possible contamination from solvent cement. Disinfection of wells, equipment, and containers, by chlorination or other means, is required if bacteriological examination is included.

However, no residual chlorine must remain after disinfection, or microbial counts will be reduced.

A dry drilling method (e.g., augering) is preferred for the construction of monitoring well boreholes, since it eliminates contamination of ground water with drilling mud, and it offers lower installation costs. Coring, with hollow or solid-stem augers, and hydraulic rotary drilling are the most common dry and wet drilling methods, respectively.

The boreholes are normally backfilled by packing with gravel and sand around the screened area of the pipe. A low-permeability material, usually bentonite clay or a sand-bentonite mixture, is then packed, to prevent surface water from channeling down the side of the casing. A concrete support is built around the above-ground portion of the well, and an outer casing and a lockable cap is installed to protect the well from damage or vandalism.

Lysimeters

The unsaturated soil zone is the soil zone located between the ground surface and the water table. Collection devices installed in the unsaturated zone will collect samples of the leachate migrating down from the biosolids-amended surface soil to the ground water aquifer, and can provide early warning of potential ground water contamination. Lysimeters are generally placed above seasonal high water table and at the depth where minimum contamination standards are established (e.g., three feet for land application). Location of lysimeters, including background lysimeters, is site-specific, and will be determined on a case-by-case basis. The Residuals Management Section of the Agency should be consulted.

Many types of lysimeters are available, and site conditions should be assessed to ensure that an appropriate lysimeter is selected. The most commonly used devices to collect leachate are pressure-vacuum lysimeters. They are relatively inexpensive and fairly reliable. In an optimum arrangement, lysimeters are installed at various depths in the unsaturated zone. Bentonite plugs are placed at the top and bottom of each hole, during backfilling, to prevent channeling of contaminated surface water directly to the lysimeter. Alternatively, the lysimeters can be installed horizontally into the soil, or at angles along the edge of the site. There is some indication in the literature that horizontal placement is better than vertical placement. The porous ceramic cup in each lysimeter should be surrounded by a slurry of wet, fine quartz which ensures hydraulic continuity with the surrounding soil.

After the lysimeters are in place, a vacuum is applied to the system, and the tubes are clamped off. To collect leachate samples, the vacuum is released, and the discharge tube is placed in a sample container. Air pressure is applied to the other tube, which forces the leachate up the tube and into the sample container.

The degree to which the porous cup selectively filters various elements may pose a problem in collection of representative samples. Preliminary testing should be conducted to evaluate whether the parameter of concern is filtered out by the porous cup.

APPENDIX C

SOIL PROPERTIES AFFECTING THE DISPOSAL OF SEWAGE BIOSOLIDS

Soil properties and features that should be considered when selecting potential sites for disposal of sewage biosolids include permeability, seasonal high water table, natural soil drainage class, available water capacity, susceptibility to flooding, and depth to bedrock. These parameters should be addressed in the application for certification. The critical properties are discussed briefly below.

Soil Permeability

The quality of soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. The U.S. Soil Conservation Service has developed the following permeability classes:

Very slow........................less than 0.06 in/hr
Slow................................0.06 to 0.2 in/hr
Moderately slow.............0.2 to 0.6 in/hr
Moderate.........................0.6 to 2.0 in/hr
Moderately rapid............2.0 to 6.0 in/hr
Rapid..............................6.0 to 20 in/hr
Very rapid.......................more than 20 in/hr

Natural Soil Drainage Class

Seven drainage classes are used by the Natural Resource Conservation Service.

Excessively Drained

Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained

Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained

Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately Well Drained

Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both. (A mesophyte is a plant which grows under conditions of well balanced moisture supply. The solum is the upper part of a soil profile, in which the processes of soil formation are active.)

Somewhat poorly drained

Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained

Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained

Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Seasonal High Water Table

The seasonal high water table is a zone of saturation at the highest depth during the wettest season. It is at least 6 inches thick, persists in the soil for more than a few days, and occurs within 6 feet of the soil surface. Soils that have a seasonal high water table are classified according to depth to the water table, type of water table, and time of year that the water table is highest, as follows:

Depth

Depth of seasonal high water table, from the soil surface to the zone of saturation, is given in feet.

Type

Three types of seasonal high water table are recognized within the soil: apparent, perched, and artesian.

Apparent Water Table

The level at which water stands in a freshly dug unlined borehole. It is influenced by the hydrostatic pressure, by pressure at greater depths penetrated by the borehole, by soil-water relations across impermeable layers, and by other factors. The term "apparent water table" is used for the level at which water stands in an uncased borehole provided the water is given adequate time for adjustment to the surrounding soil.

Perched Water Table

A water table that exists in the soil above an unsaturated zone. A water table may be inferred to be perched on the basis of general knowledge of the water levels of an area, the landscape position, the permeability of soil layers, and other evidence. To prove that a water table is perched, it is necessary to observe the water levels in cased wells placed above, in and below the less permeable layer. If the water level in the well above the less permeable layer is consistently higher than the levels in the other two wells, then the water table is perched.

Artesian Water Table

A water table that exists under hydrostatic head, beneath an impermeable layer. When the impermeable layer is penetrated by a cased borehole, the water rises. The final level of the water in the cased borehole may then be characterized as an artesian water table.

Areas with Water Tables Above the Soil much of the time, are characterized as wetlands.

Months - The months that the water table normally persists at the average highest depth range.

Depth to Bedrock

Depth to the solid rock or other impervious strata that underlie the soil.

