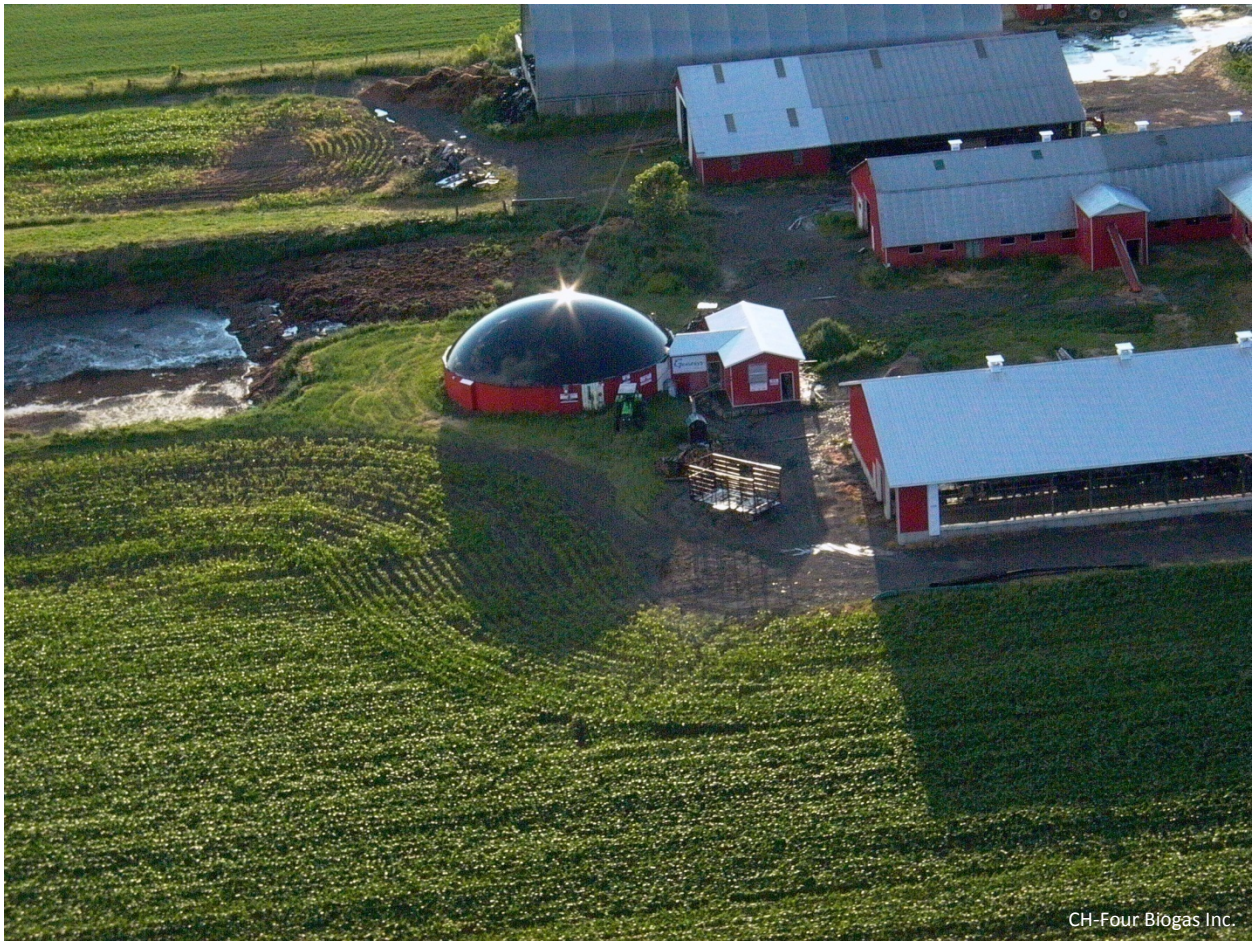
On-farm Anaerobic Digestion
Waste Discharge Authorization Guideline

BC Ministry of Environment

May 14, 2010



Disclaimer

The primary purpose of this document is to provide guidance in the application of the *Environmental Management Act* and Waste Discharge Regulation with regard to on-farm anaerobic digestion.

This is not an exhaustive guide and, where applicable, references to more detailed information are provided. In all cases, review the actual legislation and regulations for exact wording. This information is provided to the user entirely at his or her own risk. The Ministry will not be liable for any claims, damages or losses of any kind arising out of the use of, or reliance upon, this information.

Acknowledgements

The Ministry of Environment acknowledges Electrigaz Technologies Inc. for allowing the use of the technical data contained in the following two reports: Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia and Feasibility Study – Biogas Upgrading and Grid Injection in the Fraser Valley, British Columbia.

Glossary of Terms

AWCR	Agricultural Waste Control Regulation
ALC	Agricultural Land Commission
BC	British Columbia
BCUOMA	BC Used Oil Management Association
BMP	Best Management Practices
C	Celsius
CSA	Canadian Standards Association
CAZ	Controlled Access Zone
CH_4	Methane
CHP	Combined Heat and Power (cogeneration)
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO	Carbon Monoxide
DAF	Dissolved Air Flotation
EFP	Environmental Farm Plan
EMA	Environmental Management Act
EPA	Environmental Protection Agency (United States)
$Fe_2(SO_4)_3$	Iron Sulphate
GHG	Greenhouse Gas
GJ	Gigajoule
ha	Hectare
H_2S	Hydrogen Sulphide
H_2SO_4	Sulphuric Acid
K	Potassium
KI	Potassium iodine
kW	Kilowatt
LWMP	Liquid Waste Management Plan
MAL	Ministry of Agriculture and Lands
µg	Micrograms
mg/nm^3	Milligrams per Normal Cubic Metre
MOE	Ministry of Environment
MPN	Most Probable Number
MSW	Municipal Solid Waste
MW	Megawatt
N_2	Nitrogen
NaOH	Sodium Hydroxide
NH_3	Ammonia
NH_4	Ammonium
NO_3	Nitrate
NOx	Nitrogen Oxides
NMVOC	Non-methane volatile organic compound
OC	Operational Certificate

OMRR	Organic Matter Recycling Regulation
PM	Particulate Matter
ppm	Parts Per Million
PSA	Pressure Swing Adsorption
QP	Qualified Professional
SOx	Sulphur Oxides
SRM	Specified Risk Material
SWMP	Solid Waste Management Plan
THV	Total Heating Value
TKN	Total Kjeldahl Nitrogen
VOC	Volatile Organic Compound
WDR	Waste Discharge Regulation
UASB	Upflow Anaerobic Sludge Blanket

Executive Summary

Purpose of the Guideline

The Ministry of Environment, in conjunction with the Ministry of Agriculture and Lands, has developed this guideline to assist on-farm anaerobic digestion proponents in applying for a waste discharge authorization under the *Environmental Management Act* and Waste Discharge Regulation. The guideline includes an introduction to the anaerobic digestion technology, the waste discharge authorization (permitting) process, and guidance on the waste streams to be identified in the application package. The guideline also provides a list of acceptable feedstocks for on-farm anaerobic digestion and recommendations for nutrient management planning, sampling, analysis and best management practices. In addition to a Ministry of Environment waste discharge authorization, on-farm anaerobic digestion facilities may also require authorization from local governments and the Agricultural Land Commission, if located within the Agricultural Land Reserve. These additional processes are briefly outlined in the guideline.

What is Anaerobic Digestion?

Anaerobic digestion is the biological process by which organic matter (e.g., manure), is broken down in the absence of oxygen, producing raw biogas and other by-products. The raw biogas is most commonly used to generate electricity through cogeneration or upgraded to natural gas. Other benefits of anaerobic digestion include reductions in manure-related odours, pathogens, and greenhouse gas (GHG) emissions. The process also produces by-products (liquid and solid digestate), which can be utilized on the farm or further processed (e.g., composted), and sold as an additional revenue source for the farm.

Waste Discharge Authorization Types

As biogas production from anaerobic digestion facilities may involve numerous waste streams and different process technologies, a site specific waste discharge authorization from the Ministry of Environment is required for most projects. The following is an overview of the three most common waste discharge authorization types pertaining to anaerobic digestion:

- **Solid or Liquid Waste Management Plan and subsequent Operational Certificate** - for facilities using mixed feedstock (agricultural and non-agricultural waste) or non-agricultural waste exclusively, and in an area that requires amendment to the local government's solid or liquid waste management plan.

- **Permit** - for facilities using mixed feedstock (agricultural and non-agricultural waste) or non-agricultural waste exclusively and in an area that *does not* require amendment to the solid or liquid waste management plan.

- **Agricultural Waste Control Regulation** - for facilities using 100% agricultural waste feedstock (defined as manure, used mushroom medium and agricultural vegetation waste).

How to Obtain a Waste Discharge Authorization

In addition to providing information on the different types of waste discharge authorizations (regulation, waste management plan or permit), the guideline also provides information on the process involved in obtaining the waste discharge authorization and the documentation required for submission. This includes guidance on preparing the Consultation and Technical Assessment Reports. The Technical Assessment Report must describe all aspects of waste discharged to the environment from the facility. To aid in the preparation of this report, typical anaerobic digestion facility waste discharges have been identified, e.g., emissions from the biogas cleaning and upgrading equipment, co-generation, boilers, flares, etc. A summary checklist of the project details to include in the Technical Assessment Report is included in the appendices to the guideline and are summarized at the end of each chapter.

Acceptable Feedstocks

The Ministry has established a list of acceptable feedstocks for the purposes of on-farm anaerobic digestion. The items in the list have been evaluated for their appropriateness in an on-farm anaerobic digester and their placement within Schedule A, B or C provides increased safeguards for the protection of the environment and human health, as well as on-farm biosecurity. The feedstock list is provided in Appendix 1 and is divided into three schedules:

- **Schedule A:** Acceptable (acceptable "as is" for digestion),
- **Schedule B:** Limited (requires pasteurization, e.g., 70^{o} C for 1 hour), and
- **Schedule C:** Unacceptable (prohibited material, such as hazardous waste).

Digestate Land Application Requirements

The use of different feedstock material and the volume of non-agricultural waste feedstock imported onto the farm affect the feedstock testing and digestate land application requirements for an on-farm anaerobic digestion facility. Three tiers of anaerobic digestion facilities have been established based on these parameters, as follows:

- **Tier 1:** On-farm anaerobic digestion facility using 100% agricultural waste.
  Requirements: Follow the provisions of the Agricultural Waste Control Regulation, practice due diligence and adhere to best management practices.

- **Tier 2:** On-farm anaerobic digestion facility importing up to 25% non-agricultural waste.
  Requirements: Sample the imported, non-agricultural feedstock for heavy metals,

develop a Nutrient Management Plan (NMP), and follow the Tier 2 provisions for nutrient sampling, analysis, and digestate land application.

- **Tier 3:** On-farm anaerobic digestion facility importing more than 25% non-agricultural waste. *Requirements:* Sample the imported, non-agricultural feedstock for heavy metals, develop a Nutrient Management Plan, and follow the Tier 3 provisions for nutrient and pathogen sampling, analysis, and digestate land application.

The flowchart on the following page provides a summary of the facility categorization, feedstock pre-treatment requirements, and digestate management requirements.

Best Management Practices

Best management practices (BMPs) and monitoring and reporting requirements are outlined in the final chapters of the guideline. These include recommended BMPs for feedstock collection, handling, and storage, as well as recommendations for digestate storage, and strategies for the reduction of odours and fugitive dust.

On-farm Anaerobic Digestion Quick Start Guide

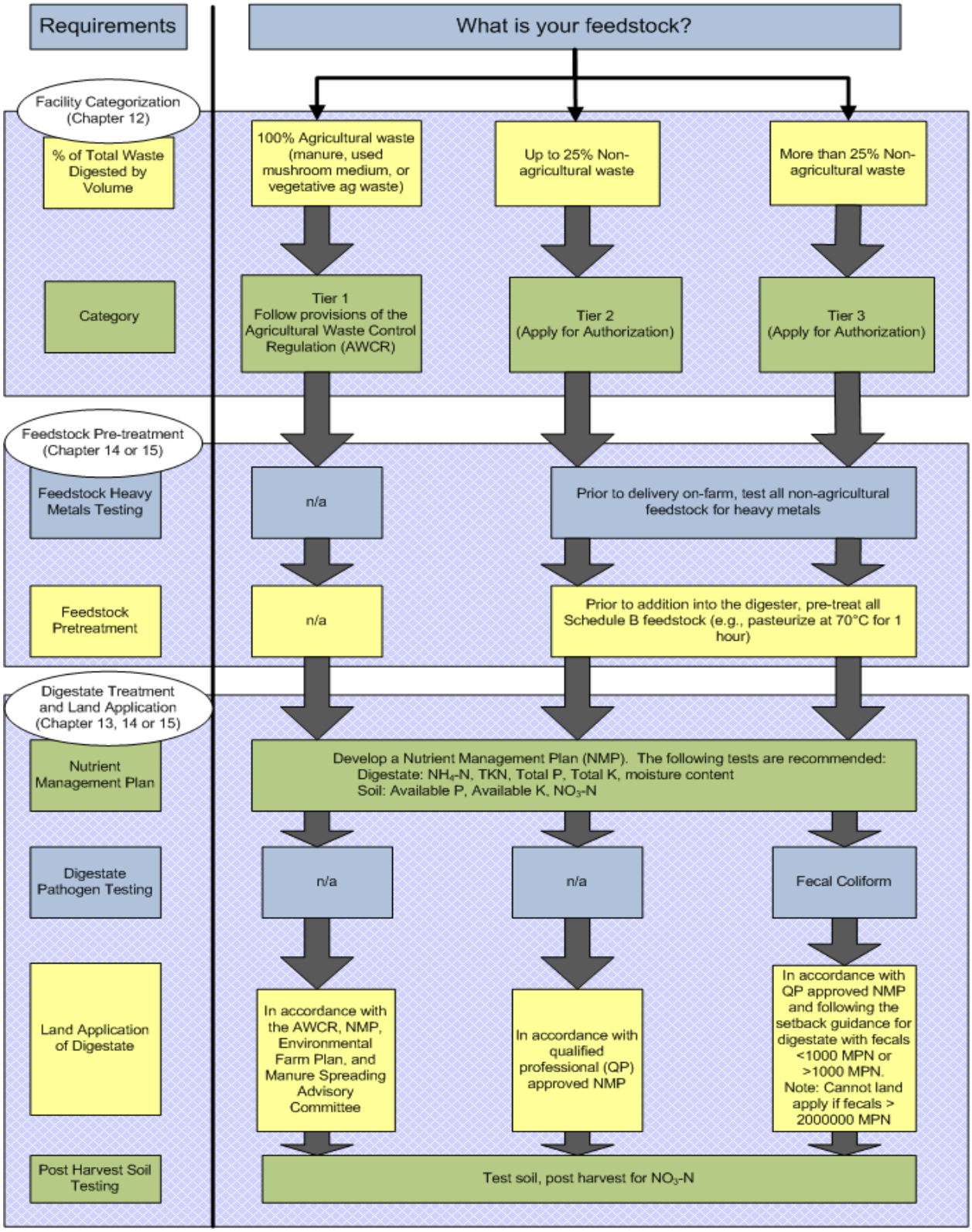


Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Anaerobic digestion is a biological process that can yield a variety of benefits. Although on-farm anaerobic digesters are common in other jurisdictions, this industry is in the initial phase of development in British Columbia (BC). The Ministry of Environment (MOE) has written this guideline to assist the increasing number of agricultural operators in BC that have expressed a strong interest in building anaerobic digestion facilities.

This guideline provides an overview of the current MOE regulatory framework, including an introduction to the *Environmental Management Act*, Waste Discharge Regulation, Agricultural Waste Control Regulation, and Organic Matter Recycling Regulation. Guidance is also provided on acceptable feedstocks, nutrient management planning, waste discharges and best management practices.

1.1 Who this Guideline is For

This guideline is intended for proponents of on-farm anaerobic digestion projects. If your project is not located on a farm, this guideline may be used to provide a general overview of the approval process and assist in identifying waste streams from the facility.

1.2 What is Anaerobic Digestion

Anaerobic digestion is the process by which organic matter (e.g., manure) is broken down in the absence of oxygen, producing biogas and other by-products. The process generally requires a 15 to 40 day in-tank retention time with temperatures ranging from 35 to 55^{o} C, depending on the process. The technology has been shown to reduce odours and pathogens by over 90%; however, while nitrogen availability increases, the nutrient content and total volume of material are not significantly reduced. The raw biogas is most commonly used to generate electricity through cogeneration or upgraded to natural gas. On average, raw biogas contains 60% methane and 40% carbon dioxide. In order to meet the natural gas grid injection standards, the carbon dioxide must be removed and a concentration of approximately 96% methane obtained.

1.3 Benefits of Anaerobic Digestion

Anaerobic digestion is a technology which can both produce renewable natural energy and also more effectively manage manure. Other benefits include the reduction of odours, pathogens, weed seeds and greenhouse gas (GHG) emissions.

The process also produces by-products (liquid and solid digestate) which can be an additional revenue source for the farm. The digestate can be used as fertilizer, animal bedding or further processed and sold, e.g., as compost.

On-farm anaerobic digesters may also be eligible to generate and sell carbon offsets. Carbon offsets are generated when a person voluntarily undertakes a project or action that reduces the amount of GHG emissions entering the atmosphere, prevents GHG emissions from entering the atmosphere, or increases the amount of GHG emissions being taken out of the atmosphere. Anaerobic digestion projects can reduce emissions in two ways, by combusting captured methane gas from organics into the less potent carbon dioxide gas, or by displacing fossil-fuel natural gas consumption through the utilization of biogas or biomethane.

Legitimate carbon offsets can be sold to either non-regulated voluntary consumers, or to regulated entities that are legally mandated to reduce their GHG emissions, such as the BC Provincial Government through the Pacific Carbon Trust. In order to be sold on a particular carbon market, carbon offsets must meet certain market-specific eligibility requirements. The Emissions Offset Regulation, under the *BC Greenhouse Gas Reduction Targets Act,* defines requirements for carbon offsets being bought by the Pacific Carbon Trust. More information on selling carbon offsets to the Pacific Carbon Trust is provided in the guidance document available at:
http://www.pacificcarbontrust.ca/Publications/PCTGuidanceBooklet/tabid/158/Default.aspx.

1.4 Types of Anaerobic Digesters

The actual process of producing biogas through anaerobic digestion can be carried out in several different ways. The two main features that differentiate one type from another are physical digester configuration and choice of process temperature.

The physical configuration of the digester affects biogas production efficiency, retention time and homogeneity of feedstock. Digesters are often divided into complete mix systems, plug flow systems, fixed film systems, upflow anaerobic sludge blanket (UASB), covered lagoon or vertical/horizontal dry digesters. The most likely systems for on-farm application in BC are complete mix and plug flow. For more information on the different digester types and their respective attributes refer to Appendix C of the report "Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia"[1].

[1]Appendix C:
http://www.bcic.ca/images/stories/publications/lifesciences/feasibility_study_anaerobic_appendices.pdf

1.5 Process Temperatures

The process temperatures are usually categorized as mesophilic digestion at temperatures near 37^{o} C and thermophilic digestion, which occurs at approximately 55^{o} C. For very cold climates there are also companies that provide systems for psycrophilic digestion at temperatures below 25^{o} C, but these systems are not common and would likely not be prevalent in BC. Thermophilic digestion results in better pathogen control and higher rates of biogas production but is more complex and harder to control. Mesophilic digestion is the most common type for on-farm application. It provides a highly stable process that requires relatively low maintenance while at the same time resulting in some pathogen control and reasonable biogas production.

