Douglas Regehr

Annual Summary of Cropping and Nitrogen Management– 2014, 2015 and 2016

Background

On March 6, 2014, Douglas Regehr of 5042 Schubert Road, Armstrong BC was served with an Information Order under the Environmental Management Act (File: 107156). The Information Order 'the Order' referenced the lands legally described as Lot 1, District 6, Lot 97 Osoyoos Division Yale District Plan KAP 70654, and identified the specific substance of concern as nitrate from agricultural waste in the Steele Springs water which originates from shallow aquifer 103 which partially underlies Mr. Regehr's property. The Information Order required completion and submission of several reports containing information on nutrient use on the farm's arable lands, and results of soil, surface water (if applicable) and groundwater testing.

This report contains Annual Summaries for the years 2014, 2015 and 2016 as per Item #3 in the Order. It contains information on the nutrient content of the manure applied on the farm during these years by field, amounts applied and timing of application. It also contains the soil and groundwater data that were collected by various individuals and organizations during these years. There is no surface water on the property.

I was contacted by Mr. Regehr on October 6, 2016 to complete reports required under the Order. Because of being retained 2.5 years after the Order was issued, the information gathered for this report represents data collected by others and not under a specific plan developed for the 2014-2016 period. Doug Macfarlane, Certified Crop Advisor (CCA), prepared Nutrient Management Plans for Mr. Regehr in spring 2015 for the 2015 cropping season, and in spring 2016 for the 2016 cropping season as per the requirements of the Order. Soil samples were collected in fall 2014 and 2015 by him to provide nutrient management information for development of the Nutrient Management Plans, and in fall 2016 under the Ministry of Agriculture Post-harvest Soil Nitrate Study. Much of the information in these summaries is taken from Mr. Macfarlane's reports with permission. Groundwater samples from Mr. Regehr's barn tap or house tap were collected periodically during 2014, 2015 and 2016 by several different individuals and organizations and analyzed at several different labs; all of this data is summarized in the reports. This information was obtained from Mr. Regehr, Brian Upper of the Steele Springs Water District (SSWD), and Doug Macfarlane, CCA, and is included with permission. Soil and groundwater lab data sheets are found at the end of the report.

Douglas Regehr owns a property at 5042 Schubert Road, Armstrong BC consisting of 19.3 hectares (47.7 acres) of arable land as well as the farmstead. The farm operated a feedlot on-site from 1980 to 1997. The feedlot was depopulated in 1997. From 2002 to 2007 the feedlot was rented by H.S. Jansen who housed 1000 replacement heifers in it year-round. The farm has not had any animals on-site since 2007 when Jansen moved his replacement heifers elsewhere. The farm has been managed organically since 2012; since that time there has been no chemical fertilizer used on the farm and all nutrients used by crops have been provided in broiler or liquid dairy manure. The land base farmed now includes the area

of the old feedlot; prior to 2015 this area was not farmed. This has increased the farm's arable land base by 3.1 hectares to a current total of 19.3 hectares.

2014 Annual Summary

2014 Crop Summary

In 2014, Douglas Regehr farmed 16.2 hectares (40 acres). Of this, 15.5 hectares were planted with hard red spring wheat for flour production, and 0.65 acres were in perennial grass used as a horse pasture (Table 2014-1). The farm had no livestock or poultry in 2014; all nutrients required by crops were brought onto the farm. The farm has been managed organically since 2012. All nutrients used on the land base in 2014 were from poultry manure.

Home field (#101): 15.5 hectare field located north of the farmstead (see site map). This field was planted with hard red spring wheat in spring 2014 and harvested in late summer 2014. This field was fertilized with broiler manure in 2014 as detailed below.

Horse Pasture: 0.65 hectare field planted to perennial grass and used to the graze the family's horses. This field received no fertilization in 2014.

2014 Nitrogen Use Summary

In 2014, the Home Field was fertilized with a total of 2.5 tons per acre (6.18 tonnes per hectare) 'as-is' of broiler manure to provide the crop's nutrient requirements. This application rate of broiler manure had been established in 2012 when the farm began to be managed organically and when broiler manure was first used to fertilize the crops. The manure analysis from 2012 is appended. The application rate was based on lab analysis of the manure and on meeting the nitrogen requirement of the wheat crop. It provided 132 kg/ha of available nitrogen to the crop in the year of application. The application rate calculations are found in Table 2014-2.

