SUMMIT ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Report

City of Whitehorse

Whitehorse
THE WILDERNESS CITY

Source Water Assessment and Protection Plan for Riverdale Aquifer

Project: 2012-2975

April 2013

SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

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April 26th 2013
File: 2012-2975

Mr. Wayne Tuck
Manager, Engineering and Environmental
City of Whitehorse
4210 4th Avenue
Whitehorse, YK, Y1A 1C2

Re: Source Water Assessment and Protection Plan, Riverdale Aquifer, City of Whitehorse Drinking Water Supply Wells

Dear Mr. Tuck:

Summit Environmental Consultants Inc. is pleased to provide this Source Water Assessment and Protection Plan for the Riverdale Aquifer. This report follows the Source to Tap Assessment Guideline, prepared by the BC Ministry of Healthy Living in Sport in 2010 and uses aspects of the 2004 BC Well Protection Toolkit prepared by the BC Ministry of Environment.

Risks are identified and ranked by priority, and they are presented alongside recommended risk management actions. The report also includes a Fuel Smart Plan and Riverdale Wells Emergency Response Plan that is to be used and maintained in conjunction with the City's main Emergency Response Plan.

We look forward to your comments on this report. Please contact any of the undersigned if you have any questions or require further information.

Yours truly,

PROFESSIONAL GEOSCIENTIST
PROVINCE OF BRITISH COLUMBIA
M. C. GREEN
#30867
26-Apr-2013

Marta Green, B.Sc., P.Geo.
Hydrogeologist

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Environmental Scientist

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Civil Engineer, Project Manager

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1 Introduction

1.1 PROJECT BACKGROUND

The City of Whitehorse ("the City") provides high quality drinking water to its population of 27,300. The source of the City's water is the South Riverdale aquifer, a shallow unconfined sand and gravel aquifer beneath the community of Riverdale. The City currently obtains 100% of its water with this one aquifer. However, a surface water intake in Schwatka Lake that was used in the past can still be used as a back-up supply. Since the City has only one active drinking water source, it is important to minimize hazards that can potentially affect drinking water quality. In 2012 the City retained Summit Environmental Consultants Inc. (Summit), the environmental sciences division of Associated Engineering (AE), to develop the Source Water Assessment and Protection Plan for the City's drinking water source wells located in the Riverdale neighbourhood. This document is the Source Water Assessment and Protection Plan for the Riverdale Aquifer.

1.2 PURPOSE OF SOURCE WATER ASSESSMENT AND PLAN

This report is intended to fulfill conditions of the City's approvals to operate the South Riverdale drinking Water Source well fields under two conditions: (1) "Permit to Operate a Large Drinking Water System" with Yukon Government Health and Social Services and (2) Water Licence MN0031 issued by Yukon Water Board to remove 20,000 cubic metres per day. This document should be submitted to Yukon Environmental Health for their approval, after which it will be presented to City Council.

1.3 REPORT FORMAT

The methodology that was used to develop this well head protection plan is based on the Comprehensive Source-To-Tap Assessment Guideline (STTAG) published by the British Columbia Ministry of Healthy Living and Sport (2010). That document was prepared by the BC provincial government and was recently updated in 2010. The BC guideline is followed for the South Riverdale well fields because an equivalent document is not yet in place for the Yukon, and it is consistent with Health Canada's guidelines for drinking water source protection (Health Canada 2002). The BC Source-to-Tap guideline builds upon the work completed by the BC Ministry of Environment (MOE) Well Protection Toolkit (BC MOE 2000). During the initial meeting, City and Yukon Environmental Health officer Dianna Hayden confirmed the acceptability of using the BC guidelines for developing this protection plan.

The report format is organised into sections that follow the structure of the BC 2010 Drinking Water STTAG. There are eight Modules in the STTAG (see Section 1.4), of which three are addressed by this project, with a Chapter in this report devoted to each Module. The Modules are presented following the introduction,

background information, and general process and advisory committee sections. This document is supplemented with maps (Appendix A), tables (Appendix B), a Fuel Smart Plan (Appendix C), an Emergency Response Plan (Appendix D), and other supporting information in additional Appendices E - K.

The report includes a description of work performed in each task and recommendations to improve drinking water protection. The outcome of the risk assessment was used to identify a series of recommendations. The recommended risk management actions follow the SMART (Specific, Measurable, Achievable, Realistic, Time-bound) principles as outlined in the STTAG -Module #8, and the Well Protection Toolkit - Step Four (BC MOE 2000). The recommendations include tasks and schedules so that the city can prepare a short-term (i.e. 1 year), and long term (i.e. 5 years) plan to improve source water protection.

1.4 SOURCE TO TAP ASSESSMENT GUIDE

The STTAG (BC Ministry of Healthy Living and Sport 2010) is used by water purveyors and health authorities across BC. This guide has helped many communities reduce drinking water hazards.

The STTAG provides a structured and consistent approach to evaluating risks to drinking water. It serves as a tool for water systems to develop a more comprehensive understanding of risks to drinking water safety and availability, how to operate effectively, and how to produce the best possible water quality. The eight STTAG modules are as follows:

- Module #1: Delineate and characterize drinking water sources
- Module #2: Conduct contaminant source inventory
- Module #3: Assess Water Source elements
- Module #4: Evaluate water system management, operation and maintenance practices
- Module #5: Audit water quality and availability
- Module #6: Review financial capacity and governance of water system
- Module #7: Characterize risks from source to tap
- Module #8: Recommended actions to improve drinking water protection

The scope of work for this project included and addressed Modules #1 (in part), #2, #7, and #8. The capture zone delineation of Module #1 was previously completed for existing well fields (AECOM 2011). In this report, we summarise the work completed in Module #1 and how we adapted it to meet the project needs. Modules 3, 4, 5 and 6 were not completed as these modules are related to engineering and governance and were not included in the request for proposals; however, components of Modules #3, #4 and #5 can be found in Sections 1.0 Introduction, Section 2.0 Drinking Water Source Description, Section 4.4 Water Source Characterization, and Appendix E Meeting Minutes.

2 Drinking Water Source Description

Historically, the source water for the City of Whitehorse has come from two different aquifers - the Whitehorse and Riverdale Aquifers (previously known as the Riverdale/Selkirk Aquifer). The Whitehorse Aquifer is found beneath the Downtown area of Whitehorse, while the Riverdale/Selkirk Aquifer is below the Riverdale area of Whitehorse. They are physically separated by the Yukon River. Wells within the Whitehorse Aquifer have not been in use since the 1950s. The name of the Riverdale/Selkirk Aquifer has caused some confusion over the years. In discussions with the City of Whitehorse, Summit understands that it should now be called the Riverdale Aquifer to help reduce that confusion in the future.

Wells in the Riverdale Aquifer were used mostly as a secondary source (supplementing Schwatka Lake) between 1950 and 2010, primarily for water tempering in the winter and to improve water clarity during the spring melt time. Usage of the Riverdale wells has increased over the years because the aquifer water quality is excellent and does not have the turbidity issues that surface water has. The wells were used in combination with surface water from Schwatka Lake up to just a few years ago when the City switched completely to the Riverdale wells system in 2010.

The wells vary in depth from 21 m below ground surface (bgs) to 44 m bgs. The aquifer material at the well screen depths is described as sand and gravel. Rainwater and melting snow percolating down towards the water table from surface pass through various layers of coarse materials including sand, sand and gravel, and gravel. Much of the recharge is coming from the Yukon River, migrating across the streambed, through multiple layers of glacio-fluvial sand, sand and gravel, and gravel before entering the well screens. A colour schematic that helps show the hydrogeological situation in vertical cross section is presented in Appendix A - Map 1.

The drinking water source wells are located in two separate locations known as the Selkirk and the South Riverdale Well Fields, as shown in Appendix A - Map 2. The Selkirk Well Field is in the northwest portion of Riverdale and is comprised of Water Source wells WW4 and WW6. The South Riverdale Well Field is between the residential area and Chadburn Lake Road on the south end of Riverdale and is comprised of WW8 and WW9. WW5N in the Selkirk well field is used as a backup water source. Other wells are also present in the Riverdale area, including proposed drinking water wells, test wells, and monitoring wells that were either used in previous investigations, or are currently used for monitoring or testing of proposed wells (see Appendix B - Table 1 for well details). Appendix A - Map 2 presents the locations of the current water supply wells, along with the locations of proposed water supply wells. Well logs for the water supply wells are included in Appendix F.

Currently four wells (WW4, 6, 8 and 9) and one back-up wells (WW5N) in Riverdale are the source of the City's water. As of 2012, the following neighbourhoods are serviced by City water: Riverdale, Downtown, Marwell, Crestview, Valleyview, Hillcrest/Airport, Ingram, Takhini, North Takhini, Arkell, Copper Ridge, Logan, Porter Creek, Granger, McIntyre, and Whistle Bend.

The well fields are in green spaces which are adjacent to residential and commercial developments. They are near the Yukon River, Schwatka Lake, and Hidden Lakes (distance to surface water ranges from 250 m to 800 m). In 2010, AECOM determined that the South Riverdale wells should not be classified as “groundwater under the direct influence of surface water" (GUDI), based on the historical water quality data and an annual pumping rate of 13,370 m^3/d (155 L/s) or less (AECOM 2010).

The 20 year projected maximum daily demand is 45,100 m^3/d (522 L/s) and average daily demand is 32,140 m^3/d or 372 L/s (Opus Dayton and Knight Consultants Ltd. 2011). This projection assumes the City of Whitehorse is using wells WW3N, 4, 4N, 6, 8, 9 and 10 with 5N as back up and one rotating backup between wells WW8, 9 and 10.

Currently, the volume of water required for the City is approximately equivalent to the volume of water available from the source wells. The system is still connected to its historical water source, Schwatka Lake, through an intake. No water is currently used from this surface water source, but the siphon could be re-activated (methods included in Appendix D), for use in an emergency with a boil water advisory. Development of new wells is a priority for the City and is on-going.

Raw water from the wells is pumped to the City’s pump house. The pump house is a chlorination facility which treats and pumps the water for distribution. It manufactures chlorine on site and has back-up hyperchlorate. The treated water is then pumped to individual homes and businesses through the distribution system. A large pressure main is installed at Two Mile Hill to connect the neighbourhoods at higher elevations. There is a station at the top of Two Mile Hill for bulk water distribution. At this location, there is continuous residual chlorine monitoring.

3 Methodology and Advisory Committee

This source water assessment and groundwater protection plan has been prepared in a manner that is consistent with the STTAG, using the general methodology presented as follows:

1. Collection and review of available data including previous groundwater reports, geological and groundwater mapping, flow records, and water quality data;
2. Conduction of site reconnaissance and review of the existing water system with the licenced operator;
3. Coordination of project meetings with the City, Yukon Environmental Health, Riverdale Residents Association, and the community;
4. Public Consultation; and
5. Completion of the Study.

The sections covering each completed Module provide additional detail on the methodologies that were used.

3.1 TECHNICAL ADVISORY COMMITTEE

In partnership with the City, the consultant team facilitated the creation of a Technical Advisory Committee (TAC) for the project including representatives from the following organisations:

- City of Whitehorse Engineering: Wayne Tuck, Jim McLeod, Larry Shipman
- City of Whitehorse Operations: Dave Albisser, Ralph Heynen (Level 1 Operator)
- City of Whitehorse Planning: Ben Campbell (Planning)
- Summit Environmental Consultants: Marta Green, P.Geo, Project Hydrogeologist
- Associated Engineering: Steve Bartsch, P.Eng, Project Manager
- Yukon Environmental Health: Dianna Hayden, B.Sc., Environmental Health Officer
- AECOM: Forest Pearson, Senior Geological Engineer

The City, Summit, and AE members of the TAC met twice early in the process in 2012. Copies of the meetings are presented in Appendix E. Ms. Diana Hayden attended the Community Meeting in March 2012 and met members of the TAC at this time. It is proposed that the full TAC annually to assess progress of the recommendations of the report upon report completion.

4 Module #1 Delineation and Characterization of Water Sources

This module includes delineation of the protection area using capture zone analysis and mapping, characterization of the individual well sources, and a review of available groundwater quality data.

4.1 MODULE #1 OBJECTIVES AND METHODS

The objective of Module #1 is to provide the framework for the source protection assessment, including a characterization of the water system, the water sources, the water system setting and governance context, and the assessment of the proposed protection area. Methods applied include:

- The Project Hydrogeologist, Marta Green, met with the City staff members at project initiation, and completed a site reconnaissance to existing and planned well fields with the City's water system operator Ralph Heynen.
- Reviewed reports in the engineering library.
- Reviewed the well head protection plans developed by others in British Columbia and Ontario to evaluate their approach and identify aspects that may be of value in Whitehorse.

4.2 DEFINITIONS

The following definition section is reproduced from the BC Well Protection Toolkit (BC MOE 2000). The planning team should become familiar with a number of technical terms that will be used throughout the development of the well protection plan. Figure 4-1 is a general model which shows many of these concepts.

Hydrogeology: Hydrogeology is the study of the flow of water and chemicals through the geological formations.

Aquifer: An aquifer is a permeable geological deposit (such as sand and gravel or fractured bedrock) that holds and yields a supply of water (Figure 4-1). The well may draw water from a large portion of the aquifer, or only part of it.

Aquifer Protection Area: The aquifer protection area is the land area on which protection measures are taken. In most cases, this will be the area defined as the capture zone. However, it may include an area larger than the capture zone (e.g. the water district boundary). It is recommended that the aquifer protection area be reviewed every year and revised as necessary.

Aquifer Transmissivity: Aquifer transmissivity refers to the rate that water can be transmitted to a pumping well.

Aquitard: An aquitard is a geological formation that does not transmit a significant amount of water to wells and springs. Some examples of aquitards are layers of finer grained sediments such as silts, clays, and compact tills.

Confined Aquifer: A confined aquifer occurs when an aquitard overlies an aquifer. The low permeability of the aquitard can help in protecting the underlying aquifer from impacts of human activities at the land surface. In those cases, an aquifer is said to be "confined."

Unconfined Aquifer: Where no aquitards overlie the aquifer, the aquifer is said to be "unconfined" and is vulnerable to impacts from human activities at the land surface, particularly if the water table is shallow. Knowing which areas of the aquifer are most vulnerable will allow you to put the greatest effort into the areas that need most protection.

Water Table: The water table is the level of standing water in the ground (Figure 4-1) and is the upper boundary of the unconfined aquifer. Where the water table comes to the surface, lakes and wetlands form.

Drawdown cone: When water is pumped from a well, the water table close to the well drops in a cone-shape (Figure 4-1). The area influenced by the pumping well is called the "drawdown cone." Its shape will vary - it is circular only where the geology is uniform and the water table is level.

Time of Travel (TOT): The capture zone can be divided into sub-areas based on "time of travel": the time it takes water to flow from a given point to the well. Usually, the capture zone is divided into one-year, five-year and ten-year time of travel (TOT) areas. The one-year TOT area is normally closest to the well; the five- and ten-year TOT areas are further away (Figure 4-1). There are two reasons for dividing the capture zone into TOT sub-areas:

- It provides the planning team with an idea of the time it would take for contaminants to travel to the well from different areas within the capture zone. Contaminants in the one-year TOT area will take a year or less to reach the well, while contaminants spilled in the ten-year TOT area can take up to ten years to reach the well.
- It makes it easier to set priorities. The first priority for protection measures will be in the one-year TOT area. As well, some contaminants (e.g. bacteria) are only able to travel a limited distance in soils before they are filtered out or die off, and are therefore of less concern when they are in the five- or ten-year TOT area.

Capture Zone: The capture zone is the land area that contributes water to the community well (a generic example of capture zone is shown in Figure 4-1). It is defined as the area within which groundwater flows towards the well. Capture zones expand the longer the well is pumped for, until a positive boundary condition or negative boundary condition is reached. Another name for this is the "recharge area." Any precipitation (rain or snow) that lands in this area may eventually end up in your well water. So may any fertilizers, oils, spills or other contaminants. It is important to define the capture zone accurately, because you cannot protect the well water without knowing where that water is coming from. Contaminants in the

capture zone could pollute the water supply to the well. Contaminants outside of the capture zone cannot pollute the water supply to the well.

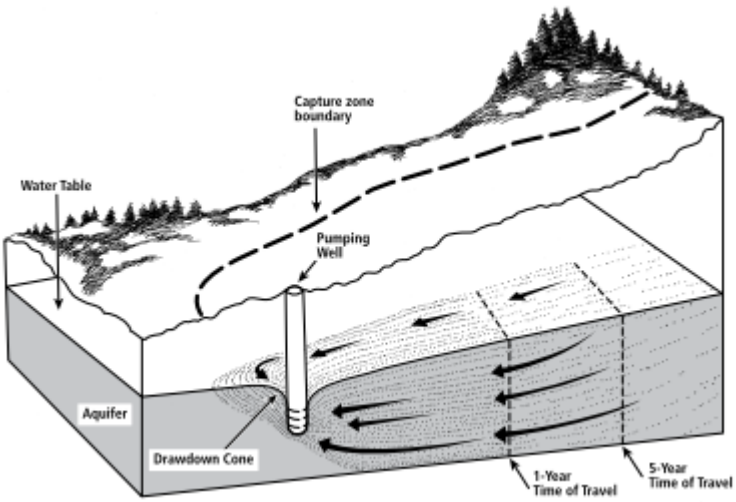

Figure 4-1
Schematic of a Capture Zone (BC MOE 2000)

4.3 CAPTURE ZONES AND DELINEATION OF AQUIFER PROTECTION AREAS

There are a number of methods to determine the capture zone, of which many are quite complex and technical (see Appendix 2.1 of the BC Well Protection Toolkit for a list of publications on this subject). The five methods most commonly used to delineate capture zones are, in order of simplest (least accurate and precise) to most complex (most accurate and precise) methods:

1. Arbitrary Fixed Radius;
2. Calculated Fixed Radius;
3. Analytical Equations;
4. Hydrogeologic Mapping; and
5. Numerical Flow Modelling.

AECOM (2011a) developed 90-day; 2-year and 10-year capture zones (Appendix A - Map 3) using the numerical flow modelling technique for the current water supply wells: WW4, 6, 8 and 9 in the South Riverdale Well Field.

For the purposes of this report, we have identified the 90-day and 10-year capture zones into Aquifer Protection Areas (APA). The primary APA is the 90-day capture zone expanded to include the locations of the proposed wells. It is the area where groundwater takes 90 days to reach the wellhead. The secondary APA is the area where groundwater takes up to10 years to reach the well head. Both aquifer protection areas are shown on Appendix A - Map 3.

Although the primary and secondary APA boundaries as defined here are sufficient for the purposes of this report, numerical flow modelling is recommended to assess capture zone of all proposed future wells prior to their connection to the system. The model results would then be used to update the Source Water Assessment and Protection Plan.

The primary APA for the South Riverdale Well Field contains Selkirk Elementary School, Super A Grocery Store / Tempo Gas Station, green space, Godzoodsaa Residence, City of Whitehorse Pumphouse, Yukon Energy Corporation Substation, Christ the King Elementary School, Yukon Electric easements and Lewes Boulevard and Nisutlin Drive.

The primary APA for the South Riverdale Well Field contains single family homes, green space, residential roads, Chadburn Lake Road, and several Yukon Electric easements.

The Riverdale community is primarily made up of one main road, with one to two blocks of commercial land, and then residential blocks of multiple and single family homes, and five schools. The boundaries of the long-term or “Riverdale” capture zone or the secondary APA are:

- North - Robert Campbell Bridge
- East - Alsek Road
- South - Power line easement between Alsek Road and Chadburn Lake Road.
- West – Annual high water mark of the Yukon River.

Note that the Whitehorse hospital is not part of the APA, but is located just north of the bridge at the north boundary of Riverdale. The Riverdale area includes the same structures identified in the primary APAs plus three other schools: F.H. Collins Secondary 200 m NW of WW5N, Grey Mountain Elementary School 550 m NE of WW9, and Vanier Catholic Secondary School 550 m SE of WW4.

4.4 WATER SOURCE CHARACTERIZATION

This section provides an overview of each supply well site and summarizes the available well water quality (potability) data.

4.4.1 Description of Individual Wells and Well Sites

Surficial geology at the Riverdale subdivision consists of quaternary unconsolidated sands and gravels adjacent to the Yukon River up to 36 m thick, underlain by silts/till, underlain by bedrock

(Appendix A - Map 1). It is in these glacio-fluvial sand and gravel deposits that the water supply wells are located.

Table 4-1 summarises well construction details for the active wells. Photos depicting the well sites during winter 2012 are included in Appendix G. All of the wells are located in residential areas. The Selkirk Well Fields are closest to institutional uses (Selkirk and FH Collins schools), commercial uses (Super A Grocery Store / Tempo Gas Station) and to a primary road (Lewes Blvd). The aquifer in the vicinity of the Selkirk Well Field is shallower, with depths to water at about 4 m bgs The South Riverdale Well Field is situated topographically slightly higher, and depths to water are about 6 m from ground surface. WW4 is the shallowest well and the largest producer, with screens installed 12 m below the water table. The other well screens start at 16 m below the water table. All of the water supply wells are housed in locked well houses, with fences in place around the houses.

Table 4-1
Summary of Active Water Supply Wells

Well	Year Installed	Depth to bottom (m bgs)	Screened Interval (m bgs)	Depth to water (m bgs)	Well Seal (m)	Security
Selkirk Well Field						
WW 4	1971	21.3	16.77-21.34	-	-	Building
WW 6	1974	26.8	20.42-26.76	-	-	Building
WW 5N	2005	44.24	35.1-44.24	3.88[a]	3.35	Building and Fence
South Riverdale Well Field						
WW 8	2008	27.40	22.7-27.4	6.1[a]	5.8	Building and Fence
WW 9	2008	29.00	21.7-29.0	5.7[a]	5.7	Building and Fence

4.4.2 Water Quality

Summit reviewed available water chemistry data from provided previous reports. The following section presents an overview of the available data, summarizes the results, and provides observations on the overall quality of the water in the Riverdale Aquifer based on the information available. Temporal plots were also created for select parameters with sufficient data to indicate whether concentrations may have increased over the past few years; however this time period is not sufficiently long enough to allow for detailed statistical trend analyses.

Available Data

Results for a number of chemical and physical parameters from the water supply wells were available in the Water Use License 2009 and 2010 Annual reports, and results for some limited

hydrocarbon analyses were available from reports prepared by Garter Lee Ltd. (2005) and AECOM (2011b).

Water Quality Results

The Water Use License 2009 and 2010 Annual Reports presented results for samples collected from Sampling Station WH2 (well water prior to treatment at the pump house). Data included results from samples from WW4, WW5N, and WW6 three times per year in 2008, 2009, and 2010, and results from samples collected from WW8 and WW9 once in 2008 and three times in 2010 (City of Whitehorse 2009; 2010). No total metals data were available for 2008.

Table 4-2 summarizes the range of concentrations from samples collected in 2011, and Appendix H presents a copy of the raw water chemistry data from the 2011 reports. Table 4-2 also includes the Guidelines for Canadian Drinking Water Quality (GCDWQ) for Aesthetic Objectives (AO) and Maximum Allowable Concentration (MAC) (Health Canada 2010).Where two guidelines exist, the more stringent is shown.

The data in Table 4-2 indicate that the water quality in the Riverdale Aquifer is excellent. The samples met the GCDWQ for all parameters tested. In addition to the parameters listed in the table, samples were collected weekly from wells WW4, WW5N, WW6, WW8, and WW9 for bacteriological analysis. All of these samples tested negative for presence of total coliforms and *E. coli.*

The 2011 results are similar to results from samples collected in 2008 - 2010 (City of Whitehorse 2009). Temporal plots showing changes in concentration over time were created for chloride (Figure 4-2), and nitrate (Figure 4-3), and show:

- Chloride concentrations appear to have varied over the 2008 to 2010 period, but do not show an increasing trend. Concentrations from wells in the Selkirk Well Field (WW4, WW5N, and WW6) consistently have higher concentrations than wells in the South Riverdale Well Field (WW8 and WW9), showing more anthropogenic impact such as road salts, but overall concentrations remain far below the guideline value of 250 mg/L.
- Nitrate concentrations in nearly all the wells were marginally higher in 2010 than in 2008 (for example, in 2008 values at WW6 ranged from 0.03 to 0.04 mg/L while values in 2010 ranged from 0.05 to 0.13 mg/L), but are still below the guideline value of 2 mg/L, showing very little to no effect from potential agricultural or septic sources such as backyard gardens or sanitary lines breaks.

Table 4-2
Summary of 2011 Water Quality Data

Parameter	Units	Detection Limit	[AO] or MAC from GCDWQ	WW4	WW5N	WW6	WW8	WW9
Aluminium	mg / L	0.005	0.1/0.2	0.005	0.005	0.005	0.008	0.005
Arsenic	mg / L	0.0002	0.010	0.0038	0.0038	0.0023	0.0025	0.0032
Boron	mg / L	0.004	5	0.020	0.033	0.015	0.005	0.005
Cadmium	mg / L	0.00001	0.05	0.00001	0.00001	0.00001	0.00001	0.00001
Chromium	mg / L	0.0004	0.05	0.0006	0.0005	0.0006	0.0005	0.0005
Copper	mg / L	0.001	[1.0]	0.002	0.006	0.009	0.003	0.011
Iron	mg / L	0.01	[0.3]	0.020	0.024	0.012	0.011	0.010
Lead	mg / L	0.0001	0.010]	0.0001	0.0001	0.0001[1]	0.0002	0.0006
Lithium	mg / L	0.001	NG	0.001	0.001	0.001	0.001	0.001
Manganese	mg / L	0.0001	[0.05]	0.007	0.006	0.005	0.005	0.005
Molybdenum	mg / L	0.00002	NG	0.0055	0.0065	0.0042	0.0021	0.0023
Nickel	mg / L	0.001	NG	0.001	0.001	0.001	0.001	0.003
Phosphorus	mg / L	0.01	NG	0.01[1]	0.01[1]	0.01[1]	0.01[1]	0.01[1]
Sodium	mg / L	0.02	[200]	11.50	17.80	9.07	1.73	1.87
Uranium	mg / L	0.0004	0.02	0.0024	0.0042	0.0028	0.0007	0.0008
Vanadium	mg / L	0.00004	NG	0.0010	0.0014	0.0015	0.0012	0.0013
Zinc	mg / L	0.001	[5.0]	0.004	0.004	0.004	0.003	0.007
Colour - Apparent	Rel. U.	-	NG	5[1]	5[1]	10[1]	7[1]	5[1]
Colour - True	Rel. U.[2]	-	15	5	5	5	5	5
Total Dissolved Solids	mg / L	1	[500]	206	304	187	83	85
Turbidity	NTU	0.02	1	0.13	0.20	0.07	0.12	0.13
pH (lab)	pH	0.01	[6.5-8.5]	7.98	7.72	7.73	7.75	7.77
Conductivity	µS/cm @25C	0.005	NG	330	455	301	139	141
T-Alkalinity	as $CaCO_3$	5	NG	135	170	123	71	71
Chloride	mg / L	-	[250]	1.73	2.52	2.31	0.46	0.52
Fluoride	mg / L	1	1.5	0.17	0.17	0.15	0.10	0.10
Sulphate	mg / L	5	[500]	62.4	82.2	31.7	7.3	7.5

Parameter	Units	Detection Limit	[AO] or MAC from GCDWQ	WW4	WW5N	WW6	WW8	WW9
Hardness	mg CaCO3/L	5	NG	169	232	155	73.6	74.7
Nitrate - N	mg / L	-	10	0.04	0.01	0.04	0.04	0.04
Nitrite - N	mg / L	-	1	0.005	0.005	0.005	0.005	0.005

Notes:

- Data is averaged from measurements taken at 3 different times in 2011. When parameter concentrations were indicated to be below the detection limit the detection limit value was used for these calculations, resulting in false high readings.
- MAC is maximum allowable concentration
- AO is aesthetic objective. Values in square parentheses [ ] are aesthetic objectives.
- NG: No guideline
- 1- Value is averaged from 2 readings only.
- 2- True colour units.

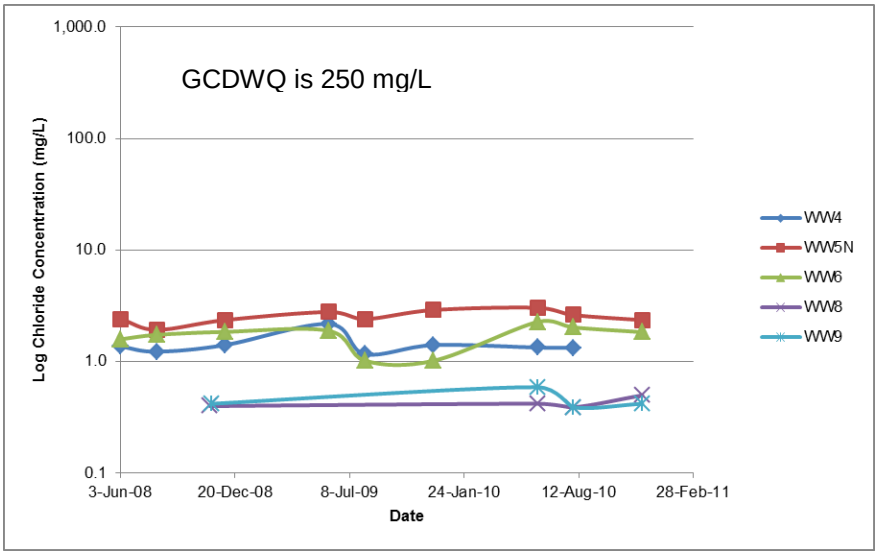

Figure 4-2
Log Chloride Concentrations from 2008 to 2010

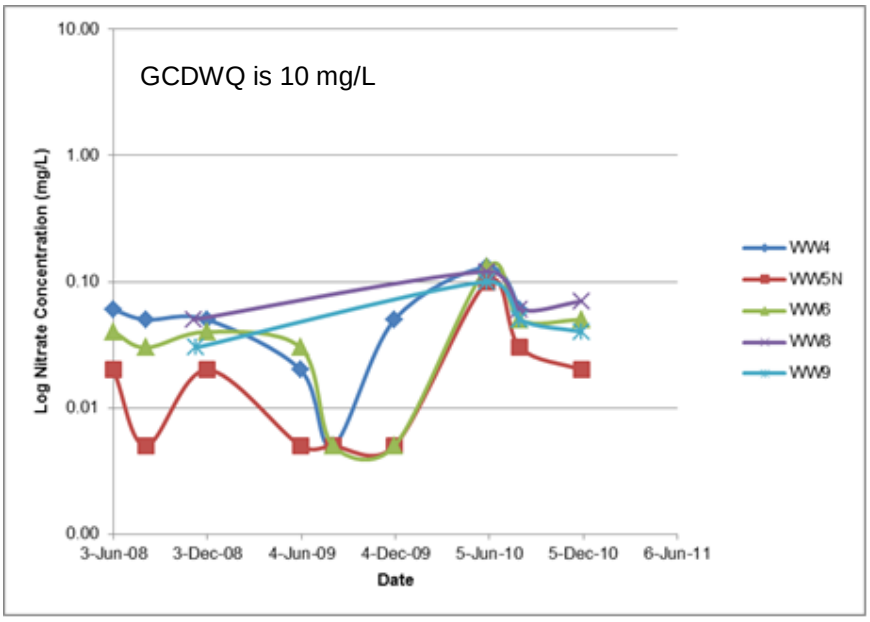

Figure 4-3
Log Nitrate Concentrations from 2008 to 2010

Similar findings are described in a report by Dayton & Knight (2010), which provided a summary of water quality results from WW4, WW5N, WW6, WW8, and WW9 from 2002 to 2010. In general, they found that water quality met the GCDWQ for water temperature, pH, true colour, arsenic, iron, manganese and sodium. Although Dayton and Knight show one turbidity exceedence (6.3 NTU), this reading is believed to be an anomaly as it is not consistent with results from the real-time turbidity meter in the pump house, which has not recorded any exceedences. Additionally, a hardness value of 258 mg/L was recorded at WW5N (Dayton & Knight 2010). There is no GCDWQ limitation for hardness; however values over 200 mg/L are considered poor but are tolerated, whereas those over 500 mg/L are considered unacceptable.

Limited hydrocarbon and pesticide analytical data are also available in previous reports. Two samples from WW5N were analyzed for halogenated and non-halogenated volatiles, extractable and polycyclic aromatic hydrocarbons, trihalomethanes, organophosphate and organochlorine pesticides, herbicides, pyrethroids, fungicides and carbonates. All were found to be below the detection limit (Gartner Lee Ltd. 2006). Additionally, in 2011 a sample collected from WW4N was analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) as well as select volatile organics, radiological parameters, pesticides, and polycyclic aromatics. Similarly, all parameters were below their respective detection limits (AECOM 2011a; 2011b).

Summary

In general, based on Table 4-2, the water quality in the aquifer is excellent and there is very little indication of anthropogenic (human) activity (such as nitrates from septic systems/sanitary line breaks or metals from industrial uses). To confirm this appraisal, we recommend completing an assessment of all parameters that have guidelines in the GCDWQ for all existing sources at least once and for all new sources at least once. This list is included in Appendix I. Recommendations for future groundwater quality monitoring and data management are provided in Section 7.0. Future operational and analytical data that is collected based on the recommendations of this report should be reviewed annually by a qualified professional with expertise in hydrogeology.

5 Module #2 Contaminant Source Inventory

This section describes the development of a contaminant source inventory for the primary and secondary APA and identification of potential drinking water hazards. Those hazards are assessed further in Module #7 (risk assignment) and through the recommendations provided in Module #8.

Information gathered from all the above sources was summarized in a Contaminant Source Inventory Table (Appendix B - Table 2) and in the accompanying Appendix A - Map 4 as potential contaminant sources.

5.1 OBJECTIVES AND METHODS

As described in the STTAG, Module #2 comprises a contaminant source inventory which identifies inherent risks to water quality as well as describing land uses, human activities and other potential contaminant sources that could affect source water quality within the assessment areas. The term “contaminant source” is defined within the STTAG to mean both actual/existing and potential source of contamination.

We used several methods in completing the assessments of potential drinking water hazards including:

- Existing records review for the Riverdale area including:
- Historical aerial photographs;
- Zoning maps;
- Telephone directories identifying historical site occupation information;
- Air Emissions Permits;
- Groundtrax Records;
- Arctic Backhoe Services Records;
- Contaminated Site Inventory;
- Environmental Issues Information System;
- Contaminated Sites on Federal Land;
- Yukon Government Fuel Storage Tank Permits (records maintained by the Fire Marshall)x;
- Historic Sites Inventory;
- Indian & Northern Affairs Fuel Tanks;
- National Defence & Canadian Forces Waste Disposal Sites;
- National Energy Board Wells;
- Waste Receivers;
- Relocation Permits;
- Spill Records;
- Special Waste Permits;
- Waste Disposal Sites;
- Yukon Oil and Gas Wells;
- Underground utility maps; and

- Relevant past reports available from the City of Whitehorse.
- A community meeting on March 22, 2012 to seek community member's input on past or present potential sources of contamination.
- Search of potential contaminants of concern within the primary and secondary APAs through Canada's Primary Environmental Risk Information Service (results are included in Appendix J).
- Contaminated Site Registry search.
- Personal interviews and phone surveys.
- A windshield survey (two persons visiting the area by vehicle) identifying obvious potential sources covering the Riverdale area.
- Field inspections of specific areas of interest within the study area.

The contaminant source inventory information was further analyzed for assessment of hazards according to the guidelines for Modules #2 and #7 and summarized in a Hazard Identification Table (Appendix B – Map 3) which summarized the following:

- Type of potential contamination sources within the assessment area;
- Nature of contaminants that have been or potentially could be released;
- Measures in place to prevent contaminant releases to the subsurface;
- Potential effects at the source level; and
- Existing preventative measures and associated barriers at the source level.

Appendix A - Map 4 shows the locations of the identified hazards.

5.2 HISTORICAL AERIAL PHOTOGRAPHS

The primary APA around WW4, WW5N and WW6 first saw development in 1950s. By 1963, the following developments were present: Lewes Boulevard, Nisutlin Drive and Selkirk Street, as well as two schools (Selkirk and Christ the King Elementary School), some administration buildings (including the Council of Yukon First Nation Administration Building), houses along Lewes Boulevard, Tatchun Road, and several un-identified use buildings. Through the decades, the zone was in-filled with more housing (both single detached and multi-residences). In the 1980s the store/gas station and the Gadzoosdaa First Nation Residences were constructed.

The primary APA around WW8 and WW9 first saw development in the 1950s. By 1963, Nisutlin Drive and Chadburn Lake Road were present. Single-detached residences developed in the area beginning in the 1970s. Through the decades, the north part of the zone was in-filled with more single-detached housing. The southern portion of the zone remains undeveloped.

The air photos indicate that potential contamination sources associated with residential and business land use date back to about 1950, so developments since then were considered in this assessment.

5.3 RECORDS REVIEW

The records review search identified eight contaminated sites, two spills and three permitted fuel storage tanks within the primary and secondary APAs. The location of these sites was included in the contaminant inventory, on Appendix B - Table 2.

Additionally, it was found that biological insecticides have been used around the City of Whitehorse. The most commonly used brands are Aquabac and Vectobac. These use a subspecies of the bacteria *Bacillus thuringiensis* (Bt) to limit the mosquito populations. There is low potential for these bacteria to infiltrate into the groundwater so their risk is not discussed further.

5.4 MAPS AND DIRECTORY REVIEW, FIELD INSPECTION AND WINDSHIELD SURVEY RESULTS

The area within the primary and secondary APAs is zoned by the City as residential (single detached and multiple housing), neighbourhood commercial, environmental protection, greenbelt, parks and recreation and public utilities. Zoning maps are included in Appendix K. These zones typically pose low to moderate environmental concerns. Businesses, institutions, and infrastructure currently and historically in the zone include:

- One gas station;
- One food market;
- Daycares;
- Schools (F.H. Collins and Vanier Catholic Secondary School, Grey Mountain Primary School and Christ the King and Selkirk Elementary School);
- City roads;
- Trails;
- Storm mains;
- Water services and mains;
- Sanitary services and mains;
- Greenbelts;
- Gadzoodsa First Nation Residence;
- Churches;
- Fish Hatchery;
- Pump Station;
- Power line easements;
- Teen Parent Center; and
- Electric power substations (one a site adjacent to WW5N).

5.5 RELEVANT REPORT REVIEW RESULTS

The following historical reports were reviewed to identify potential water well contaminant sources:

- UMA Engineering Ltd. and Environmental Dynamics Inc. September 2004. *Watershed Management Plan, Volume 2: Risk Assessment and Risk Management Strategies for Drinking Water Protection.* City of Whitehorse.
- Gartner Lee Limited. March 2005. 2004 Groundwater Exploration Program: *Pumping Tests and Water Quality Assessment- TH1S-04, TH4-04 and TH5-04.* City of Whitehorse.
- Gartner Lee Limited. July 2005. *Historical Review of Municipal Groundwater Exploration and Development.* City of Whitehorse.
- Gartner Lee Limited. February 2006. *Well 5N Construction and Testing.* City of Whitehorse.
- Gartner Lee Limited. July 2006. *2005 Groundwater Exploration Program: Test Well Drilling, Construction and Hydrogeological Testing*. City of Whitehorse.
- EBA Engineering Consultants Limited. February 2009. *2008 Groundwater Exploration and Development Program*, Whitehorse, Yukon. City of Whitehorse.
- AECOM. August 2010. *2010 City of Whitehorse Numerical Modelling.* City of Whitehorse.
- Dayton & Knight Ltd. November 2010. *Selkirk Pump Station Replacement: Technical Memorandum #1- Basis of Design.* City of Whitehorse.

