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THE REGULATION OF LAND APPLICATION OF BIOSOLIDS: SEWAGE SLUDGE, ANIMAL MANURE, AND SEPTAGE

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The Regulation of Land Application of Biosolids: Sewage Sludge, Animal Manure, and Septage.

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Executive Summary

The protection of human health and the environment is of paramount concern in the regulation of land application of biosolids (including animal manure, sewage sludge and septage). This report describes the state of regulation of land application of biosolids in a number of North American and European jurisdictions, with specific reference to: the U.S. Federal Standards for the Use or Disposal of Sewage Sludge; nutrient management plans, stabilization and monitoring of pathogens, siting restrictions, and biosolid regulations for concentrated animal feeding operations.

In recent years, a number of State, Provincial and Federal authorities in North America and Europe have undertaken extensive reviews of the regulation of land application of biosolids. Such reviews have been undertaken in response to rapid and very significant changes in agricultural practices, and to the availability of new scientific data about the potential environmental and health risks of using biosolids on agricultural land. The most significant trend in commercial agriculture in North America is the growth and concentration of livestock operations. The U.S. Environmental Protection Agency has recently proposed extensive changes to the regulation of waste management on concentrated animal feeding operations.[1] In British Columbia, the Provincial government has undertaken a review of the regulation of biosolids, and is currently proposing to replace existing regulations with the *Organic Matter Recycling Regulation*.[2] The British Columbia draft *Organic Matter Recycling Regulation* includes specific regulation of land application of biosolids, including animal manure, sewage sludge and septage.

In the United States, the regulation of land application of sewage sludge and septage is governed by the U.S. Environmental Protection Agency's Part 503 *Standards for the Use or Disposal of Sewage Sludge*.[3] The Part 503 regulations establish standards, general requirements, pollutant limits, management practices, and operational standards for the final use or disposal of sewage sludge. The rules also include requirements for the treatment of sewage sludge for pathogen and vector attraction reduction. State regulations must comply with the minimum requirements established in the federal regulations. The Part 503 regulations are the starting point for any analysis of the current state of regulation of land application of biosolids in the United States. An overview of the Part 503 regulations is contained in the body of this report.

The U.S. Part 503 regulations classify biosolids according to the degree of

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[1] . See: *Proposed Regulations to Address Water Pollution from Concentrated Animal Feeding Operations*, Office of Water, EPA, January 2001. A copy of the proposed regulations is available on-line at: http://www.epa.gov/owm/afo.htm.

[2] . See: the draft *Organic Matter Recycling Regulation*, available on-line at: http://www.bc-environment-issues.com/organic_matter_recycling_reg_1.html

[3] . See: 40 C.F.R. 503.

treatment for pathogens. Class A biosolids are biosolids which have been treated to eliminate virtually all pathogens. Class B biosolids have been treated for pathogen reduction, but may still contain significant numbers of pathogens. Class A biosolids are exempt from the Part 503 regulations; however, very specific siting and application restrictions apply to Class B biosolids. Both Class A and Class B biosolids are used widely across the United States. Anectodal evidence suggests that Class B biosolids are used more frequently than Class A biosolids, partly because it is easier to obtain Class B biosolids, and because Class A biosolids often contain fewer nutrients.[4] Survey data about which classification of biosolid is used most frequently in the United States will soon be available. A comprehensive report on the State use of biosolids, *Summary of State Biosolids Programs* is forthcoming from the U.S. Environmental Protection Agency.[5] This report, which is currently in draft form, will provide information about which biosolids are used most frequently in different U.S. States. The data for this report was obtained from State biosolid program databases.

Biosolids are rich in nutrients and are an inexpensive fertilizer for croplands. However, excessive application of nutrient-rich biosolids may cause nitrogen and phosphorus contamination of waterways and groundwater, and may lead to the contamination of water supply by pathogens. Nutrient management regulations are an important mechanism for the prevention of pollution of waterways and groundwater across North America. The purpose of nutrient management plans are to control the amount, form, placement, and timing of application of manure and other biosolids that are used as plant nutrients on farm fields. Nutrient management regulations generally require that farmers prepare detailed nutrient management plans with the assistance of professional public or private nutrient management planners. This report outlines the requirements typically found in nutrient management regulations.

One of the most critical areas of concern for regulators of the land application of biosolids is the control and monitoring of pathogens. The U.S. Part 503 regulations contain the baseline standards for pathogen and vector attraction reduction in sewage sludge and septage in the United States. U.S. States must incorporate the federal requirements into their regulations. In Canada, pathogen reduction standards vary considerabl. For instance, in Manitoba, there are no requirements for pathogen treatment of septage applied to land.[6] On the other hand, in British Columbia, detailed regulations to address pathogen control in all biosolids applied to lands are currently being

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4. Information obtained from John McGuire, Senior Inspector, Water enforcement Compliance Branch for USEPA Region 5, April 12, 2001.

5. *Summary of State Biosolids Programs*, (currently in draft form) forthcoming from the U.S. Environmental Protection Agency. For information on how to obtain this report, contact: John Walker of the USEPA in Washington, D.C., at (202) 564-0654.

6. Information on the current state of regulations and proposed regulations was obtained from: Norbert Bernard, Chief Public Health Inspector, Manitoba Conservation, April 5, 2001.

developed.[7]

Restrictions on where and when biosolids may be applied are another important mechanism for the control of pollution of waterways and groundwater. Minimum siting restrictions for biosolids are contained in the U.S. Part 503 regulations. These standards are supplemented in State and Provincial nutrient management regulations. This report describes the types of siting restrictions that appear in regulations of the land application of biosolids. Siting restrictions include set-backs from waters, protected areas, and residential areas. Restrictions on the application of biosolids in winter may also apply.

Livestock operations in North America are growing in size and density. Concentrated animal feeding operations (CAFOs) are large animal operations that produce large amounts of biosolids. This report reviews the concerns related to concentrated animal feeding operations, and describes the regulatory approaches taken by authorities in some U.S. States and in other jurisdictions.

The regulation of the land application of biosolids is a very broad area of concern which impacts significantly on farming practices and agricultural economics throughout North America and Europe. The laws and regulations governing these activities are extensive. The governance of these activities often falls under the jurisdiction of several different government departments or agencies, including authorities dealing with the environment, natural resources, conservation, agriculture and health. The regulation of the land application of biosolids is a highly complex, interdisciplinary, and multifaceted area of regulatory activity.

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[7] . See: the draft *Organic Matter Recycling Regulation*, available on-line at: http://www.bc-environment-issues.com/organic_matter_recycling_reg_1.html

Terms of Reference

The purpose of this research paper is to examine the current state of regulation of land application of biosolids including sewage sludge, animal manure and septage. The paper provides an overview of the current state of regulations, including consideration of best practices and progressive programmes pertaining to the land application of biosolids. The paper shall focus on the following elements as they appear in regulations, guidelines, rules and recommended best practices in selected jurisdictions from Canada, the United States and Europe:

- Nutrient management plans;
- Training and certification of operators for manure application;
- Restrictions on areas where biosolids might be applied;
- Sewage treatment of animal effluent on site at concentrated animal feeding operations (CAFOs);
- Reporting requirements for land appliers;
- Monitoring for and stabilization of pathogens in sewage sludge and septage;
- Agencies responsible for monitoring and enforcement of biosolids;
- The U.S. Federal Rules on the land application of sewage sludge.

This paper examines the current state of regulations in the following jurisdictions: Manitoba, British Columbia, Iowa, North Carolina, Georgia, Maine, Maryland, Ohio, Oregon, Texas, Virginia, and various jurisdictions in Europe.

Introduction

Public concern about the environmental and health impacts of the land application of biosolids has increased over the past decade. This is partly due to the growth of livestock (including cattle, hogs, and poultry) operations, and issues related to the environmentally sound disposal of the large quantity of waste produced at such facilities. Health concerns about the presence of dioxins, heavy metals and pathogens (disease-causing micro-organisms) in sewage sludge have led, in some jurisdictions, to stringent regulation governing the quality of sewage sludge and septage that may be applied to lands.[8] There is also a great deal of public concern about potential nutrient runoff from croplands into lakes, streams and rivers. Nitrogen contamination of drinking water may pose a health risk to infants, while phosphorus overload of lakes, streams and rivers causes eutrophication. Biosolids may also contaminate groundwater with heavy metals and other toxins.

Generally speaking, the land application of sewage sludge and septage is governed by regulations that are distinct from the regulation of the land application of animal manure.[9] The land application of sewage sludge and septage is usually regulated and administered by the State or Provincial Department or Ministry of Environment or by Public Health Departments, agencies or ministries of the various jurisdictions.[10] Nutrient management plan requirements for farmers may include guidelines for the application of sewage waste and septage, as well as manure. However, generally speaking, nutrient management plans deal primarily with the land application of animal manure. The preparation of nutrient management plans and the administration of nutrient management programs generally fall under the aegis of either the Ministry or Department of Agriculture, or the Ministry or Department of Environment, Natural Resources and/or Conservation.

The term "sewage sludge" is commonly used because of its wide recognition, its regulatory definition (in regulations of various jurisdictions), and its consistency with guidelines and other documents. The term is used widely in the United States, as it is consistent with the Federal Part 503 Regulation, *Standards for the Use or Disposal of*

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[8] . See, for example, the United States Federal Standards for the Final Use and Disposal of Sewage Sludge: 40 C.F.R. 503, subpart B and D. The Unites States Environmental Protection Agency is currently proposing to amend management standards for sewage sludge by adding a numerical concentration limit for dioxin and dioxin-like compounds ("dioxins") in sewage sludge that is applied to the land, and monitoring, record keeping and reporting requirements for dioxins in sewage sludge that is land applied. For a copy of the current proposal, see: http://www.epa.gov/ost/biosolids/rule.pdf.

[9] . For example, the United States Environmental Protection Agency Federal Part 503 regulations dealing with the land application of sewage sludge and septage do not address manure management. Manure management regulations in all the States under consideration in the paper are promulgated by State authorities under the authority of State legislation.

[10] . For a list of responsible authorities for different biosolid activities, see the table of U.S. Federal Regulations, State and Provincial Regulations in the last section of this report.

Sewage Sludge.[11] However, the term *biosolids* is becoming more common. Sewage sludges are distinct from other types of sludges, including industrial sludges. Therefore, the term "sewage sludge" is used throughout this paper.

[11] . The federal definition of sewage sludge is contained at 40 C.F.R. 503.9(w): "*Sewage Sludge* is solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works."

U.S. Federal Rules on Land application of Sewage Sludge (40 CFR 503)

The U.S. Federal Government has promulgated regulations to govern the final use or disposal of sewage sludge. These regulations are administered by the Environmental Protection Agency (EPA), and apply across the country. All U.S. State sludge management programs must be approved by the EPA, and must conform to federal requirements. The Federal program for the regulation of sewage sludge was created to ensure that municipal sewage sludge wastes were used in such a way that human health and the environment were protected. Under the authority of Section 405(d) of the *Clean Water Act*, the U.S. Environmental Protection Agency (EPA) promulgated, at 40 *Code of Federal Regulations (CFR)* Part 503, Phase I of the risk-based regulation that governs the final use or disposal of sewage sludge. Part 501, promulgated under Section 405(f) of the *Clean Water Act* contains the *State Sludge Management Program Regulations*. The Part 501 regulations specify the procedures that the EPA must follow in approving, revising and withdrawing State sludge management programs. As a minimum, State sludge management programs submitted for approval by the EPA must include the following:

- The authority to require compliance by any person who uses or disposes of sewage sludge with standards for sludge use or disposal issued under section 405(d) of the U.S. *Clean Water Act*.
- The authority to issue permits that apply, and ensure compliance with, the applicable requirements of section 405 of the *Clean Water Act*.
- Provisions for regulating the use or disposal of sewage sludge by non-permitees;
- The authority to take actions to protect public health and the environment from any adverse effects that may occur from toxic pollutants in sewage sludge;
- The authority to abate violations of the State sludge program, including civil and criminal penalties and other ways and means of enforcement.[12]

State regulation of land application of biosolids are generally equivalent, or exceed the Federal standards under Part 503. As part of the program to regulate the land application of sewage sludge, the U.S. Environmental Protection Agency has authorized 42 States to implement their own Pollutant Discharge Elimination System, under the national program, the *National Pollutant Discharge Elimination System (NPDES)*.

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[12] . See: 40 CFR 501, *State Sludge Management Program Regulations*.

Review of the Scientific Basis for the Part 503 Regulations

The regulation of the land application of biosolids is currently being reviewed by the United States Environmental Protection Agency (USEPA).[13] A number of reports recently published in the United States have led to some concern that the existing regulatory framework is not based on sufficient scientific study: the *Hazard ID 10* report of the NIOISH of the Centre for Disease and Control (July 2000), *the Office of the Inspector General audit report* (March 2000), and *Congressional Hearings* (March 2000). USEPA recently requested the U.S. National Academy of Science (NAS) to examine the scientific basis of the Part 503 regulations with a view to determining whether the existing regulations are adequate. This study is currently underway.[14] The purpose of the study is to review up-to-date scientific information on land application and to evaluate the EPA's methods of determining health risks due to pollutants and pathogens in biosolids.[15]

Quality of Sewage Sludge

The microbiological, mineral, and chemical composition of sewage sludge varies greatly from one municipality to the next. This is due to a number of factors: sewage treatment systems vary in effectiveness and the substances which enter sewage treatment plants vary. The composition of the final product from one source may also vary over time, and thus, the quality of sewage sludge and other biosolid products must be monitored continuously, even if they come from the same source. The microbiological, mineral, chemical and physical composition of prepared sewage sludge will determine its quality, and will determine its final use.

Under the U.S. Federal Part 503 regulation, three parameters are used as a basis for determining sewage sludge quality:

- pollutants (including arsenic, cadmium, chromium, copper, lead, mercury, molybdenum,nickel, selenium, and zinc);
- pathogens (disease-causing micro-organisms, including bacteria, viruses and parasites);
- vector attraction (rodents, flies, birds, etc.)

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[13] . See: International Water Association, Specialist Group on Sludge Management, *Newsletter, December 2000*, London, U.K..

[14] . Information about the study may be obtained on the USEPA website: http://www.epa.gov/own/bio.htm

[15] . See: International Water Association, *supra*, note 11.

Under the Part 503 regulations, it is the sole responsibility of the person who prepares the sludge to determine the quality of sewage sludge prior to land application. Since the quality of sewage sludge may vary so much, the Part 503 regulations contain different sets of quality requirements for each of the three parameters. These requirements may apply to both the preparer and the land applier. By classifying the quality of sewage sludge according to the above parameters, sewage sludge from many different sources can be used under different conditions, and, in theory, human health and the environment is still protected.

Sewage sludge which meets the highest quality standards under the Part 503 regulations is considered to be *Exceptional Quality (EQ)* sewage sludge, also known as Class A sewage sludge. All other sewage sludge is considered *non-EQ* or Class B sewage sludge. The quality of *EQ* sewage sludge is considered to be comparable to standard fertilizer products. Any person who applies *EQ sewage sludge* to land does not need to meet any requirements under the Part 503 regulations: *EQ* sludge application is wholly exempted from Part 503. However, numerous restrictions apply to *non-EQ* (Class B) sewage sludges, depending on the quality. The purpose of the additional requirements are to ensure that human health and the environment are protected at the same level as in the use of *EQ* sludge. Both Class A and Class B sewage sludges are used widely in agriculture across the United States.[16]

Under the Part 503 regulations, sewage sludge, mixtures of sewage sludge, or any material that is derived from sewage sludge must meet each of the following critera to be considered *EQ* (Class A) sewage sludge:

- For pollutants, preparers must meet both Ceiling Concentrations [40 C.F.R.503.13(b)(1)] and Pollutant Concentrations [40 C.F.R. 503.13(b)(3)];
- For pathogens, preparers must apply one of the Class A pathogen reduction methods [40C.F.R. 503.32(a)];
- For reducing vector attraction, preparers must use one of the vector attraction reduction options during the treatment process [40 C.F.R. 503.33(b)(1)-(8)].

The Federal Part 503 Regulations

Part 503 of the Code of Federal Regulations[17] provide the base-line standards for permitting, requirements appurtenant to receiving lands, pathogen and vector attraction

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[16] . A chart showing the results of a survey of the use of biosolids across the United States is available at: http://biosolids.policy.net/states/chart.vtml. Note that this chart does not distinguish between the use of Class B or Class A biosolids.

