TERMS OF REFERENCE AND WORK PLAN

Ken and Brenda Regehr

Pollution Prevention Order
File 108432

September 2016

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1 Introduction

1.1 BACKGROUND

Associated Environmental Consultants Inc. (Associated) was retained by Mr. Ken Regehr to complete the Terms of Reference (TOR) and work plan for a comprehensive monitoring program and an Environmental Impact Assessment (EIA) of the company's operations, focussing on the potential effects of nitrates and other nitrogen compounds in the soil and groundwater. The focus of the comprehensive monitoring program and EIA is the agricultural operations located at 4516 Hullcar Road in Armstrong, BC, with the exception of the operations Purple Springs Nursery Ltd. The requirements for the monitoring program and EIA are specified in the Pollution Prevention Order issued by the BC Ministry of Environment on June 8, 2016 (File 108432).

The Pollution Prevention Order was issued for Aquifer 103, an unconfined aquifer known as the Hullcar Unconfined Aquifer. The agricultural operations include a feedlot and corn and hay fields. The feedlot does not overlie Aquifer 103. However, precipitation that falls on a portion of the feedlot may infiltrate the ground and eventually migrate down-gradient and enter Aquifer 103 and downstream surface water bodies (if present). Further details on this assessment are provided in the sections below.

1.2 QUALIFIED PROFESSIONALS

The following Qualified Professionals will complete the comprehensive monitoring program and the EIA. They are listed here with their qualifications as reference. Resumes can be provided on request.

1. **Marta Green, P.Geo.** of Associated will be responsible for the groundwater component. Through education and experience in consulting for the past 16 years, Marta's skillset includes physical hydrogeology (e.g., well testing – pumping tests and slug tests), water quality, contaminant hydrogeology, and regional hydrogeological studies.
2. **Hugh Hamilton, PhD., P.Ag.** of Associated will provide guidance on monitoring design and EIA methodology, and provide senior review of the reports. He has been practicing in environmental and agricultural consulting in BC since 1990. His areas of practice include soil and water conservation, water quality, land use, and environmental impact assessment.
3. **Ruth McDougall, M.Sc., P.Ag.** will contribute to the soil and nutrient management component of the EIA. Ruth is an acknowledged expert in BC in the characterization and recycling of organic residuals to agricultural land. She has expertise in soil fertility and nutrient cycling in agricultural systems, having started in this line of work in 1990. Ruth has been involved in writing provincial guidelines for residuals recycling, and has produced Land Application Plans for the application of many residuals to agricultural land as well as Environmental Farm Plans for livestock operations.
4. **Doug Macfarlane, CCA**, will contribute to the soil and nutrient management component. He is a Certified Crop Advisor registered with American Soil Society of Agronomy and has many years of experience in BC.
5. **Rod MacLean, P.Eng.**, with Associated will contribute to the operations facilities management (not including lands where nutrients are applied) and drainage management component. Rod is a senior

engineer responsible for civil, municipal, and agricultural design services in the Okanagan, and has a long history of experience in addressing water supply conservation issues. Rod has completed a variety of irrigation and drainage assessments for both small farming operations and larger corporate facilities. He is currently the BC Director of the Canadian National Committee for Irrigation and Drainage (CANCID) and supports research across Canada.

1.3 BACKGROUND TO THE TERMS OF REFERENCE

Development of the TOR and work plan is intended to meet Requirement 1 of the Pollution Prevention Order (the Order) issued on June 8, 2016 by the Ministry of Environment (MOE) to Kenneth Regehr Holdings Ltd (File 108432). The Order applies to the following area (the Lands):

- District Lot 48, Kamloops Division of Yale Land District, Parcel Identifier 011-227-486, other than that portion occupied by Purple Springs Nursery Ltd; and
- Lands used from time to time for agricultural operations that are part of or associated with the agricultural operations of the above lands and are controlled by Ken Regehr Holdings Ltd. and Kenneth John Regehr.

Requirement 2 in the Order is to implement the monitoring program and to complete the EIA. The monitoring program and EIA will begin as soon as the TOR and work plan are approved by MOE.

