WORKING PAPER

ALBERTA ENVIRONMENT - SEPTAGE MANAGEMENT ADVISORY COMMITTEE

Technical and Regulatory Literature Review

Alberta
ENVIRONMENT

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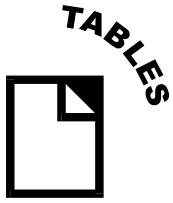

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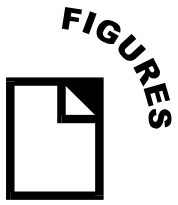


BACKGROUND

SECTION 1

Alberta Environment (AENV) has set up a Septage Management Advisory Committee (SMAC) to provide guidance towards improved management of septage in Alberta.

According to Alberta's Environmental Protection and Enhancement Act (EPEA) and Regulations:

"No person shall dispose of waste except:

a) at a waste management facility, or in a container the content of which will be taken to a waste management facility, that is subject of appropriate approval, registration or notice required under the Act, or
b) in accordance with written authorization of the Director."

AENV is reviewing its current regulations and standards related to management of septage and evaluating alternative management options. The mandate of SMAC is to provide advice and recommendations to AENV on septage management in Alberta.

The role of Associated Engineering is to gather pertinent information that will help the SMAC in recommending an appropriate strategy for regulation and management of septage in Alberta. Associated Engineering is responsible for:

- Conducting a scientific literature review and preparation of a document that outlines environmental and health concerns, and advantages of alternative management strategies for septage.
- Compiling a summary of other jurisdictions regulatory approaches and alternative regulatory options for the septage management.
- Presenting a summary of the literature review and alternative regulatory strategies to the advisory committee.
- Assisting the Chair in preparing the meeting agendas and recording of the meeting discussions and consensus.
- Preparing a draft and final recommendation report for committee approval.

This working paper presents a summary of the literature review and alternative regulatory strategies.

TECHNICAL LITERATURE REVIEW

SECTION 2

2.1 TECHNICAL LITERATURE REVIEW

This literature review is limited to domestic septage and the term *septage* should be understood to have the same meaning as *domestic septage*.

2.2 SEPTAGE CHARACTERIZATION

Septage is a liquid or solid material removed and hauled from a septic tank, holding tank, pit toilet, or similar system that receives only domestic waste. Domestic waste includes wastewater from sinks, showers, bathtubs, floor drains, toilets and urinals. Septage does not include process wastewater from commercial and industrial processes or wastes from grease traps. Septage contains water, settled organics and inorganic solids, scum (mainly grease and other organic solids), and soluble inorganic and organic materials. The inorganics consist of materials such as grease, grit, hair, rags, plastics and stones. The organic wastes are primarily related to human wastes, food preparation and residuals, and sanitary hygiene products. Septage also contains disease causing viruses, bacteria and/or parasites (USEPA 1994).

Septage is characterized by an objectionable odour, a resistance to settling and dewatering, and the potential to foam (USEPA 1994). Table 2-1 shows septage characteristics for conventional wastewater parameters, nutrients, metals, and organics. Table 2-2 presents concentrations of pathogenic organisms in septage. The comparison between septic tank waste and municipal wastewater indicates that septage may be 6 to 80 times as concentrated as typical domestic wastewater (Metcalf & Eddy 2003). Wastewater from portable toilets has higher concentration of pathogenic organisms and higher nitrogen content than wastewaters from septic tanks or holding tanks. Wastes from RV and portable toilets might also contain chemicals such as odour control, antibacterial and disinfection agents. Commonly used chemicals are biodegradable, based on information supplied by the suppliers in Edmonton. The chemicals may be bacteriological products, enzyme formulations, quaternary ammonium-based compounds ("quats," which often impart a pine scent), or formaldehyde- or paraformaldehyde-based compounds. Ammonium- and formaldehyde-based compounds have the ability to kill or severely impede useful bacteria during wastewater treatment. Moreover, formaldehydes have low biodegradability and are known carcinogens (Camp Green Canada, Thetford Corporation 2003). Camp Green lists products, which an accredited third party shows as *environmentally responsible*.

Table 2-1
Septage Characteristics

Parameter	Septic Tank[1,2] mg/L	Holding Tank/ Typical Municipal Wastewater[1,2] mg/L	Pit Toilets[3] mg/L	Ratio of Septic Tank to Wastewater[4]
Conventional Parameters				
Total Solids	34,100	720	78,140	56
Total Volatile Solids	23,100	365	60,582	68
Total Suspended Solids	12,900	220	-	68
Volatile Suspended Solids	9,000	165	-	61
Biochemical Oxygen Demand	6,500	220	-	32
Chemical Oxygen Demand	31,900	500	110,360	30
Total Kjeldahl nitrogen	590	40	8,070	18
Ammonia-N	97	25	3,920	6
Total phosphorus	210	31	3,730	31
Alkalinity	970	100	14,990	10
Oil and Grease	5,600	100	-	80
PH (pH units)	5.2-9.0[5]	-	-	-
Metals				
Aluminum	48	-	-	-
Arsenic	0.16	-	-	-
Cadmium	0.27	-	-	-
Chromium	0.92	-	-	-
Copper	8.27	-	-	-
Iron	191	-	-	-
Mercury	0.23	-	-	-
Manganese	3.97	-	-	-
Nickel	0.75	-	-	-
Lead	5.2	-	-	-
Selenium	0.076	-	-	-
Zinc	27.4	-	-	-

Parameter	Septic Tank[1,2] mg/L	Holding Tank/ Typical Municipal Wastewater[1,2] mg/L	Pit Toilets[3] mg/L	Ratio of Septic Tank to Wastewater[4]
Organics				
Methyl alcohol	1	-	-	-
Isopropyl alcohol	1	-	-	-
Acetone	0	-	-	-
Methyl ethyl ketone	1	-	-	-
Toluene	0.005	-	-	-
Methylene chloride	0.005	-	-	-
Ethylbenzene	0.005	-	-	-
Benzene	0.005	-	-	-
Xylene	0.005	-	-	-

[1,2] USEPA 1984, 1994
[3] Environment Canada (1996)
[4] Metcalf & Eddy, Inc., 1991
[5] Canadian ranges reported by USEPA (1984). U.S. reported wider ranges are 1.5-12.6

Table 2-2
Indicator Organism and Pathogen Concentrations in Septage[1]

Parameter	Septage (Counts/100 mL)	Holding Tank/Municipal Wastewater (Counts/100 mL)	Pit Toilets (Counts/100 mL)
Total Coliform	10^7-10^9	10^7-10^8	10^8-10^9
Fecal Coliform	10^6-10^8	10^6-10^7	10^7-10^8
Fecal Streptococci	10^6-10^7	-	-
Ps. Aeruginosa	10^1-10^3	-	-
Salmonella sp.	1-10^2	-	-
Parasites	Present	-	-
Helminth Worms	Present	-	-

[1] USEPA (1984)

The physical characteristics of septage vary depending upon the septic tank size, design and pumping frequency, user habits, climatic conditions, water supply characteristics, the use of household chemicals, and the use of water softeners. Knowledge of septage characteristics and variability is important in determining acceptable disposal methods (WEF 1997).

2.3 SEPTAGE QUANTITIES

Alf Durnie (2004) with Municipal Affairs estimates that there are approximately 225,000 private sewage systems in Alberta, where 20% are holding tanks and 80% are septic tanks (see Table 2-3). Based on an average sewage system tank volume of 3.4 m^3 and pump out frequency of once per week for six months of the year for holding tanks and once every two years for septic tanks, approximately 4,000,000 m^3/year of septage is pumped from holding tanks and 300,000 m^3/year of septage is pumped from septic tanks. Thus, the total amount of septage generated in Alberta in a year is estimated to be approximately 4,300,000 m^3.

2.4 ISSUES WITH LAND DISPOSAL OF SEPTAGE

Septage contains constituents that may result in environment degradation, risk to public health and/or unpleasant odours. Table 2-4 presents typical constituents of concern found in septage.

With some disposal practices, septage may provide food and shelter for vectors such as insects, rodents, and birds, which are capable of transferring pathogenic organisms contained in septage from the application site to humans and animals. Septage may contain odourous compounds including reduced sulfur compounds such as hydrogen sulfide and mercaptans, ammonia and other odourous nitrogen-based compounds, volatile acids, and volatile organic compounds, all which contribute to give septage an objectionable odour (WEF 1997).

Table 2-5 presents examples of pathogens associated with domestic sewage. The primary route of exposure to wastewater-associated pathogens is by ingestion. If reclaimed water and sludges are to be used in the production of human food crops, particularly those that are eaten raw, then there is a chance of pathogen exposure through ingestion. Consequently, there is a greater need to reduce pathogen numbers to low levels by treatment or natural decay process prior to soil application, or at least prior to crop harvesting or livestock exposure (NRC 1996).

Table 2-3
Septage Quantities in Alberta

Type of Source	Measurement
Total private sewage systems	225,000
Septic tanks	180,000
Holding tanks	45,000
Average septic tank pump out interval	2 years
Average holding tank pump out interval	Weekly (26 weeks/year)
Average tank size	3.4 m^3
Annual septic tank pump out volume	300,000 m^3/year
Annual holding tank pump out volume	4,000,000 m^3/year
Total volume of septage generated	4,300,000 m^3/year

Table 2-4
Typical Constituents of Concern in Septage[1]

Pollutant	Reason for Concern
Suspended Solids (TSS)	TSS run-off to surface waters may increase turbidity and sludge deposits. Sludge deposits may smother benthic organisms and fish eggs and may contribute to benthic enrichment, toxicity, and sediment oxygen demand. Excessive turbidity can harm aquatic life by blocking sunlight needed by plants and contributing to decreased dissolved oxygen in the water column. TSS may also affect water treatment plant performance by interfering with filtration and disinfection processes.
Pathogenic organisms (bacteria, viruses, and parasites)	Pathogenic organisms such as bacteria, viruses and parasites such as helminth ova are contained in septage. Bacteria, viruses, and parasites can cause communicable diseases. Public health hazards can result if the organisms are transferred to food crops grown on land to which septage is applied. Organisms are transported away from the site by vectors such as insects, rodents and birds.
Biodegradable organics (BOD, COD, TOC)	Biological stabilization of organics in the water column can deplete dissolved oxygen in surface waters, creating anoxic or even anaerobic conditions harmful to aquatic life. These conditions can also increase tastes and odours in drinking water and increase metal leaching from soil and rock in contact with ground and surface waters.

Pollutant	Reason for Concern
Nitrogen (N)	Nitrogen is an aquatic plant nutrient that can contribute to eutrophication and dissolved oxygen loss in surface waters, especially in lakes. Excessive nitrate-nitrogen in drinking water can cause methemoglobinemia in infants and cause pregnancy complications. Livestock also can suffer health impacts from drinking water high in nitrogen. Ammonia-nitrogen in surface waters can be toxic to fish.
Phosphorus (P)	Phosphorus is an aquatic plant nutrient that can contribute to eutrophication of surface waters and reduction of dissolved oxygen.
Toxic Organic Compounds	Toxic organic compounds present in household chemicals and cleaning agents can interfere with certain biological processes in conventional and alternative treatment systems and can persist and bioaccumulate in the aquatic environment. They can cause damage to ecosystems and human health directly or through ingestion of contaminated aquatic organisms.
Heavy metals	Heavy metal contamination in septage may result from household chemicals that contain trace concentration of heavy metals, leaching of metals from household piping and joints, or contamination of septage in hauler trucks from a previous industrial waste load. Heavy metals (e.g. lead or mercury) in drinking water can cause human health problems. In the aquatic ecosystem, they also can be toxic to aquatic life and accumulate in fish that might be consumed by humans.
Dissolved Inorganic Compounds	Chloride and sulfide can cause taste and odour problems in drinking water. Boron, sodium, chlorides, sulfate, and other solutes might limit reuse options (e.g. irrigation).
Endocrine Disrupting Chemicals (EDC)	EDC may result in septage from drugs and herbal products that humans use. EDCs can disrupt growth processes, development and reproduction (e.g. deformities and embryo mortality in birds, fish and other aquatic animals).