One significant conclusion from this work was the identification of 58 wells and/or boreholes in the study area. These provide preferential pathways to the groundwater aquifer and rarely have basic security (i.e. locked well caps and surface seals). The identified wells are summarized in Appendix B - Table 1.

5.6 PERSONAL INTERVIEWS AND PHONE SURVEYS

The following people with knowledge of current and historical land use were interviewed or surveyed by phone:

- **Mr. Paul Harris:** Long-term resident of Whitehorse provided historical details regarding different properties in the area.
- **Mr. Wayne Dear:** Co-owner of Arctic Backhoe Services (ABS), which owns and operates the only commercial land treatment facility in Whitehorse.

- **Mr. Ralph Heynen:** Senior operation maintenance worker on the drinking water system for the City.

- **Mr. Shaun Einarson:** Manager of the Super A Grocery Store / Tempo Gas Station, located at 29 Lewes Boulevard.

- **Mr. Adam Greetham:** Manager of Groundtrax Environmental Services Inc., who have removed storage tank systems and remediated spills in the Whitehorse area for over three decades.

- **Mr. Wayne Dear:** Co-Owner of Arctic Backhoe Services Ltd., who have removed storage tank systems and remediated spills in the Whitehorse area for over three decades.

- **Mr. Glenn Lamoine**: Grounds Coordinator, Property Management Agency, which maintains the school-yards adjacent to the well fields.

The results of the interviews helped to identify or clarify contaminant sources. When relevant, the information found during the interviews is presented under each risk heading in Module #7.

5.7 COMMUNITY MEETING

A press release announcing a community meeting was distributed to local media by the City. Mr. James McLeod, Engineering Projects Officer, City of Whitehorse and Ms. Marta Green, Senior Hydrologist, Summit Environmental Consultants Inc. were interviewed on a 12 minute segment on CBC Radio North at 7 am March 22, 2012. In addition Ms. Green presented project information at a meeting of the Riverdale Community Association the evening of March 21, 2012 and invited members of the Riverdale Community Association to attend the community meeting the following night.

Through this community engagement the following potential contaminant sources were identified and are presented in Appendix B - Table 2 through Table 4:

- Gasoline services station;
- Camping areas;
- Cleaners (household, toilette, oven);
- Degreasers for driveways and garages;
- Metal polishes;
- Solvents;
- Refrigerants;
- Underground storage tanks;
- Potentially elevated radon concentrations
- Rust proofers;

- Hot tub disinfection and maintenance chemicals;
- Junk cars and debris;
- Storage Tanks (above and/or below ground);
- Pesticides and Fertilizers storage areas and containers; and
- Pets/animals.

6 Module #7 Characterize Risks from Source to Tap

6.1 RISK ASSESSMENT PROCEDURES

This section presents the results of Module #7: Characterize Risks from Source to Tap (BC Ministry of Healthy Living and Sport 2010). According to Module #7, risk is "the combination of the likelihood that a hazard will occur and cause harm, and the extent and degree of that harm" and can quantitatively be evaluated by multiplying the likelihood of a hazard occurring by the consequence of that hazard (BC Ministry of Healthy Living and Sport 2010).

To determine potential risks, two ratings were applied to each potential contaminant: 1) likelihood of occurrence (i.e. the probability the event occurs, and that if it occurs the contaminant will migrate to the aquifer) and 2) magnitude of consequence. Tables 6-1 and 6-2 from Module #7 outline how each level is determined. The product of the likelihood of occurrence and magnitude of consequence is then used to determine the risk to drinking water, as shown in Table 6-3.

Table 6-1
Assignment of Risk Categories – Likelihood of Occurrence

Level	Description	Probability of Occurrence in Next 10 Years
A	Almost certain - is expected to occur in most circumstances	>90%
B	Likely - will probably occur in most circumstances	71-90%
C	Possible - will probably occur at some time	31-70%
D	Unlikely – could occur at some time	10-30%
E	Rare - may only occur in exceptional circumstances	<10%

Table 6-2
Assignment of Risk Categories – Magnitude of Consequence

Level	Description
1	Insignificant - no illness, little disruption to normal operation, little or no increase in normal operating costs.
2	Minor - small population, mild illness moderately likely, some manageable operation disruption, small increase in operating costs.
3	Moderate - minor impact for large population, mild to moderate illness probable, significant moderation to normal operations but manageable, operating costs increased, increased monitoring.
4	Major - impact to small population, severe illness probably, systems significantly compromised and abnormal operation if at all, high level monitoring required.
5	Catastrophic - Major impact for large population, severe illness probable, complete failure of system.

Table 6-3
Risk (Likelihood-Consequence) Matrix

Likelihood	Consequence				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (almost certain)	Moderate	High	Very High	Very High	Very High
B (likely)	Moderate	High	High	Very High	Very High
C (possible)	Low	Moderate	High	Very High	Very High
D (unlikely)	Low	Low	Moderate	High	Very High
E (rare)	Low	Low	Moderate	High	High

The Contaminant Risk Summary Table (Appendix B - Table 4) summarizes the risks identified to the Whitehorse drinking water aquifer for each potential contaminant source. From the project work, six high risk, four moderate risk and 13 low risk contaminant sources were identified. Below is a discussion on the

sources deemed to be of high and moderate contamination risk to for the City of Whitehorse drinking water source wells.

Appendix A - Map 4 shows the location of all potential contaminants, as well as the result of the risk assessment described above.

6.2 SEWER MAINS AND SERVICES - HIGH RISK

The risk from sanitary sewers is rated “high” based on a combination of “likely” probability and “moderate” magnitude of consequence (Appendix B - Table 4). A “likely” probability was assigned because sewer mains and services are present in the primary APA and leaks and breaks in these areas could occur in future, and several minor sewer breaks have been recorded by the City in the Riverdale area. A “moderate” magnitude of consequence was assigned because sewage could introduce a number of potential contaminants to the source water. In addition to the nutrients (i.e. nitrates and phosphates) and bacteria commonly associated with municipal wastewater, other potential contaminants include viruses, heavy metals, organic compounds (e.g. tetrachloroethylene, dichlorobenzene, and methylene chloride), chloride, sulphate, calcium, and residual pharmaceuticals and personal care products. . It is important to note that the available water quality data shows very minimal effect from human activity; therefore it does not appear that the wells have been compromised by previous sewer main or service breaks.

The highest hazard from sewer main breaks or leaks is from viruses. The City of Whitehorse disinfects all groundwater with chlorine prior to distribution. Chlorine disinfection provides very effective treatment to almost all viruses assuming contact times are met. Moreover, chlorine residual is continuously being monitored at the treatment plant, providing real-time detection of potential cross contamination to the wells. For example, if a sewer line were to break and contaminants pulled in to the source wells, the chlorine residual concentration would decrease and the operators would then be alerted of the potential for cross contamination and act accordingly.

The second highest risk from sewer main breaks or leaks is bacteriological or protozoan (*Giardia, Cryptosporidium* for example) pathogens. The presence of these larger macro-organisms are generally associated with the presence of total coliforms and *E. coli*; therefore, cross contamination of these pathogens would be picked up within one week because the water from the wells are sampled pre-treatment (chlorine disinfection) weekly. *Giardia* and *Cryptosporidium* are not effectively treated by chlorine disinfection, which is a reason why source protection is important.

The recommended action if there is a known break is to stop the potentially affected well(s) from supplying the City of Whitehorse, until the potential risk to the water quality has declined.

6.3 WELL HOUSES - INSIDE - HIGH RISK

The risk from Well Houses (inside) is rated “high” based on a combination of “Possible” likelihood and “Moderate” magnitude of consequence. A “Possible” likelihood was assigned because flooding has occurred historically in Well House 1, 2, and 8, but this flood-water did not make it into the wells themselves and because the buildings may not be constructed to withstand disasters such as fires and/or earthquakes. A moderate magnitude of consequence was assigned because the contaminants would go directly in the well without any natural protection (such as the aquifer if a spill occurs outside of the building).

Flooding in Well House 1 and Well House 2 has occurred historically and is thought to be the results of both high precipitation, and the low elevation of the Well Houses. The wells within those houses (WW1 and 2 respectively) are low to the ground, which could allow a pathway for surface water to mix with groundwater. This may also apply to low elevation non-Water Source wells in the well fields.

Flooding from surface drainage occurred in Well House 8, after a malfunction with pump fittings. Well House 8 and 9 also experienced flooding as a result of pump failure.

A Supervisory Control and Data Acquisition (SCADA) system has been put into place in all the Well Houses to monitor for potential risks include flooding. Well Houses 5N, 8 and 9 have been constructed to withstand disasters such as fires and/or earthquakes, however, Well Houses 4 and 6 may not be constructed to withstand disasters. Well Houses 8 and 9 are additionally monitored by camera.

6.4 FUEL SPILLS - HIGH RISK

The risk from past and future fuel spills is rated both “low” and “high”. The level of risk is spill specific as it depends on volume spilt and the relative proximity to a well head. A spill >100 L occurring within the primary APA and a spill >1000 L occurring within the secondary APA have a combination of “possible” likelihood and “moderate” magnitude of consequence. There are records of spills occurring within the primary APA (spills at Selkirk School and Lewes and Nisutlin Intersection). Most residential homes are heated by fuel oil stored in either above ground or underground storage tanks and there is potential for fuel spills to occur in the future at commercial, institutional, and residential buildings, which exist within the primary and secondary APAs. Therefore a “likely” likelihood of occurrence is applied. Hydrocarbons contain a variety of chemicals that can enter the dissolved phase which can negatively impact human health without significant moderation to normal operations of the pump house; therefore, a “moderate” magnitude of consequence was applied.

The following sections detail reported fuel spills within the APAs.

6.4.1 Selkirk Elementary School

Selkirk Elementary School (5 Selkirk Street, Lot 1150 Quad 105D/11, 98-47 LTO YT) is a contaminated site on file due to two reports:

1. A diesel heating oil spill occurred at the Teen Parent Centre located adjacent to Selkirk School. The majority of the contaminated soil was excavated and removed but the base of the excavation still had soil above Yukon Contaminated Sites Regulation (CSR) Standards when it was backfilled. The site remains classified as contaminated.
2. An unknown volume of diesel heating oil spilled from an above ground storage tank associated with a vacant trailer on the southwest end of the school in 1998. Soil sampling after remediation (1999) indicated the contaminated soil remained at the site in the excavation walls and base, but no further work was completed. Groundwater was encountered at the excavation's base (2.8 m). The area is still considered contaminated.

6.4.2 88-100 Lewes Blvd (Condominium 2, 65999 LTO YT)

According to Yukon Contaminated Sites Registry, approximately 1,000 L of heating fuel spilled due to a broken line, and not all contaminated soil could be removed from the site due to the presence of surrounding structures. The environmental consultant recommended *in-situ* remediation; it is unknown if this was implemented. No final restoration report was submitted to the YG-Environment to confirm that all contaminated material was successfully treated, thus the site remains contaminated.

6.4.3 Other sites (outside of the primary APA)

The following sites were also recorded during our review and are located within the secondary APA, or just outside of the secondary APA.

Contaminated Sites

1. Vanier Catholic Secondary School (1001 Lewes Boulevard) is a contaminated site due to a historical fuel spill (date unknown) and a secondary fuel spill of 1,100 to 2,000 L on September 10, 2009. 316 m^3 of contaminated soil was removed from around the two spills, however, contaminated soil remain in both spill areas.
2. FH Collins (Lot 1150 Quad 105D/11, 98-47 LTO YT) is a contaminated site on file due to a spill adjacent to the FH Collins' boiler room, along the outside exterior wall. A UST containing heating fuel leaked through the vent pipe and the total volume was unknown. Soil sampling (2008) after remediation indicated that the contaminated soil remained at the site but further work was deferred to summer 2009 due to frozen ground conditions. No further information is on file indicating the current status of the remediation. Thus, the area is still considered contaminated.

3. 18 Stewart Road: heating fuel spill (2011) caused by vandalism. Most contaminated soil was excavated and relocated to land treatment facility, but some remaining contaminated soil was to be treated in-situ. No final restoration report has been submitted to the Branch, thus site remains contaminated.
4. Grey Mountain Primary School (186 Alsek Road, Block 248, 42713 LTO YT): heating oil leak was discovered in the basement crawlspace of the school. Some contaminated soil was excavated and relocated. No confirmatory samples were obtained to delineate extent of contamination and provide confirmation that all contaminated material was successfully removed, thus site remains classified as contaminated.
5. 22 Tay Street: heating fuel tank leak (2001). Excavation and relocation of $10m^3$ soil occurred, but some contaminated material was left in place to avoid undermining the structural integrity of the building footings. A venting pipe was installed, but no final confirmatory samples were obtained to confirm that the venting successfully remediated the remaining contaminated soil.
6. 6 Morley Road (Lot 34 Block 229 32574 LTO YT): heating fuel leak in 2008; relocation permit obtained and estimated $10m^3$ of contaminated soil was relocated. No confirmatory samples were obtained, thus site remains classified as contaminated.
7. Whitehorse General Hospital (former steam plant) (Lot 1127 Quad 105D/11 94-80 LTO YT): during the removal of 2 USTs contaminated soil was discovered. Much of the contaminated material was excavated; however soil on the eastern side of the excavation could not be removed due to the presence of surrounding infrastructure. The extent of contaminated material left on site is unknown.

Storage Tanks:

8. Christ the King Elementary School (120 Nisutlin Drive): one UST (unknown size) abandoned on August 15 2000.
9. Historic Council of Yukon First Nations Administration Office (11 Nisutlin Drive): one heating fuel Aboveground Storage Tank (AST) (9,400 L).
10. Historic Council of Yukon First Nations Administration Office (11 Nisutlin Drive): one removed heating fuel AST (22,730 L).
11. Arctic Backhoe Services removed two USTs from the old Council of Yukon First Nation building footprint under the guidance of Quantum Murray. Wayne Dear, Co-owner, stated that no indications of a fuel spill or leak were noted during this work.
12. Groundtrax Environmental Services Inc. has removed storage tank systems and responded to spills in the Whitehorse area for over a decade. Adam Greetham, Manager, Groundtrax Environmental Services Inc., is not aware of spills within the study area but states they may exist. He says that the spills typically extend to 3 meters in depth and 6 meters in circumference.

6.5 GAS STATION - HIGH RISK

The risk from gas stations is “high” based on a combination of “possible” likelihood and “moderate” magnitude of consequence. A Super A Grocery Store / Tempo Gas Station, located at 29 Lewes Boulevard, is adjacent to the Selkirk Well Field and within the primary APA. There is no indication that contamination of the groundwater in the vicinity of the gas station has already occurred; however, there is a “possible” likelihood that contamination of the aquifer in the vicinity of the Selkirk well field could occur in future due to the proximity of the gas station, inherent risks of gasoline underground storage tanks and the unconfined and coarse aquifer properties. The gas station stores gasoline and small volumes of antifreeze, oils and solvents. The existing water treatment system would need to be moderated significantly to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

Shaun Einarson, Manager, indicated that the gas station was built in 1986, and that they sell gasoline but do not sell diesel. To his knowledge, they have not had a sanitation dump, car wash, mechanical shop or a fuel spill. Mr. Einarson does not believe they have replaced the USTs. Mr. Einarson stated that they check the level of gasoline in their UST regularly, but they do not have any groundwater monitoring wells.

6.6 MECHANICAL WORKSHOPS AT SCHOOLS - HIGH RISK

The risk from mechanical workshops at schools is “high” based on a combination of “possible” likelihood and “moderate” magnitude of consequence. Mechanical workshops are located at the Secondary Schools within the primary and secondary APAs. F.H. Collins is the closest secondary school. It is just outside of the 90-day capture zone for the Selkirk well field using the location of the current supply wells, and just inside the Primary APA that includes proposed well PWW3N. The second closest secondary school is Vanier Catholic School, which is within the secondary APA, but more than 500 m away from either well field. There is no indication that contamination from this source has occurred in the past; however, there is a “possible” likelihood of occurrence in future given the nature of mechanical workshops, the proximity to the Selkirk well field and unconfined and coarse aquifer properties. The school mechanical workshops could contaminate the aquifer in which the source water wells are installed with hydrocarbons, solvents, and metals. The existing water treatment system would need to be moderated significantly to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

Selkirk Elementary School is adjacent to the Selkirk well field; however, this is an elementary school and does not have a mechanic bay, metal works, or carpentry shops and is therefore a low risk.

6.7 MONITORING WELLS - HIGH RISK

The risk from monitoring wells within the primary APA is “high” based on a combination of “possible” likelihood and “moderate” magnitude of consequence. Wells not used for water supply are located within the primary APA and could be exposed to vandalism. In addition deposits and spills near the wells would have a preferential pathway to source water either within the wells and/or along the outside of the well casings. There is no indication that contamination from monitoring wells has occurred in the past; however, there is a “possible” likelihood of occurrence in future. A wide variety of contaminants could enter the supply wells if this risk occurred. The existing water treatment system would need to be moderated significantly to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

To find the locations of non-supply wells, we completed a site visit in the vicinity of the Selkirk and South Riverdale Well Fields. Test hole location data from previous reports was summarized into Appendix B - Table 1 and was used to form a map with locations of historical test holes and monitoring wells. In late May, Ms. Jacques walked the trails and light brush areas in the well fields in to confirm the well locations. The ground was snow-free during the site visit. Through this work, locations for TH1-97, TH1S-04, TH1D-04, TH4-71, TH8-71 and TH15-72 were confirmed. The results of the site visit were included in Appendix B - Table 1, well details.

6.8 POTENTIAL DRAINAGE PITS AND STORM DRAINAGE MAINS - MODERATE RISK

The risk from potential drainage pits and storm drainage mains is “moderate” based on a combination of “possible” likelihood and “minor” magnitude of consequence. Drainage pits comprise of a perforated manhole surrounded by drain rock and allows a direct pathway to the aquifer and does not allow for any renovation of surface water quality prior to entering the aquifer. Surface drainage pathways for Riverdale are shown in Appendix A - Map 5. Bioswales are surface dispersal methods that allow for the remediation or renovation of contaminants in stormwater by allowing slow percolation through topsoils with potential uptake through vegetation (Nelson and Chinitz, 2013). The City currently uses Bioswales to manage stormwater in the Riverdale area. Recently drainage pits have been proposed by City engineers as a method to manage run-off water within the primary APA of the South Riverdale Well Field where the application of bioswales is not an option so a “possible” likelihood was applied. Possible contaminants transported by rain water along roads include sediment, road salt, construction debris, lawn and garden chemicals, gasoline and motor oil. As noted earlier, water quality in the supply wells is excellent, showing only very minor chloride effects to groundwater in the Selkirk well field (likely due to road salts). The existing water treatment system was not specifically designed to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

Storm drainage mains within the APAs may create a pathway for contamination to reach source water through breaks, leaks, spills and deposits (Appendix A - Map 5). There is no indication contamination from surface water run-off has occurred in the past; however, there is a “possible” likelihood of occurrence in

future because storm mains are located within both APAs. Hydrocarbons, metals, salts, herbicides and other pesticides are examples of contaminants which could be introduced to the source water from storm drainage mains. The existing water treatment was not specifically designed to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

6.9 PROPOSED DEVELOPMENT AREAS - MODERATE RISK

The risk from proposed development areas is “moderate” based on a combination of “possible” likelihood and “minor” magnitude of consequence. There are three proposed development areas within the study area and the primary APA. Two of these are adjacent to the existing well fields, and one is adjacent to a proposed well (PWW10) (Appendix A - Map 2). Due to the proximity to the source water, any contaminants dumped, leaked or spilled on the land could reach the aquifer. Therefore, there is a moderate likelihood of occurrence. A variety of contaminants can be associated with a proposed development, such as those associated with sanitary lines, storm lines, back-yard gardens, car storage and parking. The existing water treatment system would need to be moderated significantly to treat for these contaminants; therefore, a “moderate” magnitude of consequence was assigned.

6.10 ROAD AND ROAD INFRASTRUCTURE - MODERATE RISK

The risk from proposed development areas is “moderate” based on a combination of “possible” probability and “minor” magnitude of consequence. Currently the City uses sodium chloride for road salt. Sand is mixed with about 3% salt and is applied with a sander along intersections and occasionally along roads. Water quality shows minimal impact from salts (3.04 mg/L is the highest chloride concentration in the WW5N in the past three years, compared to 0.59 mg/L in WW9, whose capture zone extends into forest south of the Riverdale subdivision). Based on this, there is no indication that contamination from roads and road infrastructure has occurred; however, due to their proximity to the well fields, the aquifer’s unconfined, shallow, and coarse properties there is a moderate probability of occurrence in future. Automotive wastes, sodium chloride, pesticides, herbicides, solid and liquid spills and runoff are the potential contaminants of concern from the roads and road infrastructure. The existing water system would have some manageable operation disruption or a small increase in operating costs if such contamination occurred (such as more monitoring requirements, improvements to stormwater management or changes to road applications); therefore, a “minor” magnitude of consequence was assigned.

7 Module #8 Recommended Actions to Promote Groundwater Protection

7.1 INTRODUCTION

The outcomes of Module #8 are recommended actions to effectively manage the identified risks. These actions will enhance the safety and sustainability of the drinking Water Source (BC Ministry of Healthy Living and Sport 2010).

The safety and sustainability of the drinking water supply are very important since the City's drinking water permits are dependent on the successful completion of a Source Water Area Protection Plan and Emergency Response Plan.

7.2 RECOMMENDED RISK MANAGEMENT ACTIONS

For each identified hazard with a moderate or high risk, recommendations were developed that considered:

1. How to reduce the level of hazard;
2. How to reduce the likelihood of the hazard affecting the aquifer (i.e.: by adding or enhancing barriers);
3. The individual, local or upper administration responsible for enacting the recommendation; and
4. Suggested timeline/priority sequence for implementation.

The team prioritized the recommendations for implementation based on:

- Risk level;
- Public health implications;
- Risk reduction benefit;
- Costs;
- Ease of implementation; and
- Need to enhance weak barriers.

This Source Water Area Protection Plan should be implemented as a part of the Emergency Response Plan (Appendix D). Detailed recommended risk management strategies are presented in Appendix B - Table 5.

Under the STTAG, it is recommended that the TAC, water supplier, and Drinking Water Officer develop risk management actions which are specific, measurable, achievable, realistic, and time bound, following the principle outlined in Module #8 (BC Ministry of Health Living and Sport 2010). The suggested time frames for risk management actions for risk management actions are presented in Table 7-1.

Table 7-1
Suggested Time Categories for Risk Management Actions

Category	Timeframe	Type of Risk Management Action
Immediate	Within 3 months	Actions addressing regulatory violations, imminent public health threats or water shortages.
Short Term	Within 1 year	Actions that are easy to implement or those addressing significant public health concerns or water quantity issues, enhancement or weak barriers.
Medium Term	1-3 years	Actions addressing moderate water quality or quantity concerns, broad systemic issues.
Long Term	3 years +	Actions addressing hazards representing chronic health implications or long-term threats to water availability, broad systemic issues.

Source: BC Ministry for Health Living and Sport, 2010.

The recommendations are included in Appendix B - Table 5 are designed to reduce the potential for future source water contamination. In summary, these recommendations:

- Reduce the risk of fuel spills through the implementation of the Fuel Smart Plan (Appendix C);
- Improving emergency preparedness through the implementation of the Emergency Response Plan (Appendix D);
- Educate the public and key City staff about source water contamination;
- Address the management and upgrades of infrastructure in ways that reduce the risk of source water contamination; and
- Implement security and detection systems that protect and monitor the source wells.

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A Appendix A - Maps

Image Source: Google Earth, 2012

N

50 Day Contaminant Travel Time

50 Day Contaminant Travel Time

WW6 (637.06m)

WW5 (637.04m)

WW4 (637.74m)

WW9 (647.28m)

WW8 (648.75m)

Yukon River

633.5 masl

632.6 masl

634.0 masl

630.0 masl

643.0 masl

636.0 masl

620.94 masl

616.85 masl

616.44 masl

610.55 masl

601.99 masl

592.85 masl

620.94 masl

620.94 masl

616.44 masl

616.44 masl

650
640
630
620
610
600
590
580

Metres Above Sea Level (approx)

0 200 m (approx)

Unit A:

Sand

Sand & Gravel

Gravel

Unit B:

Silt & Till

Unit C:

Bedrock

Drawdown Water Level

Static Water Level

Interpolated Strata Boundary

Known Strata Boundary

Well Screen

Well

50 Day Travel Time Limit

Groundwater Flow Direction

PREPARED FOR:

Whitehorse
THE WILDERNESS CITY

Map 1: 3D View of Whitehorse Drinking Water Aquifer

PROJECT NO.:	2012-2975.000
DATE:	April, 2013
FILE:	perspective.mxd

SUMMIT ENVIRONMENTAL CONSULTANTS INC.
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Current Water Supply Well

Proposed Water Supply Well (drilled)

Proposed Water Supply Well (not yet drilled)

Monitoring Well

Surface water sample location

Proposed Developement Area

PROJECT: 2012-8115.000

DATE: April, 2013

DRAWN BY: DA

Whitehorse

Map 2: Study Area

SUMMIT ENVIRONMENTAL CONSULTANTS INC.

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Current Water Supply Well

Proposed Water Supply Well (drilled)

Proposed Water Supply Well (not yet drilled)

AECOM WHPA-B (2 yr TOT)

AECOM WHPA-C (10 yr TOT)

Primary Aquifer Protection Area

Secondary Aquifer Protection Area

PROJECT: 2012-2975.000

DATE: April, 2013

DRAWN BY: DA

Whitehorse

Map 3: Riverdale Subdivision Primary and Secondary Aquifer Protection Areas

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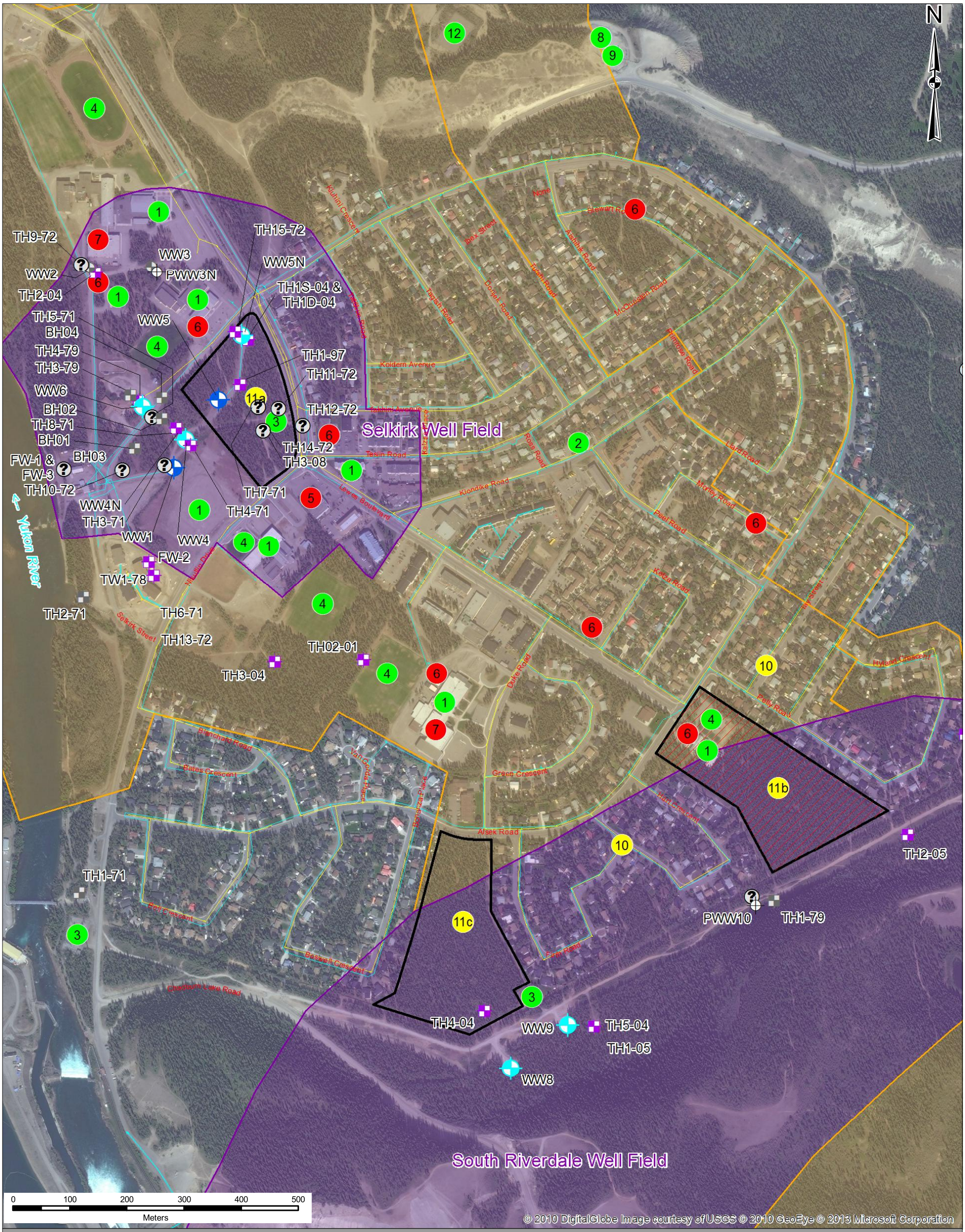


POTENTIAL CONTAMINANT SOURCES:

Point Sources (colored circles shown on map)

1) Administration Buildings
2) Antifreeze Spill
3) Substation
4) Field Maintenance
5) Gas Station
6) Fuel Spill
7) Mechanical Workshops (Schools)
8) Old Landfill
9) Snow Dump
10) Potential Drainage Pits
11) Proposed Development Areas (a, b, c)
12) Riverdale Reservoir

Non Point Sources (not shown on map)
Color Indicates Contaminant Risk

13) Monitoring Wells and Unused Supply Wells
14) Wellhouses – Inside
15) Animals and Pests
16) Camping Areas
17) Cleaning and maintenance products, hot tub disinfection chemicals, metal polishes, refrigerants, rust proofers and solvents
18) Degreasers for driveways and garages
19) Electric Power Easements
20) Junk cars and debris
21) Roads and Transportation Infrastructure
22) Sewer Lines and Mains
23) Storm Drainage Mains

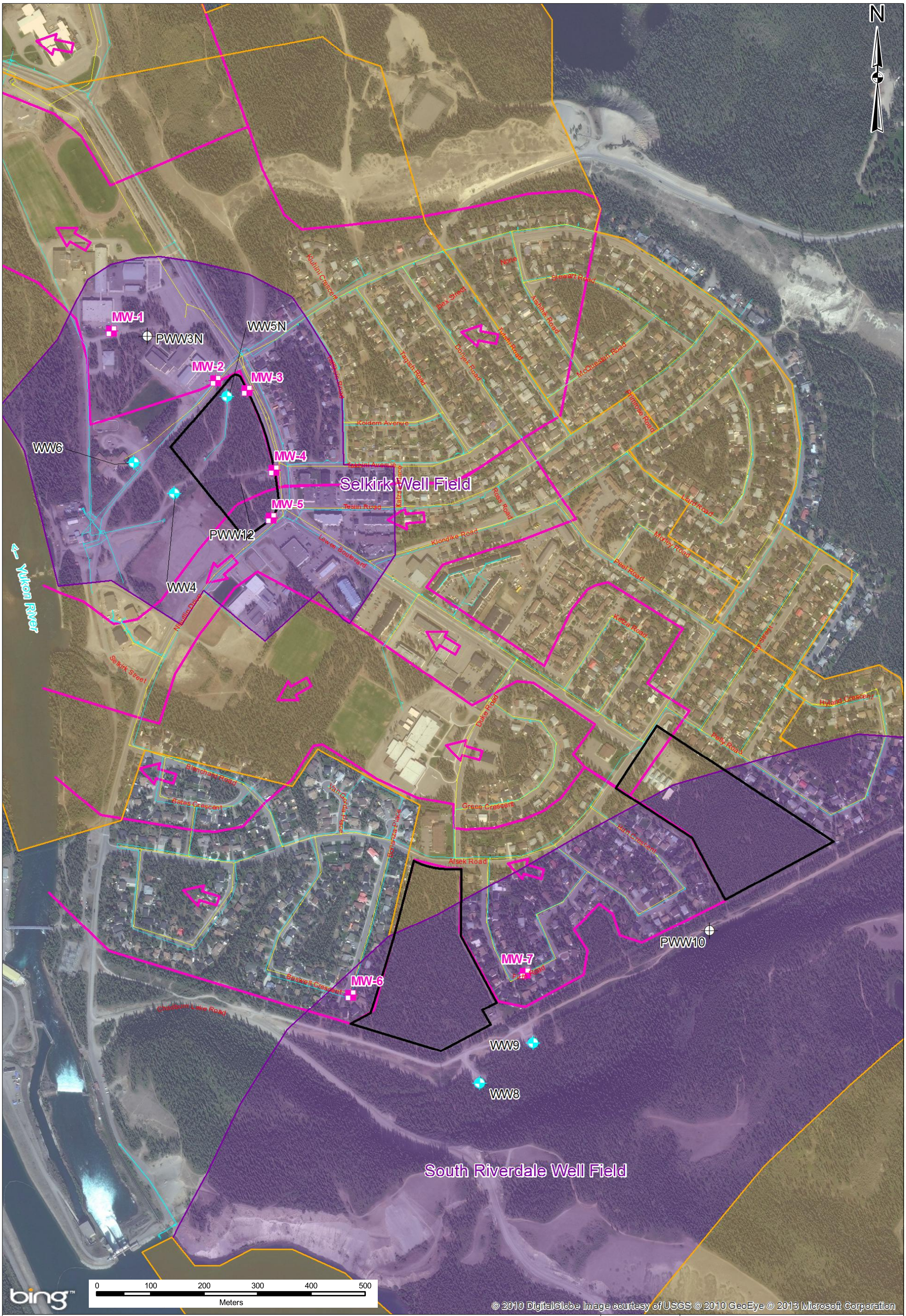
- Sanitary Sewer
- Water Line
- Proposed Development
- Primary Aquifer Protection Area
- Secondary Aquifer Protection Area
- Yukon Government Registered Contaminated Site
- Current Water Supply Wells
- Decommissioned Water Supply Well
- Monitoring Well
- Old Water Supply Well
- Proposed Water Supply Well (drilled)
- Proposed Water Supply Well (not yet drilled)
- Well Not Found
- Decommissioned Wells or Boreholes no Monitring Well Completed
- High Contaminant Risk
- Moderate Contaminant Risk
- Low Contaminant Risk

PROJECT: 2012-2975.000
DATE: April, 2013
DRAWN BY: DA

Map 4: Contaminant Source Inventory and Risk Assessment of Drinking Water Hazards

Whitehorse
THE WILDERNESS CITY

SUMMIT ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies



Proposed Monitoring Well
Current Water Supply Well
Old Water Supply Well
Proposed Water Supply Well (drilled)
Proposed Water Supply Well (not yet drilled)

Sanitary Sewer
Water Line
Primary Aquifer Protection Area
Secondary Aquifer Protection Area

Stormwater Drainage Area Boundary and Drainage Direction

Proposed Development

PROJECT: 2012-2975.000
DATE: April, 2013
DRAWN BY: DA

Whitehorse
THE WILDERNESS CITY

Map5: Riverdale Surface Water Drainage

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B Appendix B - Tables

Ta le 1 South Riverdale A uifer Well hracteristics

Well	ear Installed	asting (UTM NAD 3)	Northing (UTM NAD 3)	Depth (m gs)	Screened Interval (m gs)	Depth to Water (m gs)	Well Material	Well diameter	Found during Site isit (May and uly 2012)	omments	Surface Seal Present	Within uilding	Within Fence	Locka le asing Present	Lock Present	General Recommendations (lose or Improvements to security)
Proposed water supply wells that have not een drilled ut the location has een sited. Well may e drilled in the future demand warrants it.																
WW3N	-	497865[b]	6730391[b]	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
PWW10	-	498923	6729271	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
urrent water supply wells																
WW4	1971	497922	6730096	21.3	16.77-21.34	3 (within 90 day), 1 (outside 90 day)	Steel	12"	Yes	Water Supply Well	> 1	Yes	Yes	No	Yes	Monitor for Security. See recommendations under "Wellhouses - inside"
WW4N	2011	497925	6730105	36.70	27.1-36.7	3 (within 90 day), 1 (outside 90 day)	Steel	16"	Yes		No	No	No	Welded Steel Cap	No	Inspect for vandalism every two months
WW5N	2005	498022	6730280	44.24	35.1-44.24	3.88[a]	Steel	16"	Yes	Water Supply Well	3.35	Yes	Yes	No	Yes	Monitor for Security. See recommendations under "Wellhouses - inside"
WW6	1974	497847	6730147	26.8	20.42-26.76	-	Steel	14"	Yes	Water Supply Well	Yes	Yes	Yes	No	Yes	Monitor for Security. See recommendations under "Wellhouses - inside"
WW8	2008	498494	6728987	27.40	22.7-27.4	6.1[a]	Steel	16"	Yes	Water Supply Well. Was named TH2-08B during testing phase. Name was changed to WW8 when connected to system	5.8	Yes	Yes	No	Yes	Monitor for Security. See recommendations under "Wellhouses - inside"
WW9	2008	498614	6729064	29.00	21.7-29.0	5.7[a]	Steel	16"	Yes	Water Supply Well. Was named TH1-08 during testing phase. Name was changed to WW9 when connected to system	5.8	Yes	Yes	No	Yes	Monitor for Security. See recommendations under "Wellhouses - inside"
ld water supply wells that are still opera le ut not currently in use																
WW1	1956	497904	6730039	12.2	9.15-12.22	2.56	Steel	10"	Yes	Welded cap; well is on manual standby	> 1	Yes	Yes	Yes	Yes	Inspect for vandalism every two months
WW2	1956	497753	6730391	12.2	9.15-12.22	1.8-2.7	Steel	10"	No	Decommissioned	> 1	N/A	N/A	N/A	N/A	None
WW3	1956	497865	6730391	14.6	11.61-14.72	2.5	Steel	10"	No	Decommissioned	> 1	Yes	Yes	Yes	Yes	Inspect for vandalism every two months
WW5	1973	497982	6730158	16.8	12.19-16.76	-	Steel	12"	Yes	-	Yes	Yes	Yes	No	No	Consider welding a cap on this well. Monitor for Security. If going back on-line, inspect wellhouse for deficiencies in well head protection/pathways for contaminant migration
Monitoring wells (or old test wells of varying construction and material)																
TH1-97	1997	498018	6730184	63.1	49.7-52.1	Unknown	Unknown	Unknown	Yes		Yes	No	No	Yes	Yes	Inspect for vandalism every two months
TH1S-04	2004	498024	6730276	22.86	18.85-22.00	Unknown	Unknown	Unknown	Yes		Yes	No	Yes	Yes	Yes	Inspect for vandalism every two months
TH1D-04	2004	498022	6730277	52.95	40.57-43.72	Unknown	Unknown	Unknown	Yes		Yes	No	Yes	Yes	Yes	Inspect for vandalism every two months
TH4-71	1971	497922[b]	6730096[b]	22.3	19.21-22.25	Unknown	Steel	2"	Yes		Unknown	No	No	No	No	Decommission
TH8-71	1971	497922[b]	6730096[b]	36.6	23.78-26.83	Unknown	Steel	2"	Yes		Unknown	No	No	No	No	Decommission
TH15-72	1972	498022[b]	6730280[b]	24.4	13.41-16.46	Unknown	Steel	2"	Yes		Unknown	No	No	No	No	Decommission
Wells not found during ground truthing (most likely oreholes that were not completed with a monitoring well or wells that have een renamed and are thus duplicates)																
TH02-01	2001	498236	6729702	146.5	66.75-146.53 (open hole)	Unknown	Steel	6"	No	Vanier test well	Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH2-79	1979	499351	6728945	90.8	87.8-90.5 (open hole)	Unknown	N/A	N/A	No	Approximately 0.5 km S of PWW10 (not on map)	Yes	N/A	N/A	N/A	N/A	If located, protect or decommission