2 Terms of Reference

2.1 GOALS OF THE MONITORING PROGRAM AND EIA

The Order states that “the usefulness of the environment has been impaired due to the presence of nitrates in the groundwater as the presence of nitrates is causing the groundwater in the unconfined aquifer that lies in part underneath the Lands (commonly referred to Hullcar Aquifer 103) to be unfit for potable water for specific persons in the population.” The Order also indicates that the EIA is to assess the impact the operation has on nitrates and other nitrogen compounds entering surface water or groundwater, and the monitoring program is to be designed to inform the EIA.

The TOR and work plan are intended to clearly identify the methods to meet these goals. The TOR:

- Outlines the regulatory context for the monitoring program and EIA (Section 2.2)
- Defines the spatial and temporal boundaries of the EIA (Section 2.3)
- Defines the environmental receptor that is the focus of the assessment (Section 2.4); and
- Defines the basic steps that will be completed to design and implement the monitoring program and complete the EIA (Section 2.5).

The monitoring program and EIA are described in the work plan (Section 3).

2.2 REGULATORY CONTEXT

The Order is pursuant to section 81 of the *Environmental Management Act* (EMA) (SBC 2003 c. 53), and manure management is subject to the *Agricultural Waste Control Regulation* (BC Reg. 131/92). Fundamentally, the EMA prohibits pollution, and the Order indicates that pollution in this case has been caused by the introduction of agricultural waste to the environment. With respect to groundwater and surface water, a key indication that pollution has occurred is an exceedance of water quality guidelines or objectives; specifically, Health Canada's Guidelines for Canadian Drinking Water Quality (Health Canada 2013) for the Hullcar Aquifer 103.

Health Canada's Guidelines for Canadian Drinking Water Quality state that the maximum acceptable concentration of nitrate-N in drinking water is 10 mg/L (Health Canada 2013). Elevated nitrate consumption can lead to methaemoglobinemia, which is a blood disorder that affects the ability to transport and release oxygen throughout the body (Health Canada 2013). Its effects are most pronounced in infants, and as a result it is more commonly referred to as "blue-baby syndrome." There are also concerns that nitrate may impact thyroid gland function and be associated with cancer (Health Canada 2013). The maximum acceptable concentration of 10 mg/L nitrate-N is designed to protect the health of the most sensitive users, i.e., bottle-fed infants. However, Health Canada recommends that levels be kept as low as reasonably practicable (Health Canada 2013). The BC Approved Water Quality Guidelines also state a maximum acceptable concentration of nitrate-N in drinking water of 10 mg/L (MOE 2009).

Under the regulatory guidelines, the landowner is responsible for the nitrates contributed by its operation to soil, groundwater, and surface water. It is therefore important to know the concentrations of nitrates in either groundwater or surface water as it enters the property (i.e., the levels of nitrates prior to the effect from the operations on the Lands). Therefore, if surface water bodies are present downgradient of the Lands, and Hullcar Aquifer 103 is discharging to the surface water bodies, then surface water guidelines would also apply, including aquatic life guidelines.

The EIA will also consider the additive effect of farm operations on the Lands to the total nitrogen load in surface water and groundwater, which is likely also being contributed by activities on other properties. We will consider a statistically significant change from baseline to be an "effect." If the statistically significant change results in a concentration above a relevant guideline, this will be considered an "impact." For example, if the background concentration in the area tends to be about 3.0 mg/L, and the Guideline for Canadian Drinking Water Quality is 10 mg/L, then if the agricultural operations from the Lands are causing groundwater in wells installed in the Hullcar Aquifer 103 to exceed 4.5 mg/L (i.e. a 50% increase), this would be considered an "effect" but not an "impact." Hullcar Aquifer 103 is actively farmed across its extent in this area; therefore, baseline concentrations will be established by sampling at least two wells upgradient of Hullcar Aquifer 103, or on the edge of Hullcar Aquifer 103 where possible (see Table 3-1 Task 3d for details), and other available background data.

2.3 SPATIAL AND TEMPORAL BOUNDARIES OF THE EIA

Ken and Brenda Regehr operate a feedlot with about 3,500 head of feeders and 370 cow/calf pairs over the winter months. The operation includes several properties that Ken and Brenda Regehr either own or rent (Figure 2-1).