Table 2-5
Examples of Pathogens Associated with Raw Domestic Sewage and Sewage Solids[1]

Pathogen Class	Examples	Disease or Effects
Bacteria	*Shigella sp.*	Bacillary dysentery
	Salmonella sp.	Salmonellosis (gastroenteritis)
	Salmonella typhi	Typhoid fever
	Vibrio cholerae	Cholera
	Enteropathogenic-Escherichia coli	A variety of gastroenteric diseases
	Yersinia sp.	Yersiniosis (gastroenteritis)
	Campylobacter jejuni	Campylobacteriosis (gastroenteritis)
Viruses	Hepatitis A virus	Infectious hepatitis
	Norwalk viruses	Acute gastroenteritis
	Rotaviruses	Acute gastroenteritis
	Polioviruses	Poliomyelitis
	Coxsackie viruses	"Flu-like" symptoms
	Echoviruses	"Flu-like" symptoms
	Reovirus	Respiratory infections, gastroenteritis
	Astroviruses	Epidemic gastroenteritis
	Calciviruses	Epidemic gastroenteritis
Protozoa	*Entamoeba histolytica*	Amebiasis (amoebic dysentery)
	Giardia lamblia	Giardiasis (gastroenteritis)
	Cryptosporidium sp.	Cryptosporidiosis (gastroenteritis)
	Balantidium coli	Balantidiasis (gastroenteritis)

Pathogen Class	Examples	Disease or Effects
Helminth Worms	*Toxoplasma gondii*	Toxoplasmosis
	Ascaris lumbriocoides	Digestive and nutritional imbalances, abdominal pain, vomiting, restlessness
	Ascaris suum	Symptoms such as coughing, chest pain and fever
	Trichuris trichiura	Abdominal pain, anemia, weight loss, diarrhea
	Toxocara canis	Fever, abdominal discomfort, muscle aches, neurological symptoms
	Taenia sp.	Nervousness, insomnia, anorexia, abdominal pain, digestive disturbances
	Necator americanus	Hookworm disease
	Hymenolepis nana	Taeniasis (tapeworm infection)

[1] Source: USEPA 1992.

2.5 BENEFITS OF SEPTAGE MANAGEMENT

USEPA (1995) indicates that domestic septage can be a resource rather than a waste when properly managed. Septage contains plant nutrients such as nitrogen, phosphorus, and in some cases varying amounts of micronutrients such as boron, copper, iron, manganese, molybdenum, and zinc. Septage can reduce reliance on chemical fertilizers. Septage combined with fertilizers can provide the proper amounts of nutrients needed for crop production. Septage can also act as a soil conditioner. The addition of organic materials to fine textured clay soil can increase the amount of pore space available for root growth and the entry of water and air into the soil. In coarse-textured sandy soils, organic residues can increase the water holding capacity of the soil and provide chemical sites for nutrient exchange and adsorption.

2.6 SEPTAGE WASTE MANAGEMENT OPTIONS

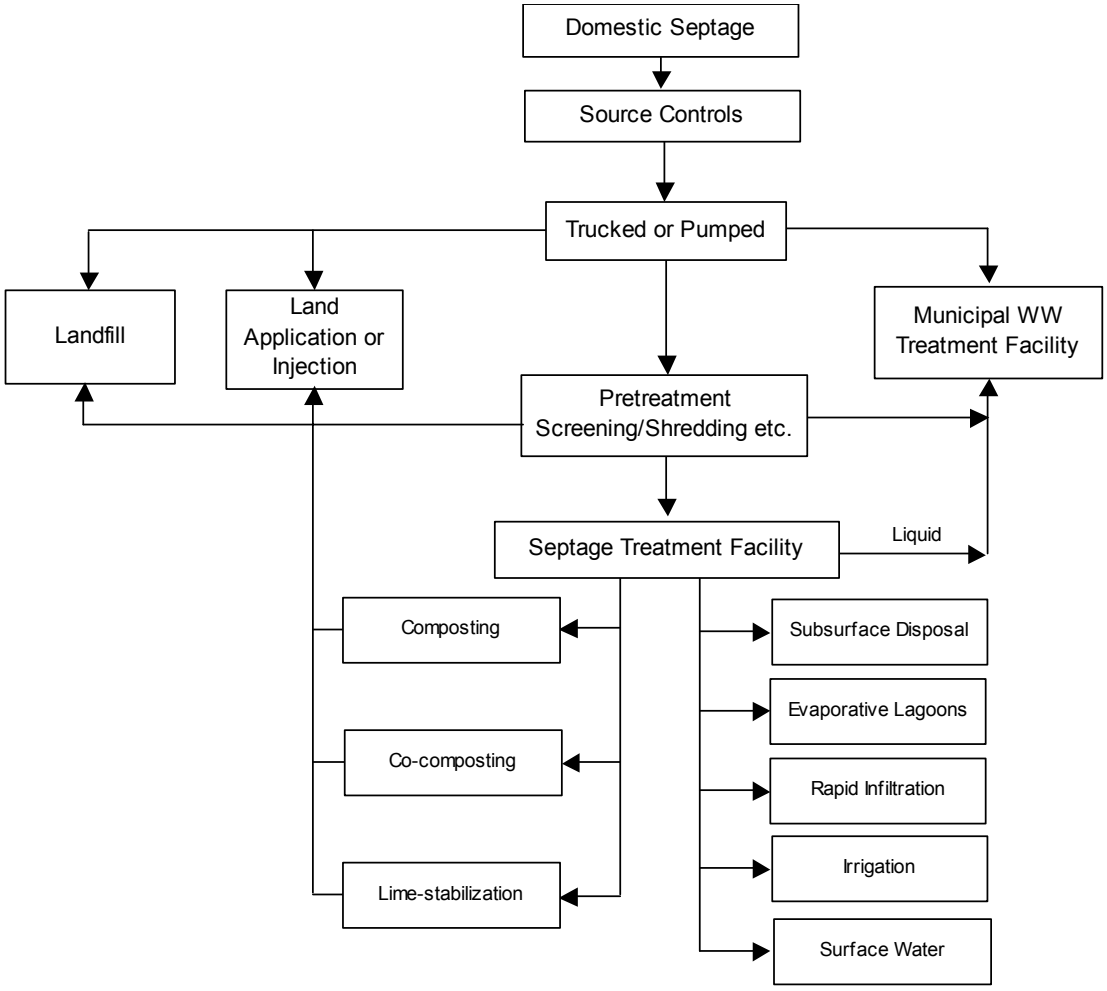
Septage requires adequate treatment and disposal if odour, public health, and environmental problems are to be avoided. The three main alternatives for the treatment and disposal of septage, as presented in Figure 2-1 include:

- Land application
- Treatment at wastewater treatment plants

- Treatment at independent septage treatment plants

The various specific options available under each alternative are covered later in this document. Factors such as land availability, treatment plant loading versus capacity, hauling distances, fuel costs, operation and maintenance costs, capital/construction funding for treatment methods, geography, site conditions, buffer zone requirements, climate and public perception play a major role in evaluating septage reuse/disposal options (WEF 1997).

Figure 2-1
Septage Management and Disposal Alternatives[1,2]



[1] Source: WEF 1997.

[2] Source Controls refer to education of the public, regulations, and enforcement to ensure appropriate disposal practices.

2.7 LAND APPLICATION

Land Application is the most economical option when access to a wastewater treatment plant or an independent septage facility is unavailable.

Some of the concerns with land application, as indicated by various literature sources, include:

- Public health concerns from the survival of various infectious agents in soil, contamination of edible crops, and transfer of pathogenic organisms by vectors to humans
- Environmental concerns from the potential contamination of surface water from runoff and groundwater from percolation
- Aesthetic concerns associated with the objectionable odour of septage
- The public's negative perception of septage waste and the septage pumping and disposal industry
- Occupational health and safety concerns

The key elements for a successful operation and maintenance program for a septage application site include the following (USEPA 1994):

- Septage receiving and holding facilities providing operational flexibility
- Screening and removal of objectionable solids
- Monitoring of septage volume and characteristics, soil, plants, surface water and groundwater
- Proper septage treatment (incorporating pathogen and vector attraction reduction prior to disposal)
- Control of septage application rates and conditions
- Proper operation and maintenance of the application equipment
- Good record keeping and retention
- Odour control

2.7.1 Site Selection

This section describes several factors that should be considered when selecting a site for the disposal of septage.

Soils

Soil types vary throughout the province. The texture of soil affects movement of water through soil. The soil texture is a classification determined by the relative amounts of sand, silt, and clay in a soil. Fine textured soils (clay) are highly impermeable, while coarse textured soils (sandy soils) are highly permeable. Land application of septage on highly impermeable soils or highly permeable soils should be given low priority. Highly impermeable soils are more susceptible to run-off problems; while highly permeable soils may allow movement of contaminated water to wells or water courses. Frozen soils increase likelihood of septage running off before it has a chance to absorb into the soil (USEPA 1995). Soil types also affect pathogen survival. Soils with a coarser texture generally should be avoided since they permit more movement of microorganisms, while soils with a finer texture are generally preferred since they restrict the movement of microorganisms by causing them to adsorb onto the charged particles.

Topography

The steepness, length, and shape of slopes influence the run-off rate. Table 2-6 presents slope limitations for land application of septage.

Table 2-6
Slope Limitations for the Land Disposal of Septage[1]

Slope	Comment
0-3%	Ideal, no concern for run-off or erosion
3-6%	Acceptable, slight risk of erosion
6-12%	Injection or immediate incorporation required
> 12%	Unacceptable

[1] USEPA (1995)

Depth to Groundwater and Bed Rock

The depth to groundwater and the type and condition of material above the water table is of importance when considering areas for land application. The greater the depth to the water table, the more desirable a site for septage disposal. The type of material above the water table is of importance since fractured rock may allow leachate to move rapidly. Unfractured bedrock at shallow depths will restrict water movement with the potential for groundwater mounding, subsurface lateral flow, or poor drainage. Thus, potential sites underlain by fractured bedrock, or with unfractured rock at shallow depths, should be avoided (USEPA 1995).

Flooding

Areas subject to flooding should be avoided.

Buffer Zones

Borders, buffers and setbacks are significant factors in site selection due to potential contamination from site runoff and/or flood events.

Weather

Soil moisture is a major consideration affecting the timing of septage application. Applying septage to soils already saturated with water can result in septage run-off and drainage. Traffic on wet soils during or immediately following heavy rainfalls may result in soil compaction and deep ruts, making crop production difficult and reducing crop yield. Muddy soils also make vehicle operation difficult and create public nuisances with the transfer of mud from fields onto roadways. Applying septage to hard, frozen ground increases likelihood of septage running off before it has a chance to soak into the soil (USEPA 1995).

2.7.2 Pathogen Control and Vector Attraction Reduction

The reduction of pathogens and vectors provide some protection against the transfer of disease from the application area.

Table 2-7 presents survival times for various bacteria, viruses and parasites in soil and on plants. Survival times depend on weather conditions, which were not readily identified in the source document. Therefore, the information may not reflect survival times that would be experienced in Alberta.

M.E. Olson (2004) presented information on bacterial, parasitic and viral pathogens common to humans and animals. He indicated that pathogens in human fecal waste have the greatest potential to cause infection in other humans. Therefore, failure to appropriately process human sewage probably proposes the greatest threat to human health.