1.6 Microbiological Decomposition of Organic Compounds to Biogas

In the biogas process, organic molecules (proteins, fats and sugars) are successively broken down to methane and carbon dioxide, i.e., biogas. The process only works effectively in the presence of several different groups of microorganisms. In order for methane to be the main final product, the various kinds of microbes must cooperate in a specific pattern. A biogas plant is operated in such a way that nutrient availability (choice of feedstock combination) and internal digester environment (pH, digester temperature, ammonia concentration, etc.) favour the species of microbes and the cooperative pattern that maximizes the methane yield. Although the process is fairly robust, it is very important that the delicately balanced conditions are kept stable to achieve the best possible methane production. Frequent and/or substantial changes to important conditions, such as the feedstock composition, are detrimental to biogas production, and by extension, counterproductive to the economic viability of the operation. A simplified process description of the step-wise decomposition is provided in Figure 1.

Full Report: http://www.bcic.ca/images/stories/publications/lifesciences/feasibility_study_anaerobic.pdf

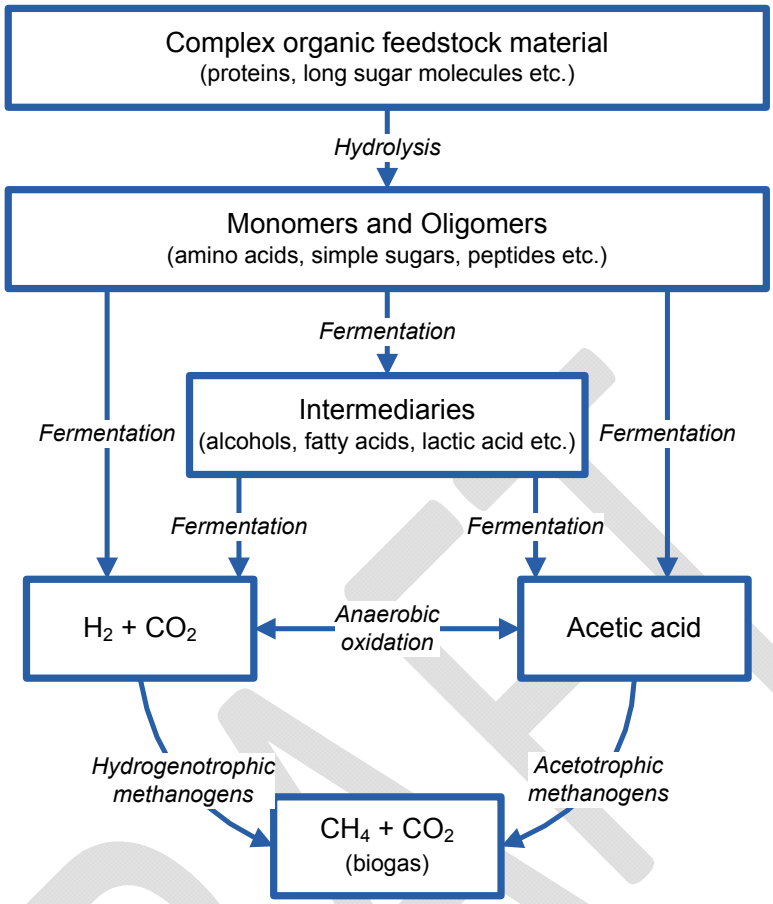


Figure 1. Simplified Process Description of Step-wise Decomposition of Complex Organic Molecules to Biogas

Chapter 2: Overview of Approval Process

2.1 Ministry of Environment Waste Discharge Authorization

Proponents of an on-farm anaerobic digestion project will require a Ministry of Environment (MOE), waste discharge authorization. In most cases the authorization will be one of the following three types:

- solid or liquid waste management plan and subsequent operational certificate,
- permit, or
- Agricultural Waste Control Regulation (AWCR).

Further information on the type of waste discharge authorization required is provided in Chapter 3. Information on how to obtain the authorization is provided in Chapter 4.

2.2 Waste Streams to Identify in the Authorization Application

In order to obtain the necessary waste discharge authorization, a detailed technical assessment of all waste discharges from the facility should be conducted. Guidance on typical waste discharges from an anaerobic digestion project is provided in Chapters 5 through 10.

2.3 Feedstocks

MOE has established a list of acceptable feedstocks for an on-farm anaerobic digestion project. This list is provided in Chapter 11 and divided as follows:

- **Schedule A:** Acceptable (acceptable "as is" for digestion),
- **Schedule B:** Limited (requires pasteurization, e.g., 70^{o} C for 1 hour), and
- **Schedule C:** Unacceptable (prohibited material).

2.4 Digestate Management

MOE has recommended standards for the land application of material (digestate) coming out of the digester. The standards vary, depending on the feedstock utilized. Three tiers of anaerobic digestion facilities have been established as follows:

Tier 1: On-farm anaerobic digestion facility using 100% agricultural waste.
Tier 2: On-farm anaerobic digestion facility importing up to 25% non-agricultural waste.
Tier 3: On-farm anaerobic digestion facility importing more than 25% non-agricultural waste.

The recommendations include an analysis for heavy metals, nutrients and pathogens as well as developing a Nutrient Management Plan. Further information is provided in Chapters 12 through 15.

Figure 2 summarizes the MOE requirements for an on-farm anaerobic digestion facility.

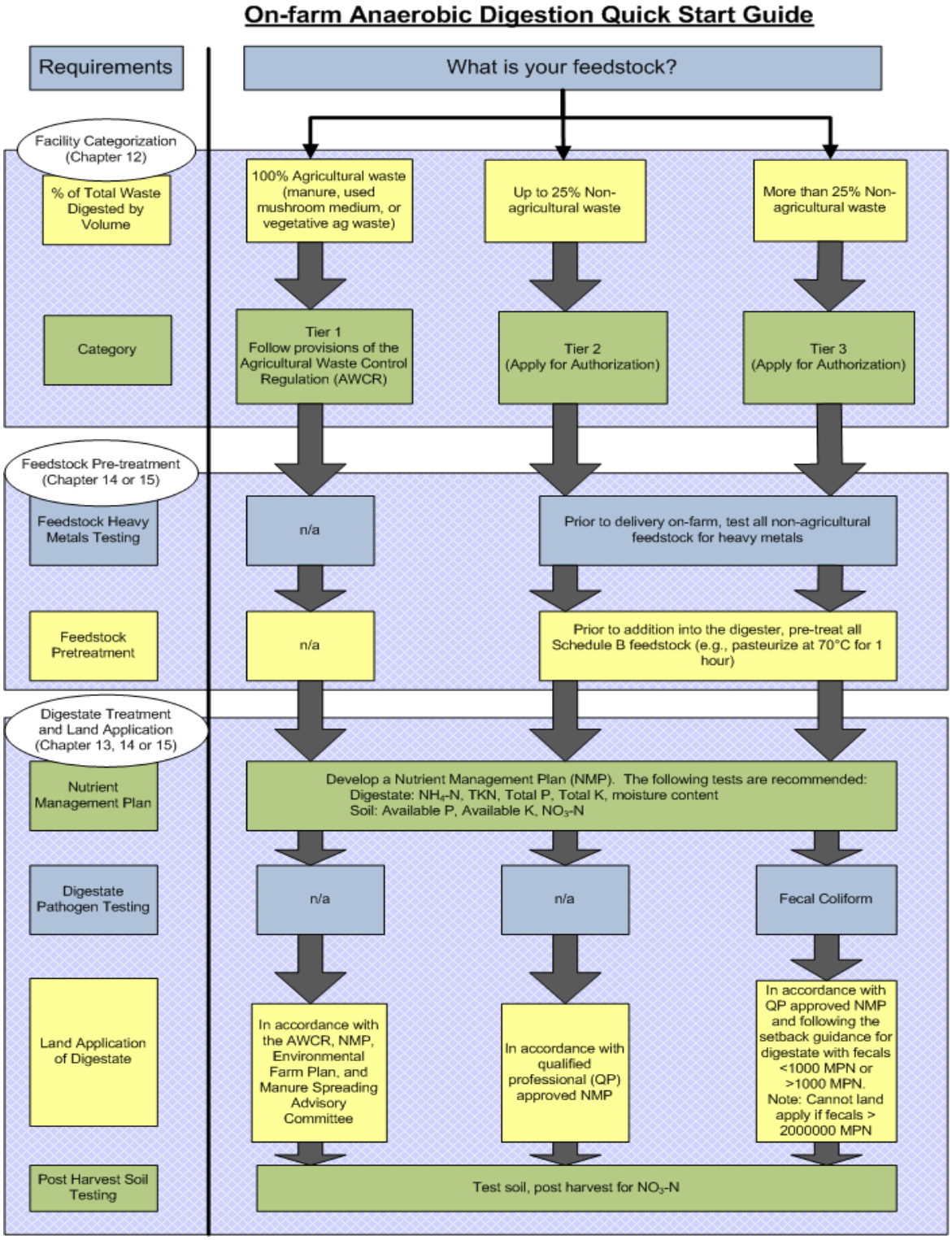


Figure 2. On-farm Anaerobic Digestion Quick Start Guide

2.5 Listing of Regulatory Agencies

Prior to the initiation of an on-farm anaerobic digestion project, all regulatory agencies should be consulted. These may include:

- **Agricultural Land Commission (ALC)** www.alc.gov.bc.ca

If the proposed facility is located within the Agricultural Land Reserve (ALR), contact the ALC to determine if an application is required. If an application for permission to carry out a Non-Farm Use in the ALR is necessary, an application must be submitted to the local government. Once the local government has reviewed and considered the application and authorized it to proceed to the ALC with comments and a recommendation, it will be decided upon by the ALC, following which the proponent will be notified regarding the outcome of the ALC's review process.

- **Local Government** www.civicnet.bc.ca/EN/main/about/ubcm-members.html

Contact the local government to enquire if an amendment to the solid or liquid waste management plan is required. Apply for an amendment to the waste management plan as directed by the local government.

- **Municipality** www.civicnet.bc.ca/EN/main/about/ubcm-members.html

Contact the municipality to enquire if there are any applicable bylaws or if amendment to current agricultural zoning is required. Apply for a zoning amendment as directed by the municipality. In addition, apply for any necessary building permits and business licenses. If discharging to municipal sewer or landfill, obtain the necessary approvals.

- **Ministry of Environment (MOE)**, Regional Operations Branch www.env.gov.bc.ca/main/regions.html

Contact the regional MOE office and enquire if an operational certificate (OC) is required as part of a waste management plan. If an OC is not required, a waste discharge authorization (e.g., permit) is required. Apply for the appropriate authorization as directed by MOE.

- **Environmental Assessment Office (EAO)** www.eao.gov.bc.ca

The EAO conducts the assessment of proposed major projects in BC, as required under the *Environmental Assessment Act*. The *Reviewable Projects Regulation* identifies the types of projects that trigger an environmental assessment. The thresholds for energy and waste projects may be relevant to very large scale anaerobic digestion facilities. When a proponent considers developing a large scale project in BC, they should first contact the EAO to discuss how the *Environmental Assessment Act* may apply to their project.

A flowchart representing the regulatory process is provided in Figure 3.

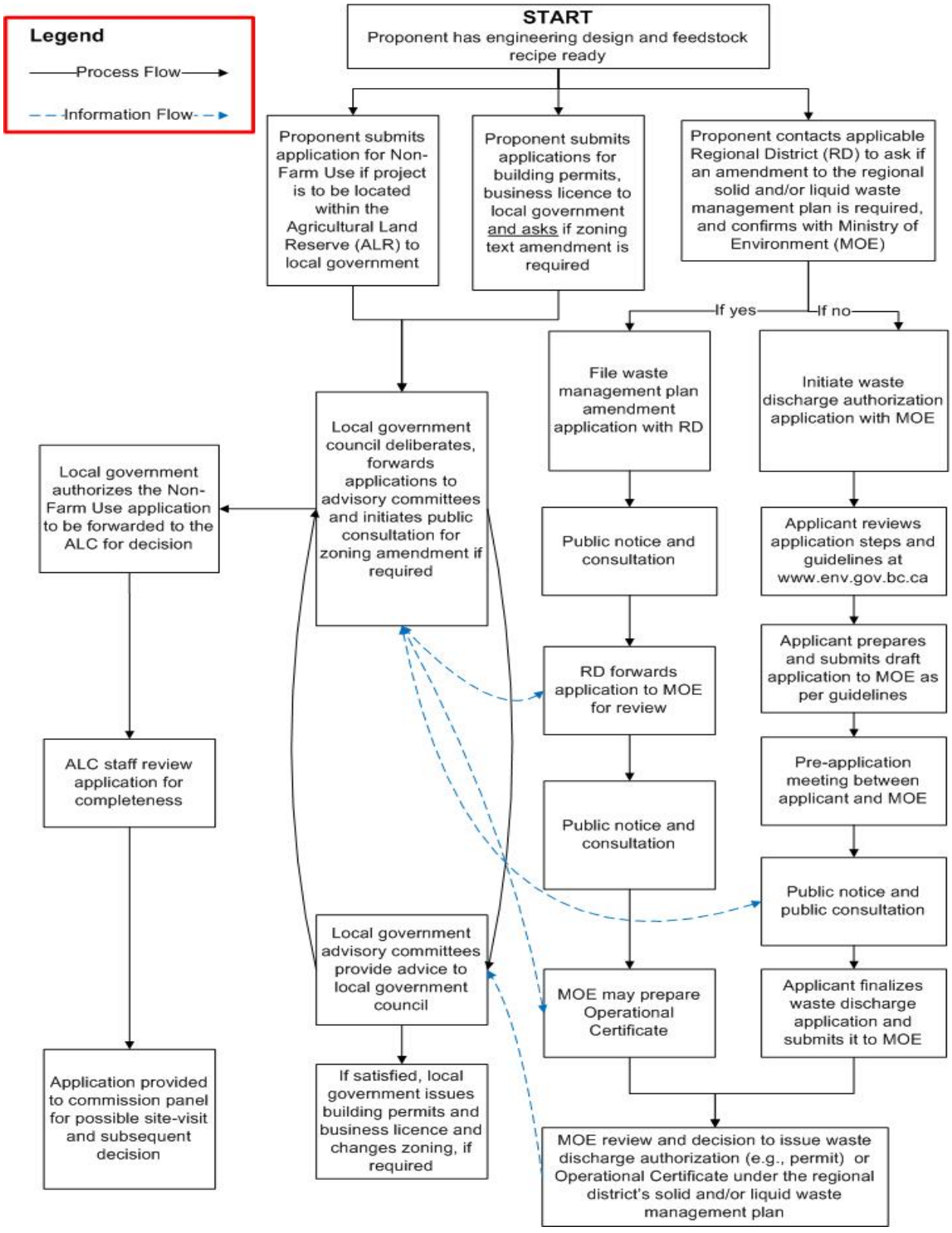


Figure 3. Flowchart of the Regulatory Approval Process

Chapter 3: MOE Regulatory Framework for Waste Discharge Authorizations

3.1 Environmental Management Act

The *Environmental Management Act* (EMA) requires waste discharge authorizations to protect human health and the environment. Section 6 of the Act states a person must not allow waste to be introduced into the environment in the course of conducting a prescribed industry, trade, business, activity or operation without an authorization.

3.2 Waste Discharge Regulation

The Waste Discharge Regulation (WDR) under EMA lists, in Schedules 1 and 2, the prescribed industries, trades, businesses, activities, and operations which require a waste discharge authorization. If an activity is not listed in Schedule 1 or 2 of WDR, then the provision in EMA section 6 (4) prevails, which prohibits the introduction of waste to the environment in such a manner or quantity as to cause pollution. Anaerobic digestion is prescribed as an activity under various classifications in WDR. The specific classification (e.g., agricultural operation, municipal solid waste management, electrical power industry, etc.), depends on the feedstock, process, and products produced at the facility. Further details on the WDR classifications are provided in Table 1.

3.3 Waste Discharge Authorizations

Waste discharge authorizations may be in the form of permits, approvals (for a maximum timeframe of 15 months), orders, regulations, plans (solid and/or liquid waste management plans), or codes of practice (minister's regulations). As anaerobic digestion facilities may involve numerous waste streams and different process technologies, a site specific waste discharge authorization will be required in most situations. The potential environmental impacts and associated risks to human health at each site must be considered prior to the issuance of the waste discharge authorization.

The following is an overview of the three most common waste discharge authorization types that pertain to an anaerobic digestion facility:

A Waste Discharge Authorization Type – Solid or Liquid Waste Management Plan Subsequent Operational Certificate

This authorization is for facilities using mixed feedstock (agricultural and non-agricultural waste) or non-agricultural waste exclusively, and the facility is required to be authorized under the local government's solid or liquid waste management plan (SWMP/LWMP).

To obtain this authorization, an amendment to the SWMP/LWMP may be required. Proponents are advised to contact the local government and regional Ministry of Environment office at the beginning of the project planning phase to determine if an amendment is required. If inclusion of the facility in the SWMP/LWMP is required, the ministry may issue an operational certificate detailing the site-specific requirements to be met. If the facility is not required to be included in the SWMP/LWMP, a Ministry of Environment waste discharge permit is required.

B Waste Discharge Authorization Type - Permit

This authorization is for:

(i) facilities where the establishment is accepting mixed feedstock (agricultural and non-agricultural waste) or non-agricultural waste exclusively and the facility is not required to be authorized under the local government's SWMP/LWMP, or

(ii) anaerobic digestion facilities that utilize biogas to produce electricity that have a rated production of more than 5 megawatts under peak load.

For further details on applying for a waste discharge permit see Chapter 4 of this guideline.

C Waste Discharge Authorization Type - Agricultural Waste Control Regulation (AWCR)

This authorization is for facilities located on a farm and using 100% agricultural waste. Agricultural waste is defined in the AWCR as including manure, used mushroom medium, and agricultural vegetation waste. In this situation the anaerobic digestion proponent must follow the provisions of the AWCR and a permit is not required. In addition to meeting the requirements of the AWCR, it is intended that the proponent practice due diligence and adhere to the best management practices as laid out in this guideline, e.g., develop and follow an approved Nutrient Management Plan.

Note: Management of slaughter wastes is not authorized by the AWCR. A site specific waste discharge authorization is required to authorize the use of slaughter wastes in an anaerobic digester.

Under the AWCR:

- agricultural waste may originate elsewhere and be transported to the farm for use in the digester,
- liquid and solid fractions of the digestate may be composted or used as a fertilizer or soil conditioner on the farm and applied in accordance with the AWCR,

- digestate composted for sale or for distribution off the farm or sold as a fertilizer, etc., must meet the requirements of applicable laws and regulations (e.g., Organic Matter Recycling Regulation, federal *Fertilizers Act* and Regulations).

For further information, a copy of the AWCR can be downloaded from the following webpage: www.bclaws.ca.

Table 1 summarizes the feedstocks that correspond with each waste discharge authorization type (permit, waste management plan and subsequent operational certificate, or regulation).

Table 1: Waste Discharge Authorization and Applicable Feedstocks

Feedstock	Scenario	Authorization Type	Categorization in the Waste Discharge Regulation
Non-agricultural waste exclusively or non-agricultural waste mixed with agricultural waste.	This categorization applies to facilities digesting non-agricultural waste or co-digesting non-agricultural waste with agricultural waste and the facility is not required to be authorized by a SWMP/LWMP.	Permit	**Commercial Waste Management or Waste Disposal Industry (WDR Schedule 1)** This means establishments primarily engaged in the commercial collection, handling, storage, treatment, destruction or disposal of waste soil, solids or liquids.
Any feedstock	This categorization is an option for facilities producing more than 5 MW of electricity and not required to be authorized by a SWMP/LWMP.	Permit	**Electrical Power Industry (WDR Schedule 1)** This means establishments that (a) are engaged in the production of electricity by the combustion of fuel, and (b) have a rated production of more than 5 MW under peak load.

