Manure and Nutrient Management Report – Huxley Farm

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1. Introduction

On May 12, 2016, Darlene R Huxley of 2148 Pyott Road, Armstrong BC was served with a Pollution Abatement Order (PAO) under the Environmental Management Act (File: UA Hullcar Aquifer, AMS# 349900). The PAO referenced the lands identified by PID 002-559-111 as well as other lands associated with the operation. This report contains the information specified in the PAO to be provided to the Director.

The recommendations in this report are based on standards and guidance from the following regulations and documents:

- BC Agricultural Waste Control Regulation
- BC Code of Agricultural Practice for Waste Management
- Huxley Pollution Abatement Order
- BC Environmental Farm Plan Program Reference Guide
- Other references as noted in the reference list

2. Disclaimer

This report is based on information obtained from the land owners which is believed to be accurate and on site conditions observed during site visits made on June 1, 2016 and June 24, 2016. Reasonable efforts were made to confirm the accuracy of information provided. No responsibility is taken for inaccurate information provided to the author in the preparation of this report. Due to the time of year of preparation of this report (June and July), site conditions may have been different than would be observed during the winter and spring months. Given these factors, this report has been prepared as accurately as possible.

3. Background

The Huxley property consists of 160 acres of land (65 hectares) located adjacent to Pyott Road in Spallumcheen BC. The farm is located 1.8 km north of the north edge of the Hullcar valley, and is approximately 100 m higher in elevation than the valley bottom. The agricultural operations on site consist of a 25 head beef-cow calf operation. The 160 acres of land that constitute the property is primarily unimproved land that is partially cleared and partially forested, and is used for hay production and grazing (Site map 1). There are 4 hay fields on the property totalling 33 acres (13 hectares) that are

used to produce hay for the cow herd and also used for summer and fall grazing. The farm has no irrigation.

The farm's cow herd is grazed on the property from May through October of each year. Cows are moved around the entire property throughout the 6 month grazing period. Cows are not fed supplemental feed during the majority of this period.

The cow herd is fed during the winter months (November through April) in a 5 acre (2 ha) seasonal feeding area near the house (Site map 2). Calving also occurs in this pasture. There is a concrete-floored barn in this pasture in which cattle are fed, and they have access to the pasture when not eating (Photograph 1). Historically, manure deposited in the barn during cattle feeding has been stockpiled outside of the barn and spread on the hay field in spring.

4. Soils, Water and Climate

Soils: The soil on the Huxley property is mapped as belonging to the Cherryville soil series (Sprout and Kelley 1960/1963). This soil type has developed on glacial till deposits. It is mapped as having a texture of gravelly sandy loam. These soils are moderately coarse textured with a moderate cation exchange capacity and a moderate ability to retain nutrients and moisture. From the available well log records, it appears that bedrock is at least 16' (5 m) from the soil surface on the property suggesting that the till deposits are 5 m thick.

Climate: The climate in the north Okanagan is characterized by hot summers with a seasonal moisture deficit where crop moisture requirements exceed precipitation. Winters are cold with air temperatures below freezing for several months and frozen soils. Annual precipitation is 557 mm (22") which is fairly evenly distributed throughout the year. Seventy percent of the precipitation (380 mm, 15") falls as rain primarily during the March through November period, and 30% as snow during the December through February period (data from the Silver Creek climate station, the closest station to the subject property) (Environment Canada 2016).

Surface and groundwater: There is a seasonal stream on the property that runs for approximately 6 weeks in the spring of each year (mid-March through April). The stream originates in a slough above the property that is fed by spring runoff and subsurface flow, and runs through the seasonal feeding pasture and through the property's lower pasture (Site map 1). The stream is 140 m from the area where the cattle congregate in the winter months and from the path of any runoff from the seasonal feeding area. The stream leaves the Huxley property along the south property boundary, and runs in an easterly direction through several neighbouring properties. It apparently terminates before reaching Deep Creek.

There are two wells on the property, a 340' deep well used for domestic and livestock water (BC WTN 62833), and a shallow dug well used for garden watering (BC WTN 14237). Both wells are >30 m from the proposed manure storage facility. Two other dug wells were found on the well log data base but have apparently been filled in (BC WTN 14239 from 1954 and WTN 1385 from 1920). Because most of the property is sloping, it is assumed that groundwater remains at least 1 m below the soil surface throughout the year. However, there may be a seasonal high groundwater table in areas of the property during the spring runoff period.