Ta le 1 South Riverdale A uifer Well hracteristics

Well	ear Installed	asting (UTM NAD 3)	Northing (UTM NAD 3)	Depth (m gs)	Screened Interval (m gs)	Depth to Water (m gs)	Well Material	Well diameter	Found during Site isit (May and uly 2012)	omments	Surface Seal Present	Within uilding	Within Fence	Locka le asing Present	Lock Present	General Recommendations (lose or Improvements to security)
TH4-79	1979	497843	6730155	26.5	24.4-26.5	Unknown	N/A	N/A	No		Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
FW2	1986	497869	6729850	63.8	34.7-68.3	Unknown	N/A	N/A	No	YG Fish Hatchery	Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
FW3	-	497722[b]	6730040[b]	-	Unknown	Unknown	N/A	N/A	No	YG Fish Hatchery	Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH2-04	2004	497767	6730380	44.65	15.90-19.05	Unknown	N/A	N/A	No		Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH3-04	2004	498081	6729699	50.60	34.61-37.76	Unknown	N/A	N/A	No		Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH4-04	2004	498448	6729087	31.24	24.42-27.57	Unknown	N/A	N/A	No		Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH5-04	2004	498640	6729060	41.57	34.38-37.53	Unknown	N/A	N/A	No		Yes	N/A	N/A	N/A	N/A	If located, protect or decommission
TH1-05	2005	498913	6729292	61.5[a]	58.35-61.50[a]	Unknown	N/A	N/A	No		None	N/A	N/A	N/A	N/A	If located, protect or decommission
TH2-05	2005	499189	6729396	61.22[a]	58.07-61.22[a]	Unknown	N/A	N/A	No		3.05 m bgs	N/A	N/A	N/A	N/A	If located, protect or decommission
TH3-05	2005	499290	6729571	73.05[a]	69.90-73.05[a]	Unknown	N/A	N/A	No	Approximately 0.15 km NE of PWW11 (not on map)	3.05 m bgs	N/A	N/A	N/A	N/A	If located, protect or decommission
TH3-08	2008	498060	6730104	48.50	45.4-48.5	8.1[a]	N/A	N/A	No		6.1 m bgs	N/A	N/A	N/A	N/A	If located, protect or decommission
TH1-80	1980	499292	6730210	-	-	Unknown	N/A	N/A	No	Approximately 0.750 km NNE of PWW11 (not on map)	N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH3-71	1971	497904[b]	6730039[b]	19.2	9.45-12.50	Unknown	N/A	N/A	No		N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH5-71	1971	497866	6730128	22.3	9.75-12.80	Unknown	N/A	N/A	No	Directly across Selkirk St. from WW6 (to the east of the path)	N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH7-71	1971	498050[b]	6730146[b]	20.7	9.75-12.80	Unknown	N/A	N/A	No	Halfway between TH11-72 and TH1-97	N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH9-72	1971	497753[b]	6730391[b]	25.9	10.36-13.41	Unknown	N/A	N/A	No		N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH10-72	1972	497798[b]	6730024[b]	29.0	13.41-16.46	Unknown	N/A	N/A	No		N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH11-72	1972	498087	6730142	24.4	17.07-20.12	Unknown	N/A	N/A	No		N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH2-80	1980	498024[b]	6731574[b]	-	-	Unknown	N/A	N/A	No	1.25 km northeast of WW3 (off the map)	N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
TH12-72	1972	498086[b]	6730042[b]	31.4	N/A	Unknown	N/A	N/A	No	Approximately 80 m E of PWW12	N/A	N/A	N/A	N/A	N/A	If located, protect or decommission
Decommissioned wells or oreholes that were not completed with a monitoring well																
TW1-78	1978	497869[b]	6729850[b]	128.0	64.02-67.38	Unknown	N/A	N/A	No	Likely Abandoned	N/A	N/A	N/A	N/A	N/A	None
TH1-79	1979	498640[b]	6729060[b]	155.0	44.2-152.7 (open hole)	Unknown	N/A	N/A	No	Well backfilled	N/A	N/A	N/A	N/A	N/A	None
FW1	1986	497722[b]	6730040[b]	51.2	46.9-51.5	Unknown	N/A	N/A	No	Decommissioned	N/A	N/A	N/A	N/A	N/A	None
TH1-71	1971	497738[b]	6729294[b]	12.5	N/A	Unknown	N/A	N/A	No	On NE side of Rotarty Centennial Bridge; No pipe set	N/A	N/A	N/A	N/A	N/A	None
TH2-71	1971	497745[b]	6729809[b]	13.7	N/A	Unknown	N/A	N/A	No	On Shore of Yukon River, S of FW1&3; No pipe set	N/A	N/A	N/A	N/A	N/A	None
TH3-79	1979	497847[b]	6730147[b]	30.5	N/A	Unknown	N/A	N/A	No	Not completed	N/A	N/A	N/A	N/A	N/A	None
TH6-71	1971	497868[b]	6729809[b]	22.9	N/A	Unknown	N/A	N/A	No	Approximately 60 m S of BH01; No pipe set	N/A	N/A	N/A	N/A	N/A	None

Ta le 1 South Riverdale A uifer Well haracteristics

Well	ear Installed	asting (UTM NAD 3)	Northing (UTM NAD 3)	Depth (m gs)	Screened Interval (m gs)	Depth to Water (m gs)	Well Material	Well diameter	Found during Site isit (May and uly 2012)	omments	Surface Seal Present	Within uilding	Within Fence	Locka le asing Present	Lock Present	General Recommendations (lose or Improvements to security)
TH13-72	1972	497861[b]	6729746[b]	21.3	N/A	Unknown	N/A	N/A	No	150 m S of TW1-78; No pipe set	N/A	N/A	N/A	N/A	N/A	None
TH14-72	1972	498061[b]	6730115[b]	21.3	N/A	Unknown	N/A	N/A	No	Approximately 10m E of PWW12; No pipe set	N/A	N/A	N/A	N/A	N/A	None
BH01	2010	497832[b]	6730063[b]	3.60	N/A	Unknown	N/A	N/A	No	Backfilled	N/A	N/A	N/A	N/A	N/A	None
BH02	2010	497838[b]	6730097[b]	3.60	N/A	Unknown	N/A	N/A	No	Backfilled	N/A	N/A	N/A	N/A	N/A	None
BH03	2010	497793[b]	6730036[b]	6.00	N/A	Unknown	N/A	N/A	No	Approximately 10 m N of TH10-72; Backfilled	N/A	N/A	N/A	N/A	N/A	None
BH04	2010	497867[b]	6730144[b]	6.00	N/A	Unknown	N/A	N/A	No	Backfilled	N/A	N/A	N/A	N/A	N/A	None

a- Measurement from top of casing
b- Nearest well location
- Data not known

Ta le 2 ontaminant Source Inv entory

Source No. (Map 4)	Source	wner urisdiction	Location	Distance Direction to Nearest Well	ontaminants of oncern	Transport Mechanism
Point Sources						
1	Administration Buildings	Council of Yukon First Nations	Nisutlin Road	90 m SSE of WW4	Building wastes and lawn and garden maintenance chemicals	Deposits, leaks and spills to soil and groundwater
2	Antifreeze Spill (reported 2009)	Private ownership	20 Klondike Road	150 m from PWW7 and PWW12	Ethylene glycol, metals, ethanol, isopropyl alcohol, and propylene glycol	Deposits, leaks and spills to soil and groundwater
3	Electric Power Sub-station	Yukon Electrical Company Limited	On Lewes Boulevard, across from Tahini Avenue	170 m E of WW4 and SSE of WW5N	PCBs, oils, solvents, sludges, acid solution, chromium, nickel and cadmium	Deposits, leaks and spills to soil and groundwater
4	Field Maintenance	City of Whitehorse, Yukon Government, or private ownership	Schools, administration buildings and residences	20 m from WW6	Nitrates, nutrients, chemical residues and left-over product containers	Deposits, leaks and spills to soil and groundwater
5	Gas Station	Tempo Gas	Nisutlin Dive and Lewes Boulevard	250 m SE of WW4	Gasoline, antifreeze, oils, and solvents	Deposits, leaks and spills to soil and groundwater
6	Fuel Spills	City of Whitehorse, Yukon Government, or private ownership (reported on various dates)	Various locations	50 m SSE of WW2	Hydrocarbons and metals	Overfill, leaks, spills and deposits to soil and groundwater
7	Mechanical Workshops at Schools	Yukon Government	At FH Collins and Vanier Secondary School	20 m NE of WW2	Hydrocarbons and solvents	3 (within 90 day), 1 (outside 90 day)
8	Old landfill/dumping area where trees, grubbing, and concrete and asphalt was placed	City of Whitehorse	City of Whitehorse	08 km NE of WW5N	Hydrocarbons	3 (within 90 day), 1 (outside 90 day)
9	Snow Dump	City of Whitehorse	City of Whitehorse	08 km NE of WW5N	Sodium chloride, hydrocarbons and ethylene glycol	3 (within 90 day), 1 (outside 90 day)
10	Potential Drainage Pits	City of Whitehorse	One in Tay Street and one in Firth Road	240 m NW of PWW10	Building wastes, lawn and garden maintenance chemicals, and gasoline and motor oil	3 (within 90 day), 1 (outside 90 day)
11	Proposed Development Areas	City of Whitehorse	11a - adjacent to Selkirk Well Field WW5, 11b - area near PWW10, PWW11 and TH1-79, 11c - Area of PWW8B and TH4-04,	11a -100 m S of WW5N,11b-450 m NE of WW9, 11c -100 m N of WW8	All contaminant source types	3 (within 90 day), 1 (outside 90 day)
12	Riverdale Reservoir	City of Whitehorse	In greenspace above Riverdale	0.6 km NNE of WW5N	All contaminant source types	Vandalism, deposits, leaks and spills to preferential pathway
Non-point Source Locations (indiv idual locations not shown on the map)						
13	Monitoring Wells and Unused Supply Wells	City of Whitehorse	In green spaces in entire study area	2 m W of WW5N	All contaminant source types	Vandalism, deposits, leaks and spills to preferential pathway
14	Wellhouses - Inside	City of Whitehorse	Buildings around historical and current source wells	Each supply well is located within a wellhouse	All contaminant source types	Vandalism, deposits, leaks and spills to preferential pathway
15	Animals and Pests	City of Whitehorse, Yukon Government, or private ownership	In green spaces in entire study area	Directly adjacent to each well building	Coliform bacteria and other microbes such as *toxoplasmosis* in cats	Deposits to soil and groundwater
16	Camping Areas	Homeless Population on City of Whitehorse Land	In green spaces in entire study area	Directly adjacent to each well building	Septage, gasoline, and household hazardous wastes	Deposits, leaks and spills to soil and groundwater
17	Cleaning and maintenance products, hot tub disinfection chemicals, metal polishes, refrigerants, rust proofers and solvents	Private ownership	Residences and commercial properties in entire study area	20 m from WW6	Acetone, benzene, bromine, calcium hypochlorite, chlorine, chlornexade, copper-based algaecides, cresols, chlorinated phenols, cyanuric acid, glycol esters, heavy metals, hexachlorophene, hydrocarbons, iodine, isopropanol, muriatic acid, peroxides, petroleum distillates, phenols, algaecides, ammonia, sodium carbonate, sodium cyanide, sodium hydroxide, sodium hypochlorite, sulphonates, trichloroethane, trichloroethylene,	Deposits, leaks and spills to soil and groundwater
18	Degreasers for driveways and garages	Private ownership	Residences and commercial properties in entire study area	20 m from WW6	Petroleum solvents, alcohols and glycol ether	Deposits, leaks and spills to soil and groundwater
19	Electric Power Easements	Yukon Electrical Company Limited	In entire study area	60 m E of WW4 and 30 m NNE of WW9	Herbicides	Runoff to groundwater
20	Junk cars and debris	Private ownership or City of Whitehorse	In entire study area	20 m from WW6	Gasoline, antifreeze, automatic transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluid and motor oils	Deposits, leaks and spills to soil and groundwater
21	Roads and Transportation Infrastructure	City of Whitehorse	Roads and transportation corridors in entire study area	A minimum of 20 m to a maximum of 140 m from all wells	Automotive wastes, sodium chloride, pesticides, herbicides, solid and liquid spills and runoff	Runoff to groundwater
22	Sewer Lines and Mains	City of Whitehorse	Throughout the study area	20 m NW of WW5N	Septage, coliform, and non-coliform bacteria, viruses, nitrates, phosphate, heavy metals, tetrachloroethylene, dichlorobenzene, methylene chloride, chloride, sulphate, and PPCPs (pharmaceuticals and personal care products)	Deposits, leaks and spills to soil and groundwater
23	Storm Drainage Mains	City of Whitehorse	Roads and transportation corridors in entire study area	400 m NNE of WW9	Hydrocarbons, metals, salts, herbicides and pesticides	Deposit and runoff to groundwater

Ta le 3 Ha ard Identification

Source No. (Map 4)	Source	ontaminants of oncern	isting Preventative Measures	Identified arriers		
				Thick Unsaturated one[1]	stimated Long Travel Time to Well[2]	Presence of rganics in Soils[3]
Point Source Locations						
1	Administration Buildings	Building wastes and lawn and garden maintenance chemicals	Regulatory requirements to prevent and respond to spills	yes	no	no
2	Antifreeze Spill	Ethylene glycol, metals, ethanol, isopropyl alcohol, and propylene glycol	Regulatory requirements to prevent and respond to spills	yes	no	no
3	Electric Power Sub-station	PCBs, oils, solvents, sludges, acid solution, chromium, nickel and cadmium	Regulatory requirements to prevent and respond to spills	no	no	yes
4	Field Maintenance	Nitrates, nutrients, chemical residues and left-over product containers	Management Practices within YG	no	no	yes
5	Gas Station	Gasoline, antifreeze, oils, and solvents	Regulatory requirements to prevent and respond to spills	no	no	no
6	Fuel Spill	Hydrocarbons and metals	Regulatory requirements to prevent and respond to spills	no	no	3 (within 90 day), 1 (outside 90 day)
7	Mechanical Workshops at Schools	Hydrocarbons and solvents	Regulatory requirements to prevent and respond to spills	no	no	3 (within 90 day), 1 (outside 90 day)
8	Old landfill/dumping area where trees, grubbing, and concrete and asphalt was placed	Hydrocarbons	Located on an upper bench allowing for vertical separation between ground surface and water table	yes	yes	3 (within 90 day), 1 (outside 90 day)
9	Snow Dump	Sodium chloride, hydrocarbons and ethylene glycol	Unknown	does not apply because salts do not adsorb to soil - defaults to no	does not apply - defaults to no	3 (within 90 day), 1 (outside 90 day)
10	Potential Drainage Pits	Building wastes, lawn and garden maintenance chemicals, and gasoline and motor oil	Regulatory requirements to prevent and respond to spills	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	3 (within 90 day), 1 (outside 90 day)
11	Proposed Development Areas	All contaminant source types	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
12	Riverdale Reservoir	All contaminant source types	Capped wells within fencing	yes	yes	Unknown - defaults to no
Non-point Source Locations (not shown on the map)						
13	Monitoring Wells and Unused Supply Wells		Capped wells, some with locks, some within fencing	no	no	no
14	Wellhouses - Inside	All contaminant source types	Locked buildings, some with fences.	no	no	no
15	Animals and Pests	Coliform bacteria and other microbes such as *toxoplasmosis* in cats	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
16	Camping Areas	Septage, gasoline, and household hazardous wastes	Regulatory requirements to prevent and respond to spills	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
17	Cleaners (household, toilette, oven)	Acetone, benzene, bromine, calcium hypochlorite, chlorine, chlornexade, copper-based algaecides, cresols, chlorinated phenols, cyanuric acid, glycol esters, heavy metals, hexachlorophene, hydrocarbons, iodine, isopropanol, muriatic acid, peroxides, petroleum distillates, phenols, algaecides, ammonia, sodium carbonate, sodium cyanide, sodium hydroxide, sodium hypochlorite, sulphonates, trichloroethane, trichloroethylene, trichlorofluoroethane and xylenes	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
18	Degreasers for driveways and garages	Petroleum solvents, alcohols and glycol ether	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
19	Electric Power Easements	Herbicides	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
20	Junk cars and debris	Gasoline, antifreeze, automatic transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluid and motor oils	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
21	Roads and Transportation Infrastructure	Automotive wastes, sodium chloride, pesticides, herbicides, solid and liquid spills and runoff	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
22	Sewer Lines and Mains	Septage, coliform, and non-coliform bacteria, viruses, nitrates, phosphate, heavy metals, tetrachloroethylene, dichlorobenzene, methylene chloride, chloride, sulphate, and PPCPs (pharmaceuticals and personal care products)	Unknown	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no
24	Storm Drainage Mains	Hydrocarbons, metals, salts, herbicides and pesticides	Regulatory requirements to prevent and respond to spills	Selkirk well field: no, South Riverdale well field: yes	no to both well fields	Unknown - defaults to no

Notes-

1- If a location has evidence of a depth to water greater than 3 m, then it is assumed that an associated barrier is present.

2- If a location has evidence of a long distance to a well, then it is assumed that an associated barrier is present.

3- If a location has evidence of organic soils present nearby, then it is assumed that an associated barrier is present.

Ta le 4 ontaminant Risk Summary

Source No. (Map 4)	Source	ontaminants of oncern	Migration Risk to Well [1]	Likelihood of ccurrence (from Ta le 6-1)	Magnitude of onse uence (from Ta le 6-2)	Risk to Drinking Water (from Ta le 6-3)
22	Sewer Lines and Mains	Septage, coliform, and non-coliform bacteria, viruses, nitrates, phosphate, heavy metals, tetrachloroethylene, dichlorobenzene, methylene chloride, chloride, sulphate, and PPCPs (pharmaceuticals and personal care products)	Moderate to High	B (likely)	3 (Moderate)	High
14	Wellhouses - Inside	All contaminant source types	High	C (possible)	3 (Moderate)	High
6	Fuel Spill	Hydrocarbons and metals	Moderate to High	C (possible)	3 (within 90 day), 1 (outside 90 day)	High (within 90 day)
5	Gas Station	Gasoline, antifreeze, oils, and solvents	Moderate to High	C (possible)	3 (Moderate)	High
7	Mechanical Workshops at Schools	Hydrocarbons and solvents	Moderate to High	C (possible)	3 (Moderate)	High
13	Monitoring Wells and Unused Supply Wells	All contaminant source types	Moderate to High	C (possible)	3 (within 90 day), 1 (outside 90 day)	High (within 90 day)
23	Storm Drainage Mains	Hydrocarbons, metals, salts, herbicides and pesticides	Moderate to High	C (possible)	2 (Minor)	Moderate
10	Potential Drainage Pits	Building wastes, lawn and garden maintenance chemicals, gasoline and motor oil	Moderate to High	C (possible)	2 (Minor)	3 (within 90 day), 1 (outside 90 day)
11	Proposed Development Areas	All contaminant source types	Moderate to High	C (possible)	2 (Minor)	3 (within 90 day), 1 (outside 90 day)
21	Roads and Transportation Infrastructure	Automotive wastes, sodium chloride, pesticides, herbicides, solid and liquid spills and runoff	Moderate to High	C (possible)	2 (Minor)	3 (within 90 day), 1 (outside 90 day)
9	Snow Dump	Sodium chloride, hydrocarbons and ethylene glycol	Moderate to High	C (possible)	1 (Insignificant)	3 (within 90 day), 1 (outside 90 day)
15	Animals and Pests	Coliform bacteria and other microbes such as *toxoplasmosis* in cats	Moderate to High	D (unlikely)	1 (Insignificant)	3 (within 90 day), 1 (outside 90 day)
16	Camping Areas	Septage, gasoline, and household hazardous wastes	Moderate to High	D (unlikely)	1 (Insignificant)	Low
17	Cleaning and maintenance products, hot tub disinfection chemicals, metal polishes, refrigerants, rust proffers and solvents	Acetone, benzene, bromine, calcium hypochlorite, chlorine, chlornexade, copper-based algaecides, cresols, chlorinated phenols, cyanuric acid, glycol esters, heavy metals, hexachlorophene, hydrocarbons, iodine, isopropanol, muriatic acid, peroxides, petroleum distillates, phenols, quaternary algaecides, quaternary ammonia, sodium carbonate, sodium cyanide, sodium hydroxide, sodium hypochlorite, sulphonates, trichloroethane, trichloroethylene, trichlorofluoroethane and xylenes	Moderate to High	D (unlikely)	1 (Insignificant)	Low
18	Degreasers for driveways and garages	Petroleum solvents, alcohols and glycol ether	Moderate to High	D (unlikely)	1 (Insignificant)	Low
19	Electric Power Easements	Herbicides	Moderate to High	D (unlikely)	1 (Insignificant)	Low
20	Junk cars and debris	Gasoline, antifreeze, automatic transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluid and motor oils	Moderate to High	C (possible)	1 (Insignificant)	Low
8	Old landfill/dumping area where trees, grubbing, and concrete and asphalt was placed	Hydrocarbons	Low	D (unlikely)	2 (Minor)	Low
1	Administration Buildings	Building wastes and lawn and garden maintenance chemicals	Low	C (possible)	1 (Insignificant)	Low
2	Antifreeze Spill (reported 2009)	Ethylene glycol, metals, ethanol, isopropyl alcohol, and propylene glycol	Low	D (unlikely)	1 (Insignificant)	Low
4	Field Maintenance	Nitrates, nutrients, chemical residues and left-over product containers	Low	C (possible)	1 (Insignificant)	Low
12	Riverdale Sub-surface Reservoir	All contaminant source types	Low	E (rare)	1 (Insignificant)	Low
3	Electric Power Sub-station	PCBs, oils, solvents, sludges, acid solution, chromium, nickel and cadmium	Low	E (rare)	1 (Insignificant)	Low

Notes-
1- If a location has one or more associated barriers from Table 3, then the risk of migration to the supply wells is deemed low. If a location does not have an associated barrier present, the risk of migration to wells is moderate.

Priority Rank	Recommendations
	High Risk - Fuel Spills. Source No. 6 (Map 4)
1	Implement the Fuel Smart Plan (Appendix C).
2	Provide emergency responders copies of the SWAPP, and arrange a meeting to discuss the signifance of the wells and different APAs.
3	Maintain the drinking water connection to surface water in Schwatka Lake as a back-up source in the event of a large spill. For spills larger than 1000 litres within the Primary APA, shut down the affected well field immediately and rely on the the alternate well field or the surface water source. When making future decisions after a spill rely on further assessment about the adequacy of the clean-up. For more detail consult the Emergency Response Plan (Appendix D).
	High Risk - Gas Station. Source No. 5 (Map 4)
4	Adopt the procedure for dealing with a fuel spill, as is outlined in the Emergency Response Plan (Appendix D).
	High Risk - Mechanical Workshops at Schools. Source No. 7 (Map 4)
5	Apply recommendations for fuel spills, and other potential contaminants of concern at mechanical workshop such as metals and volatile organic compounds. See the Emergency Response Plan (Appendix D) for more details.
6	Consider a groundwater education component to the schools.
7	Provide a copy of the report to school principles and other key school personnel and meet with them to discuss relevant issues.
	High Risk - Sewer Lines and Mains. Source No. 22 (Map 4)
8	Manage the sewer system considering its risk to the water supply source. Educate the wastewater operators about the locations of the wells, the aquifer characteristics (shallow, fast-moving, minimal treatment once in water table), and discuss relevant aspects of this report. See the Emergency Response Plan (Appendix D) for more detail.
9	For existing sanitary lines within the Primary APA, conduct assett management of sanitary line conditions, assess weak sections, and fast-track any necessary maintenance in this area. Due to uncertainty about how long it takes for large pathogens such as giardia and cryptosporidium to be effectively filtered by the aquifer materials, consider expanding the inventory outward from the Primary APA.
10	Place locations of wells, the Primary APA, and the Secondary APA on city services mapping software so that the locations of wells can be considered when planning the location of sanitary lines. Avoid placing future sanitary lines within the Primary APA or near wells.
11	Develop a regular sanitary line inspection routine for leaks and monitor sewer flows as a tool to assess sewer losses.
12	If sanitary lines and mains are necessary within the Primary APA, consider designing an advanced leak detection system in areas prone to leakage. An advanced leak detection system should include the installation of a mentoring well and monthly monitoring of conductivity, temperature, and depth to water using a datalogger.
13	Consider implementing a data management system in source water wells that includes automatic email alert messages when analytes surpass defined thresholds. The alerts should be sent to key personnel including water and sewer works manager and alternates such as Yukon Environmental Health. Operational and analytical data should be reviewed annually by a qualified professional.
14	New parking lots should have oil separators installed in storm drains.
	High Risk - Inside Wellhouses. Source No. 14 (Map 4)
15	A hydrogeologist should review the potential for adding a surface seal between the inner and outer casing of source water wells WW4, WW4N. WW5, and WW6.
16	The wellhouses may not be constructed to withstand disasters such as fires and or earthquakes. Any new buildings should be constructed to the National Building Code for post-disaster building standards. The City may consider if retrofitting of existing buildings is warranted.
17	Place a copy of report in each wellhouse, and remind City staff of risks and preventative measures in place on a yearly basis. Place a sign with the well name and emergency contact numbers on the outside of the fenced compound or wellhouse. Keep contact numbers current.
18	Consider installing remote video cameras on wellhouses that do not have them so they can be monitored remotely in the event of an emergency.
19	Maintain the flood alarm system below the lowest entry point to the well system, and design a shut-off system or drain system so that in the event of a malfunction either the well turns off automatically, or the floor drains are capable of removing the pumped volume for the amount of time it takes for an operator to turn the well off.
20	Continue to inspect the wellhouses bimonthly. Prepare a written inspection procedure with a checklist of what is to be inspected and at what interval, such as clean floors, no water, no flashing lights, no storage of chemicals or garbage inside the wellhouse.
	High Risk (Inside Primary APA) - Monitoring Wells and Unused Supply Wells. Source No. 13 (Map 4)
21	For wells that will remain in-use as monitoring wells, label each well clearly at the well site, affix keyed-alike locks, consider fencing around the well, consider adding a surface seal or a fence to the highest risk wells, and establish a bi-monthly inspection of the well heads for signs of tampering. See Table 1 for details on which wells to close and which wells to improve on.
22	Close known wells that are not to be used for future monitoring. This work must be overseen by a qualified professional with expertise in hydrogeology.
23	Adopt a well closure bylaw for Riverdale. Complete well closure reports as per requirements from YG Environmental Health.
	Moderate Risk - Drainage Pits. Source No. 10 (Map 4)
24	Improve the quality of run-off and limit stormwater volumes by encouraging the use of development standards such as Leadership in Energy and Environmental Design (LEED), and the BC Stormwater Planning Guidebook.
25	Continue to use bioswales and other on-surface natural drainage treatment of surface water run-off. Avoid drainage pits in both the Primary and Secondary APAs.
26	Require developers to provide a drainage plan of the area proposed for development.
	Moderate Risk - Proposed Development Areas. Source No. 11 (Map 4)
27	Consider requiring the installation of new monitoring wells for new developments. Any well installation should be done by a qualified professional and the slope around the well should lead away from the well head.
28	Consider requiring letters of assurance in which local government may request additional information from applicants for zoning, development permits, or temporary commercial and industrial use permits. For example, request a hydrogeological assessment for the location of proposed activities such as drilling geothermal boreholes within the Primary and Secondary APAs.
	Moderate Risk - Roads and Transportation Infrastructure. Source No. 21 (Map 4)
29	Apply Recommendation #9, 10, 11.
30	Limit salt use to 3% or less. Prohibit other road-de-icing chemicals in Riverdale. Prohibit storage of uncovered salt piles in Riverdale. Clean the streets regularly and consider installing oil/water separator in infiltration pits.
31	Consider placing signs on main roads as you are entering Riverdale that read "You are now entering a Groundwater Protection Area, please report any spills immediately to the Yukon Government." Include a phone number to provide more awareness and directions for first responder to residents and drivers. These signs are currently available from the BC Ministry of Environment.
32	Promote groundwater protection through education to city employees and the public. Information on proper handling and disposal of household and garden chemicals, and how to maintain heating oil tanks can be offered at the same time.

Priority Rank	Recommendations
Moderate Risk - Storm Drainage Mains. Source No. 23 (Map 4)	
33	Apply Recommendations for Potential Drainage Pits.
Generic Recommendations	
34	Expand on the current water quality testing program (Table 4-2). We recommend completing an assessment of all parameters that have guidelines in the GCDWQ. We have attached this list in Appendix I, which is used by Aboriginal Affairs and Northern Development Canada BC Region for new community water supply sources, and in our experience is the most comprehensive list of analyses in Canada.
35	Update the SWAPP once every five years. In particular, update the Hazard Identification and Risk Summary Tables as new wells or new contaminants are identified. In addition, numerical flow modelling is recommended to assess capture zone of all proposed wells prior to their connection to the system.
36	Provide a copy of the SWAPP to Yukon Electric because they are the owners of the substation near Wells 8 and 9. Request that they provide a list of potential contaminants of concern for the substation.
37	Meet with the fire department and discuss their fire retardant uses. Due to the toxicity of fire retardants consider alternative fire retardants for Riverdale. Also consider other solutions to minimize this risk such as vacuum-trucking run-off and hauling off-site, immediate installation of monitoring wells around the fire site, and monitoring until the risk of contamination is passed.
38	Evaluate water usage and consider whether initiating individual metering is warranted. In other communities, individual metering and a payment structure that penalizes large users is the single most effective way to reduce water consumption and thus reduce the number of wells required, minimizing the area to be protected.
39	Train a Riverdale Wells Emergency Response Team. Develop a specific communication plan for water contamination events. Prepare a schedule and process to update maps and contact information. Identify and secure funding to implement the Riverdale Well Emergency Plan.

C Appendix C - Fuel Smart Plan

SUMMIT
ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Report

City of Whitehorse

Riverdale Fuel Smart Plan

Project: 2012-2975

March 2013

1 Background Information

Fuel storage in the Riverdale neighbourhood poses a unique threat to Whitehorse's drinking water quality. The Riverdale neighbourhood is comprised primarily of single family home residential, light commercial, and institutional (elementary and secondary schools) land uses. Currently, five water wells are distributed throughout the Riverdale neighbourhood. These wells supply 100% of the drinking water needs to the residents and businesses of Whitehorse within City of Whitehorse town limits that are serviced with city water.

The Riverdale neighbourhood was developed in the 1940s when buildings used wood as a source of heat. There is no natural gas in Yukon. Overtime, the dominant heating method has switched to diesel which was stored in underground storage tanks (USTs). More recently, legislation and insurance requirements have encouraged a switch from UST fuel storage to above ground storage tanks (AST). The ASTs are primarily 1,000 L in capacity and are located adjacent to the buildings. Pipes transport the fuel from the AST to the furnaces.

If these fuels were to seep into the ground or groundwater, they would contaminate the source water and there is potential to see negative human health effects from very low hydrocarbon contaminant concentrations. Once hydrocarbons reach the groundwater table, it is very difficult to treat the groundwater, and treatment or natural attenuation can take decades, potentially resulting in the closure of one or more source water supply wells for a long period of time.

AST leaks or spills in the Riverdale area are reported to the Yukon Government approximately twice per year. The typical cause of leaks and spills are:

- Corrosion of tanks (from the inside-out for ASTs and outside in for USTs);
- Leaking fittings;
- Vandalism; and
- Overfilled tanks.

The spills are typically reported when diesel odour is noticed by the resident inside and/or outside the building. Historical remediation projects have found that the average contaminant plume is 6 m in diameter and 3 m in depth.

USTs pose a high risk for contamination due to the fact that they are buried and cannot be monitored for leaks and spills. By the time a spill from a UST is detected it is generally too late to protect the aquifer. Given the coarse nature of the subsurface material in the Riverdale neighbourhood, once contamination has occurred it will migrate to the well head relatively fast.

According to available records, the shortest distance from a diesel storage tank to a City of Whitehorse source water well ranges from 50 m to 175 m. To reduce the potential of hydrocarbon contaminated source water, sentinel wells were considered for areas between the fuel storage and the source water wells. These are employed in other jurisdiction to sample groundwater quality prior to it reaching the source water well.

This option was not deemed effective for two reasons:
1) The fuel storage is occurring in several directions relative to the source wells and therefore locating the sentinel wells would not capture all potential pathways and
2) in the Riverdale water supply wells, the shallowest depth to the water table is 3 m below ground surface.

The wells are all installed in an unconfined aquifer with sand and gravel from the surface to the well intake. These types of formations allow for fast travel times of groundwater flow between the fuel storage and the source water wells. A reasonable monitoring frequency (ie.: once every quarter) of sentinel wells would not be frequent enough to allow sufficient time for remediation planning. For these same two reasons, sampling from the supply wells for hydrocarbon parameters directly would provide just as valuable, if not better, information than sampling from sentinel wells from an early warning system point of view, as long as the lab results are compared to very low detection limits.

Instead of installation and monitoring of sentinel wells for source protection from spills and leaks from fuel storage, Summit recommends that the most practical method of protecting the Riverdale Aquifer from spills or leaks from fuel storage is through 1) Prevention of fuel spills, 2) Increasing public awareness, and 3) Sampling the water supply wells for hydrocarbon parameters. The following sections include our recommendations on how to implement these methods.

2 Recommendations

Measures that the City of Whitehorse can implement to prevent future fuel spills from threatening the water supply are primarily through the adoption of legislation and bylaws, and educating stakeholders about the risks associated with fuel storage.

To protect against drinking water well contamination related to spills and leaks from fuel storage, Summit recommends that the City of Whitehorse:

1. Replace all underground storage tanks (USTs) with covered and contained above ground storage tanks (ASTs) within the 10 year time of travel capture zone (all of Riverdale neighbourhood).
2. Install secondary containment (covered and contained) on all above ground storage greater than 100 litres within the 10 year capture zone.

3. Once all USTs have been removed and all ASTs have been covered and contained, monitor the secondary containment visually for small household type storage facilities, and introduce alarm systems for larger storage facilities.
4. Look into setting up a fuel consumption monitoring program between fuel supply companies, home and business owners, and the City of Whitehorse. For example, mandate that the oil companies release monthly consumption numbers and related addresses to the City of Whitehorse, who then plots consumption over time. If there are any anomalies to the consumption rates, the City alerts the fuel storage owner and/or inspects the storage unit for leaks/spills.
5. If a leak has occurred in the past and has already entered the aquifer, it may be too late and very difficult to stop the contamination from migrating to the wells. However, if a leak is detected right away it would be good value to clean the spill up immediately. Therefore, the City should create a spill response plan with a release of funds to enact the plan immediately when a spill occurs within the 10 year capture zone.

The above four measures would result in protecting the drinking water aquifer from contamination related to future spills and leaks that occur within the drinking water capture zone. If the City is not able to complete the above measures, the drinking water aquifer will continue to be at risk. We understand that the City has requested intermediate measures that could be implemented to reduce the risk over a longer timeframe due to budgeting restraints. Some reduction of risk (but not elimination of risk) could be accomplished with the following activities. The following recommendations are presented in two sections segregated by their priority. The Top Priority recommendations should be adopted as soon as possible (or within one year). The Normal Priority recommendations should be considered over a time frame of 1 – 3 years.

2.1 Top Priority

1. Develop methods and incentives for property owners with USTs inside the 10 year capture zone to remove and replace their USTs, piping and fittings with double-walled ASTs with interstitial alarm, piping and fittings in compliance with standards demonstrated by the Environmental Code of Practice prepared by the Canadian Council of Ministers of the Environment[1].
2. Complete an inventory and maintain a record of all fuel storage tanks, above and below ground, within the Riverdale neighbourhood. This includes storage tanks on residential properties.

[1] Canadian Council of Ministers of the Environment. 1994. Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products. Available from http://www.ccme.ca/assets/pdf/pn_1148_e.pdf

3. Once all USTs have been removed and replaced by ASTs, it is recommended that property owners be provided with incentives and methods for the implementation of the following methods of secondary containment:

a. If the AST is a double walled tank: install a leak detection alarm within the secondary containment.

b. If the AST is not double walled: install an external basin underneath the tank with 100% AST capacity. The tank and basin should be covered to prevent the accumulation of precipitation within the basin.

2.2 Normal Priority

While these recommendations are not as urgent as the top priority recommendations, their implementation is imperative to the long-term security and quality of the groundwater in the Riverdale Aquifer.

1. Monitor groundwater quality at the water supply wells quarterly for BTEX, VPH, EPH, and PAH. Plot the water chemistry and analyze the data for any increasing trends over time. Use the lowest laboratory detection possible as dilution will be high.
2. Develop a fuel consumption monitoring program between fuel supply companies, home and business owners, and the Riverdale neighbourhood. For example: Coordinate a reporting system where fuel supply companies release monthly consumption data for specific addresses. The consumption would be monitored over time, if it indicated any anomalous increases in fuel consumption then an alert would be sent to the fuel storage owner and/or someone is sent to inspect the storage tank.
3. Develop a spill response plan for the Riverdale neighbourhood with an immediate release of funds to enact if a spill were to occur within the 10 year capture zone.

3 Conclusion

Implementing these recommendations will require regular inspections and reporting and maintenance to be beneficial. As is stated above, developing an inventory of all fuel storage tanks closely followed by the removal of USTs and upgrades to ASTs is the first priority in this plan. It is important that fuel storage systems should be inspected and reported on regularly by a trained and experienced professional. In addition to these recommendations, a public education and awareness program that educates residents on the potential threats and solutions to their drinking water supply is crucial. Increased public knowledge of these issues will better allow for the voluntary adoption of these recommendations, and ultimately the quality of the drinking water supply will benefit.

