# Review of Nutrient Management Planning in British Columbia

A part of the Hullcar Situation Review
Nutrient Management Practices - Technical Report

**September 2017** **File No. 631.700-2**

Prepared for:

POLIS Project on Ecological Governance
Center for Global Studies
University of Victoria

Prepared by:

British Columbia Ministry of Agriculture
Innovation & Adaptation Services Branch

# 1 Table of Contents

# 2 Report Organization

This report addresses Terms of Reference item 2b:

*With consideration on how agricultural nutrient management practices are conducted across B.C., specifically review the requirements for nutrient management plans, including scope, guidance provided by regulators, and qualifications for professionals developing nutrient management plans.*

Section 1 contains excerpts from the 5th edition of the 'Reference Guide' for the Canada – B.C. Environmental Farm Plan Program. http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/environmental-farm-planning/efp-reference-guide/full_efp_reference_guide.pdf

- Page references in these sections refer to pages in the EFP Reference Guide.
- References to worksheets in these sections refer to the worksheets in the Appendix

Section 1 contains an excerpt from the 2nd edition of the Nutrient Management Reference Guide. http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/nutrient-managment-reference-guide/nutrientmgmt_refguide.pdf

- Page references in these sections refer to pages in the Nutrient Management Reference Guide.

Section 1.4 contains historical information not online from the B.C. Ministry of Agriculture. The information is guidance on eligibility criteria for individuals who can prepare Nutrient Management Plans that will be recognized under the Beneficial Management Practices cost-share program.

# 3 Voluntary Nutrient Management Plans under the Environmental Farm Plan program

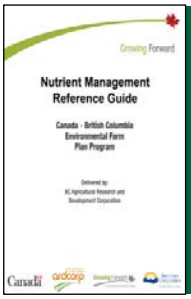
The Nutrient Management Plan (NMP) in B.C. has been developed as a subcomponent of the the Environmental Farm Plan (EFP) Program. The EFP has been developed as a voluntary program to increase education among individual producers. An expected outcome is positive behaviour change on the farm, towards compliance with environmental regulations and towards the reduction of environmental risks.

Completing the EFP with a Planning Advisor is the first step, and can possibly trigger a recommendation to do an NMP. Between the components of an EFP and an NMP, the various sources of potential water pollution by on-farm nutrients are addressed (Table 1). Examples of the EFP worksheets which guide the producer and Planning Advisor through this assessment are included in Section 8. Appendix.

**Table 1. Components of Environmental Farm Plans (EFP's) and Nutrient Management Plans under B.C.'s EFP/ BMP program. Details are provided by B.C. AGRI (2017, Review of Nutrient Management Planning in B.C.).**

| Environmental Farm Plan | Nutrient Management Plan (subcomponent of EFP) |
|---|---|
| Manure Storage – assessment of whether storage facilities are adequately sized to contain nutrient sources such as manure until they can be applied to land beneficially<br><br>Managing Runoff – assessment of whether nutrient-rich runoff from solid manure storages and the farmstead is managed (e.g., treated, contained, diverted, etc.) | Land Application of Nutrients – assessment of whether there is adequate land for the nutrients planned for land application, based on suggested nutrient balance criteria. |

The Nutrient Management Reference Guide is a reference document intended for Planning Advisors and agricultural producers in British Columbia who want to do a Nutrient Management Plan.




**Nutrient Management Reference Guide is a publication that forms part of the Environmental Farm Plan series on Beneficial Management Practices. Its purpose is to optimize nutrient use and to reduce environmental impacts. The Nutrient Balance Assessment, outlined on pages 6-11 to 6-16, will indicate which producers should refer to this publication for further evaluation. It will also be of interest to producers wanting to maximize the value of both manure and inorganic fertilizers. Table 6.8, page 6-16, outlines the basic steps in nutrient management planning.**

**A Nutrient Management Plan** is a technical process to optimize the relationship between farm management techniques, crop requirements, and land application for the purpose of maximizing nutrient use while minimizing environmental impact. The process attempts to balance nutrients on an individual crop or field basis as well as on a whole farm basis.

Developing a Nutrient Management Plan is intended to help farmers optimize their nutrient usage, while protecting valuable soil, water, and air resources. In addition to the economic and environmental benefits, nutrient management planning is a valuable educational process that helps to ensure a farmer is in compliance with all relevant legislation.

The core objectives of nutrient management planning are:

- to supply crops with nutrients at the appropriate rate, timing, and with the appropriate method to produce an economically optimal crop in terms of both yield and quality; and
- to minimize the risk of pollution by loss of nutrients via runoff, leaching, emissions to the air or other loss mechanisms

Nutrient Management Planning is not a one-time activity but an ongoing process. To make the plan practical, it must be kept in a form that will make it easy for the farmer to find the information they are looking for and also easy to record new information about manure applications, crop harvests, etc.

## 3.1 Criteria for Deciding Who Will Do a Nutrient Management Plan

For producers in any of the following four situations, completion of a Nutrient Management Plan is recommended :

**A. Farms that may be out of Compliance with Nutrient Application Legislation.** This applies to farms that answer "No" to any of the legislative questions on the Nutrient Application Worksheet in the EFP Workbook (included in Section 8. Appendix), and the proposed action is the development of a Nutrient Management Plan.

**B. Livestock Producers and Producers of Intensively-Managed Outdoor Horticultural Crops Located over Moderately or Highly Vulnerable Aquifers that are Used for Drinking Water.** Examples of such aquifers within the province include, but are not limited to, the Abbotsford-Sumas, Hopington, Grand Forks, Vedder River Fan aquifers and other aquifers referred to in Schedule 5 of the *Municipal Sewage Regulation.*

**C. Significant Manure Nitrogen Generation or Use.** Producers that generate or use manure should complete one of the following two assessments:

- Manure Assessment 1: A Manure Nitrogen Assessment for Farms that Generate Manure (whether the manure is used as a fertilizer on that farm or not), or
- Manure Assessment 2: A Manure Nitrogen Assessment for Farms that Use Manure as a Fertilizer but do not Generate Manure

The objective of the assessments is to determine if manure nitrogen generation or utilization are above the values in Table 6.6, below. Farms that apply manure at rates below these values are considered to be at a low risk of causing pollution as long as the manure is being stored, handled, and applied in compliance with the *Code* under the *Agricultural Waste Control Regulation.*

**Table 6.6 Baseline Values Used for Assessing the Requirement for a Nutrient Management Plan (used in Worksheets #4, #5)**

| Crop Type | Baseline Manure Nitrogen Application Rate (kg N/ha/yr) *Value based on Total Manure N* |
|---|---|
| Non-forage (e.g., berries, tree fruits, vegetables) | 50 |
| Forage grass (South Coastal BC) | 300 |
| Forage grass (rest of BC) | 200 |
| Forage corn | 150 |

Farms that apply manure at rates above these values may also be managing their nutrients in full compliance with the Code, but the risk of over-applying nutrients and potentially causing pollution is higher. The actual risk would be specific to the farm being assessed, depending on a variety of factors including crops being grown, yield potential, topography, proximity to watercourses and climate. For farms that apply manure at rates above these values, a Nutrient Management Plan is recommended.

**D. High Soil Phosphorus.** This applies if a farm is located in a phosphorus sensitive area (areas where surface water eventually flows to a lake or pond) and soil test phosphorus levels exceed 80 ug/g in the 0 - 15 cm depth (by the Kelowna soil test method, for mineral soils). Phosphorus sensitive areas

include, but are not limited to, the Okanagan Basin, Christina Lake Basin, Thompson River at Kamloops and other sensitive surface waters as defined by Schedule 5 of the *Municipal Sewage Regulation.*

## 3.2 Components of a Nutrient Management Plan

Planning Adviosors use an Excel NMP calculator provided by BC AGRI to develop the recommendations requyired to meet the objectives of an NMP. There are various ways to organize the information created using the NMP calculators. One way would be to print out the worksheets once the Planning Advisor is satisifed that the results meets the objectives. The 2010 updates to the NMP Calculator include a suite of spreadsheets that have been customized for specific crop groupings. The outputs of the various NMP Calculators are different so there is no standard way of organizing information. Planning advisors are encouraged to organize NMPs in a logical manner.

In addition to the worksheets, the Nutrient Management Plan should consist of written sections that provide context for the plan including the planning advisor's conclusions and recommendations that result from using the NMP Calculator software.

**A. Title Page**

The title page identifies the farm name, contact information, and the date the plan was prepared. A signature on this page or on a separate page is strictly optional and can be used to show that the planning advisor has signed off on the Nutrient Management Plan.

**B. Summary**

This section contains a brief written summary of the Nutrient Management Plan. The key information includes:

- Goals and objectives of the Nutrient Management Plan
- A general description of the farm including land base and number of livestock
- Description of the manure handling and storage system
- Description of the manure being produced, imported, or exported
- Summary of soil sampling procedures and test results
- Discussion of the farm's nutrient application schedule
- Conclusions and recommendations

**C. Maps and Diagrams**

This section should contain a farmstead map and a field map. The names given each field on the map should match the names used throughout the NMP Calculator worksheets and plan.