The field identified as the horse pasture received no fertilizer in 2014.

Table 2014-1. 2014 Crops and Nitrogen Application Rate by Field

Field ID	Field Description	Hectares	2014 Crop	2014 Nitrogen application rate*
101	Home Field	15.5	Spring wheat	132 kg N/ha
na	Horse Pasture	0.65	Grass – horse pasture	0
Total land base		16.2		

**See application rate calculations below.*

Table 2014-2. 2014 Nitrogen Application Rate Calculations

Type of manure	Broiler litter
Application rate	2.5 tons/acre or 6180 kg/ha 'as-is'
Application date	Spring 2014
Nutrient content (from broiler manure analysis in D. Macfarlane 2015 NMP).	2.99% total nitrogen 0.34% inorganic nitrogen 2.65% organic nitrogen (total N-inorganic N) 76.3% dry matter
Calculations	Organic N: 6180 kg/ha * 0.763 (DM) * 0.0265 (organic N) = 125 kg N/ha organic N Inorganic N: 6180 kg/ha * 0.763 (DM) * 0.0034 (inorganic N) * 0.5 (50% loss after spreading) = 8 kg/ha inorganic N
Plant-available nitrogen in year of application (assumes all nitrogen is plant-available in year of application as per D. Macfarlane NMP).	125 + 8 = **132 kg N per hectare**

2014 Soil Nitrate Data

Soil samples were collected from the Home Field twice in 2014 (Table 2014-3). The first sample was collected in March 2014 prior to planting and showed very low available nitrate-N in the 0 to 60 cm depth. The second sample was collected in September 2014 after wheat harvest and showed very high residual nitrate-N levels based on the Kowalenko draft soil residual nitrate-N risk rating (Table 2014-4) (Kowalenko et al 2007), and also showed nitrate present at all depths to 60 cm. According to Macfarlane (2015), a cover crop was planted on the field in fall 2014 which would have taken up some of the residual nitrate-N. It is not known how much of the residual nitrate-N was taken up by the cover crop. The cover crop was tilled in in spring 2015 prior to planting of the next wheat crop.

Table 2014-3. 2014 Spring and Post-harvest Soil Nitrate Data

Field ID	2014 Crop	Sampling Depth	March 2014 Nitrate-N (NO_3-N)	September 2014 Nitrate-N (NO_3-N)	Average NO_3-N in 0-60 cm Depth Fall 2014
		cm	mg/kg	mg/kg	mg/kg
101 Home field	Spring wheat	0-15	1	34	26.3 (very high)
		15-30	4	35	
		30-60	7	18	

Table 2014-4. Nitrogen management recommendations for soil nitrate concentrations to 90 cm depth

Rating	Soil Nitrate Concentration to 90 cm Depth (mg/kg)	Management Recommendations
Low	0-4.9	Continue with nitrogen management program
Medium	5-9.9	Consider changes to nitrogen management
High	10-20	Reduce nitrogen application without risk to crop quality or yield
Very high	>20	Reduce nitrogen application without risk to crop quality or yield

Adapted from Kowalenko et al (2007). Values converted from kg/ha assuming a soil bulk density of 1150 kg/m^3.

2014 Groundwater Nitrate-N Data

During 2014, three groundwater samples were collected from D. Regehr's barn tap (Table 2014-5). All three samples were collected by Brian Upper of Steele Springs Water District at the same time as he collected samples from Steele Spring for the water district. Samples were sent to Caro Analytical in Kelowna BC for analysis. All three samples were below the Canadian drinking water guideline of 10 mg per litre of water.

Table 2014-5. 2014 Groundwater Nitrate Data

Date	Nitrate level (mg/L)	Lab	Sampler
January 29	4.08	Caro Analytical	Brian Upper, SSWD
April 9	8.04	Caro Analytical	Brian Upper, SSWD
July 14	7.23	Caro Analytical	Brian Upper, SSWD

Note: all samples collected from D. Regehr barn tap.