D Appendix D - Riverdale Wells Emergency Response Plan

SUMMIT ENVIRONMENTAL CONSULTANTS INC.
A Member of the Associated Engineering Group of Companies

Date:	April 5, 2013	**File:**	2010-2975.000
To:	City of Whitehorse		
From:	Marta Green, P.Geol.		
Project:	Source Water Assessment and Protection Plan for Riverdale Wells, Appendix D		
Subject:	Riverdale Wells Emergency Response Plan		

MEMO

1 INTRODUCTION

1.1 PURPOSE

The Riverdale Wells Emergency Response Plan describes the roles and responsibilities, response protocols for a number of possible wellhead contamination emergency situations, and contact information for the emergency planning team members. The plan will guide the actions of the Riverdale Wells Emergency Response Planning Team; a team of community volunteers and front line service providers, in the event of an emergency related to the water supply wells located in Riverdale. The wells were used in combination with surface water from Schwatka Lake until recently. The City switched completely to the Riverdale wells system in 2010.

This plan uses sections from the Source Water Assessment and Protection Plan report to provide information and context necessary such as maps and well logs to help the Emergency Team deal with well emergencies and should thus be read in conjunction with each other.

1.2 OVERVIEW

The Riverdale Wells Emergency Response Plan and the Riverdale Wells Emergency Response Planning Team are based on the BC Ministry of Environment Well Protection Toolkit, Step 5[1]. It includes the following items:

1. Roles and responsibilities of the Well Emergency Response Team within the City's overall Emergency Plan.
2. An outline of specific response scenarios for each of the most likely and most significant threats to local water supplies.
3. An outline of specific response scenarios to unexpected threats and contamination events.
4. Identification of contacts names and responsibilities for the Well Emergency Response Team, including community members that would be part of the team. For example, providing phone numbers of where to contact neighbours that are out of town in the event of an emergency.
5. Train the Well Emergency Response Team.
6. Develop a specific communication plan for water contamination events.
7. Prepare a schedule and process to update maps and contact information.
8. Secure alternate water supplies.
9. Identify and secure funding to implement the Well Emergency Plan.

[1] BC Ministry of Environment, Lands and Parks and Ministry of Health (BC MOE). 2000. Well Protection Toolkit. Victoria: Province of British Columbia. http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/wells/well_protection/acrobat.html

Items #5, #6, #7, #8, #9 are provided as Recommendations in the main report. For the purposes of this report, Items #1, #2, #3 and #4 were completed and are presented below. Item #3 includes an outline of specific response scenarios to unexpected threats such as fire, or earthquake, or flooding due to a dam break. Summit decided that the general procedures outlined in the most likely and significant scenarios captured under Item #3 would be applicable for the unexpected events and therefore no more effort should be spent on the unexpected events.

2 ROLES AND RESPONSIBILITIES

The City of Whitehorse has an Emergency Plan and an Emergency Planning Team in place, herein referred to as the City Emergency Plan and the City Emergency Planning Team. A copy of the City Emergency Plan is attached at the end of this Appendix. This Appendix is called the Riverdale Wells Emergency Response Plan, and is to be used in conjunction with the City Emergency Plan with respect to emergencies related to the operation of the drinking water supply wells for the City of Whitehorse. The Riverdale Wells Emergency Response Plan provides details with respect to the wells themselves and provides details and steps to follow in the event of an emergency involving the drinking water supply wells.

In this appendix, contact information for the Riverdale Wells Emergency Response Planning Team is presented. The role of the Riverdale Wells Emergency Response Planning Team is to provide the first line of response in the event of a suspected or identified contamination event, and to report to the designated member of the City's Emergency Planning Team who may take over the coordination of the event depending on the severity. The Riverdale Wells Emergency Response Planning Team should be organised under the Operations Coordinator of the City of Whitehorse Emergency Organization Chart on Page 9 of the City Emergency Plan.

3 RESPONSE SCENARIOS OF MOST LIKELY AND MOST SIGNIFICANT THREATS TO WATER SUPPLY

The events included in this section are based on the Source Water Assessment and Protection Plan for Riverdale Aquifer. Events in red are high risk while Events in orange are moderate risk. Tables D-1 and D-2 should be printed and posted in each Well House for reference. They should be updated on an as needed basis along with the City Emergency Plan.

Table D-1
Response Scenario of Most Likely and Most Significant Threats to Water Supply

Most Likely Event	Triggers	Potential Contaminant	Potential Contingency Activity (depends on level of risk)	Contact (Table B-2)
Sewer Line Rupture	• Incidents of illness reported in a specific area. • Complaint of odour. • Excavation incident report.	Bacteria, viruses, nitrates, heavy metals, tetrachloroethylene, dichlorobenzene, methylene chloride, chloride, sulphate, calcium, magnesium, potassium, pharmaceuticals, personal care products and phosphates.	1. Record location and details on Riverdale Wells Emergency Response Plan Incident Report Form (attached at the end of this Appendix). 2. Locate incident on Riverdale Wells Emergency Response Plan map provided for the well and/or wells affected. 3. Identify level of risk. 4. Notify the contacts in the next column. 5. Issue Public Advisory. 6. Provide alternate drinking water source (if necessary). 7. Expand monitoring to pinpoint source. 8. Contact consultant for containment and or clean up management.	1. The City Emergency Planning Lead (City Manager) 2. Environmental Health Officer 3. Operations Manager of affected well 4. Well Protection Consulting Team
Leaks and Spill in Well Houses & Monitoring Wells	Leaks and spills within the Well Houses could contaminate source water through the wells (preferential pathway).	This could be a concern for a wide variety of contaminants.	1. Issue Public Advisory. 2. Provide alternate drinking water source. 3. Contact consultant for containment and/or clean-up management.	1. The City Emergency Planning Lead (City Manager) 2. RCMP 3. Well Operations Manager of affected well 4. Well Protection Consulting Team

Most Likely Event	Triggers	Potential Contaminant	Potential Contingency Activity (depends on level of risk)	Contact (Table B-2)
Fuel -delivery spills -ruptured lines or tanks -vandalism -improper installation	• Complaint of odour. • Delivery incident report. • Fuel level monitoring device.	Hydrocarbon chemicals	1. Determine extent of spill. 2. If necessary issue Public Advisory. 3. Provide alternate drinking water source. 4. Expand monitoring to pinpoint source. 5. Contact consultant for containment and/or clean up management. Contact business or homeowner responsible.	1. The City Emergency Planning Lead (City Manager) 2. Environmental Health Officer 3. Fire Department 4. Well Operations Manager of affected well 5. Well Protection Consulting Team Business or homeowner
Leaks and Spills from Gas Station and Mechanical Workshops	• Complaint of odour. • Delivery incident report. • Fuel level monitoring device.	• Gasoline; • Antifreeze; • Oils; and • Solvents.	1. Determine extent of spill. 2. If necessary issue Public Advisory. 3. Provide alternate drinking water source. 4. Expand monitoring to pinpoint source. 5. Contact consultant for containment and/or clean up management. 6. Contact business or homeowner responsible.	1. The City Emergency Planning Lead (City manager) 2. Environmental Health Officer 3. Well Operations Manager of affected well 4. Well Protection Consulting Team 5. Business/ or homeowner
Drainage Pits and Storm Drainage Mains	• A spill or Dumping near a Drainage Pit or Storm Drainage Main is Reported • Incidents of illness.	This could be a concern for a wide variety of contaminants.	1. If necessary issue Public Advisory. 2. Provide alternate drinking water source. 3. Expand monitoring to pinpoint source. 4. Contact consultant for containment and/or clean up management. 5. Contact business or	1. The City Emergency Planning Lead (City manager) 2. Environmental Health Officer 3. Well Operations Manager of affected well 4. Well Protection

Most Likely Event	Triggers	Potential Contaminant	Potential Contingency Activity (depends on level of risk)	Contact (Table B-2)
Fuel -delivery spills -ruptured lines or tanks -vandalism -improper installation	• Complaint of odour. • Delivery incident report. • Fuel level monitoring device.	Hydrocarbon chemicals	1. Determine extent of spill. 2. If necessary issue Public Advisory. 3. Provide alternate drinking water source. 4. Expand monitoring to pinpoint source. 5. Contact consultant for containment and/or clean up management. Contact business or homeowner responsible.	1. The City Emergency Planning Lead (City Manager) 2. Environmental Health Officer 3. Fire Department 4. Well Operations Manager of affected well 5. Well Protection Consulting Team Business or homeowner
			homeowner responsible.	Consulting Team 5. Business or homeowner
Road and Road Infrastructure	• Incidents of dead animals reported in a specific area. • Incidents of illness reported in a specific area. • Home or business owner use of prohibited substance.	Automotive wastes, sodium chloride, magnesium chloride, pesticides, herbicides, solid and liquid spills and runoff are examples of contaminants.	1. If necessary issue Public Advisory. 2. Provide alternate drinking water source. 3. Contact consultant for containment and/or clean up management. 4. Contact business or homeowner responsible.	1. The City Emergency Planning Lead (City manager) 2. Environmental Health Officer 3. Well Operations Manager of affected well 4. Well Protection Consulting Team 5. Business or homeowner
Proposed Development Areas	Incidents of illness reported in a specific area.	Hydrocarbons, metals, salts, herbicides and pesticides are examples of contaminants.	1. If necessary issue Public Advisory. 2. Provide alternate drinking water source. 3. Contact consultant for containment and/or clean up management.	1. The City Emergency Planning Lead (City manager) 2. Environmental Health Officer 3. Well Operations

Most Likely Event	Triggers	Potential Contaminant	Potential Contingency Activity (depends on level of risk)	Contact (Table B-2)
Fuel -delivery spills -ruptured lines or tanks -vandalism -improper installation	• Complaint of odour. • Delivery incident report. • Fuel level monitoring device.	Hydrocarbon chemicals	1. Determine extent of spill. 2. If necessary issue Public Advisory. 3. Provide alternate drinking water source. 4. Expand monitoring to pinpoint source. 5. Contact consultant for containment and/or clean up management. Contact business or homeowner responsible.	1. The City Emergency Planning Lead (City Manager) 2. Environmental Health Officer 3. Fire Department 4. Well Operations Manager of affected well 5. Well Protection Consulting Team Business or homeowner
			4. Contact business or homeowner responsible.	Manager of affected well 4. Well Protection Consulting Team 5. Business or homeowner responsible

4 CONTACT NAMES FOR EMERGENCY PLANNING TEAMS

In the event of an emergency, it is imperative that the necessary people and groups be notified quickly to minimize the impact and enact contingencies. The following table provides contact information for members of the City's Emergency Planning Team and the Riverdale Wells Emergency Response Planning Team, as well as other emergency support services.

Table D-2
Emergency Contact List (Last Updated March 2013)

Agency/Role	Name	Residence	Business	Cell
City of Whitehorse – Emergency Planning Team				
Lead (City Manager)	Stan Westby	-	668-8650	334-1149
	Alternate: Clive Sparks	668 4956	668-8383	334-2222
EOC Coordinator	Blaine Rapp	668 7536	668-8336	334-1119
	Alternate: Mike Stevely	456 2005	-	334-2100
	Alternate: Lana Dowie	633 3969	668-8300	-
Operations Coordinator	Brian Crist	456 2162	668-8300	334 1123
Communication Coordinator	Linda Rapp	668 7536	668-8329	334 1094
	Alternate: Doug Hnatiuk	633 2302	668-8662	334 2300
Public Information Coordinator	Robert Fendrick	393 4730	334-2122	-
	Alternate: Victor Hopkins-LeChenimant	633 5814	334-1157	-
Yukon Environmental Health				
Manager	Benton Foster	-	667-8370	-
Officer	Dianna Hayden	-	667-8321	-
Officer	Tracey Kinsella	-	667-8337	-
City of Whitehorse Operators				
	Manager, Engineering	-	668-8306	334-1194
	Operator, Water and Sewer	-	668-8350	334-1183
	Engineering Projects Officer	-	668-8304	334-1305
Community Members				
TBD				
Engineering and Hydrogeology Consulting Members				
Project Hydrogeologist	Marta Green	250-545-4234	250-545-3672	250-503-7330
Senior Hydrogeologist	Gilles Wendling	-	250-756-4538	-
Project Manager, Engineer	Steve Bartsch	-	456-2711	335-2539
Project Contaminant Scientist	Nicole Jacques	-	456-2711	334-9599
Senior Geological	Forest Pearson	-	456-4747	-

Agency/Role	Name	Residence	Business	Cell
Engineer				
Senior Mediator/Public Relations Specialist	Kathy Porter	-	250-545-3672	-
Other Emergency Support				
Fire Chief	Clive Sparks Alternate: Platoon Chief on shift	668 4956 -	668 8383 668 2462	334 2222 334 1200
RCMP	Whitehorse Detachment Commander	667 5555	667 5531	-

Attachments
City of Whitehorse Emergency Plan
Incident Report Form

CITY OF WHITEHORSE

EMERGENCY PLAN

TABLE OF CONTENTS

Appendices

IT F WHIT H RS M RG N PLAN

INTR DU TI N

G N RAL

1. During a potential or declared emergency/disaster, the responsibility for the safety of its people rests with the elected officials of a municipal government. Every municipality must be prepared to the extent of its own capabilities to meet the threat that may arise from emergencies or disasters.

AIM

2. The aim of the City of Whitehorse Emergency Plan is to provide the earliest possible coordinated response in order that the following be assured:

   a. The protection and preservation of life, health, property and the environment;

   b. Minimizing of the effects of an emergency or disaster on the City of Whitehorse and its inhabitants; and,

   c. The restoration of essential services.

Departmental ther Agency Plans

3. The City of Whitehorse Emergency Plan is a guiding document. Individual City Department and other agencies responsible for emergency planning and response will develop their own strategies in conjunction with this Emergency Plan.

DISTRI UTI N LIST

NAME

Mayor
Council
City Manager
City Manager Alternate
Fire Chief
Fire Hall # 1
Fire Hall # 2
Emergency Operations Centre Coordinator
EOC Coordinator Alternate
Operations Coordinator
Public Information Coordinator
Communications Coordinator
Public Works Manager
RCMP
YTG EMO
Emergency Social Services Director
Emergency Health Services Director
Primary EOC
Secondary EOC
Dept. of Education
Hospital
Airport
Yukon Energy
Yukon Electric
NWTel
Wildland Fire Management
Public Works & Government Services Canada
KDFN

AM NDM NTS

Number	Date	Pages	Amended By
1	13/1/99	4,11,13	B. Rapp
2	17/6/99	4,11,13	B. Rapp
3	17/8/00	4, 11,12, 13,	B. Rapp
4	20/10/00	4,12	B. Rapp
5	16/11/00	4, 11	B. Rapp
6	16/01/01	3,4,12,15,16	B. Rapp
7	3/10/01	4,11,12,13,15	B. Rapp
8	21/1/02	Whole Document	B. Rapp
9	18/2/02	4,11,13	B. Rapp
10	19/4/02	4,11,13	B. Rapp
11	18/11/03	4,11,12,13	B. Rapp
12	16/12/03	4,12	B. Rapp
13	10 June 05	3,4,9,11,12,13	B. Rapp
14	21/11/06	4,11,12	B. Rapp
15	23/05/08	4,11,12,13	B. Rapp

Section 1 - ORGANISATION AND CONTROL

The structure and responsibilities of command are as follows;

mergency Measures ommission

1) **Mayor**
   a) Chairs the Emergency Measures Commission
   b) Declares a State of Local Emergency.
   c) Acts as spokesperson for the Emergency Organisation

2) **1 ouncil Mem er**
   a) Provides direction to the City Manager on policy issues surrounding the Emergency or disaster.
   b) Decides matters of political significance or policy approval.
   c) Provides input to the Emergency Planning Team on matters related to emergency planning
   d) Approve actions requested by the Emergency Planning Team that have not been previously delegated in the plan.

M RG N PLANNING T AM

omposition

1) The implementation of the emergency plan and all emergency or disaster operations shall be directed and controlled by the Emergency Planning Team.

2) The Emergency Planning Team for the City of Whitehorse shall consist of the following positions, or others that may be appointed by the City Manager from time to time;

a) City Manager
b) City Manager Alternate
c) EOC Coordinator
d) Operations Coordinator
e) Fire Chief
f) RCMP
g) Emergency Health Services Director
h) Emergency Social Services Director
i) Public Information Coordinator
j) Communications Coordinator

3) The Emergency Planning Team will first assemble in the Primary Emergency Operations Centre located in the City Council Chambers at 2121 2nd Ave. or in the Secondary Centre which is located at Fire Hall # 2 (Takhini Fire Hall) .

Responsi ilities

4) The responsibilities of the Emergency Planning Team are as follows;

a) Advise the Emergency Measures Commission of any necessary actions that should be taken that are not covered in the Emergency Plan, to minimize the effects of an emergency or disaster.
b) Advise the Commission on expenditures of Municipal funds, which are required for the preservation of life, health, property and the environment.
c) Direct and coordinate all municipal departments, other emergency response agencies, and volunteer organizations involved.
d) Provide administrative and logistic support to any of the above noted (4c) agencies.
e) Assist the Emergency Site Manager (s) by marshalling and providing resources needed to control the emergency or disaster site.

Responsi ilities of the ity Manager

5) The responsibilities of the City Manager are as follows:

a) Act as Chair of the Emergency Planning Team
b) Appoint the Emergency Planning Committee members.
c) Assist the Emergency Planning Committee to produce an Emergency Plan for the Commission's consideration and maintain it upon adoption.
d) Coordinate all activities of those persons and/or organizations involved within the City Emergency Organization.
e) Ensure that a continuous program of training for the Emergency Organisation is carried out
f) Act as an advisor to the Emergency Measures Commission.
g) Appoint a Site Manager(s)
h) Implement the Emergency Plan when required.
i) To cooperate with the territorial Emergency Measures Organisation on all matters pertaining to planning and operations
j) To submit reports to the Emergency Measures Commission

Implementation of the mergency Plan

6) The procedure for municipal emergency services to initiate the Emergency Plan will follow as close as possible, the initiation sequence.

a) If the size, potential hazard, or seriousness of the emergency or disaster appears beyond the capability or responsibility of the first municipal emergency service at the scene, then the responding agency may implement the activation of the Emergency Plan.

b) The responsibility for the activation of the Emergency Plan will be with the City Manager. If the City Manager cannot be immediately contacted, then the following people, in order of priority, are authorized to activate the Plan;

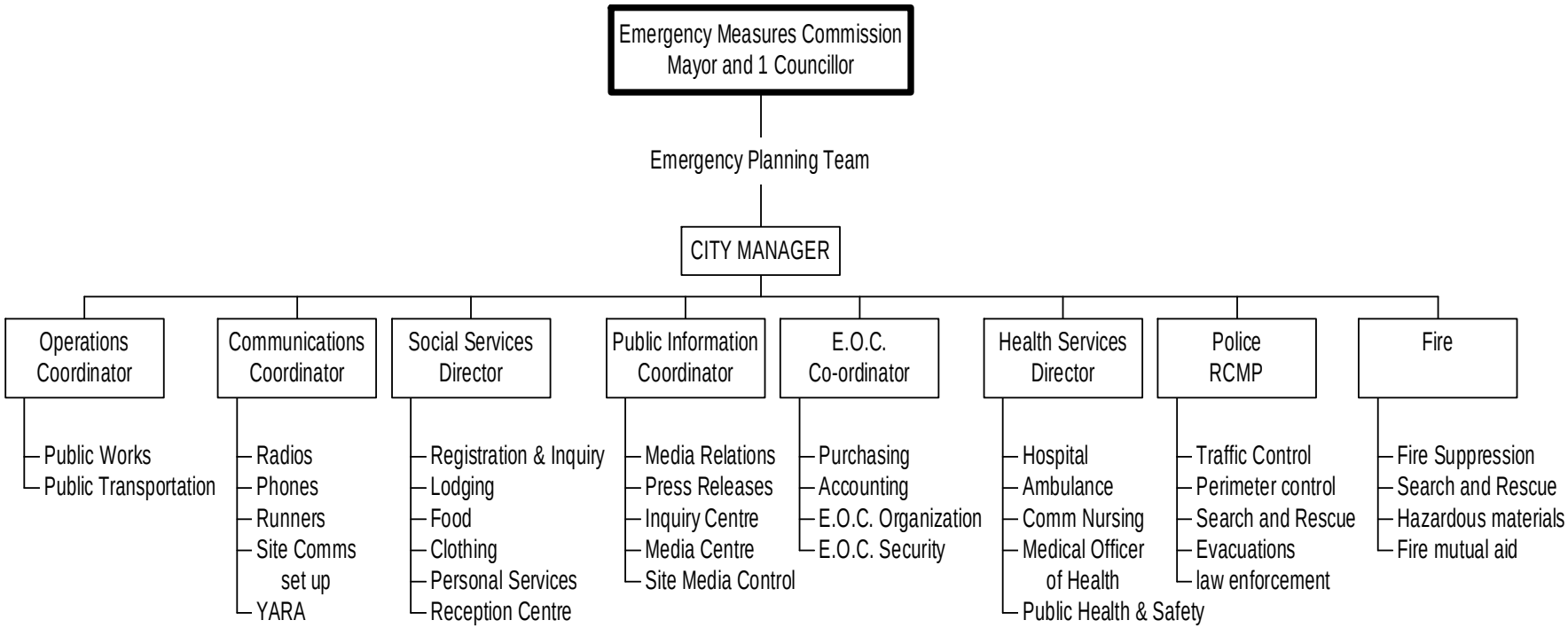
a) Emergency Operations Centre Coordinator
b) Any member of the Emergency Planning Team
c) Any member of the Emergency Measures Commission

c) Upon activation of the Emergency Plan, the City Manager will immediately appoint an agency or individual to manage the Emergency Site (s), based on the agency that is most likely to have the greatest involvement or legal responsibility in the handling of the emergency or disaster.

d) If the magnitude of the emergency or disaster requires actions beyond the normal procedures and authorities of the Municipality, the City Manager may request the Emergency Measures Commission to have a State of Local Emergency declared in accordance with our Bylaw.

e) If the implementation of all actions contained in the City of Whitehorse Emergency Plan or our Bylaw are insufficient to control the emergency or disaster, assistance may be requested from the Yukon Territorial Government by the City Manager. The request is to be made through the Yukon Territorial Emergency Measures Organization.

City of Whitehorse
Emergency Organization



S TI N II- WARNING

mergency Alerting System

1) On receipt of a warning of a real or potential emergency or disaster, the responding emergency service will contact the City Manager or if he/she is not available then any member of the Emergency planning Team.

2) On receipt of the warning from the first responding service, the City Manager, or as noted above, will activate the Municipal Emergency Organisation Alerting System in whole or in part.

3) Each member of the Emergency Planning Team is responsible for alerting the members of their departments necessary to respond to the emergency or disaster.

WARNING
SS NTIAL T L PH N NUM RS

NAM R SID N USIN SS LL

lected fficials;
Mayor Bev Buckway
Doug Graham
Dave Stockdale
Florence Roberts
Jan Stick
Jeanine Myhre
Dave Austin
ity Manager; Dennis Shewfelt
Alternate; Clive Sparks

. . . oordinator
Blaine Rapp
Alternate; Mike Stevely
Alternate; Lana Dowie

perations oordinator
Brian Crist
Alternate; Jim McLeod

Pu lic Information oordinator
Robert Fendrick
Alternate; Victor Hopkins-LeChenimant

Fire hief
Clive Sparks
Alt; Platoon Chief on shift

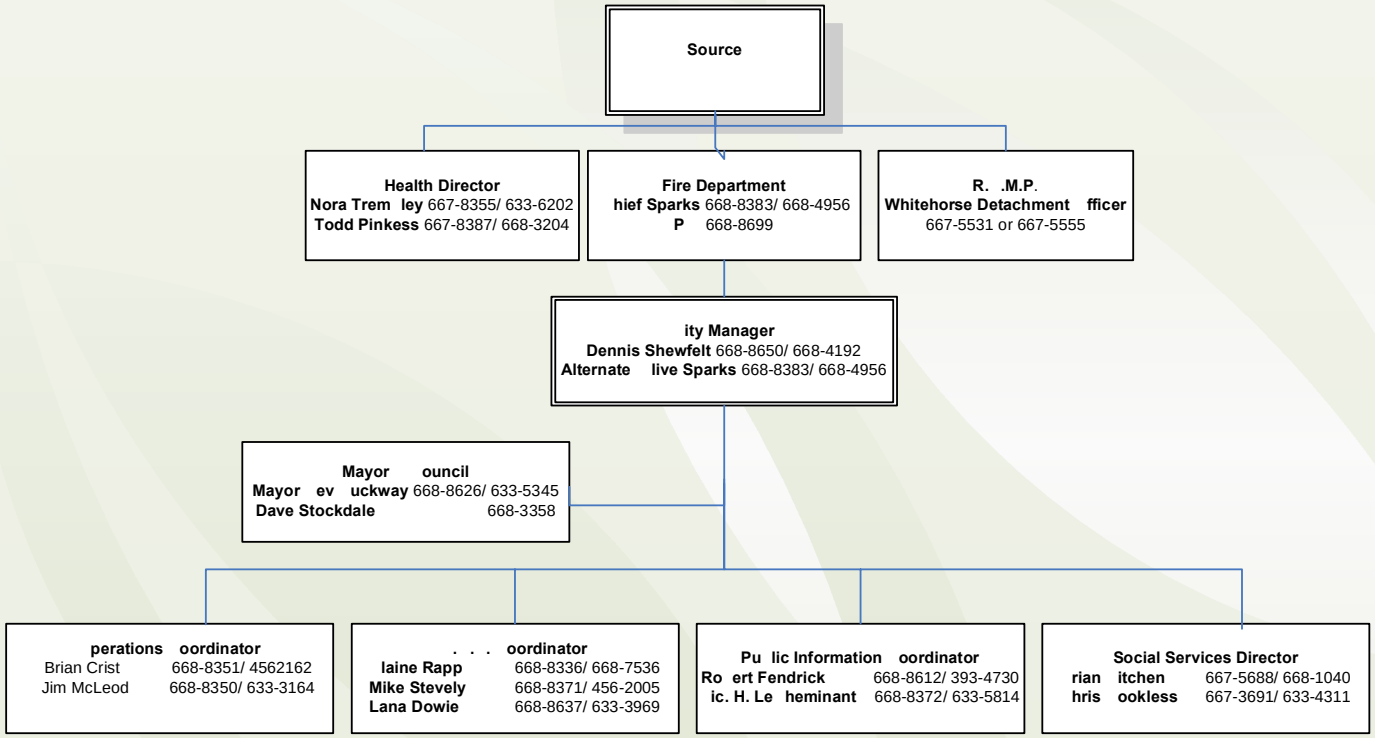
ommunications oordinator
Linda Rapp
Alt; Doug Hnatiuk

Director of Social Services
Brian Kitchen
Alt.; Chris Bookless

Director of Health
Nora Trembley
Todd Pinkess

R MP		
Whitehorse Detachment Commander	Page thru 667 5555	667-5531
TG M		667 5220
Duty Officer (24hr) same number		
Primary ity mergency perations entre		667 6830
Secondary . . .		668 2462
Hospital	(24/7) 393 8700	
ukon lectric	633 7000 (24/7)	
ukon nergy	1 800 676 2843 (24/7)	
Nwtel		867 920 3535 (24/7)
Les Chapman		393 7628
Airport Nav anada		667 8427 (24 hrs)
Dept. of ducation	668 4742 (24/7)	
Wildland Fire Management		
Duty Officer	667 3128 (24/7)	

City of Whitehorse ~ Municipal Alerting System ~ Municipal Emergency Organization



1st Telephone number is work
2nd Telephone number is home

*All numbers are 668 unless indicated

S TI N III- M RG N P RATI NS NTR S

PRIMAR M RG N P RATI NS NTR

1. The Primary Emergency Operations Centre is located at City Hall, 2121-2nd Avenue.

2. The headquarters has an Operations Centre (Council Chambers) Communications Room, Media Room, and rest area. There are limited cooking facilities (stove, fridge at Fire Hall). The building is equipped with emergency lighting and a 100-kilowatt generator is owned by the City to provide the all of the electrical requirements of City Hall/Fire Hall #1. The generator is being stored at the Municipal Services Building on 4th Ave. The hook-up for the generator is on the north side of City Hall in the parking lot.

ALT RNAT M RG N P RATI NS NTR

3. The alternate Emergency Operations Centre is located at the Takhini Fire Hall. The building has limited cooking facilities and has 3 beds. It is equipped with emergency lighting and a 50 Kilowatt generator can supply all of the electrical needs of the building. This generator is being stored at the Municipal Services Building on 4th Ave.

IT F WHIT H RS

M RG N P RATI NS NTR

PH N LIST

1) *EOC (Council Chambers)*

M RG N P RATI NS	**3 3 400**
M RG N H ALTH	**3 3 401**
M RG N S IAL S R I S	**3 3 402**
R MP	**3 3 403**
FIR	**3 3 404**
PU LI INF RMATI N	**667 6 34**
M DIR T R RDINAT R	**667 6 30**
FA LIN	**66 63**

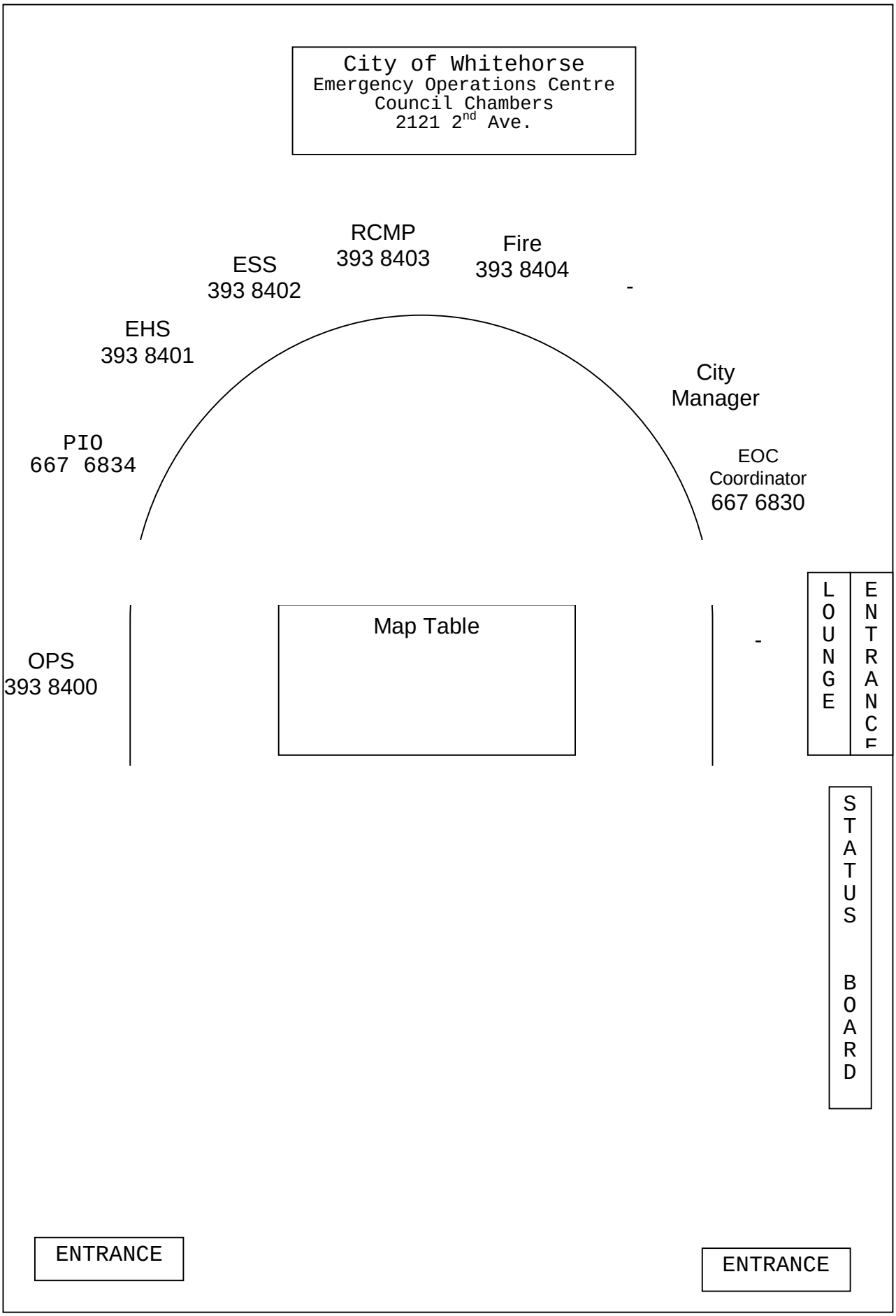
2) COMMUNICATIONS ROOM (Councillor's Boardroom)

MMS PH N LIN S	**66 63** **66 631**
R MP MMS	**66 666**

3) PIO INQUIRY LINE (H.R. area; main floor);

3 3 444

NOTE: The phone lines with an asterisk behind them are active year round. The others are on seasonal disconnect and have to be activated by calling NWTel at 668 8297 M-F 0730 – 1700 and after hours at 611.


City of Whitehorse
Emergency Operations Centre
Council Chambers
2121 2nd Ave.
RCMP
393 8403
Fire
393 8404
ESS
393 8402
EHS
393 8401
City
Manager
PIO
667 6834
EOC
Coordinator
667 6830
Map Table
OPS
393 8400
LOUNGE
ENTRANCE
STATUS BOARD
ENTRANCE
ENTRANCE

SECTION IV - PLANNING TEAM RESPONSIBILITIES

IT MANAG R
(I I M RG N RDINAT R)

R SP NSI ILITI S

1. The responsibilities of the City Manager or alternate during an emergency are to:

   (a) Activate the Emergency Planning Team call out system in whole or part,

   (b) Upon warning of an emergency, contact the Mayor and Council to consider the declaration of an emergency,

   (c) Coordinates and directs the municipal response as per the Plan,

   (d) Provide or request mutual aid when required,

   (e) Determine if municipal resources are adequate or if additional resources are needed,

   (f) Request assistance from the Yukon Territorial Government when require,

   (g) Appoint an emergency site manager (s) to manage and/or coordinate activities at the emergency site or sites,

   (h) Advise the Emergency Measures Commission of any necessary actions that should be taken which are not covered in the Emergency Plan,

   (i) MAINTAIN A LOG OF ALL ACTIONS TAKEN, and

   (j) Make a full report to Council on completion of the emergency.

. . - RDINAT R

R SP NSI ILITI S

1. The responsibilities of the Emergency Operations Centre Coordinator during an emergency are to:

   (a) Act as liaison with the Yukon Emergency Measures Organization,

   (b) Assist the City Manager in the coordination of the emergency response,

   (c) Administer the internal communications system and information flow within the Emergency Operations Centre,

   (d) Set up the Emergency Operations Centre, provide EOC staff, ensure emergency power is set up, provide EOC security, ensure all materials are available in the EOC, ensure logs and records are accurately maintained,

   (e) Coordinate purchase of any supply requirements for the EOC,

   (f) Maintain records of all purchases for the EOC,

   (g) MAINTAIN A LOG OF ALL ACTIONS TAKEN,

P RATI NS RDINAT R

R SP NSI ILITI S

1. The responsibilities of the Operations Coordinator during an emergency are to:

   (a) Provide municipal equipment and personnel as required,

   (b) Provide a list of equipment, supplies pertinent to this area, private contractors and engineering resources as required,

   (c) Disconnect any municipal service (utilities) that represent a hazard,

   (d) Provide assistance in clean-up operations and repair of damage where there is a municipal responsibility,

   (e) Advise the City Manager when sustained damages to buildings exceed safe limits,

   (f) Provide alternate supplies of water when required and liaison with the Public Health Office on matters concerning water quality and other health issues,

(g) Provide assistance in search and rescue operations,

(h) Restore essential services,

(i) Act as liaison with Yukon Electric and Yukon Energy,

(j) Coordinate public and freight transportation, and

(k) MAINTAIN A LOG OF ALL ACTIONS TAKEN.

MMUNI ATI NS RDINAT R

R SP NSI ILITI S

1. The responsibilities of the Communications Coordinator during an emergency are to:

   (a) Establish communication requirements,

   (b) Provide communications in the Emergency Operations Centre,

   (c) Provide communications to the Emergency Site,

   (d) Provide back-up communications,

   (e) Coordinate radio frequencies used,

   (f) Establish and supervise an Emergency Message Control Centre,

   (g) Liaise with Northwestel,

   (h) ENSURE THAT LOGS ARE MAINTAINED OF ALL ACTIONS TAKEN, INCLUDING ALL "IN" AND "OUT" MESSAGES.

FIR HI F
FIR AND R S U

R SP NSI ILITI S

1. The responsibilities of the Fire Chief during an emergency are to:

   (a) Coordinate fire fighting operations,

   (b) Coordinate search and rescue operations where applicable,

   (c) Activate Fire Mutual Aid if required,

   (d) Ensure that dangerous goods support agencies are contacted if necessary, and

   (e) MAINTAIN A LOG OF ALL ACTIONS TAKEN.

PU LI INF RMATI N RDINAT R

R SP NSI ILITI S

1. The responsibilities of the Public Information Coordinator during an emergency are to:

   (a) Prepare self-help information for rapid distribution,

   (b) Keep the public informed of significant developments occurring during the emergency,

   (c) Arrange for media facilities at the Emergency Operations Centre,

   (d) Provide public information support and media control at the emergency site(s),

   (e) Gather, process and disseminate information from emergency services,

   (f) Coordinate the public inquiry centre, and

   (g) MAINTAIN A LOG OF ALL ACTIONS TAKEN.

M RG N S IAL S R I S DIR T R

R SP NSI ILITI S

1. The responsibilities of the Director of Emergency Social Services during an emergency or disaster are to:

   (a) Provide the following:
   (1) emergency feeding
   (2) emergency lodging
   (3) emergency clothing
   (4) emergency registration and inquiry and
   (5) personal services.

   (b) Establish communication requirements,

   (c) Coordinate the response of volunteer organizations directly involved with Social Services,

   (d) Select the most appropriate site(s) for the coordination of Registration and Inquiry,

   (e) Alert and coordinate the response of all volunteer organizations involved in emergency social services, and

   (f) MAINTAIN A LOG OF ALL ACTIONS TAKEN.

R. .M.P.

R SP NSI ILITI S

1. The responsibilities of the R.C.M.P. during an emergency are to:

   (a) Protect lives, public and private property,

   (b) Provide search and rescue services,

   (c) Coordinate evacuations,

   (d) Seal off (inner and outer perimeters) the emergency or disaster site(s),

   (e) Control and if necessary, disperse crowds within the emergency or disaster site(s),

   (f) Control traffic to facilitate the movement of emergency vehicles,

   (g) Provide security at the site (s),

(h) Provide security and prevent looting of evacuated areas,

(i) Provide assistance to the Coroner,

(j) Provide investigative services where required, and

(k) MAINTAIN A LOG OF ALL ACTIONS TAKEN

M RG N H ALTH S R I S DIR T R

R SP NSI ILITI S

The responsibilities of the Director of Emergency Health Services are;

(a) Provide assets and resources as required for an effective emergency health service response,

(b) Arrange and provide the ambulance services,

(c) Care for the sick and injured and management of mass casualty incidents,

(d) Provide information, advice and direction on emergency sanitation procedures including but not limited to water quality, sewage and solid waste disposal, food quality, institutional hygiene, field sanitation and communicable disease control though environmental health services,

(d) Provide suitable protection for vital statistics information,

(e) Liaise with hospital personnel, and

(f) MAINTAIN A LOG OF ALL ACTIONS TAKEN.