These maps will have been prepared during the Data Collection phase (Chapter 2). They may be prepared while developing an Environmental Farm Plan and can be copied to the Nutrient Management Plan. For Nutrient Management Planning, these maps are most useful if they accomplish the following:

- Identify soil sampling units, taking into account variability and usual areas due to differences in cropping, manure and fertilizer application history, topography, soil type or texture (drainage), etc.
- Identify potentially sensitive areas including watercourses, wells, etc. Field sizes (spreadable areas) and land management practices recommended in the plan should reflect this information.

**D. Farm Nutrient Balance Summary**

This section contains the summary of nutrient balances for all fields on the farm.

- For the Forage NMP Calculator, print or refer to Worksheet 7. This worksheet summarizes the manure balances for each manure type.

- For the Vegetable NMP Calculator, print or refer to the "Farm Summary" worksheet. This worksheet summarizes the agronomic and crop removal balances as well as manure balances for the whole farm.
- For the Berry NMP Calculator, no worksheet currently provides an estimate for the whole farm. The planner can make a general statement about agronomic balances for indivdiual fields or the farm as a whole (optional).

**E. Conclusions and Recommendations**

Throughout the entire Nutrient Management Planning process, one of the roles of the planning advisor is to identify areas where practices can be improved to increase nutrient use efficiency and/or reduce risk to the environment. In addition to developing and fine-tuning the nutrient application schedule, written recommendations should address the following:

- If the calculations determine that the farm is generating more manure nutrients than can be utilized sustainably, the plan should include a strategy for dealing with nutrient surpluses. Options include altering feed rations to reduce nutrient levels in manure, use of cover crops to increase annual crop production, transporting manure off the farm, etc. Recommendations should consider the priority nutrient for each field, and general suggestions are provided in factsheets included in this guide.
- If the manure application equipment that is being used is not suitable to meet the application objectives of uniformity and accuracy of placement and rate, recommendations should be made for calibrating and adjusting equipment or if necessary, using more suitable equipment.
- If current manure application practices pose an elevated risk of causing pollution to watercourses or groundwater, the plan should include recommendations to reduce this risk. This may involve increased use of cover crops, increased use of buffers in sensitive areas, or adjustments to timing of application.
- If current practices present an elevated risk of soil compaction or erosion, the plan should include recommendations to reduce this risk (e.g. avoiding very wet conditions, limiting traffic to specific areas, lower tire pressure, etc.)

The Nutrient Management Plan should complement and enhance the Environmental Farm Plan. When the Nutrient Management Plan is completed and implemented, the process should ensure that any questions in the Environmental Farm Plan Workbook related to nutrient management will be answered with a "Yes" or "Not Applicable."

**F. Individual Field Summaries**

This section contains worksheets that give field-specific information.

- For the Forage NMP Calculator, print or refer to Worksheets 5 and 6. These worksheets summarize the agronomic and crop removal balances for each field
- For the Vegetable NMP Calculator, print or refer to the individual field worksheets. Sections 6 and 7 of each worksheet summarize agronomic and crop removal balances, respectively.
- For the Berry NMP Calculator, the planning advisor can print or refer to worksheets 2 and 3 for raspberries (or only worksheet 3 for blueberries) for one or more fields. These worksheets provide recommendations based on the agronomic balance concept only.

See Chapter 3: Nutrient Optimization for more information about the concept of agronomic and crop removal nutrient balances.

**G. Laboratory Reports**

- Soil test results
- Manure test results
- Forage quality (or crop tissue) test results

In addition to the above lab reports, the planner should attach a summary of sampling protocols if they differed or expanded upon the guidelines in the sampling factsheets.

## 1. Multi-Year Data Organization:

Ideally, a Nutrient Management Plan should be revisited each year and new reports should be generated to reflect changes in the Nutrient Management Planning strategy. The farmer can choose whether they want to start a new binder each year or add data from multiple years into the same binder.

For subsequent years, the same process for assembling a Nutrient Management Plan should be repeated. If using a new binder each year, the information in the binder should be inserted in the same order each year. It is recommended that a new binder be started every five years, or more frequently.

## 3.3 Steps To Develop a Nutrient Management Plan

| Steps to Develop a Nutrient Management Plan |
|---|
| **1. Determine On-Farm Nutrient [a] Levels**<br>• determine the quantity produced during the year<br>• determine the nutrient concentration of various inputs and outputs on a seasonal basis<br>• determine the pH and the concentration of micronutrients and salts in inputs and outputs<br>• calculate the total and plant-available portion of N, P, and K |
| **2. Determine Field Soil Nutrient Levels**<br>• sample the soil and obtain soil test lab reports that predict the amounts of N, P and K that will be available to plants during the growing season (yearly for annual crops and every third year for perennial crops)<br>• determine the pH as well as micronutrient and salt concentrations (every three to six years) |
| **3. Determine Annual Crop Nutrient Requirements** (for each field or greenhouse crop)<br>• determine the type of crop and estimate expected yield and quality reasonable for the soil and climate<br>• calculate the annual amount of N, P and K required and the time of year required |
| **4. Determine Field Annual Nutrient Balance** Determine the annual application [b]<br>• determine the amount of nutrients that need to be supplied (for N, P and K) for each field by using the following equation |
| **Determining Nutrients to be Supplied** |
| **Nutrients to be supplied = plant requirement + assumed nutrient loss [c] – soil provided nutrients**<br>• adjust the amount of nutrients to be supplied based on previous years' effectiveness monitoring [d]<br>• base nutrient application for each field on the most environmentally limiting nutrient [e] |
| **5. Determine Off-Farm Nutrient Supplementation** If on-farm nutrient sources are not sufficient to meet crop nutrient needs, supplementation will be necessary. Off-farm nutrient supplements can include chemical fertilizers, manure from other farms, and selected organic matter [f] sources.<br>• determine the nutrient concentration of all off-farm nutrient sources<br>• determine the amount of supplements that will be required (for N, P, and K) for each field on the basis of plant nutrient requirements by using the following equation |
| **Determining Off-Farm Nutrient Supplements to be Supplied** |
| **Off-farm nutrient supplements to be supplied = nutrients required from the nutrient balance – farm supplied nutrients applied** |
| **6. Determine Nutrient Application Strategy** Determine when and how all nutrients will be applied<br>• determine the timing, rate, and method of application by field for each application event<br>• determine the buffer requirements for each application by field ➔ see Buffers, page 11-4 |
| **7. Determine Farm Nutrient Balance** Determine if there is a surplus or deficit of farm nutrients<br>• when a surplus of 'farm nutrients' occurs, other sites will be needed to utilize the surplus<br>• when a deficit of 'farm nutrients' occurs, recalculate nutrient application strategy to maximize nutrient value of manure<br>• if a deficit remains after recalculation, then make a determination of the source of supplemental off-farm nutrients and the amount required |
| **8. On-Farm Nutrient Sources:** identify materials generated on the farm such as manure, silage or milk house effluent, yard water, compost, and crop residue |

[b] **Annual Application:** is the sum of nutrients required for all crops grown (i.e. multiple harvests) in a field/greenhouse throughout the calendar year

[c] **Assumed Nutrient Losses**: these are the predicted losses of nutrients to soil, water and air that result from the use of specific nutrient sources and application equipment under specific climatic, soil and crop conditions. These losses should be managed so as not to cause pollution.

[d] **Effectiveness Monitoring**: is an assessment of previous year's crop yield and quality relative to certain environmental indicator, such as changes in soil and water quality

[e] **Environmentally Limiting Nutrient:** is the nutrient which is most likely to cause an environmental impact if applied at rates above crop requirement, such as phosphorus near Interior lakes

[f] **Selected Organic Matter:** are those materials identified in Schedule 12 of the *Organic Matter Recycling Regulation*

## 3.4 Criteria for Recognized Nutrient Management Planning (NMP) Advisors

For NMP to be considered eligible for funding from the EFP program, BC AGRI established a set of desired criteria for authors of NMPs.

**Desired Qualifications:**

A NMP Advisor should be:

- a Professional Agrologist in good standing with the BC Institute of Agrologists (http://www.bcia.com/) or
- a Certified Crop Advisor, registered with the American Society of Agronomy (https://www.certifiedcropadviser.org/)
- a NMP Advisor who is a PAg or CCA should have a minimum of 2 years relevant field experience (e.g. as a soil or crop advisor, nutrient management research, extension worker, etc)

OR

- a NMP Advisor should have a recognized University degree in a related field and have seven years related field experience
- a NMP Advisor must take the BC Nutrient Management Planning training course and successfully complete all course requirements

**Continual Improvement Requirement:**

- Recognized NMP Advisors must attend all NMP update courses offered by the Ministry of Agriculture (note that the Ministry will attempt to provide at least 2 offerings of all updates to address potential scheduling conflicts).

**NMP Review:**

- All NMP Advisors will be required to submit their first three plans per two year period to the Ministry for technical review. AGRI in turn will establish criteria for assessing quality of plans. NMP Advisors who fail to meet quality requirements may be subject to probation or removal from the list of recognized Advisors.

# 4 Ministry of Environment Requirements for Nutrient Management: Per Hullcar Pollution Abatement Order

The Ministry of Environment issued pollution abatement orders (with requirements specific to the particular operation) to agricultural operators across Hullcar Valley. Pollution abatement orders are a tool to compel parties to take immediate action to manage risks to human health and the environment.

The Orders set out the following criteria, with reference to the NMP definitions described in Section 1 of this document.