The spatial extent of the study area is the lands identified in the Order. The spatial extent of the study is shown in yellow on Figure 2-1, and is referred to here as the Lands. The vertical extent of the study is from the land surface to the bottom of the Hullcar Aquifer 103.

The Order is for pollution prevention. Therefore, the objective of the EIA in the Order is to assess current agricultural practices and their potential to adversely affect groundwater. Kenneth Regehr Holdings Ltd. has been following a nutrient management plan for the past three years (since 2013). We will therefore examine records on land use and nutrient management relevant to our assessment since that time, but we will also include historical information as part of our assessment (for example, how long has the feedlot been in operation, approximate number of agricultural units on the land over time).

2.4 RECEPTOR

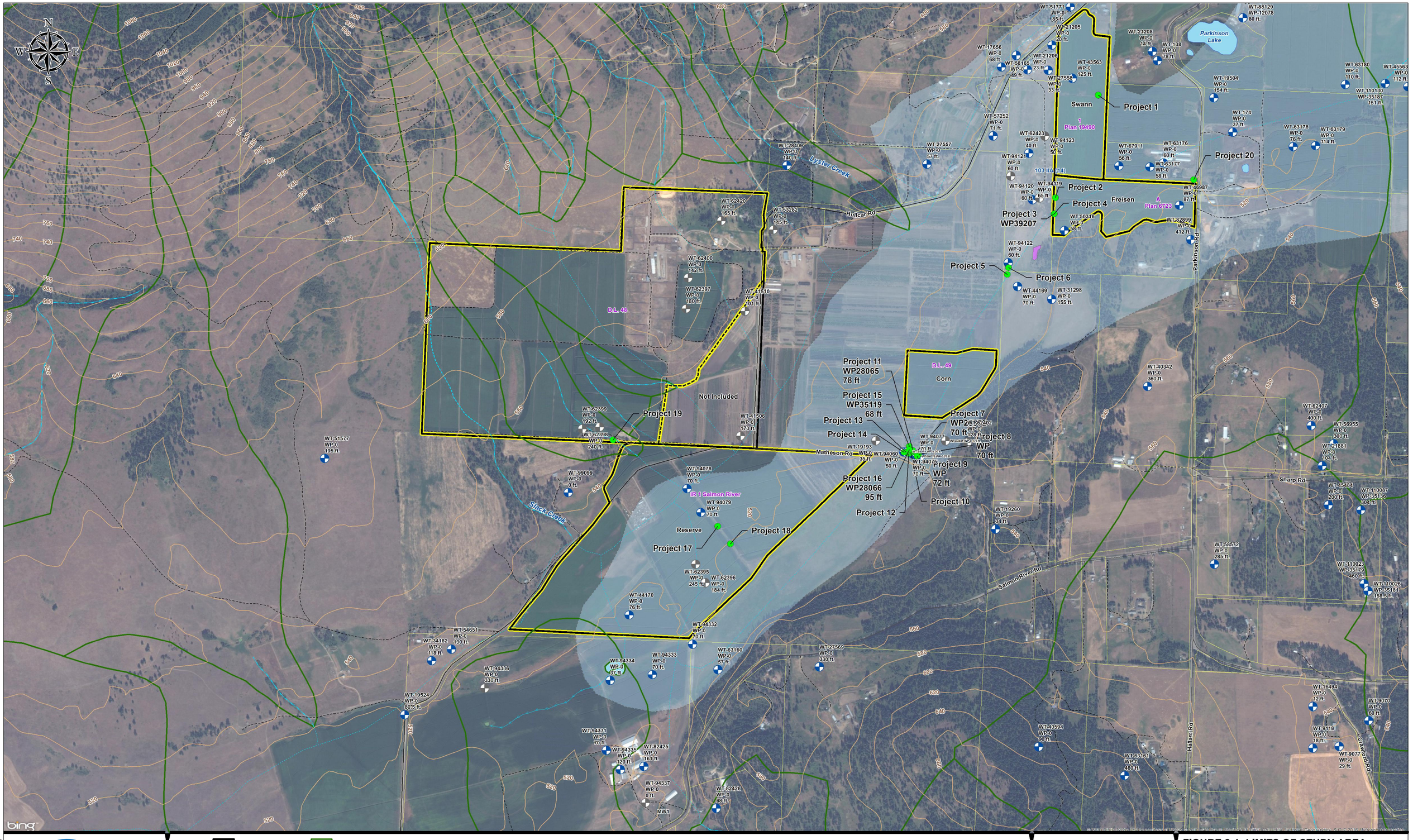
As stated in the Order, the specific substance causing pollution is agricultural waste, including manure and/or manure-laden effluent, from which nitrate is leaching into groundwater. The Order describes the presence of nitrates in the groundwater, makes the Hullcar Aquifer 103 unfit for potable water. We therefore will focus on the impacts from nitrogen (all species) on drinking water wells installed in the Hullcar Aquifer 103. The drinking water wells in the Hullcar Aquifer 103, which is an unconfined aquifer, are defined as the "receptors" of interest for the EIA. Other receptors, including aquatic life in surface water downstream of the Lands, will also be included, as appropriate.