Table 2-7
Survival Times of Pathogens in Soil and on Plant Surfaces[1]

Pathogen	Soil		Plant	
	Absolute Maximum	Common Maximum	Absolute Maximum	Common Maximum
Bacteria	1 year	2 months	6 months	1 month
Viruses	1 year	3 months	2 months	1 month
Protozoan Cysts	10 days	2 days	5 days	2 days
Helminth Ova	7 years	2 years	5 months	1 month

[1] USEPA (1992)

Various USEPA documents (USEPA 1984, 1992, 1994) indicate that pathogen transfer from the application site can be reduced by:

- Limiting public access to the site, and by imposing crop harvesting restrictions to allow pathogens to die in the soil naturally or to be washed off from food crops
- Stabilizing septage prior to land application

Vector attraction can be reduced by:

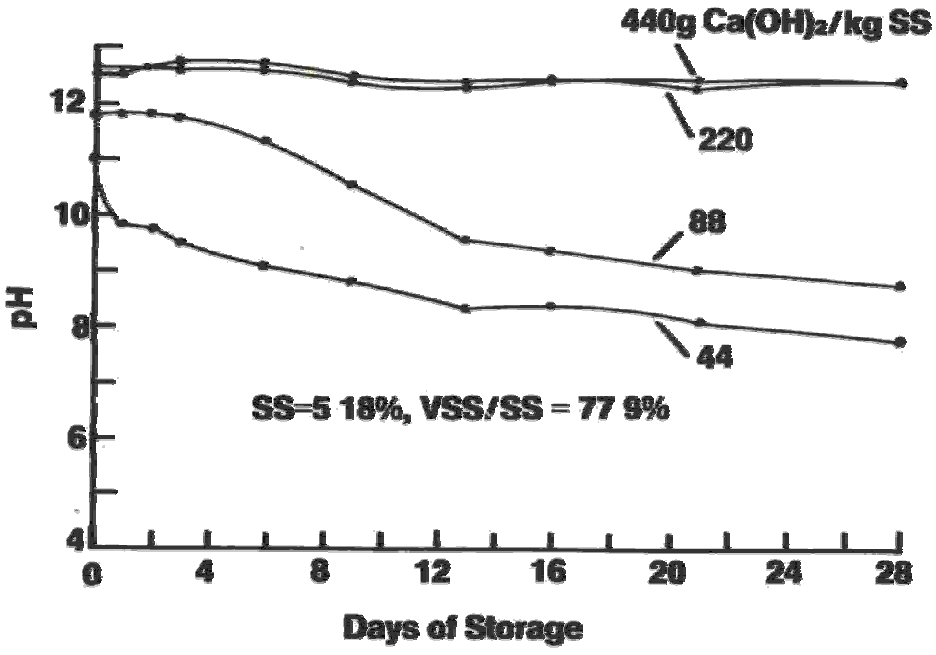
- Incorporation of domestic septage into the soil
- Subsurface injection of septage into soil
- Stabilization of septage prior to land application (USEPA 1994)

The simplest and most economical method for septage stabilization is to add sufficient lime or bases, such as sodium hydroxide, to raise the pH to 12 for a minimum of 30 minutes. High pH conditions reduce bacterial and viral pathogens by more than 99 percent. The high pH conditions, however, have little effect on species such as helminth ova. Alkaline materials commonly used to raise pH are hydrated lime (calcium hydroxide) and quicklime (calcium oxide). Alkaline stabilization reduces pathogens, odours, and vector attraction. Typically, 2.4 kg to 3 kg of quicklime per 1000 L of domestic septage (or about 3.1 kg to 4 kg of hydrated lime per 1000 L) is required. Slurry can be added:

- to the pumper truck before the septage is pumped,
- to the pumper truck while the septage is being pumped, or
- to a tank that is storing septage that was discharged from a pumper truck.

Figure 2-2 gives change in pH during septage storage following different lime dosages.

Figure 2-2
Change in pH During Storage of Septage
at 20°C Using Different Lime Dosages[1]



[1] Source: Paulsrud, J.B. (1975)

Other septage stabilization options include aerobic digestion, anaerobic digestion, and composting. Relative to alkaline stabilization, these options have higher operating costs and require more skilled operating personnel (USEPA 1994).

2.7.3 Application Method

Septage can be incorporated into the land either into the subsurface or onto the surface. Subsurface application or surface application with subsequent incorporation are the preferred methods for septage disposal as they minimize odours, reduce vector attraction, minimize ammonia volatilization losses, conserve nitrogen, minimize the amount of septage that may come in contact with rain, reduce potential water contamination, and promote public acceptance. Options for subsurface application are:

- Subsurface injection, where liquid septage is injected in a narrow cavity created beneath the soil surface by a tillage tool
- Surface septage application followed by disking to incorporate it into the soil

The simplest method involves the hauler applying septage by opening a valve and driving across the site. A splash plate or spreader plate may be used to improve domestic septage distribution onto the soil surface. A simple screen between the outlet pipe and the spreader plate can prevent non-degradable materials such as plastics and other objectionable trash from being applied to the soil. Collected trash can be sent to a sanitary landfill.

Large volume trucks may cause soil compaction in moisture rich soils. Soil compaction can be prevented by using wide-flotation tires or by deep-tilling the staging area following application (USEPA 1995).

A transfer or storage tank may be needed when sites are inaccessible due to soil site or crop conditions. For example, the soil may be frozen or too wet for application, or the timing may not be right to meet crop needs or fit in with field operations. Storage facilities increase the flexibility of land application operations. Enclosed holding tanks or lined lagoons in isolated areas are preferred since open pits or unlined storage lagoons can be a major source of nuisance odours and groundwater contamination. Holding tanks are commonly concrete

structures. Epoxy-coated aluminium tanks may also be used. Un-lined steel tanks are not advocated as they are subject to rapid corrosion and early failure (USEPA 1994).

2.7.4 Application Rates

The maximum volume of septage that may be applied to land depends on the amount of nitrogen required by the crop for the planned yield.

Nitrogen is the nutrient required in the largest amount by all crops. Nitrogen may be present in septage in an inorganic form, such as ammonium (NH_4-N), or in an organic form (Org-N). The availability of Org-N for plants depends on the microbial breakdown of organic materials in soils. The largest percentage of mineralizable organic N is converted to inorganic N during the first year of application with continued decomposition to inorganic N over the succeeding years. The amount of nitrogen available is also affected by the amount of NH_4-N lost by volatization of ammonia. Incorporating septage into soil during the application process can reduce volatization losses. The addition of N to soils in excess of crop needs result in the potential for contamination of groundwater since NO_3-N is not readily absorbed by soil particles and will move downward as water percolates through the soil profile.

The maximum volume for domestic septage recommended by USEPA that can be applied to land can be calculated by the following formula:

$$AAR = \frac{N}{0.0026}$$

where:

AAR = Annual application rate in U.S. gallons/acre/yr
N = Amount of nitrogen in lb/acre/yr required by the crop

The coefficient 0.0026 is based on the average plant-available nitrogen content of 0.0026 pounds of nitrogen per U.S. gallon of septage. When applying septage from portable toilets to land, application rates should be adjusted since portable toilets contain about 6 times the nitrogen contained in septic tanks. Table 2-8 shows typical nitrogen requirements of various crops. Table 2-9 shows the annual septage application for the corresponding crops, based on the USEPA formula above.

Table 2-8
Nutrient Requirements for Field Crops[1]

Type of Crop	Yield (bu/acre)	N (lb/acre/yr)
Grains		
Spring Wheat	40	76 - 93
Winter Wheat	50	61 - 74
Barley	80	100 - 122
Oats	100	55 - 68
Rye	55	83 - 101
Corn	100	138 - 168
Oilseeds		
Canola	35	100 - 123
Flax	24	62 - 76
Sunflower	50	67 - 82
Pulse Crops		
Peas	50	138 - 168
Lentils	30	82 - 101
Faba Beans	50	257 - 314
Other Crops		
Sugar Beets	22	190 - 232
Potatoes	20	115 - 141
Forages		
Alfalfa	5	261 - 319
Clover	4	194 - 237
Grass	3	92 - 113
Barley Sillage	3.5	130 - 180
Corn Sillage	5	140 - 172

[1] Based on data compiled by the Canadian Fertilizer Institute (2001).

Table 2-9
Septage Application Rates to Comply with Nutrient Treatment Requirements for Field Crops[1]

Type of Crop	Septage Application Rate (m^3/ha/yr)
Grains	
Spring Wheat	270 - 330
Winter Wheat	220 - 270
Barley	360 - 440
Oats	200 - 240
Rye	300 - 360
Corn	500 - 600
Oilseeds	
Canola	360 - 440
Flax	220 - 270
Sunflower	240 - 290
Pulse Crops	
Peas	500 - 600
Lentils	290 - 360
Fababeans	900 - 1100
Other Crops	
Sugarbeets	680 - 830
Potatoes	410 - 510
Forages	
Alfalfa	940 - 1150
Clover	700 - 850
Grass	330 - 400
Barley Sillage	470 - 650
Corn Sillage	500 - 620

[1] Based on USEPA application formula in Section 2.7.4.

It is important that the septage hauler informs the landowner of the estimated amount of nitrogen that will be added by the applied domestic septage. This will allow the landowner to determine how much additional nitrogen from chemical fertilizers, if any, will need to be applied (USEPA 1984 and 1994).

2.7.5 Nuisance Issues

Potential nuisance issues related with land application of septage include odour, spillage, mud, dust, road deterioration and increased local traffic. In order to gain public acceptance for the disposal of septage onto agricultural land, it is necessary to reduce or avoid associated nuisance problems.

2.7.6 Odour Reduction

USEPA (1995) indicates that objectionable odours can result in an unfavourable public reaction with reduced acceptance of land application practices. If the proposed vector and pathogen reduction alternatives are practised, odour should not pose a problem at land application sites. When septage is incorporated into the soil or injected beneath the soil, soil quickly removes water from the septage and reduces the release of odour from septage. Other practices that would reduce potential for odours include:

- Cleaning of tanks, truck and other equipment on a daily basis
- Avoiding septage application to water-logged soils or when other soil or slope conditions would cause ponding or poor drainage of the applied septage
- Avoiding septage application when wind is blowing towards areas of potential complaints
- Avoiding septage application when relative humidity is high–low humidity conditions are desired to promote drying
- Using proper sludge application rates for site conditions
- Designing and locating sludge storage facilities in a way that prevents odours
- Isolating the septage application site from residential, commercial, and other public access roads

2.7.7 Record Keeping and Management

Record keeping is an important element to ensure safe and acceptable management of domestic septage. Proper record keeping and management helps reduce occasions of illegal waste acceptance and discharge by septage haulers (WEF 1997). A good record keeping system also provides assurance to the waste generator and the public that the waste has been properly disposed.

A survey of record keeping requirements from different U.S. states indicated that most states require the haulers to keep the following records for a minimum of five years:

- The location and legal description of the application site, boundaries, fences, and access roads
- A signed agreement between the landowner and the hauler approving septage application onto their land
- The name of the driver and the license plate number of hauling vehicle with date and time of application
- Nitrogen requirements of the crop or vegetation grown at each site
- The volume of domestic septage applied during the specified one-year period
- Certification that pathogen reduction and vector attraction requirements have been met
- Notice to the waste generator indicating how septage was handled

2.8 TREATMENT AT WASTEWATER TREATMENT PLANT

Under the correct conditions, co-treatment at a wastewater treatment plant (WWTP) is a convenient and environmentally sound alternative for septage disposal. Septage can be received and incorporated into either the liquid stream unit processes or the solid stream unit processes at the WWTP. In either case, the WWTP must have adequate capacity to treat the septage without adversely affecting unit processes.

Septage may be 6 to 80 times more concentrated than typical wastewater. Septage has the potential to upset plant operations or performance if the facilities are not designed to handle septage. Some of the impacts of septage addition to WWTPs include (USEPA 1994):

- Potential toxic shock to biological processes
- Increased odour emissions with resulting complaints from the public
- Increased volume of grit, scum and screenings
- Increased organic loading to biological processes
- Potential odour and foaming problems in aerated basins
- Increased loadings to sludge handling facilities
- Increased sludge volume requiring final disposal
- Increased housekeeping requirements

Additional organic loads exerted by septage could result in the need for facility expansion or upgrading to handle the extra waste.

There are different ways to deal with concerns associated with WWTP performance. Firstly, there must be an appropriate septage receiving station that provides adequate raw solids screening and degritting. The receiving station should also have features such as odour control, flow equalization, site monitoring and access control. Odour control could include a wet chemical (caustic soda and sodium hypochlorite) scrubber, biofilter, activated carbon adsorption, or UV irradiation. The septage discharge point can be located external to the treatment plant, well upstream in the collection system. This provides the added advantage of diluting the septage with the raw wastewater flow, so that the composite wastewater strength increases more uniformly. In treatment plants that receive septage directly, the increased organic loading should be assessed with respect to aeration needs. It may be necessary to increase treatment plant aeration capacity as a result of direct septage discharge.