Incident Report Form

PERSON REPORTING INCIDENT

Name:	
Work Phone:	
Cell Phone:	
Home Phone:	

LOCATION OF INCIDENT

Site Address:	
Site Contact Name:	
Work Phone:	
Cell Phone:	
Home Phone:	

	❑ Yes ❑ No
❑	Sewer Line Rupture
❑	Pump houses & Monitoring Wells
❑	Fuel
❑	-delivery spills
❑	– ruptured lines, storage tanks
❑	-vandalism
❑	-improper installation
❑	Gas Station and Mechanical Workshops
❑	Drainage Pits and Storm Drainage Mains
❑	Road and Road Infrastructure
❑	Other
Please provide details:	

CHECK ALL CONTACTS	Indicate when the following ECP steps were taken:
❑	City Emergency Planning Lead (City manager)
❑	Environmental Health Officer
❑	Well Operations Manager of affected well
❑	Well Protection Consulting Team
❑	Business or homeowner responsible
❑	RCMP
❑	Other

ACTIONS TAKEN	
❑	Issue Public Advisory
❑	Secure alternate drinking water source
❑	Contact consultant for containment and or clean up management
❑	Contact business or homeowner responsible to complete details of how the incident occurred
❑	
❑	

LEVEL OF INCIDENT		
Catastrophic	1	❑
Major	2	❑
Moderate	4	❑
Minor	6	❑
Insignificant	24	❑

E Appendix E – Meeting Minutes

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Date	February 9, 2012	**File**	2012.2975.E.01.00
Time	9:00 - 10:15	**Page**	1 of 3
Pro ect	Wellhead Protection Plan		
Su ect	Award Meeting		
lient	City of Whitehorse		
Location	MSB - Library		
Present	Wayne Tuck (City), Jim McLeod (City), Larry Shipman (City), Dave Muir (City), Marta Green (AE), Gwenda Sulem (AE)		
Distri ution	Those Present; Steven Bartsch		

R RD F M TING

These minutes are considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise these minutes will be considered to be an accurate record of the discussions.

Action y **Discussion**

Introductions:

- Jim McLeod is a senior project technologist and is the main contact for this project (until retirement). He will be retiring in April, 2012.
- Larry Shipman is a senior project technologist. He will be overseeing the project and will lead the project after Jim's retirement.
- Wayne Tuck is the City Engineer. He will oversee the project and be able to assist if needed.
- Dave Muir is the Manager of Public Works.
- Marta Green is Project Hydrogeologist.
- Steven Bartsch is the Project Manager. Steven is currently on vacation until March 12, 2012. Marta Green will be the acting Project Manager.
- Gilles Wendling from GDW Solutions is the senior reviewer. Gilles was a senior hydrologist with EBA and is familiar with Whitehorse.
- Kathy Porter is a senior facilitator with Summit Environmental/AE and she will provide some support for the public meetings.

Contact List:

- Jim McLeod: 867-668-8667 (O), 867-334-1121 (C), jim.mcleod@whitehorse.ca
- Larry Shipman: 867-668-8304 (O), 867-334-1305 (C), larry.shipman@whitehorse.ca
- Wayne Tuck: 867-668-8306 (O), 867-334-1194 (C), wayne.tuck@whitehorse.ca
- Dave Muir: 867-668-8351 (O), dave.muir@whitehorse.ca
- Marta Green: 250-545-3672 (O), 250-503-7330 (C), mg@summit-environmental.com
- Gwenda Sulem: 867-456-2711 (O), 867-335-5681 (C), sulemg@ae.ca
- Steven Bartsch: 867-456-2711 (O), 867-335-2539 (C), bartschs@ae.ca

Discussion of Project:

- YESAB indicated a need for a Well Head Protection Plan during the development of Wells 8 and 9.

Action by	Discussion
	• The Water Shed Management Plan (by AECOM) identified goals which included having a well head protection plan. • Well 8 and 9 are located in South Riverdale. The city is proposing to expand this in the future by adding new wells. AECOM has developed a plan for future wells. • The city may be developing the area near well 8. Riverdale residents have expressed concerns if this were to occur. An informal open house for residents wanting information may be useful. • Dianna Hayden is with YG – Environmental Health. AE to contact her to introduce themselves (867-667-8321; dianna.hayden@gov.yk.ca). She had expressed a need for an emergency plan in the past. • Previously, the city obtained water from the Selkirk area and the Yukon River. Issues with turbidity in the spring and cost associated with heating the water to 5°c caused the city to develop more wells. Whitehorse now gets all their water from wells located in Riverdale. • It has been recently discovered there is only one aquifer (as opposed to two aquifers with an aquitard as previously thought). • FH Collins Secondary is being reconstructed. Well 2 may be reactivated and a new well may be made. Heat from the new well would be used to heat FH Collins. Chlorination would occur after the heat is removed.
AE City	• Wells 2 and 3 is currently not used. Their capacities were small and the supply pipe froze. • AE to obtain and scan previous reports from the City.
AE	• City to give AE new mapping done summer 2011. • Carl Freisen from Underhill should have up-to-date air photos of the aquifer area. • Riverdale residents had to remove underground oil tanks. AE to contact contractors (Arctic Backhoe and Ground Tracks), as noted in proposal. Picture records may be found with the Fire Marshal. • AE intends to follow the 2010 Comprehensive Source To Tap Assessment Guidelines by the BC Ministry of Health and the 2006 Well Protection Tool Kit by BC Ministry of Environment. Source to Tap will be the primary reference material; however it also applies to surface waters in which case AE will refer to the Well Protection Tool Kit. City suggested discussing this with Dianna Hayden and to explain being used by health authorities in BC interior quite a lot. • City requests a map over the area with an overlay of the hazards in the capture zone. • AE intends to create a 5 year inventory of the contaminated sites. Gilles, the senior reviewer, will review. • The initial informal public meeting, suggested by Kathleen Porter, with her civil mediation background, will not only help with identifying contaminant sources, it will engage the residents early on.

Action y	Discussion
	Method:
	• City request we use/follow the plans of other cities that have similar characteristics to Whitehorse. Whitehorse has a small population, does not have any upstream water issues, has a semi-desert environment, has no agriculture, and does not have any major industrial areas.
	• Jim favors using remote cities in northern BC as examples, and does not think Ontario's plan should be followed (because areas in Ontario have well issues associated with its heavy industrial use).
	• There may be more drilling for oil and gas in the future. The Well Head protection plan will aid if drilling is to proceed in the area.
	• AE plans to identify contamination sources using Module 2 of Source to Tap. The historical land use can be researched through air photos, zoning maps, telephone directories (archives), and fire insurance maps (can get from Clive Sparks of the Fire Department). Ben Campbell is a Planner with the City and can be contacted for historical zoning data. Underground utilities map can be obtained from Brian, the city's CAD tech.
	• Well monitoring data can be found in previous hydrogeological investigation reports by Gartner Lee/AECOM.
	• Heather Badry (YG Contaminated Sites) can be contacted with contaminated sites Yukon. She used to be with AECOM. Ruth Hall could also be contacted. Ruth and Heather have access to different registries.
AE	• Dave Muir can be contacted for a history of sanitary main breaks.
	• Capture zones can be found in AECOM's report.
	• There are 4 schools in Riverdale: Selkirk, Vanier, Christ the King, and FH Collins. Vanier was noted to have had a spill.
	• Community meeting Proposed for the week of March 19, 2012. Meeting can be held at the school. Doug McLain with the Riverdale community Association may be able to help. Notice should be placed in both local papers and the local radio station.
	• AE to send a new proposed end date to reflect 2 week late in issuing contract, then the City will finish the contract.
	• AE proposes to hold regular conference calls with Jim and Larry every two weeks.
	• Strength, Weakness, Opportunities, and Threat meeting scheduled for tomorrow.
	• Draft report will be reviewed first by the City. Once edited according to the City's comment, the revised draft will be presented in the public meeting and council. After discussion of the response from the public and council, the final report can be finalized.
	• Meeting adjourned at 10:15

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Date	February 10, 2012	**File**	2012.2975.E.01.00
Time	9:00 – 11:00	**Page**	1 of 4
Pro ect	Wellhead Protection Plan		
Su ect	SWOT analysis		
lient	City of Whitehorse		
Location	MSB - Library		
Present	Wayne Tuck (City), Jim McLeod (City), Larry Shipman (City), Dave Albisser (City), Ben Campbell (Planning), Ralph Heynen (Sewer and Water Operations), Marta Green (AE), Gwenda Sulem (AE)		
Distri ution	Those Present; Steven Bartsch		

R RD F M TING

These minutes are considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise these minutes will be considered to be an accurate record of the discussions.

Action y **Discussion**

Introductions:

MG
- Today's goal is to go through the strengths and weaknesses, opportunities and threats of the City of Whitehorse drinking water system. The objective is to help the authors prioritize what is important to the Well head protection plan. All ideas are welcome. This is an idea generator process.

Group

Strengths
- Excellent groundwater quality
- Abundance of groundwater to meet our needs in the future
  - Do we know that for sure?
  - 20 years+ and beyond
  - Requires developing
- Non-GUDI at current pumping rate
- Operator training in place
- Expanding reservoir capacity
  - Increased storage, increased fire protection, increased frost protection
- Good leak detection
- Extensive water quality testing program (more than minimum)
- Good relationship with health authorities
- New pump station/treatment plant coming, onsite generation of chlorine
- Getting rid of bleeders/dead ends (decrease water consumption, increase water quality)
- Meter commercial
- Unidirectional Flushing
- Hydrant maintenance program
- Signage at Schwatka Lake
- Tours of treatment system
- Drinking water week: well received
- No water supply issue

Action by **Discussion**

- Water sewer rates cover O&M and Capital costs
- Water sewer reserve plus gas tax and federal funds are available
- No Bacterialogical issues
- Low contamination risk – not very many sources of contamination/pure water source
- Less land use issues
- No farming, industrial, irrigation uses nearby
- New infrastructure has good procedure: before adding to system, flush with chlorine
- $60/month water/sewer, no complaints from customers regarding rates
- Can achieve proper contact time for disinfection

Weaknesses

Group
- Lack of redundancy/reserve/contingency and, in the event of failure, lack of options
- Complicated system, juggling wells back/forth
- 1 ½ years away from improvements
- Aging infrastructure
- Port au Creek leaks
- Leaks in new subdivision
- Dead ends/too much bleeding/decrease in water quality
- Annual report not published on-line but meets legal reporting requirements
- Water quality information is not published, no automatic alert system, tables done by hand
- Electronic file system
- Infiltration testing is done, but no exfiltration testing completed
- Lack of zoning in aquifer protection area (herbicides, pesticides)
- Lack of enforcement/enforcers (ie. spills)
- Spill into sewer - YPG fined but doesn't make public so City might not know about them
- Water main blew near home – setbacks for water main distance to homes required?
- Old infrastructure but new development – chance for leaks higher with the new development
- Starting to build high density on historically small property infrastructure design – not a lot of room available to make upgrades
- Lack of flood monitoring & real time well levels (only know if water levels have drawn down to a too low level for operations if the wells start pumping dry)
- No written maintenance program for water system
- Corporate management plan, but no water specific plan
- Heat trace lines are 30 years old and starting to fail - line will freeze which leads to bleeding costs
- Budget - restricts what we can do
- Don't have residential meters - water $1.30/$m^3$ for commercial lots
- Metering not tracked system wide
- Water quantity supposed to be done by contractor (for top of Two Mile Hill country residential use and bulk meter sales - out of area)
- Don't know population served, conflicting data

Action y Discussion

- Backflow preventers - plumbing professionals have their professional guidelines but there is no city wide BF prevention program. Plumbing codes are not enough to prevent BF in our experience.
- Lack of Best Management Practices for well houses – each well house different depending on what engineering firm designed during that capital project.
- Not keeping track of deficiencies/improvements done on wells.
- No continuous updating of improvements to as-builts when work is done.
- No central logging of maintenance completed on wells
- No as-builts on private developments so cannot respond

Group Opportunities:

- Working on the Well Protection Plan now. This will help get an expert's look at what we need, also brings in some experience dealing with this issue in other jurisdictions. Can reference for future capital work.
- Water sewer study every 5-6 years
- City wide water metering on its way
- This report might recommend that we should bring an engineer to do infrastructure assessment. The engineer should have 30 years' experience and be able to say quickly " here are your weaknesses and here are your recommendations to come up with best practices"
- Can come up with Best Management Practices for well supply
  - Have support by city
  - Fully endorsed by council
  - Wells are important to mayor
- Working on our Zoning bylaw - right now is a good opportunity to make changes
- Good time for recommendations as working on new development in Riverdale
- Maybe time to develop water quality database (no more excel spreadsheet) if the report recommends it
- Working on a new website right now, so can incorporate changes now
- OCP review committee happening now with planning department involved
  - Create one document - Environment, Health, Yukon Electric, NW Tel
  - When submissions come in, joint review
- Water/sewer/storm bylaw is currently being updated so now is a good time to influence that

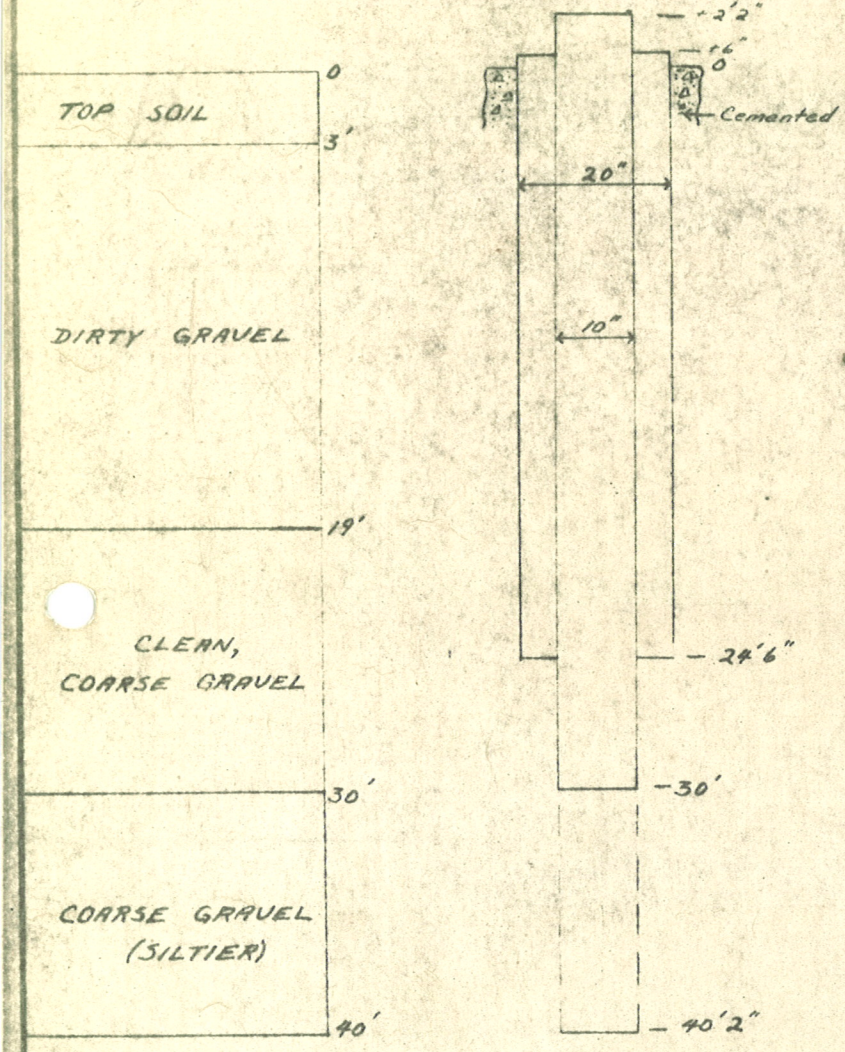
Group **Threats**

- Perception - people still think water comes from river, and that supply is endless
- Lack of personnel to do regular maintenance: need to maintain distribution system, pH, wells
- Lack of certified experienced people
- Natural catastrophes such as dam breaks, flood in Riverdale flood, forest fire - supply bombers w/well water
- Chlorine facility (Health & Safety) but now moving towards on-site generation so less of a risk
- Gas & fuel facilities in capture zones

Action y Discussion

- Unregulated increased density
- Lack of awareness by public may impact their support for our well protection plan
  - For example, they have a jug of old antifreeze – they might think “who cares if I dump it?”
- Buried fuel tanks - some insurance companies don’t require them to be removed
  - Now all new fuel tanks are required to be above ground - secondary containment is required for commercial/institutional including schools but not required for residential.
- Lack of standards for installation of ASTs
- Poor O + M on ASTS
- Monitoring wells are not abandoned properly
- Port au Creek when switched to septic tanks to community might not have properly closed/removed tanks or fields (Riverdale community was never on septic)
- Sewer system/breaks
  - Lewes Blvd especially
  - Don’t have enough people to check it - keep cutting budgets
- Information from operator not being passed to engineers because too busy to sit at computer. Phone works but messages get lost.
- Aging operators/designers/engineers/project managers
- Lack of succession planning

F Appendix F – Well Logs



Well Material

Outer Casing 20", 25', Welded

Inner Casing 10", 32'2", T & C.

Screen 10", 10'2", Stainless Steel

Plug Steel Plate

Gravel

Pump

No.	Setting BP-MB
No. Stages	Length Bowl
Bowl	Size & Lgth. Suction
Head	Size Column

Materials or setting details other than standard:

Motor

Make	Phase
Shaft	Cycles
H. P.	Volts
R. P. M.	Amps.
Type	Base
Frame	Serial

Special Equipment

Well

B. P. referred to original Ground Level

Started Nov. 8/55 Clear Depth

Preliminary Test Nov. 26/55 Length Air Line

Final Test Static Level

Guarantee Pumping Level

Pressure Capacity

Driller: Frank G. Hopper 3/10/56

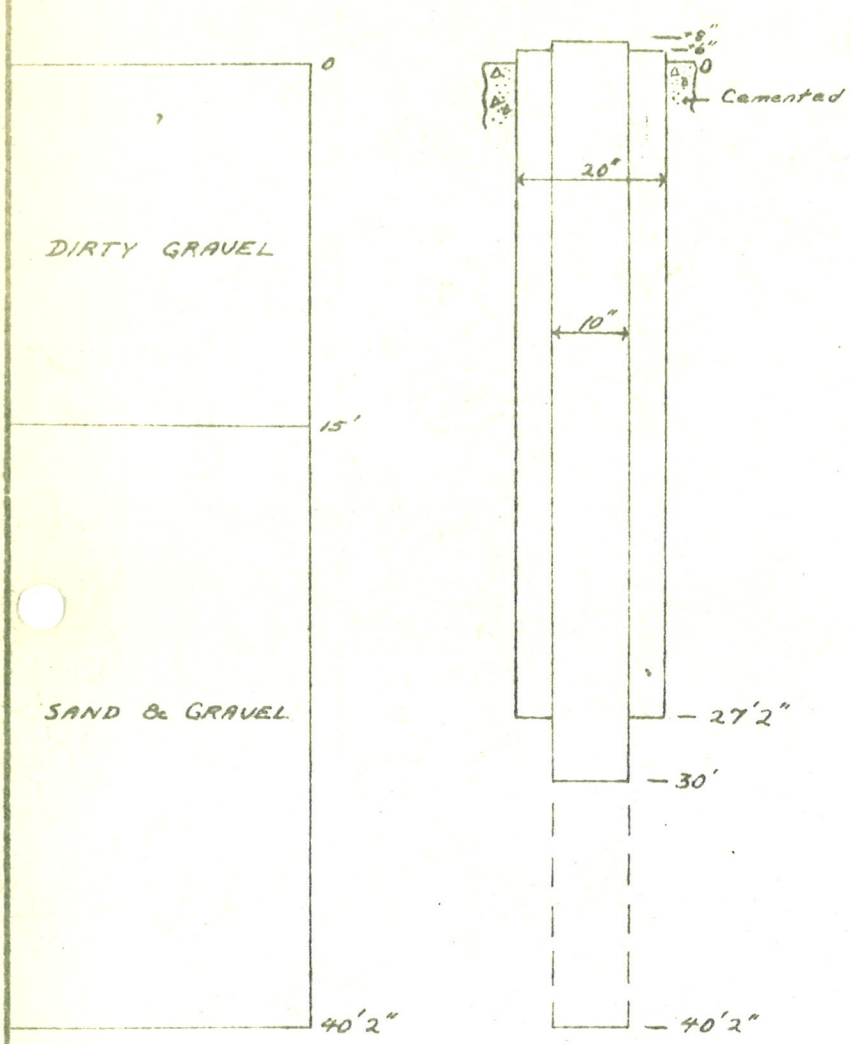
Installer:

INTERNATIONAL WATER SUPPLY LTD.
LONDON, CANADA
WATER SUPPLY CONTRACTORS

WHITEHORSE, YUKON

DRAWN BY Anne Charles APPROVED BY

WELL NO. 1



Well Material

Outer Casing 20", 27'8", Welded

Inner Casing 10", 30'8", T. & C.

Screen 10", 10'2", Stainless Steel

Plug Steel Plate

Gravel

Pump

No.	Setting BP-MB
No. Stages	Length Bowl
Bowl	Size & Lgth. Suction
Head	Size Column

Materials or setting details other than standard:

Motor

Make	Phase
Shaft	Cycles
H. P.	Volts
R. P. M.	Amps.
Type	Base
Frame	Serial

Special Equipment

Well

B. P. referred to original Ground Level	
Started Nov. 18/55	Clear Depth
Preliminary Test Dec. 2/55	Length Air Line
Final Test	Static Level
Guarantee	Pumping Level
Pressure	Capacity

Driller: Frank G. Hopper 3/10/56

Installer:

INTERNATIONAL WATER SUPPLY LTD.
LONDON, CANADA
WATER SUPPLY CONTRACTORS

WHITEHORSE, YUKON

DRAWN BY Anne Charles APPROVED BY

WELL NO. 2

Well Material

Outer Casing 20", 33' 8", Welded

Inner Casing 10", 38' 2", T. & C.

Screen 10", 10' 2", Stainless Steel

Plug Cement, 1'

Gravel

Pump

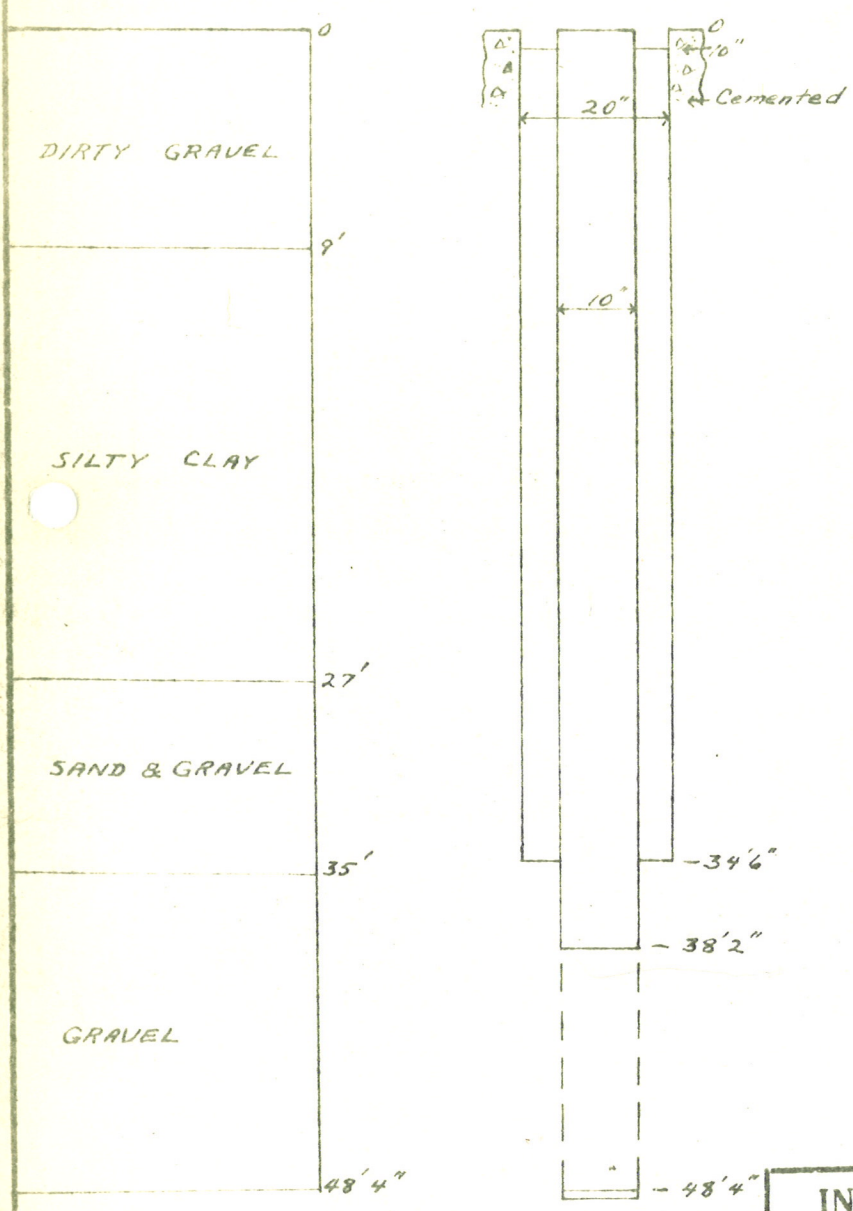
No.	Setting BP-MB
No. Stages	Length Bowl
Bowl	Size & Lgth. Suction
Head	Size Column

Materials or setting details other than standard:

Motor

Make	Phase
Shaft	Cycles
H. P.	Volts
R. P. M.	Amps.
Type	Base
Frame	Serial

Special Equipment



Well

B. P. referred to original Ground Level

Started Jan. 6/56 Clear Depth

Preliminary Test Mar. 2,3/56 Length Air Line

Final Test Static Level

Guarantee Pumping Level

Pressure Capacity

Driller: Frank G. Hopper 3/10/56

Installer:

INTERNATIONAL WATER SUPPLY LTD.

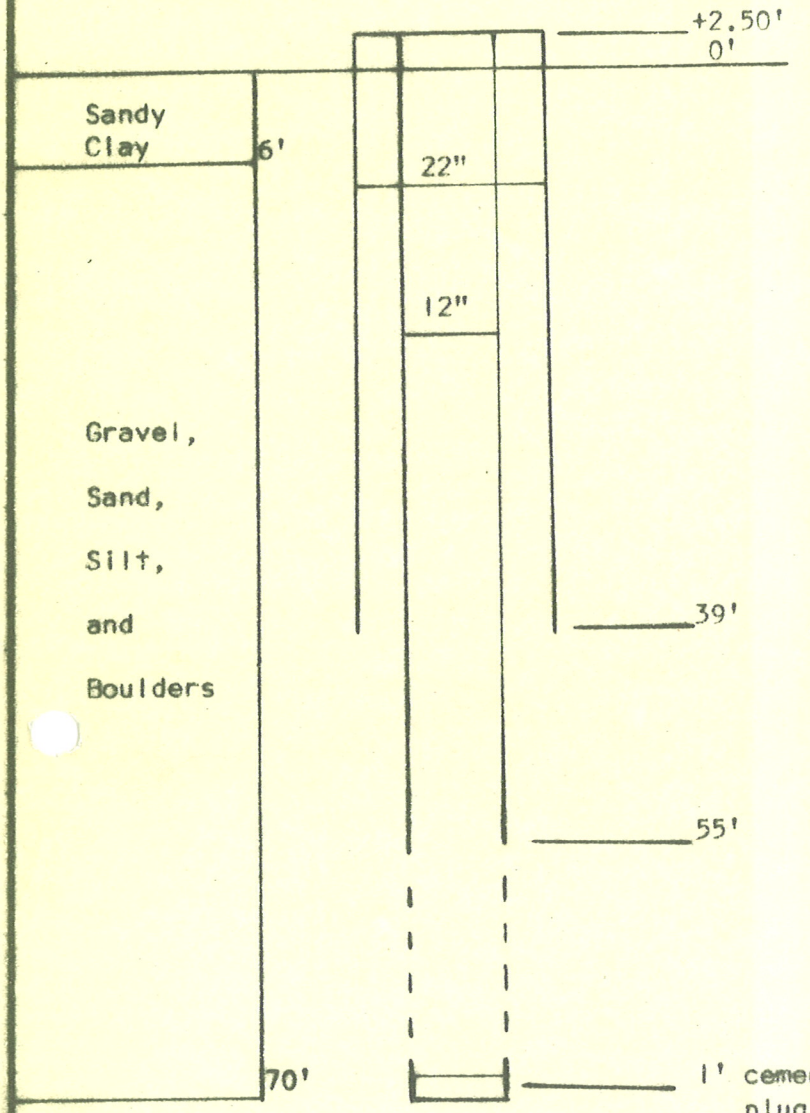
LONDON, CANADA

WATER SUPPLY CONTRACTORS

WHITEHORSE, YUKON

DRAWN BY Anne Charles APPROVED BY

WELL NO. 3



Well Material

Outer Casing 41.50' of 22" welded

Inner Casing 57.50' of 12" welded
Screen 10' of 12" SS Layne #7 slot
5' of 12" SS Layne #6 slot
Plug 1' Cement plug
Gravel 183 cu. ft.

Pump

No. **Setting** BP-MB
No. Stages **Length** Bowl
Bowl **Size & Lgth. Suction**
Head **Size Column**

Materials or setting details other than standard:
Impellers: Trim

Motor

Make **Phase**
H. P. **Cycles**
R. P. M. **Volts**
Type **Amps.**
Frame **Serial**
Bearing Nos.

Special Equipment

Well No. 4

B. P. referred to original ground level
Clear depth below B. P.
Started Nov.25/71 **Final Test**
Preliminary Test Mar.3/72 **Static Level** 5.60'
Final Test **Pumping Level** 16.34' after 24 hrs.
Guarantee **I G P M Capacity** 600 **I G P M**
Contract Pressure # **Pressure Pump** #
Length Air Line **Main** #

INTERNATIONAL WATER SUPPLY LTD.

MONTREAL OAKVILLE — LONDON, CANADA — WATER SUPPLY CONTRACTORS — SASKATOON VANCOUVER

CITY OF WHITEHORSE
Yukon Territory

DRILLED BY John Jasnoch **DRAWN BY** slh
INSTALLED BY **APPROVED BY**

PROJECT: WW4N Construction and Testing	CLIENT: City of Whitehorse	TESTHOLE NO: **WW4N**
LOCATION: Whitehorse, YT 497925 N , 6730109 E		PROJECT NO.: 60187923
CONTRACTOR: Ensign Coring & Drilling Inc.	METHOD: Air Rotary, Schramm T450W, 1997	ELEVATION (m): 637.36

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	WELL INSTALLATION	COMMENTS	ELEVATION (m)
0		SAND Light brown, subangular to subrounded, fine-grained, some medium to coarse grains, subangular to subrounded, trace silt and organics.		Outer casing still in the ground Extend to a depth of 6.09m bgs Scheduled to be removed during the summer 2011	637
1					
2		SAND and GRAVEL Light grey, subangular to subrounded, medium to coarse sand with a trace of silt.			636
3		-Abundant boulders and cobbles. -Clasts supported			635
4					634
5					633
6				Depth to groundwater: 6.18 m below ground surface (6/12/2010)	632
7					631
8					630
9					629
10				Significant water encountered, discharging from the cyclone.	628
11		GRAVEL, Sandy Dark grey, subangular, medium to coarse sand, fine gravel with a trace of silt.			627
12					626
13					625
14					624
15		Lenses of silt, subrounded, gravel size.			623
16					622
17					621
18				Rig shaking likely due to grinding of large boulders. Water discharge at approximately 15 USGPM.	620
19					619
20				Water discharge from cyclone at approximately 25-30 USGPM.	618
21				Water discharge from cyclone at approximately 60 USGPM.	617
22					616
23		SAND, Gravelly Dark grey, angular to subangular, coarse sand, fine to coarse gravel.			615
24		GRAVEL, Sandy Dark grey to olive grey, subangular, medium to coarse sand, fine to coarse gravel with a trace of silt.		Water discharge from cyclone at approximately 75 USGPM.	614
25					613

ENVIRONMENTAL (VAPOUR ONLY) WW4N.GPJ UMA.GDT 11/24/11

AECOM

LOGGED BY: Brett Hannigan	COMPLETION DEPTH: 36.73 m
REVIEWED BY: Forest Pearson	COMPLETION DATE: 12/1/10
PROJECT ENGINEER: Marc Lavigne	Page 1 of 2

PROJECT: WW4N Construction and Testing	CLIENT: City of Whitehorse	TESTHOLE NO: **WW4N**
LOCATION: Whitehorse, YT 497925 N , 6730109 E		PROJECT NO.: 60187923
CONTRACTOR: Ensign Coring & Drilling Inc.	METHOD: Air Rotary, Schramm T450W, 1997	ELEVATION (m): 637.36

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

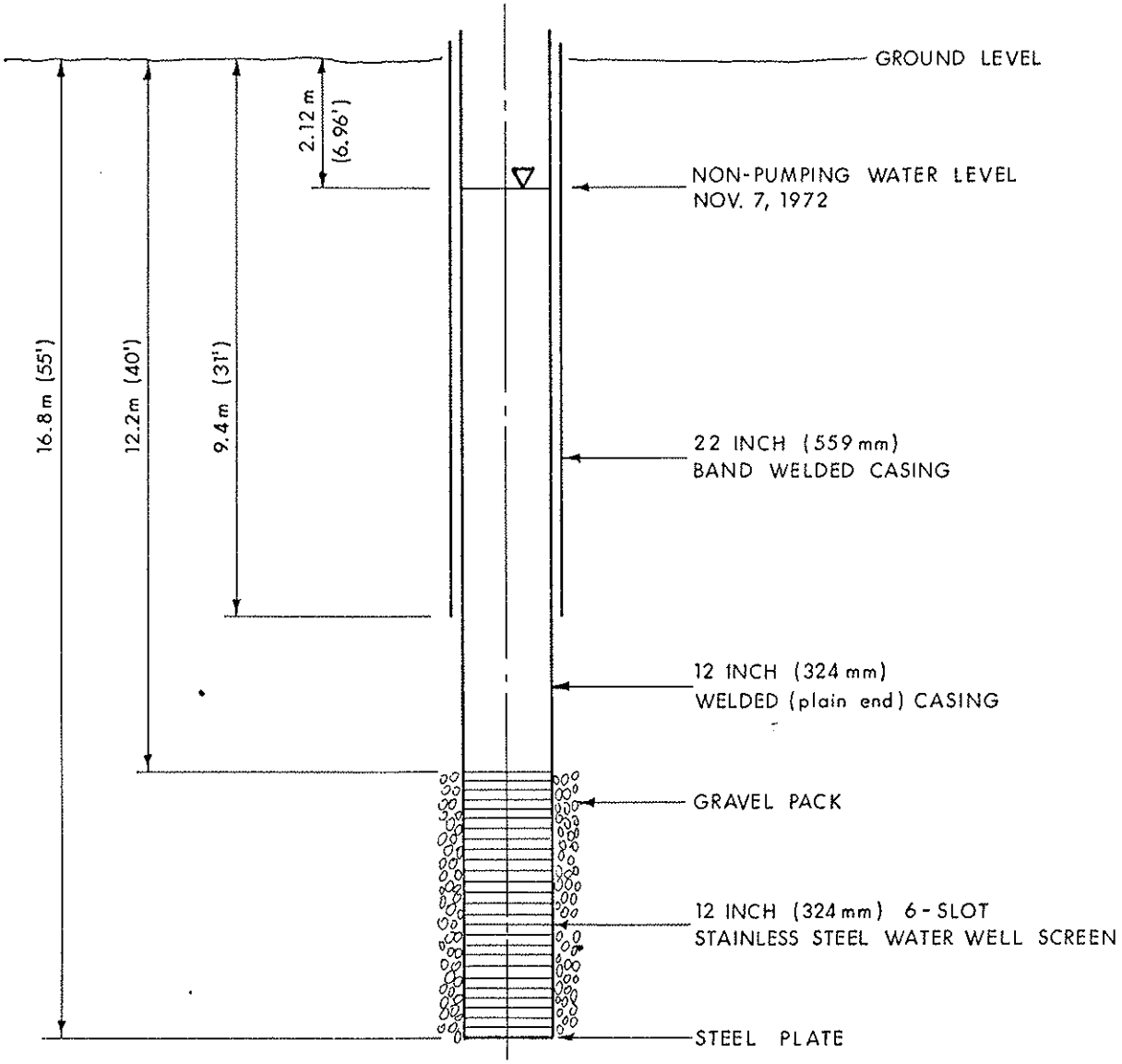
DEPTH (m)	SOIL DESCRIPTION	WELL INSTALLATION	COMMENTS	ELEVATION (m)
25			Water discharge from cyclone at approximately 100 USGPM.	612
26				611
27	SAND, Gravelly Dark grey to olive grey, subangular, medium to coarse sand, fine to medium gravel with a trace of silt.			610
28				609
29				608
30	GRAVEL, Sandy Dark grey to olive grey, subangular to subrounded, medium to coarse sand, fine to medium gravel.		Water discharge from cyclone at approximately 95 USGPM.	607
31	SAND, Gravelly Dark grey to olive grey, subangular to subrounded, medium to coarse sand, fine to medium grave with a trace of silt.			606
32	GRAVEL, Sandy Dark grey to greenish grey, subangular to subrounded, fine to coarse sand, fine to medium gravel with a trace of silt.			605
33				604
34				603
35			Gravel clasts of Miles Canyon Basalt.	602
36				601
37	Drilling terminated at 37.03 m. Refusal at till.		Well Casing Information: ID: 0.381m (15 in) OD: 0.406m (16 in) Screen Information: Depth: 36.65m below ground surface ID: 0.338m (13.3 in) OD: 0.357m (14 in) Opening: 200-Slot (5.08mm) V-wire screen Screen Length: 9.57m Total Screen Assembly Length: 10.44m - includes 0.87m of riser pipe Screen exposed to the formation (Selkirk Aquifer)	600
38				599
39				598
40				597
41				596
42				595
43				594
44				593
45				592
46				591
47				590
48				589
49				588
50				

AECOM

LOGGED BY: Brett Hannigan	COMPLETION DEPTH: 36.73 m
REVIEWED BY: Forest Pearson	COMPLETION DATE: 12/1/10
PROJECT ENGINEER: Marc Lavigne	Page 2 of 2

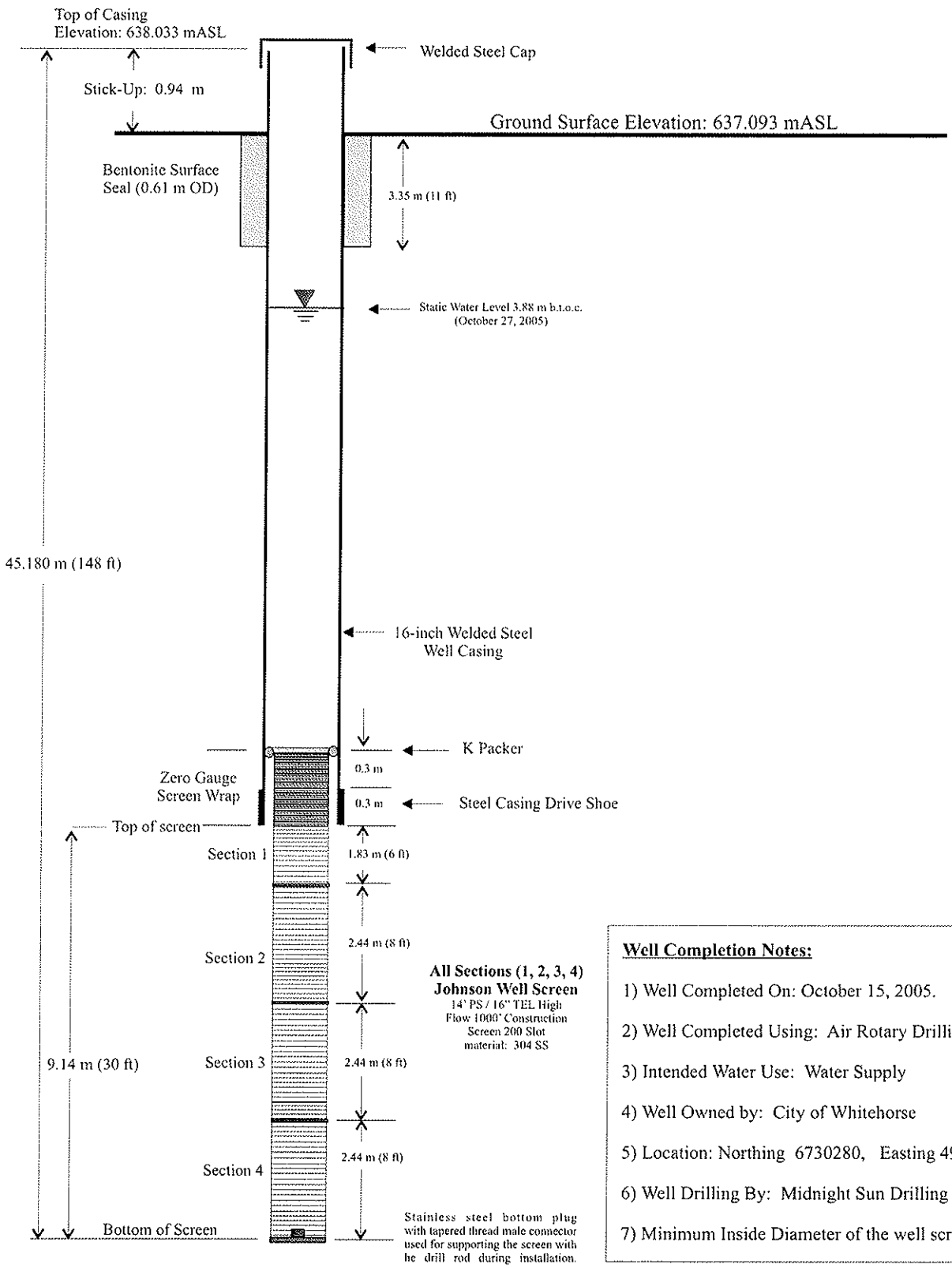
ENVIRONMENTAL (VAPOUR ONLY) WW4N.GPJ UMA.GDT 11/24/11

Driller: JOHN JASNOCH (INTERNATIONAL WATER SUPPLY LTD.)
Date: NOVEMBER, 1972
Prelim. Test: ———
Pump: 40 H.P., 3 STAGE SUBMERSIBLE PUMP ON 6 INCH (152 mm) DROP PIPE. INTAKE AT 10.7m
Elevation: 2093.98 ft. A.M.S.L.