1. Retain a Qualified Professional to prepare an Action Plan detailing measures to be taken to abate the environmental impacts identified in the EIA and submit the Action Plan to the Director by August 15, 2016. The Action Plan must include, but is not limited to:

i) description of proposed manure storage measures that ensure sufficient storage, ensure proper construction of permanent and temporary storage facilities with appropriate setbacks, and ensure minimal impact to the environment;

ii) description of proposed drainage management measures to effectively control runoff to ensure that solids, leachate, contaminated runoff and drift from sprayed materials do not enter watercourses, penetrate to groundwater or leave the property;

iii) description of proposed remedial measures to ensure manure applications do not extend beyond property boundary, in a watercourse, and near industrial and drinking water wells;

iv) description of a proposed ongoing soil, surface and groundwater monitoring program for nitrate and E.coli for the purposes of monitoring the effects of Action Plan;

v) a map identifying all fields (owned ,or leased, licenced or otherwise part of the Lands) utilized for farm operations, identifying the locations of manure storage facilities, feeding areas, drinking water well(s), industrial well(s), surface water intakes, and any other notable work(s) and identify all setbacks (i.e. minimum distances) between such facilities or areas and wells or relevant water works;

vi) a 2016 Nutrient Management Plan, as defined in the BC Environmental FarmPlan Reference Guide (the “Guide”), located at: http://www2.gov.bc.ca/gov/content/industry/agriculturesеafood/programs/growing-forward-2/environmental-farm-plan, and consistent with the recommendations in the Guide, for all farm operations occurring on the Lands; and

vii) a timeline for implementation of the Action Plan.

In this section of this order, a “Qualified Professional” is limited to:

- a Professional Agrologist in good standing with the BC Institute of Agrologists (http://www.bcia.com ), or
  - a Certified Crop Advisor, registered with the American Society of Agronomy
  - (https://www.certifiedcropadviser.org/)

with a minimum of 2 years relevant field experience as a soil or crop advisor.

The Action Plan and Nutrient Management Plan must be amended by a Qualified Professional if there is any change in the agricultural operations occurring on the Lands that affects the volume of agricultural waste produced. Any such amendments to the Action Plan must be completed and approved by the Director prior to the implementation of the change in the agricultural operations.

# 5 AGRI Recommendations for Nutrient Management Planning Requirements for Operations with Anaerobic Digesters

The BC Ministry of Environment and Climate Change Strategy and the Agricultural Land Commission are responsible for the approval of Anaerobic Digestion operations of farmland. Although not responsible for direct approvals, BC AGRI has provided guidance to producers and the responsible agencies with respect to the nutrient management planning documents required for approval.

Draft recommendations for those agencies such as the Agricultural Land Commission and Ministry of Environment who were interested in AGRI's advice on how to approve, permit, or authorize the nutrient management aspects related to anaerobic digester operations are provided below. The recommendations include requirements for a nutrient management plan to facilitate approval/permit of a new anaerobic digester or changes to an existing anaerobic digestion. The recommendations also include requirements for annual reporting, to facilitate verification that operations have stayed within the conditions under which their approval/permit were granted.

Nutrient Management
FACTSHEET

BRITISH COLUMBIA | Ministry of Agriculture

Order No. 631.600-1
Created June 2013; May 2017

# Suggested Criteria for Nutrient Management on Farms with Anaerobic Digesters and Digestate DRAFT

## Introduction

There are agencies or tribunals that may be responsible for approving anaerobic digestion (AD) operations and land applications of the AD byproducts on farms. The B.C. Ministry of Agriculture (AGRI) does not have this responsibility but may provide technical advice to guide approval decisions. The intent of this document is to describe the Ministry of Agriculture's suggested criteria for recommending approval. The scope of these criteria is limited to aspects that minimize environmental nutrient losses from farms with AD operations or the use of AD byproducts for land application.

The intended audience of this document includes the i) applicants seeking approval and ii) the agencies or tribunals (e.g. B.C. Ministry of Environment or Agricultural Land Commission) with responsibility to give approval. The audience is assumed to have a basic understanding of anaerobic digestion and nutrient management.

Criteria are suggested for two types of documents, 'Nutrient Management Plans' and 'Annual Reports':

| Nutrient Management Plans | Annual Reports |
|---|---|
| ● Describe how AD operations and use of AD byproducts *will meet* the suggested criteria for nutrient management in the upcoming year<br>● Updates expected annually | ● Describe how the AD operations and use of AD byproducts *have met* the suggested criteria for nutrient management in the past year<br>● Expected annually |

AGRI expects that Nutrient Management Plans may need to be reviewed when applicants propose to start a new AD operation or propose changes to existing AD operations or digestate use that have not been approved before. Changes could include a change in the amount or composition of feedstock materials used

for anaerobic digestion, changes to the area, or crops receiving digestate.

*Out of scope*

- Qualifications of the persons preparing or signing off on the applications
- Considerations of 'farm use' or 'non-farm use'
- Other requirements to protect environmental health (e.g. analytical tests of trace elements or metals)
- Use of AGRI's nutrient management planning software

## Suggested Criteria

AGRI recommends three overarching criteria for approval of Nutrient Management Plans (NMP) and

### 1) Is there enough storage capacity?

**1) There is enough storage capacity for the nutrient source materials.**

**Nutrient Management Plans**

- The capacities of each storage facility system should be provided in days and as volumes. The storages should be sized with at least 0.2 m (0.7 ft) freeboard. They should also be sized according to the duration (e.g. October to March, inclusive) described in Table B.1 in the Canada-BC Environmental Farm Plan (EFP) Reference Guide[1], unless exceptions are warranted as described in the EFP Reference Guide.
- Provide a process flow diagram (Fig. 1) and complete a table of Annual Storages Summary (Table 1) to account for mass of the nutrient source materials from the points they are generated or imported on the farm to the points they are used for land-application or export from the farm.
- Transfer agreements should be provided for nutrient source materials to be exported off the farm (Appendix 1). These agreements are intended to help track who has responsibility to manage the byproducts of the AD operation.

**If yes, continue to evaluate the NMP or Annual Report.**

**Annual Reports**

- The reports should provide confirmation that there were no incidents of any storage facility overflowing or leaking. Alternatively, if there were such incidents and storage facilities are sized to meet the EFP-recommended storage capacities, there should be a review of the contingency plan to prevent similar incidents in the future.

### 2) Is there enough land?

**2) There is enough land for the nutrients to be land-applied.**

**Nutrient Management Plans**

- For nitrogen (N), the maximum application rate of nutrients should not be planned to exceed the agronomic N rate on any field. This is consistent with the guidance for land applications of crop nutrients in the voluntary Nutrient Management Planning program[2], and it can be demonstrated with the use of AGRI's NMP software.
- For phosphorus (P), the concept is that applications of surplus phosphorus should not increase: the annual Farm Crop Phosphorus (P) Removal ratio should not increase after implementing the proposed changes related to AD. The ratio is *the total available P in all land-applied nutrient sources* divided by *the P removed in harvested portions of crops*, for all fields with soil test P greater than 100 ppm (Kelowna method). Tables 2a and 2b should be completed, using values from AGRI's NMP software, to compare the 'before AD' and 'after AD' ratios.

**If yes, continue to evaluate the NMP or Annual Report.**

[1] https://goo.gl/vt8ylS
[2] BC Ministry of Agriculture. 2010. Nutrient Management Reference Guide. 2nd edition.

**2) Is the Nutrient Management Plan or Annual Report complete?**

**If yes, AGRI would recommend approval.**

**Annual Reports**

- If there were high levels of post-harvest soil nitrate in any field, the agronomic N rate calculations for next year's N applications should be revised according to best practices (Table 3b).
- The annual Farm Crop P Removal ratio should not have increased after the implementation of proposed changes, unless exceptions are warranted.
- As an alternative to the Farm Crop P Removal criterion, soil test P levels that are greater than 100 ppm P (Kelowna method) should not be increasing on any field over any 2 consecutive years (Table 3b). The Farm Crop P Removal ratio should still be reported.

**3) The Document is Complete**

A checklist is provided for all the expected components of a Nutrient Management Plan (Table 3a) or an Annual Report (Table 3b). These components would support the conclusions that there is adequate storage and land according to the suggested criteria. The components include an appendix of analytical reports (Table 4).