5. Manure Storage

Permanent manure storage: The farm currently does not have a permanent storage facility for manure produced over-winter. Historically, the manure has been stored temporarily in a pile in the seasonal feeding pasture. The owner has indicated that he will build a suitably sized permanent storage facility for the manure produced in the barn during the winter feeding period, November through April. Based on the manure production volumes in the BC Environmental Farm Plan Reference Guide, the herd would be expected to produce approx. 84 cubic metres of manure over the 6 month winter feeding period (November through April) (BCMAF 2010). The owner is proposing a permanent manure storage facility with a poured concrete base and 1 m (3') walls on 3 sides. Assuming a manure depth of 1 m in the storage facility, a facility with 84 m^2 of useable floor space would hold the manure; the farmer will build the facility with his preferred dimensions to hold the required volume of manure plus over-winter precipitation.

The facility will be located in the pasture to the west of the barn (Site map 2 and Photograph 2). It will be placed such that clean runoff from above is diverted away from the facility. It will not be roofed but will be sized to hold the approximately 20 cm of rain and snow that falls during the winter storage period.

Temporary manure storage: No temporary manure storage is required on the property. Manure generated over the winter feeding period will be stored in the permanent storage facility until it is spread on the hay fields in the spring or summer. There will be no temporary manure storage on the property.

This is an acceptable solution for winter manure storage.

6. Runoff and Leachate Management on the Property

6.1 Runoff management

Climatic conditions causing runoff: In the climate of the North Okanagan where this operation is located, runoff occurs only during early spring snow melt. It occurs when there is a sudden onset of warm weather in February or March that causes rapid thawing of snow on frozen or saturated soil on sloping ground. Under these conditions, there can be significant movement of water across the landscape and if there is manure on the land surface, the runoff can become contaminated with nutrients. Runoff events do not occur every year in the North Okanagan, and when this type of event does occur it normally lasts only one or two days because snow melt occurs very quickly. During the rest of the year when soils are not frozen or saturated, heavy rains do not cause runoff except on compacted surfaces such as roadways. On arable land, even during prolonged heavy rain, rainwater infiltrates the soil.

Runoff potential on Huxley property: Much of the farm's land base is sloping and is therefore susceptible to runoff of snowmelt when this occurs. Runoff on most of the farm's land base is not an environmental concern because there is no significant accumulation of manure in one spot that could contaminate runoff. Contamination of runoff with manure is a concern only in the seasonal (winter) feeding pasture.

Diversion of clean runoff: Historically, there has in some years been runoff in the seasonal feeding pasture. The runoff has come from a neighbour's property to the north, through the hay field to the north and into the seasonal feeding pasture. This has occurred approximately once every 5 years when climatic conditions are conducive to runoff production. Runoff has not historically occurred from snowmelt in the seasonal feeding pasture itself. In 2014, a culvert was installed to capture runoff from the field above at the site where it has historically left the hay field and entered the seasonal feeding pasture. The culvert diverts clean runoff from the land above underground and discharges it lower down in the seasonal feeding pasture where there is no accumulation of manure. Because of this culvert, there is no longer any risk of runoff from the field above contacting manure in the seasonal feeding pasture. Currently, the only contamination of runoff that can occur is from snowmelt on the seasonal feeding pasture itself, and based on information from the owner, this does not occur. With the culvert diverting clean runoff and the permanent manure storage to be built in the seasonal feeding pasture, opportunity for contaminated runoff is significantly reduced.

Manure deposition in seasonal feeding pasture: In the seasonal feeding pasture there is an accumulation of manure deposited by the herd during the November to April winter feeding period when the animals are not in the barn. The owner will in future allow cattle access to the hay field above the seasonal feeding pasture during November and December (before permanent snow cover) to allow more of the manure to be deposited on the hay field. This will reduce the amount of manure in the seasonal feeding pasture.

Historically, there has been a stockpile of manure in the seasonal feeding pasture; this will not be an issue going forward as the farmer is planning to build permanent storage facility for this manure. If runoff occurs in the seasonal feeding pasture in the future, it will not contact the stockpiled manure.

Seasonal stream: There is a seasonal stream that runs through the seasonal feeding pasture during March and April. The watercourse is located a minimum of 140 m (450') from the barn and >140 m from the area where the cows congregate during the winter months. Any runoff from the seasonal feeding area flows directly down slope from the field and away from the seasonal stream. Cattle are provided with an alternative watering source in the barn so do not use the stream for watering. The stream is currently not fenced but the owner will install a temporary fence to exclude the cattle from the stream during the time that the stream is running.