Stanley
STANLEY ASSOCIATES ENGINEERING LTD.
1904-1-1-1

City of Whitehorse
WATER WELL No. 5



Well Completion Notes:

1) Well Completed On: October 15, 2005.

2) Well Completed Using: Air Rotary Drilling

3) Intended Water Use: Water Supply

4) Well Owned by: City of Whitehorse

5) Location: Northing 6730280, Easting 498022

6) Well Drilling By: Midnight Sun Drilling Company

7) Minimum Inside Diameter of the well screen is 342 mm.

Not to Scale

Gartner Lee

City of Whitehorse Well 5N Completion Diagram

City of Whitehorse

Figure 2

Project 50-913

CITY OF WHITEHORSE
WARM WATER WELL NO. 6

COMPLETION DIAGRAM

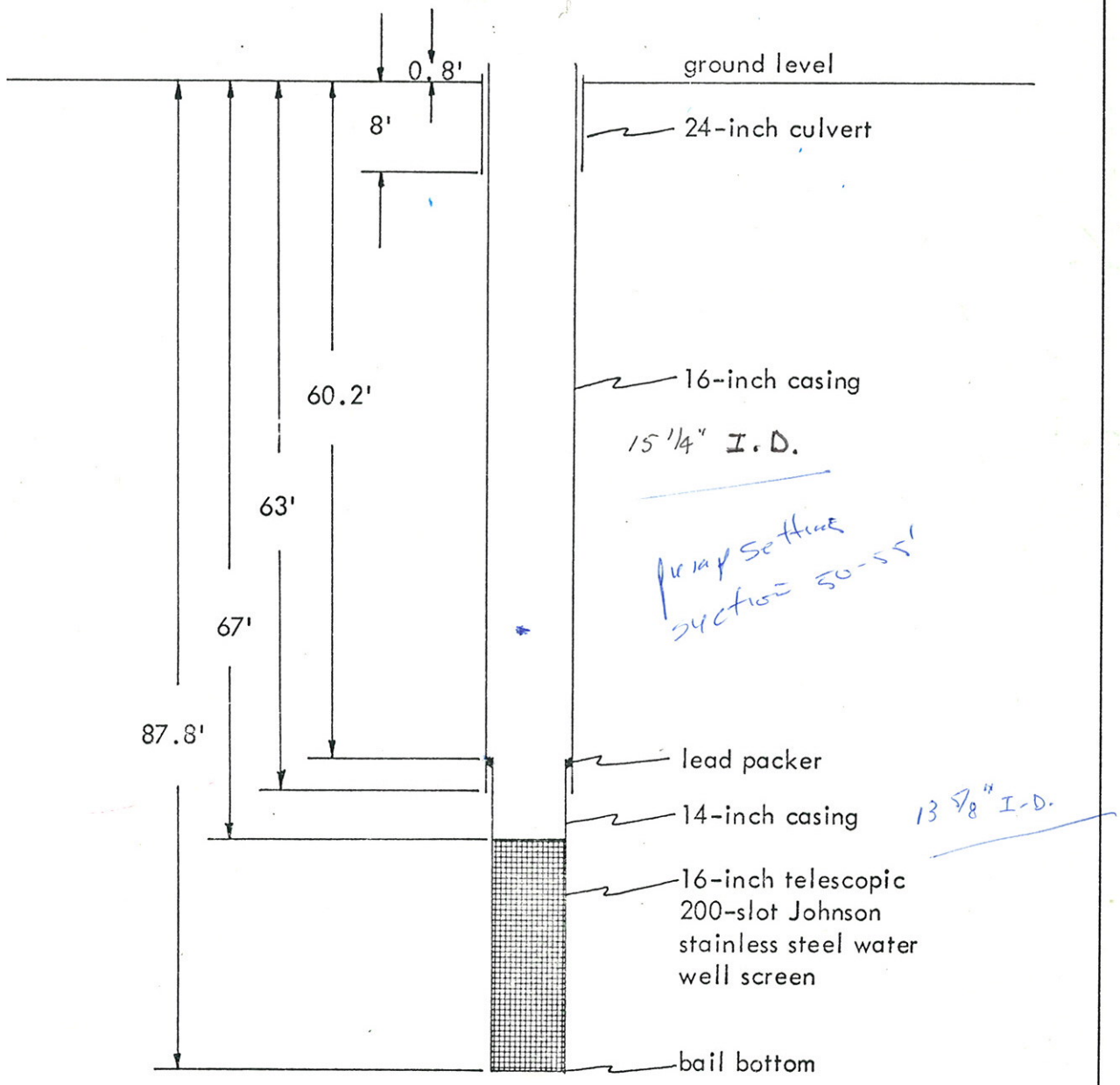
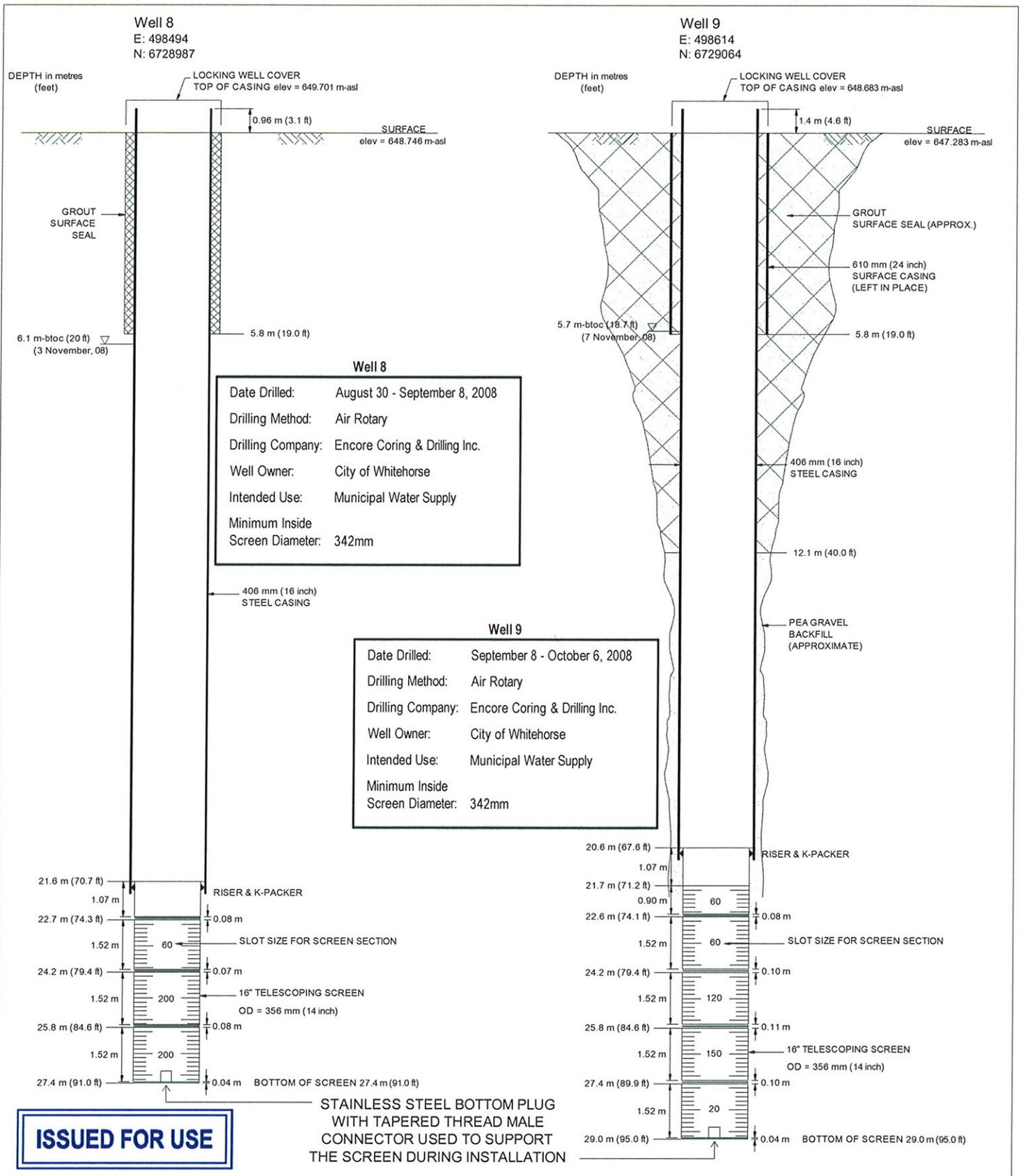


Figure 2. Completion diagram for
Warm Water Well No. 6.

hydrogeological consultants ltd.



ISSUED FOR USE

NOTES

1) Well screen manufactured by Johnson
2) See TH1-08 (Well 9) and TH2-08a, TH2-08b (Well 8) in Appendix A for well lithology and grain size analysis depths
3) Grain size analysis results included in Appendix B

CLIENT

City of Whitehorse

EBA Engineering Consultants Ltd.

2008 Groundwater Exploration and Development Program, Whitehorse, Yukon

WELL 8 AND 9 CONSTRUCTION DETAILS

PROJECT NO.	DWN	CKD	REV
W23101152.003	LM	KSJ	1
OFFICE: EBA-KELOWNA	DATE: January 8, 2009		

Figure 4

G Appendix G - Photographs

Figure 1 Photo of Well 4 Wellhouse.

Figure 2 Photo of the inside of Well 4 Wellhouse. Shows a typical view of the older wellhouses.

Figure 3 Photo of Well 5N Wellhouse.

Figure 4 Photo of the inside of Well 5N Wellhouse. Notice the clean floors and no chemicals stored in the area.

Figure 5 Photo of Well 6 Wellhouse. Gad oosdaa student residence is shown in the ackground (Well 6 is the closest well to institutions developed land).

Figure 6 Photo of Well Wellhouse. Notice the slight downhill slope away from the wellhouse which provides good drainage away from the uilding in the event of a flood in the wellhouse. Well Wellhouse is similar as it was completed at the same time.

Figure 7 Photo of Well from the rear. The completion of Well is similar. Notice the fenced compound and clean area around the wellhouse (no grass potential homes for critters).

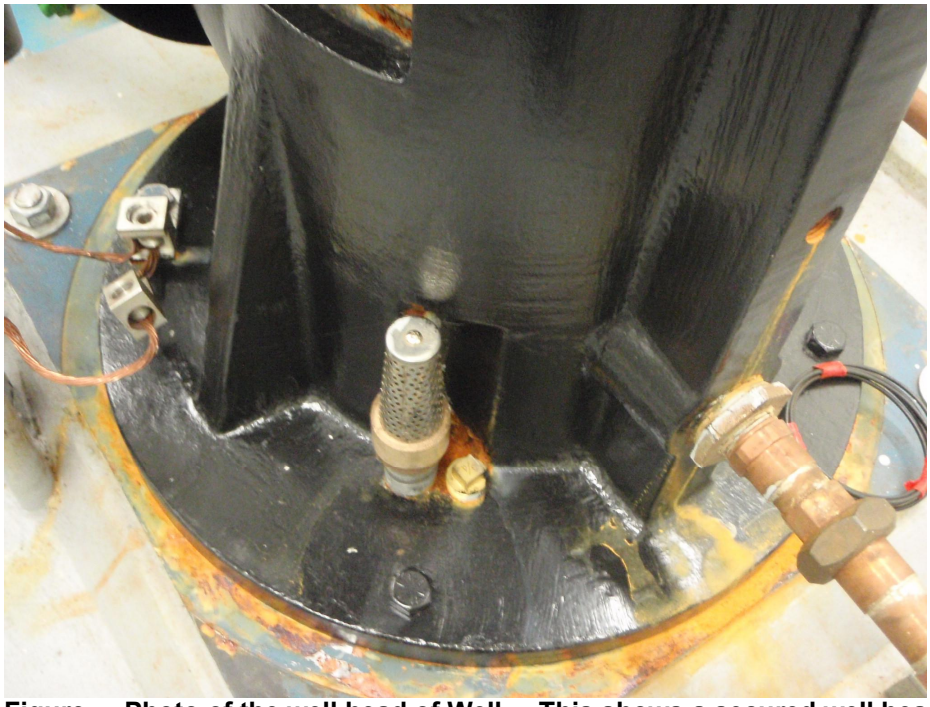


Figure Photo of the well head of Well . This shows a secured well head sealed from potential flooding with a check valve on the air vent and a olted nut for manual water level access.

Figure Photo showing the air vent on Well . Note no ackflow preventer. In the event of a flood the water would e sucked ack into the well. We understand the ity of Whitehorse has since cut off the length of the air vent to near the top and installed a flood alarm a out 0.3m a ove floor level.

Figure 10 Photo showing poorly sealed electrical and ca le conduits in Wellhouse . If a flood occurred in the wellhouse water could enter the a uifer after entering conduits.

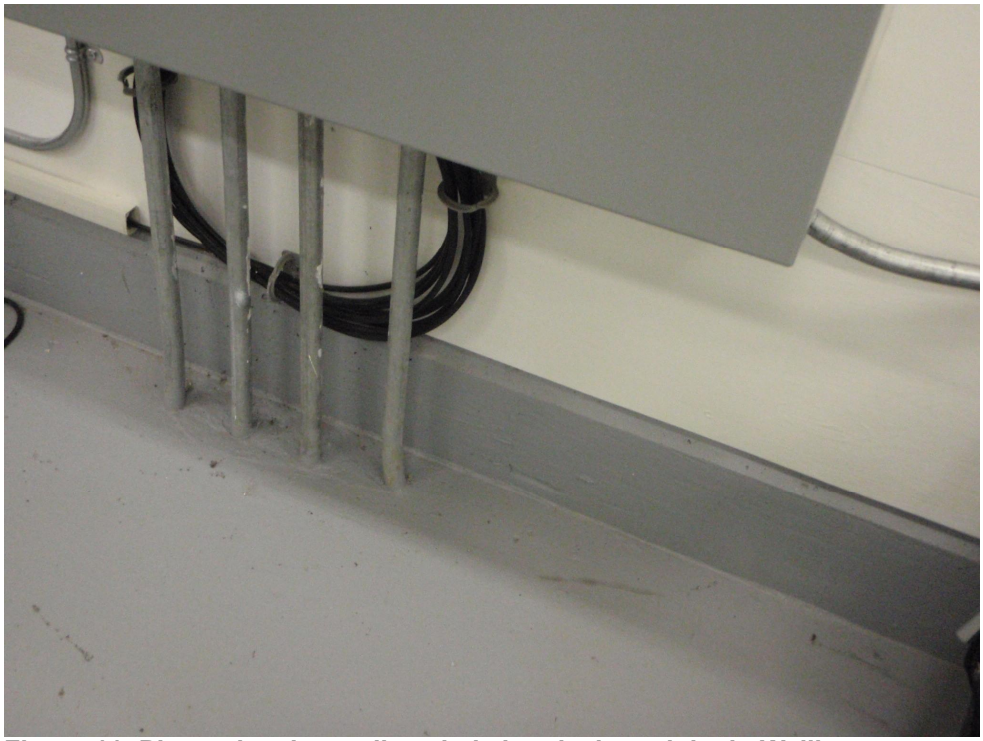


Figure 11 Photo showing well-sealed electrical conduits in Wellhouse .

H Appendix H - Raw Water Chemistry Data

PHYSICAL AND CHEMICAL ANALYSIS

RAW WATER SUPPLY
CITY OF WHITEHORSE
2011

SAMPLING STATION WH2 **Routine Chemistry**

- RAW WATER SUPPLY from Selkirk Aquifer Wells
- *Guidelines for Canadian Drinking Water Quality ** NOTE: PRIOR TO TREATMENT **

		31-May-11					3-Aug-11						7-Dec-11				Detection	GCDWQ*
		Well 4	Well 5N	Well 6	Well 8	Well 9	Well 4	Well 5N	Well 6	Well 8	Well 9	Well 4	Well 5N	Well 6	Well 8	Well 9	Limit	MAC
Parameter	**Units**																	
Colour - Apparent	*Rel. U.*	nr	nr	nr	nr	nr	<5	<5	14	8	<5		<5	<5	<5	<5		6.5-8.5
Colour _ True	*Rel. U.*	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	**Not**	<5	<5	<5	<5		
Total Diss. Solids	*mg/l*	244	284	188	58	68	168	304	180	80	76	**in**	324	194	112	112	1	
Turbidity	*NTU*	0.15	0.4	0.03	0.08	0.1	0.11	0.06	0.08	0.13	0.18	**Use**	0.15	0.1	0.14	0.12	0.02	<250
pH (lab)	*pH*	8.03	8.09	8.07	8.07	8.14	7.92	7.94	7.93	7.99	7.89		7.12	7.19	7.19	7.29	0.01	1.5
pH (field)	*pH*	8.43	8.64	9.03	8.57	8.57							7.57	7.28	7.55	7.57	0.01	10
Conductivity	*ıS/cm @25C*	387	437	314	131	145	273	463	296	146	131		466	293	140	148	0.005	1
Bicarbonate	*mg/l*																0.05	
Carbonate	*mg/l*																0.02	
Hydroxide	*mg/l*											**Not**					5	
T-Alkalinity	*as $CaCO_3$*	154	170	131	70	75	116	173	122	77	68	**in**	166	116	67	71	5	
Chloride	*mg/l*	1.87	2.07	2.27	0.48	0.64	1.58	2.49	2.17	0.3	0.43	**Use**	3	2.5	0.6	0.5		
Flouride	*mg/l*	0.16	0.16	0.15	0.09	0.1	0.18	0.16	0.15	0.1	0.09		0.19	0.16	0.1	0.1	1	<500
Sulfate (SO4)	*mg/l*	88.5	50.8	6.8	7.8	8.2	36.2	95.7	45.6	7.4	6.8		100	42.6	6.7	7.46	5	
Hardness	*ng CaCO3/l*	194	220	162	68.6	74.6	143	244	157	81	73		231	146	71.1	76.6	5	500
Nitrate - N	*mg/l*	0.03	0.01	0.03	0.04	0.03	0.04	0.01	0.03	0.02	0.04		0.02	0.07	0.07	0.04		
Nitrite - N	*mg/l*	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005		

Radiological Parameters								
Cesium - 137	Bq/L					<0.2	<0.2	<0.2	<0.2	0.2	10
Iodine - 131	Bq/L					<0.3	<0.2	<0.2	<0.4	0.2	6
Lead - 210	Bq/L					<0.02	<0.02	<0.02	<0.02	0.02	0.2
Radium - 226	Bq/L					0.006	<0.005	<0.005	<0.005	0.005	0.5
Strontium - 90	Bq/L					<0.1	<0.1	<0.1	<0.1	0.1	5
Tritium	Bq/L					<15	<15	<15	<15	15	7000

PHYSICAL AND CHEMICAL ANALYSIS

RAW WATER SUPPLY
CITY OF WHITEHORSE
2011

SAMPLING STATION WH2: **Total Metals**

- Selkirk Aquifer at the pump house

- Guidelines for Canadian Drinking Water Quality ** NOTE: PRIOR TO TREATMENT **

			31-May-11					3-Aug-11					7-Dec-11				
	Detection Limit (mg/L)	[AO], [OG] or MAC from GCDWQ* (mg/L)	Well 4	Well 5N	Well 6	Well 8	Well 9	Well 4	Well 5N	Well 6	Well 8	Well 9	Well 4	Well 5N	Well 6	Well 8	Well 9
Aluminium	0.005	[0.1/0.2]	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005	0.007	<0.005
Antimony	0.0002	0.006	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002		0.0003	<0.0002	<0.0002	<0.0002
Arsenic	0.0002	0.01	0.0037	0.0037	0	0.0019	0.0037	0.0039	0.0036	0.0032	0.0036	0.0018	**Not**	0.0041	0.0036	0.0021	0.0041
Barium	0.001	1	0.024	0.024	0.04	0.02	0.018	0.02	0.026	0.032	0.018	0.019	**In**	0.03	0.032	0.02	0.017
Beryllium	0.00004		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	**Use**	<0.00004	<0.00004	<0.00004	<0.00004
Bismuth	0.0001							<0.001	<0.001	<0.001	<0.001	<0.001					
Boron	0.004	5	0.025	0.03	0.016	<0.005	<0.005	0.014	0.03	0.012	<0.005	<0.005		0.039	0.018	<0.005	0.005
Cadmium	0.00001	0.005	0.00001	0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001	<0.00001	<0.00001	<0.00001
Calcium			28.6	30.7	28.7	19.3	17.9	24.4	33.4	27.6	19.2	21		34	27.1	20.7	19
Chromium	0.0004	0.05	0.0008	0.0008	0.0009	0.0008	0.0007	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004		<0.0004	<0.0004	<0.0004	<0.0004
Cobalt	0.00002		0.00003	0.00004	0.00002	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002		0.00004	0.00002	<0.00002	0.00007
Copper	0.001	[1.0]	0.002	0.006	0.008	0.004	0.01	0.002	0.005	0.009	0.002	0.003		0.008	0.011	0.004	0.021
Iron	0.01	[0.3]	0.029	0.053	0.016	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01
Lead	0.0001	[0.01]	<0.0001	0.0001	0	0.0004	0.0004	0.0001	0.0002	0.0001	0.0001	<0.0001		0.0001	<0.0001	<0.0001	0.0014
Lithium	0.001		<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001		0.001	<0.001	<0.001	<0.001
Magnesium	0.05		29.7	34.9	21.9	4.94	7.26	19.8	38.9	21.4	8	5.12		35.6	19	4.71	7.1
Manganese	0.0001	[0.05]	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005
Molybdenum	0.00002		0.0058	0.006	0.0042	0.002	0.0026	0.0051	0.0067	0.0041	0.0026	0.0017	**Not**	0.0069	0.0043	0.0017	0.0025
Nickel	0.001		<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**In**	<0.001	<0.001	<0.001	0.006
Phosphorus	0.01							<0.01	0.018	<0.01	0.013	<0.01	**Use**	0.02	0.01	<0.01	<0.01
Potassium	0.1		2.3	<0.001	<0.001	<0.001	1.2	1.8	2.7	1.7	1.2	0.8		2.6	1.7	0.8	1.1
Selenium	0.0006	0.01	0.0011	0.0007	0.0008	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006		<0.0006	<0.0006	<0.0006	<0.0006
Silicon	0.05		6.41	6.88	4.96	2.97	3.4	5.61	6.92	4.92	3.53	2.82		2.73	2	1.16	1.41
Silver	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		0.00006	0.00003	0.00003	0.00002
Sodium	0.02	[200]	14.4	17.6	10.1	1.67	2.42	8.6	19.4	9.35	2.2	1.44		16.4	7.75	1.33	1.75
Strontium	0.001		0.317	0.366	0.261	0.125	0.148	0.207	0.356	0.222	0.14	0.117		0.404	0.237	0.134	0.152
Sulphur	0.1		26.2	32.5	18.6	2.4	2.8	12.1	31.9	14.9	2.6	2.5		29.3	12.9	2	2.4
Tellurium	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001
Thallium	0.00001		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001	<0.00001	<0.00001	0.00002
Thorium	0.0001		<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004		<0.0004	<0.0004	<0.0004	<0.0004
Tin	0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001
Titanium	0.0001		<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001
Uranium	0.0004	0.02	0.0031	0.0038	0.003	0.0007	0.0009	0.0016	0.0043	0.0027	0.0008	0.0006		0.0046	0.0026	0.0007	0.001
Vanadium	0.00004		0.0009	0.0007	0.0015	0.001	0.0014	0.001	0.0015	0.0014	0.0014	0.0009		0.002	0.0016	0.0011	0.0016
Zinc	0.001	[5.0]	0.003	0.005	0.004	0.002	0.004	0.004	0.004	0.004	0.003	0.002		0.003	0.004	0.003	0.016
Zirconium	0.0001		<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001					

Appendix I - Recommended Analytes to Sample

CARO
ANALYTICAL SERVICES

Summit Environmental - Water Quality Parameters for INAC Project

Parameters	Sample Containers
Total and e.Coli	1 x 300 ml Sterile Plastic
Iron Bacteria	1 x 300 ml Sterile Plastic
Pesticides, Herbicides and Phenols Aldicarb, Azinphos-methyl, Bendiocarb, Carbaryl, Carbofuran, Diuron, 2,4-D, 2,4-dichlorophenol, Atrazine, Bromoxynil, Chloropyrifos, Cyanazine, Diazinon, MCPA, Metolachlor, Metribuzin, Parathion Pentachlorophenol, Phorate, Picloram, Simazine, Terbufos, Trifluralin Aldrin, Dieldrin, Methoxychlor, Diquat, Paraquat, Glyphosate, 2,3,4,6-Tetrachlorophenol, 2,4,6- Trichlororphenol	Multiple Bottles (See Page 2 for list)
Alkalinity, Ammonia, Chloride, True Color, Fluoride, Nitrate, Nitrite, pH, Sulphate, Suspended Solids, Total Dissolved Solids, UV 254nm,Turbidity, Conductivity	2 x 1L Plastic
Nitrilotriacetic Acid	1 x 1L Plastic
Total Cyanide	1 x 500ml Plastic with NaOH
Sulphide	1 x 125ml Plastic with ZnAC /NaOH
PAH – Benzo(A)Pyrene	2 x 1L Amber Glass
Total Organic Carbon	2 x 40mL clear glass vials with H3PO4
VOC`s	2 x 40ml Amber glass vials with NaHSO4
THM formation potential (routine)– Includes analysis for Trihalomethanes / Haloacetic Acids and Bromodichloromethane (BDCM) *Chlorine Demand (Must Log in with THMFP)	1 x 4L Plastic Jug
Cyanobacterial Toxins – Microcystin - LR	1 x 1L Plastic
Low Level Total Metals Scan by ICP/MS – includes Hardness	1 x 125 ml Plastic with HNO3
Low Level Dissolved Metals Scan by ICP/MS – includes Hardness	1 x 125 ml Plastic – Must be field filtered prior to adding to bottle with HNO3 – If cannot be filtered then lab will do.
Odor, ORP, Temperature – Submit data for entry on final report.	Field Tests
*Gross Alpha/Beta and other Isotope analysis such as: Lead 210 Polonium 210 Radium 226 Radium 228 *Note samples with high Total Solids can effect the analysis detection limit. Samples with greater than 300mg/l solids the 0.1 Bq/L limit for Alpha can`t be obtained, is not as much a problem for Beta as the limit is 1 Bq/L.	2 x 1L plastic with NHO3

CARO
ANALYTICAL SERVICES

Summit Environmental - Water Quality Parameters for INAC Project

Required Bottles for Pesticides Herbicides and Phenols

- 2 x 1L Amber Glass with Na2S2O3 – Labeled "Acid Herbicides"
- 2 x 1L Amber Glass unpreserved – Labeled "OC/OP/ON"
- 1 x 500mL Poly with Na2S2O3 wrapped in foil – Labeled "Diquat/Paraquat"
- 2 x 40mL Vial with Na2S2O3 – Labeled "Glyphosate"
- 2 x 40mL Vial with ChlorAC/Na2S2O3 – Labeled "Carbamates"
- 2 x 1L Amber Glass unpreserved – Labeled "Phenols"

Sampling Instructions:

Note: Due to the amount of INAC samples and various hold times, please arrange sampling schedule so that samples are not received at the lab on Friday. Best timing would be for samples to be received at the lab on Wednesday if possible.

- Samples **must be received** 24 hours after collection – This is most critical to meet the Coliform hold times.
- Place ziploc bags of crushed ice in coolers so samples will be received at the lab <10C
- Dissolved Metals – Filter sample prior to placing in the 125 ml plastic with Nitric Acid, Total metal sample does not need to be filtered
- Fill all containers to neck of bottle.
- Purge and Trap Vials: should be filled to ensure there is no headspace. Fill each vial to overflowing (positive meniscus); Set vial on a level surface and screw on the cap; Check for air bubbles (invert the vial and tap lid). If air bubbles are present, open the bottle, add additional sample, and reseal in the same manner as stated above.

June 21, 2007

Discussion Paper for Parameters to be Examined for Raw Water Sources for Design of Water Systems, INAC, BC Region

Objective

The objective of this discussion paper is to develop a list of parameters to be examined for raw water sources during the feasibility and design stages of capital projects that are funded by INAC, BC Region.

Factors to be considered

1. *Design Guidelines for Waterworks*, INAC, BC Region (Reference 2) section 3 requires that distribution water quality meet *Guidelines for Canadian Drinking Water Quality* (GCDWQ) (Reference 1). Following are some of the relevant sections of *Design Guidelines for Waterworks, BC Region*:

- Policy Statement on UV Treatment
- Section 1.1.2.1 (surface water) and 1.1.2.2 (groundwater)
- Section 3.0 Source Development
- Section 3.1.2 Quality – Surface water
- Section 3.2.2 Quality – Groundwater or GWUDI
- Policy statement on internal corrosion control
- Section 4.3.8 Stabilization

2. *Protocol for Safe Drinking Water in First Nations Communities,* INAC (Reference 3) requires that distribution water quality meet GCDWQ, and refers briefly to the Health Canada Procedure Manual for routine operational monitoring (Section 3.4 – Monitoring Requirements; page 7).

3. The document entitled *Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction - Version 1, 2005* (Reference 9) states: "A baseline chemical analysis is an analysis of all Guidelines for Canadian Drinking Water Quality for chemical parameters (including initial screening for radiological parameters) with Maximum Acceptable Concentrations (MACs). As part of this analysis, departments may choose to look at aesthetic parameters and operational guidance values as well." (Page 31)

4. Ontario requirements follow:
"3.1 Raw water characterization: In a multiple barrier system for providing safe drinking water, the selection and protection of a reliable, high quality drinking water source is the first barrier. When considering the suitability of a raw water supply, a raw water characterization that includes an analysis of all physical, chemical and microbiological parameters included in Tables 1, 2 and 4 should be conducted. Testing for gross alpha and gross beta should be undertaken to determine whether the testing for the radionuclides listed in Table 3 is required. In

addition, this characterization will enable the design of any further treatment that may be required, including impacts that any parameter may have on the treatment processes."

Ontario also requires that all parameters that have standards be monitored during operation of the water system. (Reference 10: *Technical support document for Ontario Drinking Water Standards, Objectives, and Guidelines*, June 2006, PIBS 4449e01)

5. *The Procedure Manual for Safe Drinking Water in First Nations Communities South of 60°*, 2007, by Health Canada (Reference 4) includes a section on baseline monitoring, with the following statement: "For any new drinking water system, the first sampling should include all parameters identified in this document." Therefore it would be good to include the parameters listed in this document for baseline monitoring.

6. The document entitled *Radiological Characteristics of Drinking Water - Document for Public Comment,* July 2006, Health Canada (Reference 5) is currently in draft stage, and includes a discussion about the limitations of using gross alpha, and gross beta for screening for radiological water quality.

7. The document entitled *Corrosion Control in Drinking Water Distribution Systems – Document for Public Comment*, April 2007, Health Canada (Reference 6) is currently in draft stage, and includes a discussion about factors for consideration for corrosion control, and sampling protocols to examine lead in first flush samples collected at residential and non-residential buildings at existing water systems.

8. The document entitled *UV Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*, November 2006, USEPA was recently published, and includes information about recommended water sampling protocols for design of UV Disinfection facilities.

Discussion

An initial list of parameters for consideration was developed by the following procedure:

- All parameters with current guidelines as listed in GCDWQ - Summary Table, March 2007, Health Canada were included
- The parameters listed in Section 4.2 - Baseline Monitoring in the document: *Procedure Manual for Safe Drinking Water in First Nations Communities South of 60°*, 2007, by Health Canada (Reference 4) were included
- Parameters listed in various sections of the *Design Guidelines for Waterworks*, INAC, BC Region, 2005 were included
- The document entitled *UV Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*, November 2006, USEPA was reviewed to determine if any parameters should be added for consideration of UV disinfection

- The following "Draft Guideline Technical Documents for Public Comment" by Health Canada were reviewed to determine if any parameters should be added:
    - *Corrosion Control in Drinking Water Distribution Systems,* April 2007
    - *Radiological Characteristics of Drinking Water,* July 2006
    - *2-Methyl-4-chlorophenoxyacetic acid (MCPA)in drinking water*, October 2006
    - *Chlorite and Chlorate in Drinking Water*, May 2005
    - *Chloral hydrate in drinking water*, December 2006
    - *Haloacetic Acids in Drinking Water*, July 2006
    - *Potassium in Drinking Water*, February 2007

Initial and Proposed List of Parameters

The initial and proposed list of parameters, with comments, is in Appendix A. It is proposed that all parameters be tested except as noted with "Omit" in the right hand column. Notes listed in the "Proposed List" column are defined below.

It is proposed that the parameters HAA Formation Potential and MCPA be added based on the review of the above "Draft Guideline Technical Documents for Public Comment" by Health Canada.

Based on the review of the "Draft Guideline Technical Documents for Public Comment" entitled *Radiological Characteristics of Drinking Water,* July 2006, it is proposed to include the following request on the lab requisition form: "Test for gross alpha and gross beta plus individual isotope parameters where the lab analyst decides applicable based on *Guidelines for Canadian Drinking Water Quality."* This procedure was discussed with representatives of SRC Analytical Laboratories whom do many radiological analyses.

It is proposed that the parameter Oxidation-Reduction Potential (ORP) be added based on review of *UV Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*, November 2006, USEPA.

It is suggested that revisions to *Design Guidelines for Waterworks*, INAC, BC Region be considered with respect to the frequency of testing for some parameters (Colour, turbidity, THMs, TOC, total coliforms, E. coli, giardia, and cryptosporidium) as noted in the comments column of Appendix A.

Notes for Table:

(1) The sample for dissolved iron and dissolved manganese should be filtered and preserved in the field immediately upon collection. Also turbidity measurements should be carried out in the field immediately following sample collection in order to determine if any elevated turbidity measured in the lab is the result of precipitated iron and/or manganese.
(2) Required only if considered appropriate by water treatment specialist or hydrogeologist, and with INAC concurrence
(3) Test in field only
(4) Test in field and lab
(5) Include the following request on the lab requisition form: "Test for gross alpha and gross beta plus individual isotope parameters where the lab analyst decides applicable based on *Guidelines for Canadian Drinking Water Quality."*
(6) Test for total cyanide to indicate worst case. The MAC in *Guidelines for Canadian Drinking Water Quality* is for free cyanide.
(7) Required only if UV disinfection is proposed as part of the water treatment process. Samples for UV transmittance should not be passed through a 0.45-µm filter before analysis because particles can affect the absorbance of UV light. The sample pH also should not be adjusted.
(8) Testing for this parameter would only be done if the lab analyst decides applicable based on the results for gross alpha and gross beta (See note 5)
(9) For examination of existing water supply sources, follow the sampling protocols described in the document *Corrosion Control in Drinking Water Distribution Systems – Document for Public Comment,* April 2007, by Health Canada for sampling of this parameter at residential sites, and non-residential sites to determine the existing situation.

General Notes:

- Tests should be done for total metals and dissolved iron and dissolved manganese
- Conduct other tests if considered appropriate, and with INAC concurrence
- Conduct one measurement except as described in the "Notes" and "Frequency" columns. More frequent samples may be needed to capture a water quality event (e.g., storm events). The duration of the sampling period depends on the source water quality.
- If UV disinfection is proposed as part of the water treatment process then the water sampling program should be based on the document entitled: *UV Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*, November 2006, USEPA, and *Design Guidelines for Waterworks,* 2005, INAC, BC
- In situations where water samples are analyzed in the field, an appropriate number of samples should also be analyzed at an accredited lab for quality control purposes.
- This document is not intended to be used to establish water quality monitoring procedures in GUDI determinations.

Proposed Technical Guidance Document

A proposed Technical Guidance Document based on this discussion paper is attached.