2.8.1 Record Keeping and Management

Treatment facilities need a control program to regulate the volume and components of the septage they receive so that the treatment plant process and its staff are protected. The specific elements of a waste hauler control program may vary for each facility depending on treatment plant capacity, flows and pollutant loadings, sensitivity of plant processes, type and amounts of hauled waste accepted, funding, and local issues and requirements.

A permit system may be considered to monitor waste haulers that discharge to the treatment plant. The implementation plan for the program may include components such as identifying and educating septage haulers, maintaining a

database of haulers, establishing waste manifest forms, establishing designated disposal areas, generating a database of treatment plants accepting septage, and enforcement programs against non-compliance (USEPA 1999). In addition, random sampling and analysis of septage loads could form part of this plan.

2.8.2 Waste Hauler Control Programs

Waste hauler control programs at two different treatment plants in the U.S. are summarized below (USEPA 1999).

The Littleton-Englewood WWTP Waste Hauler Control Program

- Informational mailing to septage haulers
- Electronic cards
- Restricted hours
- Sampling program
- Two discharge standpipes complete with cam-lock connections
- Automatic locking gates
- Informational signs
- Open communication with regional wastewater treatment plants and haulers

Metropolitan St. Louis Sewer District Waste Hauler Control Program

- Permit application
- Transporter and vehicle identification number
- Designated discharge point
- Restricted hours and access
- Manifest forms
- Sampling
- Gate and intercom system

2.9 INDEPENDENT TREATMENT FACILITY

When suitable land is unavailable and wastewater treatment facilities are too distant or do not have adequate capacity, independent septage treatment plants may have to be considered. These facilities vary from stabilization lagoons to a privately owned treatment plant.

Stabilization lagoons are usually the most simple and cost effective method for an independent treatment facility. Lagoons are an excellent option for rural communities with large amounts of land and relatively low number of users. Some pre-treatment, such as screening and grit removal, may be necessary prior to disposal at a lagoon. The disposal of the liquid fraction and solids stream can be through various means, depending upon the quality of the treated fraction (the disposal options are discussed below). Some concerns from with stabilization lagoons include potential unpleasant odours, vector problems, and of large quantities of accumulated solids (USEPA 1984).

The typical treatment and disposal steps at a septage treatment plant are:

- Septage receiving
- Dewatering
- Liquid treatment
- Solids stabilization
- Liquid disposal/utilization
- Solids disposal/utilization

2.9.1 Septage Receiving

Septage receiving components that need to be considered include:

- Flow metering
- Screening
- Rock/grit removal
- Flow equalization
- Odour control

2.9.2 Dewatering

Dewatering would be used to prepare septage for solids stabilization such as lime stabilization or composting. Dewatering options potentially include:

- Natural drying beds
- Vacuum-assisted drying beds
- Lagoon decant cells
- Screw presses
- Rotary presses

- Belt filter presses
- Centrifuges
- Plate and frame filter presses
- Mobile dewatering

Mobile dewatering is an option that is not commonly practiced in North America but has been practice in Europe. In this process, a mobile septage-processing unit is used. In this unit, raw septage is lime conditioned and dewatered using a vacuum filter in the same truck used for the pump out operation. After dewatering, the reject liquor is emptied into the next residential septic tank the hauler is servicing. The dewatered sludge can be applied directly to land or disposed of at septage treatment plant. Some of the advantages and disadvantages of this process (USEPA 1984 and 1994) are:

Advantages

- The liquid volume to be disposed is reduced considerably.
- Stabilized dewatered sludge allows direct land disposal.
- Mobile dewatering/haulage trucks could service a number of septic tanks before disposal is required, minimizing the time and associated cost with traveling to and from disposal sites.

Disadvantages

- Higher equipment investment costs.
- High suspended solids and high pH effluent to absorption field for a period after pumping.
- Potential health risks of transferring pathogens between different septic systems even though lime stabilization may have reduced pathogens.

2.9.3 Liquid Treatment

Once the liquid is separated from the solids, it generally needs to be treated before disposal, since the liquid is still strong wastewater. Septage liquid treatment technologies are the same as for municipal wastewater treatment and could include:

- Facultative (non-aerated) lagoons
- Aerated lagoons

- Constructed wetlands
- Discharge to a municipal wastewater treatment plant
- Advanced treatment to effluent reuse quality

Table 2-10 presents the advantages and disadvantages for each of the septage liquid treatment technologies.

Depending on its quality, the treated liquid faction of septage can be disposed several ways:

- Subsurface disposal similar to a septic tank disposal field
- Rapid infiltration and/or evaporative lagoons
- Surface water disposal
- Reuse through irrigation

Table 2-10
Advantages and Disadvantages for
Septage Liquid Treatment Technologies[1]

Process	Advantages	Disadvantages
Lagoons	• Simple Operation • Low Cost	• Large land requirements • Potential cold weather problems • Potential odour, vector problems • Effluent quality marginal
Wetlands	• Simple • Low Cost	• In development stage – design information limited • Large area required • Climate may be major limitation • Potential for mosquito breeding
Municipal WWTP	• Process more controlled than lagoons and land treatment • Performance well documented for wastewater treatment plants • Small land requirement	• Higher capital and operating costs than lagoons or wetlands

[1] USEPA 1984

2.9.4 Solids Stabilization

Septage solids from the dewatering step would need treatment prior to disposal to reduce the volatile solids content and, in some cases, to reduce the pathogen content of the septage solids. Solids stabilization options include:

- Alkaline stabilization
- Composting
- Aerobic digestion
- Anaerobic digestion

Table 2-11 presents the advantages and disadvantages of the different solid stabilization processes.

Table 2-11
Advantages and Disadvantages of the Different Solid Stabilization Processes[1]

Process	Description	Advantages	Disadvantages
Alkaline Stabilization	Lime or other alkaline material is added to raise the pH to 12.0 for minimum of 30 minutes.	• Very Simple, minimal operator attention • Low capital and O&M costs • Provides temporary reduction in sulphide odours	• Increase mass of solids requiring disposal • Handling of lime may cause dust problems • Lime feed and mixing equipment require regular maintenance
Composting	Liquid septage or septage solids are mixed with bulking agents (e.g. wood chips, saw dust) and aerated by turning or mechanically. Biological activity generates temperatures sufficiently high to destroy pathogens.	• Final product is potentially marketable and attractive to users as soil amendment • Potential for Class A biosolids	• High odour potential • Medium to high operating costs
Aerobic Digestion	Septage is aerated for 15 days to 20 days in an open tank to achieve biological reduction in organic solids and odour potential (time requirements increase with lower temperatures).	• Relatively simple • Can provide reduction in odours • Potential for Class A biosolids with autothermal thermophilic aerobic digestion	• High power costs to operate aeration system • Large tanks or basins required • Cold temperatures require much longer digestion periods
Anaerobic Digestion	Septage is retained for 15 days to 30 days in an enclosed vessel to achieve biological reduction in organic solids.	• Generates methane gas, which can be used for digester heating or other purposes • Potential for Class A biosolids with thermophilic digestion	• Require skilled operator to maintain process control • High capital costs • High maintenance requirements for gas handling equipment • Generally not used except for co-treatment with municipal sewage sludge

[1] USEPA 1984

2.10 SEPTAGE MANAGEMENT EXAMPLES

Dr. David Forgie (2004) provided insight on various septage management practices within BC. One common septage management practice is the utilization of septage disposal pits at landfills. A number of the pits are somewhat leaky; the liquid drains away and the water is treated through natural attenuation (adsorption and biofilms) on its route down to the groundwater. With rotation of several pits (fill, rest, drain, dry, remove solids), the remaining solids have an opportunity to dry, and are subsequently removed for landfill disposal, or composting followed by utilization as landfill cover. Where a site must be lined or where soils are impermeable, the excess water is drained to the leachate pond where it is treated with landfill leachate before discharge.

Some locations, such as Penticton, disposed septage to pits until the volume of septage became unmanageable. They adopted composting (with wood chips as a bulking agent) to reduce the volume of septage to a more manageable level. This composting is relatively "low tech" windrow composting, which enables them to use the final product used as landfill cover.

Comox-Strathcona is one of a few facilities that utilize screening to remove solids and dewater them sufficiently to enable landfilling. Some facilities also incorporate rock traps to remove large, relatively heavy materials, which might otherwise damage the screens. The screened liquid is then discharged to a municipal wastewater treatment plant.

The City of Vernon wastewater treatment plant has experienced loading problems due to septage, even though the septage was screened. The solution was to construct a new septage receiving facility away from the treatment plant. This facility will include screening, rock removal, grit removal, flow equalization, primary treatment and, if required, secondary treatment to meet 500 mg/L BOD and TSS limits. The facility is located remotely from the plant, discharging into the collection system. This remote discharge helps to distribute the loads as well as to reduce the odour associated with off-loading in more populated areas.

The Regional District of Nanaimo uses an electronic billing system to allocate the fair costs of septage disposal to the respective haulers. The system includes a camlock connection, meter, card lock (key pad), and automatic billing software. The only treatment provided is a rock trap. The septage is discharged to a lift station wet well at the upper end of the wastewater collection system. Ferrous chloride is added to the liquid to

bind the sulphides for odour control. Since the discharge location is well upstream in the collection system, there is ample time for mixing and dilution before the septage arrives at the treatment plant.

The Capital Region District (Victoria) illustrates the most sophisticated septage management approach in BC. Two septage-receiving screens remove solids, which are disposed at the landfill. The liquid fraction is treated aerobically with a combination of fixed film and suspended growth treatment, and dissolved air floatation provides final solids removal to meet 300 mg/L BOD and TSS limits prior to effluent discharge to the sanitary sewer.

The Greater Vancouver Regional District, Iona Wastewater Treatment Plant, experienced septage discharge problems at the facility. The problem was overcome by discharging screened septage to one of their primary clarifiers. This helped to confirm the problems. The problem discharges were largely eliminated once the offenders were confronted with the visual evidence.

2.11 SUMMARY

Advantages and disadvantages of each septage treatment alternatives are presented in Table 2-12.

Table 2-12
Advantages and Disadvantages of Septage Disposal Alternatives

PROCESS	DESCRIPTION	ADVANTAGES	POTENTIAL RISKS/CONCERNS
Land Application	Untreated septage is applied to land used infrequently by the general public, such as agricultural land, forestland, and reclamation sites.	• Recycles organic material and nutrients to the land. • Simple, economical. • Low energy use.	• Public health concerns from the survival of various infectious agents in soil, contamination of edible crops, and transfer of pathogenic organisms by vectors to humans. • Environment concerns from the potential contamination of surface water from runoff and ground water from percolation. • Aesthetic concerns from the objectionable odours of septage. • Public's negative perception of septage waste and the septage pumping and disposal industry. • Need for holding facility during periods of frozen or saturated soil.
	Stabilized septage is applied to land used infrequently by the general public, such as agricultural land, forestland, and reclamation sites.	• Recycles organic material and nutrients to the land. • Stabilization reduces odours, vectors and pathogens. • Simple, economical. • Low energy use.	• Need for holding facility during periods of frozen or saturated soil. • Public's negative perception of septage waste and the septage pumping and disposal industry.
Treatment At WWTPs	Septage is added to the plant headworks, upstream manhole, or sludge handling process for co-treatment with sewage or sludge.	• Centralizes waste treatment operations. • Reduces potential environment, health and odour concerns associated with land application of septage.	• Potential need for equalization tanks to prevent the overloading and potential toxic effects from septage loads being discharged during portion of a day only.