2015 Annual Summary

2015 Crop Summary

In 2015, Douglas Regehr farmed 19.3 hectares (47.7 acres). He converted the land that had housed the feedlot into a 3.1 hectare field for the first time. Of the 19.3 hectares, 18.6 hectares were planted to winter wheat and 0.65 acres were in perennial grass (Table 2015-1). The farm had no livestock or poultry in 2015; all nutrients required by crops were brought onto the farm. The farm has been managed organically since 2012. All nutrients used on the land base in 2015 were from livestock or poultry manure.

Home field: 15.5 hectare field located north of the farmstead (see site map). This field was planted to spring wheat in spring for harvest in late summer, and spelt in fall for harvest in mid-summer 2016. The field was fertilized with broiler manure in spring 2015 and dairy effluent in fall 2015. Nitrogen applications are summarized in the following section.

Old feedlot: 3.1 hectare field located on the site of the feedlot. This field grew the same crops as the Home Field in 2015 but was not fertilized in 2015.

Horse Pasture: 0.65 hectare field planted to perennial grass and used to graze the family's horses. This field was ploughed up in fall 2015 and planted to spelt at the same time as the other two fields. The field was not fertilized in 2015.

2015 Nitrogen Application Rate

In spring 2015, the Home Field and Old Feedlot were planted to hard red spring wheat. A total of 2.4 tons per acre (5.93 tonnes per hectare) 'as-is' of broiler manure was applied to the Home field in spring 2015 prior to planting, calculated by Doug Macfarlane to meet the nitrogen requirements of the wheat crop. The application rate was based on the 2012 broiler manure analysis which is appended. The manure was estimated to provide 127.7 kg/ha of available nitrogen in the year of application. The application rate calculations are found in Table 2015-2. The wheat crop was harvested in late summer 2015.

In late summer 2015, the Home field received 3000 gallons per acre of liquid dairy effluent from H.S. Jansen. This application provided 25.8 kg of plant-available nitrogen per hectare. The horse pasture was ploughed up in fall 2015 but was not manured. All three areas (Home Field, Old feedlot and horse pasture) were planted to spelt in fall 2015 for harvest mid-summer 2016.

The Old Feedlot received no manure in 2015.

Table 2015-1. 2015 Crops and Nitrogen Application Rate by Field

Field ID	Field Description	Hectares	2015 Crops	2015 Nitrogen application rate*
101	Home Field	15.5	Spring 2015 – wheat Fall 2015 – spelt (to be harvested mid-summer 2016)	Spring -127.7 kg N/ha August – 25.8 kg N/ha
102	Old Feedlot	3.1	Spring 2015 – wheat Fall 2015- spelt (to be harvested mid-summer 2016)	0
na	Horse pasture	0.65	Spring-summer 2015 -Grass horse pasture Fall 2015 – tilled and planted to spelt for mid-summer 2016 harvest	August – 25.8 kg N/ha
Total land base		19.3		

**See application rate calculations below.*

Table 2015-2. 2015 Nitrogen Application Rate Calculations – Spring 2015

Type of manure	**Spring 2015 - Broiler litter**
Application rate	2.4 tons/acre or 5933 kg/ha 'as-is'
Application date	Spring 2015 (prior to planting)
Nutrient content (from broiler manure analysis in D. Macfarlane 2015 NMP).	2.99% total nitrogen 0.34% inorganic nitrogen 2.65% organic nitrogen (total N-inorganic N) 76.3% dry matter
Calculations	**Organic N**: 5933 kg/ha * 0.763 (DM) * 0.0265 (organic N) = 120 kg N/ha organic N **Inorganic N:** 5933 kg/ha * 0.763 (DM) * 0.0034 (inorganic N) * 0.5 (50% loss after spreading) = 7.7 kg/ha inorganic N
Plant-available nitrogen in year of application (assumes all nitrogen is plant-available in year of application as per D. Macfarlane NMP).	120 + 7.7 = **127.7 kg N per hectare**