[17] . See: 40 CFR 503.

reduction, land application practices, reporting, and other considerations. The Federal regulations should be viewed as a starting point in any analysis of the regulation of the land application of biosolids in the United States.

The Part 503 regulations establish standards which consist of general requirements, pollutant limits, management practices, and operational standards, for the final use or disposal of sewage generated during the treatment of domestic sewage in a treatment works. The regulations set standards for sewage sludge that is applied to the land, placed on a sewage disposal site, or fired in a sewage incinerator. Pathogen and vector attraction reduction requirements for sewage sludge applied to land are also included.[18] In addition, the regulation contains the standards for the frequency of monitoring and recordkeeping when sewage sludges are applied to land, placed on a surface disposal site, or fired in a sewage sludge sludge incinerator. The regulations apply to any person who prepares sewage sludge, applies sewage sludge to land, or fires sewage sludge in a sewage sludge incinerator, and to the owner/operator of a surface disposal site.

The Part 503 regulations may be implemented by preparers or land appliers through a permit. Permits for the preparation of sewage sludge may be issued to a "treatments works treating domestic sewage", or may be issued by a State that has a State sludge management program approved by the U.S. Environmental Protection Agency in accordance with 40 CFR part 123 or 40 CFR Part 501.[19] Under the regulations, no person shall use or dispose of sewage sludge through any practice for which requirements are established in the regulations, except in accordance with such requirements.[20] Any person who prepares sewage sludge must ensure that the applicable requirements are met for the land application of sludge. States are authorized to impose penalties for non-compliance, and must vigorously enforce the regulations that are approved under Part 503 and Part 501.[21]

The Part 503 regulations include a provision which allows the responsible authority (State or Federal) to impose additional or more stringent requirements beyond those contained in the regulation. On a case-by-case basis, the permitting authority may impose more stringent requirements than those contained in the regulation if such requirements are considered to be necessary to protect public health and the environment from adverse effects of a pollutant in the sewage sludge.[22]

The regulations do not preclude a State, political subdivision thereof, or interstate

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[18] . For a detailed description of the Federal Part 503 requirements for pathogen and vector attraction reduction standards, see the section in this paper entitled: *Monitoring and Stabilization of Pathogens in Sewage Sludge and Septage*, at p.46.

[19] . See: §503.3 (a)(1).

[20] . See: §503.3 (b).

[21] . See: §501.17, *Requirements for the enforcement authority.*

[22] . See: §503.5 (a).

agency from imposing requirements for the use of sewage sludge that are more stringent than the Federal regulations.[23]

The Part 503 regulations does not cover a number of activities, including treatment processes prior to final use or disposal; the selection of a use or disposal practice (i.e. the manner in which sewage sludge is used or disposed of is a local decision); sludge generated at an industrial facility; sewage sludge with a high PCB concentration; hazardous sewage sludge; or commercial and industrial septage.[24]

Elements of the Part 503 Regulation

The Part 503 regulations are comprised of five subparts:

Subpart A: General Provisions

1. Purpose and applicability:
- establishes standards, general requirements, pollutant limits, management practices, and operational standards for the final use or disposal of sewage sludge generated during the treatment of domestic sewage in a treatment works;
- applies to any person who prepares or applies sewage sludge to land.

2. Compliance period:
- established mandatory compliance periods for the various activities under the regulation;

3. Permits and direct enforceability:
- establishes authority of EPA or State agency with EPA approved sludge management plan to issue permits;
- all activities under the regulation must be implemented through a permit;
- establishes direct enforceability of requirements under the regulation.

4. Relationship to other regulations
- establishes relationship between 503 rules and other regulations pertaining to the disposal of sewage sludge in municipal solid waste landfill sites.

5. Additional or more stringent requirements
- establishes authority to impose more stringent requirements on a case by case basis when necessary to protect public health and the environment;
- allows States to implement more stringent requirements than those contained in the Part 503 regulations.

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[23] . See: §503.5 (b).
[24] . See: §503.6.

6. Exclusions:

- establishes the following exclusions: treatment processes, selection of a use or disposal practice (the manner in which sewage sludge is disposed is a local determination), co-firing of sewage sludge, sludge generated at an industrial facility, hazardous sewage sludge, sewage sludge with a high PCB concentration, incinerator ash, grit and screenings, drinking water treatment sludge, commercial and industrial septage.

7. Requirement for a person who prepares sewage sludge:

- Sewage sludge preparers must ensure that the requirements of the regulation are met when the sewage sludge is applied to land or placed on a surface disposal site.

8. Sampling and analysis:

- establishes mandatory representative sampling of sewage sludge applied to land;

- establishes methods that may be used to analyze samples of sewage sludge for the following parameters: enteric viruses; fecal coliform; helminth ova; inorganic pollutants; salmonella sp. bacteria; specific oxygen uptake rate; total, fixed and volatile solids.

9. General definitions:

- establishes general definitions for terms such as class I sludge management facility, cover crop, permitting authority, etc..

Subpart B: Land Application

10. Applicability:

- applies to any person who prepares sewage sludge that is applied to land, to any person who applies sewage sludge to land, to sewage sludge applied to land, and to the land on which sewage sludge is applied;
- does not apply to sewage sludge that meets the pollutant concentration standards in Part 503, Class A pathogen reduction standards and vector attraction reduction standards, however, the regional administrator of EPA may apply any or all of the requirements to any sewage sludge applied to land if necessary to protect public health and the environment;

11. Special definitions:

- establishes special definitions for terms such as agronomic rate, annual pollutant loading rate, cumulative pollutant loading rate, public contact site, etc..

12. General requirements:

- establishes mandatory requirements for land application;
- prohibits land application of sewage sludge that does not meet pollutant standards in the regulation;
- prohibits land application of sewage sludge that exceeds the annual application rate;
- requires the preparer of sewage sludge to provide land applier with written notice of the nitrogen concentration of the sewage sludge;
- requires the land applier to obtain information that is necessary to comply with the regulations;
- requires the land applier to determine whether sewage sludge has been applied previously to the site;
- establishes annual loading rates;
- requires sewage sludge preparers to provide information to land appliers about the requirements of the regulation;
- requires the sewage sludge applier to provide the owner or leaseholder of land on which sewage is applied with information about the the requirements of the regulation;
- requires preparers to provide written notice to State authorities if sewage sludge is to be applied to land in another State.
- requires land appliers to provide written notice, prior to application, to the permitting authority for the State.

13. Pollutant limits:

- establishes ceiling concentrations for pollutants, cumulative pollutant loading rates, pollutant concentrations, and annual pollutant loading rates.
- establishes annual application rate for domestic septage.

§503.13 Ceiling Concentrations[25]

Pollutant	**Ceiling concentrations (milligrams per kilogram dry weight basis)**
Arsenic	**75**
Cadmium	**85**
Copper	**4300**
Lead	**840**
Mercury	**57**

[25] . From: Table 1 of §503.13, 40 C.F.R. 503.

Molybdenum	**75**
Nickel	**420**
Selenium	**100**
Zinc	**7500**

§503.13 Cumulative Pollutant Loading Rates[26]

Pollutant	**Cumulative pollutant loading rate (kilograms per hectare)**
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

[26] . From: Table 2 of §503.13, 40 C.F.R. 503.

§503.13 Pollutant Concentrations[27]

Pollutant	Monthly average concentration (milligrams per kilogram)
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

§503.13 Annual Pollutant Loading Rates[28]

Pollutant	Annual pollutant loading rate (kilograms per ha. per 365 day period)
Arsenic	2.0
Cadmium	1.9
Copper	75.0
Lead	15.0
Mercury	0.85
Nickel	21.0
Selenium	5.0
Zinc	140.0

14. Management practices:

- prohibits sewage sludge application on land if it is likely to adversely affect a threatened or endangered species listed under section 4 of the *U.S Endangered Species Act* or its designated critical habitat.
- prohibits land application of sewage sludge on a site that is flooded, frozen or snow-covered in such a way that the sewage sludge will enter a wetland or other waters;
- prohibits land application of sewage sludge within 10 meters of waters;

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[27] . From: Table 3 of §503.13, 40 C.F.R. 503.

[28] . From: Table 4 of §503.13, 40 C.F.R. 503.

- prohibits application at rates greater than the agronomic rate unless a permit is obtained;
- requires labels or information sheets to accompany sewage sludge.

15. Operational standards (pathogens and vector attraction reduction):
- requires Class A pathogen and vector attraction reduction standards to be met when sewage sludge is applied to lands, lawns, or home gardens;
- establishes requirements for domestic septage that is applied to lands.

16. Frequency of monitoring:
- establishes minimum frequency for monitoring pollutants, pathogens and vector attraction in sewage sludge and septage;
- after two years of monitoring, the permitting authority may reduce the frequency of monitoring;

§503.16 Frequency of Monitoring – Land Application[29]

Amount of sewage sludge* (metric tons per 365 day period)	**Frequency of monitoring**
Greater than zero, but less than 290.	Once per year
Equal to or greater than 290, but less than 1,500.	Once per quarter (four times per year)
Equal to or greater than 1,500 but less than 15,000	Once per 60 days (six times per year)
Equal to or greater than 15,000	Once per month (12 times per year)

* Either the amount of sewage sludge applied to the land or the amount of sewage sludge received by a person who prepares sewage sludge that is sold or given away in a bag or other container for application to the land (dry weight basis).

17. Recordkeeping:
- Establishes record-keeping requirements for preparers and appliers of sewage sludge and septage, including record-keeping for the following:
  - concentrations of pollutants;
  - description of how Class A pathogen requirements are met;
  - description of how vector attraction reduction requirements are met;
  - a description of how management practices are met;
  - a description of how site restrictions are met;
  - the location of land application sites,
  - the date and time of application;

[29] . See: Table 1, §503.16, 40 C.F.R. 503.

- the cumulative amount of pollutants contained in sewage sludge applied to land;
- the amount of sludge applied;
- the nitrogen requirement for the crop on each site;
- the rate (in gallons per acre) at which septage is appied.

18. Reporting:
- establishes reporting requirements for Class I sludge management facilities, i.e. information that the facility must provide to the permitting authority each year.

Subpart C: Surface Disposal

20. Applicability
- applies to sewage sludge placed on a sewage disposal site.[30]

21. Special definitions
22. General requirements
23. Pollutant limits (other than domestic septage)
24. Management practices
25. Operational Standards – pathogens and vector attraction reduction)
26. Frequency of monitoring
27. Recordkeeping
28. Reporting

Subpart D: Pathogens and Vector Attraction Reduction

30. Scope:
- contains the requirements for a sewage sludge to be classified as either A or B with respect to pathogens;
- contains site restrictions for land on which Class B sewage sludge is applied;
- contains pathogen requirements for domestic septage;
- contains alternate vector attraction reduction requirements for sewage sludge that is applied to land.

31. Special definitions:
- includes special definitions for terms such as aerobic digestion, pathogenic organisms, unstablized solids, etc..

[30] . Since this part does not apply to sewage sludge that is applied on land, a summary is not included here.

32. Pathogens:
- establishes six alternatives for meeting Class A pathogen standards;
- establishes three alternatives for meeting Class B pathogen standards;
- establishes site restrictions for Class B sewage sludge;
- establishes site restrictions for domestic septage.

33. Vector attraction reduction:
- establishes twelve vector attraction reduction methods for sewage sludge.

Subpart E: Incineration

40. Applicability:
- Applies to incineration activities.[31]

41. Special definitions
42. General requirements
43. Pollutant limits
44. Operational standard (total hydrocarbons)
45. Management practices
46. Frequency of monitoring
47. Recordkeeping
48. Reporting

Appendix A:
- contains procedures to determine the annual whole sludge application rate for a sewage sludge, i.e. the agronomic rate of application.

Appendix B:
- contains pathogen treatment processes.

[31] . Since this part does not apply to sewage sludge that is applied on land, a summary is not included here.

Nutrient Management Plans

Responsible Authorities

Nutrient management regulations are important tools for the prevention of nutrient contamination of waterways and groundwater. The regulation and administration of nutrient management regulations generally falls under the aegis of either the Ministry or Department of Agriculture, or the Ministry or Department of Environment, Natural Resources and/or Conservation. The responsible agencies undertake a wide range of activities associated with the administration of nutrient management regulations, guidelines, and strategies. These responsibilities include:

- Assessment of nutrient management plans prepared by certified nutrient management planners;
- Permitting for the land application of manure;
- Providing advice, assistance, and technical training to land appliers and farmers;
- Training and certification of nutrient management specialists;
- Monitoring, inspection, and enforcement of nutrient management regulations;
- Development of regional nutrient management strategies[32];
- Approval of variances to nutrient management requirements;
- Research (often in collaboration with University and College agriculture programs).

The following government departments/agencies are responsible for nutrient management in each of the jurisdictions under consideration:

Manitoba – Manitoba Environment (technical assistance for implementers is provided by Manitoba Agriculture)
British Columbia – Ministry of Agriculture and Food
Oregon – Oregon Natural Resources Conservation Service
North Carolina – Division of Environmental Management, Department of Environment, Health, and Natural Resources
Maryland – Maryland Department of Agriculture
Maine – Department Agriculture, Food and Rural Resources
Wisconsin – Department of Agriculture, Trade and Consumer Protection
Virginia – Department of Conservation and Recreation
Texas – Natural Resource Conservation Commission
Georgia – Responsible authority: Department of Natural Resources: Water Quality Control

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[32] . See, for example: Manitoba Conservation, *Development of a Nutrient Management Strategy for Surface Waters in Southern Manitoba*, Information Bulletin 2000-02E, April 20, 2000; for further information, see: *Manitoba's Manure Management Strategy*, R&D activities and outstanding needs in 1988, available on-line at: http://res2.agr.ca/initiatives/manurenet/en/manitoba_rd98.html

Iowa – Department of Natural Resources and the Iowa Environment Protection Commission.

Purpose of Nutrient Management Plans

The purpose of nutrient management plans are to control the amount, form, placement, and timing of application of manure and other biosolids that are used as plant nutrients on farm fields. Mandatory nutrient management programs exist in most States and in the Canadian provinces considered in this research paper (Manitoba and British Columbia). Generally speaking, nutrient management plans must be prepared by certified nutrient management specialists and are required before permits for the land application of biosolids will be issued. Often, the regulatory requirements for nutrient management plans are elaborate and highly specific.[33]

Taken as a whole nutrient management regulations aim to achieve the following general results:

1. To supply appropriate amounts of plant nutrients for optimum forage and crop yields;
2. To protect groundwater and waterways from contamination from nutrients (especially nitrogen and phosphorus) and pathogens.
3. To improve soil structure, and maintain the chemical and biological condition of the soil.

Health Concerns: Nitrate Leaching and Groundwater Contamination

One of the primary aims of nutrient management plan regulation is to prevent contamination of groundwater from nitrogen leaching. Nitrite-nitrogen is a water soluble nutrient that is indispensable to crop growth. Nitrate leaching occurs when excess nitrate-nitrogen is carried deeper into the soil profile by water from precipitation or snow melt. Nutrient management plans are necessary to ensure that farmers take into consideration the existing levels of nitrogen in soil, and do not apply an excess of nitrogen-rich fertilizers, manures or other biosolids. An excess of nitrate in groundwater poses a health hazard for human beings. In Manitoba, the maximum level of nitrate (measuring nitrogen as nitrate) in drinking water is 10 mg/L.[34] Higher amounts may pose a health risk to infants less than one year old, or pregnant women. Infants may develop methemoglobinemia (blue-baby syndrome), and an excess of nitrate may cause a lack of oxygen for the baby in pregnant women. Blue-baby syndrome can be prevented by

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[33] . For example, see the Manure Management Plan forms prepared by Manitoba Environment, in *Farm Practice Guidelines for Hog Producers in Manitoba*, Apendix G.

[34] . See: Manitoba Agriculture, *Farm Practices Guideline for Hog Producers in Manitoba,* 1998, p. 31.

ensuring that nitrate levels in groundwater are controlled. According to Manitoba Agriculture, there is some evidence that an association exists between nitrates in drinking water and stomach cancer.[35]

Many of the restrictions which apply to land application of manure exist specifically to address concerns about nitrate contamination of groundwater. With the increased concentration of livestock operations in North America, new health concerns may arise, particularly with respect to pathogens. It is likely that nutrient management practices and regulations will have to be modified to address emerging health concerns.