PROCESS	DESCRIPTION	ADVANTAGES	POTENTIAL RISKS/CONCERNS
Treatment At WWTPs (continued)	Septage volumes that can be accommodated depend upon the plant capacity and types of unit processes employed.	• Use of existing capital treatment plant infrastructure rather than having to develop and pay for a separate system. • Operation of the "septage facility" is integral with the treatment plant and, therefore, additional operating staff are normally not needed. • Management of septage residuals is integral with the normal management of the treatment plant residuals.	• Potential for toxic liquids to be discharged into the treatment plant due to lack of controls or regulations on what is collected by septage haulers. • Potential for additional odour control to deal with odours from septage. • Potential for need for additional aeration capacity to deal with the additional organic load from the septage. • Increased residuals handling and disposal requirements.
Treatment at Independent Septage Treatment Plants	Treatment facility is constructed solely for the treatment of septage. Treatment generates residuals, which must be disposed.	• Provides regional solution to septage management. • Reduces potential environment, health and odour concerns associated with land application of septage. • No negative loading, flow or toxic impact on municipal wastewater treatment plant. • More direct control over the septage treatment process relative to treatment at a municipal treatment plant.	• High capital and operation and maintenance costs. • Operation of a separate septage treatment facility would likely require additional operating staff over and above those at the municipal WWTP unless the septage facility can be located very close to the municipal WWTP.

REGULATIONS

SECTION 3

The following sections present the regulations applicable to the management of septage in the U.S. and Canada.

3.1 U.S. REGULATIONS – 40 CFR PART 503

U.S. regulations applicable to domestic septage are contained in the U.S. Code of Federal Regulations (40 CFR Part 503), "Standards for the Use or Disposal of Sewage Sludge," published by the Federal Register on February 19, 1993. The U.S. Environment Protection Agency defines domestic septage as "either liquid or solid material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar treatment works that receives only domestic sewage."

The regulations simplify the requirements for domestic septage disposal to "non-public contact sites." Non-public contact sites include agricultural land, forestland, and reclamation sites that the public uses infrequently.

The regulations require that:

- The land applier must ensure they that only domestic septage is applied
- The domestic septage must be applied only to non-public contact sites that include agricultural land, forestland and reclamation sites that public uses infrequently
- The land applier must certify that pathogen and vector attraction reduction requirements have been met, including crop harvesting, animal grazing, and site access restrictions
- The land applier must notify the owner of land onto which domestic septage is applied regarding crop harvesting, grazing and site restrictions
- The land applier must keep records of any domestic septage application for period of 5 years
- The land applier must not apply domestic septage to saturated or frozen soil where potential exists for contamination of surface water, or to land within 10 m (33 ft) or wetlands, streams, rivers or lakes

If septage is not applied to land, more complex provisions of 40 CFR Part 503 would apply. If septage is treated at a municipal wastewater treatment plant, septage becomes part of sewage sludge and is subject to sludge regulations in 40 CFR Part 503. If septage

is treated at an independent septage treatment facility, the sludge generated from such processes is no longer considered septage and requires compliance with sludge provisions in 40 CFR Part 503.

3.1.1 Pathogen and Vector Attraction Reduction Requirements

The regulations require that the domestic septage applier must certify that requirements for pathogen and vector attraction reduction are met.

The recommended pathogen reduction alternatives include:

- Alkaline stabilization by the addition of lime to raise pH to 12 or higher for at least 30 minutes prior to land application with crop restrictions
- Crop harvesting and site restrictions (see Table 3-1)

Table 3-2 gives examples of crops affected by pathogens and crop harvesting restrictions.

The recommended options for vector attraction reduction include:

- Subsurface injection
- Incorporation (surface application followed by plowing within 6 hours)
- Alkaline stabilization (pH of 12 or greater for 30 minutes prior to application)

Table 3-1
U.S. EPA Federal Crop and Site Restrictions [1,2]

UNTREATED SEPTAGES	ALKALINE-STABILIZED SEPTAGE	RESTRICTIONS
		CROP RESTRICTIONS
X	X	.1 Food crops[1] with harvested parts that touch the septage/soil mixture and are totally above ground shall not be harvested for 14 months after application of domestic septage.
X		.2 Food crops[1] with harvested parts below the surface of the land shall not be harvested for 38 months after application of domestic septage.
	X	.3 Food crops[1] with harvested parts below the surface of land shall not be harvested for 20 months after application of domestic septage when the domestic septage remains on the land surface for 4 months or longer prior to incorporation into the soil.
	X	.4 Food crops[1] with harvested parts below the surface of land shall not be harvested for 38 months after application of domestic septage when the domestic septage remains on the land surface for less than 4 months prior to incorporation into the soil.
X	X	.5 Animal feed, fibre, and those food crops that do not touch the soil surface shall not be harvested for 30 days after application of the domestic septage.
X	X	.6 Turf grown on land where domestic septage is applied shall not be harvested for twelve months after application of domestic septage when the harvested turf is either a lawn or land with high potential for public exposure, unless otherwise specified by the permitting authority.
		SITE RESTRICTIONS
X		.1 Public access to land with a low potential for public exposure shall be restricted for 30 days after application of domestic septage. Examples of restricted access include remote areas, no trespassing postings, and simple fencing.
X		.2 Animals shall not be allowed to graze on the land for 30 days after the application of domestic septage.

[1] USEPA 1994

[2] Food crops means crops consumed by humans.

Table 3-2
Examples of Crops Impacted by Restrictions[1]

Harvested Parts Usually Do Not Touch The Ground	Harvested Parts Usually Touch The Ground	Harvested Parts Below The Ground
Peaches	Melons	Potatoes
Apples	Eggplant	Yams
Corn	Squash	Sweet Potatoes
Wheat	Tomatoes	Rutabaga
Oats	Cucumbers	Peanuts
Barley	Celery	Onions
Oranges	Strawberries	Leaks
Grapefruit	Cabbage	Radishes
Cotton	Lettuce	Turnips
Soybeans	Hay	Beets

[1] USEPA 1993

3.1.2 Application Rate

The maximum volume of domestic septage that may be applied to any site during any 365-day period depends upon the amount of nitrogen required by the planned crop and yield. This maximum volume is calculated by the following formula:

$$AAR = \frac{N}{0.0026}$$

where:
AAR = Annual application rate in U.S. gallons/acre/yr
N = Amount of nitrogen in lb/acre/yr required by the crop

The coefficient 0.0026 is based on the average plant-available nitrogen content of 0.0026 pounds of nitrogen per U.S. gallon (3.78 litres) of septage.

3.1.3 Management Requirements

Management practices required by 40 CFR Part 503 are general in nature and include such things as site limitations and buffer zones (WEF 1997). Many states have specific best management practice (BMP) requirements that the septage hauler must follow. Such BMPs may include:

- Training/certification/regulation of haulers and registration of their vehicles
- Use of manifest systems
- Site restrictions and setback distances
- Stringent record keeping requirements
- Prohibition of septage application to flooded, frozen, or snow-covered land
- Uniform distribution of septage over the application area
- Maintenance of septage application sites to minimize potential nuisance, public health, and environment concerns
- Protection of endangered or threatened species
- Provision of storage facilities to provide operation flexibility during inclement weather

3.1.4 Record Keeping Requirements

The record keeping requirements established by USEPA require that following records be kept for a minimum of 5 years:

- The location of the site where domestic septage is applied
- The number of acres to which domestic septage is applied at each site
- The date and time of each domestic septage application
- The nitrogen requirement for the crop or vegetation grown on each site during the year
- The gallons of septage, which are applied to the site during the specified 365-day period
- Certification that pathogen and vector attraction reduction requirements have been met
- A description of how the pathogen reduction and vector attraction requirements are met for each batch of domestic septage that is applied

3.2 CANADIAN REGULATIONS

In Canada, septage disposal regulations fall under provincial jurisdictions. The federal government does not have specific guidelines or regulations for the treatment and disposal of septage. Land application of untreated septage onto agricultural land is under review in Alberta, Nova Scotia and Ontario; whereas, Saskatchewan, Manitoba, and Prince Edward Island allow disposal onto land. Septage disposal onto land is banned in British Columbia, Quebec, Newfoundland and Labrador and New Brunswick.

3.2.1 Ontario

In Ontario, the Nutrient Management Act sets out requirements for the land application of agricultural and non-agricultural materials, where non-agricultural sources are defined as the following materials if they are intended to be applied to land as nutrients:

- Pulp and paper biosolids
- Sewage biosolids
- Any other material that is not from an agricultural source that is capable of being applied to land as a nutrient

The Nutrient Management Act will be phased in January 2007 for non-agricultural source material. According to the act, the maximum application rate is defined by the run-off potential of the site, which in turn depends on the field slope and the permeability of the soil. Table 3-3 presents the relationship between slopes and application rates. Table 3-4 shows maximum rates for surface application and for injection/incorporation.

According to McAilin (2004) of the Ontario Ministry of Environment, the application of un-stabilized portable toilet waste is currently prohibited on land. In addition, Ontario is working on phasing out land application of untreated septage because pathogens in septage are a significant contamination source.

Table 3-3
Run-Off Potential

Hydrological Soil Group	Maximum Sustained Field Slope[1] Within 150 metres from the Top Bank of Surface Water		
	At least 3% but less than 6%	At least 6% but less than 9%	At least 9% but less than 12%
A Rapid	Very Low	Low	High
B Moderate	Low	Moderate	High
C Slow	Moderate	High	No Application
D Very Slow	High	High	No Application

[1] Application of liquid prescribed materials is not allowed on land with a slope of greater than 12% Source: Ontario (2003).

Table 3-4
Single Application Liquid Loading Limit

Run-off Potential	Maximum rate of single application to land if the materials are applied to the surface of land (in cubic metres per hectare)	Maximum rate of single application to land if the materials are injected, or incorporated into the land or if the land is pre-tilled (in cubic metres per hectare)
High	50	75
Moderate	75	100
Low	100	130
Very Low	130	150

Source: Ontario 2003

3.2.2 British Columbia

Dave Forgie (2004) provided insight with respect to septage management within the Province of British Columbia (BC).

Raw septage application to land is not allowed in BC since this material would not meet Class B requirements under the Organic Matter Recycling Regulation. Perhaps the historical reasoning behind this restriction relates to BC's limited land base (limited land areas for septage disposal) and competition for the land from more desirable organic sources (e.g. agricultural wastes). In the lower Fraser Valley, agricultural wastes alone provide ample nitrogen. There is a concern that

with excess applications, overloading from nitrogen may adversely impact groundwater.

In BC, the Organic Matter Recycling Regulation (OMRR, BC Reg. 18/2002) governs the production, quality, and land application of certain types of organic matter. The regulation applies to the construction and operation of composting facilities and the production, distribution, storage, sale, and the use of land-applied biosolids and compost. Land application of untreated septage is not allowed. Generally, composting and/or other treatment processes would be required for septage to meet Class B biosolids standards thus enabling application to land. The land application and distribution requirements include:

- Land application plan - discharger must have a qualified professional prepare a land application plan and obtain written certification from a qualified professional that the land application was carried out in accordance with the plan
- Class B biosolids standard – septage must meet defined criteria for:
  - pathogen reduction processes
  - vector attraction reduction
  - pathogen reduction limits
  - quality criteria (less restrictive than for Class A biosolids)
  - sampling and analyses – protocols and frequency
  - record keeping

The trace element ceiling limits for biosolids under OMRR are significantly lower than those specified in the scientific, risk-assessment-based U.S. 40 CFR Part 503 rule.

3.2.3 Newfoundland and Labrador

In Newfoundland and Labrador, septage treatment is provided by the private sector (Mathews, 2004). There are two major vacuum truck companies operating in the province with one company having 90% of the business and its own treatment site. The treatment site uses a centrifuge for dewatering, and composting to stabilize the dewatered solids. The supernatant from the centrifuge is discharged to a municipal treatment plant after proper testing.

3.3 COMPARISON OF SEPTAGE LAND APPLICATION REGULATIONS

Table 3-5 shows a comparison of the regulations for the land application of domestic septage to non-public contact sites in Canada and the U.S.