Buffer strip: There is a vegetated strip below the seasonal feeding area approximately 70 m (200') deep which appears to be sufficient to manage any runoff from the seasonal feeding area should this occur. The farmer has indicated that when runoff has occurred historically from the seasonal feeding area (prior to installation of the diversion culvert), this buffer strip contained any particulates and absorbed the flow of runoff. Runoff does not reach the house below the seasonal feeding pasture (which is part of the property), and does not reach the property boundary which is located approximately 500 m south of the seasonal feeding pasture.

With the implementation of the manure management suggestions above and given current conditions, there does not appear to be any risk of contaminated runoff leaving the property or contacting surface water.

6.2 Leachate management

Leachate is understood in the context of this PAO to be water contaminated with nutrients as the result of contact with stockpiled manure. It is assumed that it does not refer to water contacting individual fecal deposits on pasture land.

On the subject property, leachate production is a potential concern only in the seasonal feeding area where manure has historically been temporarily stockpiled before being land applied in the spring.

As discussed in section 5, the farm owner has indicated that he will build a permanent manure storage facility sized to store all manure from the winter feeding period (November through April). This will eliminate the risk of leachate forming from runoff contacting stockpiled manure. Once the permanent manure storage facility is built, there will be no further risk of leachate from stockpiled manure in the seasonal feeding pasture.

Manure deposition in the seasonal feeding pasture by the farm's 25 cows and approximately 6 calves during the 6 month winter feeding period amounts to approx. 60 kg/ha of inorganic nitrogen per year (Table 1b). It is expected that growth of forage in the seasonal feeding pasture (and subsequent grazing of the forage) will easily take up this nitrogen during the growing season (a grass crop can utilize 100 to 400 kg/ha of inorganic nitrogen during one growing season). It is not expected that manure deposition by livestock on the seasonal feeding pasture will lead to significant excess nitrate on the site. As indicated above, the owner will allow cattle access to the hayfield to the north during the early winter feeding period (November and December) which will spread fecal deposits on a larger land base.

7. Manure and Fertilizer Nitrogen Application Rates

7.1 Annual nitrogen budget for farm

In order to determine whether nitrogen is being applied at an agronomic rate on the subject property, it is necessary to calculate the annual nitrogen budget for the farm. This is shown in Tables 1a and 1b below. The farm's annual nitrogen inputs and outputs have been divided into the grazing period (May through October) and the winter feeding period (November through April).

Nitrogen budget – May through October (Table 1a)

During these months, the cow herd plus calves graze the farm's 65 ha (160 acres) of hay and pasture land. Based on annual nitrogen excretion by cows and calves (BCMAF 2010), the amount of inorganic nitrogen excreted by the herd per hectare has been calculated as 4.3 kg per ha per year. The herd grazes the whole property in rotation, so manure is assumed to be spread evenly around the property. However, this nitrogen is actually cycled on the property because, during most of this period, the cattle are not fed any supplementary feed but eat only grass from the property, and the land base is not fertilized (except the hay fields where nitrogen is taken up and removed in the hay crop). Therefore, the nitrogen contributed during the 6 month grazing period is not a net addition of nitrogen but rather a cycling of nitrogen on the property with some removal in calf weight gain.

Nitrogen budget – November through April (Table 1b)

During these months, the cow herd (plus 3-6 calves remaining) is fed in a 5 acre (2 ha) pasture adjacent to the house. The cows are fed in the barn and spend approximately half of their time in the barn. The

cows are fed the hay produced on the 33 acres of hay land plus some additional purchased hay. During this time, the herd excretes approximately 483 kg of nitrogen in the barn which ends up in the winter manure storage pile, and 483 kg of nitrogen on the 5 acre seasonal feeding pasture. Assuming 25% inorganic nitrogen in the manure deposited on the seasonal pasture, a total of 60 kg/ha/yr of manure-origin inorganic nitrogen is applied to this pasture.