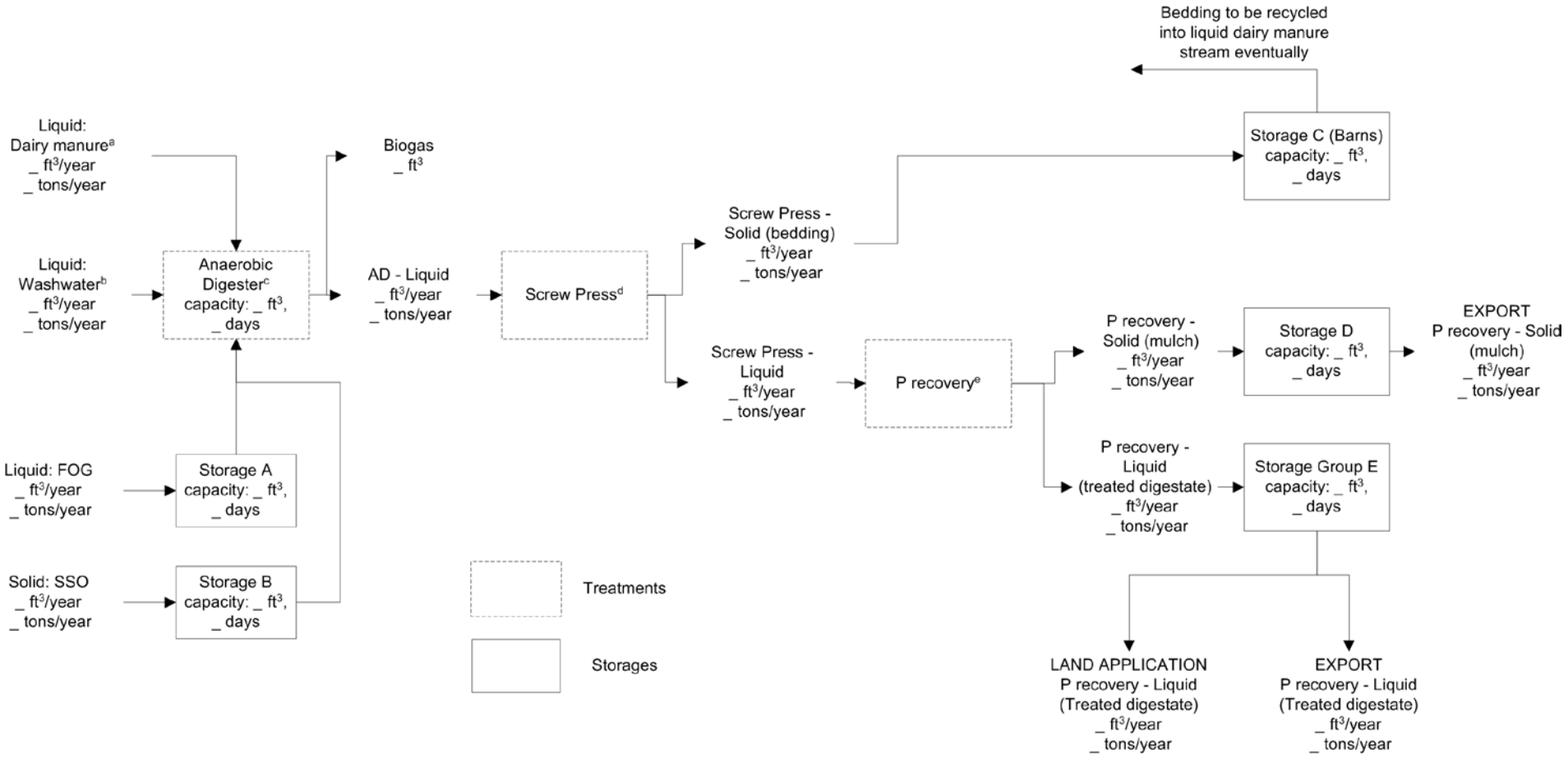



**Figure 1.** Example of a process flow diagram for a farm with an anaerobic digester, subsequent manure treatment technologies, and storage facilities. The diagram describes the annual inputs (including nutrients generated and nutrients imported) into each treatment and storage, and the annual outputs (including nutrients for land application and nutrients for export).

The following may be added to complete the diagram:
- The volume ($ft^3$ per year) and weight (tons per year) of each input and output, as indicated by the blank spaces.
- The capacity of each storage as a volume ($ft^3$) and in days, assuming the maximum rate ($ft^3$ per day) at which the storage will be filled during the recommended period of storage.
- In the footnotes, additional information supporting the calculations:

e.g. a. 396 milking age cows, 201 heifers, and 66 calves (Holsteins)
e.g. b. milking center washwater: 1.2 $ft^3$ per day per milking cow (330 milking cows)
e.g. c. The estimated % conversion of solids in AD feedstocks to biogas
e.g. d. Screw press is assumed to convert 15% of influent volume to solids
e.g. e. Phosphorus (P) recovery is assumed to convert 4% of influent volume to solids

Table 1 Annual Nutrient Storages Summary: an example for a Nutrient Management Plan (NMP).

◉ Nutrient Management Plan (after proposed changes) ○ Annual Report

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Nutrient Storage System (indicate liquid or solid) | Inputs into storage system (tons/year) | Land Application (tons/year) | Export or transfer to other storage (tons/year) | Balance (tons/year) B-C-D | Average P content of nutrient sources imported, land-applied or exported (%, fresh weight) | $P_2O_5$ in Land Application (lbs $P_2O_5$/year) |
| A: liquid Fats, Oils and Greases (FOG) | 8,800 | 0 | 8,800 | 0 | 0.024 | 0 |
| B: solid Source Separated Organics (SSO) | 8,800 | 0 | 8,800 | 0 | 0.090 | 0 |
| C: solid bedding (barns) | 4,820 | 0 | 4,820 | 0 | - | 0 |
| D: solid P-rich mulch | 1,090 | 0 | 1,090 | 0 | 1.1 | 0 |
| E: liquid digestate | 26,200 | 22,300 | 3,900 | 0 | 0.040 | 40,850 |
| Total | | | | | | Total P Additions (lb $P_2O_5$) |
| | | | | | | **40,850** |

- In Column B, enter the annual amount (tons) of each nutrient source material that will be (NMP) or was (Annual Report) in a storage facility and then land-applied or exported.
- In Column C, enter the annual amount (tons) of each nutrient source material that will be (NMP) or was (Annual Report) land-applied.
- In Column D, enter the annual amount (tons) of each nutrient source material that will be (NMP) or was (Annual Report) exported from the storage, off-farm or into another storage.
- The absolute value of the values in Column E should be less than 10% of the corresponding value in Column B; if not, explain the difference in the NMP or Annual Report.
- In Column F, enter the average P content of each nutrient source material that will be (NMP) or was (Annual Report) land-applied or exported.

Additional guidance:
- Add as many rows as needed to describe all nutrient storage systems and cases of direct utilization
- Worksheet 7 and Worksheet 4 of AGRI's Forage NMP Calculator can be used to complete the above table for an NMP (but not the Annual Report):
Worksheet 7, Column C matches with Column A above

Worksheet 4,

Column B matches with Column F above
Worksheet 7, Column D matches with Column B above
Worksheet 7, Column E matches with Column C above
Worksheet 7, Column F matches with Column D above

## Table 2a Crop Phosphorus Removal Balances: example values for a Nutrient Management Plan *before* proposed changes

○ Nutrient Management Plan (before proposed changes) ○ Nutrient Management Plan (after proposed changes) ○ Annual Report

- In the Nutrient Management Plan (NMP) for approval of proposed changes to operations, the following table must be completed for each of 2 cases: 1) the year before the proposed changes are implemented, and 2) the year after the proposed changes are implemented. In subsequent NMPs, the table must be completed for the upcoming year at the time the NMP is prepared.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field ID[a] | Field size (ac) | Soil test P[a] (ppm) | Crop | Crop P Removal[b] (lb $P_2O_5$/ton) | Crop Yield[b] (tons/ac) | Cover Crop (if harvested) | Cover crop P Removal[b] (lb $P_2O_5$/ton) | Cover crop Yield[b] (tons/ac) | Crop P Removal (lb $P_2O_5$/ac), E x F + H x I | P Additions: Nutrient Source 1[c] (lb $P_2O_5$/ac) | P Additions: Nutrient Source 2[c] (lb $P_2O_5$/ac) | P Additions: Nutrient Source 3[c] (lb $P_2O_5$/ac) | Total P Additions (lb $P_2O_5$/ac), K+L+M | Crop P Removal ratio, N ÷ J > 1.0 accumulation < 1.0 drawdown |
| 1 | 75.0 | 151 | Grass | 7.4 | 6.0 | | | | 44.4 | 120 | | | 120 | 2.7 |
| 2 | 113.0 | 251 | Corn | 4.0 | 8.0 | Fall rye | 7.4 | 2.0 | 46.8 | 70 | 25 | 50 | 145 | 3.1 |
| 3 | 92.0 | 98 | Grass | 7.4 | 6.0 | | | | 44.4 | 120 | | | 120 | 2.7 |
| 4 | 115.0 | 197 | Corn | 4.0 | 8.0 | Fall rye | 7.4 | 2.0 | 46.8 | 70 | 25 | 50 | 145 | 3.1 |
| | | | | | | | | | 0.0 | | | | 0 | |
| | | | | | | | | Totals | Crop P Removal (lb $P_2O_5$), ∑(B x J) | | | | P Additions (lb $P_2O_5$), ∑(B x N) | Farm Crop P Removal ratio, ∑N ÷ ∑J > 1.0 accumulation < 1.0 drawdown |
| | | | | | | | | Only fields with ≥ 100 ppm soil test P | 14,000.4 | | | | 42,060 | **3.0** |
| | | | | | | | | All fields | 18,085.2 | | | | 53,100 | |

a. Soil test P in the 0-6 inch depth (Kelowna method-equivalent value, determined with the Soil Test P and K Converter Tool at https://goo.gl/yg1jap).
b. Crop yields are on a dry-ton basis.
c. Nutrient Source 1: dairy manure
Nutrient Source 2: starter fertilizer
Nutrient Source 3: chicken manure

This is the value (3.0 in this example) that should not increase following implementation of proposed changes.