Table 3-5
U.S. and Canadian Regulations for the Land Application of Domestic Septage to Non-public Contact Sites

	U.S. Federal (USEPA)	Minnesota	Michigan	Georgia	Indiana	Washington	Illinois	Oklahoma	Alberta (LOA)*	Saskatchewan	Manitoba	PEI	Ontario	BC
PERMITS/CERTIFICATION REQUIRED	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
APPLICATION RATE														
Based on:	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement	Crop Nitrogen Requirement		Crop Nitrogen Requirement	Case Specific[8]		Run-off potential	Crop Nitrogen Requirement
Hydraulic Loading Limits		94 m^3/ha/day 140 m^3/ha/winter	140 m^3/ha/month 560 m3/ha/year	375 m^3/ha/year					Case Specific[11]				50 - 150 m^3/ha/day[13]	
PATHOGEN REDUCTION	Lime stabilization and harvesting restrictions OR Site and harvesting restrictions	Lime stabilization and harvesting restrictions OR Site and harvesting restrictions	Aerobic/Anaerobic digestion, lime stablization, composting, air drying, or other approved process OR Site and harvesting restrictions	Site and harvesting restrictions	Lime stabilization and site restrictions	Optional for septic tank/ holding tank wastes. Stablization required for portable toilet wastes.	Optional for septic tank/ holding tank wastes. Stablization required for portable toilet wastes.	Lime stabilization and site restrictions	Not Required	Optional	Not Required	Not Required	Stabilization required for portable toilet wastes	Fecal coliforms to be reduced to less than 2,000,000 MPN per gram of total solids (dry basis), or one of five recognized processes: aerobic digestion, air drying, anaerobic digestion, composting, lime stabilization (pH of 12 after 2
VECTOR ATTRACTION REDUCTION	Lime Stabilization OR Injection OR Incorporation	Lime Stabilization OR Injection OR Incorporation	Incorporation OR Stringent site management requirements	Lime Stabilization OR Injection OR Incorporation		Lime Stabilization OR Injection OR Incorporation	Optional	Lime Stabilization	Injection OR Incorporation within 48 hours of surface application OR Reduced Application Rates	Not Required	Not Required		Not Required	Vector attraction reduction required using one of the following processes: aerobic digestion, anaerobic digestion, composting, lime stabilization (pH of 12 after 2 hours of contact)
CROP HARVESTING RESTRICTIONS														
Human food crops with harvestable portions that touch the soil surface but are above ground	14 months	14 months	Case specific[3]	14 months	14 months	14 months	Case Specific[6]	14 months	3 years	Not Allowed	None	1 year	3 weeks - 15 months [17]	18 months
Root Crops[1]	20 months	20 months	Case specific[4]	20 months	20 months	20 months	Not allowed	20 months	3 years	Not Allowed	None	1 year		38 months
Root Crops[2]	38 months	38 months		38 months	38 months	38 months		38 months	3 years	Not Allowed	None	1 year		38 months
Other Food, Fibers or Feed	30 days	30 days	30 days	30 days	30 days	30 days	30 days	30 days	Case Specific[10]	30 days	None			
Turf	1 Year	1 Year		1 Year	1 Year	1 Year	1 Year	1 Year			None			
Grazing	30 days[4]	30 days	30 days	30 days[4]	30 days[4]	30 days[4]	30 days[4]	30 days[4]	3 years[12]	2 - 6 months[7]	60 days	1 year	2 - 6 months[14]	60 days
ACCESS RESTRICTIONS[5]														
High potential for exposure	1 year[4]	1 year[4]	1 year[4]	1 year[4]	1 year[4]	1 year[4]	1 year[4]	1 year[4]	None					
Low potential for exposure	30 days[4]	30 days[4]	1 year[4]	30 days[4]	30 days[4]	30 days[4]	30 days[4]	30 days[4]	None	30 days				
SETBACK REQUIREMENTS														
Surface Waters	None	15-60 m	45 m (Injected) 150 m (surface)	90 m	30 m (Injected) 60 m (surface)	30 m		30 m	30 m (minimum) 50 m (preferred)	100 m	60 m	Case Specific[9]	20 - 150 m[16]	30 m
Intermittent Streams	None	60-180 m		90 m	30 m (Injected) 60 m (surface)		60 m	30 m	30 m (minimum) 50 m (preferred)		60 m			30 m
Private Drinking Water Well	None	60 m	45 m (Injected) 240 m (surface)	90 m	150 m	30 m	60 m	30 m	50 m	100 m	60 m	150 m	90 m	30 m
Public Drinking Water Well	None	300 m		90 m	300 m	30 m	60 m	90 m	50 m	100 m	60 m	150 m	100 m	30 m
Residence	None	60 m	45 m (Injected) 240 m (surface)	90 m	150 m (injected) 180 m (surface)	15 (injected) 60 m (surface)	60 m	400 m	500 m (minimum) 800 m (preferred)	1000 m	460 m	300 m	50 m	
Property Boundary	None	180 m	45 m (Injected) 240 m (surface)	90 m	15 m (Injected) 30 m (surface)	1.5 m (injected) 15 m (surface)	60 m	3 m	10 m (minimum) 30 m (preferred)		60 m		25 m	30 m
Recreational Area	None	180 m	45 m (Injected) 240 m (surface)	90 m			60 m	30 m	200 m (minimum) 500 m (preferred)	1000 m			50 m	
Road Right-of-Ways	None	60-180 m	45 m (Injected) 60 m (surface)	90 m	60 m (Injected) 90 m (surface)	15 (injected) 60 m (surface)	60 m		10 m (minimum) 20 m (preferred)			15 m		30 m
Holes and Channels	None	60-180 m		90 m	15 m (Injected) 30 m (surface)		60 m	30 m			60 m			30 m
Soil Requirements									Sand and gravel unacceptable	Unacceptable on bedrock, and sandy soils				
Slope	None	<6% (surface spread) <12% (injected) <2% (winter)	<6% (surface spread) <12% (injected) <2% (winter)	<15%		<3 %			<5 %	<5 %			< 12%	< 12%
Depth of groundwater/bedrock	None	0.9 m	0.76 m				1.2 m	1.5 m	>2 m	1.5 m			> 0.3 m	1 m
Surface horizon permeability	None	< 5 mm/hour						< 5 mm per hour			> 25 sec per cm			
MONITORING/RECORD KEEPING														
Years to be Retained		5 years	5 years	5 years	5 years			5 years	5 years	5 years	3 years	None		3 years
Required Information														
Site Location		Yes	Yes	Yes	Yes	Location	Yes	Yes	Yes	Yes	Yes			yes

Table 3-5
U.S. and Canadian Regulations for the Land Application of Domestic Septage to Non-public Contact Sites

	U.S. Federal (USEPA)	Minnesota	Michigan	Georgia	Indiana	Washington	Illinois	Oklahoma	Alberta (LOA)*	Saskatchewan	Manitoba	PEI	Ontario	BC
Site Map		Yes	Yes	No	No	No	No	No	No	No	No			yes
Date of Application		Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	No			yes
Time of Application		No	No	No	No	No	No	Yes	No	No	No			yes
Number of Acres		Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No			yes
Septage Application Rate		Yes	No	Yes	No	No	No	Yes	Yes	No	No			yes
Nitrogen Application Rate		Yes	No	No	Yes	Yes	No	Yes	No	No	No			yes
Total Amount of Septage applied		Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes			yes
Total Amount of Septage transported		No	Yes	No	No	No	No	No	No	No	Yes			yes
Crop Grown		Yes	No	Yes	No	Yes	Yes	Yes	No	No	No			yes
Pathogen Reduction		Yes	No	Yes	Yes	Yes	No	No	No	No	No			yes
Vector Attraction Reduction		Yes	No	Yes	No	Yes	No	No	No	No	No			yes
Certification		Yes	No	Yes	Yes	Yes	No	Yes	No	No	No			yes
Name of hauler and business		Yes	Yes	Yes	Yes	No	No	No	No	No	No			yes
Source of Septage		Yes	No	No	Yes	Yes	No	No	Yes	Yes	No			yes
Land Owner's Agreement		No	Yes	No	No	No	No	No	Yes	Optional	No			yes
Method of Application		No	No	No	Yes	No	Yes	No	No	No	No			
pH and duration		No	No	No	Yes	No	No	Yes	No	No	No			

1 = If septage remains on soil surface for four months or longer
2 = If septage remains on the soil surface for less than four months
3 = Pathogen reduction by composting, heat drying or thermophilic aerobic digestion required prior to disposal where crops for direct human consumption are grown.
4 = Non Stablized sludge
5 = Public and animal access restricted using fencing and posting of signs.
6 = Application not allowed on root vegetables or low growing fruits and vegetables that might be eaten raw
7 = Grazing not allowed for 2 months for cattle and horses, and 6 months for swine and sheep.
8 = Application only permitted if septage is distributed under the control of the generator of septage.
9 = Setback distances from water courses vary depending upon the slope of the land (eg 15 m when slope <2%, 37 m when slope is 2-5%, 107 m when slope is 5-10%, 213 m when slope > 10%)
10 = Septage can only be applied on land intended for the production of forages, oil seeds, small grains, trees and commercial sod. No harvesting restrictions for these crops.
11 = Application Rates vary depending upon the application method (for septic tanks the rate is 500 m^{-3}/ha/yr or 100 m^{-3}/ha/day when tilled into the soil; 250 m^{-3}/ha/yr or 50 m^{-3}/ha/day without tilling; 10 m^{-3}/ha/yr with only one application during winter/ for holding tanks annual application rates are lower than septic tanks ie 300 m^3/ha/yr with tilling and 150 m^3/ha/yr without tilling).
12 = Grazing restriction of 3 years is only for dairy farming pasturing.
13 = Application rates vary depending upon the application method and run-off potential (see Table 3-3 and 3-4). (The rates vary from 50 m^3/ha with high run-off potential and surface application to 150 m^3/ha with low run-off potential and injection or incorporation into soil.)
14 = In Ontario, grazing restrictions for horses, beef, or dairy cattle is 2 months, and for swine, sheep, or goats is 6 months.
15 = In Ontario, application not allowed on lawns, recreational area, golf course, land where tobacco is grown, where plant availabe phosphorus exceeds 60 mg of P per litre of soil, or where pH is less than 6.
16 = In Ontario, surface water in fields where nutrients are applied are required to be bordered by a 3 m continuous vegetated cover of perennial grasses, forbs, trees or forage crops that can be harvested as hay or sillage. Setback from surface water 20 m when run-off potential is low, and 150 m when run-off potential is high.
17 = Harvesting restrictions in Ontarion are as follows: Commercial sod: 12 months; hay and haylage: 3 weeks, tree with fruits and grapes: 3 months, small fruits: 15 months; vegetables: 12 months.
In Ontario, soil to be analysed for availabe phosphorus, available potassium, regulated metals and soil pH before application. Non-agricultural material other than biosolids have to analysed for TKN, ammonia and ammonium nitrogen, nitrate and nitrite nitrogen, total phosphorus and total solids, regulated metals to check that
In Ontario, storage facilities required for storage during inclement weather conditions. Application prohibited on frozen land.
*LOA refers to Letter of Authorization
In Maine, conditions limit land application to only 5-6 months per year. Most land application sites have storage for winter use. The storage tanks also are necessary for septage treatment prior to land application.

3.4 REGULATORY APPROACHES

3.4.1 Environmental Regulatory Options in Alberta

Rob Burland (2004) provided the following background on regulatory options available in Alberta. Environmental regulation in Alberta is carried out in 3 ways:

1. Directly under the Environmental Protection and Enhancement Act (EPEA) and Regulations
2. Through approvals, registrations and notifications for designated activities
3. Through environmental codes of practice referenced in regulations

EPEA and its regulations provide general prohibitions or rules to protect the environment. These rules are broad in scope and can only be changed by the Alberta Legislature. There are some sections in the Act that allow for an Alberta Environment (AENV) director to authorize an activity (e.g. for the disposal of waste); however, these are rare.

EPEA and its regulations enable AENV to regulate various activities that may impact the environment. This allows AENV to set environmental rules based on the nature of the activity and site-specific situations, and to provide a consultative framework for setting these rules. Activities that are regulated by AENV are specified in the Activities Designation Regulation (ADR). The ADR provides for three levels of regulation based on the environmental risk of the activity – approvals, registrations and notifications.