Proper Nutrient Management

The proper management of manure application will minimize the risk of nitrate leaching from manure. The most important practice in manure management is to ensure that the amount of manure applied does not exceed the nutrient requirements of the crop. Nitrate leaching can be prevented by making sure that the crop planted will take-up the nitrogen in manure as the nitrogen becomes available. Nitrate leaching may also be prevented by proper timing of application of manure. Applying manures in the spring may be optimal in some circumstances. However, fall application may be more appropriate where the spring application of manure is not practical.

The amount of organic nitrogen in soils will increase with continuous application of manure. Organic nitrogen does not become available to plants immediately. Gradually, through a process called mineralization, organic nitrogen is converted to nitrate-nitrogen, and becomes available for plants. With frequent application of manure, the amount of nitrogen that is available to plants in a field may increase so much that future applications must be modified to take into account the existing levels of nitrate-nitrogen. Determining the correct amount of nitrogen to apply to a field is one of the responsibilities of nutrient management planners.

Excess application of manure can lead to an imbalance in the soil chemistry, which may lead to reduced crop yields. Nutrient management regulations and groundwater standards generally specify the maximum nitrate levels for soil. Nitrates that exceed the maximum are considered evidence of soil pollution[36]. High concentrations of nitrates and other nutrients from manure may be detrimental to plant growth and must be avoided by careful nutirient management planning, and by complying with the requirements of the regulations.

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[35] . Ibid, p. 32.

[36] . See: *Livestock Manure and Mortalities Management Regulation*, Manitoba Regulations 42/98, p. 24.

Sensitive Groundwater Areas

Some soils and groundwater conditions are considered sensitive to agricultural practices which involve the application of manure. The level of sensitivity depends on the type of soil and the depth of overburden (soil, subsoil, and parent material) that lies above an aquifer. The type of vegetation on the surface may also be a factor.

Nutrients from manure applied to the soil surface may leach more rapidly in very permeable soils (for example, in soils where sand or gravel lie above an aquifer, or where the overburden above and aquifer is very shallow). The nutrient uptake of crops in these areas may be quite low since vegetation in these soils is relatively sparee. Nutrients applied to permeable soils may eventually reach the aquifer. More intensive management can ensure that excess manure is not applied in such areas, and the risk of nitrate leaching can be minimized.

The following management practices for manure application in coarse or sandy soils are recommended by Manitoba Agriculture[37]:

- Spring/summer applications only;
- Shallow injection, surface banding and broadcasting;
- Planting crops with a high demand for nitrogen, crops with deep root systems and early spring growth;
- Regular testing and monitoring of soil groundwater and plant tissue;
- Accurate record-keeping of manure management data.

Seasonal Considerations

Manure decomposes at different rates depending on seasonal conditions. Nutrients in manure become available gradually as decomposition occurs. If manure is not incorporated into the soil in fall application, more nutrients will be lost from runoff than in spring application. Summer application is recommended by Manitoba Agriculture for pastures, forage crops and summer fallow.[38] Care must be taken when applying manure to summer fallow since such fields usually release enough nitrogen for the following year's crop.

Special restrictions on winter spreading apply in all jurisdictions.[39] For a detailed description of restrictions on winter spreading in Manitoba, see the section in this paper entitled: *Nutrient Management in Manitoba.*

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[37] . From: Manitoba Agriculture, *Farm Practices Guideline for Hog Producers in Manitoba*, 1998, p. 24.
[38] . Ibid. p. 25.
[39] . The U.S. Part 503 regulations prohibit land application of sewage sluge on sites that are flooded, frozen or snow covered so that the sewage enters a wetland or other waters. See: 40 C.F.R. 503.14(b).

Set-backs (Distance to Surface Waters)

Set-backs (buffers) between land application sites and surface waters are necessary to reduce runoff. The appropriate set-backs are determined partly by the slope of the land. The greater the slope, the higher the chance that manure may run off. Land appliers must be extremely careful when applying manure on steep slopes.[40] Erosion from steep slopes should be prevented after spreading by planting the soils with crop cover. The appropriate set-back will also depend in part on the soil conditions and on the application rate. In *Farm Practices Guideline for Hog Producers in Manitoba*, Manitoba Agriculture recommends the following set-backs:

Recommended Distances* from Watercourses, Sinkholes, Springs, Wells and Residential Property Lines for Manure Spreading (in square meters)[41]

	Surface Applied and Irrigation**	Surface Applied and Irrigation**	
Slope	No incorporation	Incorporation within 48 hours	Injection
Less than 4%	30	20	5
4-6%	60	40	10
6-12%	90	60	15

* Distances are based on soil not supporting perennial forage crops or with minimal trash cover.

** Where a perennial forage crop or good trash cover is present, distances may be reduced by 1/2.

Training and Certification of Nutrient Management Planners

Many of the U.S. States examined have promulgated regulations outlining specific requirements for training and certification of private and/or public sector nutrient management consultants and operators (operators are persons who apply biosolids to agricultural lands).[42] For example, under the Maine *Nutrient Management Rules*, promulgated under the *Nutrient Management Act*[43], all nutrient management plans must

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[40] . Ibid. p. 25.

[41] . From: Manitoba Agriculture, *Farm Practices Guideline for Hog Producers in Manitoba*, 1998, p. 25.

[42] . See: Maine: §7 Certification of Persons to Prepare Nutrient Management Plans, 01-001 Department of Agriculture, Food and Rural Resources, Ch. 565, *Nutrient Management Rules*; Maryland: Title 15 Department of Agriculture, Subtitle 20, Soil and Water Conservation, Chapter 04, Nutrient Management Certification and Licensing; Iowa: Iowa Code, §455B.203A, *Manure applicators certification.*

[43] . *See: 01-001 Department of Agriculture, Food and Rural Resources, Ch. 565, Nutrient Management Rules, promulgated under 7. M.R.S.A. Chapter 747.*

be prepared and approved by a person who has been certified by the Commissioner of the Maine Department of Agriculture, Food, and Rural Resources. Persons in Maine who wish to work as nutrient management specialists must apply to the Department of Agriculture and must meet the educational requirements outlined in either A or B below:

- Persons seeking certification as Nutrient Management Planning Specialists shall provide proof of certification by a national certifying program for nutrient management planning approved by the Commissioner such as:

  (1) The National Alliance of Independent Crop Consultants
  (2) The American Society of Agronomy
  (3) The American Registry of Certified Professionals in Agronomy, Crop and Soils.

- Persons seeking certification may become certified through a Maine State training and certification program approved by the Commissioner. All persons seeking certification through a Maine state program must pass the appropriate Nutrient Management Planning Certification Test and have either:

  (1) Successfully completed a pre-certification training workshop offered by the Department, UMCE or other agency approved by the Commissioner, or;
  (2) Demonstrated a good understanding of agricultural subjects including soil fertility, crop management and manure management from past education, training and/or experience by passing a test approved by the Commissioner for this purpose.[44]

In Maryland, the nutrient management certification and licensing regulations are promulgated under the authority of the Agriculture Article, in §§8-801-8-806 of the Annotated Code of Maryland. Under the regulation, "certified nutrient management consultants" are individuals who have been certified by the Maryland Department of Agriculture to prepare nutrient management plans. Applicants in Maryland must meet one of the following educational requirements:

- A school-authenticated college degree in an agriculturally related area, and 1 year of practical experience acceptable to the Department; or
- A combination of education and practical experience related to nutrient management planning which is acceptable to the Department.[45]

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[44] . See: §7(2)(A) and (B), 01-001 Department of Agriculture, Food and Rural Resources, Ch. 565, *Nutrient Management Rule*.

[45] . See: Title 15 Department of Agriculture, Subtitle 20, Soil and Water Conservation, Chapter 04, *Nutrient Management Certification and Licensing*, section .04.

In Iowa, commercial applicators and persons who apply manure from confined feeding operations are prohibited from applying manure to land unless they are certified by the Department of Natural Resources.[46] The Iowa Code directs the Department of Natural Resources to adopt regulations for the certification of manure applicators and for the educational program requirements.[47] Some exemptions from the certification requirements apply. For example, persons who are actively engaged in farming and who trade work with another farmer are exempt from the certification requirements.[48]

Nutrient management plans are mandatory in all jurisdictions for concentrated animal feeding operations (CAFOs), and for the land application of sewage sludge or septage. However, the classification scheme for CAFOs varies dramatically across jurisdictions. Similar farming operations in different jurisdictions may have to meet widely divergent standards for nutrient management.[49]

Requirements for Certified Nutrient Management Planners: Case Study of Virginia

The certification of Virginia Nutrient Management Planners is administered by the Department of Conservation and Recreation (the "Department"). Three qualifications must be met before a person may be certified: prior relevant education, job-related experience dealing with nutrient management, and passing a two-part Virginia Nutrient Management Examination. A person who already has a college degree in agriculture requires one year of job related experience in nutrient management. Without a college degree, applicants must demonstrate that they have a combination of education including nutrient management related courses or training, and a minimum of three years of job related experience. An application fee of $100 U.S. covers two years of certification, after the person has passed the examinations. Certifications are valid for two years.[50] For re-certification, the applicant must take a number of courses approved by the Department of Conservation and Recreation, and must prepare at least one nutrient management plan.[51] Prior to scheduled examinations, the Department provides training courses on nutrient management concepts, including basic soil science, soil fertility, environmental management, fertilizer, manure, biosolids management, and other relevant topics.[52]

The requirements for training and certification of nutrient management planners in Virginia are contained in *Nutrient Management Training and Certification Regulations*, Chapter 15, Virginia Administrative Code, 5-15, promulgated under §10.1-

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[46] . Iowa Code, 455B.203A, *Manure applicators certification.*

[47] . See: 455B.203A, *Manure applicators certification*, section 4(a).

[48] . See: 455B.203A, *Manure applicators certification*, section 5(a) and (b).

[49] . For a description of regulations in several U.S. States, see the section in this paper on *Concentrate Animal Feeding Operations*, p. 66.

[50] . Note that in many other jurisdictions, certification is valid for only one year.

[51] . The requirements for certification are outlined at 4 VAC 5-15-40.

[52] . See: 4 VAC 5-15-70.

104.2 of the Code of Virginia. This regulation governs the Department of Conservation and Recreation's voluntary Nutrient Management Training and Certification Program for individuals who prepare nutrient management plans.

Under the Virginia regulation, the purpose of preparing a nutrient management plan is described as follows:

> A nutrient management plan is prepared to indicate how primary nutrients are to be managed on farm fields and other land for crop production and in a way which protects groundwater and surface water from excessive nutrient enrichment. Plans contain operating procedures based on expected crop yield, existing nutrient levels in the soil, organic residuals, optimum timing and placement of nutrients, environmental resource protection, and agronomic practices such as liming, tillage, and crop rotation. The department shall certify the competence of individuals to prepare these plans and provide criteria relating to the development of nutrient management plans.[53]

The Department may issue specialized certification in such areas as agriculture and urban agronomic practices.[54]

Certification Examinations

Virginia nutrient management certification examinations contain the following elements:

- General understanding of overall nutrient management concepts such as nutrient cycling on farms, the purpose of nutrient management planning, economic aspects of nutrient use, and components of a nutrient management plan;
- Basic soil science concepts such as soil physical and chemical properties including texture, structure, organic matter, and horizon development, and how such characteristics influence crop productivity and adaptation, water runoff, and filtration;
- Environmental management concepts such as the water cycle, nutrient loss mechanisms, environmental effects of nutrients in waters including Chesapeake Bay, identification of high risk sites relating to nutrient use and appropriate nutrient management practices to reduce nutrient losses;

[53] . 4 VAC 5-15-20.
[54] . 4 VAC 5-15-30.

- Nutrient sampling, testing, and analysis such as basic sampling procedures, relationship of soil test level with likelihood of crop response, soil nitrate testing, manure and biosolids sampling and interpretation, and determining nitrogen supplied by legumes;

- Basic soil fertility concepts such as relationship of soil pH to nutrient availability and toxicity, essential elements for crop growth, limiting factors to crop production, cation exchange capacity and related concepts, nutrient cycles, and forms of nutrients in soils;

- Fertilizer management concepts such as types of fertilizers, nutrient analysis of common materials and grades, basic calculations and blending, calibration of equipment, and application methods;

- Manure management concepts such as nutrient content and volume produced determination of available nutrients, selecting sites for manure application, proper timing and placement, coordination of fertilizers with manure, application methods and calibration;

- Biosolids management concepts such as determination of available nutrients, nutrient content, forms of nutrients, types of sludges, coordination with fertilizer applications, and application methods;

- Nutrient management training and certification regulatory requirements, and requirements of other nutrient management related laws, regulations, and incentive programs; and

- Development of multiple components of nutrient management plans and completion of calculations comparable to development of nutrient management plans such as, but not limited to, determination of specific soil types in fields, determination of specific nutrient requirements based on soil productivity and soil analysis results, evaluation of field limitations based on environmental hazards or concerns, and interpretation of manure analysis results.[55]

Record Keeping Requirements for Nutrient Management Consultants

In Virginia, nutrient management specialists are required to keep records relating to the work they have undertaken. The requirements are outlined in the Virginia *Nutrient Management Training and Certification Regulations*. The regulations require that the following information be included in annual reports:

[55] . From 4 VAC 5-15-60.

- Name and certificate number of the planner;
- Any change in mailing address;
- The number of nutrient management plans completed;
- The acreage covered by the plans and planned acreage by county and state watershed codes;
- A breakdown of planned acreage by cropland, hay, pasture, and specialty crops by county and watershed code; and
- Other information indicating the number of practices facilitated by the planner such as manure testing and the use of the PSNT [pre-sidedress nitrogen test].[56]

In addition to the information contained above, certified nutrient management planners in Virginia must keep the following specific records for a period of not less than three years from the date the plan was prepared:

- A complete copy of each nutrient management plan prepared and shall make such plans available for inspection by department personnel upon request within two weeks of receiving such request;
- Records for each plan with all of the following information if the information is not already contained in the plan:

    (1) Representative soil analysis results for fields, or field grids if grid soil sampling is used, dated not more than three years prior to the date the nutrient management plan was completed to include information on soil fertility levels for phosphorus and potassium, and pH level;
    (2) Copies of soil survey maps or a soil survey book containing maps for each field unless a soil survey has not been published for the county;
    (3) Yield records for each field to include calculations used to determine the planning yield if upward adjustments to soil productivity based yields were made to more than 20% of the fields covered by the plan
    (4) Type and number of livestock, if any, as well as a description of the livestock to include average weight;
    (5) Calculations of records indicating annual quantity of manure produced or expected to be produced; and
    (6) Organic nutrient source analysis, if applicable, to include information on percentage of moisture, total nitrogen or total Kjeldahl[57] nitrogen, total phosphorus, and total potassium.

- A summary listing of all plans prepared to include landowner or operator's name and the date the plan was prepared or revised.[58]

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[56] . 4 VAC 5-15-100 A.
[57] . Kjeldahl nitrogen is the combined measure of nitrogen including all organic and inorganic nitrogen containing compounds.
[58] . 4 VAC 5-15-100.

Compliance and Disciplinary Action: Penalties

The Department may suspend or revoke certification if a certified person violates the requirements of the regulations, but only after the informal fact-finding procedures of the Virginia Administrative Process Act (§9-6.14:1 et seq. of the Code of Virginia) are followed. A list of circumstances in which certification may be revoked includes providing misleading information, operating without a certificate, preparing a plan that does not comply with the regulations, and failing to keep proper records.[59]

Advisory Committee

Under the Virginia Code, the Department may establish a nutrient management training and certification advisory committee.[60]

Nutrient Management in Manitoba

In Manitoba, manure storage, application and transport is governed by the *Livestock Manure and Management Regulation*[61], under the Manitoba Environment Act[62]. This regulation was adopted in 1998 after public consultation and a public review of the *Livestock Waste Regulation* that was in effect. The purpose of the regulation is to protect the environment, enhance enforcement capabilities and to ensure that livestock production is sustainable.

Nutrient management in Manitoba is regulated by the Department of Environment. Manure management plans must be registered through a Regional Department of the Environment, and the Regional Departments are responsible for providing advice on the requirements of for nutrient management plans.