Available Water Capacity

The capacity of soils to hold water available for use by most plants. The capacity, in a 60-inch profile, or to a limiting layer, is expressed as:

Very low - less than 2.4"
Low - 2.4 - 3.2"
Moderate - 3.2 - 5.2"

High - more than 5.2"

APPENDIX D

MONITORING REQUIREMENTS FOR DIFFUSE WASTE MANAGEMENT ACTIVITIES

Introduction

An in-depth guide to biosolids sampling and analysis entitled "*THE WASTEWATER TREATMENT PLANT OPERATOR'S GUIDE TO BIOSOLIDS SAMPLING PLANS*", was developed in 2007 by the New England Interstate Water Pollution Control Commission (NEIWPCC) in collaboration with the six New England states and New York state.

This guide provides an in-depth blueprint for developing a biosolids sampling plan and includes detailed sections on data quality objectives and analysis, sample collection and handling procedures, test methods, and many other aspects of biosolids monitoring.

A hard copy of the manual is available directly from NEIWPCC, or can be downloaded in electronic form at the following internet address:

http://www.neiwpcc.org/biosamplingguide.asp

The monitoring requirements and recommendations defined in this guidance document (not the NEIWPCC guide) were written for sewage biosolids with normal levels of contamination. Requirements for other wastes will be evaluated on a case-by-case basis; frequencies and parameters which provide a similar level of monitoring will be required. Information on test methods and more detailed information on field sampling techniques may be found in U.S. EPA manual SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods." Deviations from these methods must give equivalent results and be approved by the Agency. The specific analytical methods to be used are established in the adopted procedure titled "Procedure Designating Methods for Chemical and Biological Analyses for Residual Waste Management".

This appendix specifies accepted methods for monitoring of solid wastes, groundwater, soil and plant tissue. The appendix is structured as follows:

I. Solid Waste Samples

II. Groundwater Samples

III. Soil Samples

IV. Plant Tissue Samples

For each type of sample listed above, there are specifications for:

A. Sampling Frequency and Parameters

B. Sampling Methods

C. Sample Handling

I) Solid Waste Samples

A) Sampling Frequencies and Parameters

4) Parameter Group 1: Based on Flow (measured annual average)

a) Frequencies

i) At facilities with a flow greater than 1 MGD, sample biosolids for metals analysis four times per year. Sample for nutrients three times per year. Include sampling before spring and fall diffuse disposal episodes.

ii) At facilities with a flow less than 1 MGD, sample biosolids twice per year, before spring and fall diffuse disposal episodes.

b) Parameters

i) Percent total solids, %TS

ii) pH, hydrogen ion concentration

iii) Nutrients (dry weight, expressed as a percent):

aa) TKN, total Kjeldahl nitrogen
ab) NH3-N, ammonia nitrogen
ac) NO3-N, nitrate nitrogen
ad) TP, total phosphorus
ae) TK, total potassium
af) available phosphorus

iv) Metals (dry weight, expressed as mg/kg):

aa) Cadmium, Cd
ab) Chromium, Cr
ac) Copper, Cu
ad) Lead, Pb
ae) Mercury, Hg

af) Molybdenum, Mo
ag) Nickel, Ni
ah) Selenium, Se
ai) Zinc, Zn

5) Parameter Group 2:

a) Frequencies:

prior to certification, and at frequencies specified by certifications, on a case-by-case basis.

b) Parameters

i) Total PCB's (polychlorinated biphenyls, dry weight, expressed as mg/kg). Total organic halides (TOX) may be used as a screening test. If TOX is less than 10 mg/kg, dry, then PCB test is unnecessary.

ii) TCLP Toxicity Test Method, or other EPA-approved toxicity test method. Note that it is possible to use a calculation method for the TCLP metals. If this option is selected, dry mg/kg results must be available for arsenic, barium, selenium, and silver, in addition to the metals listed in Parameter Group 1 (except copper and molybdenum). All other TCLP parameters must be subjected to the full extraction and analysis.

6) Parameter Group 3:

Other parameters as required by the Agency, at frequencies to be determined on a case-by-case basis.

B) Sampling Methods

Representative Samples:

Solid waste samples should be representative of solid waste immediately prior to utilization or disposal. Representative samples should be collected for analysis at that point in the treatment or storage process where solid waste is normally withdrawn for utilization or disposal.

a) For samples at less than 15% total solids, taken from vessels other than lagoons, the contents of treatment or storage vessels must be well-mixed immediately prior to sample collection.

b) For samples at greater than 15% solids, or from lagoons:

i) Dewatering presses:

If possible, thoroughly mix the contents of a liquid treatment or storage vessel before pressing a liquid waste to be sampled in dewatered form. If the liquid can be mixed, one dewatered grab sample is sufficient. If liquid cannot be mixed, collect at least five representative grab samples during the press run. To make a composite sample, thoroughly mix the grab samples in a clean plastic bucket, then transfer an adequate amounts of the mixture to the sample containers. Use non-metallic tools for mixing and transfer.

ii) Drying beds, storage bunkers, storage piles:

Composite sample required. Collect a minimum of five grab samples from representative areas and mix thoroughly in a clean, plastic bucket.

iii) Lagoons:

Composite samples of the biosolids are required. The use of a device similar to a Sludge Judge is recommended. At least five grab samples should be mixed thoroughly in a clean, plastic bucket.