Table 2015-3. 2015 Nitrogen Application Rate Calculations - Fall 2015

Type of manure	August 2015 – liquid dairy effluent (HS Jansen)
Application rate	3000 gallons/A
Application date	August 2015
Nutrient content (from manure analysis in D. Macfarlane 2016 NMP).	10.1 lbs/1000 gallons total nitrogen 6.8 lbs/1000 gallons inorganic nitrogen 3.3 lbs/1000 gallons organic nitrogen (total N – inorganic N
Calculations	**Organic N:** 3.3 lbs/1000 gallons @ 3000 gallons/A = 9.9 lbs/A **Inorganic N:** 6.8 lbs/1000 gallons @ 3000 gallons/A *0.64 (64% retention after spreading) = 13.1 lbs/A
Plant-available nitrogen in year of application	9.9+13.1 = 23 lbs N/A or **25.8 kg N/ha**

2015 Soil Nitrate Data

Soil samples were collected from the Home Field twice in 2015 (Table 2015-4). Samples were collected at the 0-15, 15-30 and 30-60 cm depths. The first sample was collected in April 2015 prior to planting and showed low available nitrate-N in the 0 to 60 cm depth. The second sample was collected in August 2015 after wheat harvest and showed medium residual nitrate-N levels. The risk rating is based on the Kowalenko draft soil residual nitrate-N risk rating (Table 2015-5) (Kowalenko et al 2007).

Soil samples were not collected from the Old Feedlot or the Horse Pasture in 2015.

Table 2015-4. Spring and Post-harvest Soil Nitrate-N Data

Field ID	2015 Crop	Sampling Depth	Nitrate-N (NO_3-N) April 2015	Nitrate-N (NO_3-N) August 2015	Average NO_3-N in 0-60 cm Depth August 2015
		cm	mg/kg	mg/kg	mg/kg
101 Home field	Spring wheat	0-15	7	8	6 (medium)
		15-30	8	6	
		30-60	10	5	

Table 2015-5. Nitrogen management recommendations for soil nitrate concentrations to 90 cm depth

Rating	Soil Nitrate Concentration to 90 cm Depth (mg/kg)	Management Recommendations
Low	0-4.9	Continue with nitrogen management program
Medium	5-9.9	Consider changes to nitrogen management
High	10-20	Reduce nitrogen application without risk to crop quality or yield
Very high	>20	Reduce nitrogen application without risk to crop quality or yield

Adapted from Kowalenko et al (2007). Values converted from kg/ha assuming a soil bulk density of 1150 kg/m^3.

2015 Groundwater Nitrate-N Data

During 2015, six groundwater samples were collected from D. Regehr's barn tap (Table 2015-6). All six samples were collected by Stephanie Little, BC Ministry of Environment. Samples were sent to Maxxam or ALS for analysis. The first four samples (February, March, April and May) were below the Canadian drinking water guideline of 10 mg per litre of water. The June and August 2015 samples exceeded the guideline. It is difficult to interpret this data set because two different labs were used during the year which may have led to slightly different test outcomes.

Table 2015-6. 2015 Groundwater Nitrate Data

Date	Nitrate level	Lab	Sampler
February 17	8.64	Maxxam	Stephanie Little, MoE
March 26	9.03	Maxxam	Stephanie Little, MoE
April 21	6.89	Maxxam	Stephanie Little, MoE
May 20	7.97	Maxxam	Stephanie Little, MoE
June 22	**10.2**	ALS	Stephanie Little, MoE
August 26	**11.4**	ALS	Stephanie Little, MoE

Note: all samples collected from D. Regehr barn tap.

2016 Annual Summary

2016 Crop Summary

In 2016, Douglas Regehr farmed 19.3 hectares (47.7 acres). All arable land was farmed as one piece (Table 2016-1). The farm had no livestock or poultry on site in 2016; all nutrients required by crops were brought onto the farm. The farm has been managed organically since 2012. All nutrients used on the land base in 2016 were from poultry manure.

Home field, old feedlot and horse pasture: Planted to spelt in fall 2015, harvested in mid-July 2016 and replanted to canola in fall 2016. The canola will be harvested in mid-summer 2017. Area received no fertilization until fall 2016 when the Home Field was amended with a small application of broiler manure prior to spelt seeding.