Feedstock	Scenario	Authorization Type	Categorization in the Waste Discharge Regulation
Non-agricultural wastes exclusively or non-agricultural waste mixed with agricultural waste.	This categorization applies to facilities digesting non-agricultural waste or co-digesting non-agricultural waste with agricultural waste and the facility is required to be authorized via the local government's SWMP/LWMP.	Solid or liquid waste management plan and subsequent operational certificate issued by MOE. May require amendment to the SWMP/LWMP.	**Municipal Solid Waste Management (WDR Sch 1)** This means activities and operations for the management, treatment or discharge of refuse that (a) originates from residential, commercial, institutional, demolition, land clearing or construction sources, or (b) is included in a waste management plan.
Agricultural waste only, as defined in the Agricultural Waste Control Regulation (includes manure, used mushroom medium, and agricultural vegetation waste).	This categorization applies to facilities digesting 100% agricultural waste. The digestate may be used on that farm or sold off-farm (following applicable laws and regulations). The farm must be classified as a farm by the *Assessment Act.*	Agricultural Waste Control Regulation (AWCR) *Note:* It is expected that in addition to following the requirements in the AWCR, proponents will also practice due diligence and follow the recommended BMPs set out in this guideline.	**Agricultural Operations (WDR Schedule 2)** This means operations or activities carried out on farms for purposes of agriculture, including, but not limited to, (a) producing or keeping livestock, poultry, farmed game, fur bearing animals, crops, grain, vegetables, milk, eggs, honey, mushrooms, horticultural products, trees, tree fruits or berries, and (b) operating machinery and equipment for agricultural waste management or for applying fertilizers and soil conditioners.

Chapter 4: How to obtain a Ministry of Environment Waste Discharge Authorization

4.1 Summary of Initial Information to Submit to MOE

Anaerobic digestion proponents are advised to consult with the Ministry of Environment (MOE) regional office to confirm the type of waste discharge authorization required. For MOE regional office contact information, see the following website: http://www.env.gov.bc.ca/main/regions.html.

In order to determine the waste discharge authorization type, ministry staff will require a general overview of the project. Providing the following information is recommended:

1) Location of digester (e.g., address, whether or not property is in the ALR, or considered a farm under the *Assessment Act*).
2) Detailed feedstock summary and maximum anticipated tonnes and/or volumes (e.g., dairy manure, whey, grocery store organic waste).
3) Anaerobic digestion technology provider and type of digester.
4) Proposed use of the biogas (e.g., electricity production or biogas upgrading, a brief description of equipment/technology, and if there are plans to sell the power to a utility and/or use on-site).
5) Proposed use of the solid and liquid portions of the digestate (e.g., used on-site as a soil amendment, fertilizer, or animal bedding, and/or if there are plans to sell it).
6) Other relevant project documents, publications, pamphlets.

With this information, ministry staff will advise the proponent which type of waste discharge authorization is required. If it is determined the facility is required to be included in the local government's solid or liquid waste management plan, the proponent should follow the direction provided by the local government. Once the facility is included in the waste management plan, the ministry may issue the facility an operational certificate (OC). The OC will detail the site specific requirements for the operation. If it is determined the facility is not required to be included in the solid or liquid waste management plan, the proponent should apply to the ministry for a waste discharge authorization (permit), unless authorized by the AWCR.

4.2 How to Obtain a Waste Discharge Authorization

MOE has developed a comprehensive website detailing the waste discharge authorization application process at: http://www.env.gov.bc.ca/epd/waste_discharge_auth/intro.htm. This website contains an introduction and overview of the application process, application forms, and guidance documents. The guidance documents provide further information on how to complete the application forms, conduct the public consultation process, and how to prepare

the Consultation Report and Technical Assessment Report. Proponents are advised to review the above website and undertake certain activities prior to the formal submission of the application. These activities include:

- attending a pre-application meeting with ministry staff;
- consultation with the public, agencies, and stakeholders; and
- preparing a Technical Assessment Report, completed by a qualified professional, of the potential for any discharges to impact human health and the environment (if required - discuss with MOE regional office).

4.3 The Five Steps of the Waste Discharge Authorization Application Process

There are five steps in the waste discharge authorization application process:

1. Pre-Application
2. Preparation of Application
3. Application
4. Ministry Review
5. Decision

Table 2 describes in detail, the five steps of the waste discharge authorization application process.

Table 2: Waste Discharge Authorization Application Process

Stage	Activity	
1. Pre-Application	**A. Applicant –** review of authorization process	**Applicant:** • reviews Ministry of Environment process/guidance documents on ministry internet website • reviews regulatory requirements that pertain to application
	B. Applicant – preparation of draft application documents	**Applicant:** • completes draft application documents: - application form - terms of reference for Technical Assessment Report, if aware that it is applicable - public and agency consultation plan - Environmental Protection Notice • submits draft application documents to Ministry of Environment
	C. Ministry of Environment & Applicant – pre-application meeting	**Ministry of Environment:** • arranges a pre-application meeting with the applicant **Ministry of Environment & Applicant:** • meet for review of scope and detail of draft

Stage	Activity	
		application documents (as referenced in B above) • confirm whether Technical Assessment Report is required • discuss circulation, posting and publishing requirements
2. Preparation of Application	**A. Applicant** • preparation of application • consultation	**Applicant:** • based on pre-application meeting with Ministry of Environment, modifies draft application documents as necessary: • prepares draft version of Technical Assessment Report and submits the report to the Ministry of Environment • posts Environmental Protection Notice at the site • publishes notice in newspapers and the BC Gazette according to the Public Notification Regulation • circulates the modified draft application form and Environmental Protection Notice to First Nations and agencies • makes draft Technical Assessment Report available to agencies, First Nations and the public • consults with First Nations and the public according to the consultation plan, and responds to information requests and public, First Nations and agency comments • *Note:* It is recognized that consultation may not be completed at this point
	B. Applicant – finalization of application	**Applicant:** • prepares Consultation Report; and, in consideration of consultation • prepares final application form • prepares final Technical Assessment Report
3. Application	**A. Applicant –** submission of application	**Applicant:** • submits to the Ministry of Environment ➢ final application form ➢ final Technical Assessment Report ➢ Consultation Report • submits application fee according to the Permit Fees Regulation
4. Ministry Review	**A. Ministry of Environment –** review of application	**Ministry of Environment staff:** • reviews application form, Technical Assessment Report and Consultation Report • if considered acceptable, prepares draft authorization with conditions necessary to protect the environment for applicant's review • *Note:* Significant changes may require repeated notification and publishing and/or consultation.

Stage	Activity	
	B. Applicant – review of draft recommendations	**Applicant:** • reviews draft recommendations including draft authorization • provides comment to Ministry of Environment
5. Decision	**A. Ministry of Environment –** decision on application	**Ministry of Environment staff:** • provides recommendations including draft authorization, if applicable, for Director's decision **Director:** • makes a decision on the application.

4.4 Application Forms

The following website provides copies of the waste discharge authorization application forms available for downloading: http://www.env.gov.bc.ca/epd/waste_discharge_auth/app_forms/index.htm. The Ministry has also prepared a document titled *Guidance on Applications for Authorizations under the Environmental Management Act – Completing an Application Form* which provides detailed information on how to fill out each form. This document is available for download at: http://www.env.gov.bc.ca/epd/waste_discharge_auth/guidance/pdf/applications.pdf.

It is highly recommended that proponents review the above linked website and guidance document for detailed information on how to fill out the application forms.

4.5 Consultation Report

All waste discharge authorization applicants must prepare a Consultation Report. Detailed information on the requirements of the Consultation Report is provided in the consultation guidance document titled *Guidance on Applications for Authorizations Under the Environmental Management Act - Consultation* which is available for download at: http://www.env.gov.bc.ca/epd/waste_discharge_auth/guidance/pdf/consultation.pdf.

Highlights of the consultation process include:

- informing the public, agencies, First Nations, and stakeholders of the project details
- notification by posting the Part 2a or 2b Environmental Protection Notice at the site, and in one local newspaper
- providing a 30 day comment period
- notifying the municipality, property owner, and/or regional district
- publishing the application in the BC Gazette I

4.6 Technical Assessment Report

The MOE Regional Manager will indicate to the applicant during the pre-application meeting whether or not a Technical Assessment Report will be required. In most cases it will be a requirement for an anaerobic digestion facility. Part 3 Discharge Details and Part 4 Receiving Environment are to be included as part of the report. Applicants who must complete a Technical Assessment Report should refer to the following guidance document for further information *Guidance on Applications for Permits under the Environmental Management Act - Technical Assessment* which is available for download at: http://www.env.gov.bc.ca/epd/waste_discharge_auth/guidance/pdf/assessment.pdf.

This document outlines the requirements of the Technical Assessment Report and provides a suggested structure of the report as follows:

1. Executive Summary
2. Table of Contents
3. Introduction
4. Project Description
    - Project history
    - Overview
    - Proposed phases
    - Operational system
        - Inputs
        - Non-product outputs
    - Management Systems (odour reduction strategy, odour complaint response plan, and Nutrient Management Plan)
5. Discharges and Treatment
6. Receiving Environment
7. Assessment
8. Proposed Monitoring

Draft terms of reference for the report should be presented to ministry staff for review prior to preparing the report to ensure all information is included. The Technical Assessment Report must be completed by a qualified professional (QP), (see the next section for the definition of QP).

For further clarity and to assist proponents in preparing an anaerobic digestion waste discharge authorization application package, a comprehensive checklist of items to include is provided in Appendix 2.

Tip: Throughout this guideline the information that should be included in the Technical Assessment Report and waste discharge authorization application is highlighted in a grey box.

4.7 Qualified Professional

A qualified professional (QP) will be required to approve and sign off on many project related documents. These may include the Technical Assessment Report submitted during the permit application process or the Nutrient Management Plan required for digestate management.

A qualified professional is generally defined as:

> In relation to a duty or function, an individual who
>
> (a) is registered in British Columbia with a professional organization, is acting under that organization's code of ethics, and is subject to disciplinary action by that organization, and
>
> (b) through suitable education, experience, accreditation and knowledge, may reasonably be relied on to provide advice within his or her area of expertise, which area of expertise is applicable to the duty or function.

QPs must satisfy both criteria, (a) and (b). Examples of professional organizations include:

- B.C. Institute of Agrologists
- Association of Professional Engineers and Geoscientists of BC
- Applied Science Technologists & Technicians of British Columbia

Further information on how to find a QP is provided here:
http://www.env.gov.bc.ca/epd/waste_discharge_auth/bc_contacts.htm

Chapter 5: Overview of Waste Discharges to Identify in the Application

Many components of an on-farm anaerobic digestion project will have waste discharges. Waste discharges are categorized as solid waste discharges, effluent, or air emissions. Waste discharged to the environment (e.g., directly to land, water, or air) requires authorization from the Ministry of Environment.

Most of the waste discharges from an on-farm anaerobic digestion project can be managed to avoid direct discharges to the environment. For example, effluent discharged to a sewer system (and subsequently treated at a wastewater treatment plant), or solid waste disposed of at an authorized landfill. Some waste discharges (e.g., the air emissions from biogas combustion) cannot be completely eliminated through management. However, they can be mitigated through treatment (e.g., installation of pollution control devices). In a waste discharge authorization application, it is important to identify and quantify all waste discharges to the environment and describe what actions will be taken to manage those discharges.

As there are numerous anaerobic digestion technology design options, this chapter provides an overview of the most common waste discharges found at an on-farm anaerobic digestion facility. The first phase of the anaerobic digestion process is feedstock management which involves unloading the feedstock and preparing it for digestion. The potential discharges from this phase are odour and run-off from the holding tanks or pre-treatment buildings. The second phase is the anaerobic digestion process itself. Under normal operating conditions there should be no waste discharges from this phase. However, in the event of a catastrophic structural failure, there is the potential for air emissions. Phase 3, is biogas utilization. The potential discharges are air emissions from the flare, boiler and biogas upgrading or co-generation equipment, as well as potential effluent and solid waste discharges. These discharges are discussed in greater detail in Chapters 6 through 10. Lastly, phase 4 of the process, is digestate management. These potential discharges are discussed further in Chapters 12 through 15.

Throughout the following chapters, wastes are categorized as hazardous or non-hazardous. These are based on the best information available but are not definitive. It is the operator's responsibility to properly categorize the waste and manage it accordingly.

Figure 4 below provides a summary flowchart of potential waste discharges from a typical on-farm anaerobic digestion facility with associated biogas upgrading equipment.

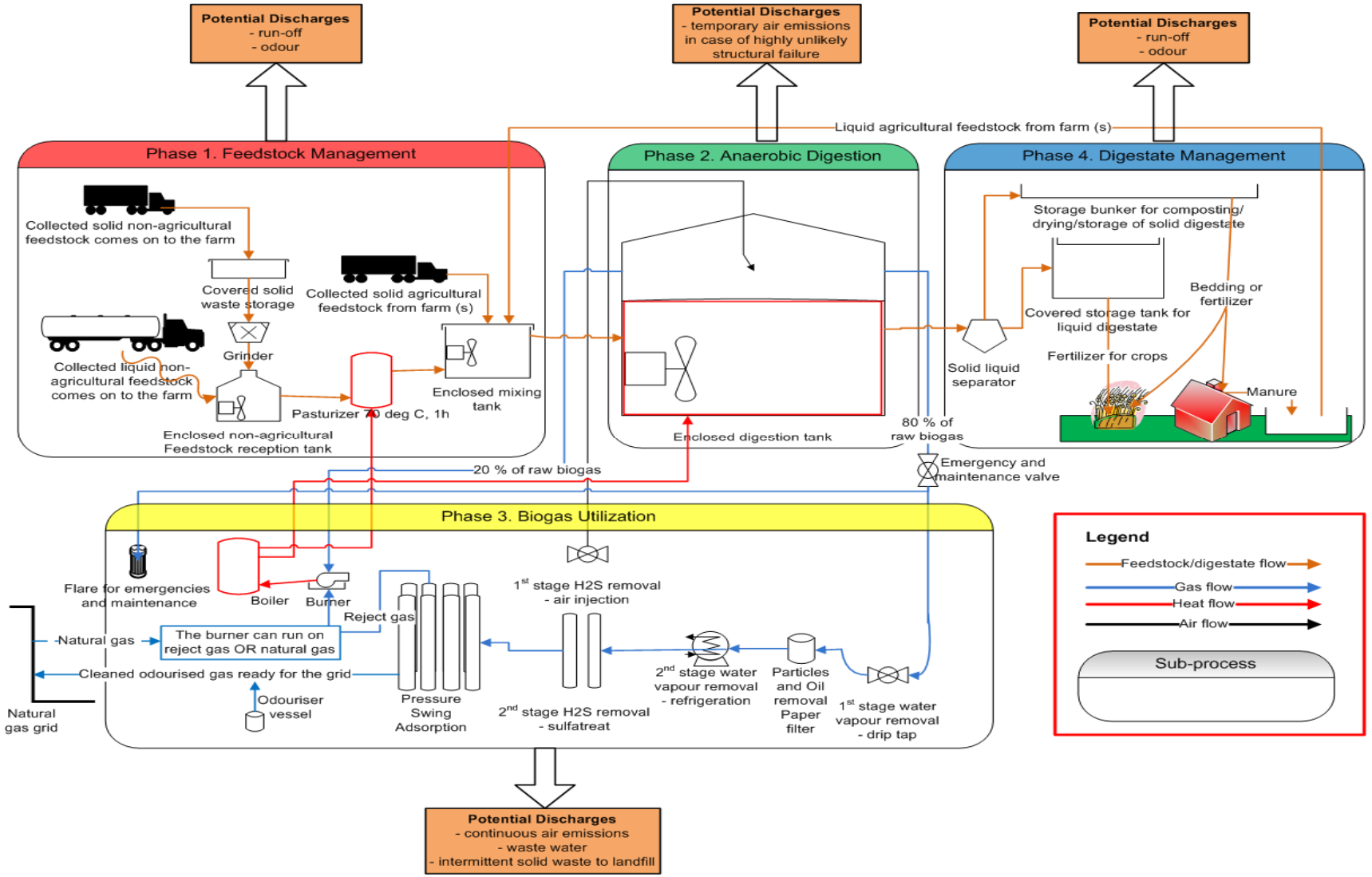


Figure 4. Flowchart of an Example On-farm Anaerobic Digestion Facility with Biogas Upgrading and Potential Discharges

5.1 Biogas Conversion Technologies and Summary of Potential Discharges

Once the biogas is produced, there are a number of technology options for converting it to a usable product. The following table outlines various biogas conversion technologies.

Table 3: Biogas Conversion Technologies

Technology	Process Details
Simple combustion	Biogas is burned in a modified natural gas burner to generate hot air for heating and drying. Boilers are used to generate hot water/steam.
Electrical generators	Internal combustion engines burn biogas to power an electrical alternator to generate electricity. The two types of engines are gas or diesel. These have approximately 30-40% efficiency.
Biogas upgrading to pipeline or vehicle fuel standards	Biogas must be cleaned (removal of H_2S, water vapour, NH_3, particles, etc.) and upgraded (removal of CO_2).
Turbines	Raw biogas is not suitable for turbines as it has low BTU value, is wet and corrosive. Turbines can be utilized if biogas is conditioned before use. Product development is still on-going. This technology may be more frequently used in the future.
Fuel cells	Molten-carbonate fuel cells, this technology is in the research and development stage.

Table 4 below provides a summary of potential effluent, air emissions, and solid waste discharges from on-farm anaerobic digestion projects. The table describes a full roster of technologies and methods that may be utilized in any given project. No project will incorporate all of the components described below but rather a subset in a project-specific sequence. These are described in more detail in subsequent chapters.

Table 4: Summary of Potential Discharges Related to Biogas Utilization

			Air emissions discharge	Effluent (liquid waste) discharge	Solid waste discharge
Biogas cleaning	H2S removal	Biological fixation	NOx @ biogas combustion	No	No
		Iron chloride dosing	No	No	No
		Water scrubbing	Vented reject gas if regenerative process	Scrubbing water	No
		Activated Carbon	No	No	Replaced filter media
		Iron Hydroxide or Oxide	No	No	Replaced filter media
		Sodium Hydroxide	No	Scrubbing water	No

	Water Vapour removal	Refrigeration	No	Condensate water	No
		Absorption	No	No	Replaced drying media
		Adsorption	No	No	Replaced drying media
	Ammonia removal		No	Scrubbing water	No
	Particle removal		No	No	Replaced filters
	Siloxane removal		No	No	Replaced filter media
	Oxygen removal		Reject gas combustion emission	No	Replaced adsorption media
	Nitrogen removal		Yes	No	No
Biogas upgrading		Water Scrubbing	Vented reject gas if regenerative process	Scrubbing water	No
		Chemisorption and physisorption	No	hazardous chemicals (infrequently)	Replaced column packing material
		Pressure Swing Adsorption	Reject gas combustion emission	Vented reject gas if regenerative process	Replaced adsorption media
		Membrane Separation	Reject gas combustion emission	No	Replaced membrane
		Cryogenic Distillation	No	Liquid hazardous coolant	No
Co-generation		Converted internal combustion diesel engine	Stack/tailpipe emissions	Replaced oil	Replaced filters
		Internal combustion gas engine	Stack/tailpipe emissions	Replaced oil	Replaced filters
		Micro turbine	Stack/tailpipe emissions	Replaced oil	Replaced filters
Biogas boiler			Stack/tailpipe emissions	No	No
Flare			Biogas combustion emissions	No	No

Project proponents should engage their design engineer to identify any and all of the components in Table 4 that are applicable to their project. If the project contains components that are not specifically described, it is important to identify these as well. Once the components have been identified, ensure the application addresses all associated discharges suggested in the table. Chapters 6 through 10 give further context to the components and their respective discharges and Appendix 3 provides links to Air Quality Objectives and Standards.

Chapter 6: Biogas Cleaning

Biogas is composed primarily of methane (CH_4), carbon dioxide (CO_2) and various other gases. Typically, the composition of raw biogas from anaerobic digestion is:

Methane	CH_4	50%-80%
Carbon dioxide	CO_2	20%-50%
Water Vapour	H_2O	Saturated 2-5% (mass)
Nitrogen	N_2*	1-4%
Oxygen	O_2*	< 1%
Hydrogen sulphide	H_2S	50-5000 ppm
Ammonia	NH_3	0-300 ppm
Trace gasses	Siloxanes and halogenated hydrocarbons in very low concentrations	
Non-gaseous	Particulate and oil in low concentrations	

*Only present if air is injected into the digester for H_2S reduction

Biogas from on-farm anaerobic digestion should not contain relevant amounts of anything that is not present in the list above. In fact, even the potential trace gasses should be absent from farm biogas due to the feedstocks utilized, and the hydrogen sulphide and ammonia should be at the lower end of the spectrums presented above.