C) Sample Handling

1) The following are directions for the analytical parameters indicated. Requirements of laboratories may vary. Check the specific requirements of your laboratory.

a) Percent Total Solids (Total Residue)

i) Sample size:

250 milliliters (ml)

ii) Sample containers:

Plastic, glass, or Teflon airtight containers. Heavy-duty plastic bags may be adequate, if leak-proof. Containers must be clean, and should be rinsed with ASTM Type II reagent water (distilled water), then dried. Container size should approximate sample size to minimize interaction with air and evaporation.

iii) Sample preservation:

Cool at time of collection by placing on ice or by refrigeration. Maintain sample at near-freezing temperature (4^{o}C, 39^{o}F) until analysis.

iv) Maximum holding time until analysis: testing should be done as soon as possible. Maximum seven days.

b) pH (Hydrogen Ion Concentration)

i) Sample size:

250 ml

ii) Sample containers

Plastic, glass, or Teflon airtight containers. Heavy-duty plastic bags may be adequate, if leak-proof. Containers must be clean, and should be rinsed with Type II water, then dried. Container size should approximate sample size to minimize interaction with air.

iii) Sample preservation:

testing should be done as soon as possible. If the pH of a sample is not taken immediately, place sample in an airtight container that is filled to capacity. Maintain sample at 4^{o}C (39^{o}F) until analysis.

iv) Maximum holding time for analysis is six hours. If not analyzed within 6 hours, indicate holding time on report.

c) Nutrients:

Nitrogen series and total phosphorus. Total potassium is treated as a metal (see d.).

i) Sample size:

250 ml.

ii) Sample containers:

Plastic, glass, or Teflon airtight container. Containers must be clean, and should be rinsed with Type II water, then dried. Container size should approximate sample size, to minimize interaction with air.

iii) Sample Preservation:

maintain sample at 4^{o}C (39^{o}F) until analysis. Testing should be done as soon as possible. If a non-dewatered sample must be held longer than 24 hours, also preserve it with 0.5 ml concentrated sulfuric acid per 250 ml of sample. Acid may be omitted for dewatered samples.

iv) Maximum holding time until analysis: twenty-eight days, for preservation by sulfuric acid and for dewatered samples.

d) Metals

i) Sample size:

minimum of 250 ml total, all metals combined. Mercury sample, minimum 100 ml, could be stored separately (see iv. below).

ii) Sample containers:

Plastic, glass or Teflon closed containers. Prior to use, containers must be cleaned and rinsed sequentially with 1:1 nitric acid (HNO3), tap water, 1:1 hydrochloric acid (HCl), tap water, and Type II water. Container size should approximate sample size, to minimize interaction with air.

iii) Sample preservation:

Maintain sample at 4^{o}C (39^{o}F) until analysis.

iv) Maximum holding times until analysis:

Six months except 28 days for mercury. Mercury sample could be stored separately.

e) Total PCB's (Polychlorinated Biphenyls)

i) Sample size:

500 ml

ii) Sample container:

Amber-colored, wide-mouth 500 ml glass jar with Teflon-faced cap. Clean container required. Container size should approximate sample size, to minimize interaction with air.

iii) Sample preservation:

Maintain sample at 4°C (39°F) until analysis.

iv) Maximum holding time until analysis

Seven days to extraction, except seventy-two hours if pH is less than 5 or greater than 9. Maximum thirty days between extraction and analysis, but testing should be done as soon as possible.

II) Groundwater Samples

A) Sampling Frequencies and Parameters

The frequency of sample collection is dependent upon the goals of a particular groundwater monitoring (i.e., whether it is long-term or short-term). The estimated rate of pollutant travel in a given hydrogeologic setting will indicate intervals of time which will show a change in water quality. Careful analyses of the initial and later samplings may indicate that adjustment of the sampling frequency is warranted. Arbitrary selection of sampling frequency may not reveal the true picture of groundwater quality at the disposal site. This document only sets the minimum requirement for sampling.

1) Frequencies

a) Background:

Before permitted waste is applied to site.

b) Twice per year, during site use:

i) In spring, after thaw but before application.

ii) In fall, before application.

2) Parameters

a) TDS, total dissolved solids, or total filterable residue (mg/l)

b) Ionic Concentrations:

i) pH, hydrogen ion concentration
ii) Specific conductivity (micro-mhos/centimeter)
iii) Total hardness (mg $CaCO_3$/l)
iv) Alkalinity (mg $CaCO_3$/l)

c) Nutrients (mg/l):

i) TKN, total Kjeldahl nitrogen
ii) NH_3-N, ammonia nitrogen
iii) NO_3-N, nitrate nitrogen
iv) TP, total phosphorus
v) TK, total potassium

d) Metals (dissolved, mg/l):

i) Arsenic, As
ii) Barium, Ba
iii) Cadmium, Cd
iv) Chromium, Cr
v) Copper, Cu
v) Lead, Pb
vi) Mercury, Hg
vii) Nickel, Ni
viii) Selenium, Se
ix) Silver, Ag
x) Zinc, Zn

f) Electrolytes (mg/l):

i) Sodium, Na
ii) Chloride, Cl
iii) Sulfate, SO_4

g) Organic Analytes:

i) Total organic carbon, TOC (mg/l)
ii) Polychlorinated biphenyls (PCB's) micrograms per liter (ug/l): Total organic halides (TOX) may be used as a screening test.

7) Other parameters as required by the Agency, at frequencies to be determined on a case-by-case basis.