References

1. Guidelines for Canadian Drinking Water Quality - Summary Table, March 2007, Health Canada
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index_e.html

2. Design Guidelines for Water Works, Fifth Edition, September 2005, INAC BC Region

3. Protocol for Safe Drinking Water in First Nations Communities, March 2006, INAC
http://www.ainc-inac.gc.ca/H2O/sdw/index_e.html

4. The Procedure Manual for Safe Drinking Water in First Nations Communities South of 60°, 2007, First Nations and Inuit Health Branch, Health Canada

5. Radiological Characteristics of Drinking Water - Document for Public Comment, July 2006, Health Canada
http://www.hc-sc.gc.ca/ahc-asc/public-consult/consultations/col/rc-cr/rep-rapp_e.html

6. Corrosion Control in Drinking Water Distribution Systems – Document for Public Comment, April 2007, Health Canada
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/consultation/corrosion/toc-tdm_e.html

7. Protozoa: Giardia and Cryptosporidium - Guidelines for Canadian Drinking Water Quality: Supporting Documentation, April 2004, Health Canada
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/protozoa/index_e.html

8. UV Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule, November 2006, U.S. Environmental Protection Agency Office of Water
http://www.epa.gov/safewater/disinfection/lt2/compliance.html

9. Guidance For Providing Safe Drinking Water in Areas of Federal Jurisdiction - Version 1, August 2005, Health Canada
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/guidance-federal-conseils/index_e.html

10. Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines, Pub.# 4449e01, June 2006, Ontario Ministry of the Environment
http://www.ontario.ca/drinkingwater/stel01_046947.pdf

Appendix A - Discussion Paper
Water Quality Parameters to be Examined for Raw Water Sources for Design of Water Systems
INAC, BC Region June 21, 2007

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
Bacteriological parameters (GCDWQ)				
Escherichia coli	Frequency of sampling for this parameter is not included in the INAC Design Guidelines section 1.1.2. Consider revision			
Total coliforms	Frequency of sampling for this parameter is not included in the INAC Design Guidelines section 1.1.2. Consider revision			
Chemical and physical parameters (GCDWQ)				
Aldicarb	Insecticide			
Aldrin + dieldrin	Insecticide			
Aluminum		Yes		
Antimony		Yes		
Arsenic		Yes		
Atrazine	Herbicide			
Azinphos-methyl	Insecticide			
Barium		Yes		
Bendiocarb	Insecticide			
Benzene		Yes		
Benzo[a]pyrene		Yes		
Boron		Yes		
Bromate	Potential disinfection by-product from ozonation		Omit	
Bromodichloromethane (BDCM)	Potential disinfection by-product from chlorination. BDCM is one of the THMs. Quarterly measurement of THMFP for one year is required (Design Guidelines section 1.1.2).			Quarterly measurement of formation potential for one year for surface water and GUDI sources. One measurement of formation potential for groundwater sources.
Bromoxynil	Herbicide			
Cadmium		Yes		
Carbaryl	Insecticide			
Carbofuran	Insecticide			
Carbon tetrachloride		Yes		

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
Chloramines—total	Chloramines are produced when ammonia is added to chlorinated water during the disinfection process. (commonly referred to as Chloramination)		Omit	
Chloride		Yes		
Chlorpyrifos	Insecticide			
Chromium		Yes		
Colour (true)	Weekly measurement for one year for both surface water and groundwater is currently required by INAC Design Guidelines section 1.1.2. Consider revision.	Yes		Weekly measurement for duration that may be up to one year for surface water and GUDI sources
Copper		Yes	(9)	
Cyanazine	Herbicide			
Cyanide		Yes	(6)	
Cyanobacterial toxins–Microcystin-LR	Cyanobacterial toxins are toxins produced by cyanobacteria or blue-green algae		(2)	
Diazinon	Insecticide			
Dicamba	Herbicide			
1,2-Dichlorobenzenee		Yes		
1,4-Dichlorobenzenee		Yes		
1,2-Dichloroethane		Yes		
1,1-Dichloroethylene				
Dichloromethane				
2,4-Dichlorophenol		Yes		
2,4-Dichlorophenoxyacetic acid (2,4 -D)	Herbicide			
Diclofop-methyl	Herbicide			
Dimethoate	Insecticide			
Dinoseb	Herbicide			
Diquat	Herbicide			
Diuron	Herbicide			
Ethylbenzene		Yes		
Fluoride		Yes		
Glyphosate	Herbicide			
Haloacetic Acids--Total (HAAs)	Draft guideline MAC. Potential disinfection by-product from chlorination. Quarterly measurement of HAA formation potential for surface water for one year is proposed. One measurement for groundwater and GUDI sources is proposed.			Quarterly measurement of formation potential for one year for surface water and GUDI sources. One measurement of formation potential for groundwater sources.
Iron		Yes	(1)	
Lead		Yes	(9)	

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
Malathion	Insecticide			
Manganese		Yes	(1)	
Mercury		Yes		
Methoxychlor	Insecticide			
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	Proposed draft guideline MAC. Herbicide			
Methyl tertiary-butyl ether (MTBE)				
Metolachlor	Herbicide			
Metribuzin	Herbicide			
Monochlorobenzene		Yes		
Nitrate		Yes		
Nitrate + Nitrite				
Nitrite				
Nitrilotriacetic acid (NTA)		Yes		
Odour	AO is "inoffensive". Labs could test for "Threshold Odour Number" for low cost ($15)			
Paraquat (as dichloride)	Herbicide			
Parathion	Insecticide			
Pentachlorophenol		Yes		
pH		Yes	(4)	
Phorate	Insecticide			
Picloram	Herbicide			
Selenium		Yes		
Simazine	Herbicide			
Sodium		Yes		
Sulphate		Yes		
Sulphide (as H2S)		Yes		
Taste			Omit	
Temperature			(3)	
Terbufos	Insecticide			
Tetrachloroethylene				
2,3,4,6-Tetrachlorophenol		Yes		
Toluene		Yes		
Total dissolved solids (TDS)		Yes		
Trichloroethylene (TCE)		Yes		
2,4,6-Trichlorophenol		Yes		
Trifluralin	Herbicide			

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
Trihalomethanes-total (THMs)	Potential disinfection by-product from chlorination. Quarterly measurement of THMFP for one year for both surface water and groundwater is currently required by Design Guidelines section 1.1.2. Consider revision.			Quarterly measurement of formation potential for one year for surface water and GUDI sources. One measurement of formation potential for groundwater sources.
Turbidity	Weekly measurement for one year for both surface water and groundwater is currently required by INAC Design Guidelines section 1.1.2. Consider revision.	Yes		Daily measurement for duration that may be up to one year for surface water and GUDI sources.
Uranium		Yes		
Vinyl chloride		Yes		
Xylenes—total		Yes		
Zinc		Yes		

Radiological parameters (GCDWQ)

Gross alpha	GCDWQ recommendation for screening	Yes	(5)	
Gross beta	GCDWQ recommendation for screening	Yes	(5)	
radium-226	Considered analysis of this parameter based on the draft Guideline Technical Document . It is proposed instead to test for gross alpha and gross beta, with request on lab requistion form to "Also test for individual isotope parameters where the lab analyst decides applicable"		(8)	
radium-228	Considered analysis of this parameter based on the draft technical guideline document. It is proposed instead to test for gross alpha and gross beta, with request on lab requistion form to "Also test for individual isotope parameters where the lab analyst decides applicable"		(8)	
polonium-210	Considered analysis of this parameter based on the draft technical guideline document. It is proposed instead to test for gross alpha and gross beta, with request on lab requistion form to "Also test for individual isotope parameters where the lab analyst decides applicable"		(8)	

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
lead-210	Considered analysis of this parameter based on the draft technical guideline document. It is proposed instead to test for gross alpha and gross beta, with request on lab requistion form to "Also test for individual isotope parameters where the lab analyst decides applicable"		(8)	
radon-222	No guideline in GCDWQ. Recommended by Northern District, FNIHB, Health Canada, Pacific Region as means to assist with identification of the cause of screening exceedance.		Omit	

Additional Parameters on the list for baseline testing in Health Canada Procedure Manual 2007

Alkalinity		Yes		
Ammonia		Yes		
Calcium		Yes		
Hardness		Yes		
Magnesium		Yes		
Silver		Yes		
Total suspended solids (TSS)	Design Guidelines Policy statement for UV	Yes		

Other parameters

Total Organic Carbon	Weekly measurement for one year for both surface water and groundwater is currently required by INAC Design Guidelines section 1.1.2. Consider revision.			Weekly measurement for duration that may be up to one year for surface water and GUDI sources
UV transmittance at 254 nm	Design Guidelines Policy statement for UV		(7)	Daily measurement for duration that may be up to one year for surface water and GUDI sources.
Iron bacteria	Design Guidelines Policy statement for UV		(7)	
Giardia	Measurement is currently required by Design Guidelines section 1.1.2. It is proposed that testing not be required. However consultants may choose to include testing during GUDI Assessments or evaluation of surface water.		Omit	

Parameter	Comments	On list in Procedure Manual (Ref. # 4)?	Proposed List (Omit = omit from testing)	Frequency
Cryptosporidium	Measurement is currently required by Design Guidelines section 1.1.2. It is proposed that testing not be required. However consultants may choose to include testing during GUDI Assessments or evaluation of surface water.		Omit	
Oxidation-Reduction Potential (ORP)	Testing for ORP recommended in the USEPA UV Disinfection Guidance Manual For the Final Long Term 2 Enhanced Surface Water Treatment Rule		(7)	

J Appendix J - Potential Contaminant Source Identification Documents

Canada's Primary Environmental Risk Information Service

Project Site:	**Whitehorse Well Protection Plan 2** **2 Firth Rd** **Whitehorse, YT Y1A**
Client:	**Nicole Jacques** **Associated Engineering** **301- 4109 4Th Avenue** **Whithorse, YT Y1A 1H6**
ERIS Project No:	**20120409025**
Report Type:	**Custom Report - .25km Search Radius**
Prepared By:	**Rafal Wojtasik** rwojtasik@eris.ca
Date:	**April 18, 2012**

Table of Contents

Order Number: 20120409025
Site Name: Whitehorse Well Protection Plan 2
Site Address: 2 Firth Rd Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

Report Summary

Order Number: 20120409025
Site Name: Whitehorse Well Protection Plan 2
Site Address: 2 Firth Rd Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

Number of Mappable Records Surrounding the Site

Database		Selected	On-site	Within 0.25	0.25km to 0.25km	Total
AIR	Air Emission Permits	Y	0	0	0	0
AUWR	Automobile Wrecking & Supplies	Y	0	0	0	0
CHEM	Chemical Register	Y	0	0	0	0
CS	Contaminated Site Inventory	Y	0	0	0	0
DMP	Designated Material Permits	Y	0	0	0	0
EHS	ERIS Historical Searches	Y	0	0	0	0
EIIS	Environmental Issues Information System	Y	0	0	0	0
FCS	Contaminated Sites on Federal Land	Y	0	0	0	0
FST	Fuel Storage Tanks	Y	0	0	0	0
HIS	Historic Sites Inventory	Y	0	0	0	0
IAFT	Indian & Northern Affairs Fuel Tanks	Y	0	0	0	0
LTF	Land Treatment Facilities	Y	0	0	0	0
MINE	Canadian Mine Locations	Y	0	0	0	0
MNR	Mineral Occurences	Y	0	0	0	0
NATE	National Analysis of Trends in Emergencies System (NATES)	Y	0	0	0	0
NDWD	National Defence & Canadian Forces Waste Disposal Sites	Y	0	0	0	0
NEBW	National Energy Board Wells	Y	0	0	0	0
NEES	National Environmental Emergencies System (NEES)	Y	0	0	0	0
NPCB	National PCB Inventory	Y	0	0	0	0
NPRI	National Pollutant Release Inventory	Y	0	0	0	0
ODS	Ozone Depleting Substances & Other Halocarbons	Y	0	0	0	0
OGW	Oil and Gas Wells	Y	0	0	0	0
PCFT	Parks Canada Fuel Storage Tanks	Y	0	0	0	0
PES	Pesticide Register	Y	0	0	0	0
REC	Waste Receivers	Y	0	0	0	0
REL	Relocation Permits	Y	0	0	0	0
RST	Retail Fuel Storage Tanks	Y	0	0	0	0
SCT	Scotts Manufacturing Directory	Y	0	0	0	0
SPL	Spills	Y	0	0	0	0
SWP	Special Waste Permits	Y	0	0	0	0
WDS	Waste Disposal Sites	Y	0	0	0	0
YOGW	Yukon Oil and Gas Wells	Y	0	0	0	0
		TOTAL	0	0	0	0

The databases chosen by the client as per the submitted order form are denoted in the 'Selected' column in the above table. Counts have been provided outside the primary buffer area for cursory examination only. These records have not been examined or verified, therefore, they are subject to change.

SITE DIAGRAM

ECOLOG ERIS
Pinpointing Your Environmental Risks
12 Concorde Pl, Suite 800 North York, ON M3C 4J2
416-510-5204

Project Property: Whithorse Well Protection Plan 2
2 Firth Rd
Whitehorse, YT
Y1A

ERIS Project #: 20120409025

Date: APR-18-2012

LEGEND

- Project Property
- Database Location

Points of Interest
- Chimney
- Silo

Pipe & Transmission Lines
- Pipeline
- Transmission Line
- Transmission Tower
- Transformer Station

Rail
- Railway - Main
- Railway - Sidetrack
- Railway - Abandoned
- Bridge
- Tunnel

Transportation - Other
- Embankment
- Trail
- Runway

Hydrographic Features
- Permanent Waterway
- Intermittent Waterway
- Open Reservoir
- Dyke/Levee
- Dam
- Breakwall
- Wetland

Landuse Classifications
- Open Area
- Residential
- Commercial
- Resource and Industrial
- Government and Institutional
- Parks and Recreational
- Waterbody

Recreation
- Golf Course/Driving Range
- Park/Sports Field
- Other Recreation Area
- Sports/Race Track
- Cemetery
- Campground

Vegetation
- Wooded Area
- Orchard
- Vineyard

Industrial Resources
- Conveyor
- Crane: Moveable
- Crane: Stationary
- Tank
- Rock Cut
- Auto Wrecker
- Lumber Yard
- Pit

This diagram is to be used solely for relative street location purposes.
It may not accurately portray street or site positions.

Site Report

Order Number: 20120409025
Site Name: Whitehorse Well Protection Plan 2
Site Address: 2 Firth Rd Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

FOR COMPLETE INFORMATION, REFER TO DETAIL REPORT

A search has been conducted for this site (address) and company name. No records were found, within the database(s) selected, that meet either of these criteria.

Detail Report

Order Number: 20120409025
Site Name: Whitehorse Well Protection Plan 2
Site Address: 2 Firth Rd Whitehorse YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

If information is required for sites located beyond the selected address, please contact your ERIS representative.

Spills

Spills

Map Key	Company	Address	Spill Date	Sector	Substance	Amount	Source
n/a		Chadburn Lake Whitehorse	6-Aug-93		Fuel	unknown	unkown
			Cause:	Use			
			Reason:	sheen under dock			

Appendix: Yukon Database Descriptions

EcoLog Environmental Risk Information Services Ltd can search the following databases. The extent of historical information varies with each database and current information is determined by what is publicly available to EcoLog ERIS at the time of update. **Note:** Databases denoted with "*" indicates that the database will no longer be updated. See the individual database descriptions for more information.

Territorial Government Source Databases:

Air Emission Permits **1998-May 2011** **AIR**

The Department of Renewable Resources maintains a database of companies/organizations who have acquired a permit under the "Air Emissions Regulation", for the operation of the following types of activities. These include the manufacturing of asphalt; production and exploration of oil and natural gas; quarrying, crushing and screening of stone/clay/ shale /coal/ minerals; processing or handling of coal; equipment capable of generating/burning/using heat energy; use of incinerators; the use of equipment for incineration of special waste; electrical generating facilities; and the storage/other handling of solid, liquid or gaseous materials. The database provides information pertaining to the permit number, expiry date, status and the type of permit.

Designated Material Permits **July 2003-May 2011** **DMP**

The Designated Material Regulations, under the Yukon Environment Act, mandates that anyone who is a retailer or depot operator of "designated materials" must obtain a permit. Where a depot operator has acquired a Solid Waste permit and it addresses the deport location, a designated materials permit is not required. As of May 2004, only tires are considered "designated materials". The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Fuel Storage Tank **1997-Sept 2001** **FST**

The Yukon Department of Renewable Resources maintains an inventory of fuel storage tanks within the Territory. The tanks are registered to the department pursuant to Storage Tank Regulations, Environment Décret 1996/194 with permits. The Storage Tank Regulations came into effect on January 1, 1997. The regulations include requirements for the storage of hazardous substances, including petroleum products, pursuant to Part 10 of the Environment Act. This database applies to new tanks that are being installed or constructed; and existing tanks that undergo major renovations after January 1, 1997. Fuel storage tanks not found in this database include: those that have a capacity of 4,000 litres or less and are used to supply comfort heating systems; tanks that are used to store crude oil, and tanks used for aboveground storage of hazardous substances (other than petroleum products) with a capacity of less than 2000 litres.

Historic Sites Inventory **1987-Aug 2002** **HIS**

The Heritage Branch of the Yukon government maintains an inventory of all historic sites within the Territory. The database provides information on history, condition, ownership, location, resource type, and date of construction. Please note that even though the inventory was initiated in 1987, the database does contain records where the date of construction of a historic site was previous to 1895.

Land Treatment Facilities **2002-May 2011** **LTF**

The Yukon's Contaminated Sites Regulation mandates that permits must be acquired for the construction and operation of Land Treatment Facilities - for the purpose of restoring and rehabilitating contaminated soil, sediment, snow or other similar media. The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Mineral Occurrences **1900-May 2009** **MNR**

The Yukon Geology Program maintains an inventory of 2577 separate mineral occurrences in the Yukon, which document metallic, industrial mineral and coal deposits. Information within the database pertains to owner/operator, year, name, claim name, status, deposit type, mining district, tectonic element and commodity.

Ozone Depleting Substances & Other Halocarbons **1998-May 2011** **ODS**

The Yukon's Ozone Depleting Substances & Other Halocarbon (ODS) Regulations regulate the handling, use and sale of Ozone Depleting Substances (ODS) in the Yukon. The release of ODS's are prohibited, with certain exemptions found in s.2(2) of the Regulations. Ozone depleting substances are considered to be CFC's, Halons, Chlorocarbon compounds and Hydrochlorofluorocarbons. Other Halocarbons refer to Hydrofluorocarbons and Perfluorocarbons. The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Pesticide Register **1998-May 2004** **PES**

This is a database of individuals who apply for a "service", "vendor" or "usage" license for those specific pesticides and fertilizers that require a permit. The database is maintained by the Department of Renewable Resources, and provides information pertaining to the permit number, expiry date, status and the type of permit.

Waste Receivers **1997-July 2002** **REC**

The Department of Renewable Resources maintains a "Waste Manifest" which details information regarding waste transfers from generating facilities to registered Receivers. The provincial inventory provides information on the waste receiving facility name, location, physical state (solid/liquid), waste type, amount/quantity received and the degree of danger.

Relocation Permits **May 2004-May 2011** **REL**

The Yukon's Contaminated Sites Regulation mandates that permits must be acquired in order to move contaminated material from one site to another. The provincial inventory provides information on the registered facility, location, permit number, permit type, and status.

Special Waste Permits **1998-May 2011** **SWP**

The Special Waste Regulations, under the Yukon Environment Act, mandate that anyone who generates, stores, handles, mixes, transports, disposes or releases special wastes is to acquire a "Special Waste" permit. Permits are required for both special waste generators and special waste facilities. The provincial inventory provides information on the generating/waste receiving facility, location, permit number, permit type (generator, facility), status and types of waste generated/received.

Waste Disposal Site Inventory **2000-May 2011** **WDS**

This inventory pertains to active, regulated waste disposal sites within the Yukon, where registered sites hold a permit for acceptance of different forms of solid waste. This database provides information in regard to permit number, type of waste accepted, status and permit type. Please note that references within the database to SPW and AER, are in regard to the Special Waste Regulation and Air Emissions Regulation respectively.

Yukon Oil and Gas Wells **April 1957-July 2002*** **YOGW**

The Yukon Oil and Gas Resources Branch is responsible for maintaining a database of all oil and gas wells drilled in the Yukon. All well locations were provided by the National Energy Board and verified through branch field inspections. Please note that as of May 1991, no new wells have been drilled in the territory. The database details information on well owner/operator, well name, location, drill date, well id, status, elevation, class, and depth of the well.

Federal Government Source Databases: **Diagram Identifier:**

Contaminated Site Inventory **1998-May 2011** **CS**

Yukon INAC Contaminated Sites Inventory is an inventory of sites of potential environmental concern compiled by Indian and Northern Affairs Canada. These sites on this inventory may or may not be contaminated and some might also be sites with solid waste/debris, old mining structures, etc. Inclusion on this list should not be taken as confirmation of contamination. Similarly, sites not included on this list should not be assumed to be free of contamination. For information on any of the sites listed below, contact the Environmental Programs Branch.

Environmental Issues Inventory System **1992-2001*** **EIIS**

The Environmental Issues Inventory System was developed through the implementation of the Environmental Issues and Remediation Plan. This plan was established to determine the location and severity of contaminated sites on inhabited First Nation reserves, and where necessary, to remediate those that posed a risk to health and safety; and to prevent future environmental problems. The EIIS provides information on the reserve under investigation, inventory number, name of site, environmental issue, site action (Remediation, Site Assessment), and date investigation completed.

Contaminated Sites on Federal Land **June 2000-Jan 2012** **FCS**

The Treasury Board of Canada Secretariat maintains an inventory of all known contaminated sites held by various Federal departments and agencies. This inventory does not include properties owned by Crown corporations, but does contain non-federal sites for which the Government of Canada has accepted some or all financial responsibility. All sites have been classified through a system developed by the Canadian Council of Ministers of the Environment. The database provides information on company name, location, site ID #, property use, classification, current status, contaminant type and plan of action for site remediation.

Indian & Northern Affairs Fuel Tanks **1950-Aug 2003** **IAFT**

The Department of Indian & Northern Affairs Canada (INAC) maintains an inventory of all aboveground & underground fuel storage tanks located on both federal and crown land. Our inventory provides information on the reserve name, location, facility type, site/facility name, tank type, material & ID number, tank contents & capacity, and date of tank installation.

National Analysis of Trends in Emergencies System (NATES) **1974-1994*** **NATE**

In 1974 Environment Canada established the National Analysis of Trends in Emergencies System (NATES) database, for the voluntary reporting of significant spill incidents. The data was to be used to assist in directing the work of the emergencies program. NATES ran from 1974 to 1994. Extensive information is available within this database including company names, place where the spill occurred, date of spill, cause, reason and source of spill, damage incurred, and amount, concentration, and volume of materials released.

National Defence & Canadian Forces Waste Disposal Sites **2001-April 2007** **NDWD**

The Department of National Defence and the Canadian Forces maintains an inventory of waste disposal sites located on DND lands. Where available, our inventory provides information on the base name, location, type of waste received, area of site, depth of site, year site opened/closed and status.

National Energy Board Wells **1920-June 2007** **NEBW**

The NEBW database contains information on onshore & offshore oil and gas wells that are outside provincial jurisdiction(s) and are thereby regulated by the National Energy Board. Data is provided regarding the operator, well name, well ID No./UWI, status, classification, well depth, spud and release date.

National Environmental Emergencies System (NEES) 1974-2003 **NEES**

In 2000, the Emergencies program implemented NEES, a reporting system for spills of hazardous substances. For the most part, this system only captured data from the Atlantic Provinces, some from Quebec and Ontario and a portion from British Columbia. Data for Alberta, Saskatchewan, Manitoba and the Territories was not captured. However, NEES is also a repository for all previous Environment Canada spill datasets. NEES is composed of the historic datasets – or Trends – which dates from approximately 1974 to present. **NEES Trends** is a compilation of historic databases, which were merged and includes data from NATES (National Analysis of Trends in Emergencies System), ARTS (Atlantic Regional Trends System), and NEES. In 2001, the Emergencies Program determined that variations in reporting regimes and requirements between federal and provincial agencies made national spill reporting and trend analysis difficult to achieve. As a consequence, the department has focused efforts on capturing data on spills of substances which fall under its legislative authority only (CEPA and FA). As such, the NEES database will be decommissioned in December 2004.

National PCB Inventory 1988-2008 **NPCB**

Environment Canada's National PCB inventory includes information on in-use PCB containing equipment in Canada including federal, provincial and private facilities. All federal out-of-service PCB containing equipment and all PCB waste owned by the federal government or by federally regulated industries such as airlines, railway companies, broadcasting companies, telephone and telecommunications companies, pipeline companies, etc. are also listed. Although it is not Environment Canada's mandate to collect data on non-federal PCB waste, the National PCB inventory includes some information on provincial and private PCB waste and storage sites.

National Pollutant Release Inventory 1993-2009 **NPRI**

Environment Canada has defined the National Pollutant Release Inventory ("NPRI") as a federal government initiative designed to collect comprehensive national data regarding releases to air, water, or land, and waste transfers for recycling for more than 300 listed substances.

Parks Canada Fuel Storage Tanks 1920-Jan 2005 **PCFT**

Canadian Heritage maintains an inventory of all known fuel storage tanks operated by Parks Canada, in both National Parks and at National Historic Sites. The database details information on site name, location, tank install/removal date, capacity, fuel type, facility type, tank design and owner/operator.

Spills 1972-2000 **SPL**

Environment Canada maintains an inventory of known spills that have occurred throughout the Yukon and are reported under the Yukon Spills Regulations. The database identifies spill source, substance discharged, amount of discharge, reason for spill and approximate location of occurrence within the Yukon.

Private Source Databases:

Automobile Wrecking & Supplies 2001-Jun 2010 **AUWR**

This database provides an inventory of all known locations that are involved in the scrap metal, automobile wrecking/recycling, and automobile parts & supplies industry. Information is provided on the company name, location and business type.

Chemical Register May 2004-Jun 2010 **CHEM**

This database includes a listing of locations of facilities within the Yukon that either manufacture and/or distribute chemicals.

ERIS Historical Searches 1999-Sept 2011 **EHS**

EcoLog ERIS has compiled a database of all environmental risk reports completed since March 1999. Available fields for this database include: site location, date of report, type of report, and search radius. As per all other databases, the ERIS database can be referenced on both the map and "Statistical Profile" page.

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Oil and Gas Wells **1988-2011** **OGW**

The Nickle's Energy Group (publisher of the Daily Oil Bulletin) collects information on drilling activity including operator and well statistics. The well information database includes name, location, class, status and depth. The main Nickles' database is updated on a daily basis, however, this database is updated on a monthly basis. More information is available at www.nickles.com.

Retail Fuel Storage Tanks **2000-Jun 2010** **RST**

This database includes an inventory of known fuel outlet locations (including marinas) that have on their property gasoline, waste oil, natural gas and / or gas propane storage tanks.

Scott's Manufacturing Directory **2003-Mar 2011** **SCT**

Scott's Directories is a data bank containing information on nearly 100 manufacturers in the Yukon. Even though Scott's listings are voluntary, it is the most comprehensive database of Yukon manufacturers available. Information concerning a company's address, plant size, and main products are included in this database.

Canada's Primary Environmental Risk Information Service

Project Site:	**City of Whitehorse Well Head Protection Plan** **Lewes Blvd & Nisutlin Dr** **Whitehorse, YT Y1A**
Client:	**Nicole Jacques** **Associated Engineering** **301- 4109 4Th Avenue** **Whithorse, YT Y1A 1H6**
ERIS Project No:	**20120409024**
Report Type:	**Custom Report - .25km Search Radius**
Prepared By:	**Matt Thompson** mthompson@eris.ca
Date:	**April 18, 2012**

Table of Contents

Order Number: 20120409024
Site Name: City of Whitehorse Well Head Protection Plan
Site Address: Lewes Blvd & Nisutlin Dr Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

Report Summary

Order Number: 20120409024
Site Name: City of Whitehorse Well Head Protection Plan
Site Address: Lewes Blvd & Nisutlin Dr Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

Number of Mappable Records Surrounding the Site

Database		Selected	On-site	Within 0.25	0.25km to 0.25km	Total
AIR	Air Emission Permits	Y	0	0	0	0
AUWR	Automobile Wrecking & Supplies	Y	0	0	0	0
CHEM	Chemical Register	Y	0	0	0	0
CS	Contaminated Site Inventory	Y	0	2	0	2
DMP	Designated Material Permits	Y	0	0	0	0
EHS	ERIS Historical Searches	Y	0	0	0	0
EIIS	Environmental Issues Information System	Y	0	0	0	0
FCS	Contaminated Sites on Federal Land	Y	0	0	0	0
FST	Fuel Storage Tanks	Y	0	0	0	0
HIS	Historic Sites Inventory	Y	0	0	0	0
IAFT	Indian & Northern Affairs Fuel Tanks	Y	0	2	0	2
LTF	Land Treatment Facilities	Y	0	0	0	0
MINE	Canadian Mine Locations	Y	0	0	0	0
MNR	Mineral Occurences	Y	0	0	0	0
NATE	National Analysis of Trends in Emergencies System (NATES)	Y	0	0	0	0
NDWD	National Defence & Canadian Forces Waste Disposal Sites	Y	0	0	0	0
NEBW	National Energy Board Wells	Y	0	0	0	0
NEES	National Environmental Emergencies System (NEES)	Y	0	0	0	0
NPCB	National PCB Inventory	Y	0	0	0	0
NPRI	National Pollutant Release Inventory	Y	0	0	0	0
ODS	Ozone Depleting Substances & Other Halocarbons	Y	0	0	0	0
OGW	Oil and Gas Wells	Y	0	0	0	0
PCFT	Parks Canada Fuel Storage Tanks	Y	0	0	0	0
PES	Pesticide Register	Y	0	0	0	0
REC	Waste Receivers	Y	0	0	0	0
REL	Relocation Permits	Y	0	0	0	0
RST	Retail Fuel Storage Tanks	Y	0	0	0	0
SCT	Scotts Manufacturing Directory	Y	0	0	0	0
SPL	Spills	Y	0	0	0	0
SWP	Special Waste Permits	Y	0	0	0	0
WDS	Waste Disposal Sites	Y	0	0	0	0
YOGW	Yukon Oil and Gas Wells	Y	0	0	0	0
		TOTAL	0	4	0	4

The databases chosen by the client as per the submitted order form are denoted in the 'Selected' column in the above table. Counts have been provided outside the primary buffer area for cursory examination only. These records have not been examined or verified, therefore, they are subject to change.

SITE DIAGRAM

ECOLOG ERIS
Pinpointing Your Environmental Risks
12 Concorde Pl, Suite 800 North York, ON M3C 4J2
416-510-5204

Project Property: City of Whitehorse Well Head Protection Plan
Lewes Blvd & Nisutlin Dr
Whitehorse, YT
Y1A

ERIS Project #: 20120409024

Date: APR-18-2012

LEGEND

- Project Area
- Database Location

Points of Interest
- Chimney
- Silo

Pipe & Transmission Lines
- Pipeline
- Transmission Line
- Transmission Tower
- Transformer Station

Rail
- Railway - Main
- Railway - Sidetrack
- Railway - Abandoned
- Bridge
- Tunnel

Transportation - Other
- Embankment
- Trail
- Runway

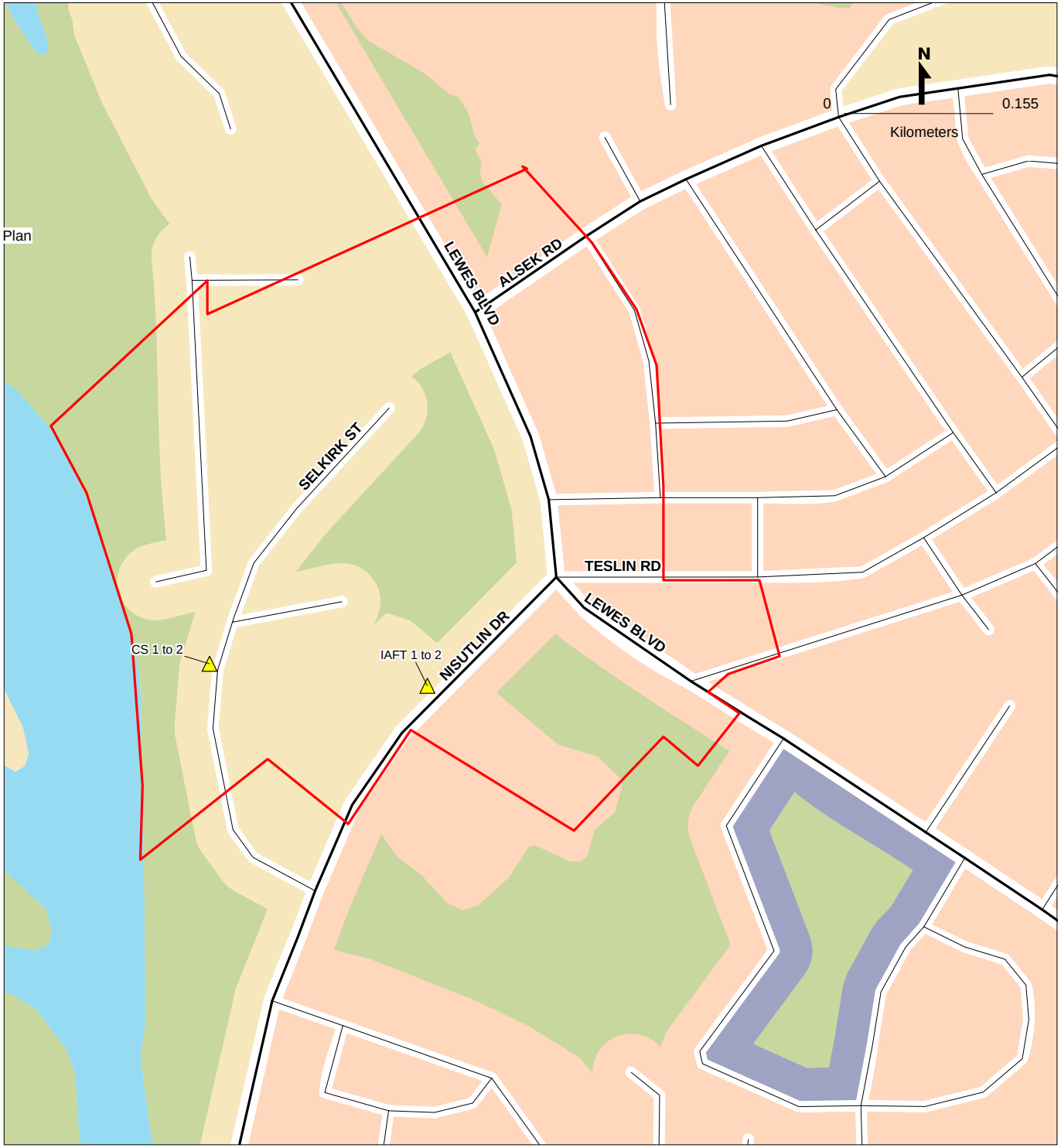
Hydrographic Features
- Permanent Waterway
- Intermittent Waterway
- Open Reservoir
- Dyke/Levee
- Dam
- Breakwall
- Wetland

Landuse Classifications
- Open Area
- Residential
- Commercial
- Resource and Industrial
- Government and Institutional
- Parks and Recreational
- Waterbody

Recreation
- Golf Course/Driving Range
- Park/Sports Field
- Other Recreation Area
- Sports/Race Track
- Cemetery
- Campground

Vegetation
- Wooded Area
- Orchard
- Vineyard

Industrial Resources
- Conveyor
- Crane: Moveable
- Crane: Stationary
- Tank
- Rock Cut
- Auto Wrecker
- Lumber Yard
- Pit



This diagram is to be used solely for relative street location purposes. It may not accurately portray street or site positions.

Site Report

Order Number: 20120409024
Site Name: City of Whitehorse Well Head Protection Plan
Site Address: Lewes Blvd & Nisutlin Dr Whitehorse, YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

FOR COMPLETE INFORMATION, REFER TO DETAIL REPORT

A search has been conducted for this site (address) and company name. No records were found, within the database(s) selected, that meet either of these criteria.

Detail Report

Order Number: 20120409024
Site Name: City of Whitehorse Well Head Protection Plan
Site Address: Lewes Blvd & Nisutlin Dr Whitehorse YT Y1A
Report Type: Custom Report, 0.25 km Search Radius

If information is required for sites located beyond the selected address, please contact your ERIS representative.

Air Emission Permits

Contaminated Site Inventory

Fuel Storage Tanks

Indian & Northern Affairs Fuel Tanks

National Environmental Emergencies System (NEES)

Spills

Air Emission Permits

Map Key	Company	Address	Permit No.	Permit Type	Status	Expiry Date
n/a	Yukon Electrical Company Limited	Diesel Generating Plants, WL, Old Crow, Pelly, Carmacks, Ross River, HJ, Teslin Whitehorse	4201-60-012 **Permit For:** **Mail Address:** Whitehorse	Air Emissions (60)		31-Dec-08

Contaminated Site Inventory

Map Key	Company	Address	Land Use	Land Tenure	Water Use
CS-1	Selkirk Elementary School	5 Selkirk Street Whitehorse Y1A 3J5	**Contaminants:** **Estimated Quantity:** **Loc. Contaminants:** **Summary:** **Legal Description:** **Site File No:**		
CS-2	Selkirk Elementary School	5 Selkirk Street Whitehorse Y1A 3J5	**Contaminants:** **Estimated Quantity:** **Loc. Contaminants:** **Summary:** **Legal Description:** **Site File No:**	 Lot 1150, Quad 105D/11	

Fuel Storage Tanks

Map Key	Company	Address	Date Issued	Permit Number	# Tanks/Type	Tank Size	Product
n/a	Government of Yukon	School - 120 Nisutlin Drive, Whitehorse	Aug.15, 2000	00006	1 UST	Unknown - Abandonment	
			Legal Description:	Lot 349, Grp. 804, Plan 23261			

Indian & Northern Affairs Fuel Tanks

Map Key	Company	Address	Site No.	Installed Date	Owner/Operator	Reserve Name
IAFT-1	Council for Yukon FN Admin Office	11 Nisutlin Drive Whitehorse Y1A 3S4		1998	INAC	
			Facility Type:	Office		
			Tank Type:	AST		
			Tank Desc:	Operating tank for heating		
			Tank No:			
			Tank Material:			
			Contents:	Heating fuel / furnace oil		
			Capacity:	9,400 litres		
			Current Status:	Active		
IAFT-2	Council for Yukon FN Admin Office	11 Nisutlin Drive Whitehorse Y1A 3S4		1968	INAC	
			Facility Type:	Office		
			Tank Type:	AST		
			Tank Desc:	Operating tank for heating		
			Tank No:			
			Tank Material:			
			Contents:	Heating fuel / furnace oil		
			Capacity:	22,730 litres		
			Current Status:	Removed		

National Environmental Emergencies System (NEES)

Map Key	Company	Address	Incident Date	Contaminant
n/a		Yukon River under Bridge Parkside (Lewes Blvd) Whitehorse	10/26/00 14:30	
			Amount:	
			Units:	
			Quantity:	
			Cause:	Unknown
			Source:	Unknown
			Reason:	Unknown
			Sector:	Unknown

Spills

Map Key	Company	Address	Spill Date	Sector	Substance	Amount	Source
n/a		Lewes Blvd. & Nesutlen Dr. Whitehorse	26-May-94		Oil	15 Litres	unkown
			Cause:	unkown			
			Reason:	oil & water found at north side of crosswalk			
n/a		Nesutlen Dr. & Selkirk St. Whitehorse	09/04/95		unkown	unknown	Nesutlen Drive Storm Sewer
			Cause:	Dumped			
			Reason:	sediments from Lewes Market Parking Lot flushed			

Appendix: Yukon Database Descriptions

EcoLog Environmental Risk Information Services Ltd can search the following databases. The extent of historical information varies with each database and current information is determined by what is publicly available to EcoLog ERIS at the time of update. **Note:** Databases denoted with "*" indicates that the database will no longer be updated. See the individual database descriptions for more information.