Since the primary objective of an on-farm anaerobic digestion system is to produce methane, it is desirable to remove other biogas components because they represent an environmental hazard, a processing problem, or dilute the energy density of the biogas. The following sections present various ways of managing the non-methane components of biogas. The removal of these other components is broken down into two steps, biogas cleaning and biogas upgrading. Biogas cleaning refers to the removal of H_2S, water vapour, NH_3, particles, etc., whereas biogas upgrading generally refers to the removal of CO_2. All biogas applications have some level of biogas cleaning, however, co-generation requires significantly less.

6.1 Removal of Hydrogen Sulphide (H_2S)

H_2S is present in biogas resulting from the anaerobic digestion of organic material containing sulphur. The concentration of this toxic and corrosive gas in raw biogas may vary greatly depending on the nature of the feedstock. Concentrations are reported between 50 – 5000 ppm for H_2S in raw biogas. H_2S in biogas has to be reduced to levels where it does not harm the process downstream. Downstream concerns revolve around public health and safety issues such as human toxicity and corrosive effect on mechanical parts and gaskets. In terms of equipment tolerances, H_2S concentrations have to typically be reduced to between 200-500 ppm for combustion of biogas in an internal combustion engine (co-generation) while injection into the grid as upgraded biomethane (natural gas equivalent), would require reduction down to below 4 ppm.

Barring structural failures or direct venting of raw biogas to the atmosphere no H_2S should be discharged from an on-farm biogas system. The only other pathway for biogas to exit the system is via combustion (flare, boiler burner or internal combustion engine) which will oxidize H_2S to SOx.

Several methods for reducing the concentration of H_2S can be applied in an on-farm anaerobic digestion context. Table 5 summarizes the different technologies and their waste discharges.

Table 5: Summary of Typical H_2S Removal Methods and their Waste Discharges

H_2S Removal Method	**Technical Description**	**Contaminants Introduced to Biogas or Digestate**	**Waste Discharges**
Biological fixation	Air is ventilated into the gas headspace above the digesting feedstock in the digester. The target is 2-6% air in the biogas. Sulphur oxidizing bacteria converts H_2S to elemental sulphur (S) and water.	Nitrogen is introduced to the biogas with air injection. Excess air may drive the H_2S oxidization process to produce sulphuric acid instead of elemental sulphur.	No direct discharges. Presence of nitrogen (N_2) in biogas results in NOx emissions when combusted. Sulphuric acid is fully buffered in the digestate and is therefore not discharged.
Iron chloride dosing	Liquid iron chloride solution is injected directly into the feedstock mixing tank. Normal dosing is 4 g / liter feedstock. H_2S is converted and contained in the feedstock as $Fe_2(SO_4)_3$. has the added positive effect of reducing odour.	While chloride ions are introduced to the system, they remain in the digestate where they cause no problem.	No direct discharges. Added chloride does not result in chloride-related combustion discharges.
Water scrubbing	Create a solution of H_2S in water by feeding the biogas through a counter flow of water. Normally only used in combination with water scrubbing biogas upgrading technologies.	No contaminants introduced.	Scrubbing water is discharged. The process can be designed as a regenerative process, in which case scrubbing water discharge would be significantly reduced.

H_2S Removal Method	Technical Description	Contaminants Introduced to Biogas or Digestate	Waste Discharges
			If the process is regenerative the desorbed gas will be vented out through an absorption filter of active carbon, iron hydroxide or iron oxide type (see next items in table). The desorbed gas that passes through the filter constitutes an air discharge.
Activated Carbon	Raw biogas flow is led through an activated carbon filter impregnated with potassium iodine (KI) or sulphuric acid (H_2SO_4). This method is usually used in combination with and subsequent to ventilation of air into the biogas (see biological fixation). H_2S is converted to elemental sulphur (S) which is returned to digester.	No contaminants introduced.	Regeneration of the activated carbon will result in air emissions however this activity will most likely occur off-site at a specialized facility. Activated carbon is listed as a Dangerous Good.
Iron Hydroxide or Oxide	Biogas is passed through a media composed of woodchips and iron oxide or hydroxide. H_2S reacts to form iron sulphide. Less common media are rust-coated steel wool or pelleted “red mud” (a by-product of aluminum production).	No contaminants introduced.	This process is often regenerative, but eventually the filter media will have to be replaced. Depending on filter media used, the spent media may constitute a hazardous waste and must be disposed of accordingly. *Note:* FeS is pyrophorric – can spontaneously combust.
Sodium Hydroxide	Biogas bubbled in an NaOH solution forms sodium sulphide or sodium hydrogen sulphide.	No contaminants introduced.	Scrubbing water containing sodium sulphide or sodium hydrogen sulphide. Caustic solutions are frequently dangerous goods. The spent material may or may not be. The process requires less scrubbing

H_2S Removal Method	Technical Description	Contaminants Introduced to Biogas or Digestate	Waste Discharges
			agent (NaOH solution) compared to pure water scrubbing but the process cannot be made regenerative.

6.2 Water Vapour Removal

Biogas from anaerobic digestion is commonly saturated with water. Most biogas utilization processes require relatively dry gas, so drying is often necessary. Some cleaning and upgrading techniques (e.g., water scrubbing), add water vapour to a non-saturated biogas. Nevertheless, biogas has to be dry prior to grid injection and fairly dry before combustion.

Water vapour is a problem, as it may condense into water or ice when passing from high pressure to lower pressure. This may result in corrosion issues and the pressure regulator clogging in the gas conveyance system.

Several methods for reducing the presence of water vapour can be applied in an on-farm anaerobic digestion context. Table 6 summarizes the different technologies.

Table 6: Summary of Water Vapour Removal Methods

Water Vapour Removal Method	Technical Description	Contaminants Introduced to Biogas or Digestate	Waste Discharges
Passive gas cooling	Gas is lead underground for a short period of time to be cooled. Cooling condenses water from the gas which is collected.	No contaminants introduced.	Could result in discharge of condensate water to the sewer but normally the condensate is recycled back into the digester.
Refrigeration	Heat exchangers are used to cool the biogas to desired dew point where water vapour condenses. Biogas can be pressurized to achieve further dryness.	No contaminants introduced.	Could result in discharge of condensate water to the sewer but normally the condensate is recycled back into the digester. Spent refrigerant contaminated with another substance may constitute a hazardous waste and must be disposed of accordingly.

Absorption	Glycol or hygroscopic salts absorb water as biogas is directed through the drying medium. Drying medium is regenerated by drying it at high temperature.	No contaminants introduced.	Process is regenerative but eventually the drying media will have to be replaced. In the case of hygroscopic salts this will result in a non-hazardous solid waste stream.
Adsorption	Silica gel or aluminum oxide adsorbs water as biogas is directed through the medium. Drying medium is regenerated by drying it at high temperature at high pressure (otherwise air needs to be injected for regeneration).	No contaminants introduced.	Process is regenerative but eventually the drying media will have to be replaced, which will result in a non-hazardous solid waste stream.

6.3 Ammonia

Apart from being corrosive on mechanical parts, the combustion of ammonia (NH_3) as a constituent of biogas leads to the formation of nitrogen oxides (NOx). However, since there is very little NH_3 in biogas derived from organic feedstock, it usually stays below 1 ppm.

Given that ammonia is soluble in water, the concentration can be further reduced by refrigerated water vapour removal methods as well as any water scrubbing technology where the biogas is passed through a counter flow of water. Neither of these systems introduces contaminants and only non-regenerative water scrubbing generates a waste discharge, e.g., scrubbing water to sewer.

6.4 Particles

Some dust and oil particles from the compressors may be present in the gas. These particles have to be filtered out using 2 to 5µm filters made of paper or fabric, which will need to be replaced at regular intervals as part of normal maintenance. No contaminants are introduced but the replaced filters will constitute a non-hazardous solid waste discharge.

6.5 Siloxanes

Siloxanes can be found in cosmetics, deodorants, food additives and soaps. The presence in biogas causes abrasive siloxane deposits on pistons and cylinder heads which reduce engine life drastically. They are mainly found in landfill gas and wastewater treatment plant biogas and should not be present in farm biogas from the acceptable feedstocks presented in this guideline

(see Chapter 11). Activated carbon filtration can be used to remove siloxanes in cases where they are found to be present. This would not introduce contaminants but the filter media may constitute a hazardous solid waste discharge when replaced.

6.6 Halogenated hydrocarbons

When present in biogas, halogens are corrosive to mechanical parts and can lead to the formation of dioxins and furans during combustion. Halogenated hydrocarbons and higher hydrocarbons are present in biogas from landfills but rarely in biogas from sewage sludge and should not be present in farm biogas from acceptable feedstocks (see Chapter 11). Activated carbon filtration can be used to remove halogenated hydrocarbons in cases where they are found to be present. This would not introduce contaminants but the filter media may constitute a hazardous waste discharge when replaced.

6.7 Oxygen

Oxygen is a common biogas contaminant in landfill gas but is not found at high concentrations in biogas from anaerobic digestion unless introduced through biological fixation as part of the H_2S removal system. However, most of the oxygen is used by the biological process leaving only traces of oxygen in the H_2S scrubbed biogas. The significance of oxygen as a biogas contaminant is not related to environmental or process impacts but rather it has a dilution effect on biogas energy content. No methods specifically aimed to remove oxygen are likely to be employed in an on-farm biogas production context. However, oxygen is partially removed by the biogas upgrading methods of membrane separation and low pressure PSA that are explained in Chapter 7. No contaminants are introduced and the only waste discharges are those associated with the biogas upgrading methods as presented in Table 8.

6.8 Nitrogen

Since it is inert, the effect of nitrogen on the final output is a dilution of the energy content of the biogas. Landfill gas contains a large proportion of nitrogen but it should be absent from farm biogas derived from acceptable feedstocks as presented in Chapter 11 of this guideline, unless H_2S abatement requires air injection. At 4% injection of air, the output of nitrogen would be 3.1%. Nitrogen is very difficult to remove. The two biogas upgrading methods of PSA and cryogenic systems can remove nitrogen but it is generally too expensive. As a result the most common way of dealing with nitrogen in biogas is to try to limit introduction of it before or during biogas cleaning and to simply accept whatever the resulting nitrogen levels are in the final bio-methane product. Presence of nitrogen in the biogas may lead to increased NOx combustion emissions.

Proponents should identify the following in an application:

- Expected chemical composition of the raw biogas
- The biogas cleaning methods that will be utilized to remove contaminants from the raw biogas
- Expected discharge levels from the utilized biogas cleaning methods (use vendor information and/or real data from the facility to address all potential discharges mentioned in Table 4 and text of Chapter 6).

Chapter 7: Biogas Upgrading

After biogas cleaning has removed contaminants, the main purpose of biogas upgrading is to remove components that dilute the energy density of biogas, primarily carbon dioxide. Biogas upgrading is only present as a process step in an on-farm anaerobic digestion project if the gas utilization method is injection into the natural gas grid. Biogas upgrading is not typically done if the biogas utilization method is electricity production through co-generation or space heat production through a biogas boiler. The target of biogas upgrading is to produce an upgraded biogas, biomethane, that meets the specifications for natural gas grid injection or compressed natural gas (CNG). The specifications for British Columbia are presented in Table 7 below.

Table 7: Summary of Natural Gas grid Injection Specifications for BC

Gas component	Acceptable level
Hydrogen Sulphide (H_2S)	4.3 ppm
Oxygen (O_2)	0.2 %
Carbon Dioxide (CO_2)	2 %
Moisture content	65 mg /nm^3
Methane (CH_4)	THV 36 MJ/m^3

Biogas upgrading methods and their specifics are summarised in Table 8 below.

Table 8: Summary of Biogas Upgrading Methods

Upgrading method	Technical Description	Waste Discharges
Water Scrubbing	CO_2 is dissolved into water at high pressure. Biogas is passed through a counter flow of this water in a packed column to enhance contact between the gas and the water. CO_2 is dissolved in the water at a higher rate than CH_4 so the biogas escaping at the top of the vessel will have a lower relative concentration of CO_2. The scrubbing water, containing mainly dissolved CO_2 but also some CH_4, is then brought to a flash tank where pressure is reduced. The CH_4 departs first and is re-circulated to the water scrubbing column. Thus, the relative CH_4 concentration in the biogas gradually increases. The CO_2 that is desorbed in the flash tank is ejected to the atmosphere through a filter that absorbs potential remnants of H_2S. Water scrubbing will result in approximately 2 litres of discharged scrubbing water per normal	Scrubbing water containing dissolved CO_2 and H_2S if it has not been removed by prior processes. Traces of CH_4 may also be dissolved in the discharged scrubbing water. If the process is regenerative the desorbed gas will be vented out through an absorption filter. The desorbed gas that passes the filter constitutes an air discharge. The infrequent replacement of the inert granular column

Upgrading method	Technical Description	Waste Discharges
	cubic meter (nm^3) of raw biogas that is processed.	packing media will result in a non-hazardous solid waste stream.
Chemisorption and physisorption	Organic solvents and other chemicals can be used to absorb CO_2 instead of water in a process very similar to water scrubbing. The water substitute comes in different forms and brands such as polyethylene glycol, Selexol®, Genosorb®, mono ethanol amine or di-methyl ethanol amine. Because these chemicals substantially increase the CO_2 removal efficiency it is possible to reduce the scale of upgrading infrastructure.	Although these processes are regenerative the scrubbing chemical will eventually need to be renewed. This will result in an intermittent liquid waste stream that would have to be managed as a hazardous waste. The infrequent replacement of the inert granular column packing media will result in a non-hazardous solid waste stream.
Pressure Swing Adsorption	At high pressure, selected molecules are trapped in an adsorbent medium and are released at low pressure. The adsorbent is either zeolites (crystalline polymers), carbon molecular sieves or activated carbon. Depending on the adsorbent and operating pressure used, CO_2, O_2 and N_2 can be adsorbed while methane passes through. After adsorbing targeted molecules the raw biogas flow is turned off for an instant, the pressure is released and the targeted molecules "let go" of the adsorbent and are evacuated as reject gas. Raw biogas flow is turned on, pressure is increased and the cycle starts again. This cycle is done with multiple vessels to produce a continuous flow device. Biogas containing water vapor at 100% relative humidity (>100 PSI and up to 35^{o} C) is not an issue for the PSA. Liquid water and H_2S (>50 ppm) are contaminants for the adsorption media and must be removed ahead of this process. The reject gas will contain some methane and will therefore be combusted before release into the atmosphere to destroy methane and convert H_2S to SOx. This reject gas can be used as heat	Air emissions from combustion of reject gas. The infrequent replacement of the adsorption media will result in a non-hazardous solid waste stream.

Upgrading method	Technical Description	Waste Discharges
	recovery if desired or sent through another PSA for additional methane recovery.	
Membrane Separation	Selectively permeable membranes can be used to retain CH_4 on one side by using a pressure differential on each side. The higher diffusion rate of CO_2 through the membrane allows most of it to migrate through it while most of the CH_4 is retained. The method can also be used to remove some H_2S from the stream. The solid membrane process has a gas flow on each side of the membrane and operates at high pressure, up to 40 atmospheres. When high levels of methane are needed in the output stream there are high methane losses in the permeate stream. The permeate gas (reject gas) will therefore be combusted before release into the atmosphere to destroy methane and convert H_2S to SOx.	Air emissions from combustion of reject gas. The very infrequent replacement of the membrane will result in a non-hazardous solid waste stream.
Cryogenic Distillation	At atmospheric pressure, CH_4 condenses at -161.6^{o} C and CO_2 freezes at -78.5^{o} C. This enables separation of the two components in different phases. It is best performed at elevated pressure to ensure that CO_2 condenses in a liquid form and not as a solid (dry ice) that would clog the piping system. If methane is condensed, nitrogen will also be removed.	The coolant (e.g., glycol) will require infrequent replacement. It may constitute a hazardous waste and is to be disposed of accordingly.

Proponents should identify the following in an application:

- The method(s) that will be utilized to upgrade the biogas
- Expected waste streams (including composition) from the utilized biogas upgrading method(s) (use vendor information and/or real data from the facility to address all potential discharges mentioned in Table 8 and text of Chapter 7).

Chapter 8: Electricity Production through Co-Generation

Another pathway of producing energy from biogas is to generate electricity and heat through a process called combined heat and power (CHP) or co-generation (co-gen). Utilizing biogas for co-gen requires significantly less stringent biogas cleaning than what is required prior to biogas upgrading. The biogas cleaning for use in co-gen involves H_2S removal, water vapour removal and filters to remove particulates and oil. Please refer to Chapter 6 for technical descriptions of these biogas cleaning methods and their waste discharges. Co-gen equipment manufacturers prefer biogas with an average H_2S concentration of < 200 ppm and are unlikely to honour warranties if the average H_2S concentration is > 500-600 ppm. Co-gen methods and their specifics are summarised in Table 9 below.

Table 9: Summary of Co-gen Methods

Co-gen method	Technical Description	Waste Discharges
Converted internal combustion diesel engine	Biogas is combusted in a converted, stationary internal combustion engine originally designed for diesel fuel. The engine in turn drives a generator which generates electricity. Heat exchangers are used to transfer heat from exhaust gas as well as friction heat from the engine and generator to local heat sinks, such as the digester tank, pasteurization tank, farm buildings and other domestic purposes for immediate use. The conversion of diesel engines usually involves adding a gaseous fuel injector and replacement of gaskets to more corrosion resistant materials. Converted diesel engines running on biogas normally need diesel as a pilot fuel at start up and in some cases as a 10% auxiliary fuel throughout the process.	Air emissions in the form of combustion exhaust. Replaced engine oil and oil filters from scheduled maintenance will represent a liquid or solid waste discharge that should be recycled or disposed of properly, e.g., delivered in an appropriate container to the local transfer station specifically allocated for oils. Proponents should call the BC Used Oil Management Association (BCUOMA) to identify collectors of this type and quantity of used oil and filters.
Internal combustion gas engine	Biogas is combusted in a stationary internal combustion engine specifically designed for gaseous fuel. The engine in turn drives a generator which generates electricity. Heat exchangers are used to transfer heat from exhaust gas as well as friction heat from the engine and generator to local heat sinks for immediate use. No separate pilot or auxiliary fuel is required for gas engines.	Same as above.

Co-gen method	Technical Description	Waste Discharges
Micro turbine	Biogas is used as a fuel for combustion together with compressed air. The combustion temperature heats exhaust gases which causes expansion, resulting in increased exhaust volume and velocity. The high velocity exhaust gases drive the turbine which in turn is connected to an electrical generator. Heat exchangers are used to transfer heat from exhaust gas as well as friction heat from the turbine and generator to local heat sinks for immediate use.	Same as above. Micro turbine co-gen can be expected to have less emissions compared to internal combustion engines.

8.1 Co-gen Design and Installation

Co-gen equipment should be designed by a qualified professional and installed in accordance with the manufacturer's specifications and applicable legislation e.g., the *Safety Standards Act*, Electrical Safety Regulation. The installation must also be certified to the applicable Canadian Standards Association (CSA) standard. Proponents should consult with the BC Safety Authority regarding co-gen requirements, inspections and approvals.

8.2 Co-gen Emission Factors

Co-gen air emission factors are provided in the following study: Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia. The study is available for download at: http://www.bcic.ca/images/stories/publications/lifesciences/feasibility_study_anaerobic.pdf.

Proponents should identify the following in an application:

- Expected H_2S concentration in the biogas when it reaches the co-gen unit
- Expected discharge levels from utilized co-gen method. Stack tests from comparable units preferred, vendor information, emission factors (from US EPA) or mass balance, could also be used as appropriate with justification for rationale.