The requirements of the Manitoba regulations are summarized below:

- A permit is required before any manure storage facility may be constructed. The permit must be obtained to ensure that the structure is designed by a qualified, professional engineer, contains appropriate environmental protection for the local soils and water, and is properly sited with respect to wells, springs, sinkholes, watercourses and other environmentally sensitive features. Manure storage

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[59]. 4 V.A.C.5-15-110.
[60]. 4 V.A.C. 5-15-120.
[61]. *From the Livestock Manure and Mortalities Management Regulation, Manitoba Regulations 42/98.*
[62]. *The Environment Act* (CCSM c. E125)

facilities may not be constructed within the boundaries of the 100 year flood elevation unless satisfactory flood protection is provided;

- Manure spread on agricultural land must be applied as a fertilizer. The amount of manure that may be applied is restricted, based on soil texture, nitrite content in the upper 60 centimeters of the soil, and the type of crop to be grown. Annual manure management plans must be submitted at least 60 days before manure application from large-scale livestock operations. The plans must describe the volume and quantity of manure to be spread, the method of land application, and the landowners and locations where manure is to be spread. Submission of soil test results prior to spreading of manure is mandatory.

- Spreading of manure is prohibited for large-scale producers during the five month period between November 10 and April 15. Existing large scale-operations have until November 10, 2003 before they must have sufficient storage capacity to enable them to comply. Small-scale livestock producers are exempt from the ban on winter spreading but must comply with mandatory setback distances from watercourses, wells, springs, and sinkholes. Escape of manure from the boundaries of the agricultural operation is prohibited.

- Enforcement may include a Warning, Order and/or Offence Notice. Warnings may be issued for first time offences that may have minimal environmental consequences. Orders to take corrective action are commonly issued for situations involving runoff or manure or manure storage facilities that may require maintenance.

- Fines plus court costs for Offence Notices range from $382 for individuals to $1,470 for corporations. Repeat offenders causing serious environmental degradation may be prosecuted directly under the Environment Act, where penalties for individuals range up to $100,000 and for corporations up to $1 million and imprisonment.[63]

According to a recent report from Manitoba Agriculture, the most common offences during the first year of enforcement of the Livestock Manure and Mortalities Regulation included manure stored too close to water courses, escape of manure from the agricultural operation, excessive application, and manure storage permit infractions.[64]

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[63] . This summary adapted from Manitoba Agriculture, *Livestock Stewardship 2000, Manitoba, Regulations and Guidelines*. Available on-line at:
http://www.gov.mb.ca/agriculture/news/lsteward/stewardship7.html#Environment

[64] . Ibid.

Restrictions on Winter Spreading

In general, nutrient management regulations include a number of restrictions on the winter spreading of manure. These restrictions exist to prevent runoff of manure from fields that are covered in ice and snow. Manure that is spread on frozen soil does not readily incorporate into the soil and may also runoff into watercourses and adversely impact on water quality. Winter application of manure is also not recommended because nutrients in the manure will be lost during spring runoff.

The Manitoba *Livestock Manure and Mortalities Management Regulation* includes detailed restrictions on winter spreading.[65] The restrictions are summarized below:

- No person may apply livestock manure to land between November 10 and April 15 unless the following exceptions apply:
  - the operator of an existing agricultural operation has less than 400 animal units on the day the regulation came into force (this exception applies until November 10, 2001.
  - In emergency situations or because of other extenuating circumstances where the director of the Regional Department of Agriculture has given prior authorization to apply manure to land between November 10 and April 15.
  - In cases where the director considers it appropriate to vary the restrictions given local soil and weather conditions.

- No person shall apply livestock manure to land between November 10 and April 15 if the mean slope of the land is 12% or more.

- In all cases, even where the exceptions listed above, the director may, by order prohibit an operator from applying manure during November 10 and April 15 if, in the opinion of the director, the application would likely cause pollution to surface water, groundwater or soil; or result in manure escaping from the boundary of the operation. Compliance with any order of the director is mandatory.

- No person shall apply livestock manure to land between November 10 and April 15 except in accordance with the following minimum setback distance requirements[66]:
  - 10 meters from any property boundary;
  - for land having a mean slope of less than 4%, 150 meters from any surface watercourse, sinkhole, spring, or well;

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[65] . See: Manitoba *Livestock Manure and Mortalities Management Regulation* 42/98, Sections 14 (1)-(9).
[66] . See: Manitoba *Livestock Manure and Mortalities Management Regulation* 42/98, schedule B (section 14), *Setback Requirements for Winter Spreading of Livestock Manure.*

- for land having a mean slope of 4% or more, but less than 6%, 300 meters from any surface watercourse, sinkhole, spring or well;
- for land having a mean slope of 6% or more, but less than 12%, 450 meters from any surface watercourse, sinkhole, spring or well.

Threshold Animal Units

Under the *Livestock Manure and Mortalities Management Regulation*,[67] 400 animal units trigger the mandatory preparation and submission of manure management plans. Currently, animal units are defined for a single type of livestock and totals are not cumulative across species. Thus, a farm with nearly 400 animal units of cattle and nearly 400 animal units of hogs would not trigger the additional manure management requirements. In such cases, farms are not prohibited from winter spreading of manure, nor are they required to submit manure management plans.

Provincial Nutrient Management Strategy

Nutrient runoff into surface waters is one of the primary concerns in dealing with nutrient management. Manitoba Conservation is currently developing a nutrient management strategy for surface waters in Southern Manitoba to address the eutrophication of surface waters. This strategy considers issues in the control of nutrient loading from both point and non-point sources.[68]

Nutrient Management in Maryland

The *Agricultural Operation Nutrient Management Plan Requirements* for Maryland, incorporates the performance and technical standards found in the Maryland Department of Agriculture's *Maryland Nutrient Management Manual*.[69] The regulations require farmers and operators to develop nutrient management plans for nitrogen from biosolids and animal manure use by December 31, 2001, and to implement the plan by December 31, 2002. Plans for both Phosphorus and Nitrogen must be developed by December 31, 2004, and implemented by December 31, 2005.[70]

The regulations require the following elements to be included in the nutrient management plan:

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[67] . See: Manitoba *Livestock Manure and Mortalities Management Regulation* 42/98.
[68] . See: Manitoba Conservation, *Development of a Nutrient Management Strategy for Surface Waters in Southern Manitoba*, Information Bulletin 2000-02E, April 20, 2000.
[69] . Maryland Department of Agriculture, *Maryland Nutrient Management Manual* (November 1999).
[70] . Code of Maryland Regulations, §15.20.07.04.

- Plan Identification
- Map or Aerial Photograph
- Plan Elements
- Field or Management Unit Specific Information
- Summary of Nutrient Recommendations
- Plan Maintenance

Recommendations by nutrient mangement consultants must be consistent with technical standards promulgated by the Maryland department of Agriculture.

The Maryland Administrative Code *Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation* is a thorough example of a regulation governing the preparation of nutrient management plans.[71] The Maryland regulation requires a detailed discussion of the following elements:

- Nutrient Rates
- Expected Crop Yield or Production Goal
- Soil Analysis Results
- Determination of Limiting Nutrient
- Natural Organic Fertilizer
- Timing of Nutrient Application
- Manure Management

The Maine Department of Agriculture, Food and Rural Resources has also promulgated extensive *Nutrient Management Rules* including rules for the certification and training of nutrient management planners.[72]

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[71] . See: Code of Maryland Regulations *Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation*, Title 15 Department of Agriculture, Subtitle 20, Soil and Water Conservation, Chapter 08. 15-2-08.

[72] . Maine Adminstrative Code, *Nutrient Management Rules*, 01-001 Department of Agriculture, Food and Rural Resources, Ch 565.

Summary of Requirements of Nutrient Management Plans[73]

General

Nutrient management plans are designed to maximize the benefits to croplands of spreading manure and other biosolids while minimizing surface runoff and other associated environmental and health risks. With such goals in mind, nutrient management planners take into account the existing nutrient content of soils, the amount of nutrients needed for planned or existing crops, and the geophysical factors which must be taken into account to avoid polluting waterways and groundwater. Effective nutrient management planning requires an in-depth knowledge of best practices related to the use of biosolids, and in most jurisdictions, only certified nutrient management consultants are authorized to develop such plans. To ensure proper nutrient management, regulations governing this practice generally contain the following requirements[74]:

- prepared by a certified nutrient management consultant;
- address all aspects of the agricultural operation, including tillage, cropping, pasture, or production of an agricultural product, such as plants, trees, sod, food, feed, animals, and fiber;
- identify, manage, and dispose of all primary nutrients produced on, imported to, and exported from the operation;
- protect water quality and improve manure utilization;
- encompass all lands where animals are kept and all lands used for manure storage, treatment, or utilization that is under the control of the agricultural operator;
- contain or manage manure to minimize the potential for nutrient loss or runoff before export to other agricultural operations or receiving facilities when agricultural operators have insufficient land to utilize manure and waste nutrients associated with animal production;
- minimize the potential for nutrient loss or runoff prior, during, and after application when an agricultural operator imports animal manure or waste nutrients associated with animal production for nutrient application on the operator's land;
- contain recommendations to farmers for the application of nutrients to specific lands. Generally, operators are prohibited from exceeding the recommended nutrient application rates;
- best management practices, strategies, or a phased-in approach

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73. Summary includes provisions from the following State and Provincial nutrient management laws and regulations: Annotated Code of Maryland 15.20.07.00, *Agricultural Operation Nutrient Management Plan Requirements*; 15.20.08.05 Code of Maryland Regulations, *Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation*; 01-001 Maine Administrative Code, Ch. 565, *Nutrient Management Rules*; 4 Virginia Administrative Code 15-150, *Required Nutrient Management Plan Procedures*; Manitoba Regulation 42/98, *Livestock Manure and Mortalities Regulation*; Oregon Natural Resources Conservation Service, *Nutrient Management*, Acre Code 590; British Columbia *Agricultural Waste Control Regulation* (B.C. Reg. 131/92); Iowa Code, Section 455B.203A, *Manure Applicators Certification.*

74. See note 73.

identified to achieve soil fertility over time within optimal ranges;

Determining Plant Nutrient Requirements and the Agronomic Rate of Application of Biosolids

Different crops require different amounts of nutrients. Some crops, such as corn, are considered "heavy feeders," and require substantial amounts of nitrogen for healthy growth. Other crops, such as legumes, have the opposite effect: legumes fix nitrogen in the soil, thereby increasing the nitrogen concentration of soils. The crop rotation on any given field will be a factor in determining what additional nutrients must be added to soils through the use of biosolids or other fertilizers. One of the most important elements of a nutrient management plan is to calculate the agronomic rate of application, i.e. to determine the existing nutrient content of soils, to calculate the amount of additional nutrients that will be required, and to calculate the amount of biosolids that can be safely applied. The U.S. Part 503 regulation defines the agronomic rate as the application rate of a biosolid designed to: a) provide the amount of nitrogen needed by the food crop, feed crop, fiber crop, cover crop, or vegetation grown on the land, and: b) to minimize the amount of nitrogen in the biosolid that passes below the root zone of the crop or vegetation grown on the land to the groundwater.[75] Regulations that outline the requirements of nutrient management plans often contain detailed sections on the determination of the agronomic rate of calculation. Supporting technical documents, and worksheets for the calculation of agronomic rates may be included in the regulations, or referred to.[76] Discussion of determining plant nutrient requirements and the agronomic rate in the regulations generally include the following elements:[77]

- nutrient application practices for each field in the plan;
- soil tests to determine existing nutrient levels;
- consideration of nutrients contained in fertilizers, manures, biosolids, legumes in the crop rotation, crop residues, residual nutrients, and all other sources of nutrients;
- calculations of crop nutrient needs for each field;
- recommend nutrient application rates based on crop nutrient needs including: nitrogen (N), phosphate (P2O5), and potash (K2O);
- indicate clearly that application rates for nitrogen and phosphorus should not exceed the crop nutrient needs to prevent runoff of excess nitrogen;
- routing of phosphorus to fields with lowest phosphorus soil analysis;
- development and implementation of a comprehensive soil conservation plan;

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[75] . See: 40 CFR 503.11(b).

[76] . See: Manitoba Agriculture, *Farm Practices Guidelines for Hog production in Manitoba*, Appendix C; see also: *Environmental Guidelines for Beef Producers* and *Environmental Guidelines for Dairy Producers,* sections on: *Land Application of Manure*, Ministry of Agriculture and Food, British Columbia, (see Tables 9.1, 9.2, and 9.3) and section E.1, *Detailed Calculations for Beef Cattle Manure Land Application.* These guidelines are available on-line at: http://www.agf.gov.bc.ca/resmgmt/fppa/pubs/environ/beef/beef_e.htm

[77]. See Note 73.

- recommended application rates for potassium, secondary nutrients, and micronutrients that are at agronomically or economically justifiable levels for expected crop production;
- estimate of expected crop yield (this is often done by estimating from past crop yields or soil productivity on specific fields; however,other methods may also be used);
- follow regulations on methods for determining expected crop yields, if such methods are included in the applicable regulations;
- representative soil analysis results using specified standard soil sampling and analysis, within specific time period (e.g. three years), using standard techniques for obtaining soil samples;
- may require that the most recent organic nutrient source analysis results be used, or an average of past nutrient analysis may be used to determine the nutrient content of organic nutrient sources;
- incorporate standard values published in government technical support documents;
- account for mineralization of organic nutrients from previous applications (i.e. plans must take into consideration the amount of nitrogen that is available in soils from previous applications of biosolids);
- take into consideration the expected nitrogen contributions from legumes in previous rotations;
- consider how soil pH will impact on nutrient availability and whether pHlevels must be adjusted to suit the crop;

Timing of Nutrient Application

The timing of the application of nutrients to a field is an important consideration in the overall nutrient management plan. Generally, it is recommended that biosolids be applied at the time closest to when the crops will require the nutrients so as to avoid runoff of nutrients, and to benefit most from the nutrients that are being applied. Spring application of biosolids is recommended, however, spring application is not always feasible given the short growing seasons in northern jurisdictions. Nutrient management planning regulations generally include the following elements with respect to the timing of nutrient application:[78]

- timing recommendations as close to plant nutrient uptake periods as possible;
- if no actively growing crop is in place, plans may require that an agronomically feasible crop be planted within a specific number of days (for example, 30 days) following nutrient application;
- reference to, or incorporation of technical standards for timing of nutrient application, as published by the responsible government agency;
- requirements for split application of inorganic nitrogen fertilizers as starter or

77. See note 73.

broadcast, and sidedressing or top dressing in row crops and small grains;
- prohibition of utrient application on frozen or snow covered grounds, except in emergency circumstances; restriction on any application to frozen or snow covered ground to fields with steep slopes.[79]

Method of Applying Nutrients

There are many ways in which nutrients may be applied to fields. Spreader equipment is designed specifically for spreading solid, semi-solid or liquid biosolids (including septage). Whatever the method used for spreading, the land applier must meet stringent requirements on the volume and location of spreading. Different spreading equipment will have different results, and it is common knowledge that spreader equipment does not always apply nutrients uniformly. Such variances in the efficiency of spreader equipment must be taken into account by the land applier. Land appliers are responsible for knowing how accurate their spreading equipment is, and they must make any necessary adjustments to comply with the application rates that are recommended in approved nutrient management plans. The regulations generally consider the following factors with respect to nutrient management plans and the methods used for the application of biosolids:[80]

- minimize runoff, leaching and volatization losses;
- reference to standards on the application rates of liquid manures or sludges;
- follow maximum liquid manure or sludge application rates;
- indicate that the application of liquid manure or sludge must not exceed the hydraulic loading capacity of soils at the time of application;
- biosolids and manures incorporated or injected into the crop root zone;
- incorporate recommended buffer zones around wells, springs, surface waters, sinkholes and rock outcrops, with reference to the standards for buffer zones contained in regulations or guidelines;

Manure Production and Use

In preparing a nutrient management plan, it is necessary to estimate the amount of manure that will be produced at an animal operation. As part of this process, nutrient management consultants are generally required to do the following:[81]

- estimate the annual manure quantity produced on each farm using official tables

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[79] . For a detailed description of the restrictions on land application of biosolids in winter, see the section of this report entitled: Restrictions on Areas Where Biosolids Might Be Applied, at p. 58.