Territorial Government Source Databases:

Air Emission Permits **1998-May 2011** **AIR**

The Department of Renewable Resources maintains a database of companies/organizations who have acquired a permit under the "Air Emissions Regulation", for the operation of the following types of activities. These include the manufacturing of asphalt; production and exploration of oil and natural gas; quarrying, crushing and screening of stone/clay/ shale /coal/ minerals; processing or handling of coal; equipment capable of generating/burning/using heat energy; use of incinerators; the use of equipment for incineration of special waste; electrical generating facilities; and the storage/other handling of solid, liquid or gaseous materials. The database provides information pertaining to the permit number, expiry date, status and the type of permit.

Designated Material Permits **July 2003-May 2011** **DMP**

The Designated Material Regulations, under the Yukon Environment Act, mandates that anyone who is a retailer or depot operator of "designated materials" must obtain a permit. Where a depot operator has acquired a Solid Waste permit and it addresses the deport location, a designated materials permit is not required. As of May 2004, only tires are considered "designated materials". The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Fuel Storage Tank **1997-Sept 2001** **FST**

The Yukon Department of Renewable Resources maintains an inventory of fuel storage tanks within the Territory. The tanks are registered to the department pursuant to Storage Tank Regulations, Environment Décret 1996/194 with permits. The Storage Tank Regulations came into effect on January 1, 1997. The regulations include requirements for the storage of hazardous substances, including petroleum products, pursuant to Part 10 of the Environment Act. This database applies to new tanks that are being installed or constructed; and existing tanks that undergo major renovations after January 1, 1997. Fuel storage tanks not found in this database include: those that have a capacity of 4,000 litres or less and are used to supply comfort heating systems; tanks that are used to store crude oil, and tanks used for aboveground storage of hazardous substances (other than petroleum products) with a capacity of less than 2000 litres.

Historic Sites Inventory **1987-Aug 2002** **HIS**

The Heritage Branch of the Yukon government maintains an inventory of all historic sites within the Territory. The database provides information on history, condition, ownership, location, resource type, and date of construction. Please note that even though the inventory was initiated in 1987, the database does contain records where the date of construction of a historic site was previous to 1895.

Land Treatment Facilities **2002-May 2011** **LTF**

The Yukon's Contaminated Sites Regulation mandates that permits must be acquired for the construction and operation of Land Treatment Facilities - for the purpose of restoring and rehabilitating contaminated soil, sediment, snow or other similar media. The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Mineral Occurrences **1900-May 2009** **MNR**

The Yukon Geology Program maintains an inventory of 2577 separate mineral occurrences in the Yukon, which document metallic, industrial mineral and coal deposits. Information within the database pertains to owner/operator, year, name, claim name, status, deposit type, mining district, tectonic element and commodity.

Ozone Depleting Substances & Other Halocarbons **1998-May 2011** **ODS**

The Yukon's Ozone Depleting Substances & Other Halocarbon (ODS) Regulations regulate the handling, use and sale of Ozone Depleting Substances (ODS) in the Yukon. The release of ODS's are prohibited, with certain exemptions found in s.2(2) of the Regulations. Ozone depleting substances are considered to be CFC's, Halons, Chlorocarbon compounds and Hydrochlorofluorocarbons. Other Halocarbons refer to Hydrofluorocarbons and Perfluorocarbons. The provincial inventory provides information on the registered facility, location, permit number, status and expiry date.

Pesticide Register **1998-May 2004** **PES**

This is a database of individuals who apply for a "service", "vendor" or "usage" license for those specific pesticides and fertilizers that require a permit. The database is maintained by the Department of Renewable Resources, and provides information pertaining to the permit number, expiry date, status and the type of permit.

Waste Receivers **1997-July 2002** **REC**

The Department of Renewable Resources maintains a "Waste Manifest" which details information regarding waste transfers from generating facilities to registered Receivers. The provincial inventory provides information on the waste receiving facility name, location, physical state (solid/liquid), waste type, amount/quantity received and the degree of danger.

Relocation Permits **May 2004-May 2011** **REL**

The Yukon's Contaminated Sites Regulation mandates that permits must be acquired in order to move contaminated material from one site to another. The provincial inventory provides information on the registered facility, location, permit number, permit type, and status.

Special Waste Permits **1998-May 2011** **SWP**

The Special Waste Regulations, under the Yukon Environment Act, mandate that anyone who generates, stores, handles, mixes, transports, disposes or releases special wastes is to acquire a "Special Waste" permit. Permits are required for both special waste generators and special waste facilities. The provincial inventory provides information on the generating/waste receiving facility, location, permit number, permit type (generator, facility), status and types of waste generated/received.

Waste Disposal Site Inventory **2000-May 2011** **WDS**

This inventory pertains to active, regulated waste disposal sites within the Yukon, where registered sites hold a permit for acceptance of different forms of solid waste. This database provides information in regard to permit number, type of waste accepted, status and permit type. Please note that references within the database to SPW and AER, are in regard to the Special Waste Regulation and Air Emissions Regulation respectively.

Yukon Oil and Gas Wells **April 1957-July 2002*** **YOGW**

The Yukon Oil and Gas Resources Branch is responsible for maintaining a database of all oil and gas wells drilled in the Yukon. All well locations were provided by the National Energy Board and verified through branch field inspections. Please note that as of May 1991, no new wells have been drilled in the territory. The database details information on well owner/operator, well name, location, drill date, well id, status, elevation, class, and depth of the well.

Federal Government Source Databases: **Diagram Identifier:**

Contaminated Site Inventory **1998-May 2011** **CS**

Yukon INAC Contaminated Sites Inventory is an inventory of sites of potential environmental concern compiled by Indian and Northern Affairs Canada. These sites on this inventory may or may not be contaminated and some might also be sites with solid waste/debris, old mining structures, etc. Inclusion on this list should not be taken as confirmation of contamination. Similarly, sites not included on this list should not be assumed to be free of contamination. For information on any of the sites listed below, contact the Environmental Programs Branch.

Environmental Issues Inventory System **1992-2001*** **EIIS**

The Environmental Issues Inventory System was developed through the implementation of the Environmental Issues and Remediation Plan. This plan was established to determine the location and severity of contaminated sites on inhabited First Nation reserves, and where necessary, to remediate those that posed a risk to health and safety; and to prevent future environmental problems. The EIIS provides information on the reserve under investigation, inventory number, name of site, environmental issue, site action (Remediation, Site Assessment), and date investigation completed.

Contaminated Sites on Federal Land **June 2000-Jan 2012** **FCS**

The Treasury Board of Canada Secretariat maintains an inventory of all known contaminated sites held by various Federal departments and agencies. This inventory does not include properties owned by Crown corporations, but does contain non-federal sites for which the Government of Canada has accepted some or all financial responsibility. All sites have been classified through a system developed by the Canadian Council of Ministers of the Environment. The database provides information on company name, location, site ID #, property use, classification, current status, contaminant type and plan of action for site remediation.

Indian & Northern Affairs Fuel Tanks **1950-Aug 2003** **IAFT**

The Department of Indian & Northern Affairs Canada (INAC) maintains an inventory of all aboveground & underground fuel storage tanks located on both federal and crown land. Our inventory provides information on the reserve name, location, facility type, site/facility name, tank type, material & ID number, tank contents & capacity, and date of tank installation.

National Analysis of Trends in Emergencies System (NATES) **1974-1994*** **NATE**

In 1974 Environment Canada established the National Analysis of Trends in Emergencies System (NATES) database, for the voluntary reporting of significant spill incidents. The data was to be used to assist in directing the work of the emergencies program. NATES ran from 1974 to 1994. Extensive information is available within this database including company names, place where the spill occurred, date of spill, cause, reason and source of spill, damage incurred, and amount, concentration, and volume of materials released.

National Defence & Canadian Forces Waste Disposal Sites **2001-April 2007** **NDWD**

The Department of National Defence and the Canadian Forces maintains an inventory of waste disposal sites located on DND lands. Where available, our inventory provides information on the base name, location, type of waste received, area of site, depth of site, year site opened/closed and status.

National Energy Board Wells **1920-June 2007** **NEBW**

The NEBW database contains information on onshore & offshore oil and gas wells that are outside provincial jurisdiction(s) and are thereby regulated by the National Energy Board. Data is provided regarding the operator, well name, well ID No./UWI, status, classification, well depth, spud and release date.

National Environmental Emergencies System (NEES) 1974-2003 **NEES**

In 2000, the Emergencies program implemented NEES, a reporting system for spills of hazardous substances. For the most part, this system only captured data from the Atlantic Provinces, some from Quebec and Ontario and a portion from British Columbia. Data for Alberta, Saskatchewan, Manitoba and the Territories was not captured. However, NEES is also a repository for all previous Environment Canada spill datasets. NEES is composed of the historic datasets – or Trends – which dates from approximately 1974 to present. **NEES Trends** is a compilation of historic databases, which were merged and includes data from NATES (National Analysis of Trends in Emergencies System), ARTS (Atlantic Regional Trends System), and NEES. In 2001, the Emergencies Program determined that variations in reporting regimes and requirements between federal and provincial agencies made national spill reporting and trend analysis difficult to achieve. As a consequence, the department has focused efforts on capturing data on spills of substances which fall under its legislative authority only (CEPA and FA). As such, the NEES database will be decommissioned in December 2004.

National PCB Inventory 1988-2008 **NPCB**

Environment Canada's National PCB inventory includes information on in-use PCB containing equipment in Canada including federal, provincial and private facilities. All federal out-of-service PCB containing equipment and all PCB waste owned by the federal government or by federally regulated industries such as airlines, railway companies, broadcasting companies, telephone and telecommunications companies, pipeline companies, etc. are also listed. Although it is not Environment Canada's mandate to collect data on non-federal PCB waste, the National PCB inventory includes some information on provincial and private PCB waste and storage sites.

National Pollutant Release Inventory 1993-2009 **NPRI**

Environment Canada has defined the National Pollutant Release Inventory ("NPRI") as a federal government initiative designed to collect comprehensive national data regarding releases to air, water, or land, and waste transfers for recycling for more than 300 listed substances.

Parks Canada Fuel Storage Tanks 1920-Jan 2005 **PCFT**

Canadian Heritage maintains an inventory of all known fuel storage tanks operated by Parks Canada, in both National Parks and at National Historic Sites. The database details information on site name, location, tank install/removal date, capacity, fuel type, facility type, tank design and owner/operator.

Spills 1972-2000 **SPL**

Environment Canada maintains an inventory of known spills that have occurred throughout the Yukon and are reported under the Yukon Spills Regulations. The database identifies spill source, substance discharged, amount of discharge, reason for spill and approximate location of occurrence within the Yukon.

Private Source Databases:

Automobile Wrecking & Supplies 2001-Jun 2010 **AUWR**

This database provides an inventory of all known locations that are involved in the scrap metal, automobile wrecking/recycling, and automobile parts & supplies industry. Information is provided on the company name, location and business type.

Chemical Register May 2004-Jun 2010 **CHEM**

This database includes a listing of locations of facilities within the Yukon that either manufacture and/or distribute chemicals.

ERIS Historical Searches 1999-Sept 2011 **EHS**

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From: McLeod, Jim <Jim.McLeod@whitehorse.ca>
To: Marta Green
Cc: Steven Bartsch
Sent: Thu Mar 22 12:05:34 2012
Subject: Background Info

633 4255

100

-
- 3 1950 1960
-

-
-

-

1940

ames D. McLeod . .T.
Engineering Projects Officer

Engineering and Environmental Services

ity of Whitehorse
Bus: 867-668-8667

Fax: 867-668-8386
www.whitehorse.ca

From: Bethany.Peters@gov.yk.ca [mailto:Bethany.Peters@gov.yk.ca]
Sent: Tuesday, May 22, 2012 4:01 PM
To: Tuck, Wayne
Cc: Bryan.Levia@gov.yk.ca
Subject: RE: Whitehorse Riverdale Aquifer - Contaiminated site at Selkirk School

Hi Wayne,

I have attached the 1999 report that details the excavation of the fuel spill, for your information. (Within the report is a figure that shows the location of the spill.) The report erroneously states that “no significant risk to the environment or to human health remains at this site, and no further action is required.” While it is true that the surface contamination was removed when the soil was excavated, the full extent of contamination is unknown. The base of the excavation exceeded applicable CSR standards for LEPH, ethylbenzene, toluene and xylenes. The report notes that further excavation of contaminated material would have been difficult with the available equipment; no rationale was provided for not obtaining more suitable equipment to continue the investigation.

Furthermore, a sewer pipeline was discovered in the vicinity of the spill, and efforts should have been made to determine if the pipeline acted as a lateral conduit for contamination. Without proper sampling of the bedding sand and the area around the sewer pipe, the full vertical and horizontal extent of contamination remains unknown. Without proper delineation, I cannot answer your question about how large an area of contamination remains, or the extent of contamination remaining after 12 years of natural attenuation.

Considering this file dates back to 1999 and has not been updated since then, I do not believe there are any new plans for additional remediation. Thus, the site remains on our registry of contaminated sites. The report was prepared for Property Management Agency in 1999; you may wish to contact PMA to inquire if any further work was conducted in response to the spill.

Please let me know if you have any further questions about the report or the site.

Best,

Environmental Protection Analyst
8
867 667 8848 867 393 6205

-----Original Message-----
From: Tuck, Wayne [mailto:Wayne.Tuck@whitehorse.ca]
Sent: Tuesday, May 15, 2012 3:46 PM
To: Bethany.Peters
Cc: 'Marta Green'; 'Jim McLeod'
Subject: RE: Whitehorse Riverdale Aquifer - Contaiminated site at Selkirk School

From: Bethany.Peters@gov.yk.ca [mailto:Bethany.Peters@gov.yk.ca]
Sent: Tuesday, May 15, 2012 3:35 PM
To: Tuck, Wayne
Cc: Heather.Badry@gov.yk.ca; Bryan.Levia@gov.yk.ca
Subject: RE: Whitehorse Riverdale Aquifer - Contaminated site at Selkirk School

Hi Wayne,

I just spoke with Bryan Levia regarding the site, as it is a spills file. He has requested Records Centre to pull the file, as it is currently archived. From the contaminated sites registry summary document on the property, I understand that there was a heating oil spill at the Teen Parent Centre located adjacent to the Selkirk School in 1998. Complete remediation did not occur. However, I would like to review the spills file in its entirety, and get back to you with any other relevant details.

As you noted, FH Collins is also part of the same legal address (Lot 1150). We also have information on file regarding contamination adjacent to the FH Collins' boiler room, where a spill occurred along the outside exterior wall. (A UST containing heating fuel leaked through the vent pipe; total volume unknown). Soil sampling (2008) after remediation indicated the contaminated soil remained at the site but further work was deferred to summer 2009 due to frozen ground conditions. No further information is on file indicating the current status of the remediation. Thus, the area is still considered contaminated.

I will follow up regarding the Teen Parent Centre file review and get back to you. Let me know if you have any other questions,

Environmental Protection Analyst
8
867 667 8848 867 393 6205

-----Original Message-----
From: Heather.Badry
Sent: Tuesday, May 15, 2012 2:10 PM
To: Bethany.Peters
Subject: FW: Whitehorse Riverdale Aquifer - Contaiminated site at Selkirk School

Hi Beth,

I seem to recall that you did an info request on this recently. If that is the case, would you mind responding to Wayne?

Heather Badry
Contaminated Sites Coordinator
Environment Yukon
Ph: 867-667-8816 Fax: 867-393-6205
Email: heather.badry@gov.yk.ca
http://environmentyukon.gov.yk.ca/contaminatedsites

From: Tuck, Wayne [mailto:Wayne.Tuck@whitehorse.ca]
Sent: Tuesday, May 15, 2012 1:57 PM
To: Bryan.Levia; Heather.Badry
Subject: Whitehorse Riverdale Aquifer - Contaiminated site at Selkirk School

Wayne H. Tuck P. ng.

ity of Whitehorse
Bus: 867-668-8306

Fax: 867-668-8386
www.whitehorse.ca

" tim s a a lt o a i l o lo spai o t t o t ma a — H. G. Wells, 1904

From: Marta Green [mailto:mg@summit-environmental.com]
Sent: Tuesday, May 15, 2012 12:46 PM
To: Tuck, Wayne
Subject: RE: Well 3N - Meeting Tuesday morning or Wednesday afternoon?

- Selkirk Elementary School (5 Selkirk Street, Lot 1150 Quad 105D/11, 98-47 LTO YT): diesel heating oil spill at the Teen Parent Centre located adjacent to Selkirk School; majority of contaminated soil was excavated and removed but base of excavation still had soil above CSR standards when it was backfilled. Site remains classified as contaminated.

Regards,

Marta Green, B.Sc., P.Geo.
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Fax: 250.545.3654

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Hi Nicole,

I found one additional site in Riverdale:

- 22 Tay Street: heating fuel tank leak (2001); excavation and relocation of 10m^3 soil occurred, but some contaminated material was left in place to avoid undermining the structural integrity of the building footings. A venting pipe was installed, but no final confirmatory samples were obtained to confirm that the venting successfully remediated the remaining contaminated soil.

Cheers,

Environmental Protection Analyst
8
867 667 8848 867 393 6205

-----Original Message-----
From: Nicole Jacques [mailto:nrj@summit-environmental.com]
Sent: Tuesday, May 22, 2012 4:41 PM
To: Bethany.Peters
Subject: Riverdale Contaminated Sites Search?

Hi Bethany, we have recently expanded our area of concern for a project we are doing. We are now interested in identifying Contaminated sites and Spills in all of Riverdale. So far, I have the following:

Contaminated Sites

- FH Collins (Lot 1150 Quad 105D/11, 98-47 LTO YT) is a contaminated site on file due to a spill adjacent to the FH Collins' boiler room, along the outside exterior wall. (A UST containing heating fuel leaked through the vent pipe; total volume unknown). Soil sampling (2008) after remediation indicated the contaminated soil remained at the site but further work was deferred to summer 2009 due to frozen ground conditions. No further information is on file indicating the current status of the remediation. Thus, the area is still considered contaminated.
- Selkirk Elementary School (5 Selkirk Street, Lot 1150 Quad 105D/11, 98-47 LTO YT): diesel heating oil spill at the Teen Parent Centre located adjacent to Selkirk School; majority of contaminated soil was excavated and removed but base of excavation still had soil above CSR standards when it was backfilled. Site remains classified as contaminated.
- 88-100 Lewes Blvd (Condominium 2, 65999 LTO YT): approximately 1000L heating fuel spilled due to a broken line; not all contaminated soil could be removed from the site due to the presence of surrounding structures. Environmental consultant recommended in-situ remediation; it is unknown if this was implemented. No final restoration report was submitted to the YG-Environment to confirm that all contaminated material was successfully treated, thus site remains contaminated.
- 18 Stewart Road: heating fuel spill (2011) caused by vandalism. Most contaminated soil was excavated and relocated to land treatment facility, but some remaining contaminated soil was to be treated in-situ. No final restoration report has been submitted to the Branch, thus site remains contaminated.
- Grey Mountain Primary School (186 Alsek Road, Block 248, 42713 LTO YT): heating oil leak was discovered in basement crawlspace of school; some contaminated soil was excavated and relocated. No confirmatory samples were obtained to delineate extent of contamination and provide confirmation that all contaminated material was successfully removed, thus site remains classified as contaminated.
- 6 Morley Road (Lot 34 Block 229 32574 LTO YT): heating fuel leak in 2008; relocation permit obtained and estimated 10m3 contaminated soil was relocated. No confirmatory samples were obtained, thus site remains classified as contaminated.
- Whitehorse General Hospital (former steam plant) (Lot 1127 Quad 105D/11 94-80 LTO YT): during the removal of 2 USTs contaminated soil was discovered. Much of the contaminated material was excavated; however soil on the eastern side of the excavation could not be removed due to the presence of surrounding infrastructure. Extent of contaminated material left on site is unknown.

Spills:

- Lewes Blvd and Nisutlin Drive: 15 L of oil and water was observed at the north site of the sidewalk on May 26, 1994.
- Chadburn Lake: fuel sheen was observed under a rock on the shores on August 6, 1993.
- 20 Klondike Road apartment C: spill report (2009) of vehicle leaking antifreeze.

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Site 1

Flight Line: A10563
Photo Number: 28
Year: 1946
Scale: 1:30000

Flight Line: A13476
Photo Number: 194
Year: 1952
Scale: 1:20000

Flight Line: A18097
Photo Number: 70
Year: 1963
Scale: 1:10000

Flight Line: A18878
Photo Number: 63
Year: 1965
Scale: 1:15000

Flight Line: A37359
Photo Number: 90
Year: 1976

Flight Line: 128
Photo Number: 260
Year: 1981
Scale: 1:10000

Flight Line: A28473
Photo Number: 81
Year: 2001
Scale: 1:10000

Site 2

Flight Line: A12788
Photo Number: 97
Year: 1950
Scale: 1:15000

Flight Line: A18097
Photo Number: 68
Year: 1963
Scale: 1:10000

Flight Line: A20992
Photo Number: 48
Year: 1969
Scale: 1:20000

Flight Line: NW95871
Photo Number: 44
Year: 1971
Scale: 1:25000

Flight Line: A37359
Photo Number: 90
Year: 1976

Flight Line: 128
Photo Number: 259
Year: 1981
Scale: 1:10000

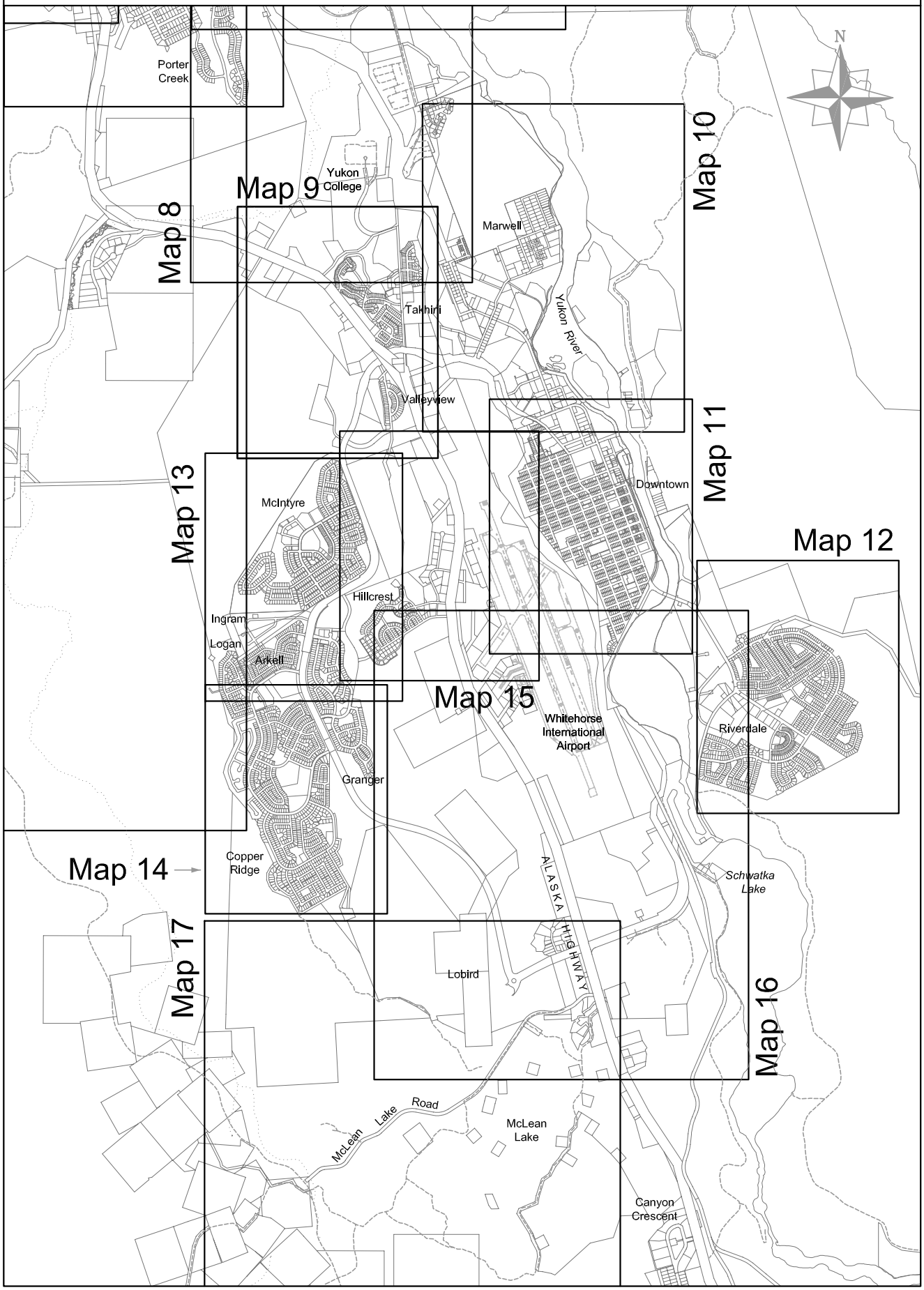
Flight Line: A27856
First Photo Number: 137
Last Photo Number: 170
Year: 1992

Flight Line: A28473
Photo Number: 80
Year: 2001
Scale: 1:10000

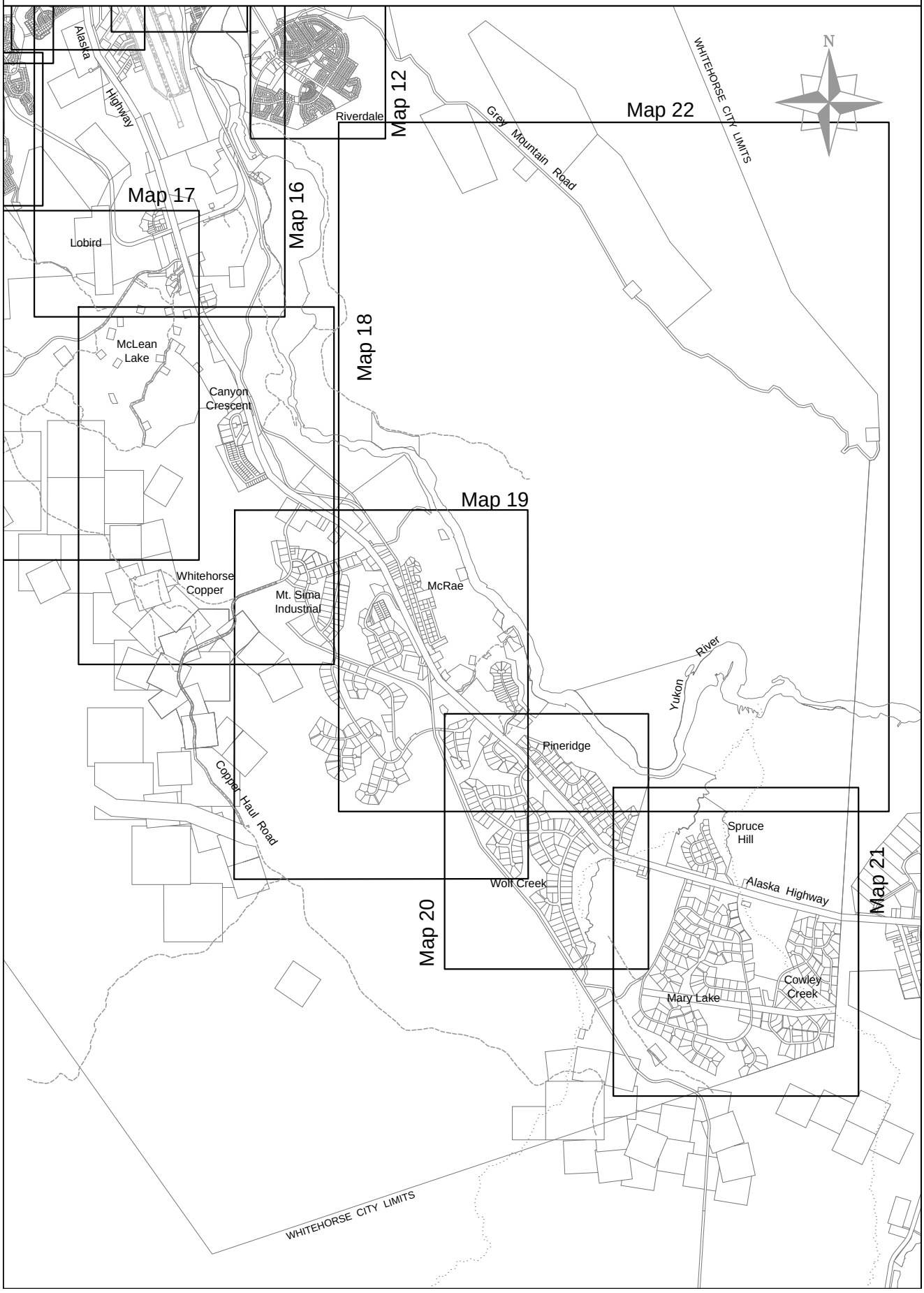
K Appendix K - Zoning Maps

List of Maps

CENTRAL INDEX MAP



SOUTH INDEX MAP



Zone Abbreviations

Section 9 Residential Zones

9.1	RA	Residential Alternative
9.2	RC1	Country Residential 1
9.3	RC2	Country Residential 2
9.4	RCM	Comprehensive Residential Multiple Family
9.5	RCM2	Comprehensive Residential Multiple Family 2
9.6	RCS	Comprehensive Residential Single Family
9.7	RCS2	Comprehensive Residential Single Family 2
9.8	RCT	Comprehensive Residential Townhouses
9.9	RD1	Residential Downtown 1
9.10	RD2	Residential Downtown 2
9.11	RM	Residential Multiple Housing
9.12	RP	Residential Mobile Home Park
9.13	RR	Restricted Residential Detached
9.14	RS	Residential Single Detached

Section 10 Commercial Zones

10.1	CC	Core Commercial
10.2	CCC	Commercial/Community Centre
10.3	CH	Highway Commercial
10.4	CIM	Mixed Use Commercial/Industrial
10.5	CM1	Mixed Use Commercial
10.6	CM2	Mixed Use Commercial 2
10.7	CMW	Commercial Mixed Use Waterfront/Motorways
10.8	CN	Neighbourhood Commercial
10.9	CNC	Comprehensive Neighbourhood Commercial
10.10	CPG	Commercial Parking Garage
10.11	CR	Commercial Recreation
10.12	CS	Service Commercial
10.13	CW	Commercial Waterfront

Section 11 Industrial Zones

11.1	IA	Airport
11.2	IH	Heavy Industrial
11.3	IQ	Quarries
11.4	IS	Service Industrial

Section 12 Public/Institutional Zones

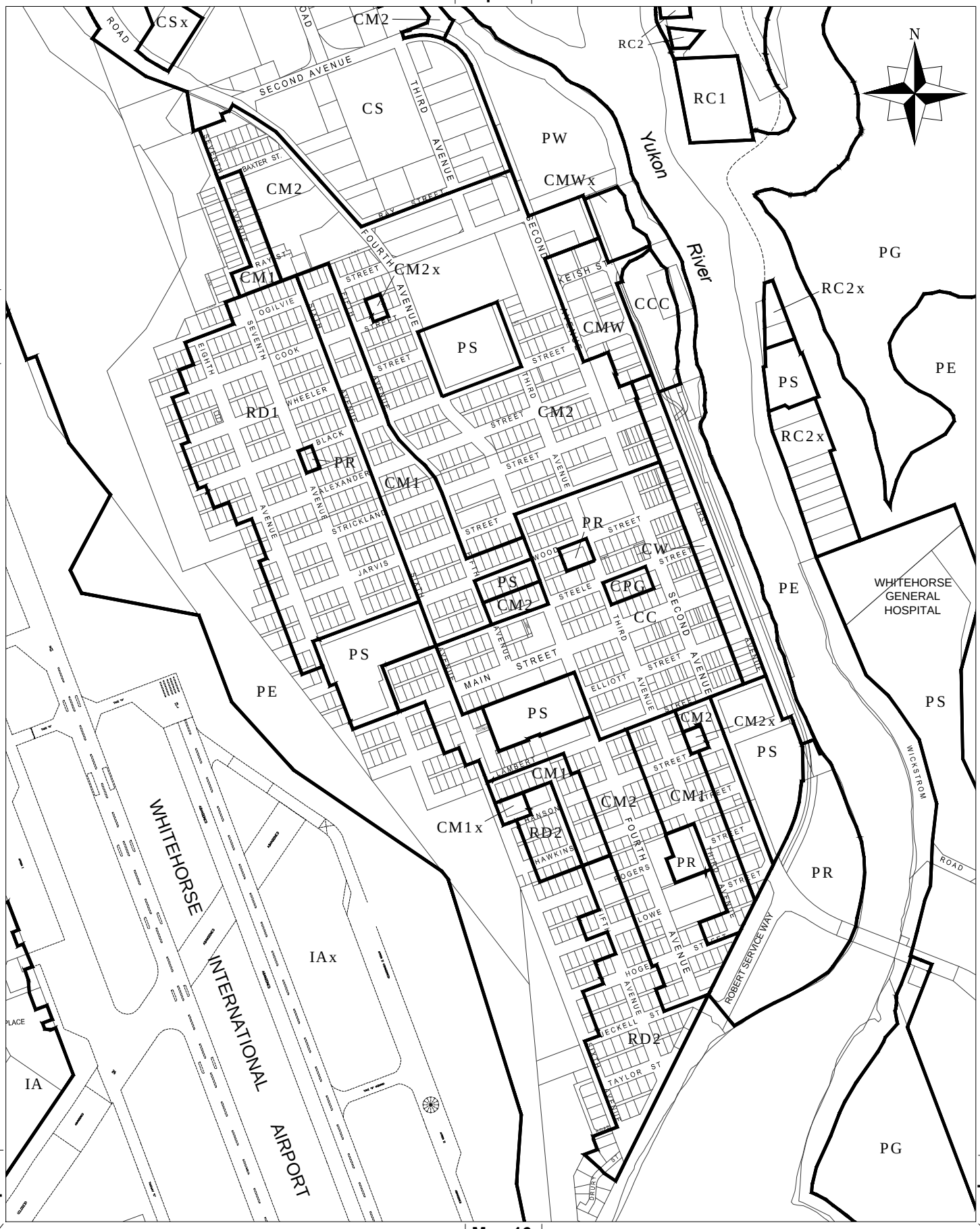
12.1	PE	Environmental Protection
12.2	PG	Greenbelt
12.3	PR	Parks and Recreation
12.4	PS	Public Services
12.5	PU	Public Utilities
12.6	PW	Public Waterfront

Section 13 Other Zones

13.1	FD	Future Development
13.2	UR	Undesignated Rural

DOWNTOWN

MAP 11



May 27, 2011

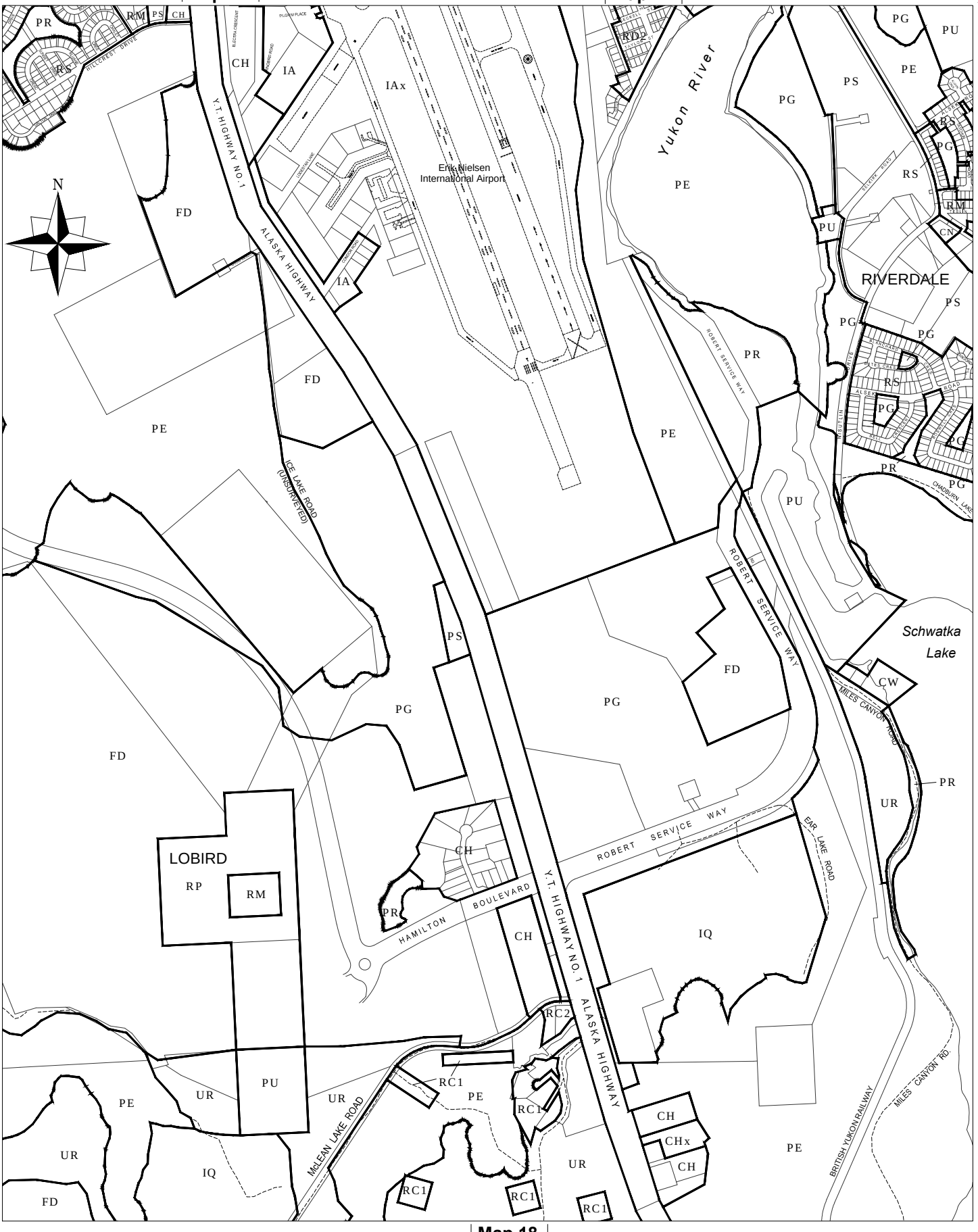
MAP 12

RIVERDALE

May 27, 2011

MAP 16

AIRPORT, LOBIRD
ROBERT SERVICE WAY



May 27, 2011