2016 Nitrogen Application Rate

In 2016, the Home Field, Old Feedlot and horse pasture were farmed as one field growing spelt in spring-summer and canola in fall. No manure was applied to any of the fields until fall 2016 when approximately 0.6 ton/acre (1.48 tonne/ha) of broiler manure was applied to the Home Field. This provided approximately 31.8 kg of nitrogen per hectare. Table 2016-2 contains the nitrogen application rate calculations.

The Old Feedlot area was not fertilized in 2016.

Table 2016-1. 2016 Crops and Nitrogen Application Rate by Field

Field ID	Field Description	Hectares	2016 Crops – all fields	2016 Nitrogen application rate*
101	Home Field	15.5	Spelt – planted fall 2015 and harvested mid-July 2016	Spring 2016: no manure Fall 2016: 31.8 kg N/ha
102	Old Feedlot	3.1		0
na	Horse Pasture	0.65	Canola – planted fall 2016 for late summer 2017 harvest	Spring 2016: no manure Fall 2016: 31.8 kg N/ha
Total land base		19.3		

*See application rate calculations below.

Table 2016-2. 2016 Nitrogen Application Rate Calculations

Type of manure	Broiler litter
Application rate	Approx. 0.6 ton/A or 1483 kg/ha 'as-is' (25% of total application, the remainder to be applied in spring 2017)
Application date	August 2016
Nutrient content (dry basis, from broiler manure analysis in D. Macfarlane 2015 NMP).	2.99% total nitrogen 0.34% inorganic nitrogen 2.65% organic nitrogen (total N-inorganic N) 76.3% dry matter
Calculations	**Organic N:** 1483 kg/ha * 0.763 (DM) * 0.0265 (organic N) = 29.9 kg N/ha organic N **Inorganic N:** 1483 kg/ha * 0.763 (DM) * 0.0034 (inorganic N) * 0.5 (50% loss after spreading) = 1.9 kg/ha inorganic N
Plant-available nitrogen in year of application (assumes all nitrogen is plant-available in year of application as per D. Macfarlane NMP).	29.9+1.9 = **31.8 kg N per hectare**

2016 Soil Test Data

Spring and Fall Tests for Nutrient Management Planning: Soil samples were collected from the Home Field twice and the Old Feedlot once in 2016 (Table 2016-3). Samples were collected at the 0-15, 15-30 and 30-60 cm depths. The Home Field sampled in March 2016 at the start of spring growth, and showed available nitrate-N in the 0 to 60 cm depth. The Home Field and Old Feedlot were sampled in August 2015 after spelt harvest and showed medium residual nitrate-N levels in the Home Field and high levels in the Old Feedlot. The risk rating is based on the Kowalenko draft soil residual nitrate-N risk rating (Table 2016-5) (Kowalenko et al 2007).

Results of Ministry of Agriculture Post-harvest Soil Nitrate-N Testing: In fall 2016, soil samples were collected from the Home Field and the Old Feedlot as part of the Ministry of Agriculture post-harvest soil nitrate study. Table 2016-4 contains the soil data. Samples were collected at 4 depths, 0-15, 15-30, 30-60 and 60-90 cm.

Home Field: The average residual nitrate level in the home field was 10 mg/kg which is considered to pose a high environmental risk based on the Kowalenko draft ratings (Table 2016-4) (Kowalenko et al 2007). Nitrate was concentrated in the top 30 cm of soil which suggests little downward movement during the growing season. The soil nitrate-N level in the 0-30 cm depth was higher than measured in August 2016 because the field received a small application of broiler manure after spelt harvest to provide nutrients for the canola crop that was planted in September. The nitrate-N was concentrated in the top 30 cm of soil so it is expected that this nitrate-N will be will be available to the crop in spring 2017.