80. See note 73.

81. See note 73.

and forms;
- estimate the total amount of manure produced and the amount that can be used on the farm, with reference to official values for crop nutrient up-take;
- include recommendations for proper use of excess manure;

Protection of Environmentally Sensitive Sites

- recommendations for protecting environmentally sensitive sites, including protecting habitats of endangered species ;
- reference to regulations on protected areas;

Plan Maintenance and Revisions

Nutrient management plans must be updated to take into account changes in production of manure (including changes in animal type), changes in crop rotation that affect the level of nutrients in the soil, and other changes in the farm practice that may affect the nutrient requirements of specific fields. Nutrient management planners must anticipate that significant changes may take place on the farm, and must indicate in their plans that plans must be revised in the event such changes occur. The following requirements for updating and revising nutrient management plans are generally contained in nutrient management regulations:[82]

- Site specific nutrient management plans including information on soil fertility and seasonal application of required nutrients for a specified period of time, from one to five years of production (for example, Maryland requires information for 3 years of production, Virginia requires one to five years). Revised and updated plans submitted to the responsible authority prior to expiration of the current plan;
- consider the need for modification if cropping systems, rotations, fields, animal numbers,[83] animal type, or animal waste management systems are changed, added or removed;
- indicate that plans will be invalid if the available land area for the use of manure decreases below the level necessary to use all the manure in the plan, or if there are changes in the number of animals that affect the amount of land necessary to use all the manure;
- include adjustments to figures for the rate of nutrient production and application if the number of animals increases, or if there are changes in the storage or application of wastes.
- include adjustments to figures for the rate of nutrient production if the nutrient

82. See note 73.

83 . Note that in the Maryland regulations, a change in the average number of animal units of 10% or greater, will require an amended nutrient management plan when the resultant manure production will require significant management adjustments.

content of manure changes due to changing feed ration, animal type, or if a new sampling and analysis technique is used for nutrient content.

- indicate that soil analysis must take place approximately every three years to determine soil fertility and pH (requirements for soil analysis vary slightly across jurisdictions);
- use recent soil analysis data to update nutrient management plans;
- manure analysis is recommended before field application until a baseline nutrient content is established for the type of manure on the corresponding farm operation.
- indicate that modified rates for the application of nitrogen may be recommended if a nitrogen test administered during the growing season indicates different levels of nitrogen than planning time applications;
- make adjustments to plans in the event of an occurrence or condition beyond the control of the operator, including a natural disaster, unanticipated weather condition, animal mortality, or disease.
- Adjustments must be made to plans if market changes or economic factors lead to modification in the agricultural operation, or for other limitations, such as equipment calibration limits;
- Ajustments must be documented, and it may be required to submit a revised nutrient management plan to the responsible authority.

Record Keeping and Reporting Requirements

A large component of the regulations governing nutrient management plans are the requirements for record keeping and reporting. Persons who prepare biosolids, and land appliers must keep very detailed records of the physical, chemical and micro-biological composition of biosolids. Likewise, nutrient management planners, and operators who implement those plans must also maintain good records. Record-keeping often involves completing forms that are issued by the responsible authority.[84] Records maintained by government authorities may be used to develop inventories of lands receiving biosolids as part of an overall nutrient management strategy or program for environmental monitoring of the use of biosolids. Record-keeping and reporting requirements generally include the following:[85]

- requirement to submit new nutrient management plans to the responsible authority each time a plan is updated;
- requirement to cooperate with the responsible authority in the evaluation of compliance with the plan;

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[84] . For an example of nutrient management forms, see Manitoba Agriculture forms, including the following forms: Animal Unit Inventory List, Manure System Information, Manure Management Plan, and Instructions For Filling Out The Manure Management Plan in Manitoba Agriculture, *Farm Practice Guidelines for Hog Producers in Manitoba*, 1998.

[85]. See note 73.

- requirement that perators must allow inspections of the sites governed by the plans;
- requirement for plans to contain descriptive information of the agricultural operation, including the owner, location of operation, type of operation, and the name of the individual preparing the plan;
- requirement to include a summary of the plan, including all nutrient recommendations during the plan period, and soil analysis information;[86]
- responsible authority may agree to protect confidentiality of all nutrient management plan information submitted;
- responsible authority may periodically review records of an agricultural operator to determine if a nutrient management plan is implemented;
- requirements regarding the process that must be followed to initiate an inspection, and provisions indicating that the inspection shall minimize any inconvenience to the operator;
- requirement to retain records for up to 3 years, including nutrient management plans, soil analysis results, specific field or management unit yield information for the previous 5 years, information documenting nutrient use to meet specific production goals for three production cycles, or 3 years, whichever is less, and a description of container production;
- requirement to document the timing, rate, quantity, type or types, and analysis of nutrients used, with reference to the field location, consistent with the production plan, site map or aerial photograph provided in the plan;
- requirement to keep records of manure analysis results;
- requirement to maintain monitoring information for runoff testing, including test results;
- requirement to keep records which justify any changes made to the nutrient management plan;
- requirement to keep records in a manner acceptable to the responsible authority and must make them available to the authority upon request;

Penalties for Non-compliance with Requirements for Nutrient Management Plans

Various sanctions exist for non-compliance with regulations pertaining to the preparation of nutrient management plans. Penalties may include the following elements:[87]

- Written warnings for first violations of deadlines;
- Fines for subsequent violations;
- Maximum fines per year;
- A separate violation for each day that the violation occurs;
- Failure to comply may result in further action by the responsible authority;

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[86] . For example, see: Code of Maryland Regulations 15-20-07-06 A.(2)(c).

87. See note 73.

- The responsible authority may consider the willfullness of the violation in assessing a civil penalty. Generally, provisions for appealing a penalty are provided in the regulations.

Progressive Programmes: Tax Credit Programs

A number of the jurisdictions examined have promulgated laws and regulations which provide economic incentives for improved nutrient management on farms. For expample, in Virginia, a tax credit program assists farmers in purchasing more accurate nutrient application equipment. Farmers are eligible for a 25% tax credit on the purchase of equipment that meets state specifications and if they develop nutrient management plans for their operations.

State Technical Assistance

Many states provide direct assistance to farmers in nutrient management practices through such activities as demonstration field days, farmer meetings, and individual contacts. For example, the Virginia Department of Health's Biosolids Use Regulations states that the Virginia Department of Conservation and Recreation is a resource for farmers. The department reviews sludge permit applications to address nutrient management issues. In Virginia, public nutrient management specialists also provide assistance in preparation of plans in 20 of the counties which require nutrient management plans in local confined livestock ordinances.[88]

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[88] . See: Virginia Department of Conservation and Recreation, *Soil and Water Conservation: Virginia's Nutrient Management Program*, December, 2000. Available on-line at: http://www.dcr.state.va.us/sw/nutmgt.htm.

Monitoring and Stabilization of Pathogens in Sewage Sludge and Septage

Untreated sewage sludge and septage will contains disease-causing pathogens. Biosolids must undergo highly specialized treatment processes to eliminate pathogens prior to land application. Pathogens are micro-organisms such as *salmonella* bacteria, enteric viruses, and viable *helminth ova* that may cause diseases. The presence or absence of pathogens are important factors determining the quality of biosolids for land application. In general, the preparer of biosolids for land application is responsible for obtaining certification that sewage sludge, septic waste and other biosolid products have been treated to reduce or entirely eliminate pathogens.

U.S. Federal Rules for Pathogen and Vector Attraction Reduction in Sewage Sludge

Under the Part 503 regulation[89], the preparer of sewage sludge is required to monitor sewage sludge to ensure that it complies with the Part 503 regulations pertaining to pathogen control. *The Guide for Land Appliers*[90] contains recommendations for optional monitoring for pathogens.

Class A and Class B pathogen reduction standards

Under the Part 503 regulation, two classes of pathogen reduction methods exist: Class A and Class B. This classification system has been adopted universally in U.S. State regulations addressing pathogen control in biosolids. Class B pathogen reduction methods substantially reduce the number of pathogens contained in sludge, but pathogens are not completely eliminated. Class A pathogen reduction methods completely eliminate the risk of pathogens. Land appliers who apply sewage sludge treated by Class A methods are note required to meet any additional requirements with respect to pathogens.

To reduce potential health risks associated with the use of Class B biosolids, numerous site restrictions exist for the use of Class B treated sewage sludge. These restrictions exist to provide time for natural processes to further reduce pathogen levels. Such restrictions apply in the siting of land application and also in the way in which the land is cultivated after sewage sludges have been applied. For example, restrictions on the cultivation of root crops may apply.[91]

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[89] . 40 CFR 503

[90] . See: USEPA, *A Guide for Land Appliers of the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge*, 40 CFR 503.

[91] . See: On the standards for Type II residuals, see the Code of Maine 06-096 Department of Environmental Protection, Ch. 419, Agronomic Utilization of Residuals, Section 3 C. and Appendix B.

Public Access

Under the Part 503 regulations, siting restrictions apply to Class B sewage sludge to deal with public access to the site, to address health issues related to the crop harvest and to restrict the presence of animals on the site. For farmland in rural areas, remote lands and securely fenced lands, federal rules restrict public access to the site for 30 days.[92] If the site is used frequently by the public (areas such as parks, playgrounds or golf courses), or if there may be frequent use by the public, access to the site must be restricted for one year after Class B sewage sludge has been applied.[93]

Various other restrictions may apply to the site, depending on its use. Mandatory waiting periods prior to harvesting food crops may apply. Similar restrictions may apply on sites where feed crops, fiber crops, and turf are grown, and on sites where livestock will be located.[94]

Responsibilities of Land appliers and Landholder/leaseholders

Under the 503 rules, it is the responsibility of either the land applier or the landowner/leaseholder to implement restrictions on public access, crop harvest, and animal grazing. Land appliers are required to inform the landowner/leaseholder of the restrictions which apply where Class B sewage sludge has been spread. If the land owner agrees to comply with site restrictions, the land applier has the responsibility to certify that the restrictions have been complied with, and must keep this information in official records for a period of five years.[95] The land applier must provide the landowner with a list of all restrictions which apply, and must certify that the land owner was informed.[96]

Federal Site Restrictions for Class B Sewage Sludges

The following Part 503 site restrictions apply to sewage sludge treated with Class B pathogen reduction standards:

- Public access to land with a high potential for public exposure shall be restricted for 1 year after the application of sewage sludge;
- Public access to land with a low potential for public exposure shall be restricted for 30 days after sewage sludge application;
- Food crops, feed crops, or fiber crops shall not be harvested for 30 days after sewage sludge is applied;

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[92] . Source: 40 CFR 503.32(b)(5)(viii).
[93] . Source: 40 CFR 503.32(b)(5)(vii).
[94] . Source: 40 CFR 503.32(b)(5)(i - vi).
[95] . Source: 40 CFR 503.17.
[96] . Source: 40 CFR 503.17.

- Food crops with harvested parts that touch the sewage sludge/soil mixture and are totally above the land surface (e.g. melons, cucumbers, squash) shall not be harvested for 14 months after the application of sewage sludge;
- Food crops with harvested parts below the surface of the land (e.g. root crops, such as potatoes, carrots, radishes) shall not be harvested for 20 months after application when the sewage sludge is not incorporated into the soil or remains on the soil surface for 4 or more months prior to incorporation into the soil;
- Food crops with harvested parts below the surface (e.g., root crops, such as potatoes, carrots, radishes) shall not be harvested for 38 months if the sewage sludge is incorporated into the soil within 4 months after sewage sludge application;
- Animals shall not be grazed on a site for 30 days after sewage sludge application;
- Turf shall not be harvested for 1 year after sewage sludge application if the turf is placed on land with a high potential for public exposure or on a lawn, unless otherwise specified by the permitting authority.[97]

Vector Attraction Reduction

Animals and insects (such as rodents, flies, and birds) may be attracted to sewage sludge. Contact by animals and insects with sewage sludge may lead to the transmission of pathogenic microorganisms to human beings; and therefore, such animals might be vectors for the spread of disease. The U.S. Federal rules for vector attraction reduction are contained at 40 C.F.R. 503.15 and 40 C.F.R. 503.33. Ten options to reduce vector attraction are provided in the regulations.

Vector attraction reduction options 1 through 8 are treatment options and are implemented by the preparer of sewage sludge. Options 9 and 10 are considered "barrier" options and are undertaken by the land applier if none of the treatment options have been satisfied. The land applier is not required to implement either of the barrier options if the treatment options have been performed by the preparer. Land appliers must implement and certify compliance with one of the following barrier options if treatment options have not been carried out:

Vector attraction reduction option 9 (40 C.F.R. 503.33):

- Sewage sludge shall be injected below the surface of the land;
- No significant amount of the sewage sludge shall be present on the land surface within 1 hour after the sewage sludge is injected;
- When sewage sludge that is injected below the surface of the land is Class A for pathogens, the sewage sludge shall be injected below the land surface within 8 hours after being discharged from the pathogen treatment process (to prevent regrowth of

[97] . This summary from: *A Guide for Land Appliers of the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge*, 40 CFR 503.

Salmonella bacteria).

Vector attraction reduction option 10 (40 C.F.R. 503.33):

- Sewage sludge applied to the land shall be incorporated into the soil within 6 hours after application to the land;
- When sewage sludge that is incorporated into the soil is Class A for pathogens, the sewage sludge shall be applied to the land within 8 hours after being discharged from the pathogen treatment process.[98]

Pathogen Control under State and Provincial Regulations

The U.S. federal regulatory program to control discharges of pollutants to surface waters of the United States is the National Pollutant Discharge Elimination System (NPDES). As part of this program, the U.S. Environmental Protection Agency has authorized 42 States to implement their own Pollutant Discharge Elimination System. Authorized State Pollutant Discharge Elimination Systems adopt the federal standards for pathogen reduction and vector attraction reduction. The distinction between Class A and Class B sewage sludge that is established in the Federal Part 503 is reproduced in all State regulations on the land application of sewage sludge.

Texas

In 1998, the U.S. Environmental Protection Agency (EPA) authorized Texas to implement its Texas Pollutant Discharge Elimination System (TPDES) to carry out the National Pollutant Discharge Elimination System (NPDES). In Texas, the land application of sewage sludge and domestic septage is regulated by Title 30 Texas Administrative Code (TAC) Chapter 312, and is administered by the Texas Natural Resource and Conservation Commission. The statutory authority for these rules originated from the Texas Water Code §5.103 and Safety Code §§361.011 and 361.024.

The Texas Chapter 312 regulations governing the use and disposal of sewage sludge are equivalent to Parts 122, 123, 501 and 503 of the Federal regulations. Under the Texas Code, exceptional quality sewage sludge must meet the standards for pollutants (heavy metals) [at 30 T.A.C. §312.43(b)(3)(Table 3)], the Class A pathogen reduction standards [at 30 T.A.C. §312.82(a)], and at least one of the requirements relating to vector attraction reduction [at 30 TAC §312.83(b)(1)-(8)].

Subchapter D: Pathogen and Vector Attraction Reduction, of Chapter 312 of the Texas Administrative Code contains the requirements that must be met for sewage sludge

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[98] . Summary of vector reduction options from: USEPA, *A Guide for Land Appliers of the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge*, 40 CFR 503.

to meet either Class A or Class B pathogen reduction standards. The Subchapter outlines the following:

- site restrictions for the land on which Class B sewage sludge is applied for beneficial use;
- pathogen reduction requirements for domestic septage that is applied to agricultural land, forest, or a reclamation site for beneficial use;
- pathogen reduction requirements for domestic septage placed on an active sludge unit;
- site restrictions for the land on which domestic septage is applied for beneficial use or placed on an active sludge unit;
- vector attraction reduction requirements for sewage sludge and domestic septage land applied for beneficial use or placed on an active sludge unit.[99]

For Class B sludge, the preparer and land applier must meet the applicable site restrictions. Under the Texas Administrative Code, the following site restrictions apply:

- Food crops with harvested parts totally above the land surface that touch the sewage sludge/soil mixture shall not be harvested from the land for at least 14 months after the application of sewage sludge;
- Food crops with harvested parts below the surface of the land shall not be harvested for at least 20 months after the application of sewage sludge when the sewage sludge remains on the land surface for four months or longer prior to incorporation into the soil;
- Food crops with harvested parts below the surface of the land shall not be harvested for at least 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than four months prior to the incorporation into the soil;
- Food crops, feed crops and fiber crops shall not be harvested for at least 30 days after application of sewage sludge;
- Animals shall not be allowed to graze on the land for at least 30 days after application of sewage sludge;
- Turf grown on land where sewage sludge is applied shall not be harvested for at least one year after application of sewage sludge when the harvested turf is placed on either land with a high potential for public exposure or a lawn;
- Public access to land with a high potential for public exposure shall be restricted for at least one year after application of sewage sludge;
- Public access to land with a low potential for public exposure shall be restricted for at least 30 days after application of the sewage sludge.[100]

The same siting restrictions apply to domestic septage.[101] In addition, for

[99] . See: 30 TAC Chapter 312, Subchapter D: Pathogen and Vector Attraction Reduction, §312.81.(a)-(e).
[100] . From: 30 TAC Chapter 312, Subchapter D: *Pathogen and Vector Attraction Reduction*, §312.82.(b)(3).

domestic septage, the following restriction applies:

- The pH of domestic septage applied to agricultural land, forest, or a reclamation site shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for a period of 30 minutes.