Table 1. Annual manure nitrogen budget – Huxley Farm

1a. Nitrogen excreted in manure by livestock on site – May through October when cattle are on pasture (cows with calves)

Type of livestock	Number of livestock on farm	N excreted per animal per month (kg/month)	Months on 65 ha pasture	N excreted on pasture (kg/yr)	Inorganic N (25% of total) (kg/yr)	Inorganic N per hectare of land (kg/ha/yr)
Beef cows	25	6.1	6	915	229	3.5
Calves	25	1.4	6	210	53	0.8
Total	**50**	**7.5**	**6**	**1125**	**282**	**4.3**

1b. Nitrogen excreted in manure by livestock on site – November through April when cattle are in seasonal feeding pasture (most calves have been sold)

Type of livestock	Number of livestock on farm	N excreted per animal per month (kg/month)	Months in seasonal feeding pasture	N excreted in barn and stored in manure storage (50%) (kg/yr)	N excreted on seasonal feeding pasture (50%) (kg/yr)	Inorganic N on seasonal feeding pasture (25% of total N on 2 ha pasture) (kg/ha/yr)
Beef cows	25	6.1	6	458	458	57
Calves	6	1.4	6	25	25	3
Total	**50**	**7.5**	**6**	**483**	**483**	**60**

7.2 Current nitrogen application rate at Huxley farm

The PAO specifies that the farm owner must adhere to manure and inorganic fertilizer application rates determined by a Qualified Professional. In my opinion, the farm is currently applying less nitrogen in manure and fertilizer than crop requirements. Based on standard values from the BC Environmental Farm Plan Reference Manual and other references (BCMAF 2010; Sullivan 2008) and my calculations, the operation is applying approximately 50 kg per hectare per year of plant-available or inorganic nitrogen in manure and chemical fertilizer to their 6 hectare hay field (Table 2), and less on other hay fields which receive only chemical fertilizer. A typical unirrigated grass stand in the North Okanagan requires 100 kg N/ha/yr (or more) for optimum crop yield (Bittman et al 1999). At this time, the operation is supplying insufficient nitrogen in manure and fertilizer to optimize yields.

The operation has one hay field 6 hectares (15 acres) in size on which they apply a small amount of chemical N fertilizer and all the manure from the over-winter stockpile, and an additional 7 hectares (17 acres) of hay land on which they apply only chemical fertilizer at 30 kg/ha/yr (Photograph 3). They take one cut of hay from the hay fields in June-July and the fields are grazed for the rest of the year. Nitrogen consumed while cows graze hay fields is mostly deposited back on the fields. Table 2 below shows

calculations of nitrogen applied annually to the 15 acre hay field in manure and fertilizer. The calculations are based on the nitrogen excreted by the livestock during the winter feeding period (November through April) as shown in Table 1b. The calculations show that approximately 50 kg/ha/yr of nitrogen is applied to the 6 hectare hay field which is less than half of the nitrogen that would be required for the crop to obtain optimum yields. This is based on the assumption that 25% of the nitrogen in manure is available during the year of application (Sullivan 2008), and 100% of the chemical fertilizer is available during the year of application. The other hay fields receive only 30 kg/ha/yr of nitrogen fertilizer. There is a small residual amount of nitrogen available to the crop from historic manure applications, amounting to approximately 10% of the annual application in manure which would contribute up to 5 kg/ha/yr of available nitrogen to the crop.

At this time, the farm's manure and fertilizer applications are below agronomic rates. The farm could safely apply up to 50 kg/ha/yr of additional nitrogen as fertilizer on the 6 hectare hay field, and 70 kg/ha/yr on the other hay fields. No changes are required to the farm's application rates of manure and chemical fertilizer at this time unless they wish to improve forage yield in which case they could apply more chemical fertilizer.

Table 2. Nitrogen applied to 6 ha hay field per year vs. crop requirements

Source of nitrogen	Calculation	N applied (kg per hectare per year)
Manure from winter storage	483 kg/6 ha = 81 kg/ha/yr 81 kg/ha/yr * 25% inorganic N = 20 kg/ha/yr	20
Chemical fertilizer	150 lbs/A/yr (168 kg/ha) of 18-16-12	30
Total N applied	**20+30 kg/ha**	**50**
Crop requirement	Unirrigated grass stand, one cut, North Okanagan	100
Deficit of N	**100- 50**	**50**

8. Timing of Manure Application

The farm's winter-stockpiled manure is applied to the perennial grass crop grown on the farm's 6 hectare hay field. Manure is applied to the hay field during the April through June period each year. The manure supplies approximately 10% of the nitrogen requirements of the crop. This is within the timing and rates as outlined in Table 6.10 of the Environmental Farm Plan Program Reference Guide (BCMAF 2010) which indicates that up to 100% of the crop's nitrogen requirement in manure can be applied during April and May, and up to 75% during June and July.