2.5 ENVIRONMENTAL ASSESSMENT PROCESS

The environmental assessment process will include the following tasks:

- Characterize the existing (baseline) environmental conditions on the Lands and underlying aquifer, considering climate, soils, surficial geology, aquifer characteristics, and water quality.
- Describe farm operations on the Lands, particularly confined area operation (feedlots), manure and nutrient storage and management.
- Assess the effects of farm operations on the environment, considering the magnitude, timing, duration, and reversibility of any adverse effects.
- Identify management practices or other mitigation measures to avoid or minimize the identified adverse effects. The EIA will include the recommended preliminary mitigation strategy, with the details to be developed later as part of the Action Plan.
- Determine if there are any residual effects that cannot be reasonable mitigated.
- Develop a monitoring program to assess the effectiveness of the mitigation measures.

The implementation of these tasks is described in the work plan (Section 3).



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Legend

- Subject properties
- Aquifer 103
- Study area
- Contours
- Bedrock outcrop
- Watershed boundary
- Surveyed well
- MOE registered well - location not verified in field
- MOE registered well - not found onsite

Notes:
WT - well tag number
WP - well plate identifier
300 ft - depth to bottom

0 100 200 300 400 500 Meters

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FIGURE 2-1: LIMITS OF STUDY AREA

Kenneth Regehr Holdings Ltd.
Comprehensive Monitoring Plan

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3 Work Plan

The work plan includes two phases:

- Development and implementation of a comprehensive monitoring program; and
- The EIA.

The comprehensive monitoring plan is designed to inform the EIA, and will form the basis for later monitoring to evaluate the effectiveness of the Action Plan. The work plan for the comprehensive monitoring program and EIA is described in Table 3-1.