For vector attraction reduction, twelve compliance alternatives are offered.[102] These compliance alternatives are identical to the compliance alternatives provided in the Part 503 Federal Rules.[103]

Maine

Under the Code of Maine regulations for the Agronomic Utilization of Residuals, biosolids are classified as "Type II" residuals if they may contain human pathogens. Sewage sludge and septage are therefore classified as Type II residuals and additional operational standards apply. As in the Federal Part 503 regulations, Type II residuals must be treated to a Class A or Class B pathogen and vector attraction reduction standard. The degree to which the residual is treated for pathogens and vector attraction determines the Class of the residual. As in the Federal regulations, Class A sewage sludge is sludge which has been treated to completely eliminate pathogens. Class B sewage sludge is sludge which has been treated, but which may still contain pathogens. When residuals are treated to Class A standards, in which pathogens are reduced to ambient soil concentrations, no additional siting standards apply. When residuals are treated to Class B standards, in which pathogens are reduced by about 90%, additional siting and operational standards apply.[104]

For land application of Type II residuals (sewage sludge or septage) in the State of Maine, the generator of the biosolid must ensure that the following additional standards (in addition to those required for all other residuals) are met:

- The sewage sludge or septage must be treated to a Class A or Class B vector attraction reduction standard and Class A or B pathogen reduction standard prior to use.[105]
- The sewage sludge or septage must also meet the following analytical standard at the time the residual is utilized: The density of *Salmonella sp.* bacteria in the residual must be less than three Most Probable Number per four grams of total solids (dry weight basis). In the absence of analytical data on *Salmonella sp.* this standard is

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[101] . Ibid. at 312.82 (c)(1)-(2).
[102] . 30 TAC Chapter 312, Subchapter D: *Pathogen and Vector Attraction Reduction*, §312.83 (b)(1)-(12).
[103] . 40 CFR §503.33(b)(1)-(12).
[104] . On the standards for Type II residuals, see the Code of Maine, 06-096 Department of Environmental Protection, Ch. 419, *Agronomic Utilization of Residuals*, Section 3 C. and Appendix B.
[105] . See: standards for Type II residuals, see the Code of Maine 06-096 Department of Environmental Protection, Ch. 419, *Agronomic Utilization of Residuals*, Section 3 C. and Appendix B.

presumed to have been met when the density of fecal coliform in the residual is shown to be less than 1000 Most Probable Number per gram of total solids (dry weight basis).

Oregon

The Oregon Department of Environmental Quality is the responsible authority for the administration of rules related to the land application of biosolids. Under 340-050-0026 of the Oregon Administrative Rules, *Land Application of Domestic Wastewater Treatment Facility Biosolids, Biosolids Derived Products, and Domestic Septage*, the Federal requirements under 40 CFR 503 must be met for pathogen reduction and vector attraction reduction. Federal siting regulations also apply.

Additional requirements for the stablization of pathogens in septage are required in the Oregon Administrative Rules:

(6) Prior to land application, domestic septage shall be screened to ensure the removal of hair, plastics and other coarse materials. Screenings shall be disposed of at a permitted solid waste landfill. Further, septage shall undergo the following additional treatment prior to land application:

(a) Domestic septic tank pumpings: The pH of the domestic septage shall be increased by introducing and actively mixing sufficient alkaline agent to elevate the pH to 12 or higher (without further addition of alkaline agent) for a minimum period of 30 minutes.

(b) Domestic holding tank, chemical toilet, and vault toilet pumpings: Prior to alkaline stablization, domestic holding tank, chemical toilet, or vault toilet pumpings shall be mixed with domestic septic tank pumpings at a ratio of at least three gallons septic tank pumpings per gallon holding tank, vault toilet, or chemical toilet pumpings.

(7) The pH of blended domestic septage shall be increased to 12 or more by introducing and actively mixing sufficient alkaline agent to elevate the pH to 12 or more (without further addition of alkaline agent) for minimum period of 2 hours. A the end of the active mixing process, the domestic septage-alkaline agent mixture shall be allowed to further react for at least 22 additional hours. At the end of the 22 hours reaction process, the pH of the domestic septage-alkaline agent mixture shall be at least 11.5.[106]

[106] . 340 OAR 050-0026-(5).

Maryland

Standards for pathogen control under Title 26 of the Code of Maryland Regulations do not conform directly to the standards provided in the Federal Part 503 regulations. In contrast to the Federal 503 Rules, which contain specific biologically based standards which must be met, the Code of Maryland merely states that all sewage sludge must be treated by a process to significantly reduce pathogens (PSRP) or by a process to further reduce pathogens (PFRP), unless the sludge is disposed of in a manner that precludes potential health hazards due to the presence of pathogens. The following methods are outlined in the Code of Maryland regulations:

Processes to Significantly Reduce Pathogens (PSRP's):

- Aerobic Digestion: The process is conducted by agitating sludge with air or oxygen to maintain aerobic conditions at residence times ranging from 60 days at 15° C to 40 days at 20 ° C, with a volatile solids reduction of at least 38%.
- Air Drying: Liquid sludge is allowed to drain or dry, or both, on under-drained sand beds, or paved or unpaved basins in which the sludge is at a maximum depth of 9 inches. A minimum of 3 months is required, 2 months of which temperatures average on a daily basis above 0° C.
- Anaerobic Digestion. The process is conducted in the absence of air at residence times ranging from 60 days at 20° C to 15 days at 35° C, with a volatile solids reduction of at least 38 percent.
- Composting: Using the within-vessel, static aerated pile or window composting methods, the solid waste is maintained at minimum operating conditions of 40° C for 5 days. For 4 hours during this period the temperature exceeds 55° C.
- Lime Stablization: Sufficient lime is added to produce a pH of 12 after 2 hours of contact.
- Other Methods: Other methods or operating conditions may be acceptable if the applicant demonstrates that pathogens and vector attraction of the waste (volatile solids) are reduced to an extent equivalent to the reduction achieved by any of the above methods. In particular, aerobic and anaerobic digestion, when performed in accordance with plans approved by the Department under COMAR 26-03-02, are considered to satisfy PSRP requirements.

Processes to Further Reduce Pathogens (PFRP):

- Composting: Using the within-vessel composting method, the solid waste is maintained at operating conditions of 55° C or greater for 3 days. Using the static aerated pile composting method, the solid waste is maintained at operating conditions of 55° C or greater for 3 days. Using the windrow composting method, the solid waste attains a temperature of 55° C or greater for at least 15 days during the composting period. Also during the high temperature period there will be a minimum of five turnings of the windrow.

- Heat Drying: Dewatered sludge cake is dried by direct or indirect contact with hot gases, and moisture content is reduced to 10% or lower. Sludge particles reach temperatures well in excess of 80° C, or the wet bulb temperature of the gas stream in contact with the sludge at the point where it leaves the dryer is in excess of 80° C.
- Heat Treatment. Liquid sludge is heated to temperatures of 180° C for 30 minutes.
- Thermophilic Aerobic Digestion. Liquid sludge is agitated with air or oxygen to maintain aerobic conditions at residence times of 10 days at 55-60° C, with a volatile solids reduction of at least 38%.
- Any of the processes listed below, if added to the processes described in *Processes to Significantly Reduce Pathogens* [above], to further reduce pathogens. Because the processes listed below, on their own, do not reduce the attraction of disease vectors, they are only add-on in nature:
  - (a) Beta Ray Irradiation: Sludge is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20° C).
  - (b) Gamma Ray Irradiation: Sludge is irradiated with gamma rays from certain isotopes, such as Cobalt and Cesium, at dosages of at least 1.0 megarad at room temperature (ca. 20° C).
  - (c) Pasteurization: Sludge is maintained for at least 30 minutes at a minimum temperature of 70° C.
  - (d) Other Methods: Other methods or operating conditions may be acceptable if pathogens and volatile solids are reduced to an extent equivalent to the reduction achieved by any of the above methods.[107]

Post Application Restrictions on Cultivation and Use of Lands

Regulations on land application of biosolids are required to address the potential for contamination of food crops where biosolids are used which have not been treated to eliminate 100% of pathogens. Under the Maine regulations, at sites where Class B pathogen reduction standards are used, the generator must ensure that a number of additional provisions are met:

- Residuals must be applied a minimum of fifteen (15) inches above the groundwater surface at the time of application. If residuals are injected or incorporated, a minimum of fifteen (15) inches of separation must be maintained between the water table surface and the limit of incorporation or injection. Residuals treated to class B pathogen standards and that are used in flood plains, must be applied prior to September 15th.

- The buffers and setbacks established by sections 3.B(2) and (4) [see description above] must be met. Additionally, unless otherwise provided for in a site specific soil erosion control plan, the residual may not be spread within 25 feet of site waterways

[107] . See: Code of Maryland Regulations, Title 26, Department of the Environment, Subtitle 04, *Regulation of Water Supply, Sewage Disposal, and Solid Waste*, Section .08(B)(C).

including gullies, ravines and swales.

- Food crops grown on the application site with harvested parts that touch a Class B with respect to pathogens residual/soil mixture and are totally above the land surface, are not harvested for at least fourteen (14) months after the last application of the residual that is treated to a Class B pathogen standard.

- Food crops grown on the application site are not harvested for at least twenty (20) months after the last application of a residual that is treated to a class B pathogen reduction standard when the crops have harvested parts below the surface of the land and the residual that is treated to a Class B pathogen reduction standard remains on the land surface for four months or longer prior to incorporation into the soil.

- Food crops grown on the application site are not harvested for at least thirty-eight (38) months after the last application of residual that is treated to a class B pathogen reduction standard when the crops have harvested parts below the surface of the land and the residual that is treated to a class B pathogen reduction standard remains on the land surface for less than four months prior to incorporation into the soil.

- Food crops, feed crops, and fiber crops grown on the application site are not harvested from the land for at least thirty (30) days after the last application of the residual that is treated to a Class B pathogen reduction standard.

- Domestic animals are not allowed to graze on the land for at least (30) days after the last application of the residual that is treated to a Class B pathogen reduction standard.

- Turf is not harvested for at least one year after the last application of a residual that is treated to a class B pathogen reduction standard.

- Topsoil is not mined from a site for at least thirty-eight (38) months after the last application of a residual that is treated to a Class B pathogen reduction standard.

- Public access to land with a high potential for public contact is restricted at the time of application and for one year after the last application of the residual that is treated to a Class B pathogen reduction standard. At a minimum, signs must be placed at common entranceways, unfenced open areas, and other appropriate locations to provide notice of restricted access.

- Public acces to land with a low potential for public exposure is restricted at the time of application and for 30 days after the last application of the residual that is treated to a class B pathogen reduction standard. If necessary, the Department may require that signs be placed at appropriate locations to provide notice of restricted access, especially at common entranceways or unfenced open areas.

Stablization of Septage to Reduce Pathogens

U.S. Federal Regulations and State Requirements

In the United States, prior to land application, septage must be stablized with alkali material.[108] Under section 503.32(c)(2) of the U.S. Part 503 regulations, domestic septage must undergo treatment to reduce pathogens prior to land application.[109] As with other Part 503 Regulations, U.S. States must comply with the minimum federal requirements. In addition, under §503.32(c)(1), certain site restrictions[110] must also be complied with when applying septage to agricultural lands.

The requirements for stabilization of septage under section 503.32(c)(2) are the following:

> The pH of domestic septage applied to agricultural land, forest, or a reclamation site shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes and the site restrictions in §503.32(b)(5)(i) through (b)(5)(iv) shall be met.[111]

The federal regulations do not prohibit States from promulgating more stringent requirements. Minor additional requirements are included in the *Septage Management Rules*[112] for the State of Maine. The Maine rules require that after adding alkaline material to septage, the "alkaline material and septage must be thoroughly blended into a homogenous mixture".[113] Moreover, the regulations require that the pH of the mixture must be at least 12 at the time of land application.[114]

Manitoba Regulations

There are no requirements for stabilization of septage for pathogens prior to land application in Manitoba. Septic tank wastes are currently pumped directly onto agricultural lands. However new regulations are being developed which will permit the land application of septage only on lands owned by the person applying the septage. Set-

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[108] . Alkali materials which may be used for this purpose include: lime (calcium oxide), caustic (sodium hydroxide), wood ash, or sawdust.

[109] . See: *A Guide to the Federal EPA Rule for Land Application of Domestic Septage to Non-Public Contact Sites*, published by the U.S. EPA, available on-line, at:
http://www.epa.gov/own/pdfs/septage_guide.pdf

[110] . See the siting restrictions in §503.32(b)(5) which are discussed in this paper under the heading: "public access".

[111] . See: 40 C.F.R. 503.32(c)(2).

[112] . See: Code of Maine Rules, 06-096, Department of Environmental Protection, Ch. 420, Septage Management Rules.

[113] . See: Ibid, §6(B)(1)(a).

[114] . See: Ibid, §6(B)(1)(c).

back distances will apply, and farms must be a minimum of 10 acres. There are no additional requirements for pathogen reduction in septage in the proposed regulations.[115]

British Columbia

The regulation of land application of septage in British Columbia falls under the *Waste Management Act*. There is no regulation which deals specifically with the land application of septage. However, before an operator may apply septage to agricultural lands, a permit must be issued by the Ministry of Environment, Lands and Parks. In such permits, the conditions specified under the *Waste Management Act* must be met in a Liquid Waste Management Plan. The Ministry considers proposals for the land application of septage on a case-by-case basis. In each case, the proponent must explain how the septage will be treated, and the Ministry then decides whether the proposed treatment method is adequate.[116]

New regulations for the land application of biosolids are currently being considered in British Columbia. The new regulations will contain specific requirements for septage.[117] The proposed *Organic Matter Recycling Regulation* will amend the existing *Production and Use of Compost Regulation.*[118] Under the proposed regulation, septage must be treated for pathogen reduction and vector attraction reduction.

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[115] . Information on the current state of regulations and proposed regulations was obtained from: Norbert Bernard, Chief Public Health Inspector, Manitoba Conservation, April 5, 2001.

[116] . This information obtained from: Chris Jenkins, Pollution Prevention and Remediation Branch, British Columbia Ministry of the Environment, Lands and Parks, April 6, 2001.

[117] . Ibid.

[118] . Production and Use of Compost Regulation, B.C. Reg 334/93.

Restrictions On Areas Where Biosolids Might Be Applied

Siting restrictions for biosolids vary depending on the quality of the biosolid. Restrictions on where animal manure may be applied are contained within regulations governing manure management in the nutrient management planning process. Restrictions on the land application of sewage sludge and septage are contained in regulations pertaining specifically to sewage sludge and septage. Set-backs and buffer zones exist to protect groundwater and waterways, and may exist to protect environmentally sensitive areas.

Generally, in all cases of the agronomic use of biosolids, including manure, sewage sludge and septage, the biosolid must be physically and chemically suitable for the intended land use, must be non-hazardous, and must be of a known and consistent quality. The biosolid must increase the nutrient content of the soil at a rate commensurate with the nutritional needs of the crop to be grown, otherwise improve agricultural soil conditions, or provide another horticultural benefit in which the biosolid meets or exceeds the generally accepted product specifications and standards for the product it is replacing. Each substance in a mixed biosolid material must add to the agronomic benefit of the whole mixture. Nutrient management plans prepared by certified nutrient management specialists are mandatory almost without exception prior to the issuance of a permit for the land application of biosolids by the responsible agency.

Siting Restrictions

The primary aim of siting restrictions for the land application of biosolids is to protect groundwater and waterways. To achieve this result, State, Federal and Provincial regulations contain various siting restrictions, including the following general restrictions:

- biosolids may not pollute any waterway, and biosolids may not be place where they will be washed into waterways;[119]
- biosolids may not be applied when the soil is frozen, snow-covered, or water-saturated;[120]
- biosolids must be applied evenly at or less than the maximum allowable application rates. Application rates are determined by calculating the agronomic requirements for nitrogen, phosphorus and other nutrients such as calcium carbonate.[121]

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[119] . See: 40 C.F.R. 503.14(b).