9. Setbacks for Manure and Fertilizer Application

The PAO stipulates that applications of manure and chemical fertilizer must adhere to the specified setbacks from surface water, wells and property boundaries. The hay fields are situated such that there are no surface water sources or wells within 30 metres of the field boundaries. The owners have been advised to maintain a setback of 3.5 metres from the public road when applying manure or chemical fertilizer to hay fields.

10. Management of seasonal stream

A seasonal stream runs through the seasonal feeding pasture and through another pasture to the south before leaving the property (Photograph 4). This stream runs during freshet which is approximately mid-March to the end of April. To minimize impacts on water quality during the time the stream is running, it is recommended that the owner institute the following measures:

1. Install a temporary fence to exclude cattle from the stream when it is running.
2. Graze the pasture below the seasonal feeding pasture after the seasonal stream has stopped running.

11. Action Items to improve manure and nutrient management on site

The following action items will be completed by the farm owner:

1. Construct permanent manure storage facility for manure generated during 6 month winter feeding period sized to hold 84 cubic metres of manure plus precipitation.
2. Allow cattle access to hay field north of seasonal feeding pasture during early winter feeding period to reduce manure accumulation in seasonal feeding pasture.
3. Install a temporary fence to exclude cattle from the seasonal stream when it is running (mid-March-April).
4. Maintain a 3.5 m setback from Pyott Road when applying manure or fertilizer to hay fields.
5. Graze the pasture to the south of the seasonal feeding pasture after the seasonal stream has dried up.
6. Move cattle out of the seasonal feeding pasture as early as possible in spring to minimize manure accumulation in the pasture.