Chapter 9: Boiler Emissions

If upgrading and natural gas grid injection is selected as the biogas energy production option there will be very little spare heat from the process. It is therefore necessary to have an on-site auxiliary heat source to heat the digester up to required operating temperature. In this case auxiliary heating can be accomplished through running a boiler on diverted biogas (in the range of 15-30% of produced raw biogas). Reject gas from the biogas upgrading process can also be sent to the boiler burner to utilize any remaining energy content and to destroy any remaining methane and H_2S. Reject gas is the carbon dioxide rich gas that has been stripped out of the raw biogas in the biogas upgrading process in order to produce the highly concentrated (95%+) methane product that is to be injected into the natural gas grid. Out of the biogas upgrading methods presented in Chapter 7, only pressure swing adsorption, membrane separation and potentially regenerative water scrubbing, will have a reject gas stream that is rich enough to burn in an auxiliary boiler.

9.1 Boiler Design and Installation

Boilers would have to comply with the *Safety Standards Act*, Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation and CSA B51 Boiler, Pressure Vessel and Pressure Piping Code. Proponents are advised to consult with the BC Safety Authority regarding applicable requirements, inspections and approvals.

9.2 Boiler Emission Factors

Emission factors for biogas boilers are provided in the following study: Feasibility Study – Biogas Upgrading and Grid Injection in the Fraser Valley, British Columbia. The study is available for download at: www.lifesciencesbc.ca/files/PDF/feasibility_study_biogas.pdf.

Proponents should identify the following in an application:

- The type of gas combusted in the boiler (raw biogas, reject gas, fossil natural gas or a combination thereof)
- If a combination of gasses are combusted in the boiler, then describe the proportion of the respective gas streams in the combined mix
- Expected discharge levels from the boiler (use vendor information and/or real data from the facility to address all potential discharges).

Chapter 10: Flaring Emissions

On-farm anaerobic digestion facilities should be designed with a flare to avoid the direct venting of biogas to atmosphere. The flare should be installed with the capacity to accept all biogas from the digester and associated structures during an emergency situation or maintenance period. By routing the biogas through a flare, it is combusted and less harmful gases are emitted. Other benefits of flaring include a reduction in odour, the destruction of volatile organic compounds (VOCs), and the conversion of H_2S to SO_2.

10.1 Types of Flares

There are two types of flares, open and enclosed. Open flares generally have a simpler design and are less effective at controlling emissions. They also have considerable heat loss and therefore are usually elevated for worker safety. Enclosed flares are considered more advanced, are designed for a specific gas flow, and are better able to control emissions. Although enclosed flares are preferred, an open flare may be sufficient due to the intermittent use of flares associated with anaerobic digesters.

10.2 Design and Installation

Flares should be designed by a qualified professional and installed in accordance with the manufacturer's specifications and applicable legislation e.g., the *Safety Standards Act*, the Canadian Standards Association Code for Digester Gas and Landfill Gas Installations (CAN/CGA-B105-M93, January 1993 and the B105S1-07 Supplement No. 1 to CAN/CGA-B105-M93, January 2007). Proponents should consult with the BC Safety Authority regarding biogas flare requirements (e.g., diameter, stack height, etc.), inspections and approvals.

10.3 Flaring Emission Factors

Emission factors for flares are provided in the following study: Feasibility Study – Biogas Upgrading and Grid Injection in the Fraser Valley, British Columbia. The study is available for download at: www.lifesciencesbc.ca/files/PDF/feasibility_study_biogas.pdf.

10.4 Air Dispersion Modeling

Air dispersion modeling may be required for a waste discharge authorization for biogas flaring. The proponent should contact the regional MOE office to determine the appropriate level of assessment for the project and the required modeling parameters. A Level 1 Assessment is the first level of air dispersion modeling and provides an estimate of the worst case air quality impact. Depending on results of the Level 1 Assessment, a Level 2 or 3 Assessment may be required. A copy of the Guidelines for Air Dispersion Modeling in British Columbia and further

information is provided on the following website:
http://www.bcairquality.ca/assessment/dispersion-modelling.html.

Proponents should identify the following in an application:

- Type of flare
- Capacity of the flare
- Fuel types to be burned (e.g., % biogas)
- Expected flare operation time, annually
- Expected minimum retention time and temperature
- The points in the gas stream at which biogas can be directed towards the flare
- Air dispersion modelling results (if required) including:
    - Expected worst case discharge levels from the flare, e.g., emissions from the flare when it operates on biogas from the least clean diversion point (use vendor information and/or real data from the facility to address all potential discharges)
    - Local and global air quality and the effect of undesirable reaction products
    - Visual, noise, and odour impacts.

Chapter 11: Feedstock for an On-Farm Anaerobic Digester

It is important to determine if the feedstock is classified as agricultural or non-agricultural waste. Agricultural waste is defined in the Agricultural Waste Control Regulation (AWCR) as:

- manure,
- used mushroom medium, and
- agricultural vegetation waste.

This classification is significant in the context of an on-farm anaerobic digestion project because the feedstock combination determines the type of waste discharge authorization to obtain and reflects the pre-treatment and testing requirements for safe operation.

If the project is based solely on agricultural waste (as defined above), the requirement is to comply with the AWCR. A site specific waste discharge authorization from the Ministry of Environment is not required. If any portion of the feedstock for an on-farm anaerobic digestion facility is classified as non-agricultural, there is a requirement to contact the local government and regional MOE office and apply for a site specific waste discharge authorization in accordance with this guideline (see Chapter 3). In either case, proponents are strongly encouraged to adhere to applicable best management practices as described in Chapter 16.

The Agricultural Land Commission (ALC) may also set limits such as the maximum volume of imported non-agricultural waste onto a farm if the farm is located within the Agricultural Land Reserve. Chapter 2 of this guideline provides the web address for the ALC and provides a brief overview of the process to obtain the appropriate ALC approvals.

11.1 Feedstock List

This section contains a list of items identified as acceptable feedstock for on-farm anaerobic digestion. The feedstock list is divided into three schedules: A, B and C. Schedule A describes materials that are acceptable "as is" to go into the digester. The feedstocks listed under Schedule B are "limited" and require pasteurization (e.g., 70^{o} C for 1 hour), before being introduced into the digester in order to reduce pathogens. Schedule C describes materials that are unacceptable as feedstock for on-farm anaerobic digestion. The feedstock list is also provided as Appendix 1 of this guideline.

Schedule A: Acceptable Feedstock for On-farm Anaerobic Digestion

Type of Feedstock	Specification
Agricultural waste and agricultural vegetation waste	- manure - used mushroom medium - residues from primary crop production - organic waste matter derived from the drying or cleaning of field crops or nut crops on farms - non-food vegetative matter resulting from gardening operations, landscaping, and land clearing on farms - animal bedding derived from straw, paper, hog fuel, wood chips, bark, shavings or sawdust
Brewery waste/winery waste	- used or diverted grain, malt, hop flowers, berries, fruit, leaves and twigs and yeast resulting from brewing or wine making process
Cooking oil from restaurants and food processors	- used or un-used food grade cooking oil that has been collected in a separate container and kept separate from all other waste streams until unloaded at the anaerobic digestion facility
Milk	- clean milk (without antibiotics), that has passed specification (e.g. oxidized, lack of refrigeration, etc.)
Organic by-products from ethanol or biodiesel facilities	- corn, canola-based mash, glycerine, etc.
Plant matter	- fruit, vegetable and vegetative material derived from fruit and vegetable processing or retail locations - herbaceous plant waste from flower shops, off-farm nurseries and retail locations - non-food vegetative matter resulting from gardening operations, landscaping, and land clearing - spent algae specifically grown in a controlled environment These are materials which either originated at a non-farm location or have been removed from a primary agricultural operation to a processing or retail facility and therefore no longer fit within the definition of agricultural waste (agricultural vegetation waste) as defined in the Agricultural Waste Control Regulation.
Waste products from animal feeds	- waste products from animal feeds listed in Classes 1,2,3,4 and 5 of Part 1 of Schedule IV to the Feeds Regulation, 1083 (SOR/83-593) made under the *Feeds Act* (Canada), <u>*excluding*</u> any materials that contain an animal product that has not been denatured Also includes materials that previously would have been a product described above but are no longer suitable for use in feeding of farm animals for reasons that do not include

	contamination by another material.
Whey	- whey and whey permeate, the watery part of milk that remains after the manufacture of cheese

Schedule B: Limited Feedstock for On-farm Anaerobic Digestion[1]

Type of Feedstock	Specification
Biosolids	- stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled in accordance with the requirements of Organic Matter Recycling Regulation (OMRR)
Dissolved air flotation (DAF) waste	- floc and scum from dissolved air flotation systems in food processing industries
Domestic septic tank sludge	- sludge removed from a septic tank used for receiving, treating and settling domestic sewage
Fat, Oil and Grease (FOG)	- grease trap fats, oils and grease from food processing and preparation
Fish wastes	- fish carcasses and parts from harvested wild stocks, commercial aquaculture operations and fish processing facilities. This would include offal, viscera and mortalities from fish and shellfish. It would also include faeces captured from commercial aquaculture net pens.
Food wastes	- recyclable food for humans that has been diverted from residential, commercial or institutional sources
Hatchery waste	- broken or unhatched eggs, unhatched chicks, membranes, embryonic fluids (Eggshell is not a recommended anaerobic digestion feedstock as it may harm equipment and settle in tanks.)
Milk processing waste	- sludge or biomass from treatment of milk or fluid milk which has been diverted from human food consumption
Paunch manure	- manure present in the digestive tract at the time of slaughter
Pet food, pet food residues	- waste streams and residues from preparation and processing of pet food as well as pet food that has gone off specifications or has expired
Poultry wastes except those that have died from infectious diseases	- carcasses, offal and viscera of domestic fowls, such as chickens, turkeys, ducks or geese, raised for meat or eggs
Red-meat waste except those that have died from infectious diseases	- carcasses, offal and viscera, of red-meat animals such as cattle, swine, sheep, fallow deer, farmed game and farmed bison. *Note:* Specified Risk Material is an unacceptable feedstock, see Schedule C.

Waste products from animal feeds	- listed in Classes 1,2,3,4 and 5 of Part 1 of Schedule IV to the Feeds Regulation, 1083 (SOR/83-593) made under the *Feeds Act* (Canada), *including* any material that contain an animal product that has not been denatured.

[1] The feedstock listed in Schedule B requires pasteurization, e.g., 70° C for 1 hour, or as specified by a qualified professional and approved by MOE.

Schedule C: Unacceptable Feedstock for On-Farm Anaerobic Digestion

Type of Feedstock	**Specification**
Catering waste from means of international transport	- airplane food waste, cruise ship food waste, etc.
Hazardous waste	- as defined by the Hazardous Waste Regulation
Mortalities that have died from infectious diseases	- e.g., transmissible spongiform encephalopathy
Organic wastes that are or contain: • Solvents containing volatile organic compounds • Fuels and petroleum products • Resins and plastics	
Specified risk material (SRM) or waste containing SRM	- as defined by the Canadian Food Inspection Agency

If the intended feedstock is not listed, contact the regional Ministry of Environment office to clarify the requirements for that feedstock.

11.2 Feedstock

The design of an anaerobic digester and estimated production of biogas are dependent on the quality of the feedstock. The preliminary design is often based on literature values of feedstock properties or the experience of the design engineer. Since feedstock properties may vary greatly between sources it is important to corroborate literature values and empirical experience with tests of the actual feedstock that is to be used in a new anaerobic digestion facility. Knowing the properties of the intended feedstock is also important for estimating the digestate fertilizer value.

To ensure that projected biogas production volumes can be achieved, it is recommended that:

- Each applicable feedstock type is sampled separately; and
- The following parameters are analyzed:

- physical characteristics (moisture content, ash, pH, electrical conductivity, C/N ratio, and foreign matter),
- chemical characteristics (total N, nitrate, ammonium N, phosphorus, potassium, total S, total carbon), and
- heavy metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, and zinc).

Further information on the sampling and analysis of the feedstock, digestate, and soils is provided in Chapters 12 through 15.

Proponents should identify the following in an application:

- The intended volumes of agricultural feedstock (itemized by feedstock type)
- Results from nutrient analysis of all agricultural feedstock
- The intended import volumes of all non-agricultural feedstock (itemized by feedstock type)
  - Total annual import volume
  - Average daily import volume
  - Intended maximum volume to be stored on-site at any given time
- Results of physical and chemical analysis of all non-agricultural feedstock.

Chapter 12: Digestate Management

Digestate is the term used to refer to the product of the anaerobic digestion process. Digestate is removed from the digester as a slurry with approximately 5-15% solids. The digestate is often pushed through a roller or screw press to separate the liquid and solid fractions. These fractions can be used as additional revenue sources for the farm. Liquid digestate can be piped to a storage area and further processed or used as fertilizer. Solid digestate can be used as fertilizer, animal bedding, or further processed (e.g., composted in accordance with the Organic Matter Recycling Regulation), for subsequent sale.

The following digestate management recommendations are based on a three-tiered approach, depending on the volume of non-agricultural feedstock brought to the on-farm anaerobic digestion facility. The three tiers have been established as follows:

Tier 1: On-farm anaerobic digestion facility using 100% agricultural waste*
Tier 2: On-farm anaerobic digestion facility importing up to 25%** non-agricultural waste
Tier 3: On-farm anaerobic digestion facility importing more than 25%** non-agricultural waste

*agricultural waste is defined in the Agricultural Waste Control Regulation (AWCR) as: includes manure, used mushroom medium, and agricultural vegetation waste.

**25% by volume, per year.

The following table summarizes the digestate management recommendations for Tier 1, Tier 2, and Tier 3 digesters. More detail on the recommendations (for heavy metal, pathogen, and nutrient analyses) can be found in Chapters 13, 14, and 15.

Table 10: Digestate Management Recommendations for the Tier 1, Tier 2, and Tier 3 Anaerobic Digesters

Tiers	Schedule B Feedstock Pasteurization	Land Application Plan	Heavy metal analyses of non-agricultural feedstock prior to delivery	Nutrient Management Planning	Nutrient analyses of soil, pre and post-application of the digestate	Nutrient analyses of digestate, pre-application	Pathogen analyses of the digestate, pre-application	Digestate Land application recommendation (setbacks and environmental concerns)
Tier 1 -100% agricultural feedstock				✓*				Based on AWCR
Tier 2 – Up to 25% non-agricultural feedstock	✓		✓	✓	✓	✓		Based on Environmental Farm Planning (EFP) and Manure Spreading Advisory
Tier 3- More than 25% non-agricultural feedstock	✓	✓	✓	✓	✓	✓	✓	As outlined in this guideline (taken from OMRR)

*100% agricultural feedstock on-farm anaerobic digestion facilities authorized under the Agricultural Waste Control Regulation, are advised to practice due diligence and consider implementing applicable best management practices as described in Chapter 16.

Chapter 13: Recommendations for Tier 1 On-farm Anaerobic Digestion Facilities (100% agricultural waste)

On-farm anaerobic digestion facilities using 100% agricultural wastes as feedstock are categorized as a Tier 1 anaerobic digestion facility and may be authorized under the Agricultural Waste Control Regulation (AWCR). In managing any kind of waste, practicing due diligence and adhering to best management practices (BMPs) is recommended. Therefore in addition to meeting the provisions of the AWCR, the applicable BMPs for feedstock and digestate management outlined in the following chapters should be adhered to for this tier. If the solid digestate fraction is to be used as animal bedding, it should be processed to a point where sanitary conditions for bedded animals can be ensured.

For management and planning purposes, it is also recommended to analyze all feedstocks for nutrients and estimate the crop nutrient requirements. This is to prevent nutrient overloading on soils and to plan for managing the discharge of the digestate.

Chapter 14: Recommendations for Tier 2 On-farm Anaerobic Digestion Facilities (up to 25% non-agricultural waste)

The following flowchart summarizes the feedstock and digestate management steps for a Tier 2 anaerobic digestion facility.

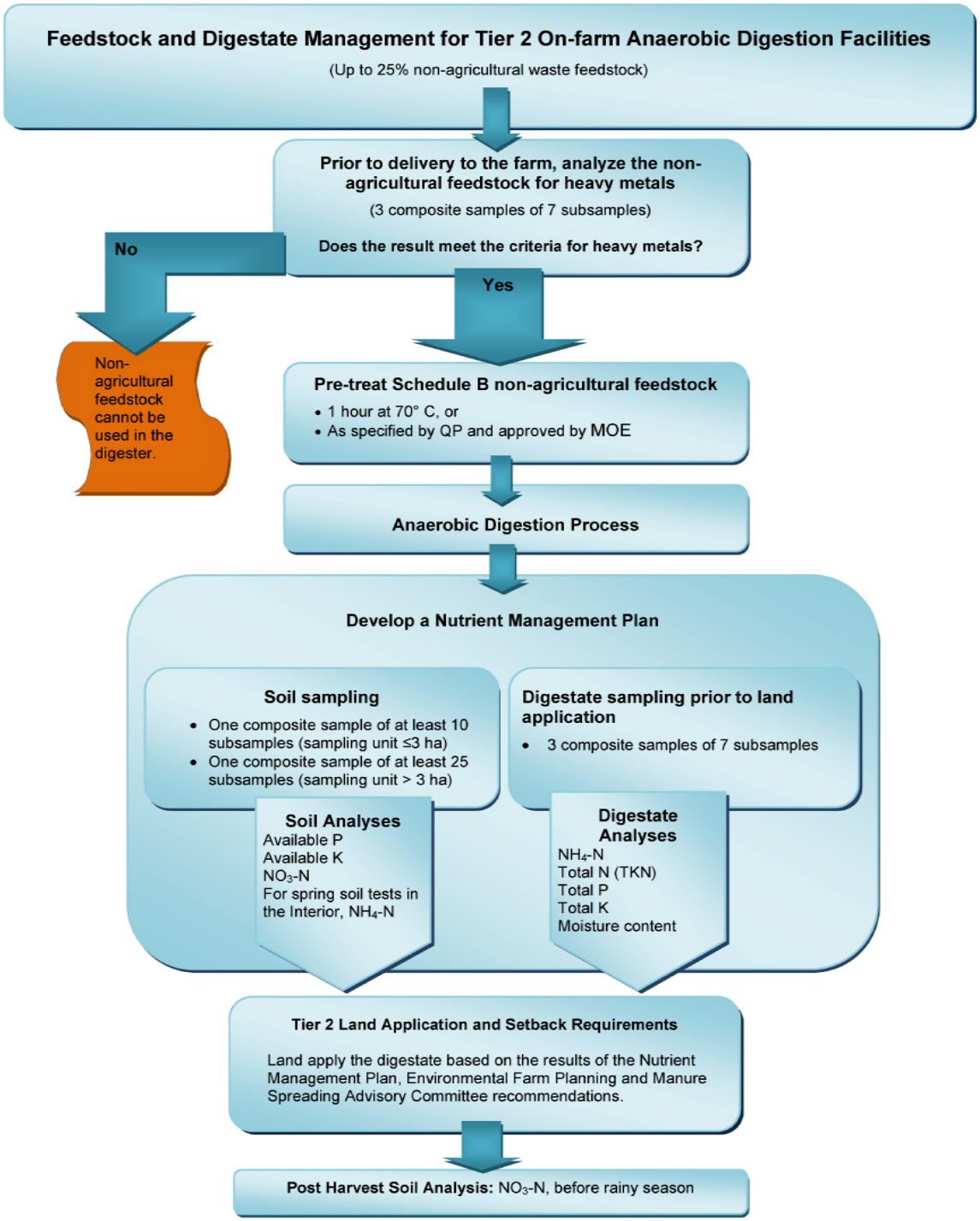


Figure 5. Flowchart of Feedstock and Digestate Management for a Tier 2 Anaerobic Digestion Facility

14.1 Heavy Metals Sampling Frequency (non-agricultural feedstock)

Prior to delivery onto the farm, the imported, non-agricultural feedstock should be sampled for heavy metals at a frequency that is dependent on the consistency of the source, and the composition of the feedstock.