Approvals: Approvals are required for activities that have the highest level of environmental risk. Examples of facilities or activities that require an approval are water/wastewater treatment plants, larger landfills, and large industrial processing facilities. An approval is a regulatory document that provides terms and conditions on how an activity is conducted or how a facility is constructed, operated, and reclaimed. An approval is obtained after a proponent makes an application to Alberta. Public consultation is part of the approval process. Notice of an approval application for a proposed activity or facility is published in the local area and the public has an opportunity to comment, state concerns and appeal an approval if it is issued.

Registrations: Registrations are required for activities or facilities that have a lesser degree of environmental risk and that have a standard method of operation. Examples of activities or facilities that require a registration are smaller landfills, and wastewater systems that use lagoons and compressor stations. A registration is obtained after a proponent makes an application to AENV. In most cases the registration holder is required to follow a Code of Practice that is published by AENV. There is no public consultation associated with a registration; however with some activities, an applicant is required to first obtain a development permit by the local authority. The local development approval process provides for public consultation.

Notifications: Activities or facilities that require notification are of low environmental risk. These include waste transfer or storage facilities and small vegetation composting operations. With these activities, a proponent is required only to notify AENV of the operation by providing the name of the person responsible, the location, and any other relevant information.

Environmental Codes of Practice are documents developed by AENV in consultation with industry groups to provide a set of standard environmental rules under which a specified industry operates. Codes may be referenced in the regulations as the rules under which an activity must be conducted and are, therefore, legal documents. In most cases, an operation will register with AENV and operate under a code of practice; however, a Code of Practice may be in effect without an associated registration.

3.4.2 USEPA Regulatory Approaches

Septage management presents a unique challenge to individuals and facilities accepting it. Since septage reuse and disposal practices depend on the owners of small septage pumping/hauling firms, proper management of septage hauling and disposal programs is just as important as the design of the hauling, treatment and disposal systems (USEPA 1984, WEF 1997).

A septage management program should address the following specific activities (USEPA 2003):

- Well-defined procedures and rules for handling and dispersing septage
- Tracking or manifest systems that identify sources, haulers, transport equipment and final destination
- Well-defined treatment/reuse techniques employed at the disposal sites
- Education of the homeowners
- Training, licensing/certification programs for service providers
- Corrective action/enforcement programs against poor performance

Table 3-6 presents septage management approaches proposed by the USEPA document "Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment System" (USEPA, 2003)

Various USEPA sources suggest or require the following elements as a part of a septage management program:

- Education of homeowners and septage hauling industry
- List of certified service providers in the area
- List of wastewater treatment plants accepting septage
- Pre-approval of land application sites
- Hauling vehicles displaying the name of the business; the address and a sign indicating that it is transporting domestic septage
- Corrective action/enforcement programs against poor performance
- Tracking or manifest systems that identify sources, haulers, transport equipment and final destination
- Addition of permanent staff to provide site monitoring, plan implementation, and data collection
- Inspections and auditing: an electronic reporting system to track corrective measures or auditing by third-party service providers to impose enforceable instruments–Michigan and Montana currently have an online listing of septage haulers with land application sites and wastewater treatment plants accepting septage

Table 3-6
Residual Management Approaches

Basic Approach	Intermediate Approach	Advanced Approach
Assure that residuals are being reused or managed in compliance with applicable rules; educate and remind owners of the need to inspect and/or pump treatment tanks at regular intervals; and require only state-certified/licensed residuals handlers and approved sites.	Require homeowners and licensed/certified service providers to report when residuals are removed and tanks inspected in order to renew operating permit; maintain and disseminate list of acceptable service providers based on investigated complaints.	Create and administer tracking, inspection and monitoring plan for all aspects of residuals removal, hauling and reuse/disposal; provide any necessary supplemental training and registration/ licensing programs for local providers or arrange it with training centres and universities; and employ only approved providers.

3.4.3 Regulatory Approaches Used in the U.S. States

Regulatory approaches used by various states in U.S. to help ensure that septage haulers comply with the state laws and rules are as follows:

Montana

- Septage haulers are required to be licensed and must pay an annual licensing fee of $125. The hauler must also to certify that he will dispose of septage according to the laws and rules of the State of Montana. Licensing application forms require:
  - business and applicant name and location
  - septage collection areas
  - septage disposal site location
  - proposed septage disposal volume for each site
  - method of disposal
  - source of septage

- Septage haulers must complete a separate application for each new disposal site. Septage haulers need pre-approval for each land application site. Application for approval must include:
  - land owners' name, legal description of site, site map, and number of acres for land application
  - type of crop, crop nitrogen requirements
  - estimated depth to groundwater, soil type, approximate slope, distance to closest surface waters, and present use of adjacent lands
  - operation and maintenance plan
  - affidavit certifying that the applicant is either the owner of the site, has a lease given to accomplish the permitted purpose, or has provided a notification to the landowner of the site restrictions for crop harvesting and animal grazing following the land application of septage on property
  - land owner or waste treatment plant manager signature allowing permission to use the disposal site
  - applicant certification
  - health officer certification that physical requirements of Montana rules and laws are met, and/or zoning certification (if required) that use of the site is in confirmation with local zoning regulations
- Operation and Maintenance plan must include:
  - measures used to control access to site
  - vector attraction and pathogen reduction methods used
  - animal grazing and crop harvesting restrictions for the site
  - list of equipment available to manage each type of waste
- Compliance with rules and laws are measured by disposal site inspection. Montana currently has an online list of septage haulers with land application sites and wastewater treatment plants that accept their septage. Environment assessments of application sites are also available online.

Georgia

- Septage haulers need pre-approval for each application site. Approval application must include information such as:
  - a plan of the property, with topography, showing the drainage characteristics of property including locations of streams, lakes, or other water courses and impoundments on or adjacent to the property

  - water supplies, including individual and community wells within 500 feet of disposal area
  - all buildings and neighbouring land uses within 500 feet of disposal area
  - disposal area boundaries, and location of all-weather roadways to and from the disposal area
  - soil types and their distribution in disposal area
  - percolation test results, when deemed necessary by the department
  - seasonal water table elevation and/or location of rock strata or other impervious strata
  - an estimate of the maximum septage application rate in gallons per day
  - vector attraction reduction method
  - method of securing disposal site
  - signature of property owner approving land application of septage
- Haulers are required to maintain records for five years after septage land application. These records must include:
  - site location
  - application rate
  - number of acres of each site
  - crop or vegetation grown on each site
  - certification
  - description of how pathogen and vector attraction reductions are met
- Compliance with rules and laws are measured by a review of records.

Indiana

- Businesses hauling septage need a permit, and all vehicles must have a separate licence.
- A permit is required to use storage facility and/or treatment facility.
- Land application sites must be pre-approved and inspected.
- Applications for pre-approval must include information such as:
  - a statement signed by the landowner granting permission and acknowledging crop and use limitations
  - a site map that indicates all required features of interest

  - a soil survey map classifying soils and their permeability within the proposed site
  - an application fee of $30 per site
- A quarterly report must also be submitted to the Department of Environment.

North Carolina

- Septage management firms in North Carolina are required to have three types of permits:
  - The first permit is required for the firm that operates the septage pumping business. The permit application form must include information such as owner name, business name and areas of operation.
  - The second permit is required for each site that will be used for septage land application. The site application permit must include information such as the location of the facility, types of septage to be applied, anticipated volume to be applied, aerial photographs of the site, and background soil analysis.
  - The third permit is required for the storage facility. Information needed for the storage facility permit includes information such as the location of facility, types of septage to be stored, a description and size of the facility, and number and types of structures to be used.
- Septage haulers are required to maintain records that include:
  - site location
  - number of acres involved in land application
  - nitrogen requirements of crops
  - amount of septage applied
  - certification that material applied is only domestic septage
  - pathogen and vector attraction reduction requirements are met
  - description of pathogen and vector attraction reduction methods

Minnesota

- Septage haulers in Minnesota are required to be licensed, but no permits are required for disposal sites.
- A permit is needed to use a storage structure for temporarily septage storage during inclement weather conditions.

- Haulers are required to develop and maintain records stated in the regulations summary shown in Table 3-3. Compliance is monitored by records reviews.

Michigan

- Septage haulers in Michigan are required to be licensed.
- Land application sites must be pre-approved. Approval application for the land application site to include information such as: land owner agreement granting permission for land application to property, site map, site location and certification stating that the hauler will comply with all the rules and laws. The inspecting authority inspects site before the application is completed. After the site is inspected, property owners within 800 ft are informed by the hauler, and given 10 working days to comment. If no valid, technical comments are received within the 10 working days, the land is then approved.
- If septage is to be disposed of at a wastewater treatment facility, approval from the wastewater treatment manager is required.
- Required fees are as follows:
  - $300.00 for a new three-year business license
  - $75.00 for a three-year vehicle license per truck
  - $100.00 for one-time fee for each new business application deposited into the septage waste site contingency fund
- Compliance is monitored through the inspection of disposal sites.

Pennsylvania

- Septage haulers are required to be registered and trained.
- Septage disposal is allowed only at permitted facilities.
- Record Keeping. Information to be maintained include: source of septage, date and time of application, disposal site and amount of septage handled. An operational log to demonstrate that pH requirements have been met. Records to be maintained for a minimum of 5 years.

3.4.4 Other Regulatory Approaches Used in Canada

Alberta

Section 3.4.1 describes available Alberta regulatory approaches which include approvals, authorizations, registrations, notifications and codes of practice. These are currently used under EPEA to regulate septage management activities in the province.

Dr. Armani has provided SMAC with information on manure management in Alberta. Since land disposal of septage and manure have similar issues and concerns, the one regulation approach could also be considered for Alberta.

Manitoba

- Application of septage on to agricultural land allowed only under the control of the generator of the waste.
- Septage haulers need to be registered.
- Haulers are required to keep a daily record of the disposal sites and amount of septage handled for a period of three years.

British Columbia and Ontario

Both BC and Ontario regulate septage and other wastewater biosolids along with agricultural wastes and under a single regulation or act in each province:

- BC: Organic Matter Recycling Regulation
- Ontario: Nutrient Management Act

GLOSSARY

SECTION 4

Algae: Simple rootless plants that grow in sunlit areas in relative proportions to the amount of nutrients available.

Alkaline: Typically exhibiting a high pH (well above 7).

Anaerobic: Without oxygen.

Ammonia: A pungent alkaline gas, a compound of nitrogen and hydrogen (NH_3). It is formed naturally when bacteria decompose nitrogen-containing compounds.

Anoxic: Without free oxygen, but with bound oxygen such as NO_3^- (nitrate).

Aquatic: Belonging to water, or living in or near water.

Bacteria: Single-celled organism.

Benthic, benthos: Associated with or living on the bottom of a large body of water.

Buffer: An area of land between two conflicting land-uses.

Bioaccumulation: The net uptake of a material by an organism from food, water, and /or air that results in elevated internal concentrations.

Biodegradable: Capable of decomposing rapidly under natural conditions.

Biosolids: Nutrient rich organic material resulting from the treatment of domestic wastewater.

Blackwater: Wastewater from toilets and/or urinals.

Carcinogen: A cancer-causing substance.

Class A Biosolids: Biosolids that have undergone a recognized heat treatment process to reduce fecal coliform bacteria to < 1000 MPN per gram of total solids (dry weight) and that meet stringent limits for various metal constituents.

Class B Biosolids: Biosolids with defined but less stringent treatment, bacterial and metals limits than Class A.

Chemical Toilet Wastes: Wastes from portable toilets that use de-odorizing chemicals. The most common chemicals are biodegradable based on enzyme formulations. Other types include those based on quaternary ammonium compounds ("quats," which often impart a pine scent) and formaldehyde based compounds.

Compaction: Condition of the soil in which soil particles are pressed together, reducing the size of the pore spaces between them.

Commercial Wastes: Non-domestic wastewater from facilities such as dry cleaning institutions, gas stations, car washes etc.

Domestic Wastewater: The wastewater that is the composite of liquid and water-carried wastes associated with the use of water for drinking, cooking, cleaning, washing, hygiene, sanitation or other domestic purposes, together with any infiltration and inflow wastewater, that is released into a wastewater collection system.

Endocrine-disrupting chemical: Chemical that can cause dysfunction in the hormonal systems of organisms that ingest it.