## Table 2b Crop Phosphorus Removal Balances: example values for a Nutrient Management Plan *after* proposed changes

○ Nutrient Management Plan (before proposed changes) ○ Nutrient Management Plan (after proposed changes) ○ Annual Report

- In the Nutrient Management Plan (NMP) for approval of proposed changes to operations, the following table must be completed for each of 2 cases: 1) the year before the proposed changes are implemented, and 2) the year after the proposed changes are implemented.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field ID[a] | Field size (ac) | Soil test P[a] (ppm) | Crop | Crop P Removal[b] (lb $P_2O_5$/ton) | Crop Yield[b] (tons/ac) | Cover Crop (if harvested) | Cover crop P Removal[b] (lb $P_2O_5$/ton) | Cover crop Yield[b] (tons/ac) | Crop P Removal (lb $P_2O_5$/ac), E x F + H x I | P Additions: Nutrient Source 1[c] (lb $P_2O_5$/ac) | P Additions: Nutrient Source 2[c] (lb $P_2O_5$/ac) | P Additions: Nutrient Source 3[c] (lb $P_2O_5$/ac) | Total P Additions (lb $P_2O_5$/ac), K+L+M | Crop P Removal ratio, N ÷ J > 1.0 accumulation < 1.0 drawdown |
| 1 | 75.0 | 151 | Grass | 7.4 | 6.0 | | | | 44.4 | 108 | | | 108 | 2.4 |
| 2 | 113.0 | 251 | Corn | 4.0 | 8.0 | Fall rye | 7.4 | 2.0 | 46.8 | 100 | | | 100 | 2.1 |
| 3 | 92.0 | 98 | Grass | 7.4 | 6.0 | | | | 44.4 | 108 | | | 108 | 2.4 |
| 4 | 115.0 | 197 | Corn | 4.0 | 8.0 | Fall rye | 7.4 | 2.0 | 46.8 | 100 | | | 100 | 2.1 |
| | | | | | | | | | 0.0 | | | | 0 | |
| | | | | | | | | Totals | Crop P Removal (lb $P_2O_5$), ∑(B x J) | | | | P Additions (lb $P_2O_5$), ∑(B x N) | Farm Crop P Removal ratio, ∑N ÷ ∑J > 1.0 accumulation < 1.0 drawdown |
| | | | | | | | | Only fields with ≥ 100 ppm soil test P | 14,000.4 | | | | 30,900 | **2.2** |
| | | | | | | | | All fields | 18,085.2 | | | | **40,836[d]** | |

a. Soil test P in the 0-6 inch depth (Kelowna method-equivalent value, determined with the Soil Test P and K Converter Tool at https://goo.gl/yg1jap).
b. Crop yields are on a dry-ton basis.
c. Nutrient Source 1: Anaerobic Digestate (from Storage Group E, Figure 1)

The expected Total P Additions in this 'after AD' table (40,836 lb $P_2O_5$) should be similar to the expected Total P Additions from Table 1 (40,850 lb $P_2O_5$).

The expected criterion for phosphorus is met in this example because the value (2.2 in this example) does not increase following the implementation of proposed changes.

Table 3a Expected Components of the Nutrient Management Plan

| Section | Component | Guidelines |
|---|---|---|
| **Title Page** | • Document title and date in which the plan is in effect.<br>• Name, address, and contact information for farm operation.<br>• Name, address, and contact information of farm owner/operator (if different from above).<br>• NMP preparer's name, contact information, affiliation, credentials, and signature sign-off.<br>• Signature sign-off of farm owner/operator. | • n/a |
| **Table of Contents** | | |
| **1. Introduction** | • Operation Type: e.g. dairy, field beans, etc.<br>• Location Information: legal descriptions, Parcel Identifier (PID), the area for all owned, leased, or rented lands contributing to or receiving nutrient sources.<br><br>Soil and water resources before and after implementation of proposed changes in the Application:<br>• General Site Description: land application considerations such as nearby surface waters, unconfined aquifers, sensitive crops and/or neighbours, and climate characteristics limiting timing of nutrient applications.<br>• Field Descriptions: for each field, the soil and landscape characteristics that affect the potential for runoff, erosion and leaching losses of sediments and nutrients (e.g. soil texture, drainage potential and surface soil erosion potential).<br><br>Nutrient source materials before and after implementation of proposed changes:<br>• Generator/Receiver: Will the farm be generating digestate? Will the farm be receiving digestate?<br>• Number of Animals: number of each animal type, number of production cycles per year for birds<br>• Manure and Feedstock Handling and Storage: how manure and feedstocks are handled from their points of origin (excretion or arrival on the farm) to the final storage prior to land application or export off the farm.<br>• Operational Description of the Anaerobic Digester, including the type, capacity, and storage length (days/months) of:<br>- storage for all AD feedstocks and effluent (e.g. for liquid and solid digestate material);<br>- typical AD unit operation (e.g. completely mixed with 30 day retention time); and,<br>• Type or Nutrient Removal System: include the manufacturer and technical specifications provided (e.g. removal efficiency, loading rates, etc). | • Indicate and describe the components that will change following implementation of the proposed changes in the Application.<br>For example,<br>• Location Information: 40 acres of rented land will be added to the farm to receive digestate.<br>• Manure and Feedstock Handling and Storage: the AD feedstocks will change from 25% off-farm sources to 49% off-farm sources, with no change in the total volume or type of AD feedstocks. |
| **2. Maps** | • General Area: identify areas that may be sensitive to land applications of nutrients such as neighbouring farms, water bodies, water supplies, and habitat. This map must support the General Site Description.<br>• Production Area: outline and/or label all buildings (e.g., housing, milk barn, hay storage, feed storage); storage areas (e.g., solid manure, liquid manure, digestate); water sources (including surface water, tile drains, and wells); manure/digestate treatments (e.g. solid/liquid separator, nutrient recovery system)<br>• Include a schematic of the digester and related storage areas and tie-ins. The type of storage structures (i.e., earthen lagoon with roof, above ground steel tanks, etc) and their volumes must be specified. | • Adjacent fields may be grouped together, based on soil texture, soil fertility, crop type, and farm management (e.g., both fields are a silty clay loam with high soil test P, perennial grass crop, and receive only liquid manure).<br>• Field maps should be given to all persons conducting land applications. |

| | | |
|---|---|---|
| | • Field Map: outline and label each field or land application area with a name, farmable area (acres), crop type, slope, slope direction, and buffer/setbacks.<br>• Legend, north arrow, and scale on each map | |

## TABLE 3a Expected Components of the Nutrient Management Plan continued

| Section | Component | Guidelines |
|---|---|---|
| **3. Nutrient Storage** | **There is enough storage capacity for the nutrient source materials.**<br>• Table B.1 in the EFP Reference Guide (http://goo.gl/LNx0ts) specifies periods of the year for which storage is recommended; Ministry of Environment must approve exceptions to these recommendations and the recommended storage period (periods of the year and days) must be provided.<br>• The capacities of storage facilities (as a volume and in days) must be provided, calculated with at least 0.2 m (0.7 ft) freeboard, and they must meet or exceed the volume that is expected to enter storage facilities during the recommended storage period.<br>• There must be an annual mass balance (tons per year and volume per year) that shows the nutrient source materials to be generated on the farm, the off-farm nutrient source materials to be imported, the treatment processes and their byproducts, all nutrient storages and the materials that they will store, and all nutrient sources that will be land-applied or exported.<br>• Complete Table 1 (Nutrient Storages Summary): enter all the nutrient source materials that will be stored and how they will be fully utilized for land application or export<br>• The methodology and calculations to derive the nutrient contents of the materials to be land-applied must be explained. | • A process flow diagram is expected to describe the annual mass balance, to illustrate the quantity of materials entering and/or exiting each of 4 phases (Fig. 1):<br>i) generation and import (e.g. on-farm and off-farm manure, washwater, yard/roof runoff/rainfall entering storages, off-farm AD feedstocks)<br>ii) treatment processes (e.g. anaerobic digestion, solid/liquid separation, composting, seepage from solid manure piles)<br>iii) storage<br>iv) land application and export off farm<br>• Current reference materials for the EFP program, including the Nutrient Management Reference Guide, may be used to describe manure generation, including milking centre washwater and precipitation inputs on dairy farms.<br>• As an alternative to a figure (e.g. Fig. 1), the 'MSTOR' component of the AgriSuite software* may be used to facilitate and print calculations of the mass balance. MSTOR will not calculate precipitation inputs for locations in BC at this time.<br>• Estimates of the final nutrient contents of the nutrient sources to be land-applied (e.g. digestate) should be the same as those in Section 4 of the NMP (Land Application).<br>*Ontario Ministry of Agriculture. NMANv3.2 software http://apps.omafra.gov.on.ca/NMAN/NMAN3.html |
| **4. Land Application** | **There is enough land for the nutrients to be land-applied.**<br>Complete the following for each of 1) the year before the proposed changes are implemented, and 2) the year after the proposed changes to AD are implemented:<br>• Describe cropping (and tillage) practices, crop rotations and yields.<br>• Calculate annual agronomic N, P, K balances and crop P, K removal balances* for each field.<br>• Complete Table 2a and 2b (Crop Phosphorus Removal Balances)<br>• The annual Farm Crop Phosphorus (P) Removal ratio must not be greater in the case of "after the proposed changes to AD are implemented" than "before the proposed changes to AD are implemented."<br><br>For the case of "after proposed changes to AD are implemented,"<br>• The maximum application rate of nutrients must not exceed the crop N requirements in any field, as indicated by the agronomic N balances*.<br><br>*Agronomic balances and crop removal balances are defined in the Nutrient Management Reference Guide http://www.agf.gov.bc.ca/resmgmt/NutrientMgmt/index.htm#nutrientguide | • Once nutrient contents of crop nutrient sources are obtained, the NMP Calculator software in the EFP program can be used to meet expectations under the Land Application section. Where differences exist between the EFP program's guidance and the expectations in this document, this document takes precedence.<br>• Irrigation water should be considered in the agronomic N balances.<br>• Professional judgment includes consideration of the following factors in the selection of nutrient application rates:<br>• the soil and landscape characteristics of each field in the Field Description (Section 1: Introduction)<br>• nutrient source, as well as the timing and methods of application<br>• A spreadsheet version of Table 2 (Crop P Removal Balances) is available to help identify which values from the NMP Calculator software should be used to complete Table 2.<br><br>• If the NMP Calculator software is used, negative values of agronomic N balances indicate that the crop N requirements will be exceeded for the field in question. |