Recommendations for sampling the feedstock:

- sample once every 12 months or
- sample more frequently in the first two to three years of operation based on MOE recommendations, and
- repeat sampling if the feedstock composition or type changes, or is received from a different source.

14.2 Heavy Metals Sampling Procedures (non-agricultural feedstock)

Three composite samples each of 7 subsamples should be taken from the imported non-agricultural feedstock. Each subsample should be taken from a different spot of the feedstock storage pile at a minimum depth of 30 cm (if possible). If the depth of the sample is less than 30 cm, samples should be taken from below the surface of the feedstock or the feedstock should be well mixed before sampling.

14.3 Non-Agricultural Feedstock Heavy Metals Limits

Table 11 includes a list of recommended heavy metals for which the non-agricultural feedstock should be tested, prior to delivery on the farm. The table also includes the recommended maximum concentration of the heavy metals.

Only non-agricultural feedstock with a maximum concentration not exceeding the limits listed in Table 11 should be mixed in the digester. The limit is not cumulative but rather ensures that no non-agricultural feedstock coming onto the farm is allowed to be over the limits presented in Table 11.

Table 11: On-farm Anaerobic Digestion Heavy Metal Maximum Concentration for Tier 2 Non-agricultural Feedstock

Substance	**Maximum concentration in anaerobic digestion non-agricultural feedstock** µg/g dry weight
Arsenic	13
Cadmium	3
Chromium	100
Cobalt	34
Copper	400

Lead	150
Mercury	2
Molybdenum	5
Nickel	62
Selenium	2
Zinc	500

14.4 Schedule B Feedstock Pasteurization

The list of acceptable feedstock for on-farm anaerobic digestion is provided in Chapter 11, as well as Appendix 1. The feedstock list is broken down into three schedules: A, B, and C. In order to reduce pathogens, it is recommended that all feedstock listed in Schedule B undergo pasteurization prior to digestion for:

- 1 hour at 70° C, or
- as specified by a qualified professional and approved by MOE.

14.5 Nutrient Management Planning

For farms with a Tier 2 anaerobic digestion facility, it is recommended that for each 12 month period, a qualified professional (QP) develop and approve a Nutrient Management Plan for the land on which the digestate will be applied. The QP should select a nutrient management strategy that considers the environmental risks associated with the land application of the digestate.

The BC Ministry of Agriculture and Lands' Nutrient Management Planning Calculator and Nutrient Management Reference Guide* can be used to develop the Nutrient Management Plan. A nitrogen based approach for nutrient management planning can be used, although the QP that prepares the plan should also consider the environmental risks associated with over application of phosphorous (P). In some cases a P-based approach could be selected. For example, at sites where the soil P level is elevated and runoff or erosion may result in P entering a sensitive receiving environment.

If a P-based approach is selected, the following maximum application rates are recommended for the land application of the digestate. The maximum application rate of the digestate and all other nutrients should be land applied such that the first-year available P in the digestate during any one-year period does not exceed the annual crop nutrient uptake of P plus:

i) 20 kg P per hectare per year if the soil test P (plant available P), as determined for the Nutrient Management Plan, is between 100 and 140 parts per million (Kelowna method or equivalent values of another method), or

ii) 10 kg P per hectare per year if the soil test P (plant available P), as determined for the Nutrient Management Plan, exceeds 140 parts per million (Kelowna method or equivalent values of another method).

*The Nutrient Management Planning Calculator is available to QPs upon request from the following contact at the BC Ministry of Agriculture and Lands:

Orlando Schmidt
Environmental Soils Specialist
Sustainable Agriculture Management Branch
Email: Orlando.Schmidt@gov.bc.ca
Phone: (604) 556 - 3101

The Nutrient Management Reference Guide is available online at: http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/EFP_Nutrient_Guide/Nutrient_Guide_toc.htm.

14.6 Digestate Sampling Frequency

For a Tier 2 on-farm anaerobic digestion facility, the digestate sampling frequency for nutrients is based on the consistency of the source, and the composition of the feedstock.

Recommendations for sampling the digestate:

- sample once every 12 months, or
- sample more frequently in the first two to three years of operation based on MOE recommendations, and
- repeat sampling if the feedstock composition or type changes, or is received from a different source.

14.7 Digestate Sampling Procedures

For the digestate (after digestion and before land application), three composite samples, each of 7 subsamples should be taken. Each subsample should be taken from a different spot of the pile or lagoon at a minimum depth of 30 cm while each composite sample should include subsamples from different spots of the digestate storage pile.

14.8 Recommended Digestate Analyses

The following analyses of the digestate are recommended prior to land application and to facilitate the nutrient management planning process:

i. Ammonium nitrogen (NH_4-N)
ii. Total Kjeldahl Nitrogen (TKN)
iii. Total phosphorous (P)
iv. Total potassium (K)
v. Moisture content

14.9 Soil Sampling Frequency

Recommendations for sampling soil:

- sample before the first land application of the digestate, and
- repeat sampling every 12 months to provide a baseline of nutrient concentration in the soil, and
- conduct post harvest sampling to monitor the level of nitrate (NO_3), in the soil.

14.10 Soil Sampling Procedures

One composite sample of at least 10 subsamples should be taken from each sampling unit ≤3 ha in area and one composite sample of at least 25 subsamples should be taken from larger sampling units.

Soil samples should be collected from a depth of 0 to 15 cm. Post harvest soil samples should be taken from 15-30 and 30-60 cm sampling depths to monitor nitrate leaching.

14.11 Recommended Soil Analyses

The following analyses of soil are recommended prior to the first land application of the digestate and to facilitate the nutrient management planning process:

i. Available phosphorus (P)
ii. Available potassium (K)
iii. Nitrate-nitrogen (NO_3-N)
iv. For spring soil tests in the Interior, ammonia-nitrogen (NH_4-N)

The following post harvest soil analysis is recommended to monitor the level of remaining nitrate:

i. Nitrate-nitrogen (NO_3-N)

For more information on sampling and analyses, refer to the following documents:

Nutrient Management Factsheet, Soil Sampling for Nutrient Management
http://www.agf.gov.bc.ca/resmgmt/publist/600Series/631500-1.pdf

Nutrient Management Factsheet, Manure Sampling and Analyses for Nutrient Management
http://www.agf.gov.bc.ca/resmgmt/publist/600Series/631500-3.pdf

Land Application Guideline for the Organic Matter Recycling Regulation and Soil Amendment Code of Practice http://www.env.gov.bc.ca/epd/industrial/regs/codes/soil_amend/pdf/land-app-guide-soil-amend.pdf.

14.12 Digestate Land Application

The land application of solid and/or liquid digestate should be in accordance with the Nutrient Management Plan and follow the requirements outlined in the Environmental Farm Planning Reference Guide (EFP) for monthly manure spreading practices (e.g., minimum setback distances), and the recommendations of the Manure Spreading Advisory Committee. The Manure Spreading Advisory is updated on an ongoing basis as a result of changes in seasonal weather and other dynamic conditions influencing suitable manure spreading practices. The current advisory should be followed.

The EFP Reference Guide is available at:
http://ardcorp.ca/userfiles/file/efp/EFP_Reference_Guide_March_2005_part_6.pdf
(Chapter 6 Soil Amendments pages 21 and 22).

The Manure Spreading Advisory is available at:
http://www.agf.gov.bc.ca/resmgmt/ManureAdvisory/index.htm.

14.13 Composting

If the solid digestate fraction is to be used as animal bedding, it should be processed to a point where sanitary conditions for bedded animals can be ensured. The digestate can also be composted based on the provisions of the Organic Matter Recycling Regulation (OMRR), and if Class A or B compost is produced it can be land applied as per OMRR. OMRR is available for download at: http://www.env.gov.bc.ca/epd/epdpa/mpp/omrreg.html.

14.14 Record Keeping

The results of all analyses should be kept at the facility for at least 36 months.

Chapter 15: Recommendations for Tier 3 On-Farm Anaerobic Digestion Facilities (more than 25% non-agricultural waste)

The flowchart in Figure 6 summarizes the feedstock and digestate management steps for a Tier 3 anaerobic digestion facility.

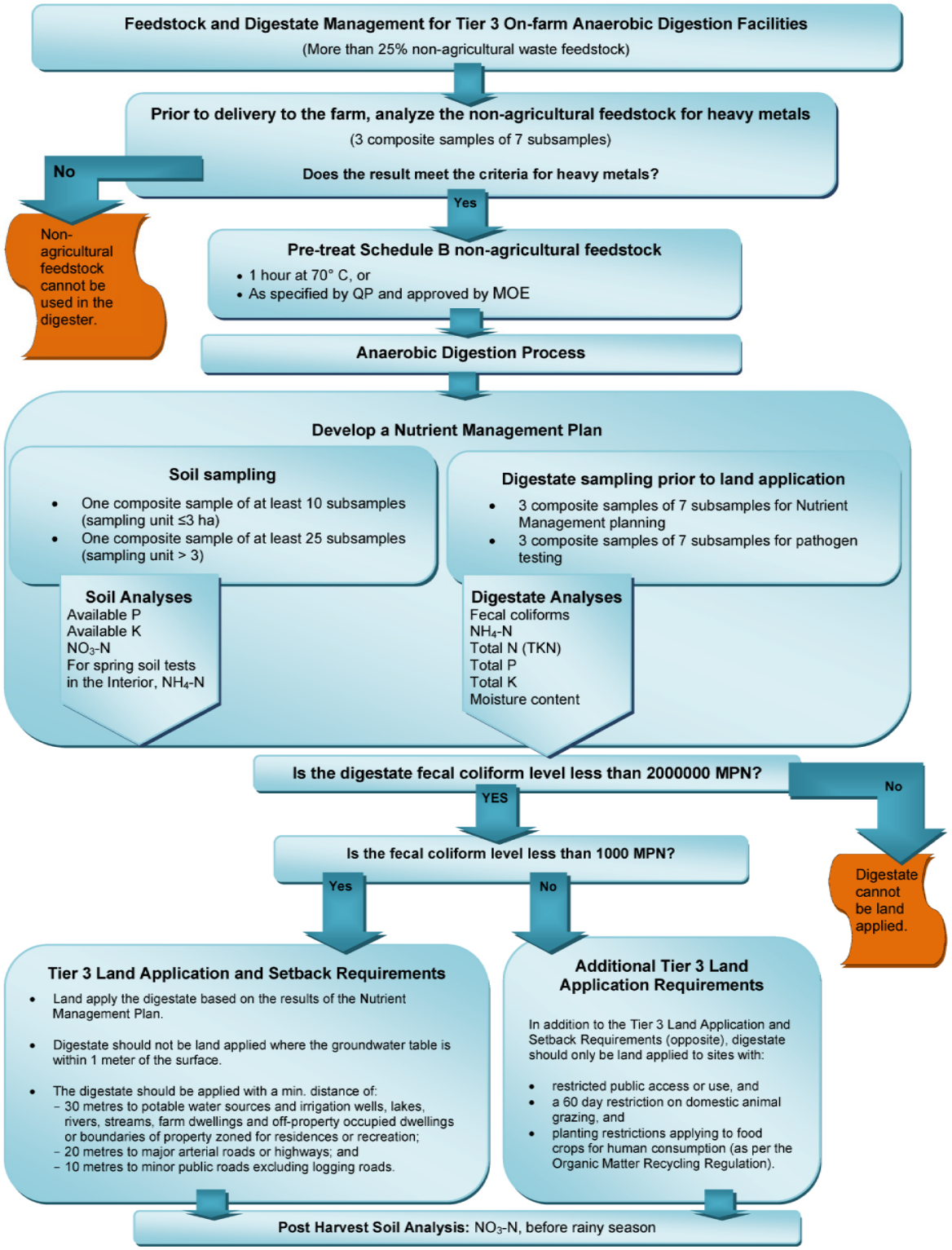


Figure 6. Flowchart of Feedstock and Digestate Management for a Tier 3 Anaerobic Digestion Facility

15.1 Heavy Metals Sampling Frequency (non-agricultural feedstock)

Prior to delivery onto the farm, the imported, non-agricultural feedstock should be sampled for heavy metals at a frequency that is dependent on the consistency of the source, and the composition of the feedstock.

Recommendations for sampling the feedstock:

- sample once every 12 months, or
- sample more frequently in the first two to three years of operation based on MOE recommendations, and
- repeat sampling if the feedstock composition or type changes, or is received from a different source.

15.2 Heavy Metals Sampling Procedures (non-agricultural feedstock)

Three composite samples each of 7 subsamples should be taken from the imported non-agricultural feedstock. Each subsample should be taken from a different spot of the feedstock storage pile at a minimum depth of 30 cm (if possible). If the depth of the sample is less than 30 cm, samples should be taken from below the surface of the feedstock or the feedstock should be well mixed before sampling.

15.3 Non-Agricultural Feedstock Heavy Metals Limits

Table 12 includes a list of recommended heavy metals for which the non-agricultural feedstock should be tested, prior to delivery on the farm. The table also includes the recommended maximum concentration of the heavy metals.

Only non-agricultural feedstock with a maximum concentration not exceeding the limits listed in Table 12 should be mixed in the digester. The limit is not cumulative but rather ensures that no non-agricultural feedstock coming onto the farm is allowed to be over the limits presented in Table 12.

Table 12: On-farm Anaerobic Digestion Heavy Metal Maximum Concentration for Tier 3 Non-agricultural Feedstock

Substance	**Maximum concentration in anaerobic digestion non-agricultural feedstock** µg/g dry weight
Arsenic	13
Cadmium	3
Chromium	100
Cobalt	34

Copper	400
Lead	150
Mercury	2
Molybdenum	5
Nickel	62
Selenium	2
Zinc	500

15.4 Schedule B Feedstock Pasteurization

The list of acceptable feedstock for on-farm anaerobic digestion is provided in Chapter 11, as well as Appendix 1. The feedstock list is broken down into three schedules: A, B, and C. In order to reduce pathogens, it is recommended that all feedstock listed in Schedule B undergo pasteurization prior to digestion for:

- 1 hour at 70° C, or
- as specified by a qualified professional and approved by MOE.

15.5 Nutrient Management Planning

For farms with a Tier 3 anaerobic digestion facility, it is recommended that for each 12 month period, a qualified professional (QP), should develop a Nutrient Management Plan for the land on which the digestate will be applied. The QP should select a nutrient management strategy that considers the environmental risks associated with land application of the digestate.

The BC Ministry of Agriculture and Lands' Nutrient Management Planning Calculator and Nutrient Management Reference Guide* can be used to develop the Nutrient Management Plan. A nitrogen based approach for nutrient management planning can be used, although the QP that prepares the plan should consider the environmental risks associated with over application of phosphorous (P). In some cases a P-based approach could be selected e.g., at sites where the soil P level is elevated and runoff or erosion may enter a sensitive receiving environment. If a P-based approach is selected, the following maximum application rates are recommended for the land application of the digestate.

The maximum application rate of the digestate and all other nutrients should be land applied such that the first-year available phosphorus in the digestate during any one-year period does not exceed the annual crop nutrient uptake of P plus:

i) 20 kg P per hectare per year if the soil test P (plant available P), as determined for the Nutrient Management Plan, is between 100 and 140 parts per million, or

ii) 10 kg P per hectare per year if the soil test P (plant available P), as determined for the Nutrient Management Plan, exceeds 140 parts per million.

*The Nutrient Management Planning Calculator is available to qualified professionals upon request from the following contact at the BC Ministry of Agriculture and Lands:

Orlando Schmidt
Environmental Soils Specialist
Sustainable Agriculture Management Branch
Email: Orlando.Schmidt@gov.bc.ca
Phone: (604) 556 – 3101

The Nutrient Management Reference Guide is available online at:
http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/EFP_Nutrient_Guide/Nutrient_Guide_toc.htm

15.6 Digestate Sampling Frequency

The digestate sampling frequency for nutrients depends on the consistency of the source and composition of the feedstock.

Generally the digestate should be sampled:

- once every 12 months, or
- more frequently in the first two to three years of operation based on MOE recommendations, and
- sampling should be repeated if the feedstock composition or type changes or is received from a different source.

For pathogen (fecal coliform) testing, 7 discrete samples should be taken from every 1000 cubic meters of the total digestate (after digestion and before land application).

15.7 Digestate Sampling Procedures

For nutrient concentration of the digestate (after digestion and before land application), three composite samples each of 7 subsamples should be taken. Each subsample should be taken from a different spot of the pile or lagoon at a minimum depth of 30 cm. Each composite sample should include subsamples from different spots of the pile or lagoon.

For pathogen testing, the 7 discrete samples should be taken from:

- the liquid digestate, if only liquid digestate is land applied,
- the liquid and solid digestate without separation, if the digestate is land applied without separation of solid and liquid fractions,

- the solid digestate, if only the solid digestate is land applied.

For more information on sampling for pathogens, refer to OMMR and the "Land Application Guidelines for the Organic Matter Recycling Regulation and the Soil Amendment Code of Practice" page 67 Pathogen Reduction: http://www.env.gov.bc.ca/epd/industrial/regs/codes/soil_amend/pdf/land-app-guide-soil-amend.pdf.

15.8 Recommended Digestate Analyses

The following analyses of the digestate are recommended prior to land application and to facilitate the nutrient management planning process:

i. Ammonium nitrogen (NH_4-N)
ii. Total Kjeldahl Nitrogen (TKN)
iii. Total phosphorous (P)
iv. Total potassium (K)
v. Moisture content
vi. Pathogens **

** For Tier 3 on-farm anaerobic digestion facilities only digestate with a geometric mean of fecal coliform levels of 7 discrete samples that is < 2000 000 most probable number (MPN) per gram of total solids (dry weight basis) can be land applied. If the process of digestion achieves fecal coliform levels of < 1000 MPN per gram of total solids (dry weight basis) the Land Application Plan restrictions are fewer than land application restrictions for a digestate with fecal coliform levels < 2000 000 MPN (see section 15.7).

15.9 Soil Sampling Frequency

For nutrient management planning purposes the soil should be sampled:

- before the first land application of the digestate, and
- repeated every 12 months to provide a baseline nutrient concentration in the digestate and the soil, and
- conduct post harvest sampling to monitor the level of nitrate (NO_3), in the soil.

15.10 Soil Sampling Procedures

For nutrient management, one composite sample of soil of at least 10 subsamples should be taken from each sampling unit ≤3 ha in area and one composite sample of at least 25 subsamples should be taken from larger sampling units.

Soil samples are collected from a depth of 0 to 15 cm. Post harvest soil samples should be taken from 15-30 and 30-60 cm sampling depths to monitor nitrate leaching.

15.11 Recommended Soil Analyses

The following soil analyses are recommended prior to the first land application of the digestate and to facilitate the nutrient management planning process:

i. Available phosphorus (P)
ii. Available potassium (K)
iii. Nitrate-nitrogen (NO_3-N)
iv. For spring soil tests in the BC Interior, ammonia-nitrogen (NH_4-N)

The following post harvest soil analysis is recommended to monitor the level of remaining nutrient.

i. Nitrate-nitrogen (NO_3-N)

For more information on sampling and analyses, refer to the following documents:

Nutrient Management Factsheet, Soil Sampling for Nutrient Management
http://www.agf.gov.bc.ca/resmgmt/publist/600Series/631500-1.pdf

Nutrient Management Factsheet, Manure Sampling and Analyses for Nutrient Management
http://www.agf.gov.bc.ca/resmgmt/publist/600Series/631500-3.pdf

Land Application Guideline for the Organic Matter Recycling Regulation and Soil Amendment Code of Practice http://www.env.gov.bc.ca/epd/industrial/regs/codes/soil_amend/pdf/land-app-guide-soil-amend.pdf.