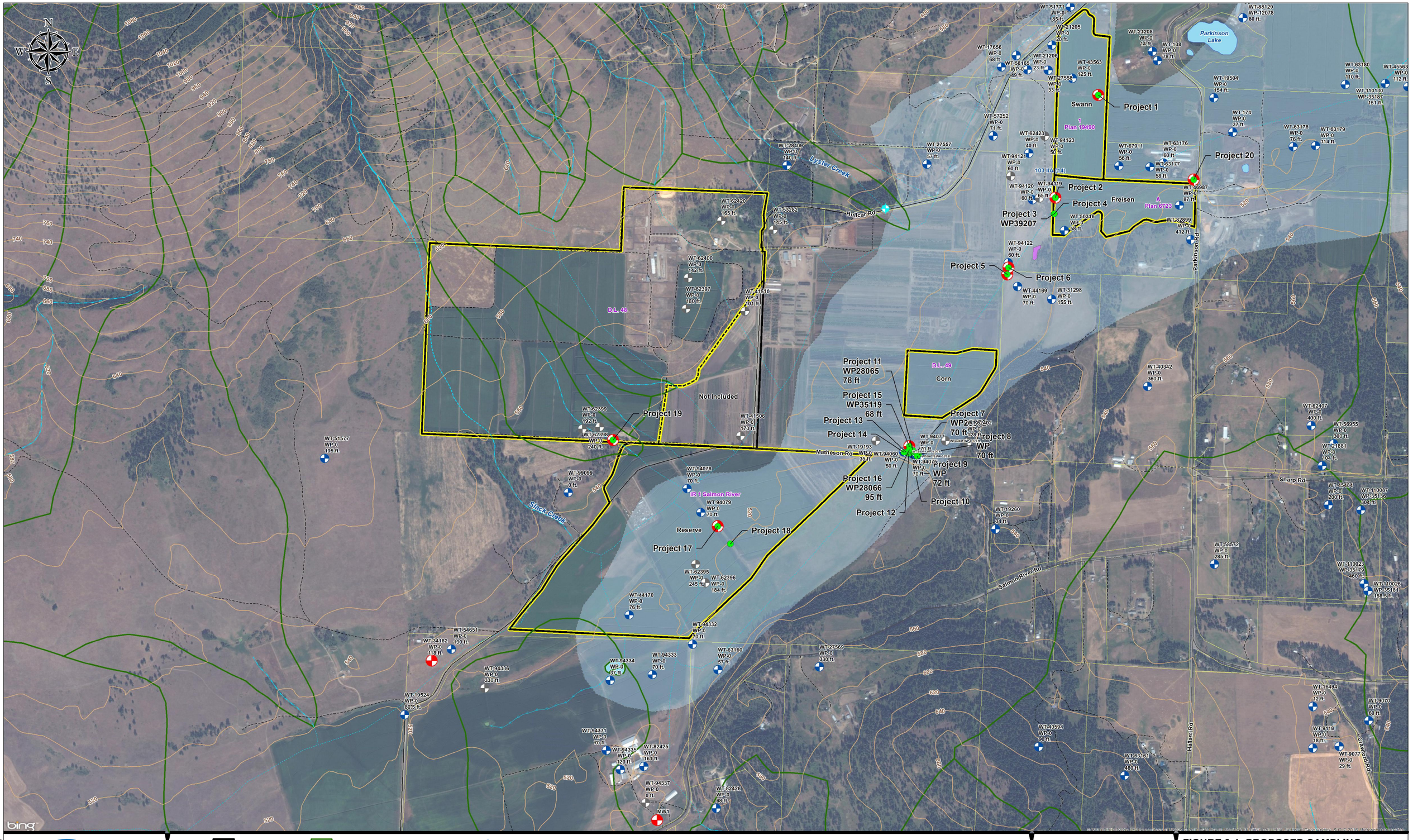
The results of the EIA will provide the information necessary to develop the Action Plan, which is Requirement 3 in the Order. The Action Plan will detail the mitigation measures that will be taken to prevent the potential environmental impacts identified in the EIA.