II) Sampling Methods

1) Representative Samples: Samples must represent the condition of the groundwater in the area at the time of collection. Standing water in a well may differ in composition from groundwater; therefore the well must be cleared before collection.

a) Clearing Stagnant Water

i) Measure depth and calculate volume of water in well.

ii) Remove at least three times the volume of water in the well before sample collection. Withdrawal of water from the top of the water column ensures greater replacement of static well water with fresh groundwater.

iii) Evacuation to dryness is acceptable for clearing, if the recharge is slow enough so that water does not cascade down the inside of the casing.

b) Scheduling of sample collection:

Background samples and point-of-compliance samples should be collected at the same session. In no case should the time interval between collections be greater than the expected time of groundwater travel between wells.

c) Filtering:

In general, samples should be filtered before preservation, to remove contamination from sediments in the well. A less desirable alternative to filtering is to allow sediment to settle in collection bottles for a few minutes, then decant to clean collection bottles. Filtered samples may be preserved in the lab.

i) For field filtering, use of 102 or 142 millimeter backflush filters with pop-out polycarbonate centers and swing-away bolts is recommended. For filter paper use nitrocellulose, pore size 0.45 micrometers.

ii) Rinse filter by filtering 250 ml of sample. Discard the 250 ml portion.

iii) Filter sample and fill sample containers.

iv) Backflush filter with 1000 ml ASTM Type II reagent water (distilled water) between wells and after completion of sampling.

v) Upon completion of sampling, rinse filter with 500 ml 10% nitric acid, followed by 1000 ml Type II water. (May be done in lab. See below, 2.d.i., for special consideration.)

vi) If field filtering is not possible, and decanting is impractical, samples should be preserved in the field and filtered in the lab (if particulates are present).

2) Sampling Devices and Use

a) General:

A sampling device should be constructed of materials that do not contaminate the sample. It must perform and be operated so as to ensure collection of a representative sample. If the device is to be used for several wells, or removed and reused in the same well, it must be easily cleaned. It must be efficient enough to withdraw sufficient sample volume for all analyses in one session.

i) The following are not generally acceptable for collecting samples for analysis: gas-driven piston pumps, suction-lift pumps, submersible diaphragm pumps, gas-lift samplers, and impeller pumps.

b) Bailers:

Bailers can be metal, plastic, or, infrequently, glass or glass-lined. It is recommended that the line be made of braided nylon fish line (30 pound minimum). Other material may be used but should be easily cleaned.

i) Before and after use in the field, bailer should be cleaned with a non-contaminating soap, then thoroughly rinsed 3 times with tap water and 3 times with ASTM Type II (distilled) water.

ii) Immediately before initial use of bailer in each well, rinse bailer surfaces 3 times with Type II water, then let drain. If bailer is not used to evacuate well, rinse 3 times with well water before collecting sample.

iii) Pour rinse water and bailed water away from well casing.

iv) Do not touch bailer to sample bottle.

v) Sample is taken from top of bailer (unless the bailer is specifically constructed to release sample at bottom).

vi) For special considerations for individual analysis, see section d below.

c) Pumps:

Peristaltic pumps with silicone tubing are generally recommended.

i) Before and after use in the field, tubing should be cleaned with a non-contaminating soap, then thoroughly rinsed with tap water and with at least one liter of Type II (distilled) water.

ii) Immediately before initial use in each well, rinse tubing with at least one liter of Type II water. If tubing is not used to clear well, rinse with at least one liter or more of well water before collecting sample.

iii) Pour rinse water and evacuated water away from well casing.

iv) Do not touch tubing to sample bottle.

v) For special considerations for individual analysis, see section d below.

d) Special Considerations for Individual Analyses:

i) Nitrogen Series:

Sampling devices that are used to collect groundwater for the nitrogen series (Kjeldahl, ammonia, nitrate) should be rinsed with 10% sulfuric acid rather than 10% nitric acid. See B.1.c.v. As an alternative, a trip blank may be taken. If more accuracy is required, a blank should be taken before use in each well.

ii) Sulfate:

Sampling devices that are used to collect groundwater for sulfate should be rinsed with 10% nitric acid rather than 10% sulfuric acid. As an alternative, a trip blank may be taken. If more accuracy is required, a blank should be taken before use in each well.

iii) Metals:

When a metal bailer is used to collect samples to be analyzed for a metal, consideration needs to be given to the level of detection required and the corrosiveness of the water sample.

iv) Organic Analytes:

Samples for organic constituents (particularly PCB's) should be collected with a Teflon or glass bailer or similar device, to prevent analyte from adhering to collection device. Organics samples should not be pumped. Sample bottles must not be prewashed with sample before collection. Care must be taken to completely fill bottles, so that volatile constituents will not volatilize into air pockets.

C) Sample Handling

1) For specific guidance on handling groundwater samples contact the Residuals Management Section or see the NEIWPCC sampling guide.