15.12 Land Application Plan

A Land Application Plan approved by a qualified professional is recommended for each Tier 3 anaerobic digestion facility. The Land Application Plan should be effective for every 12 month period and include a Nutrient Management Plan plus the following administrative information:

a) the full legal name and address of the facilities where the digestate is produced;
b) the name of the local contact, local address, and telephone number for the discharger of digestate;
c) the name and address of the qualified professional producing the Land Application Plan;
d) the name of the registered owner of the land upon which the land application of digestate will take place;
e) the street address and legal description of the land application site;
f) the location and boundaries of the land application site, and provide a map or plan;

g) written authorization of registered owner(s) or his or her agent(s) for the land application of digestate;

h) the intended commencement date and subsequent dates for land application;

i) storage and leachate management practices for digestate at the application site;

j) a physical description of the constituents, including foreign matter, of the digestate to be applied.

k) the results of all recommended analyses;

l) a Nutrient Management Plan, signed and certified by a qualified professional that supports the planned application rates;

m) pH and electrical conductivity in the soil where the digestate is to be applied;

n) pH and electrical conductivity in the digestate to be applied.

15.13 Digestate Land Application

The following recommendations apply to Tier 3 on-farm anaerobic digestion facilities for the land application of digestate:

- The land application of digestate is to be in accordance with an approved Land Application Plan.
- Digestate may not be applied to frozen land.
- Anaerobic digestion solid digestate with fecal coliform levels ≥1000 MPN per gram of total solids (dry weight basis) of the digestate should:

    a) be applied only to sites with restricted public access or use;

    b) not be applied to land where the groundwater table at the time of application is within one metre of the surface;

    c) be applied only if:
        (i) domestic animal grazing is restricted for 60 days and food crops for human consumption with harvested parts above the surface of the land are not to be grown for 18 months, and
        (ii) food crops for human consumption with harvested parts below the surface of the land are not to be grown for 38 months;

    d) be applied with the following minimum distances:
        (i) 30 metres to potable water sources and irrigation wells, lakes, rivers, streams, farm dwellings and off-property occupied dwellings or boundaries of property zoned for residences or recreation;
        (ii) 20 metres to major arterial roads or highways;
        (iii) 10 metres to minor public roads excluding logging roads;

- Anaerobic digestion solid digestate with fecal coliform levels < 1000 MPN per gram of total solids (dry weight basis) of the digestate should:

    a) not be applied to land where the groundwater table at the time of application is within one metre of the surface;

    b) be applied with the following minimum distances:
        (i) 30 metres to potable water sources and irrigation wells, lakes, rivers, streams, farm dwellings and off-property occupied dwellings or boundaries of property zoned for residences or recreation;
        (ii) 20 metres to major arterial roads or highways;
        (iii) 10 metres to minor public roads excluding logging roads.

15.14 Composting

If the solid digestate fraction is to be used as animal bedding, it should be processed to a point where sanitary conditions for bedded animals can be ensured. The digestate can also be composted based on the provisions of OMRR and if Class A or B compost is produced it can be land applied based on OMRR. OMRR is available for download at: http://www.env.gov.bc.ca/epd/epdpa/mpp/omrreg.html.

15.15 Record Keeping

The results of the analysis required by the Land Application Plan should be kept at the facility for at least 36 months after production of the digestate.

Chapter 16: Recommended Best Management Practices

This chapter contains recommended best management practices (BMPs) for an anaerobic digestion facility. This includes feedstock collection, handling, and storage BMPs as well as recommendations to reduce odour and fugitive dust; and general guidance on workplace safety and emergency planning. Although BMPs are not regulated requirements, they may become regulated requirements when written into a waste discharge authorization. As such, proponents are advised to review these BMPs in order to evaluate their applicability to the project.

16.1 Collection

Collection is defined as the system through which feedstock is brought to the digester. The collection system will consist of pumping through pipes from adjacent farms (piping) and/or trucking from farms, food processors or other producers of feedstock that are appropriate for on-farm anaerobic digestion. To facilitate traceability, feedstock brought on to the farm should be documented in accordance with the recommendations in Chapter 17. Appropriate feedstock can be in liquid or solid form. Liquid form is preferable, especially if the feedstock may cause odour problems during pre-storage, as the whole collection and pre-storage system can then be completely enclosed. If the collection distance is not suitable for piping, liquid feedstock should be transported to the anaerobic digestion facility using a tanker truck, similar to the models used for septic tank clean up and sewage transportation. Solid feedstock should be transported to the digester using trucks with covered, leak-proof boxes.

Proponents should identify the following in an application:

- The type of collection system(s) utilized within the project (e.g., piping, liquids trucking or solids trucking)
- If piping is involved, the volume and type of material being piped
- If liquids trucking is involved, the type of truck as well as volume and type of material being trucked
- If solids trucking is involved, the type of truck as well as volume and type of material being trucked
- The total number of trucks entering the anaerobic digestion site per day.

16.2 Handling

Handling is defined as the way collected feedstocks are received at the digestion facility. Since these types of anaerobic digestion facilities will be operating on active farms it is important to adhere to biosecurity and food safety standards. This means that dirty traffic (feedstock,

digestate) should be separated from clean traffic (feed, live animals, food products) by the use of two separate driveways to avoid cross contamination. Some farm types, poultry and hog operations in particular, have strict biosecurity programs and rules that must be followed. Trucks that are traveling from farm to farm and trucks carrying non-food grade waste should be disinfected (tires and under carriage) at the entrance to the property before proceeding to the digester facility. For further information see the Biosecurity Program Manual available on the BC Agricultural Research & Development Corporation's website at: http://www.ardcorp.ca/index.php?page_id=15.

Unloading of incoming feedstock is a critical control point that has to be properly managed to avoid odour, run-off and cross contamination. Liquid feedstock should be pumped directly from the tanker truck or the pipeline into an enclosed pre-storage tank. Solid feedstock should either be tipped directly into pulping equipment for subsequent storage as a liquid in an enclosed pre-storage tank, or tipped directly into the solid feedstock storage facility. Solid feedstock that must be stored in a solid form at an on-farm anaerobic digestion facility should be covered as soon as possible after loading it into the solid feedstock storage facility.

Proponents should identify the following in an application:

- The measures that will been taken to separate clean and dirty traffic at the farm that is hosting the anaerobic digestion facility
- The disinfection process at the entrance to the property for trucks that are traveling from farm to farm and trucks carrying non-food grade waste
- The way in which liquid feedstock is unloaded into the pre-storage tank
- The way in which solid feedstock is unloaded into the pre-storage facility (for example, will it be loaded into the liquid storage tank through a pulper or loaded into solid feedstock storage on-site?).

16.3 Pre-storage

Pre-storage is defined as the facilities (tanks or structures) in which feedstock is stored before the digestion process. Pre-storage can be divided into two sub-categories, namely liquid and solid pre-storage facilities.

16.3.1 Liquid Pre-storage

The pre-storage tank system for liquid feedstock may include any and all of the following components in various combinations: reception tank, pasteurization tank, storage tank and mixing tank. The pre-storage system for liquid feedstock for on-farm anaerobic digestion should consist of fully enclosed tanks, i.e., an odour-tight receptacle. Complete enclosure

addresses many problems, such as dilution by rain water, air emissions including odour, cross contamination, run-off and vector attraction (rodents, flies, scavengers, etc.). The tanks can be above or below grade and are usually made of either concrete or steel (although fibreglass and plastic tanks exist as well). Below-grade tanks are preferable, because they facilitate the process of unloading feedstock, provided that ground water and floodplain concerns can be addressed through appropriate design and structuring. Pre-storage tanks for liquid feedstock can also be used to store macerated (pulped) solid feedstock. Storage of solid feedstock as a pulp in an enclosed storage tank is the preferred option compared to having solid feedstock stored as solids at the digester site. There should be a secondary containment system around the storage tanks and the unloading area to catch spills and potential accidental overflows. The secondary containment could for example be a raised ledge around the area combined with appropriate grading towards a drain grate. Collected spill or overflow should be able to be pumped back into the digester system.

16.3.2 Solid Pre-storage

Pre-storage facilities for solid feedstock for on-farm anaerobic digestion should prevent any run-off, minimize odour and keep scavengers and other vectors out of the stored material. The storage facility may consist of a storage bunker with an impermeable base and impermeable walls on three sides. The front of the bunker (machine entrance) should have a raised ledge to prevent overflow of liquids seeping out of the stored solid feedstock as well as a collection grate that collects all seeping liquids. Seeping liquids should be pumped to the digester system through a sump system. An alternative to the three walled bunker-style storage system could be to use the same types of long plastic pods (e.g., Ag-Bags) that are sometimes used for silage. This would contain run-off and provide odour control as long as all potential seepage from the open front end of the pod is collected via a secondary containment system and drains down to a sump system, it can then be pumped to the digester system. Another alternative would be a steel container from which solid feedstock is augured out to a pulper or directly to the mixing tank.

Proponents should identify the following in an application:

- The type of pre-storage system for liquid feedstock (include structural material, whether above/below grade and how complete enclosure is achieved)
- The components of the liquid feedstock storage system (reception tank, pasteurization tank, storage tank, mixing tank, etc.) including the respective sizes of the various tanks
- The type and size of pre-storage for solid feedstock (bunker, container, plastic pod, etc.) if applicable

- The system for collecting and returning any run-off from pre-storage, loading and unloading
- The maximum amount of liquid and solid agricultural feedstock (manure, crop residues, crops, etc.) that will be in pre-storage facilities on-site at any given time
- The maximum amount of liquid and solid non-agricultural feedstock (food processing waste, fats, oils and greases, grocery waste, etc.) that will be in pre-storage facilities on-site at any given time.

16.4 Pre-treatment

Prior to addition to the digester tank, different feedstock types can be mixed together and homogenized. This may include shredding, pulping, mixing and/or macerating the feedstock into a consistent form. A feedstock with consistent viscosity may reduce the frequency of constant operational adjustments to the digester system.

The Schedule B feedstock materials listed in Chapter 11 present a higher risk of causing contamination, and require pasteurization prior to homogenization with Schedule A feedstocks. All Schedule B feedstocks are recommended to be pasteurized at 70^{o} C for a minimum of one hour, or as specified by a qualified professional.

The homogenized Schedule A and B feedstock can be pre-heated prior to introduction into the digester. Pre-heating is not the same as pasteurization as it is conducted at a lower temperature and is intended to be a cost effective way of allowing the newly introduced feedstock to come up to temperature within the digester. The pre-treatment steps should take place in enclosed tanks to prevent odours and runoff.

Proponents should identify the following in an application:

- Type and volume of feedstock that will require pasteurization (as per Chapter 11, Schedule B)
- Pasteurization design parameters such as temperature and retention time.

16.5 Post-Storage

Post-storage is defined as the facilities (tanks or structures) in which digestate is stored after the digestion process. Post-storage can be divided into two sub-categories, namely liquid and solid post-storage facilities.

16.5.1 Liquid Post-storage

The facilities for storing liquid digestate after the digestion process may consist of open pits or fully contained tanks that are designed to eliminate the chance of run-off or leaks. It is important to have enough available liquid digestate storage space to ensure that the digestate can be applied to crops when the fertilizer is needed and it is environmentally safe to land apply.

The digestion process will convert much of the organically bound nitrogen to ammonium nitrogen and at the same time raise the pH slightly. Both of these factors make digestate more prone to loss of nitrogen through ammonia emissions during storage and land application (compared to raw liquid manure). In order to retain fertilizer value and prevent ammonia emissions, it is advisable to cover liquid digestate in the post-storage stage. The cover can be a floating contact cover or a framed "circus tent" type cover. Both have the added advantage of providing an opportunity to siphon off any remaining methane, increasing the overall efficiency of the digester, as well as further reducing odour from the operation.

16.5.2 Solid Post-storage

Post-storage facilities for separated solids should be designed in such a way as to prevent any run-off of seepage from the stored solids. The storage facility may consist of a storage bunker with an impermeable base and impermeable walls on three sides. The front of the bunker (machine entrance) should have a raised ledge to prevent overflow of liquids seeping out of the stored solid feedstock as well as a collection grate that collects all seeping liquids. Seeping liquids should be pumped to the digester system through a sump system.

The post storage facility can also serve as a composting or curing facility for the separated solids. It is advisable to have a roof structure covering the solids storage/composting facility to keep the material dry to prevent anaerobic conditions.

Proponents should identify the following in an application:

- Type of post-storage system for liquid feedstock (include structural material, whether above/below grade)
- Type and size of post-storage for solid feedstock if applicable
- System for collecting and returning any run-off from post-storage, loading and un-loading
- Calculated storage capacity expressed in days, based on post-storage size and digestate flow rate.

16.6 Odour Control

Odour control is defined as equipment and management practices that reduce neighbour and community impacts related to foul smells originating at the anaerobic digestion facility.

Compared to handling raw manure, anaerobic digestion is a good way of reducing odour. There is, however, a risk for increased odour associated with storing and transporting agricultural and non-agricultural feedstocks to and from the digester site. It is very important for an on-farm anaerobic digestion project to ensure that odour from storage and handling of feedstock and digestate is minimized in order to maintain the net positive impact of anaerobic digestion with respect to odour. Common practices to reduce odour at on-farm anaerobic digestion facilities include pumping liquid feedstock directly into fully enclosed storage tanks, pulping solid feedstock and pumping it directly into completely enclosed liquid storage tanks instead of storing it on-site in solid form, aerating and covering solid feedstock storage facilities and covering digestate storage tanks. If particularly odorous feedstock is to be handled it may be necessary to unload, store, and handle that feedstock within a negative air pressure building with an attached biofilter for exhaust air.

The hydrogen sulphide portion of the biogas may also be a source of odour if not managed properly. It is very important the biogas remains within the anaerobic digestion system and associated works with controls, e.g., flares, in place to avoid direct venting to atmosphere. For further information on flaring, see Chapter 10.

Another potential source of odour is composting the solid digestate after it has been removed from the digester and the liquid portion extracted. By composting and selling the solid digestate, an additional revenue source is created. When composting, the key to limiting odour is to ensure proper aeration while minimizing agitation of the composting material. Composting under cover, on a concrete pad with forced air outlets underneath the pile represents best management practices with respect to limiting odour from composting. For further guidance on composting refer to the Ministry of Environment's website for the Organic Matter Recycling Regulation and supporting documents at: http://www.env.gov.bc.ca/epd/epdpa/mpp/omrreg.html.

16.6.1 Odour Reduction Strategy

The proponent should develop an Odour Reduction Strategy to control offensive odours. The strategy should identify actions to undertake to minimize odours, e.g., remove the waste stream from the process that is causing the offensive odour, improve control technologies, etc.

16.6.2 Odour Response Plan

The proponent should include an Odour Response Plan in the waste discharge authorization application. The plan should provide, at minimum, the following information:

a) How complaints will be recorded (name and contact info of complainant)
b) Party responsible for responding to the complaint
c) A detailed description of the complaint (date, time, wind speed and direction to enable validation of complaint)
d) Steps to be undertaken to prevent the same situation from reoccurring
e) The action proposed to respond to the complainant
f) The follow up process to determine the effectiveness of the mitigating actions
g) Notification process to the Ministry of Environment

In the event of any undesirable odourous emissions from the operation, the proponent may be required to provide additional control measures and/or curtail the operation.

Proponents should identify the following in an application:

- Identify all potential points of odour at the facility. For example, escaping air from tanks for liquid storage during feedstock filling, unloading of dry feedstock, composting of digested solids, etc.
- Odour Reduction Strategy to minimize odour, including equipment and infrastructure design, as well as management practices
- Odour Response Plan and forms to log complaints.

16.7 Fugitive Dust

Fugitive particulate emissions created within the operation area must be suppressed. The main cause of fugitive dust associated with an anaerobic digestion facility is usually from vehicle traffic on unpaved roads transporting feedstock to the facility and by-products from the facility. Remedial actions include paving or spraying the roads with water. Measured ambient air quality may be compared to the Ministry of Environment's Air Quality Objectives and Standards (see Appendix 3). If the measured ambient air quality exceeds objective values, the sensitivity of the receiving environment, the contribution of the particulate source to the measured ambient values, plus any other pertinent information, may be evaluated. The waste discharge authorization may be amended to require additional monitoring or control measures for fugitive particulate sources.

Proponents should identify the following in an application:

- Strategy for controlling fugitive dust at the facility
- Length and surface type of driveways used for truck access to the facility.

16.8 Setbacks

A setback is the minimum required distance between any two points of interest. In locating an anaerobic digestion facility, the setback would be between a piece of infrastructure included in an on-farm anaerobic digestion system and a point of interest in the surroundings. Applicable infrastructure may include pre-storage and handling facilities, the digesters themselves, biogas cleaning and utilization equipment, as well as solid liquid separation equipment, composting/storage facilities for separated solids, and post-storage of liquid digestate. The infrastructure related to anaerobic digestion is similar to agricultural waste storage facilities, on-farm storage facilities, silos and on-farm petroleum storages.

The table below compares existing setbacks from the Agricultural Waste Control Regulation (AWCR) and recommended setbacks from the Ministry of Agriculture and Land's Strengthening Farming Factsheet titled Guide for Bylaw Development in Farming Areas (Bylaw Guide). The setbacks in the Bylaw Guide are in Part C which is available at: http://www.agf.gov.bc.ca/resmgmt/publist/800Series/840000-1.pdf.

Table 13: Comparison of Agriculture Related Setbacks from the AWCR and Bylaw Guide

Setbacks From	AWCR	Bylaw Guide
Storage facility to any watercourse	15 m	n/a
Storage facility to any source water for domestic purposes	30 m	n/a
Field storage facility to any watercourse or any source of water used for domestic purposes	30 m	n/a
Agricultural liquid or solid waste storage facility to edge lot line	n/a	30 m*
Generator shed to edge lot line	n/a	15 m**
Agricultural liquid or solid waste storage facility to domestic water supply intake	n/a	30 m
Principal farm buildings, structures, & areas from domestic water supply intake	n/a	30 m** 6 m ***
Principal farm buildings, structures, & areas from natural streams, channelized streams and constructed channels or	n/a	15 or 30 m** 4.5 m***

ditches		

* For livestock, poultry, game or fur operations.
** For greenhouse, nursery, speciality wood, or turf crops operations.
*** For livestock, poultry, game fur – 30 m is for confined livestock area and only if there are more than 10 agricultural units in that area.

For biosecurity reasons the digester tanks, loading areas and access roads to the digester facility should be built in such a way that there is no risk of cross contamination with traffic within any existing Controlled Access Zones (CAZ). CAZ is a buffer area around a poultry or livestock production barn where both human and vehicle traffic is tightly controlled to prevent spread of disease to and between production animals.

For setbacks regarding the spreading of digestate see Chapters 13 through 15.

Proponents should identify the following in an application:

- The minimum distance between any infrastructure related to on-farm anaerobic digestion and:
  - lot line;
  - domestic water supply intake;
  - natural streams, channelized streams and constructed channels or ditches; and CAZs for biosecurity purposes.

16.9 Workplace Safety

Anaerobic digestion involves heavy machinery and materials that can negatively impact human health and the environment. It is important that proper precautions are taken to reduce the risks associated with these facilities. These recommendations are suggested minimum standards. Consult with WorkSafe BC for definitive rules.

- All individuals working with the anaerobic digester should receive training that includes system components, normal operation, emergency operations and maintenance.
- Open flames should not be permitted within 10 meters of the digester. Principal operators must ensure that appropriate signage is in place, e.g., no smoking.
- The principal operator of the digester should perform a weekly inspection that includes checking for cracks, tears, or points of distress on the digester machinery, the presence of an odour, and signs of feedstock or gas leakage.
- Preventative maintenance should be conducted at least yearly in accordance with the component manufacturer's recommendations.
- Methane is highly explosive when mixed with air. It can also displace oxygen when near the ground and cause asphyxiation. Therefore, all buildings associated with the digester should be well ventilated. Motors, wiring, and lights should be explosion-proof; flame

arrestors should be used on gas lines, and alarms and gas-detection devices should be used.