Table 3-1
Proposed work plan

Phase	Task	Description
Phase 1: Comprehensive Monitoring Plan	**Task 1: Review background information and complete a site visit and inspection of facilities including Feedlot**	a) Review nutrient management plans (including review of methods and protocols for historic sample collection), groundwater monitoring records, soil and climate information for the farm, historic soil nutrient data where available, facility drawings, surface water, groundwater movement and recharge information, farm history including use, annual agricultural units per year, changes in farm practice and any other pertinent historical information that is available. b) Calculate average monthly potential evapotranspiration and irrigation demand using climate and soils data. c) Conduct a site visit and review farming practices with landowner to document and compare to Agricultural Waste Control Regulation, and the BC Environmental Farm Plan Reference Guide where applicable: • Location of confined area operations (feedlots). • Location and size of manure storage facilities if applicable; • Location, size and management of field storage areas if applicable; • Location of on-site wells in Hullcar Aquifer 103; • Type, size and number of livestock on site, and seasonal variations; • Farmed land base – number and size of fields; • Cropping practices including crop types and rotations; • Manure and fertilizer application rates, import and export of manure on site; • Fields irrigated and irrigation rates and schedules; • Integrity of manure storage facilities and confined livestock area surfaces; and • Drainage management in confined livestock areas, other livestock areas and on cropped land base over aquifer. d) Review the results of the 2016 receptor survey to identify the nearest existing drinking water wells or springs. We have assumed that the receptor survey will be conducted by others as part of the Hullcar Aquifer Study. e) A map showing facilities, farmed land base, surface water bodies, aquifers, and wells will be provided.
	Task 2: Assess nitrogen management practices	a) Summarize sources of nitrates including but not limited to temporary and permanent manure storage areas, confined livestock areas, livestock seasonal feeding areas, cultivated fields, and pastures. This will include a map showing features and facilities. b) Describe farming operation including number of livestock, acres farmed over aquifer and elsewhere, crops grown, typical yields and nitrogen uptake by crops, manure handling system, manure storage type and capacity, manure use by field, manure brought from onsite, moved from off-site, and chemical N fertilizer use. c) Calculate estimated annual nitrogen loading on land-base over aquifer (tabulated by field), based on nutrient use information from operator and the scientific literature. d) Assess influences of precipitation, irrigation scheduling, and crops on the movement of nitrogen from surface soils to groundwater. e) Assess integrity of manure storage facilities and confined livestock areas. f) Assess adequacy of current drainage management in confined livestock areas, other livestock areas and cropped landbase. g) Determine the need for soil testing and soil sampling locations based on an understanding of the manure storage facilities and nutrient receiving sites as deemed necessary based on results of tasks 1 and 2.
	Task 3: Survey wells, and conduct water sampling	a) Measure groundwater levels and sample groundwater in 8 existing wells within or adjacent to Hullcar Aquifer 103, and under or downgradient of, the Study Area (as shown in red Figure 3-1). Collect groundwater samples using low flow sampling techniques. Conduct purging until consistent (stabilized) field-measured chemistry (e.g., electrical conductivity, pH, and temperature) is observed. Collect samples as per the British Columbia Field Sampling Manual (MWLAP 2013). b) Measure groundwater levels and sample groundwater in 2 existing wells up-gradient to the Study Area to assess baseline conditions, as follows: we will seek permission and sample two of the following wells or similar: Well tag 34182, Well tag 54651 on Figure 3-1, and/or an up-gradient proposed monitoring well (MW1) on the Grace-Mar property, just southwest of the Reserve field (as marked in red on Figure 3-1). c) Sample two surface water samples (Lyster Creek at Hullcar Road, and Slack Creek). No other surface water receiving environments have been identified; however, if a surface water receiving environment is located during the site visits or during a precipitation event during the timeframe of the study, we have allowed for collection of up to two additional surface water samples. d) Complete laboratory analysis of the water samples collected. Courier samples to an analytical laboratory for analysis of dissolved metals (for groundwater samples only), ammonia, nitrate, nitrite, total Kjeldahl nitrogen (TKN), organic nitrogen, and total nitrogen. e) Survey the top of casing and ground surface of each existing well(s) that will be used as part of the monitoring plan, with an accuracy of +/- 2 cm.
	Task 4: Analyse water data	a) Upload all water quality results directly from the laboratory to Wireless Water™ Database Management Services, and then tabulate and compare results to baseline results and to applicable guidelines as identified during Task 1, including (but not limited to) the Guidelines for Canadian Drinking Water Quality and BC aquatic life, irrigation, and livestock watering guidelines. b) Upload results to EMS. We have assumed that location numbers for the EMS database will be provided to us by MOE once we provide a list of well plate identifiers and UTM coordinates that will be sampled to MOE.

	Task 5: Review post-harvest soil sampling results	a) Soil sampling will be conducted as part of nutrient management plans after crop harvest. Sampling will be undertaken at the recommended three depths 0-15, 15-30, and 30-60 cm. All samples will be analysed for nitrate, ammonium, organic matter, and TKN[1]. We will review the soil sampling results and provide interpretation.
Phase 2: Environmental Impact Assessment and Reporting	**Task 6: Conduct EIA**	a) Refine the identification of receptors and the spatial extent of the study area or limits of monitoring. b) Calculate descriptive statistics for the water and soil quality, and assess differences between wells/locations. For the soil data, we will use descriptive statistics to compare residual soil nitrate at varying depths in the soil within fields, and total residual nitrate and residual nitrate by depth between fields where applicable. For the water data, we will include an assessment of the well logs, including suitability of length and placement of screen for assessing water quality in Hullcar Aquifer 103, when completing our assessment of water quality results. c) Assess the likelihood that current (since 2014) agricultural operations on the Lands have caused nitrate-N concentrations in the aquifer to exceed baseline (causing an "effect"). If an effect has been caused, assess the likelihood the effect has caused an "impact" (exceeds guidelines). Identify the operations or management practices that have the potential to introduce nitrate to groundwater, given the understanding of the biophysical environment.
	Task 7: Draft comprehensive monitoring and EIA report	Compile the results of the comprehensive monitoring program and EIA into a draft technical report that will be submitted to MoE for review. The monitoring program section will describe tasks completed, methods applied, and results obtained, including the results on farm nitrogen balance and nitrogen loading practices, and groundwater sampling. Based on the technical assessment, the report will determine the likelihood that current farm practices are causing pollution, on their own or in combination with activities on other properties. The report will include the laboratory reports from the sampling programs in an appendix, and will include photographs, maps, and graphs. The details of action items for abatement/mitigation will not be included in the current scope. This will be a separate task, identified as the Action Plan in the Order, with a different schedule; and would be completed if an adverse effect on groundwater from the current farm practices is identified by the EIA. However, the report will provide a preliminary identification of pollution prevention strategies (actions) that would be put in place based on the EIA findings.
	Task 8: Finalize comprehensive monitoring and EIA report	The report will be finalized after receiving comments from MOE on the draft report.