[120] . See: Ibid. (U.S. Federal requirements); See also: Section 14, *Manitoba Livestock Manure and Mortalities Management Regulation.*

[121] . See, for example: Federal requirments at 40 C.F.R. 503.14(d); Oregon Administrative Rules: 340-050-0026(4)(e); Virginia Administrative Code: 4 V.A.C. 5-15-150(A)(2)(b); Code of Maryland Regulations: 15-20-08-05(B)(1); Code of Maine: 01-001-565§6(1)(D); North Carolina Administrative Code: T15A-C2-S2H.0217(a)(1)(C)(i); British Columbia Agricultural Waste Control Regulation (B.C. Reg. 131/92), section

Siting Restrictions Under U.S. Federal Standards

The U.S. Federal Part 503 Standards contain management practices for the land application of sewage sludge. These practices help to ensure that sewage sludge is applied in a manner that protects human health and the environment. The management practices regulate the way in which bulk sewage sludge is applied to land. Restrictions with respect to the following issues may apply to the land application of sewage sludge in certain areas:

- Proximity to threatened or endangered species
- Flooded, frozen, or snow-covered lands
- Set-backs from waters
- Agronomic rates

Proximity to threatened or endangered species:

The application of bulk sewage sludge to lands where it is likely to adversly affect threatened or endangered species or their critical habitat is prohibited under the Part 503 rules.[122] An "adverse affect" is any direct or indirect action that will reduce the likelihood of survival and recovery of any threatened or endangered species. Any place where a threatened or endangered species lives and grows during any stage in its life cycle is considered a "critical habitat." Operators may obtain a list of threatened or endangered species from the U.S. Department of Interior, Fish and Wildlife Service (FWS).

The Guide for Land Appliers makes the following recommendations with respect to threatened or endangered species:

> Application of sewage sludge to land that is subjected to normal tillage, cropping and grazing practices, mining, forestry and other activities that, by their nature, turn the soil and impact vegetation is not likely to cause and increase any negative impact on endangered species and in fact may be beneficial because of the nutritive and soil building properties of sewage sludge. However, it is the responsibility of the land applier to determine whether the application of sludge might cause an adverse effect on threatened or endangered species or their critical habitats. The Part 503 rule requires the land applier to certify that the applicable management practices have been met, including the requirement concerning threatened or endangered species, and that records be kept indicating how the applicable management practices have been met.

14(e).

[122] . 40 CFR 503.14.

To comply with this management practice, the land applier should consult with FWS to determine whether any threatened or endangered species or designated critical habitats are present at the site. The land applier should retain all documentation to demonstrate that the site was evaluated for potential effects on threatened or endangered species and/or their habitat and that necessary protective measures were identified and implemented.[123]

Flooded, Frozen or Snow Covered Land

The application of sewage sludge to flooded, frozen, or snow covered lands such that sewage sludge enters a wetland or waters is prohibited by the Part 503 rules.[124] Therefore, before applying sewage sludge to flooded, frozen, or snow-covered lands, the land applier must ensure that adequate measures are put in place to control runoff. Various regulatory elements exist to control runoff, including slope restrictions, buffer zones/filter strips, tillage, crop residue, vegetation requirements, berms, dikes, silt fences, diversions, sediment basins and terraces.

Set-backs from waters

Set-back requirements are common in all regulations dealing with the land application of biosolids. The Part 503 regulations contain specific set-back requirements for sewage sludge. Unless authorized by permit, Part 503 prohibits the application of sewage sludge on agricultural land, forest, or a reclamation site within 10 meters of any waters of the United States. The intent of the buffer zone is to create a barrier against the entry of sewage sludge into waters. Permits may be issued to apply sewage sludge within 10 meters from waters if the application is expected to enhance the local environment.

Agronomic Rate

As in most regulations governing the land application of biosolids, the Part 503 regulations require that sewage sludge be applied to land at a rate that is equal to or less than the agronomic rate for the site. The agronomic rate is the rate of application that provides the nitrogen required by the crop and which minimizes the amount of nitrogen that leaches into groundwater. Applying too much sewage sludge may lead to the contamination of ground water by nitrites. Federal and State regulations generally recommend or require that biosolids be applied as close to the time of maximum nutrient

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[123] . See: USEPA, *A Guide for Land Appliers of the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge*, 40 CFR 503.

[124] . See 40 C.F.R. 503.14(b).

uptake as possible. Operators are advised or required to consult the guidelines prepared by State sludge management programs in order to calculate the proper agronomic rate of application. These calculations may be made as part of the development of the operators nutrient management plan, or as part of the State or local permitting process for the application of sewage sludge.

There are circumstances in which the permitting authority may authorize the application of sewage sludge at rates that exceed the agronomic rate. *The Guide for Land Appliers* notes that:

> Typically, sewage sludge will be applied at a rate that exceeds the agronomic rate only once, to improve the physical properties of the soil and supply nitrogen and other nutrients. Once a vegetative cover has been established, future applications of sewage sludge should be limited to the agronomic rate of the vegetation grown.[125]

Restrictions under State and Provincial Legislation

Siting standards for biosolid application are derived mainly from the Part 503 Federal Rules for the land application of sewage sludge. The general purpose of the restrictions are to prevent runoff from biosolid use into waters and environmentally sensitive areas.

Set-backs

Required setbacks are indicated as boundaries of the spreading area located a minimum distance from certain features. The Maine Department of Environmental Protection regulations on the Agronomic Utilization of Residuals contains the following minimum setbacks:

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[125] . See: *A Guide for Land Appliers of the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge*, 40 CFR 503, p. 27.

Minimum Setbacks for leachable residuals, Code of Maine Rules. [126]

Type of Feature:	Distance in Feet from boundary to feature:
Public well	500
Private well	300
Property line	25
Bedrock outcrop	25

Other Siting Requirements[127], under the Code of Maine Rules include:

Soil cap

On certain types of soils, a minimum soil cap must be present.

Minimum Depth to Bedrock

For established perennial crops such as hay, the bedrock must be a minimum of 10 inches below the ground surface. For other crops, including row crops, the depth to bedrock at the site must be a minimum of twenty inches below the ground surface.

Slope

The slope of a site may not exceed 15% for agricultural settings and 25% for forestry settings.

Siting restrictions for Sewage Sludge with High Concentrations of Heavy Metals

Stricter siting requirements may exist for sewage sludge with high concentrations

[126] . See: 06-096 Code of Maine Rules, Chapter 419, *Agronomic Utilization of Residuals*. Section 3 A (1).
[127] . See 06-096 Code of Maine Rules, Chapter 419, *Agronomic Utilization of Residuals*. Section 3 A (2-4).

of heavy metals. Under the Code of Maine rules, which were substantially amended in 1999, additional siting requirements apply to sewage sludge, mixtures of sewage sludge, and other residuals with heavy metal contents exceeding specified.[128]

The stricter siting requirements are summarized below:

Buffers and Setbacks

Boundaries of the utilization site must be located a minimum distance from surface water, according to the following table, unless otherwise approved in a site specific soil erosion plan. The Maine Department of Environmental Protection may increase setbacks if necessary to meet other standards which may apply to a specific site.

Minimum Buffers to Protect Surface Water[129]

Buffer Characteristics*	Distance in feet from application area to marine waters, lakes, ponds, rivers, streams, brooks and intermittent streams
0-3% slopes, wooded	35
3-8% slopes, wooded	50
8-15% slopes, wooded	100
15-25% slopes, wooded	150
0-3% slopes, non-wooded	50
3-8% slopes, non-wooded	75
8-15% slopes, non-wooded	150

* The slope and cover type refer to the buffer area, and not the adjacent utilization field. "Non-wooded buffer" for purposes of this table means vegetated fields, reverting fields or grassed areas, and forested areas in which more than 40 percent of the timber has been harvested in the past ten years.

In addition to the requirements above, the utilization site may not be located within 300 feet of the high water mark of:

- surface water classified as GPA [?]
- lakes, ponds and springs that are public drinking water supplies;
- the shoreline within 1 mile upstream of the intake pipe on a stream or river that is a

[128] . The stricter requirements also apply to the use of type II residuals that have not been treated to class A pathogen standards.

[129] . From: Code of Maine Rules 06-096 Department of Environment, Ch 419, Agronomic Use of Residuals, Section 3. B (2). Table 419.2

public drinking water supply.

Slope

The slope may not exceed 15% for agicultural settings 25% for forestry settings.

Flood Plain

The utilization site may not be located within the 100 year flood plain. This provision does not apply to sites that will receive type II residuals treated to a class B pathogen treatment standard.[130]

Other Siting Standards for the Utilization of Sludge

Proximity to Rivers or Streams, generally

The Maine Department of Environment may not issue a license for a site where sludge will be utilized within 75 feet of a river, perennial stream or great pond.

Abutting property

The Maine Department of Environment will condition a site licence to restrict the land application of sludge to no less than 50 feet from abutting property boundaries, if so requested in writing by the abutting property owner during the process of the site specific license.

[130] . For applicable pathogen reduction standards, see Code of Maine Rules, Appendix B, 06-096 Department of Environment, Ch. 419 *Agronomic Utilization of Residuals*.

Concentrated Animal Feeding Operations

Concentrated animal feeding operations (CAFOs) are livestock operations (including cattle, dairy operations, hogs, and poultry) that involve very large numbers of animals. CAFOs are also referred to as confined animal feeding operations. Confined animal feeding operations are operations where animals are confined to a limited space for a specified time period. In some cases, animals in confined animal feeding operations are confined year-round. Special nutrient management and waste management regulations apply to concentrated and confined animal feeding operations in many of the jurisdictions under consideration in this paper. The purpose of these regulations are to address the specific health and environmental concerns related to the large amounts of waste that are produced on CAFOs.

The livestock industry throughout North America has undergone dramatic changes over the past 20 years. Animal operations are becoming concentrated in larger units. The result of this growth in feedlot size is that animal wastes are becoming concentrated in specific geographic areas. Increases in the number of reports of spills, discharges, and runoff of nutrients from livestock facilities have coincided with the growth of animal operations.[131] Large livestock operations are being constructed in areas where there is not enough land to accommodate the animal manure at agronomic rates. Soils and waterways may be contaminated with nutrient overloads in these areas. Similar problems associated with the concentration of animal operations have arisen in countries such as the Netherlands and Denmark, where land areas are much smaller than in most North American jurisdictions.[132]

Concerns about the Conventional Treatment of Animal Wastes on CAFOs

Animal manures are treated at storage facilities to convert the manure into a more stable product. Treatment processes are designed to reduce odours, to recover nutrients or energy from the manure, or to reduce the volume of stored manure. Recent studies suggest that there may be severe environmental and health impacts of conventional animal waste treatment systems, such as hog manure lagoons.[133] The use of alternative treatments of animal wastes at such facilities prior to land application or disposal may

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[131] . See: USEPA, *Proposed Regulations to Address Water Pollution from Concentrated Animal Feeding Operations*, Office of Water, January 2001, at 1.

[132] . See: Manitoba Agriculture, *Livestock Stewardship 2000 – Experiences Elsewhere*, available on-line: http://www.gov.mb.ca/agriculture/news/lsteward/stewardship6.html.

[133] . See: Environmental Defence Fund, *Hog Lagoons: Pitting Pork Waste Against Public Health and Environment*, June, 1999, pp. 6-12; Copeland, C. and Jeffrey Zinn, *Animal Waste Management and the Environment: Background for Current Issues*, The Committee for the National Institute for the Environment, May 12, 1998; United States Senate Committee on Agriculture, Nutrition, & Forestry, *Animal Waste Pollution in America: An Emerging National Problem, Environmental Risks of Livestock & Poultry Production*, December, 1997.

help to reduce potential health and environmental risks.[134] The Environmental Defense Fund Inc. has strongly recommended that conventional animal waste treatment systems be substituted with more environmentally sound technologies. However, apart from conventional storage and nutrient management requirements, waste management regulations for CAFOs generally do not include requirements for the use of non-conventional animal waste treatment systems. In some jurisdictions, it is not considered economically feasible to treat animal wastes using non-conventional methods.[135]

Currently, the U.S. Environmental Protection Agency (EPA) is proposing substantial changes to the National Pollution Discharge Elimination System regulations to reduce the amount of water pollution from large livestock operations. The changes are being proposed in response to public concern about the contamination of waterways and groundwater from animal wastes from large operations. The EPA's national strategy aims to ensure that all animal feeding operations "develop and implement technically sound, economically feasible and site-specific comprehensive nutrient management plans (CNMPs) to minimize impact on water quality and public health."[136]

The treatment of manure by non-conventional methods is not considered to be economical on Canadian farms.[137] The Manitoba *Livestock Manure and Mortalities Management Regulation*[138] does not require specific waste treatment for large operations, beyond the normal requirements for nutrient management planning and manure storage.

Threshold Number of Animals for CAFOs

Manure management plans are often not required for open feedlots. However, once livestock operations reach a certain size, manure management plans and animal waste management systems are often mandatory.

The threshold number of animals that must be met for an operation to be considered a CAFO varies between jurisdictions. Often, the threshold is simply a number of animals of a given type. For example, the *Maine Administrative Code* defines an

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[134] . Alternative animal waste treatment systems include: aerobic processes, storage aeration, pre-storage aeration, composting, anaerobic processes (lagoons and digesters), refeeding, dehydration, and solids separation. For further discussion on alternative treatment systems, see: P.E.I. Department of Agriculture and Forestry/Department of Technology and Environment, *Guidelines for Manure Management for Prince Edward Island*, January 7, 1999.

[135] . For a discussion on this point, see: Canadian Pork Council, *Canadian Code of Practice for Environmentally Sound Hog Production*, p. 21.

[136] . See: *Proposed Regulations to Address Water Pollution from Concentrated Animal Feeding Operations*, Office of Water, EPA, January 2001. A copy of the proposed regulations is available on-line at: http://www.epa.gov/owm/afo.htm.

[137] . See: Canadian Pork Council, *Canadian Code of Practice for Environmentally Sound Hog Production*, p. 21.

[138] . *See: Manitoba Livestock Manure and Mortalities Management Regulation, 42/98.*

"animal operation" as any agricultural operation involving 250 or more hogs, 100 or more confined cattle, 75 or more horses, 1000 or more sheep, or 30,000 or more confined poultry.[139] Under the *Code,* farms which are considered animal operations must meet additional waste management requirements. In other jurisdictions, the threshold is determined by the total weight of the animals in the operation. For example, Iowa regulations impose additional animal waste management requirements on any confined animal feeding operation with an animal weight capacity of more than 400,000 pounds of cattle or more than 200,000 pounds of animals other than cattle.[140] In other jurisdictions, an operation is considered to be a CAFO simply if the animals are confined (a specific threshold number of animals is not necessarily stated).[141] Another common method for measuring the threshold number is by animal units (1 animal unit = 1 a.u.). For example, in Maryland, one animal unit means the measure equivalent to 1,000 pounds of live animal weight, as defined in 40 CFR 122, Appendix B.[142]

In British Columbia, livestock is considered to be in a *confined* area if they are contained on sites where no crop is grown, or where a crop is grown but the amounts of manure produced exceed the crop requirements. Manure from confined operations must be collected, stored, and spread on cropland.[143]

In Texas there are two categories of CAFOs. A CAFO is defined as animal feeding operation which confines and feeds or maintains over 300, or over 1000 animal units, for a total of 45 days or more in any 12-month period. Different permit requirements exist for operations that meet the different threshold number of animal units. An animal unit is based on the standard of one animal unit = one slaughter or feeder cow, or equivalent.

To illustrate the use of animal units in determining whether or not an operation is a CAFO, the following table is included. The table outlines the number of animals which meet the threshold for facilities larger than 1000 animal units in Texas:

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[139] . See: Maine Administrative Code, 143-§215.10A.

[140] . See:Iowa Administrative Code, 567 Environmental Protection, Ch. 65, *Animal Feeding Operations, Manure Management Plan Forms for Confinement Animal Feeding Operations,* Water Quality Bureau, Department of Natural Resources, Iowa.

[141] . See: Oregon Administrative Code, 340 Department of Environmental Quality, Division 51, Confined Animal Feeding Operations, section 0010(2).

[142] . See: Code of Maryland Regulations, T15-20-08-03.