III) Soil Samples

A) Sampling Frequencies & Parameters

I) Diffuse Disposal Facilities

a) Twice per year, spring and fall, prior to waste application.

i) pH, hydrogen ion concentration.

ii) Lime requirement based on pH and reactive aluminum.

iii) Nutrients (dry weight, expressed as a percent):

aa) Total and water extractable phosphorus.
ab) Available potassium.
ac) Available magnesium.

b) Prior to certification and at least 6 months prior to the end of each certification period:

i) Metals (dry weight, expressed as mg/kg):

aa) Arsenic, As

ab) Cadmium, Cd
ac) Chromium, Cr
ad) Copper, Cu
ae) Lead, Pb
af) Mercury, Hg
ag) Molybdenum, Mo
ah) Nickel, Ni
ai) Selenium, Se
aj) Zinc, Zn

ii) Total PCB's (dry weight, expressed as mg/kg). Not required at aerated lagoon cleanout disposal sites.

c) Optional: UVM Nitrate Test for Corn, in June/July. Test gives an estimate of available nitrogen from all sources - organic and inorganic - and indicates how much fertilizer, if any, is needed for maximum yield.

d) Other parameters and frequencies, as determined by the Agency on a case-by-case basis.

e) For soils, pH is determined on a water or salt (0.01m $CaCl_2$) basis. EPA SW-846 specifies the salt basis for calcareous soils. The salt basis gives less variable measurements for the same field, and is more useful for field management. Either method may be used, but the same method must be used continuously for a given field. The salt basis typically gives readings 0 to 1 standard pH unit lower than readings from the water basis, with readings 0.5 unit lower on an average. The Solid Waste Management Rules require a soil pH of 6.5 to 8.0, based on water. Unless both tests are run on the same samples, to determine the actual difference, a range of 6.0 to 7.5 will be used for results from the salt method.

B) Sampling Methods

1) Representative Samples:

Soil samples must represent the existing conditions of the field or area from which they were taken. For background constituent levels, representative samples can be taken at the time backhoe test pits are dug, during the investigative and site documentation stage. For the periodic sampling required, borings or cores can be taken. Unless otherwise specified, the sample should be taken in the plow layer of the field (at least 6 inches deep).

a) Do not sample areas such as:

i) Turf at edges of fields or between fields

ii) Lime, biosolids, or manure piles (except from areas surrounded by stockpile berms, after removal of biosolids)

iii) Animal droppings

iv) Fences or roads

v) Rows where fertilizer has been banded

vi) Eroded knolls

vii) Low areas, unless a low area is large. In that case, sample the low area separately.

2) Composite Samples:

Collect composite samples consisting of cores or borings randomly collected from at least ten different points in the designated area to be sampled (see 3 below).

3) Minimum number of samples recommended:

a) If field has uniform soil type (USDA/SCS): One COMPOSITE sample for every 4 acres.

b) If field has more than one soil type: For each USDA/SCS soil type mapping unit, collect one composite sample for every 4 acres, or the entire soil mapping unit, whichever is the lesser area. Contact the Agency for guidance.

c) If designated field has more than one crop, then sample each crop area as a separate field.

4) Sample Mapping

a) Number all samples. On a field map, show composite sample areas and sample numbers.

b) Show current crop management on the field map.

C) Sample Handling

1) The following are specific directions for the analytical parameters indicated:

a) Percent Total Solids (Total Residue)

i) Sample size:

200 grams (approx. 1 cup)

ii) Sample containers:

Plastic, glass, or Teflon airtight containers. Heavy-duty plastic bags may be used. Containers must be clean, and should be rinsed with ASTM Type II reagent water (distilled water), then dried. Container size should approximate sample size, to minimize interaction with air and evaporation.

iii) Sample preservation:

Cool at time of collection by placing on ice, or by refrigeration. Maintain at near-freezing temperature ($4^{o}C$, $39^{o}F$) until analysis.

iv) Maximum holding time until analysis:

Testing should be done as soon as possible. Maximum seven days.

b) pH (Hydrogen Ion Concentration) and Lime Requirement

i) Sample size:

50 grams (approx. 1/4 cup)

ii) Sample container:

Plastic, glass or Teflon airtight containers. Heavy-duty plastic bags may be used if leak-proof. Containers must be cleaned, and should be rinsed with Type II water, then dried. Container size should approximate sample size, to minimize interaction with air.

iii) Sample preservation:

Testing should be done as soon as possible. If the pH of a sample is not taken immediately, place sample in an airtight container that is filled to capacity. Maintain sample at 4^oC (39^o F) until analysis.

iv) Maximum holding time until analysis is six hours. If not analyzed within 6 hours, indicate holding time on report.

c) Available Nutrients

i) Sample size:

50 grams (approx. 1/4 cup)

ii) Sample containers:

Plastic, glass, or Teflon airtight containers. Containers must be clean, and should be rinsed with Type II water, then dried. Container size should approximate sample size, to minimize interaction with air.

iii) Preservation:

Maintain sample at 4^oC (39^oF) until analysis. Testing should be done as soon as possible.

iv) Maximum holding time until analysis: twenty-eight days.

d) Total Metals

i) Sample size:

200 grams (approximately one cup). A minimum of 10 grams per metal is suggested. Mercury sample should be stored separately (see v. below).

ii) Sample containers:

Glass, plastic, or Teflon closed containers. Prior to use, containers must be cleaned and rinsed sequentially with 1:1 nitric acid (HNO3), tap water, 1:1 hydrochloric acid (HCl), tap water, and ASTM Type II distilled water. Container size should approximate sample size, to minimize interaction with air.

iii) Sample preservation for all metals except mercury: Air-dry samples at less than 40°C (104°F), then grind them in a non-metallic system and pass them through a 2 mm sieve. Until drying, store samples at 4°C (39°F).

iv) Sample preservation, for mercury (Hg) only: Air-dry samples at room temperature or store at 4°C (39oF). Dried samples should be ground (non-metallic system) and passed through a 2 mm sieve.

v) Maximum holding time until analysis:

Six months, except twenty-eight days for mercury. Mercury sample could be stored separately.

IV) Plant Tissue Samples

A) Sampling Frequencies and Parameters

1) Frequencies

a) Prior to certification (if plants are available), and six months prior to the end of each certification period.

b) Yearly, if any metal has been applied to more than 75% of site lifetime amount of metal allowable, or if metal is present in biosolids above USDA concentration limit, or if the Agency determines that plant uptake of the metal is of concern.