## TABLE 3a Expected Components of the Nutrient Management Plan continued

| Section | Component | Guidelines |
|---|---|---|
| **5. Contingency Plans** | • What to do if there are more nutrients than expected<br>• What to do if there is a greater amount of nutrient source materials than there is storage capacity on the farm<br>• What to do in cases of unanticipated releases of nutrients<br>• How to handle weather and equipment conditions that affect plans for nutrient storage or applications<br>• What are alternatives for winter manure or digestate application? Under what conditions will these alternatives be implemented? | • n/a |
| **6. References** | • A reference list of literature cited | • n/a |
| **7. Appendices** | • All calculations for the agronomic and crop removal balances (Section 4: Land Application) of nutrients.<br>• Any exceptions to the sampling methodology in the Nutrient Management Reference Guide: http://www.agf.gov.bc.ca/resmgmt/NutrientMgmt/index.htm#nutrientguide<br>• Analytical reports including QA/QC reports provided by laboratories (Table 3)<br>• Record keeping forms including dates, volume, material, field identification of all land applications (e.g. manure, fertilizer, digestate, irrigation water).<br>• Transfer agreements (Appendix 1) | • Calculations for the agronomic and crop removal balances can be demonstrated by providing printouts and Excel files of the completed versions of the NMP Calculator software.<br>• In the Nutrient Management Plan (NMP) for approval of proposed changes to AD operations, there would be one Excel file for each of 2 cases: 1) the year before the proposed changes to AD are implemented, and 2) the year after the proposed changes to AD are implemented.<br>• In subsequent NMPs, the Excel file would have to be completed for the upcoming year at the time the NMP is prepared. |

Abbreviations: AD, Anaerobic Digestion; BC, British Columbia; EFP, Canada – BC Environmental Farm Plan program; K, potassium; MoE, BC Ministry of Environment; N, nitrogen; NMP, Nutrient Management Plan; P, phosphorus; QA/QC, Quality Assurance/Quality Control

Table 3b Expected Components of the Annual Report

| Section | Component | Guidelines |
|---|---|---|
| **Title Page** | • Document title and date in which the plan is in effect.<br>• Name, address, and contact information for farm operation.<br>• Name, address, and contact information of farm owner/operator (if different from above).<br>• NMP preparer's name, contact information, affiliation, credentials, and signature sign-off.<br>• Signature sign-off of farm owner/operator. | • n/a |
| **1. Nutrient Storage** | • There must not have been incidents when capacity was exceeded in any storage facility. Alternatively, if there were, there must be a reasonable explanation of why, what was done, and what will be done to prevent such incidents in the future.<br>• Records of nutrient transfers | • If there were such incidents, and storage facilities are sized to meet the EFP-recommended storage capacities, there should be a review of the contingency plan to prevent similar incidents in the future.<br>• Records of nutrient transfers may be provided by updating all fields in the Nutrient Transfer Agreements (Appendix 1) to describe the actual transfer |
| **2. Land Application[a]** | • If there were high levels of post-harvest soil nitrate in any field, the agronomic N rate calculations for next year's N applications should be revised according to best practices.<br>• Post-harvest soil nitrate (0-30 cm or 0-12 inch depth) is considered high if the following limits are exceeded: 30 ppm $NO_3$-N for grass fields; 45 ppm $NO_3$-N for all other crop types.<br>• Table 2 (Crop Phosphorus Removal Balances) must be completed based on actual land application practices and crop yields.<br>• The annual Farm Crop P Removal Ratio (Table 2) must not have increased after the implementation of proposed changes relative to the Farm Crop P Removal Ratio before the proposed changes to AD are implemented<br>• As an alternative to the Farm Crop P Removal requirement, soil test P levels that are "very high" must not be increasing on any field over a 2-year period.<br>• Soil test P (0 to 6 inch depth) is "very high" if it exceeds 100 ppm (Kelowna-method).<br>• Soil test P is increasing if the trend line for a 2-year period is increasing, following the implementation of proposed changes, based on annual sampling at pre-plant and post-harvest periods.<br>• Sidedress applications of N from any source to corn fields must be made based on a Pre-Sidedress Nitrate Test (PSNT). | • If post-harvest nitrate levels are high year-after-year, measures should be implemented to decrease these levels. See the factsheet, "Post-Harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades" for advice: https://ir.library.oregonstate.edu/xmlui/handle/1957/20221<br>• If using the NMP Calculator software, appropriate responses to high PHNT could be to increase the N fertility factor for the Updated NMP for next year.<br>• N applications could exceed crop requirements without resulting in high PHNT results (e.g. because of mid-season leaching of excess soil N)<br>• If neither the requirement for Farm Crop P Removal Ratio nor soil test P is met, it may be acceptable to describe a reasonable plan to decrease the average Farm Crop P Removal Ratio in the future to the ratio that existed prior to implementing the proposed changes.<br>• Chapter 6 of the Nutrient Management Reference Guide provides information about soil sampling protocols: http://goo.gl/XZ94yl |
| **3. Appendices** | • All calculations for the required agronomic and crop removal balances (Section 2: Land Application) of nutrients.<br>• Any exceptions to the sampling methodology in the Nutrient Management Reference Guide: http://www.agf.gov.bc.ca/resmgmt/NutrientMgmt/index.htm#nutrientguide<br>• Completed record-keeping forms from the most recent NMP.<br>• Analytical reports including QA/QC reports provided by laboratories (Table 4) | • Calculations for the required agronomic and crop removal balances can be demonstrated by providing printouts and Excel files of the completed versions of the NMP Calculator software. |

Table 4 Minimum Expectations for Sampling and Analysis

| Parameters | Nutrient Management Plan in the Application | Updated Nutrient Management Plans | Annual Reports |
|---|---|---|---|
| **Soil Test P**<br>**Soil Test K** | • For each field, use analytical results (0-15 cm or 0-6 inch depth) that are less than 3 years old on the date of the NMP<br>• Annual pre-plant (spring) and post-harvest (fall) soil test P analysis (0-15 cm or 0-6 inch depth) is expected if<br>• Convert values to Kelowna-method equivalent values using the Soil Test P and K Converter (http://www.agf.gov.bc.ca/resmgmt/NutrientMgmt/Excel_Spreadsheet/Soil_test_P_and_K_converter_Jan2014.xls) | | |
| **Soil $NO_3$-N and $NH_4$-N** | • Not expected but pre-plant (spring) $NH_4$-N and $NO_3$-N values are recommended if time permits | • Annual post-harvest nitrate test results (0-30 cm or 0-12 inch depth) from the previous cropping year are required for each field. | • Annual post-harvest nitrate test results (0-30 cm or 0-12 inch depth) are expected for each field.<br>• Annual pre-sidedress nitrate test results (0-30 cm or 0-12 inch depth) are expected for each corn field that received sidedress N fertilizer. |
| **Soil pH** | • For each field, use an analytical result that is less than 3 years old on the date of the NMP or Annual Report. | | |
| **Soil EC** | • For each field, use an analytical result that is less than 1 year old on the date of the NMP or Annual Report. | | |
| **Digestate for Land Application or Export:**<br>**Total N, $NH_4$-N, $NO_3$-N**<br>**Total P**<br>**Total K**<br>**% moisture (dry matter)**<br>**pH, EC** | • Use estimates that result from the calculations for Nutrient Storage (Section 3 of the NMP, Table 3a) | • Use analytical results from at least 1 sample that represents each land application or export in the previous year | • Use analytical results from at least 1 sample that represents each land application or export in the previous year. |
| **Other nutrient sources[a] for Land Application or Export:**<br>**Total N, $NH_4$-N, $NO_3$-N**<br>**Total P**<br>**Total K**<br>**% moisture (dry matter)** | • Use analytical results from at least 1 sample that is less than 1 year old on the date of the NMP, or in lieu of analytical results use appropriate book values and cite their source. | • Use analytical results from at least 1 sample for each nutrient source that is less than 1 year old on the date of the NMP. | • Use analytical results from at least 1 sample that represents each land application or export in the previous year. |
| **Irrigation water:**<br>**Total N, $NH_4$-N, $NO_3$-N, EC**<br>**Total P** | • Use at least one sample annually from each source of irrigation water. | | |
| **Crop yields** | • If yields reportedly increase after implementation of proposed changes, provide measurements of yields (including harvested cover crops) and method(s) of measurement. | | |
| **Crops (Harvested Portions):**<br>**Total N (protein content)**<br>**Total P**<br>**Total K**<br>**% moisture (dry matter)** | • For each field, use analytical results that are less than 3 years old on the date of the NMP or Annual Report, or in lieu of analytical results use appropriate book values and cite their source. | | |