[143] . See: British Columbia Ministry of Agriculture and Food, *Environmental Guidelines for Beef Producers* - 9: Land Application of Manure. This document available on-line at: http://www.agf.gov.bc.ca/resmgmt/fppa/pubs/environ/beef/beef_e.htm

Biosolid Regulation in Europe

About 35% of the biosolids produced in Europe are applied to lands, 50% are used as landfill, 8% are incinerated, and 7% are disposed at sea.[153] The land application of biosolids in Europe has been under scrutiny in recent years by the public, governments, farmers, the food industry and food distribution industry.[154] In the U.K., fears surrounding BSE (mad-cow disease) and other diseases has led to increasing general concern about environmental and health risks in agriculture. In most of Europe, the regulation of biosolid use has been strengthened in recent years.[155] For example, in France, stricter requirements for heavy metals and more stringent pathogen reduction standards have been implemented.[156]

At the moment, no consistent framework currently exists for dealing with the environmental and health concerns arising from the use and disposal of biosolids in Europe.[157] Of all the biosolids that may be applied to land, only sewage sludge has been the subject of any attempts at consistent regulation.[158]

A U.K. based organization called the Specialists Group on Sludge Management is in the process of preparing a report on the state of regulation on sludge application around the world.[159] This international report will address the topic of: "Criteria and principles which are behind the legislation on sludge utilization worldwide and evaluating possibilities for homogenization" and will be presented at the 2001 International Water Association Congress to be held in Berlin.

The European Committee for Standardization (CEN)[160] created a technical committee (CEN/TC 308) in 1993 to examine sludge characterization, treatment and disposal. This committee is chaired by France. The CEN/TC 308 has recently proposed a number of objectives for strategic directions for future work on biosolid regulation, including the following:

- To elaborate documents (standards or reports) on vocabulary, terminology, methods of analysis and characterization, methods of good practice for different methods of use and disposal of sludges, and operational practices for preparing sludges. The aim is to harmonize the technical language, methods and practices for sludges within its scope across Europe;

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[153] . See: International Water Association, Specialist Group on Sludge Management, Newsletter, December 2000, London, U.K.
[154] . Ibid.
[155] . Ibid.
[156] . Ibid.
[157] . Ibid.
[158] . Ibid.
[159] . Ibid.
[160] . The European Committee for Standardization (CEN) can be located at: http://www.cenorm.be/

- To write a CEN Report to describe the actual production and market condition of sludges and to propose future applications;
- To enable compliance with legislation through the application of consistent analytical methods;
- To promote and enable sustainable development through good practice for the conservation of organic matter and completion of nutrient cycles;
- To contribute to improvements in public and environmental health and food safety through promoting and disseminating good practice;
- To contribute to and support the production and revision of European Directives relevant to sludges;
- To support European stakeholders in sludge management (legislators, private companies dealing with production, treatment and use).[161]

Nutrient Management in the Netherlands, Denmark and Belgium[162]

The Netherlands

The land area of the Netherlands is extremely small compared to most jurisdictions in North America. At the same time, farmers in the Netherlands raise very large numbers of livestock. Farms produce much more manure than necessary to fertilize crops. The result has been the over-application of manure on agricultural areas and associated environmental problems such as eutrophication and contamination of groundwater. Increasing environmental problems in the Netherlands associated with agriculture led to the adoption of nutrient control regulations in 1984. Regulations were established to control copper and other micro-elements in animal feeds. Limits were place on the growth of hog and poultry operations. An ammonia reduction program was implemented to lower ammonia emissions by 50% by 2000. Methods for manure application that lowered ammonia emissions were promoted. Standards to reduce the amount of phosphorus applied to lands were implemented, and a manure transport system was devised for farmers with surplus phosphorus.

The goals that were established in the 1984 regulations were not achieved, and a new nutrient control system was implemented to address phosphorus accumulation in soils and nitrogen leaching. In 1998, the Netherlands implemented an accounting system to track nitrogen and phosphate inputs in fertilizers and feeds, and to monitor the output of nutrients in products and manure. The mandatory mineral accounting system (MINAS) came into effect on January 1, 1998. Under the MINAS system, 2.5 livestock units are allowed per hectare (equivalent to 102.5kg of phosphorus for one year of

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[161] . *Ibid.*

[162] . The information contained in this section on the Netherlands, Belgium and Denmark is obtained from a report prepared on the impact of regulation on agriculture: MEF (Ministere de l'Environnement et de la Faune, Québec, *Etude d'Impact du Reglement sur la Réduction de la Pollution d'Origine Agricole, 1997.*

manure produced). In hog operations, this is equivalent to 13.9 growing pigs and 5 breeding sows with piglets per hectare.

The government of Netherlands has also attempted to deal with the excess production of nutrients by restricting the production of livestock manure and by promoting animal feeds with low mineral content. The phosphate levels in manure of animals consuming low mineral feeds declined by approximately 10%. The government also promoted the sale of animal manure as a way of redistributing manure from one part of the country to another. The substitution of manure for commercial fertilizers has also led to an overall reduction in the use of fertlizers. Fines are imposed for farmers who lose nutrient in excess of specified levels.[163] An ammonia emissions permit trading system (Green Label system) has also been implemented as a way of promoting the reduction of ammonia emissions.

The government of the Netherlands expects excess production of phosphorus and related contamination to continue until at least 2010. Hog production is considered to be the main source of the excess phosphorus. The government has responded by reducing the allowable number of hogs in production.

Denmark

Denmark produces approximately the same amount of hogs as all of Canada, on a land area about one-fifth the size of Manitoba. Manure management systems in Denmark are designed to control the input and use of nitrogen in commercial fertilizers and manure. Contamination of waterways and groundwater from phosphorus is a serious concern and phosphorus is currently being monitored. Nutrient management plans are required by over 60,000 farms. These plans may be audited, and fines may be imposed for non-compliance.

Belgium

The livestock density in the Flanders region of Belgium has been fixed at four animal units per hectare. Controls on the numbers of animals in confined animal feeding operations have been in effect since 1987. Existing hog operations cannot grow larger than 1000 hogs. Expansion of new hog facilities has been prohibited in some parts of the country.

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[163] . See: Manitoba Agriculture, *Livestock Stewardship 2000 – Experiences Elsewhere*. Available on-line: http://www.gov.mb.ca/agriculture/news/lsteward/stewardship6.html.

U.S. Federal Regulations

(A) Land Application of Sewage Sludge and Septage

40 C.F.R. 503, *Standards for the Use or Disposal of Sewage Sludge.*

40 C.F.R. 501, *State Sludge Management Program Regulations.*

40 C.F.R. 122, *EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.*

40 C.F.R. 125, *Criteria and Standards for the National Pollutant Discharge Elimination System.*

EPA – A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge.

U.S. Code, Title 33, Section 1345, *Disposal or Use of Sewage Sludge.*

(B) Nutrient Management

Clean Water Act

(C) CAFOs

Clean Water Act

State and Provincial Regulations

Iowa

(A) Land Application of Sewage Sludge and Septage

Responsible authority: Department of Natural Resources

Iowa Code 455B.171 *Water Quality*

Iowa Administrative Code, Standards for the Land Application of Sewage Sludge IAC 567 [Environmental Protection] Ch. 67.

(B) Nutrient Management

Responsible Authority:

Iowa Code 455B.203A *Manure Applicators Certification*

Iowa Code Ch. 200A *Bulk Dry Animal Nutrient Products*

Iowa Code Ch. 161C *Water Protection Projects & Practices*

Iowa Administrative Code, Title 27 [*Soil Conservation*], Ch. 13, *Organic Nutrient Management Program.*

Iowa Administrative Code, Title 21, Ch. 49, *Bulk Dry Animal Nutrients.*

21-49.8(200A) Manure Management Plans.

(C) CAFOs

Iowa Administrative Code, Title 567 [Environmental Protection], Ch. 65, *Animal Feeding Operations*

Ohio

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Division of Soil and Water Conservation, under the Department of Natural Resources.

Ohio Revised Code, Title 61, Water Supply, §6111.01, *Water Pollution Control*

(B) Nutrient Management

1501 Ohio Administrative Code: 15-5-05 *Land Application of Animal Wastes*

"Ohio Livestock Manure & Wastewater Management Guide", under Resource Conservation Ch. 119, OAC 1515-1-01

(C) CAFOs

Ohio Revised Code, Title 15, Conservation of Natural Resources, §1511, *Division of Soil & Water Conservation.*

North Carolina

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Director of the Department of Environment and Natural Resources.

(B) Nutrient Management

North Carolina Administrative Code, Title 15A, r. C2-S2H.0200 et seq.

(C) CAFOs

North Carolina Administrative Code, Title 15A, r. C2-S2H.0200 et seq.

North Carolina Administrative Code, Title 15A-C6-S6F.0001

Wisconsin

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Department of Agriculture, Trade and Consumer Protection; Department of Natural Resources

Wisconsin Administrative Code, Natural Resources, Ch. 204, *Domestic Sewage Sludge Management*

Wisconsin Statutes, Section 283.31/283.01(20)

(B) Nutrient Management

Wisconsin Administrative Code, Natural Resources, Ch. 243, *Animal Waste Management*

Wisconsin Administrative Code, Agriculture, Trade, & Consumer Protection, Ch. 50, *Soil & Water Resource Management Program*

(C) CAFOs

Wisconsin Administrative Code, Natural Resources, Ch. 243, *Animal Waste Management*

Wisconsin Statutes, Ch. 92, Soil and Water Conservation and Animal Waste Management.

Oregon

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Oregon Department of Environmental Quality

Oregon Administrative Rules, 340 Department of Environmental Quality, Division 50, *Land Application of Domestic Wastewater Treatment Facility Biosolids, Biosolids Derived Products, and Domestic Septage.*

Oregon Revised Statutes, Ch. 468B.095, Water Quality, *Use of Sludge on agricultural, horticultural or silvicultural land*

(B) Nutrient Management

Oregon Revised Statutes, Ch. 468B.095, Water Quality, *Animal Waste Control*

Oregon Administrative Rules, Department of Agriculture 603, Division 74, *Confined Animal Feeding Operation Program*

Oregon Administrative Rules, Department of Environmental Quality, Division 51, *Confined Animal Feeding or Holding Operations*

(C) CAFOs

Oregon Revised Statutes, Ch. 468B.095, Water Quality, *Animal Waste Control*

Oregon Administrative Rules, Department of Agriculture 603, Division 74, *Confined Animal Feeding Operation Program*

Oregon Administrative Rules, Department of Environmental Quality, Division 51, , *Confined Animal Feeding or Holding Operations*

Maine

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Department of Environmental Protection

Code of Maine Rules, 06-096, Department of Environmental Protection, Ch. 419, *Agronomic Utilization of Residuals.*

Code of Maine Rules, 06-096, Department of Environmental Protection, Ch. 420, *Septage Management Rules.*

Revised Statutes of Maine, Chapter 13, *Waste Management.*

(B) Nutrient Management

01-001 Department of Agriculture, Food and Rural Resources, Ch. 565, *Nutrient Management Rules.*

(C) CAFOs

01-001 Department of Agriculture, Food and Rural Resources, Ch. 565, *Nutrient Management Rules.*

Texas

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Natural Resource Conservation Commission

Texas Administrative Code, Title 30, Natural Resource Conservation Commission, Ch. 312, *Sludge Use, Disposal, and Transportation*, SubChapter B: *Land Application for Beneficial Use and Storage at Beneficial Use Sites.*

Texas Administrative Code, Title 30, Natural Resource Conservation Commission, Ch. 312, *Sludge Use, Disposal, and Transportation*, SubChapter C: *Additional Conditions and Procedures for Wastewater Discharge Permits and Sewage Sludge Permits*
Texas Administrative Code, Title 30, Natural Resource Conservation Commission, Ch. 312, *Sludge Use, Disposal, and Transportation*, SubChapter D: *Pathogen and Vector Attraction Reduction.*

Texas Administrative Code, Title 30, Natural Resource Conservation Commission, Ch. 312, *Sludge Use, Disposal, and Transportation*, SubChapter A: *General Provisions.*

Texas Water Code, §5.103

Texas Health and Safety Code §§361.011 and 361.024

(B) Nutrient Management

Natural Resources Conservation Service Conservation Practice Standard, *Nutrient Management*, Code 590

(C) CAFOs

Natural Resources Conservation Service Conservation Practice Standard, *Nutrient Management*, Code 590

Maryland

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Department of the Environment

Code of Maryland Regulations, Title 26, Department of the Environment, Subtitle 04, Regulation of Water Supply Sewage Disposal, and Solid Waste, Chapter 06, *Sewage Sludge Management.*

Annotated Code of Maryland, Title 9, Environment Article, Subtitle 2.

Annotated Code of Maryland, , Agriculture Article, Subtitle 8

(B) Nutrient Management

Responsible Authority: Department of Agriculture

Code of Maryland Regulations, Title 15, Department of Agriculture, Subtitle 20, Soil and Water Conservation, Ch. 07, *Agricultural Operation Nutrient Management Plan Requirements;* Ch. 04, *Nutrient Management Certification and Licensing*; Ch. 08, *Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation.*

(C) CAFOs

Code of Maryland Regulations, Title 15, Department of Agriculture, Subtitle 20, Soil and Water Conservation, Ch. 07, Agricultural Operation Nutrient Management Plan Requirements

Code of Maryland Regulations, Title 15, Department of Agriculture, Subtitle 20, Soil and Water Conservation, Ch. 08, *Content and Criteria for a Nutrient Management Plan Developed for an Agricultural Operation.*

Virginia

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Department of Health

Virginia Administrative Code, Title 12, Health, Agency 5, Department of Health, 585, *Biosolids Use Regulation*

Code of Virginia, Title 32.1, Health, Ch. 6, Environmental Health Services, 163.

(B) Nutrient Management

Responsible Authority: Department of Conservation and Recreation

Virginia Administrative Code, Title 4, Conservation and Natural Resources, Agency 5, Department of Conservation and Recreation, Ch. 15, *Nutrient Management Training and Certification Regulations*

(C) CAFOs

Code of Virginia, Title 62.1 Waters of the State, Ports and Harbors, Ch. 4, Public Water Supply, 44.17 *General Permits for Confined Animal Feeding Operations.*

British Columbia

The regulation of the land application of biosolids in British Columbia is administered by the British Columbia Ministry of the Environment.

New regulations under the *Waste Management Act* are currently being considered for the land application of biosolids in British Columbia. The proposed regulation is currently called the *Organic Matter Recycling Regulation*, and will amend the *Production and Use of Compost Regulation.*[164]

The discharge of municipal sewage effluent is currently governed by Municipal Sewage Regulation[165] under the Waste Management Act. The Waste Management Act includes regulations and guidelines dealing with the health and environmental impact of the agricultural use of biosolids. Prior to application of biosolids or effluent to farmland, the conditions specified under the Waste Management Act must be met in a Liquid Waste Management Plan and a permit must be issued by the Ministry of Environment.

For further information on biosolid and effluent reuse in British Columbia, the following Ministry of Environment publications are available:

- Municipal Sewage Discharge Criteria Summary;
- Guidelines for the Disposal of Domestic Sludge under the Waste Management Act;
- Municipal Organic Matter Recycling Regulation;
- Pollution Control Guidelines for Municipal Effluent Application to Land;
- Pollution Control Objectives for Municipal Type Waste Discharge in British Columbia.[166]

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[164] . *Production and Use of Compost Regulation, B.C. Reg 334/93*

[165] . *Municipal Sewage Regulation, B.C. Reg. 129/99*

[166] . See: British Columbia Ministry of Agriculture and Food, *Farm Practices: Biosolids and Effluent Use*, June 5, 1996. Available on-line at: http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/activity/biosolid.htm

Manitoba

(A) Land Application of Sewage Sludge and Septage

Responsible Authority: Manitoba Conservation

Waterworks, Sewerage and Sewage Disposal Regulation, 331/88R.

Private Sewage Disposal Systems and Privies Regulation 95/88.

(B) Nutrient Management

Responsible Authority: Manitoba Agriculture and Food; Manitoba Conservation

Manitoba Livestock Manure and Mortalities Management Regulation, 42/98.

The Environment Act (C.C.S.M. c. E125)

(C) CAFOs

Responsible Authority: Manitoba Agriculture and Food; Manitoba Conservation

Manitoba Livestock Manure and Mortalities Management Regulation, 42/98.

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