2) Parameters

a) Total Nutrients (dry weight, expressed as percent):

i)TN, Total Nitrogen
ii)TP, Total Phosphorus
iii)TK, Total Potassium

b) Total Metals (dry weight, expressed as mg/kg):

i)Cadmium, Cd
ii)Copper, Cu
iii)Lead, Pb
iv)Molybdenum, Mo
v)Nickel, Ni
vi)Selenium, Se

3) Other parameters and frequencies, as determined by the Agency on a case-by-case basis.

B) Sampling Methods

1) General:

Mature plants (just prior to harvest) are preferred for sampling, as this is the age of the crop that will be fed to livestock. Subsequent samples from the same field should be taken at the same age of crop. If sampling must be done other than at time of harvest, contact the Agency for sampling guidelines.

2) Representative Samples (Crops):

a) Sample above-ground portion of plant that will be fed to animals. Sample should be representative of crop use. For example, when grain is separated from crop for feeding, it should be sampled separately.

b) Plant sampling should mirror soil sampling: typically one sample per four acres. See Soils (III) for specifics.

Corn: For each sample, select a minimum of four plants representative of the area. If a chopper is available, select 10 to 25 plants and take a representative sample from the processed plants.

Grasses: A minimum of fifteen plants should be collected per sample.

Avoid portions covered with dust, or dirt, or damaged by insects, machinery or disease, unless they are representative of the entire crop.

3) Representative Samples (Silviculture):

a) Plant sampling should mirror soil sampling: typically one sample per four acres. See Soils (III) for specifics. Types of samples will vary considerably. Sample parts of plants that are used as food by wild animals.

b) Specific Sampling Requirements:

i) Sample coniferous foliage during the dormant season.

ii) Sample deciduous leaves at maturity.

iii) Sample both dominant and co-dominant trees.

iv) Sample upper portions of the crown for foliage samples.

v) Do not sample foliage or twigs which bear cones.

C) Sampling Handling

1) General

a) Before drying samples, rinse them with ASTM Type II reagent water (distilled water). If possible, rinse before chopping.

b) Samples should be dried in a forced-air drying oven at close to, but less than, 65^oC (149^oF), as quickly as possible. If a forced-air drying oven is not immediately available, samples should be cooled at collection and stored at 4^oC (39^oF), or frozen in heavy, polyethylene bags for not more than 48 hours. Samples may be air-dried at room temperature (spread them out on clean brown paper), with sufficient ventilation to prevent molding. Green samples decompose quickly when shipped in airtight containers. With adequate precautions against heating, samples may be delivered to labs in clean brown paper bags or cardboard boxes.

c) After drying, grind samples to a fine grain and store in airtight containers for analysis.

2) It is recommended that holding times of dried plant samples not exceed those of dewatered solid waste samples.

The following references have been used to compile Appendix D.

1. EPA (WH-522) Contract #68-03-3410, "Sampling Procedures and Protocols for the National Sewage Sludge Survey," August 1988.
2. EPA (WH-522) Contract #68-01-6990, "Analytical Methods for the National Sewage Sludge Survey," August 1988
3. EPA Contract #68-01-7043, WA #P2-5, Draft, "POTW Sludge Sampling and Analysis Guidance Document," June 1988.
4. EPA, SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," third edition, November 1986.
5. EPA - 625/1-83-016, Process Design Manual for "Land Application of Municipal Sludge," October 1983.
6. EPA - 600/4-79-020, Manual of "Methods for Chemical Analysis of Water and Wastes," revised March 1983.
7. Manitoba Agricultural Farmfacts, Agdex 533, "Plant Tissue Analysis," March 1981.

8. VT Agency of Natural Resources, Water Resources Laboratory, Field Methods Manual, revised October 1989.
9. VT. Agency of Natural Resources, Water Resources Laboratory, Analytical Methods Manual, revised December 1989.
10. NEIWPCC – "The Wastewater Treatment Plant Operator's Guide to Biosolids Sampling Plans", September 2006.

APPENDIX E

CALCULATION OF BIOSOLIDS LAND APPLICATION RATES

1. BIOSOLIDS

Biosolids land application rates are based on available nitrogen supplied by the biosolids relative to the crop nitrogen requirement, or by the metals content of the biosolids, whichever is more limiting. Usually nitrogen is the limiting factor. The application rate is often referred to as an "annual" application rate, but the rate will actually depend on the site crop management practices. The application rate is not based on a calendar year. Generally it is based instead on nitrogen uptake and use by a crop.

Biosolids nitrogen (N) exists in two forms, organic and inorganic. The inorganic nitrogen consists of ammonia-nitrogen and nitrate-nitrogen, and is readily available to plants. The organic nitrogen must be mineralized (decomposed) over time before it is available for plant use. Rates of mineralization are given in Appendix F.

% inorganic N = % ammonia N (NH_3-N) + % nitrate N (NO_3-N)

% organic N = % Total Kjeldahl N (TKN) - % ammonia N (NH_3-N)

Research has shown that approximately 40% of the organic nitrogen in aerobically digested biosolids and 20% of the organic nitrogen in anaerobically digested biosolids is available to plants in the first year. All of the nitrate is available under all conditions. If a biosolids is not injected or otherwise immediately incorporated, only 30% of the ammonia is available, due to volatilization to the atmosphere. Otherwise, all of the ammonia is available.