Abbreviations: AD, Anaerobic Digester; EC, Electrical Conductivity; K, Potassium; MoE, British Columbia Ministry of Environment; N, Nitrogen; $NH_4$, Ammonium; $NO_3$, Nitrate; P, Phosphorus; SAR, Sodium Absorption Ratio

a. "Other nutrient sources" are those besides digestate (e.g. manures or compost) that will be land-applied or exported, excluding commercial fertilizer and irrigation water

## Transfer Agreement

*The main components being considered for an agreement follow:*

Transfer agreements are expected if there will or may be transfers of nutrient source materials (digestate, manure, etc.) from the applicant's farm operation to a) another farm operation or b) to a broker who will transport the materials to another farm operation. Transfer agreements should have the following components:

Name of Receiver(s)
For each Receiver,

- Location (Parcel Identifier, PID)
- Type of material to be transferred
- Volume of nutrient source materials being transferred
- Proposed dates of transfer
- Tillable acres available for the nutrient source materials

*Examples of transfer agreements can be adapted from Ontario:*http://www.omafra.gov.on.ca/english/engineer/facts/14-005.htm#4

# 6 Appendix: EFP Worksheets

Reference Guide Chapter 6

| | Nutrient Application (Manure, Fertilizer & Compost) Does not apply to this EFP | Yes | No | ? | N/A |
|---|---|---|---|---|---|
| 198 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 12*<br>***Are manure application rates and timing selected so as to match but not exceed crop nutrient requirements?*** | | | | |
| 199 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 11*<br>***Is application done in a manner that prevents manure or fertilizer from being directly discharged into a watercourse or ground water?*** | | | | |
| 200 | federal *Fisheries Act, Section 36(3)* (nutrients could be a "*deleterious substance*")<br>***Is the direct or indirect deposit of deleterious substances into a watercourse avoided?*** | | | | |
| 201 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Sections 13 and 14*<br>***Is application done in a manner, and timed (NOT on frozen land, in diverting wind, on areas having standing water, or on saturated soil) so as to prevent runoff or the escape of agricultural wastes from causing pollution, of a watercourse or ground water, and preventing it from going beyond the farm boundary?*** | | | | |
| 202 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 14*<br>***When applying liquid manure to tile-drained fields, are application practices adjusted so that manure will not directly flow into tile drains?*** (use of practices such as pre-tillage within 7 days and/or injection and/or an application rate appropriate to soil conditions) | | | | |
| 203 | When using manures or other soil amendments have nutrient levels, (including C:N ratios) been tested to ensure that amendment is being applied appropriately (tested within the last 2 years)? | | | | |
| 204 | Are nutrients applied only to cropland, avoiding sensitive areas (such as wildlife habitat)? | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 205 | Is manure application and timing selected so that emissions are reduced? (such as using injection methods and selecting time of day or day of week least offensive) | | | | |
| 206 | Is the nutrient application equipment selected and operated in a manner to apply nutrients uniformly and in a controlled manner? | | | | |
| 207 | Has the nutrient application equipment been calibrated within the past year for rate and uniformity? | | | | |
| 208 | Is the nutrient application equipment operated to minimize soil compaction or erosion? | | | | |
| 209 | Are soil fertility levels known for each field? (tested within the past 2 years) | | | | |
| 210 | Are crop yields and quality known for each harvest? | | | | |
| 211 | Are there records for application rates, times and methods of various nutrient sources? | | | | |
| 212 | When liquid manure is being delivered to a field through pipes that pass within 10 m [30 ft] of any ditch or watercourse, is there secondary containment for the pipes? | | | | |
| 213 | Complete a Nutrient Management Plan if answering "No" or "?" to any of the sub-questions below: | | | | |
| | • As a livestock producer or an intensively managed outdoor horticulture crop producer, using nutrients over moderately to highly vulnerable aquifers (refer to Table 6.6) used for drinking water, has a Nutrient Management Plan been completed and is it being followed? (e.g., berry, nursery, tree fruits, vegetable crops over aquifers such as in Abbotsford-Sumas, Hopington, Grand Forks, Vedder Fan Aquifer) | | | | |
| | • Based on the Calculations in Worksheets 4 or 5, (pages 66 and 67) are annual manure nitrogen application rates less than the baseline application values (for the whole farm) that would trigger a Nutrient Management Plan? | | | | |
| | • For farms located in phosphorus sensitive areas, is the soil phosphorus level less than 80 µg/g? (e.g., areas where surface water eventually flows to a lake or pond) | | | | |
| | Background for these questions and steps to develop a Nutrient Management Plan are outlined in the **Reference Guide**, Chapter 6, Nutrient Management Planning. Specific nutrient management information is described in detail in the **Nutrient Management Reference Guide** publication. | | | | |

Reference Guide Chapter 3

**This section applies to operations that produce manure or use manure**

| | Manure Handling and Storage (Including Field Storage) Does not apply to this EFP ☐ | Yes | No | ? | N/A |
|---|---|---|---|---|---|
| 102 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 4*<br>***Is the stored manure produced or used on the farm?*** | | | | |
| 103 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 6(a)*<br>***Is the manure storage capacity sufficient to store manure and other wastes until they can be spread properly as a fertilizer?*** (complete Worksheet 2 (liquid manure) or 3 (solid manure), page 62 and 64 to answer this question) | | | | |
| 104 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Sections 3, and 6*<br>***Is solid and liquid manure collected and stored in a manner that prevents its escape and from causing pollution?*** (built to engineered standards and secure from impacts of 1 in 100-year floods) | | | | |
| 105 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 7(1)*<br>***Is the manure storage facility, other than field storage, located at least 15 m [50 ft] from watercourses?*** (horizontal distance) | | | | |
| 106 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 7(1)*<br>***Is the manure storage facility, other than field storage, located at least 30 m [100 ft] from any source of water for domestic purposes?*** (horizontal distance to water intake) | | | | |
| 107 | *Public Health Act, Public Health Act Transitional Regulation, Section 18* (manure storage sites could be considered a "*probable source of contamination*")<br>***Are probable sources of contamination stored at least 30.5 m [100 ft] from any well?*** (horizontal distance) | | | | |
| 108 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 9*<br>***In areas of high rainfall (greater than 600 mm [24 in] Oct 1st to April 30th) are field stored manure piles covered from October 1st through April 1st?*** | | | | |
| 109 | federal *Fisheries Act, Section 36(3)* (manure or manure leachate could be a "*deleterious substance*")<br>***Is the direct or indirect deposit of deleterious substances into a watercourse avoided?*** | | | | |
| 110 | Is the manure storage located and managed to prevent manure and its leachate from contaminating watercourses? | | | | |
| 111 | Is the manure storage located and managed to prevent leachate from contaminating ground water? | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 112 | For semi-solid and liquid manure storage, is a leak detection system used? | | | | |
| 113 | For liquid manure facilities is there secondary containment? | | | | |
| 114 | Are manure storages covered to prevent the release of air emissions? (such as floating plastic or straw) | | | | |
| 115 | Are manure additives used to control ammonia emissions? (e.g., natural antimicrobial additives, plant-derived essential oils and aerobic bacteria) | | | | |
| 116 | Is manure handled in a way that prevents emissions? (such as minimizing agitation or keeping storage tanks below ground). | | | | |
| **Field Storage of Solid Manure - Short Term (2 weeks or less)** | **Does not apply to this EFP** ☐ | | | | |
| 117 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(1)*<br>***Is solid manure the only type of manure stored in the field and is it used within two weeks?*** | | | | |
| 118 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(1)b*<br>***Is leachate or contaminated water prevented from reaching surface water or ground water?*** | | | | |
| **Field Storage of Solid Manure - Long Term** | **Does not apply to this EFP** ☐ | | | | |
| 119 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(2)*<br>***Is solid manure the only manure stored in the field?*** | | | | |
| 120 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(2)c*<br>***Is leachate or contaminated water prevented from reaching surface or ground water?*** | | | | |
| 121 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(2) a*<br>***Is the manure used within 9 months?*** | | | | |
| 122 | *Environmental Management Act, Code under the Agricultural Waste Control Regulation, Section 8(2)b*<br>***Are the piles located at least 30 m [100 ft] from any watercourse?*** (horizontal distance) | | | | |
| **Manure Contingency Plan** | **Does not apply to this EFP** ☐ | | | | |
| 123 | *Environmental Management Act, Spill Reporting Regulation, Section 2*<br>***Is the amount of a manure spill that must be reported known, and can the farm operation meet the requirement to immediately report a spill should it be discovered?*** | | | | |
| 124 | Has a contingency plan been developed to deal with manure emergencies such as spills, equipment failures, fires or vandalism and is it current? | | | | |

## Worksheet #4 — Manure Nitrogen Application Assessment for Farms that Generate Manure — Workbook Question 217

**Question:** Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

**Information:**

Type of animal (Refer to Table 6.7*) [1]

Reset

Number of animals [2]

Portion of manure remaining on the farm after manure export (value between 0 and 1) [3]

Assumed annual N excretion per animal place (Refer to Table 6.7*) [4] kg N/animal

**Calculations:**

Step 1 Estimate the manure N excreted and remaining on farm, using Equations below:

**Equation:**

| Number of animals | x | portion of manure left | x | Annual N Excretion/ animal place (kg) | = | Annual N Excreted and remaining on Farm (kg) |
|---|---|---|---|---|---|---|

[2] x [3] x [4] kg/Animal = [5] kg N

Step 2 Calculate annual baseline manure N application for crops grown on farm, using Equation below:

**Equation:**

| Area Manure Spread on (ha) | x | Manure N Application Rate (kg N/ha) | = | Manure N Application for Farm (kg) |
|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **non-forage area** | [6] | ha x | *50* | kg N/ha | = | [10] | kg N |
| **forage grass (Fraser Valley) area** | [7] | ha x | *300* | kg N/ha | = | [11] | kg N |
| **forage grass (rest of BC) area** | [8] | ha x | *200* | kg N/ha | = | [12] | kg N |
| **forage corn area** | [9] | ha x | *150* | kg N/ha | = | [13] | kg N |

Step 3 Calculate Annual Baseline Manure N application for whole farm

(Sum of boxes 10 to 13) = [14] kg N

**Answer:**

Step 4 Is the annual N excretion remaining on the farm [5] less than [14] the baseline application value?