[1] Analyses for these variables also enable the calculation of total N and organic N.



Legend

- Subject properties
- Aquifer 103
- Study area
- Contours
- Bedrock outcrop
- Watershed boundary
- Proposed sampling locations - groundwater
- Proposed sampling locations - surface water
- Surveyed well
- MOE registered well - location not verified in field
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Notes:
WT - well tag number
WP - well plate identifier
300 ft - depth to bottom

0 100 200 300 400 500 Meters

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FIGURE 3-1: PROPOSED SAMPLING LOCATIONS

Kenneth Regehr Holdings Ltd.
Comprehensive Monitoring Plan

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4 Schedule

Requirement 2, the completion of the comprehensive monitoring program and EIA, was requested in the Order to be completed by August 1, 2016. Our original TOR and Work Plan proposed a revised schedule to submit the results of the monitoring program and EIA on September 20, 2016. However, since then, we have reviewed in detail the tasks required to complete the EIA and propose that the draft monitoring program and EIA be prepared by November 28, 2016, and the final monitoring program and EIA report by Dec 12, 2016, assuming comments are received by the MOE by Dec 5, 2016.

The main reason a change in the proposed schedule is required is because post-harvest soil sampling, based on the farmer's expectation of corn cutting for this year's harvest, will be completed by the end of September. The lab typically turns around the analysis within one week; however, this may be up to two weeks given the busy season. This means that we would not have the post-harvest sampling results to start our review until October 17, 2016 at the latest. We would therefore aim to have our draft report prepared six weeks after we receive the last of the laboratory results.

The revised proposed schedule is provided in Table 4-1.

Table 4-1
Proposed project schedule

ID	Task	Days	Start	End	23-Sep-16	30-Sep-16	7-Oct-16	14-Oct-16	21-Oct-16	28-Oct-16	4-Nov-16	11-Nov-16	18-Nov-16	25-Nov-16	2-Dec-16	9-Dec-16	16-Dec-16	23-Dec-16	30-Dec-16
		80	**23-Sep-16**	**12-Dec-16**															
Phase 1 - Comprehensive Monitoring Program			**23-Sep-16**	**17-Oct-16**															
1	Review background information and complete site visit	14	23-Sep-16	7-Oct-16															
2	Assess nitrogen management practices	14	23-Sep-16	7-Oct-16															
3	Survey wells, and conduct water sampling and analyses	14	7-Oct-16	21-Oct-16															
4	Analyse water data	7	21-Oct-16	28-Oct-16															
5	Review post harvest soil sampling results	3	14-Oct-16	17-Oct-16															
Phase 2 - Environmental Impact Assessment and Reporting			**17-Oct-16**	**12-Dec-16**															
6	Conduct EIA	21	17-Oct-16	7-Nov-16															
7	Draft Comprehensive Monitoring and EIA report	21	7-Nov-16	28-Nov-16															
8	Final Comprehensive Monitoring and EIA report	14	28-Nov-16	12-Dec-16															

Closure

This report was prepared for Ken and Brenda Regehr and outlines the TOR and work plan for the comprehensive monitoring program and EIA.

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

Respectfully submitted,
Associated Environmental Consultants Inc.

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Senior Hydrogeologist

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

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