In 2005, the Residuals Management program determined that there had been several instances in which biosolids had been applied to agricultural sites at a rate that provided more nitrogen than the crops being grown required. The program determined that these over-applications had occurred due to deficiencies in the rate calculation model that has been in use for the past two decades (the model was first formally established in the 1989 Guidelines), primarily as a result of how the model was used to account for nitrogen availability from biosolids applied in the fall of the year, multiple application events during the calendar year, and for any dairy manure that was co-managed on the sites.

In order to prevent this situation from recurring, the program moved to create a new model for calculating application rates that accounts for multiple application events over the course of a single growing season as well as incorporating the model used by the Vermont Department of Agriculture, Food and Markets for determining nitrogen derived from dairy manure management on cropped fields. The new model also provides separate sets of equations for spring and fall application events. The objective of the new model was to provide a more accurate calculation of the amount of plant available nitrogen (PAN) that will be provided under the different management scenarios used in Vermont.

An extensive literature review was conducted to gather and evaluate research that has been conducted on the rate at which organic forms of nitrogen, which are not available for plant uptake and use, are mineralized to inorganic, plant available nitrogen species. Ultimately, the new biosolids model was based primarily upon three research projects:

for biosolids:

> "Estimating Plant Available Nitrogen in Biosolids"; John T. Gilmour, et. al.; Water Environment Research Federation; Project 97-REM-3
> which is available on the internet at:
>
> http://www.epa.state.oh.us/dsw/sludge/WERF_sludge_PAN_calcs.pdf
>
> and,
>
> "Nitrogen Availability from Sewage Sludge"; Magdoff and Amadon;
> Journal of Environmental Quality; 1980, 11 (4)
>
> which is not available on-line, and

for manure:

> "Nutrient Recommendations for Field Crops in Vermont"; Jokela, Magdoff, Bartlett, Bosworth, and Ross, University of Vermont; UVM Extension Publication BR 1390
>
> which is available on the internet at:
>
> http://www.uvm.edu/extension/publications/nutrientrec/manure.htm

Although the new model uses the same basic framework as the old model, the old model's sets of "stand alone" equations used for the various management scenarios have been integrated into a single set of equations that should help ensure their proper application. Two versions of the new model have been developed: 1) a hard copy version, based in Microsoft Word, that can be printed and then calculated manually, and 2) an electronic version, based in Microsoft Excel, that requires data entry only and in which the computer performs the calculations.

Within the model, there are several significant changes to the underlying equations that should provide a more accurate accounting of the nitrogen cycle's dynamics and which should lead to a closer balance between the nitrogen requirement of the crop being grown and plant available nitrogen. These changes include:

1) The organic nitrogen mineralization rates for spring applied biosolids have not been revised because there is a satisfactory correlation between the work of Magdoff and Amadon in the late 1970's and more contemporary research. However, the contemporary research and recurrent requests by farmers to apply additional nitrogen to land application sites early in the growing season on sites where biosolids had been applied the previous fall, suggests that over the winter, biosolids mineralize at

slightly slower rates than was observed in Magdoff and Amadon's research. Therefore, the new model employs lower first year mineralization rates for fall applied biosolids than did the old model.

2) It is not appropriate to carry over the significant portions of inorganic nitrogen (NH_4 and NO_3) through the winter that was done under the old model. The new model accounts for the near complete loss of these forms of nitrogen (due to volatilization, denitrification, and leaching) over the winter months. Similarly, the old model does not account for sufficient losses of the ammonium forms (NH_4) of nitrogen due to volatilization under scenarios where the biosolids are not injected or incorporated. Accordingly, the availability rates for the inorganic forms of nitrogen employed in the new model vary significantly from the old model. These changes can result in higher calculated application rates depending on the management scenario and season in which the biosolids are applied.

3) The old model did not provide a set of equations specific for lime stabilized lagoon biosolids. These biosolids are considered in the new model.

4) The old model was very unclear and inefficient in the manner in which residual nitrogen derived from previous biosolids applications was calculated. The new model has addressed those issues and more accurately accounts for nitrogen carryover, particularly under management scenarios where biosolids may be applied more than once per year and where application events vary in the season during which they occur from year to year.

5) The new model accounts for the loss of the ammonia and nitrate forms of nitrogen (via leaching, volatilization, and plant uptake) in its calculation of residual nitrogen availability, where these factors were only partially considered in the old model.

6) The old model assumed that the nitrogen content of all dairy manure is 10 lbs N/wet ton, did not accurately account for residual nitrogen from past manure applications, and did not account for variations in nitrogen mineralization and availability (0% - 95% availability) due to factors such as manure management practices and site soil conditions. The new model integrates the Vermont Department of Agriculture, Food and Markets' method of calculating manure derived plant available nitrogen into the overall nitrogen balance. The new model therefore accounts for variations in manure's nitrogen content based upon its solids content (5.5 – 10 lbs N/wet ton) and variations in that nitrogen's mineralization rate and availability based upon such factors as time to tillage, soil drainage classification, and the season in which is was applied to the site.

7) A comparison of the availability of the various forms of nitrogen for the old and new models is presented in the following table:

		% availability of nitrogen forms							
		SPRING APPLICATIONS				FALL APPLICATIONS			
management technique	model	organic	inorganic	NH_4	NO_3	organic	inorganic	NH_4	NO_3
anaerobic injected	old	20	100	0	0	20	100	0	0
	new	20	100	0	0	15	0	25	0
anaerobic not injected	old	20	0	50	100	20	0	50	100
	new	20	0	30	100	15	0	5	0
aerobic injected	old	40	100	0	0	40	100	0	0
	new	40	100	0	0	35	0	25	0
aerobic not injected	old	40	0	50	100	40	0	10	100
	new	40	0	30	100	35	0	5	0
lagoon any method	old	0	0	0	0	0	0	0	0
	new	40	0	0	100	35	0	0	0

The Department developed model is the only approved method for calculating application rates.