- Principal operators should be familiar with the safety precautions regarding manure pits, manure gas, and confined spaces on the WorkSafeBC website: http://www2.worksafebc.com/Portals/Agriculture/Home.asp.

16.10 Emergency Plan

Each on-farm anaerobic digester proponent should create and implement an emergency plan. This plan should be developed prior to construction and contain the following elements:

- All relevant emergency contact numbers, including neighbours and all parties directly responsible for the digester.
- Description of the people, animals, and farm.
- Map of the facilities with all hazards, fire extinguishers and exits clearly marked.
- Priority procedures for emergency response and reporting an emergency.
- Evacuation procedures.
- Procedure to account for all personnel after evacuation.
- Procedures for personnel remaining behind to operate emergency equipment or shut down facility operations before they evacuate.
- Procedures specific to the following:[2]
    - Accidental release of materials hazardous to the environment
    - Biosecurity emergencies including Foreign Animal Disease outbreaks
    - Blizzard emergencies
    - Earthquake emergencies
    - Fire emergencies
    - Explosion emergencies
    - Flood emergencies
    - Heat wave emergencies
    - High wind emergencies

[2] http://www.isafarmnet.com/index.html

Chapter 17: Monitoring, Record Keeping, and Reporting

17.1 Monitoring and Record Keeping

Each anaerobic digestion proponent should establish and maintain a written record of the monitoring activities described in Table 14. Records should be kept for 36 months and be made available to MOE upon request within 2 business days.

Table 14: Monitoring and Record Keeping Schedule for an On-farm Anaerobic Digestion Facility

Critical Control Point	Monitored Parameter	Recording Frequency	Record Keeping Requirement
Non-agricultural feedstock delivery			
Source of feedstock	Name and address of generator and hauler as well as date of delivery to anaerobic digestion facility	Each load delivered to the anaerobic digestion facility	36 months from load delivery
Type of feedstock	Type of feedstock from Chapter 11, e.g. fats, oils and grease, etc.		
Amount of feedstock	Weight (tonne)/load		
Refused loads	Name and address of generator and hauler as well as date of delivery to anaerobic digestion facility and reason for refusal	Each refused load	36 months from load refusal
Non-agricultural feedstock content			
Incoming heavy metals (**Tier 2 and Tier 3 anaerobic digestion facilities only**)	Heavy metals concentration as described in Table 11 and 12	Every 12 months and when feedstock changes	36 months after sampling
Pasteurization of Schedule B feedstock	Temperature and retention time	Continuously	36 months
Agricultural feedstock delivery and content			
Source of feedstock	Name and address of farms that deliver feedstock	Once, before commencing operation and when feedstock changes	For the duration of the project
Type of feedstock	Type of feedstock from Chapter 11, e.g., Agricultural waste		
Amount of feedstock	Weight (tonne)/day or as received if less frequent		
Incoming nutrients	Organic N, NH_4-N, NO_3/NO_2-N, total P, total K, moisture content and ash		
Digestate and Soil Sampling			
Out-going liquid digestate amount	Volume (m^3)/day	Once every 24 hr period	36 months
Out-going solid digestate amount	Volume (m^3)/day		
Out-going liquid digestate nutrients	NH_4-N, total TKN, total P, total K, and moisture content	Every 12 months and when feedstock changes	36 months after sampling
Out-going solid digestate nutrients (if	NH_4-N, total TKN, total P, total K, and moisture content		

used as fertilizer or soil amendment)			36 months after sampling
Soil nutrient content of land where digestate is to be applied	Available P, available K, NO_3-N and for the Interior spring time NH_4-N	Once per year	
Post harvest residual soil nitrogen content	NO_3-N		
Out-going digestate pathogens (**Tier 3 anaerobic digestion facilities only**)	Fecal Coliform (MPN)	Every 1000 m^3 of digestate flow	
Digestate delivery			
Destination of solid and/or liquid digestate	Name and address of receiver of digestate as well as date of delivery	Each load exiting the facility	36 months from load delivery
Biogas operations monitoring			
Biogas composition	Time logged H_2S concentration in raw biogas as it leaves the digester (continuous analyzer)	Continuously	
Biogas flow rate	Time logged flow rate to/from processing equipment	Continuously	
Flare operation	Activation and deactivation time, volume of gas combusted, reason for activation	Each activation cycle	
Low/High pressure valves	Activation and deactivation time, volume of gas vented, reason for activation	Each activation cycle	
Odour	Intensity, (source of odour, reason for odour and wind direction, if applicable)	Once every 24 hr	
Complaints			
Complaints registration	Reason for complaint, time and date of complaint, contact information to complainant if available and actions taken to address complaint.	Each occurrence	36 months

17.2 Reporting

Reporting requirements specific to the on-farm anaerobic digestion facility will be developed by the Ministry of Environment and included as part of the waste discharge authorization.

Chapter 18: Further Resources

18.1 British Columbia Resources

Publications

- *An Overview of On-farm Biogas Production*, MAL Waste Management Factsheet, http://www.agf.gov.bc.ca/resmgmt/publist/300Series/382600-1.pdf
- *On-Farm Anaerobic Digestion Education Mission-Vermont*, MAL Report, http://www.agf.gov.bc.ca/resmgmt/publist/300Series/382600-2.pdf
- *Farmstead Refuse*, MAL Farm Practice Factsheet, http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/activity/870218-35_Farmstead_Refuse.pdf
- *Non-agricultural Waste,* MAL Farm Practice Factsheet, http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/activity/870218-47_Non_Agric_Waste.pdf
- *British Columbia Environmental Farm Plan Reference Guide,* MAL, http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/EFP_Refguide/refguide_toc.htm
- *Resources from Waste: A Guide to Resource Recovery,* Ministry of Community and Rural Development, http://www.cd.gov.bc.ca/lgd/infra/resources_from_waste.htm

Websites

- Anaerobic Digestion Initiative Advisory Committee, http://www.bcfarmbiogas.ca/
- BC Milk Producers Association, http://www.bcmilkproducers.ca/index.php
- BC Bioenergy Network, http://bcbioenergy.ca/home/index.html
- BC Innovation Council, http://www.bcic.ca/
- BC Sustainable Energy Association, http://www.bcsea.org/
- Community Energy Association, http://www.communityenergy.bc.ca/
- Ministry of Community and Rural Development, http://www.cd.gov.bc.ca/lgd/infra/resources_from_waste.htm

18.2 Resources from Other Jurisdictions

Publications

- *Anaerobic Digestion Basics,* Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/engineer/facts/07-057.htm
- *A Primer for Planners on Anaerobic Digestion (Biogas) Systems in Prime Agriculture Areas,* Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/landuse/facts/ad_primer.htm
- *Considerations and Opportunities for Building a Farm-Based Anaerobic Digester System in Ontario,* Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/engineer/facts/consider.htm

- *Nutrient Management Regulation Requirements for On-Farm Anaerobic Digestion Facilities,* Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/engineer/facts/nm_ad.htm
- *Developing an Implementation Plan for Anaerobic Digestion,* United Kingdom Department for Environment, Food, and Rural Affairs, http://www.defra.gov.uk/environment/waste/ad/pdf/implementation-plan.pdf

Websites

- Anaerobic Digestion and Biogas, Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/engineer/energy.html
- Go Biogas! Ontario Agriculture and Food Biogas Systems Blog, http://gobiogas.blogspot.com/
- The AgSTAR Program, U.S. Environmental Protection Agency, http://www.epa.gov/agstar/
- ManureNet, Bioenergy and Manure Management Information, http://gis.lrs.uoguelph.ca/AgriEnvArchives/bioenergy/manurenet.html
- Anaerobic Digestion, United Kingdom Department for Environment, Food, and Rural Affairs, http://www.defra.gov.uk/environment/waste/ad/index.htm
- Renewable Energy Research: Biomass-Anaerobic Digestion, The California Energy Commission, http://www.energy.ca.gov/research/renewable/biomass/anaerobic_digestion/index.html
- Anaerobic Digestion and Bio-Gas, Midwest Rural Energy Council, http://www.mrec.org/anaerobicdigestion.html
- England's Official Information Portal on Anaerobic Digestion, http://www.biogas-info.co.uk/

18.3 Relevant Provincial Legislation

The following Acts and Regulations can be downloaded for viewing from the BC Laws website at: http://www.bclaws.ca.

- *Agricultural Land Commission Act*
- *Agricultural Land Reserve Use, Subdivision and Procedure Regulation*
- *Agricultural Waste Control Regulation*
- *Environmental Management Act*
- *Farm Practices Protection (Right to Farm) Act*
- *Hazardous Waste Regulation*
- *Health Act*
- *Organic Matter Recycling Regulation*
- *Recycling Regulation*

- *Permit Fees Regulation*
- *Soil Amendment Code of Practice*
- *Spill Reporting Regulation*
- *Waste Discharge Regulation*
- *Workers Compensation Act*

18.4 Relevant Federal Legislation

Federal Acts and Regulations can be viewed from the Department of Justice website at: http://laws.justice.gc.ca/en/index.html.

- *Feeds Act*
- *Fertilizers Act*
- *Fisheries Act*

Appendix 1: Feedstock List

Same as Chapter 11

Schedule A: Acceptable Feedstock for On-farm Anaerobic Digestion

Type of Feedstock	Specification
Agricultural waste and agricultural vegetation waste	- manure - used mushroom medium - residues from primary crop production - organic waste matter derived from the drying or cleaning of field crops or nut crops on farms - non-food vegetative matter resulting from gardening operations, landscaping, and land clearing on farms - animal bedding derived from straw, paper, hog fuel, wood chips, bark, shavings or sawdust
Brewery waste/winery waste	- used or diverted grain, malt, hop flowers, berries, fruit, leaves and twigs and yeast resulting from brewing or wine making process
Cooking oil from restaurants and food processors	- used or un-used food grade cooking oil that has been collected in a separate container and kept separate from all other waste streams until unloaded at the anaerobic digestion facility
Milk	- clean milk (without antibiotics), that has passed specification (e.g. oxidized, lack of refrigeration, etc.)
Organic by-products from ethanol or biodiesel facilities	- corn, canola-based mash, glycerine, etc.
Plant matter	- fruit, vegetable and vegetative material derived from fruit and vegetable processing or retail locations - herbaceous plant waste from flower shops, off-farm nurseries and retail locations - non-food vegetative matter resulting from gardening operations, landscaping, and land clearing - spent algae specifically grown in a controlled environment These are materials which either originated at a non-farm location or have been removed from a primary agricultural operation to a processing or retail facility and therefore no longer fit within the definition of agricultural waste (agricultural vegetation waste) as defined in the Agricultural Waste Control Regulation.
Waste products from animal feeds	- waste products from animal feeds listed in Classes 1,2,3,4 and 5 of Part 1 of Schedule IV to the Feeds Regulation, 1083 (SOR/83-593) made under the *Feeds Act* (Canada), *excluding* any materials that contain an animal product that has not

	been denatured Also includes materials that previously would have been a product described above but are no longer suitable for use in feeding of farm animals for reasons that do not include contamination by another material.
Whey	- whey and whey permeate, the watery part of milk that remains after the manufacture of cheese

Schedule B: Limited Feedstock for On-farm Anaerobic Digestion[1]

Type of Feedstock	**Specification**
Biosolids	- stabilized municipal sewage sludge resulting from a municipal waste water treatment process or septage treatment process which has been sufficiently treated to reduce pathogen densities and vector attraction to allow the sludge to be beneficially recycled in accordance with the requirements of Organic Matter Recycling Regulation (OMRR)
Dissolved air flotation (DAF) waste	- floc and scum from dissolved air flotation systems in food processing industries
Domestic septic tank sludge	- sludge removed from a septic tank used for receiving, treating and settling domestic sewage
Fat, Oil and Grease (FOG)	- grease trap fats, oils and grease from food processing and preparation
Fish wastes	- fish carcasses and parts from harvested wild stocks, commercial aquaculture operations and fish processing facilities. This would include offal, viscera and mortalities from fish and shellfish. It would also include faeces captured from commercial aquaculture net pens.
Food wastes	- recyclable food for humans that has been diverted from residential, commercial or institutional sources
Hatchery waste	- broken or unhatched eggs, unhatched chicks, membranes, embryonic fluids (Eggshell is not a recommended anaerobic digestion feedstock as it may harm equipment and settle in tanks.)
Milk processing waste	- sludge or biomass from treatment of milk or fluid milk which has been diverted from human food consumption
Paunch manure	- manure present in the digestive tract at the time of slaughter
Pet food, pet food residues	- waste streams and residues from preparation and processing of pet food as well as pet food that has gone off specifications or has expired

Poultry wastes except those that have died from infectious diseases	- carcasses, offal and viscera of domestic fowls, such as chickens, turkeys, ducks or geese, raised for meat or eggs
Red-meat waste except those that have died from infectious diseases	- carcasses, offal and viscera, of red-meat animals such as cattle, swine, sheep, fallow deer, farmed game and farmed bison. *Note:* Specified Risk Material is an unacceptable feedstock, see Schedule C.
Waste products from animal feeds	- listed in Classes 1,2,3,4 and 5 of Part 1 of Schedule IV to the Feeds Regulation, 1083 (SOR/83-593) made under the *Feeds Act* (Canada), *<u>including</u>* any material that contain an animal product that has not been denatured.

[1]The feedstock listed in Schedule B requires pasteurization, e.g., 70° C for 1 hour, or as specified by a qualified professional and approved by MOE.

Schedule C: Unacceptable Feedstock for On-Farm Anaerobic Digestion

Type of Feedstock	**Specification**
Catering waste from means of international transport	- airplane food waste, cruise ship food waste, etc.
Hazardous waste	- as defined by the Hazardous Waste Regulation
Mortalities that have died from infectious diseases	- e.g., transmissible spongiform encephalopathy
Organic wastes that are or contain: • Solvents containing volatile organic compounds • Fuels and petroleum products • Resins and plastics	
Specified risk material (SRM) or waste containing SRM	- as defined by the Canadian Food Inspection Agency

Appendix 2: Check List for On-farm Anaerobic Digestion Project Application

It is important that the applicant provides adequate information so that the full scope and impact of the project can be understood. To accomplish this, applicants will have to supply satisfactory information addressing all of the following items in an application:

Feedstock (refer to Chapter 11)

- ☐ Intended import tonnage of all non-agricultural feedstock (itemized per feedstock type – refer Chapter 11)
    - Total annual import tonnage
    - Average daily import tonnage
    - Intended maximum tonnage stored on-site at any given time
- ☐ Results of physical and chemical analysis of all non-agricultural feedstock (including heavy metals analysis)
- ☐ Intended tonnage of agricultural feedstock (itemized per feedstock type)

Collection (refer to Chapter 16)

- ☐ Type of collection system(s) utilized within the project (e.g., piping, liquids trucking or solids trucking)
- ☐ If piping is involved, the volume and type of material being piped
- ☐ If liquids trucking is involved, the type of truck as well as volume and type of material being trucked
- ☐ If solids trucking is involved, the type of truck as well as volume and type of material being trucked
- ☐ The total number of trucks entering the anaerobic digestion site per day

Handling (refer to Chapter 16)

- ☐ Measures that will been taken to separate clean and dirty traffic at the farm that is hosting the anaerobic digestion facility
- ☐ Disinfection process at the entrance to the property for trucks that are traveling from farm to farm and trucks carrying non-food grade industrial or municipal waste
- ☐ The way in which liquid feedstock is unloaded into the pre-storage tank
- ☐ The way in which solid feedstock is unloaded into the pre-storage facility (for example, will it be loaded into the liquid storage tank through a pulper or loaded into solid feedstock storage on-site)

Pre-Storage (refer to Chapter 16)

- ☐ Type of pre-storage system for liquid feedstock (include structural material, whether above/below grade)
- ☐ Components of the liquid feedstock storage system (reception tank, pasteurization tank, storage tank, mixing tank, etc.) including respective size of the various tanks

- ☐ Type and size of pre-storage for solid feedstock (bunker, container, plastic pod, etc.) if applicable
- ☐ System for collecting and returning any run-off from pre-storage, loading and unloading
- ☐ The maximum amount of liquid and solid agricultural feedstock (manure, crop residues, crops, etc.) that will be in pre-storage facilities on-site at any given time
- ☐ The maximum amount of liquid and solid non-agricultural feedstock (food processing waste, fats, oils and greases, grocery waste, etc.) that will be in pre-storage facilities on-site at any given time.

Pre-Treatment (refer to Chapter 16)

- ☐ Type and volume of feedstock that will need pasteurization (as per Chapter 11, Schedule B)
- ☐ Pasteurization design parameters such as temperature and retention time

Post-Storage (refer to Chapter 16)

- ☐ Type of post-storage system for liquid feedstock (include structural material, whether above/below grade and how complete enclosure is achieved)
- ☐ Type and size of post-storage for solid feedstock if applicable
- ☐ System for collecting and returning any run-off from post-storage, loading and un-loading
- ☐ Calculated storage capacity expressed in days, based on post-storage size and digestate flow rate

Odour Control (refer to Chapter 16)

- ☐ Identify all potential points of odour at the facility. For example, escaping air from tanks for liquid storage during feedstock filling, unloading of dry feedstock, composting of separated solid digested solids, etc.
- ☐ Strategy to minimize odour including equipment and infrastructure design as well as management practices.
- ☐ Odour complaint tracking plan and forms to log complaints

Fugitive Dust (refer to Chapter 16)

- ☐ Length and surface type of driveways used for truck access to the facility.

Set-Backs (refer to Chapter 16)

- ☐ Minimum distance between any infrastructure related to on-farm anaerobic digestion and:
    - lot line;
    - domestic water supply intake;
    - natural streams, channelized streams and constructed channels or ditches; and
    - CAZ (controlled access zone for biosecurity purposes)

Anaerobic Digestion – Microbial Process (refer to Chapter 1)

- Intended operational temperature for the digestion process
- Digester type and manufacturer

Biogas Cleaning (refer to Chapter 6)

- Expected chemical composition of the raw biogas
- The biogas cleaning methods that will be utilized to manage contaminating components in the raw biogas
- Expected discharge levels from the utilized biogas cleaning methods

Biogas Upgrading (refer to Chapter 7) – ONLY REQUIRED IF RELEVANT TO THE SPECIFIC PROJECT

- The method(s) that will be utilized to upgrade the biogas
- Expected discharge levels from the utilized biogas upgrading method(s)

Electricity Production through Co-Generation (refer to Chapter 8) – ONLY REQUIRED IF RELEVANT TO THE SPECIFIC PROJECT

- Expected H_2S concentration in the biogas when it reaches the co-generation unit
- Expected discharge levels from the utilized co-generation method

Heat production with Biogas Boiler (refer to Chapter 9) – ONLY REQUIRED IF RELEVANT TO THE SPECIFIC PROJECT

- The type of gas combusted in the boiler (raw biogas, reject gas, fossil natural gas or a combination)
- If a combination of gasses are combusted in the boiler, then describe the proportion of the respective gas streams in the combined mix
- Expected discharge levels from the boiler

Biogas Flaring (refer to Chapter 10)

- Type of flare
- Expected annual operative time for the flare
- The points in the gas stream from where biogas can be directed towards the flare
- Expected worst case discharge levels from the flare, e.g., emissions from the flare when it operates on gas from the least clean diversion point

Appendix 3: Air Quality Objectives and Standards

BC's Air Quality Objectives http://www.env.gov.bc.ca/air/codes/index.html#objectives
BC's New Air Quality Objectives http://www.bcairquality.ca/
BC Emission Criteria for Gas Turbines http://www.env.gov.bc.ca/air/codes/ecfgt.html#info

Table 15: Canada Wide Standards

Parameter	Limit
PM2.5	30 µg/m3, 24 hour averaging time*
Ozone	65 ppb, 8-hour averaging time*
Mercury	20 µg/Rm3 (from municipal waste incineration)
PCDD/PCDF	80pg I-TEQ/m3 (from municipal waste incineration)

* by year 2010, achievement to be based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years.