Old Feedlot: The average residual nitrate level in the old feedlot area was 21.5 mg/kg which has a very high environmental risk rating. In this field, nitrate was higher in the 0-30 cm depth than in deeper soil layers but there was also a significant amount of nitrate found in the 30 to 90 cm depth which suggests

downward movement in the soil either in previous years (the area has not been sampled before), during the growing season or with fall rainfall in 2016. Because samples were not taken from the Old Field in 2015, it is not possible to compare results with previous years. This field has not been fertilized or manured since it was decommissioned in 2007. This suggests that there continues to be a considerable amount of nitrogen released from the organic matter layer built up in the feedlot over the years of use. The amount of ammonium in the soil was also higher at all depths than in the Home Field.

Table 2016-3. 2016 Soil Nitrate-N Data for Nutrient Management Planning

Field ID	2016 Crops	Sampling Depth	March 2016 Nitrate-N (NO_3-N)	August 2016 Nitrate-N (NO_3-N)	Average NO_3-N in 0-60 cm Depth August 2016
		cm	mg/kg	mg/kg	mg/kg
101 Home field	Spelt/canola	0-15	11	8	7.25 (medium)
		15-30	11	7	
		30-60	7	7	
102 Feedlot	Spelt/canola	0-15	na	35	20 (high)
		15-30	na	17	
		30-60	na	14	

Table 2016-4. 2016 Post-harvest Soil Nitrate-N Data

Field ID	2016 Crops	Sampling Depth	October 2016 Nitrate-N (NO_3-N)	Average NO_3-N in 0-90 cm Depth	Ammonium-N (NH_4-N)
		cm	mg/kg	mg/kg	mg/kg
101 Home field	Spelt/canola	0-15	30	10 (high)	8
		15-30	16		5
		30-60	5		4
		60-90	2		3
102 Old Feedlot	Spelt/canola	0-15	35	21.3 (very high)	6
		15-30	35		10
		30-60	14		9
		60-90	15		23

Table 2016-5. Nitrogen management recommendations for soil nitrate-N concentrations to 90 cm depth

Rating	Soil Nitrate-N Concentration to 60-90 cm Depth (mg/kg)	Management Recommendations
Low	0-4.9	Continue with nitrogen management program
Medium	5-9.9	Consider changes to nitrogen management
High	10-20	Reduce nitrogen application without risk to crop quality or yield
Very high	>20	Reduce nitrogen application without risk to crop quality or yield

Adapted from Kowalenko et al (2007). Values converted from kg/ha assuming a soil bulk density of 1150 kg/m^3.

Results of groundwater testing

In 2016, groundwater from D. Regehr's well was tested 8 times (Table 2016-6). All but one of the samples (January 19) exceeded the Canadian drinking water guideline of 10 mg/L. Samples were collected by 4 different individuals and groups, and were sent to 3 different labs which makes the data difficult to compare however, even allowing for variability between samplers and analytical differences between labs, it is clear that the groundwater from the D. Regehr well was above the guideline for most of 2016.

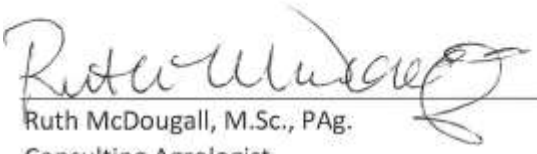
Table 2016-6. 2016 Groundwater Nitrate Data

Date	Nitrate level	Lab	Sampler
January 19	8.8	Caro Analytical	Brian Upper, SSWD
April 7	**12.4**	Caro Analytical	Western Water staff
June 1	**14.3**	Caro Analytical	Western Water staff
July 22*	**12.3**	A&L Canada	Doug Macfarlane, Emerald Bay Ag Services
July 22	**12.6**	A&L Canada	Doug Macfarlane, Emerald Bay Ag Services
August 16*	**17.0**	ALS	Twyla Legault, FLNRO
November 3*	**11.3**	Caro Analytical	Brian Upper, SSWD
November 30*	**14.8**	Caro Analytical	Brian Upper, SSWD

**Samples collected from D. Regehr house exterior tap. All other samples collected from D. Regehr barn tap.*

Reference

Kowalenko, G., O. Schmidt, E. Kenney, D. Neilsen, and D. Poon. 2007. Okanagan Agricultural Soil Study 2007. Available at: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/environmental-farm-planning/okanagan_soil_study_report_2007.pdf



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