The model, which is based in Microsoft Excel©, is available on the internet by following the link at the following site:

http://www.anr.state.vt.us/dec/ww/residuals.htm

If you do not have internet access, contact the Residuals Management Program and a copy can be provided on either a floppy disc or on a CD.

2. SEPTAGE

Septage application rates may be calculated either of two ways:

1. By the analysis of a representative sample of a large quantity of septage that has been accumulated in a storage facility (eg. A lagoon or storage tank) and which will be applied to the land in a single application event. In this case, the application rate for the site may be calculated using the Department developed and approved application rate calculation model.

2. By the use of the formula developed by the USEPA:

   Application rate = N ÷ 0.0026

   Where N = the number of pounds per acre of nitrogen required by the crop being grown.

APPENDIX F

TABLES FOR DETERMINING BIOSOLIDS LAND APPLICATION RATES

TABLE 1

ANNUAL NITROGEN, PHOSPHORUS AND POTASSIUM UTILIZATION BY SELECTED CROPS IN VERMONT (lbs per acre)[1]

CROP	YIELD	NITROGEN	PHOSPHORUS	POTASSIUM
Corn				
silage	20 tons	150	70	200
grain	100 bushels	150	70	200
Forage Grasses				
bromegrass	4 tons	150	40	150
reed canary grass	5 tons	150	40	150
orchard grass	5+ tons	150	40	150
timothy	4 tons	150	40	150

[1] The values above are the fertilizer requirements for Vermont crops established by the University of Vermont Extension Service and adopted by the Vermont Agency of Food, Agriculture, and Markets. Since land management practices and the cropping history of sites vary, county Extension Service agents should be contacted for additional information on fertilizer needs.

TABLE 2

RELEASE OF NITROGEN DURING THE DECOMPOSITION OF SEWAGE BIOSOLIDS IN SOIL (lb. N released per dry tons biosolids added)

Years After Initial Year of Biosolids Application	Mineralization Rate (%)	Percent Organic N Content of Biosolids ($\%TKN - \%NH_3\text{-}N$)								
		2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1	10	4	5	6	7	8	9	10	11	12
2	5	2	2.5	3	3.5	4	4.5	5.0	5.5	6
3	5	2	2.5	3	3.5	4	4.5	5.0	5.5	6

Table 2 is based on the following formula:

lb N released per dry ton biosolids added
= (% mineralization rate/100) x (% organic nitrogen/100) x 2000/100

TABLE 3

SITE LIFETIME AMOUNTS OF WASTE METALS ALLOWED ON LAND APPLICATION SITES[1]

(maximum amounts of metals, lb./acre)

METAL	CUMULATIVE LOADING LIMIT (lbs/acre)	
	lbs/acre	kilograms/hectare
Arsenic (As)	36.6	41
Cadmium (Cd)[2]	4.5	5.04
Copper (Cu)	1339.5	1500
Lead (Pb)	267.9	300
Mercury (Hg)	15.2	17
Nickel (Ni)	375.1	420
Selenium (Se)	89.3	100
Zinc (Zn)	2500.5	2800

[1] Established by federal rule at 40 CFR 503.13 – Table 2

[2] Established by Vermont Solid Waste Management Rule, §6-702.

APPENDIX G

REMAINING SITE LIFE CALCULATIONS

§6-606 (b)(1)(B) of the Rules requires each application for certification to provide an estimate of the remaining useful life of each diffuse disposal site. Typically, this calculation is based on the most recently calculated maximum allowable application rate. However, if recent applications to the site have used up a large proportion of the nitrogen requirement and the calculation has yielded an abnormally low maximum allowable application rate, it is more appropriate to base the site life calculation on the average rate at which biosolids have been applied to the site.

To calculate the remaining useful life of a site, the following process is used:

1) Calculate the number of dry tons/acre of biosolids that have been applied to the site in each application event throughout the history of the site's use.

2) Calculate the pounds/acre for each of the nine regulated metals that was applied to the site in each application event, using the formula:

(dry tons/acre applied) X (mg/kg, dry weight of metal) X (0.002)

3) Sum the pounds/acre for each regulated metal that has been applied to the site to calculate the total number of pounds of each regulated metal that has been applied to the site.

4) Subtract the total pounds/acre of each metal that has been applied to the site from the corresponding maximum allowable cumulative loading in the following table to determine the remaining number of pounds/acre of each regulated metal that may be applied to the site.

METAL	lbs/acre CUMULATIVE MAXIMUM
Arsenic (As)	36.6
Cadmium (Cd)	4.5
Chromium (Cr)	257.0
Copper (Cu)	1339.5
Lead (Pb)	267.9
Mercury (Hg)	15.2
Molybdenum (Mo)	67.0
Nickel (Ni)	375.1
Selenium (Se)	89.3
Zinc (Zn)	2500.5

5) Divide the remaining number of pounds/acre of each regulated metal by the maximum allowable application rate (or the average application rate, as explained above), to determine the number of years remaining based on each regulated metal.

6) The lowest number of years, as calculated in 5), is the estimated remaining site life.