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References

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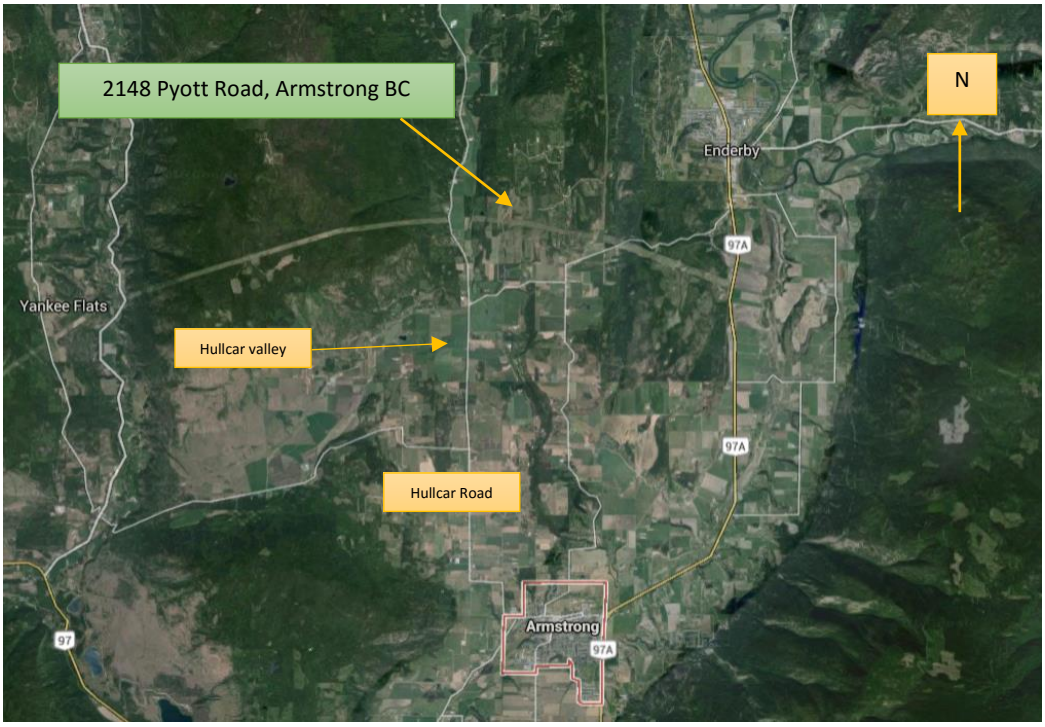
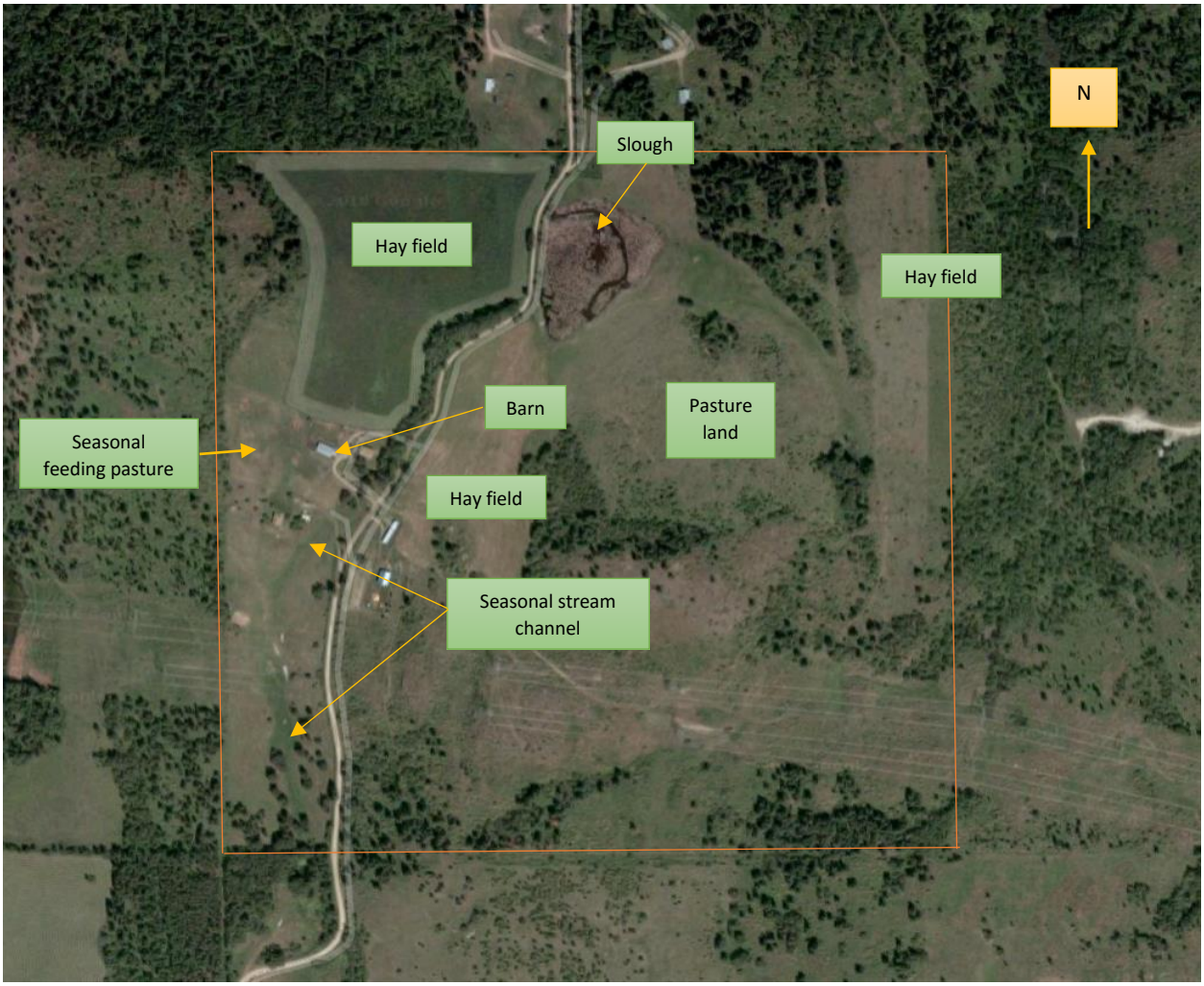
Location Map: Huxley Farm, 2148 Pyott Road, Armstrong BC



Site Map 1: 2148 Pyott Road showing property boundaries, hay field and seasonal stream channel



Site map 2. Location of proposed manure storage facility

Photographs

Photograph 1. Concrete floored feeding alley in barn

Photograph 2. Approximate location of proposed manure storage facility (in right foreground of photo in front of barn)

Photograph 3. Typical topography of farm's hay fields (June 24, 2016)

Photograph 4. Route of seasonal stream through lower pasture of property. On June 1, 2016 when first site visit was made, stream was not flowing.