Eutrophication: A condition in an aquatic ecosystem where high nutrient concentrations stimulate blooms of algae.

Ecosystem: The system of interactions between living organisms and their environment.

Feedstock: Any material, which is converted to another form or product.

Graywater: Wastewater from a laundry, kitchen, sink, shower, bath, or other domestic sources. It does not include wastewater that contains excrement, urine, or combined stormwater.

Domestic Septage: Liquid or solid material removed from a septic tank, holding tank, pit toilet or similar system that receives only domestic wastes. This does not include wastes from grease traps, industrial or commercial processes.

Heavy metal: Metal element with a high atomic weight, such as cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

Holding Tank: A single compartment tank used to collect and store domestic wastewater from a residence, building, institution or development prior to it being transferred into a mobile equipment for disposal elsewhere.

Incorporation: The mixing of nutrients into the surface of soil by tillage with a minimum depth of soil disturbance of 10 centimetres.

Industrial Wastes: Non-domestic wastewater from industrial facilities such as oil refineries, chemical plants, pulp and paper mills.

Infiltration: Movement of surface water into soil or rock through cracks and pores.

Injection: The placement of nutrients below the surface of the soil of the land.

Inorganics: Matter other than plant or animal, and not containing a combination of carbon, hydrogen and oxygen as in living things (e.g. rock, metals etc.).

Leachate: A liquid resulting when water percolates, or trickles, through waste materials and becomes contaminated.

Leaching: The removal in solution of soluble minerals and salts by dissolving them away from solids.

Mercaptan: A compound containing an —SH group; a thiol.

Methemoglobinemia: A blood related condition found in babies due to nitrate poisoning. This poisoning limits the blood's ability to carry oxygen thereby causing a baby to look blue-hued, also known as "blue baby syndrome."

Organic: Substances produced by the metabolism of a living organism. Chemically, it is described as a compound or molecule containing carbon bound to hydrogen.

Parasite: An organism living off a host organism.

Pathogens: Organisms that can cause an infection or disease.

Permeability: Ease with which water and air are transmitted through soil. It is a property determined by soil pore space, size, shape, and distribution.

Parasites: means plants or animals that live, grow, and feed on or within another living organism without benefiting the host organisms.

Pit privy: An outdoor toilet facility in which the sewage receptacle consists of an excavation in the ground.
Precursor: A substance from which another substance is formed.

Process Wastewater: Commercial or industrial wastewater, which is of non-domestic origin.

Runoff: The part of precipitation, snowmelt, or irrigation water that flows from the land to streams or other surface waters. Surface runoff flows away without penetrating the soil. Groundwater runoff enters streams by seeping through soil.

Septic Tank: Means a two-compartment digestion chamber in which sewage sludge is retained in the first compartment, and the effluent is discharged from the second.

Scum: A film of impurities that can form on the surface of water. Sources of scum include oil, grease, and soaps.

Stabilization: Stabilization is a treatment method designed to reduce levels of pathogenic organisms.

Turbidity: A measure of water clarity.

Toxicity: The quality or degree of being poisonous or harmful to living organisms.

Vectors: Organisms such as flies, rats and birds that might transport pathogens off-site.

Viruses: The smallest life forms known that are not cellular in nature. They live inside the cells of animals, plants and bacteria and often cause disease.

Volatile: Materials that are capable of vaporizing or evaporating quickly at relatively low temperatures.

Winter: The time that soils are frozen or snow covered, so that incorporation or injection are not possible. This time varies from year to year.

Symbols and Abbreviations

AAR – Annual Application Rate

AENV – Alberta Environment

BOD – Biochemical Oxygen Demand

cap – capita

COD – Chemical Oxygen Demand

EMS – Environmental Management System

gal – Gallons

ha – hectare

L - litre

m – meter

m^3 – cubic meter

m^2 – square meter

mL – milliliters

NH_3 – Ammonia

NH_4-N – Ammonium nitrogen

NO_3-N – Nitrate nitrogen

Org-N – Organic nitrogen

SMAC – Septage Management Advisory Committee

TSS – Total Suspended Solids

US – United States of America

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CLOSURE

This report was prepared for Alberta Environment and the Septage Management Advisory Committee to undertake a technical and regulatory review of septage management.

The services provided by Associated Engineering in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectively submitted

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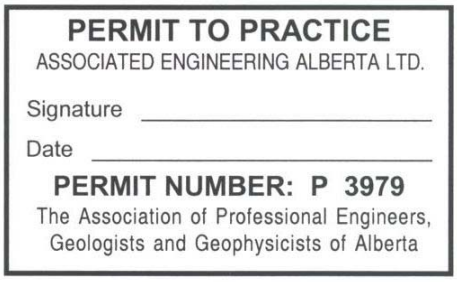

Permit Stamp

CONTACTS

APPENDIX A

Canadian Provincial Contacts for Septage Management Regulations

British Columbia
Jack Briden
250-387-9985

In BC, septage is disposed off in municipal wastewater treatment plants or independent septage treatment facilities. Composted septage can be applied on land.

Manitoba
Larry Strachan
204-945-7071

In Manitoba, land application of septage is discouraged; however, it is practised where access to treatment facility is unavailable. Haulers have to be registered to transport septage.

New Brunswick
Sheryl Johnson
506-453-7945

In 1996, septage was declared due to be a contaminant, and land disposal of septage has not been allowed since then. Before 1996, septage was disposed of in trenches and lagoons. Currently, New Brunswick has 6 regional treatment systems that accept septage.

Newfoundland and Labrador
Contact: Toby Mathews
709-729-5793

Land disposal of septage is not allowed. Originally about a decade ago, septage was allowed to be disposed off into trenches on unsecured land. With time it was observed that, vacuum trucks dumping on to land were increasing in numbers. On a given day 8-10 vacuum trucks were seen to be disposing off on the trenches on the same land site. This created problems with sites overflowing flies and smells. Thus, a ban was imposed by the municipality in eastern region followed by the western region of the province to stop land disposal.

Septage treatment is currently provided by the private sector. Treatment encompasses dewatering provided by a centrifuge with the supernatant going to a municipal treatment plant after proper testing, and solids being discharged to a composting facility. Composted solids could be applied as soil conditioner on land that is not used to grow crops for human consumption.

There are two major vacuum truck companies operating in the province with one company having 90% of the business and its own treatment site. The treatment site consists of dewatering and composting facility. Hauling distances could be significant in some cases (distances between two major cities that have treatment facilities is 500 miles), and the costs associated with disposal very high. The generator pays the costs associated with disposal.

Due to the high costs associated with the disposal, septic tank waste generators in rural areas with low income found to be dumping wastes in their backyard. This usually can't go on for long, since neighbours easily detect vector attraction and odour problems and report to the municipality.

Having two major vacuum truck operation companies has helped the province.

Land disposal of sludge generated in wastewater treatment plants not allowed until further treatment. Capital and operating costs associated with sludge management are high, and sludge is usually sent to a separate treatment facility.

There are special cases, where prepared excavation sites reviewed by the government can be used for the disposal of sludge for one time use only.

Ontario
Lisa McAilin
416-314-0535

Ontario has banned disposal of untreated portable toilet wastes onto land. Ontario is currently looking at phasing out disposal of septage onto land.

Prince Edward Island
Jim Young
902-368-5034

Saskatchewan
Todd
West Boreal EcoRegion
306-236-7540

Septage disposal is allowed on land. Best management practices available but not followed. Septage haulers in Meadow Lake area use their 5 or 6 quarter sections of land to spread septage. Cottages dispose of their septage on to land themselves. Their approach is different every year on how they spread or what section of land they use. Field officers available that check land application of septage if complaints are received.

Saskatchewan is aware that septage disposal is becoming a public perception issue, and Saskatchewan might be reviewing their regulations in the near future. Saskatchewan is waiting for Ontario to finalize their regulations and will use Ontario and EPA to refine Saskatchewan's septage disposal regulations.

Other Contacts:

Pat Powers
Chemical Engineer
Operator of Bonny brook/Pine Creek WWTP
March 3, 2004

WWTP has a septage receiving facility, which has a manifest system to monitor septage received from haulers. Haulers are responsible for what they bring in, and are required to report composition and volume of septage. Operators take samples to determine that septage is non-toxic in nature. The facility is concerned with potential toxic nature of septage and mixed industrial waste loads.

Solids from the treatment plant applied on to land in a scientific way. Land application uses GPS system that applies septage uniformly onto land at a controlled rate. Special vehicles called terragators are used for land application, and are able to go across land without damaging soil. Application vehicles are equipped with injectors that inject liquid

beneath the soil surface. Septage is applied onto land with permission from the owner of the land.

EMS OUTLINE

APPENDIX B

ENVIRONMENTAL MANAGEMENT SYSTEM
TABLE OF CONTENTS

BACKGROUND

1 GENERAL

1.1 Environmental Policy

Pollution prevention/ conduct operation in an environmentally responsible manner; free from recognised hazards
Restoration/cleanup of existing environmental perturbances/contamination
Compliance with applicable laws and regulations
Foster conservation and sustainable use

2 PLANNING

2.1 General

Outline of the environmental management system planning process:
identifying environmental aspects, and
legal and other requirements,
establishing objectives and targets, and
establishing environmental management programs.

2.2 Environmental Aspects

Environmental aspects are those elements of an organisation's activities, products or services that can interact with or have an impact upon the environment. For example:

wastewater pre-treatment facilities;
aboveground storage tanks (ASTs), and
underground storage tanks (USTs);
hazardous waste management sites;
sites under investigation/remediation
storm water drainage/collection systems;
wastewater/storm water outfalls;
chemical and hazardous materials storage areas
air emission sources

2.3 Legal and Other Requirements

W5 accountable for maintaining currency with information sources for environmental legal and other requirements.

2.4 Objectives and Targets

Objectives are environmental requirements specifically outlined by environmental regulation and permit.
Targets are designed to drive proactive behaviour to lessen the environmental impact to the installation and surrounding community beyond those stated in the objectives. That is, they are long-term or "big picture" goals.

2.5 Environmental Management Programs

The environmental management programs designate and distribute responsibilities for achieving specific objectives and targets as well as performing specified environmental activities - which are the means for achieving the targets. The programs also identify the time frames within which the objectives and targets are to be achieved or performed. (i.e., SMART **S**pecific, **M**easurable, **A**chievable, **R**esult-oriented, **T**ime-related)

3 IMPLEMENTATION AND OPERATION

3.1 Structure and Responsibility

Delineates respective roles and responsibilities for developing and implementing environmental policy. Plan-Do-Check-Act.

3.2 Training, Awareness, and Competence

Identifies competencies required.
Identifies specific training requirements.
Training plans to ensure maintenance of awareness/competency within program area are updated annually.
Identifies parties responsible for maintaining training plans.
Identifies how training verification will be carried out.

3.3 Communications

W5 for communicating information on environmental matters to interested parties.

3.4 Environmental Documentation

Outline of applicable environmental controls.

3.5 Document Control

W5 for EMS documentation.
Printed controlled documents include a header or footer indicating the life-span of the document. A printed document beyond the life-span date is considered obsolete and should be destroyed.

3.6 Operational Control

Management plans for identified environmental aspects and impacts. These specific plans and procedures outline steps that must be followed to achieve compliance with applicable regulations.

3.7 Emergency Preparedness and Response

W5 for different levels of emergency response training for dealing with hazardous materials, hazardous waste, spill response, etc.

4 CHECKING AND CORRECTIVE ACTION

4.1 Monitoring and Measurement

Methods of monitoring, measurement, recording and reporting of activities that have environmental impacts.

4.2 Non-Conformance and Corrective and Preventive Action

W5 for written record of results of audits and inspections.

4.3 Records

W5 for maintenance of records of policies and procedures related to its EMS, including direction regarding retention periods and disposition of records.

4.4 Environmental Management System Audit

W5, internal vs. external.

5 MANAGEMENT REVIEW

Scope and W5 of review. For example the EMS's suitability, adequacy, and effectiveness and the possible need for changes to the policy, objectives, or other elements of the EMS, maintenance of written record and distribution of the meeting minutes.