*NO* **a NMP is recommended**

**or** *YES* **a NMP is Optional**

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

**Note: *Refer to Tables in BC Environmental Farm Plan Reference Guide**

## Worksheet #5 Manure Nitrogen Application Assessment for Farms that Use Manure but do not Generate Manure — Workbook Question 217

**Question:** Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

**Information:**

Type of animal (Refer to Table 6.7*) [1]

Reset

Manure Volume [2] $m^3$

Average manure N concentration (Refer to Table 6.7*) [3] kg $N/m^3$

**Calculation:**

Step 1 Estimate total N content of manure supply, using Equation below:

| Equation: | | | | |
|---|---|---|---|---|
| Manure Volume ($m^3$) | x | Assumed manure N concentration ($N/m^3$) | = | Total N content (kg) |

[2] $m^3$ x [3] kg $N/m^3$ = [4] kg N

Step 2 Calculate manure N application value for crops grown on farm, using Equation below.

| Equation: | | | | |
|---|---|---|---|---|
| Area Manure Spread on (ha) | x | Manure N Application Rate (kg N/ha) | = | Manure N Application for Crop (kg) |

| | | | | | | |
|---|---|---|---|---|---|---|
| non-forage area | [5] | ha x | 50 | kg N/ha | = | [9] kg N |
| forage grass (Fraser Valley) area | [6] | ha x | 300 | kg N/ha | = | [10] kg N |
| forage grass (rest of BC) area | [7] | ha x | 200 | kg N/ha | = | [11] kg N |
| forage corn area | [8] | ha x | 150 | kg N/ha | = | [12] kg N |

Step 3 Annual Baseline Manure N application for whole farm = [13] kg N

**Answer:**

Step 4 Is the manure N content [4] less than [13] the baseline application value?

NO **a NMP is recommended**

**or** YES **a NMP is Optional**

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

**Note: *Refer to Tables in BC Environmental Farm Plan Reference Guide**

## Worksheet #5 Manure Nitrogen Application Assessment for Farms that Use Manure but do not Generate Manure — Workbook Question 217

**Question:** A vegetable farm orders 100 $m^3$ of broiler manure for application onto 10 ha of vegetable crop land.

Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

**Information:**

Reset

| | | | |
|---|---|---|---|
| Type of animal | Poultry Broiler | 1 | |
| Manure Volume | 100 | 2 | $m^3$ |
| Average manure N concentration | 15.8 | 3 | kg N/$m^3$ |

**Calculation:**

Step 1 Estimate total N content of manure supply, using Equation below:

**Equation:**

| Manure Volume ($m^3$) | x | Assumed manure N concentration (N/$m^3$) | = | Total N content (kg) |
|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 100 | 2 | $m^3$ | x | 15.8 | 3 | kg N/$m^3$ | = | 1,580 4 kg N |

Step 2 Calculate manure N application value for crops grown on farm, using Equation below.

**Equation:**

| Area Manure Spread on (ha) | x | Manure N Application Rate (kg N/ha) | = | Manure N Application for Crop (kg) |
|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| non-forage area | 10 | 5 | ha | x | 50 | kg N/ha | = | 500 | 9 | kg N |
| forage grass (Fraser Valley) area | | 6 | ha | x | 300 | kg N/ha | = | 0 | 10 | kg N |
| forage grass (rest of BC) area | | 7 | ha | x | 200 | kg N/ha | = | 0 | 11 | kg N |
| forage corn area | | 8 | ha | x | 150 | kg N/ha | = | 0 | 12 | kg N |

Step 3 Annual Baseline Manure N application for whole farm = 500 13 kg N

**Answer:**

Step 4 Is the manure N content 1,580 4 less than 500 13 the baseline application value?

NO **NMP is recommended**

For this vegetable farm example, the estimated N content of the manure brought onto the farm is greater than the calculated annual baseline application of manure N for the farm.

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

# Worksheet #2 — Sizing Liquid Manure Storage — Workbook Question 103

**Question:** What size of liquid manure storage is required for this livestock operation?

**Information:**

| | | | |
|---|---|---|---|
| Desired storage duration (select site) (Table B.1*) | | 1 | days |
| Precipitation on the site from Oct 1 to April 30 (refer to Table B.1*) | | 2 | m |
| Storage depth | | 3 | m |
| Storage width | | 4 | m |
| Check if storage is roofed: | ☐ | | |
| Runoff to be stored from roofs and confinement yards - from Worksheet 11 | | 5 | $m^3$ |
| Other liquid wastes to be stored | | 6 | $m^3$ |

Reset

**Calculation:**

Step 1 Establish daily manure volume

**Equation:**

**Daily Manure Production for type and Class of Class of Livestock = Number of Animals x Animals Daily Manure Production Rate**

| Class of Animal | 7 Average Number on Farm | | 8 Liquid Manure Storage (Table 3.4*) Litres per day per animal | | 9 Total Storage Required Litres/day |
|---|---|---|---|---|---|
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |
| | | x | | = | |

Farm daily manure volume

**Equation:**

**Farm Daily Manure Production = Sum of the Daily Manure Production For Each Livestock Type or Class**

| | | |
|---|---|---|
| | 10 | Litres/day |
| Converted to $m^3$: | 11 | $m^3$/day |

Step 2 Determine manure storage required

**Equation:**

**Manure Storage required = Farm daily manure production x Days of storage required**

= 11 $m^3$/day x 1 days = 12 $m^3$

Step 3 Determine total storage required

**Equation:**

**Total storage required = Manure Storage required + Contaminated runoff (liquid storage only) + Other Liquid Wastes**

= 12 $m^3$ + 5 $m^3$ + 6 $m^3$ = 13 $m^3$

Step 4 Determine effective storage facility for rectangular tanks

NOTE: If calculated length is unsuitable, choose different width or depth until size is suitable.

**Equation:**

| Effective storage depth | = | Storage depth | - | Precipitation at the site (0 if roofed) | - | Safety freeboard (normally 0.2 m) |
|---|---|---|---|---|---|---|
| | = | 3 m | - | 2 m | - | 0.2 m = 14 m |

**Equation:**

| Storage length | = | Total storage required | ÷ | Effective depth of storage | ÷ | Storage width |
|---|---|---|---|---|---|---|
| | = | 13 $m^3$ | ÷ | 14 m | ÷ | 4 m = 15 m |

**Note: Refer to Tables in BC Environmental Farm Plan Reference Guide**

## Worksheet #4 Manure Nitrogen Application Assessment for Farms that Generate Manure

**Workbook Question 217**

**Question:** Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.

**Information:**

Type of animal (Refer to Table 6.7*) [1]

Reset

Number of animals [2]

Portion of manure remaining on the farm after manure export (value between 0 and 1) [3]

Assumed annual N excretion per animal place (Refer to Table 6.7*) [4] kg N/animal

**Calculations:**

Step 1 Estimate the manure N excreted and remaining on farm, using Equations below:

| Equation: | | | | | | |
|---|---|---|---|---|---|---|
| Number of animals | x | portion of manure left | x | Annual N Excretion/ animal place (kg) | = | Annual N Excreted and remaining on Farm (kg) |

[2] x [3] x [4] kg/Animal = [5] kg N

Step 2 Calculate annual baseline manure N application for crops grown on farm, using Equation below:

| Equation: | | | | |
|---|---|---|---|---|
| Area Manure Spread on (ha) | x | Manure N Application Rate (kg N/ha) | = | Manure N Application for Farm (kg) |

| | | | | | | |
|---|---|---|---|---|---|---|
| non-forage area | [6] | ha x | 50 | kg N/ha | = | [10] kg N |
| forage grass (Fraser Valley) area | [7] | ha x | 300 | kg N/ha | = | [11] kg N |
| forage grass (rest of BC) area | [8] | ha x | 200 | kg N/ha | = | [12] kg N |
| forage corn area | [9] | ha x | 150 | kg N/ha | = | [13] kg N |

Step 3 Calculate Annual Baseline Manure N application for whole farm

(Sum of boxes 10 to 13) = [14] kg N

**Answer:**

Step 4 Is the annual N excretion remaining on the farm [5] less than [14] the baseline application value?

NO **a NMP is recommended**

**or** YES **a NMP is Optional**

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

**Note: *Refer to Tables in BC Environmental Farm Plan Reference Guide**